

FACTORS AFFECTING COFFEE (*COFFEA ARABICA* L.) QUALITY IN EHTIOPIA: A REVIEW.

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Abstract

Coffee(*Coffea arabica* L.) is the most important agricultural commodity and beverage enjoyed throughout the world. In Ethiopia, about 25 % of the total populations of the country are dependent on production, processing, distribution and export of coffee. Besides genetic and environmental factors, the range of cares taken from field to cupping can affect coffee quality. Different studies were conducted to determine those factors. Therefore, the objective of this review is to assess previous work on factors that affect quality of coffee in Ethiopia and to know the research gap on quality of coffee. Cup 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), processing systems (post harvest factors), storage conditions, industrial processing, preparation of the beverage and taste of the consumer. The environment has also a strong influence on coffee quality. Pests and diseases attacks can affect the cherries directly or cause them to deteriorate by debilitating the plants, which will then produce immature or damaged fruits. There is a need of conduct research to specify which quality of coffee is affect by those pests and diseases. Processing and storage is a very important activity in coffee production and plays a crucial role in quality determination. Coffee is either processed by the wet or dry methods. Since researches indicated that wet processing method is high in quality, the MoA have to encourage using this method of processing. Storage is one of the most important and crucial stage in processing of any agricultural commodity. Post-harvest procedures and the physiology of the plant itself affect coffee quality. Farmer's perception has also its own role on desirable quality of coffee.

Keywords: Coffee, *Coffea arabica*, Factors, Quality, Ethiopia.

INTRODUCTION

Coffee (*Coffea arabica* L.) is the most important agricultural commodity and beverage enjoyed throughout the world and worth up to US \$ 14 billion annually for producing country. More than 18 countries, including Ethiopia, cultivate coffee, which is exported as raw, roasted or soluble product to more than 165 countries worldwide providing a livelihood for an estimate of some 100 million people around the world (ICO, 2001). Many countries are involved in coffee production, trade, communication and it is estimated that, more than 125 countries export and re-export coffee products. In addition, more than 50 developing countries are earning 25 % of their foreign exchange from coffee (ITC, 2002).

Ethiopia remains the largest producer of coffee in Africa and is the fifth largest coffee producer in the world next to Brazil, Vietnam, Colombia, and Indonesia, contributing about 4.2 percent of total world coffee production. Ethiopia is the birthplace of Coffee Arabica and mostly produces this variety. Coffee has economic, environmental as well as social significance to the country (Abu and Teddy, 2010).

Coffee grows at various altitudes, ranging from 550 to 2750 meters above sea level. However, *arabica* is best thrives and produced between altitudes of 1300 and 1800 meters above sea level with annual rainfall amount ranging from 1500 to 2500 mm with an ideal minimum and maximum air temperatures of 15 and 25°C, respectively. But, for extremes and some cases, it grows up to 550 meter above sea level (like Bebeke) and in areas where annual rainfall ranges from 1000 to 2000 mm (CTA, 1999; Bayetta, 2001).

The total area covered by coffee in Ethiopia is about 600,000 hectares, with a total of annual coffee production ranges from 300,000-350,000 tones, which is about 600 kg ha⁻¹. Out of this, more than 90 % of the coffee is produced by small-scale subsistent farmers, while the remaining comes from private and government

owned large-scale farmers (Workfes and Kassu, 2000; MoARD, 2008).

Since coffee becomes today's one of the leading marketable commodity next to oil, qualified professionals are seriously investigating the quality of coffees, because they know that the district flavors and character of coffee to safeguard consumers demand and interest beside today's market challenge. For example, the specialty markets of coffee are paying the premium price for the specialty preparation of coffee keeping its original types. In this regard, quality is a must that one can observe as a raw (green appearance), cup quality (smell the aroma, evaluate the body and perceive taste, flavor) and overall quality standard. Indeed, assessment of organoleptic quality is an extremely demanding exercise (Leroy *et al.*, 2006). That is, it is obviously important knowing the geographic and specific botanical origin of coffee for the purpose of fair international trade. This is because the origin can be used either alone or in blend imparts to the finished products on its unique sensory characteristics. Furthermore, premium price has been paid for certain origins, which also often stated on the label of coffee product (Prodoliet, 2004). Based on the extreme demand for coffee quality to the character of those origins (types): Yirgacheffee and Sidama brands are now internationally recognized and registered as property right to Ethiopia with their distinct character/flavor and taste (IPO, 2008). In addition, to expand export market and for sustainable utilization of the immense genetic diversity, keeping the coffee quality is a serious issue to compete and sustain in the competitive market (IPO, 2008; Dessie *et al.*, 2008).

Ethiopia exports its coffee based on their areas of origin (type), which are known for their own distinct quality and agronomic characters (MoARD, 2008). The development of local landraces for

each locality largely based on their yield performance and resistance to major diseases like coffee berry disease (CBD) and quality would help to reduce quality adulteration of the inherent quality of known coffee in the country. Besides genetic and environmental factors, the range of cares taken from field to cupping can affect coffee quality. In this regard, research information on the influence of environmental factors such as soil, altitude, rainfall, and temperature as well as field management on coffee quality is done in Ethiopia so as to overcome with the problem which encountered the quality of coffee production even though it is scanty in most coffee growing regions of the country. Therefore, the main objective of this review is:

- a) to assess previous works on factors affect quality of coffee in Ethiopia
- b) to identify the research gaps on producing quality of coffee in Ethiopia

LITERATURE REVIEW

Coffee Quality

According to the International Organization for Standardization (ISO) (2000), Quality is described as "the ability of a set of inherent characteristics of a product, system or process to fulfill requirement of customers and other interested parties". These inherent characteristics can also be called "attributes. 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 (Leroy *et al.*, 2006). 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 (Leroy *et al.*, 2006). It should be noted that each consumer market or country may define its own organoleptic qualities; at the consumer level: coffee quality deals with price, taste and flavor, effects on health and alertness, geographical origin, environmental and sociological aspects (ISO, 2000).

More specifically, ISO (2004a) defined a standard for green coffee quality (ISO 9116 standard) 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. These ISO standards define methods of measurements for several of these qualities such as, defects, moisture content, bean size, some chemical compounds and preparation of samples to perform cup tasting.

According to the definition of quality and standards authority of Ethiopia (QSAE) (2000) a quality is conformance with requirements or fitness for use in which the parties involved in the industry (customer, processor, supplier, etc) should agree on the requirements and the requirements should be clear to all stake holders involved in the process. On the other hand, Coffee quality control and auction Center was established with a key objective of maintaining coffee quality control, which in turn facilitates the coffee marketing system to be standard based, and for the betterment or proper functioning of the long coffee supply chain of Ethiopia (Endale, 2008).

Cup quality

Coffee quality, especially liquor or cup quality, determines both the relative price and usefulness of a given quantity of coffee (Agwanda *et al.*, 2003). Cup quality, often referred to as drinking quality or liquor quality, is an important attribute of coffee (Muschler, 2001; Agwanda *et al.*, 2003) and acts as yardstick for price determination (Agwanda *et al.*, 2003).

Moisture content

The moisture content of coffee bean is an important attribute and indicator of quality. High moisture content of the beans is a loose sensorial defect. If coffee beans are too wet (above 12.5 % moisture), can mould easily during storage. In addition, if the beans are too dry (below 8 % moisture) they lose flavor. The moisture content can influence the way coffee roast and the lost of weight during roasting. Green coffee with low moisture contents tend to roast faster than those with high moisture content (Leroy *et al.*, 2006; ITC, 2002).

Organoleptic quality

When assessing organoleptic quality, one has to take into account that consumers have a specific taste according to their nationality, which leads to an unreliable definition of organoleptic quality (Wintgens, 2004; Leroy *et al.*, 2006). In addition, organoleptic characteristics must be stable, especially for the roaster and the consumer. The smell of the ground-roasted coffee before water added sometimes called fragrance. Then, one can smell the aroma, evaluate the body and perceive taste and flavors. Organoleptic quality measurement relies on overall or sensory evaluation (Leroy *et al.*, 2006). Hence, assessment of coffee organoleptic quality is an extremely demanding exercise; indeed the flavor obtained in a coffee cup is the result of multiple aromatic compounds present in the coffee (more than 800 in the roasted coffee) (Clifford and Wilson, 1985).

Physical quality

The International Coffee Organization (ICO, 2001) implemented a Coffee Quality Improvement Program (CQIP) with recommendation to exporting countries. It is not recommended to export coffee with the characteristics having foreign material of non coffee origin; foreign materials of non bean origin, such as pieces of parchment or husk; abnormal beans for shape regularity or integrity; abnormal beans for visual appearance, such as black beans; abnormal beans for taste of the cup after proper roasting and brewing.

Bean size, which is usually determined by screening, is of particular importance to roasters since bean of the same size would be expected to roast uniformly. In addition, these size and shape differences of coffee beans were influenced by botanical variety and environmental growth circumstances (Sivetz and Dosrosier, 1979; EAFCA, 2008).

Factors Affecting Coffee Quality

Cup 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), processing systems (post harvest factors), storage conditions, industrial processing, preparation of the beverage and taste of the consumer (Moreno *et al.*, 1995). Coffee quality is of critical importance to the coffee industry. 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. Moreover, factors that determine coffee quality are genotypes, climatic conditions, and soil characteristics of the area, agronomic practices, harvesting methods and timing, post harvest processing techniques, grading, packing, storage conditions and transporting, all contribute either exaltation or deterioration of coffee (Behailu *et al.*, 2008).

Similarly, Damanu (2008), reported coffee quality as a combination of the botanical variety, topographical conditions, and climatic conditions and the care taken during growing, harvesting, storage, exports preparation and transport.

Climatic and soil factors

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

According to Mekonen (2009) temperature is the most important element, which affects coffee bean quality. The higher the temperature, the higher the metabolic activity of the seed. Coffee with moisture content as low as 11 % loss their quality after 6 months under a temperature of 35°C. On the other hand, a coffee with moisture content above 15 % will maintain its quality at

temperature as low as 10°C. Coffee needs to be maintained at low temperature to reduce its metabolism and respiration.

Yigzaw (2005) reported that coffee grown with heavy application of nitrogen fertilizer had poorer, lighter and thinner quality than that from unfertilized fields. An excess of nitrogen increase the caffeine content, resulting in a more bitter taste of the brew. The caffeine and chlorogenic acid contents of the beans are not affected by the levels of phosphorus, calcium, potassium and magnesium in the soil (Wintgens, 2004). A lack of zinc will lead to the production of small light grey-colored beans, which will produce poor liquor (Wintgens, 2004). On the other hand, magnesium deficiency had an adverse effect on cup quality (Mitchell, 1988). High concentration of calcium (>0.11%) and potassium (>1.75%) in the beans is associated with a bitter and "hard" taste (Wintgens, 2004).

According to Mekonen (2009) report Coffee quality can be affected by climatic and soil factors. In his study, nitrogen and phosphorous negatively correlated with coffee quality. In addition, calcium negatively correlated with the quality of coffee. Soil pH was noted to indirectly associate with the character and acidity of coffee. In addition, total quality, body and shape were directly correlated with soil pH. Except pH, Mg and Ca, the other soil properties were negatively correlated with total coffee quality. Above all, soil nitrogen content inversely associated with most coffee attributes. The findings are quite in line with that of Yadessa *et al.* (2008) and Wintgens (2004).

Pre-harvest practices

Almost all Ethiopian coffee farmers do not use fertilizers except on commercial farms. The Ministry of Agriculture (MoA) doesn't encourage the practice of applying fertilizer in coffee farmlands. Use of pesticides on coffee farms is also inadequate. There are only a limited number of farmers who use pesticides despite the presence of Coffee Berry Disease (CBD), Coffee Wilt Disease (CWD), and

Root Rot Disease (RRD) in major coffee growing areas (Abu and Teddy, 2013).

Taye (1998) reported the use of decomposed coffee husk at a rate of 10 ton ha⁻¹ (4 kg tree⁻¹ on dry weight basis) was found to be superior in terms of yield performance of coffee trees. A significant improvement in growth and yield of mature coffees was reported in response to coffee pulp and husk compost application.

Pruning practice has its own role in the quality of coffee. Goal of pruning is to create well-structured, healthy trees that give good cherry yields over a long period of time or to rejuvenate old trees by stumping. In more detail: the objectives are: to avoid unnecessary competition for nutrients by removing unproductive wood; to remove weak branches that will not yield, or only a little; to avoid high humidity and fungus development through better air circulation; to create better access to the core of the tree when spraying pesticide; and to decrease the risk of the damage to the coffee trees' canopy during periods of heavy rain and/or wind (Michiel Kuit, 2004).

The survey result reported by Techaleet *et al.* (2013) in Gomma woreda showed that 93.33% of the respondents practiced rehabilitation pruning and only 6.67% of respondents have no pruning practice in their coffee field. Hence, majority of the coffee farmers in the study area are practicing coffee tree pruning. According to Adriana *et al.*, (2009) coffee tree pruning is an extremely important pre harvest activity for reducing incidences of diseases, modifying air movement within the plantation, which in turn reduces leaf drying time and helps maintaining the frame work of the plants in desired shape. In addition, the result showed that 50% of respondents applied compost to their coffee field and (50%) of respondents do not apply compost in their coffee field. This indicates that half of the farmers created a very good growth conditions which have a positive effect on bean size and flavor.

Muschler (2001) indicated that shade improved the appearance of green and roasted coffee beans as well as the acidity and body of the brew, especially for those produced in suboptimal (low altitude) coffee production zones, by promoting slower and balanced filling and uniform ripening of berries.

The weed is found to be a serious problem which reduces the productivity and quality of coffee in most area. The study on Gomma woreda by Techaleet *et al.* (2013) showed that majority of the coffee plantations in the study areas are infected by soft weed (53.33%), couch grass (40%) and a combination of soft weed and couch grass (6.66%). Therefore, it is true that quality could decrease, because of the competition for nutrient, light and moisture with different types of weeds growing in coffee field. Similar findings were reported by (Adriana *et al.*, 2009). To control this weed problem the study indicated that most of the respondents used slashing mechanisms 125(83.33%), whereas; 20(13.33%) of the respondents used chemicals to control weed and the remaining 5(3.33%) of respondents used both chemical and slashing methods.

Pests and diseases attacks can affect the cherries directly or cause them to deteriorate by debilitating the plants, which will then produce immature or damaged fruits disease and insect attack (such as leaf miner and mites) may also result in lower quality beans (Wintgens, 2004). For instance, as reported by Wintgens (2004) the coffee berry borer *Hypothenemus hampei* feeds and reproduces inside the coffee beans and causes their quality to deteriorate.

Coffee Berry Disease (CBD), *Colletotrichum kahawae*, Coffee Wilt Disease (CWD), *Gibberellaxylarioides* and Coffee Leaf Rust (CLR), *Hemileiavastatrix* are the three major diseases reducing production and quality of coffee in Ethiopia (Zeru *et al.*, 2005). Coffee

berry disease is a common disease in Ethiopia. A study reported by Emana (2014) in Hararghe, Eastern Ethiopia resulted the disease incidence ranged up to 100 %, 80 %, 95 % and 90 % was observed in Bedeno, Boke, Habro and Darolebu districts respectively.

The antestia sting bug as a vector of micro-organisms damages the bean and causes a bitter flavor. Similarly, the fly *Ceratitis capitata* feeds on the mucilage and the cherry becomes infected with micro-organisms; the secondary bacterial infection causes a distinct potato flavor. OTA (Ochratoxin A) is a form of mycotoxin, produced as a metabolic product of *Aspergillus ochraceus*, *A. carbonarius* and strains of *A. niger* reported to exist on coffee dried on bare ground (Eshetu and Girma, 2008).

According to Techaleet *et al.* (2013) at Gomma woreda showed that 36.67% of respondents use cultural practices to prevent coffee disease, whereas; 16.67% of respondent cannot use any mechanism to prevent coffee disease. However; disease occurrence can lead to poor quality coffee that gives off and disagreeable odor. Diseases attack can 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 (Wintgens, 2004). So that is based on the above finding it's advisable to create awareness among the coffee growers about coffee disease management as far as coffee quality and export standard are concerned.

Apart from agronomic practices, cup quality is influenced by the age of the tree. Accordingly, Yigzaw (2005) reported that samples from young trees are likely to be mild and thin, but fine in flavor. Samples from old trees produce strong taste and a harsh characteristic brew. Medium aged trees, 15 to 20 years old, bear beans with good flavor as well as acidity and body (Yigzaw, 2005).

Harvest factors

Maturity also has a strong influence on coffee quality. The main factor affecting natural coffee quality is harvesting method. It is widely agreed that traditional hand-picking and husbandry labor, as opposed to mechanical harvest, produce the best quality green coffee by decreasing the percentage of defects in coffee batches (Bertrand *et al.*, 2006).

Immature harvesting is most serious problem in coffee harvesting. Under rip cherries are very difficult to process and low quality product is produced. One of the main causes of immature harvesting is fear of theft (Yigzaw, 2005). Endaleet *et al.* (2008) pointed out that low caffeine content were found in bean harvested at immature stage (unripe). Overripe cherries should not be picked often they are already fermenting on the tree leading to very bad off-tastes. A handful of over-fermented beans can spoil the quality of an entire container green bean. Ripe cherries that take too long to be processed will also lead to over-fermented beans. It is very important to transport cherries to the factory as soon as possible after harvesting. If this is not possible one can slow down the fermentation rate, and thereby the rate of quality loss, by evenly spreading out the cherries around 10cm thick. Of course the cherries should not get indirect contact with soil, dogs, chicken, motorbikes, etc. from over-ripe cherries (Endaleet *et al.* 2008).

Dried cherries, either on the tree or fallen down on the soil should not be picked. Especially fallen cherries as they pose a health risk because of bacterial infection and development of moulds and Ochratoxin A which is known to cause cancer (Michiel Kuit 2004).

Post-harvest factors

Depending on the post harvest processes, significant effects on

coffee quality can be observed (Barel and Jacquet, 1994). Processing and storage is a very important activity in coffee production and plays a crucial role in quality determination (Mburu, 1999).

Processing

Coffee is either processed by the wet or dry methods, which vary in complexity and expected quality of the coffee (Wrigley, 1988). Both sun-drying as well as wet-processing methods are operated in Ethiopia, which accounts for 70% and 30% of coffee produced in the country, respectively (Jacquet *et al.*, 2008).

In the majority of the study area coffee is prepared using a dry processing (natural sundried) system, which is the first method by which the fresh cherries are harvested and sundried as a whole. Generally, farmers harvest selectively red cherries by picking them by hand; however a premature harvest can be sometimes carried out by strip picking for needs of cash and fear of thefts (Jacquet *et al.*, 2008). After drying the cherries are sold to local collectors "Sabsabis", wholesalers "Akrabis" or cooperatives, which are operating the secondary processing facilities (CFC, 2004).

The second method is the wet processing method in which the fresh red cherries are processed in three stages i.e. removals of the pulp and mucilage, fermentation and washing, and drying of parchment coffee (CFC, 2004).

According to Mekonen (2009) wet processing method resulted in high mean values for good cup quality (attributes like acidity, body and flavor) and bean physical quality (attributes like odor) as compared to the dry processing method. From his result it can be concluded that wet processing method is the best approach to obtain fine and typical quality flavor in the cup that attract consumers according to their preference in the international market.

The perceived acidity of washed coffees is also significantly higher than the acidity found in naturally (dry) processed coffees. This is likely due to an increase in the body of naturally processed coffees relative to wet processed coffees since body masks the coffee's acidity (Yigzaw, 2005).

However, assessment made on wet-processed Jimma coffee by Brownbridge and Eyassu (1968) revealed that it is very heterogeneous, containing beans of all shapes, sizes and plain liquor, probably because of such a mixture types characterized by small beans of a nice green color and exquisite aroma. As the authors reported neither plant genetics nor the environment can be modified, but effort should be concentrated on the very critical post harvest practices such as harvesting, processing, drying, storing and transporting of coffee cherries, which are liable to be a major influence components of the quality of the cup.

Green coffee storage

Anwar (2010) reported that, storage is one of the most important and crucial stage in processing of any agricultural commodity. In case of coffee storage, the goal is to achieve and maintain its commercial value as long as possible by preserving the integrity of the bean with all its characteristics. The need for adequate storage is crucial since coffee beans are living entities in which their viability depends largely on storage condition and food safety has now become an extremely important issue since the effects of toxic substances, which would develop during storage, can cause significant harm to human health. In addition, although coffee does not have a great nutritional value, its price is based on its sensorial value. This is dedicated aspect, which can easily be affected if

storage is not adequate. Besides this, due to the inherent imbalance between supply and demand in the coffee market, it is sometimes necessary to store coffee for long period of time in which the length of storage affects the quality of coffee.

Storage facilities should be clean, cool, shaded, dry and well ventilated. In conditions of high relative humidity and temperatures, coffee beans will absorb moisture and develop mold. They may be bleached out in color and lose some desirable flavor. In this regard, the farmers in the study area are using poor storage facilities which lead to changes in the inherent qualities and appearance of the green coffee as a result of potential development of molds (Techaleet *et al.* 2013).

Genetic factors

As harvesting method, post harvest procedures and the physiology of the plant itself affect coffee quality, its genetic origin (species and genotype) also greatly influence coffee quality (Leroy *et al.*, 2006). 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; cup quality must be the first priority to be considered (Yigzaw, 2005).

Selvakumar and Sreenivasan (1989) observed coffee cup 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 shape and structure of beans (elephant, pea bean and empty beans) are the result of both genotype and environmental factors (Wintgens, 2004).

Socio-economic factors

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 adoption of improved varieties, literacy, visit and proximity to research center positively influenced farmers' perception.

Many evidences shows that female households have less access to improved technologies, credit and extension service (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. According to the findings of Negussie *et al.* (2008), only 26% of the female-headed households had access to improved coffee varieties as compared to 88% for the male-headed and 87% of the male respondents ever used fertilizer as compared to 55% for females in survey made in Gomma woreda.

Adoption of improved practices by farmer is necessarily based on his/her capacity to access, process and utilize information related to improved technologies. The finding of several studies (Zemedu, 2004) revealed that level of education is strong and significant determinant of farmers' adoption of improved agricultural technologies. In addition to this Elias (2005) reported that poor quality of coffee supplied by farmers; poor infrastructure and inadequate facilities and lack of institutional credit were the major problems of coffee production and marketing in the Gomma woreda. According to the author lack of credit service was a problem reported by both the coffee growers (22%) and the coffee traders (21%).

Even though several attempts were made and significant

achievements were recorded in transferring coffee research outputs to end-users by (JARC and different actors. Nevertheless, wider dissemination and utilization of the technologies have been constrained by technical, socio-economic, and institutional factors (Negussie *et al.*, 2008).

CONCLUSION AND RECOMENDATIONS

Ethiopian coffee quality become deteriorates from time to time. As many researches indicated that this deterioration is because of soil and climatic factors, genetic factors, pre harvest practices, harvesting method and timing, post harvest process, storage and social factor.

The environment has a strong influence on coffee quality (Altitude, daily temperature fluctuations, amount and distribution of rainfall and the physical and chemical characteristics of the soil) are very important factors. Soil also has its own role in quality of coffee. An excess of nitrogen increase the caffeine content, resulting in a more bitter taste of the brew. High concentration of calcium (>0.11%) and potassium (>1.75%) in the beans is associated with a bitter and "hard" taste. nitrogen and phosphorous negatively correlated with coffee quality. In addition, calcium negatively correlated with the quality of coffee. Soil pH was noted to indirectly associate with the character and acidity of coffee.

In pre harvest processes use of decomposed coffee husk, Pruning practice, shade, control of common diseases and weeds etc has important role in quality of coffee. Almost all Ethiopian coffee farmers do not use fertilizers except on commercial farms. But decomposed coffee husk at a rate of 10 ton ha⁻¹ (4 kg tree⁻¹ on dry weight basis) was found to be superior in terms of yield performance of coffee trees. Pruning practice has its own role in the quality of coffee. Shade also improved the appearance of green and roasted coffee beans as well as the acidity and body of the brew. In the other hand the Pests and diseases attacks and weed is found to be a serious problem which reduces the productivity and quality of coffee in most area. Maturity also has a strong influence on coffee quality. Overripe cherries and under rip cherries are not recommended for harvesting.

Coffee is either processed by the wet or dry methods. In the majority of the study area coffee is prepared using a dry processing (natural sundried) system. However, other researches indicated that wet processing method has high mean values for good cup quality (attributes like acidity, body and flavor) and bean physical quality (attributes like odor) as compared to the dry processing method. In addition, Storage facilities should be clean, cool, shaded, dry and well ventilated. On the other hand, genetic origin (species and genotype), farmers' perception and adaption of technology also greatly influence coffee quality.

Therefore, to overcome on the problem which encounter to produce quality coffee production in Ethiopia, it is better to work on the following research gaps:

- a) It is important to conduct more researches on effect of application of fertilizer.
- b) More of the researches in related with disease and pest is concerning with only the incidence and severity. So. Further researches concerning with the control mechanism of those diseases and pests should be conducted.
- c) Coffee quality is seriously affected by weed. However, there is no specification on which quality type it is serious. Therefore, there is room for further research to distinguish which quality type is seriously affected by weed and its significance as well.

d) Many researches indicated that wet processing method is preferable than dry processing method. However in our country more of the processor are used by dry processing method. Therefore, actions should have to be taken to use wet processing method.

e) Farmers' perception and adaption of technology has also influence on quality of coffee. So it is important to give different opportunities for the producers to adapt different technologies and it asks effort to give enough awareness for the farmers to change unreal perceptions.

f) There is need of more researches on the solution of each factor to overcome desirable quality of coffee.

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