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Assessment of pre and post-harvest management practices on coffee (*Coffea arabica* L.) quality determining factors in Gedeo zone, Southern Ethiopia

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In Gedeo zone, coffee quality is declining from time to time due to several improper pre and post-harvest management practices. Therefore, this study was designed with the objective of assessing impact of pre and post-harvest management practices on *Coffea arabica* L. quality determining factors in Gedeo zone, Southern Ethiopia. Totally, 90 household respondents were used from three Woredas and selected purposively. Finally, quantitative data was analyzed by employing SPSS (version 20). In pre harvesting practices, the result indicated that most of the respondents owned old coffee trees (>20 years), prune their tree frequently within one year interval and observed various diseases on their coffee tree. According to the survey result, majority of farmers use shade trees, which is the most common cropping practiced by coffee producing farmers in the study area, and majority of the farmers use dry method of coffee processing. Descriptive statistics of the field survey revealed that majority responded the provision of support and training from the respective Agricultural research and Development offices. On the contrary, the coffee farming family suffered from shortage of money as well as time at harvesting stage of coffee. On the side of traders, they received extension services in maintaining coffee quality in particular. Most of the traders in the study area in order to buy and sell coffee, did not get advises from market advisers. In general, most management practices in addition to trading methods in the study area have problems in maintaining coffee quality in the zone.

Key words: *Coffea arabica* L, coffee quality, pre-harvest, post-harvest, Gedeo zone.

INTRODUCTION

Coffee *(Coffea arabica* L.) is a non-alcoholic stimulant beverage crop that belongs to the family *Rubiaceae* and genus *Coffea.* Coffee is the world's favorite drink (Techale et al., 2013). Coffee Arabica is believed to

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originate in humid high rain forests of south and south western Ethiopia. Coffee ranked as the fifth most important trade commodity after wheat, cotton, maize and rice (FAO, 2008).

Ethiopia is known for producing the finest Arabica coffee to the world market (Herhaus, 2014); however, the deterioration of the quality of coffee produced is a major challenge in the country (Birhanu et al., 2013). Coffee is the major source of foreign currency income for Ethiopia and contributes more than 35 percent of total export earnings (Feyera, 2006). Ethiopia is well known not only for being the home of Arabica coffee, but also for its very fine quality coffee acclaimed for its aroma and flavor characteristics. Coffee is distinguished based on unique characteristics which includes Sidamo, Yirgachefe, Harar, Gimbi, Jimma and Limmu coffee types (Anwar, 2010). On the other hand, coffee produced in some parts of Ethiopia, especially from Harrar and Yirgachefe, is always sold at a premium price both at domestic and international coffee markets because of its distinctive fine quality (Chifra et al., 1998; ITC, 2002) and appropriate processing approach. Ethiopia possesses a diverse genetic base for the Arabica coffee with considerable heterogeneity and is the center of origin for Coffee arabica, even though Ethiopia produces a range of distinctive Arabica coffees and has considerable potential to sell a large number of specialty coffee (Gebreselassie et al., 2017).

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 and Solomon, 2006). According to Duguma et al. (2018) at the pre-harvest level, inadequate use of fertilizers, limited moisture, lack of practicing rejuvenation and pruning, coffee wilt and berry diseases, insect pest incidence were the main factors to deteriorate the quality coffee production as well as at the post-harvest level, carrying out of improper harvesting practices, hardly use of recommended packaging materials, conducive storage system, mixing of water and foreign matters on dried coffee were some of the factors affecting the quality of the coffee. Also harvesting and post-harvest, processing methods highly significantly influenced all coffee quality parameters (Ameyu, 2017).

Coffee is significantly produced in four Gedeo zone districts (Dilla Zuria, Wenago, Yirgachefe and Kochere) and serves as a major means of income for the livelihood of coffee farming families. Despite the favorable climatic conditions, variety of local coffee types for quality improvement and long history of its production in Gedeo zone, coffee quality is declining from time to time due to several improper pre and post-harvest management practices.

However, in the Yirgachefe zone, coffee always sold at a premium prices both at domestic and international coffee markets because of its distinctive fine quality and appropriate processing approach, but the other coffee producing districts in the zone do not have same quality like that of Yirgachefe . Still, there are gaps such as lack of profound assessment works to estimate the prevalence of coffee quality problems in different districts of Gedeo zone, lack of adequate information on the effects of post-harvest and pre-harvest handling techniques on coffee quality.

So it is must to give an attention for those practices because they affect directly or indirectly raw bean as well as liquor coffee quality parameters under various stages. Therefore, the study was designed to assess impact of pre and post-harvest management practices on coffee (*C. arabica* L.) quality determining factors in Gedeo zone, southern Ethiopia.

MATERIALS AND METHODS

Description of the study area

This assessment work was conducted in Gedeo zone, southern Ethiopia in a year (2016-2017). Gedeo zone is one of the 13 zones of Southern Nations and Nationalities Peoples Regional State (SNNPRS) of Ethiopia; it has six rural districts (Dill Zuria, Wenago, Yirgachefe, Kocherie, Bule and Gedeb). Gedeo lies between 5 and 7° North latitude and 38 and 40° East longitude. Gedeo extends south as a narrow strip of land along the eastern escarpment of the Ethiopian highlands into the Oromia Region, which borders the zone on the east, south and west; Gedeo shares its northern boundary with Sidama zone. The area characterized as warm humid temperature with mean annual temperature ranges between 17 and 22.4°C and mean annual rainfall between 1200 and1800 mm. The area altitude ranges from 1200 m.a.s.l in the vicinity of Lake Abaya to 2993 m.a.s.l at Haro Wolabu Pond, Bule woreda.

Sampling technique and procedure

At first stage, from six districts of Gedeo zone, 4 districts (Dill Zuria, Wenago, Yirgachefe and Kochere) produce coffee but by considering limiting factors such as time, money and other facilities; 3 districts (Wenago, Yirgachefe and Kocherie) were selected purposively due to the fact that these districts are well known in coffee production in the zone, and also, the crop is significantly produced and serves as a major means of income for the livelihood of coffee farming families. Then by considering the size and suitability of the districts, 3 kebeles were selected purposively. From each kebeles based on amount of coffee production, 5 PAS (peasant associations) were selected purposively from each kebeles, then 6 highly producer household farmers were selected purposively from each selected PAS. The list of household heads in the selected PAS was obtained from the kebele offices and development agents (DAs). Finally, the sample frame of the study were made up of the total number (90) of respondents from the selected districts and interviewed to point out their views based on the questioner in collaboration with local administers, key informants and DAs. Besides, coffee traders (47) were selected purposefully from the three districts with the collaboration of kebele offices and DAs and interviewed to point out their views based on

the questionnaire.

Methods of data collection

A semi-structured questionnaire with both close and open ended question was set to collect primary data. Secondary data and information were also collected. To develop the questionnaire (to collect information), in-depth interviews were conducted with farmers, government office, non-government offices, DAs, local administers and key informants. Then, coffee producers and traders were interviewed to point out their views on pre and post-harvest management practices as well as related problems on coffee quality in the Gedeo zone. Additionally, focus group discussions were held with farmers to strengthen and cross-check the data obtained from different stakeholder in selected survey areas. The survey was supplemented by experts' knowledge, cooperative unions, kebele offices and DAs.

Analysis of field survey

Quantitative data collected from the field through structured questionnaires were analyzed by employing the statistical procedures of SPSS version 20 software. Percentage mean, frequency distribution, proportion and ratio were used to analyse the qualitative data. Qualitative data gathered from various sources was organized, triangulated, interpreted, discussed and narrated. Problem ranking was done to identify the magnitude of different factors which are affecting coffee quality in study the area.

RESULTS AND DISCUSSION

This study was undertaken under field condition. The field survey data were collected from respondents using structured questionnaire.

Analysis through descriptive statistics

Demographic factors

Table 1 presents demographic and socioeconomic characteristics of the sample respondents. The total sample size of farm respondents handled during the survey was 90. Of the total sample respondents, 26.7% were male-headed households and only 2.2% were female-headed in Wenago Woreda, 30% were male-headed households and 1% was female-headed in Yirgachefe Woreda and also, 37.8% were male-headed households and only 2.2% were female-headed in Kochere Woreda. Totally, 95.9% of respondents were males and 5.1% were females in the survey areas. This result confirmed the prior expectation that male-headed households have more access to improved technology, updated information, credit and extension services than female-headed household. This result is consistent with other findings; Doss and Morris (2000) showed that females have less access to an improved agricultural technologies and extension services, which contribute to lower adoption rates. In addition to, male-headed households have better access to information than female households do, which helps for adoption of improved agricultural technologies. Therefore, it said to be on improving and maintaining coffee quality male-headed, household can have better than female-headed.

About 46.7% of the respondents were found in the age category of greater than 36 and less than 50 years, in the age category of greater than 50 years 20%, and greater than 25 and less than 35 years 16.7%, while the remaining 6.6% were greater than 10 and less than 25 years old as shown in Table 1. From three survey areas, high numbers of farmers were categorized under age of greater than 36 and less than 50 in Wenago and Kochere areas. But in Yirigachefe woredas, majority of farmers were found to be in the age category of greater than 50 years.

With regards to educational status, majority of respondents who are living in Kochere were found to be educated which is 36.7% compared to other woredas and 5.6% of Yirgachefe respondents were illiterate. Educational status of the household head in the three woredas has significant difference at 5% significance level. Level of education can have a significant effect on coffee quality because illiterate farmers are not well adopting improved technology. Similarly, the finding of several studies revealed that the level of education is a strong and important determinant of farmers' adoption of improved agricultural technologies (Zemedu, 2004). Besides, as reported by Deressa et al. (2009), years of schooling positively influenced farmers' adoption decisions on improved agricultural techniques. Therefore, education is crucial for the farmers to understand and interpret the information coming from any direction to them.

In terms of family size, the majority of sample farmers (61.1%) had less than ten family members, while 15.6% of them had greater than ten family members. Family size also showed variation at 5 percent significance level.

Pre-harvest factors and some agronomic practices

Age of coffee trees

The result of the field survey showed that among 90 coffee farmers interviewed, 74.4% owned old coffee trees (>21 years), while 25.6 % of them owned coffee trees less than twenty one years old as shown in Figure 1. This result implies that majority of the coffee plantations in the study areas are physiologically declining as their yield and quality might decrease as reported by Clifford (1985). The survey result was supported by Duguma et al. (2018) and most of Chole district coffee is found in the interval of old coffee trees which give a low both in the quality and amount of product. Yigzaw (2005) reported that samples from young trees are likely to be mild and thin, but fine in

Table 1. Demographic and socioeconomic characteristics of samples (categorical variables).

Variable	Item	Wenago		Yirgachefe		Kochere		Total	
		N	%	N	%	N	%	N	%
Household	Female	2	2.2	1	1.1	2	2.2	5	5.1
	Male	24	26.7	27	30	34	37.8	85	95.9
Age	10-25	3	3.3	3	3.3	-	-	6	6.6
	26-35	3	3.3	8	8.9	4	4.4	15	16.7
	36-50	14	15.6	8	8.9	20	22.2	42	46.7
	>50	5	5.6	12	13.3	10	11.1	27	30
Family size	1-5	7	7.7	6	6.7	8	8.9	21	23.3
	6-10	15	16.7	19	21.1	21	23.3	55	61.1
	11-15	3	3.3	6	6.7	5	5.6	14	15.6
Educational status	illiterate	4	4.4	5	5.6	1	1.1	10	11.1
	1-8 grade	15	16.7	19	21.1	24	26.7	58	64.5
	9-12 grade	7	7.7	6	6.7	9	10	22	24.4

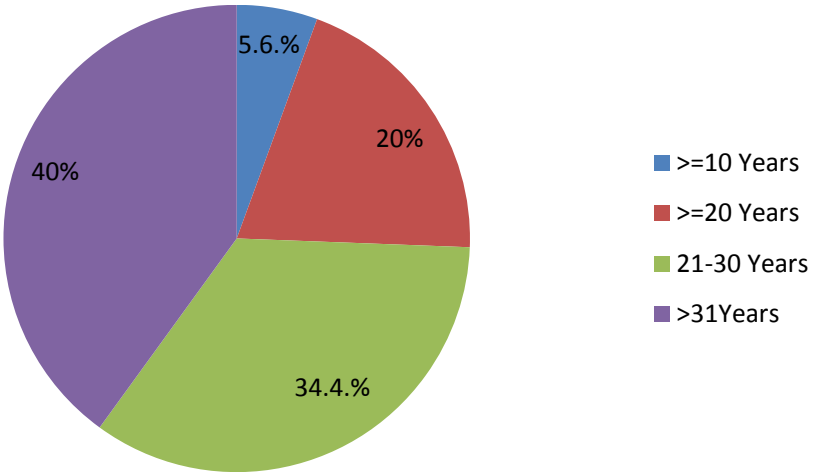

Figure 1. Age of coffee tree in study area owned by respondents.

flavor. Beans from old trees produced 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, thus in this study, most coffee trees aged above 20 years are hypothesized to have been inversely related with coffee quality. In general, poor coffee quality is being produced because of old age.

Coffee tree pruning

In this study, the result showed that 94.9% of respondent coffee farmers practiced pruning. 45.6 and 41.1% of respondents practice formative and maintenance pruning respectively and also 84.4% of respondents prune their tree frequently within one year interval as shown in Table 2. Pruning practice has its own role in the quality of coffee. Goal of pruning is to create well-structured and healthy trees that give good cherry yields over a long period of time or to rejuvenate old trees by stumping. According to Franca and Oliveira (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, Wintgens (2004) reported that coffee pruning can usually have a positive effect on bean size and flavor.

Table 2. Practices of coffee tree pruning, type and frequency in study area.

Variable		Frequency	Percent
Coffee tree pruning	Yes	85	94.4
	No	5	5.6
Type of pruning	Formative pruning	41	45.6
	maintenance pruning	37	41.1
	Rejuvilination	12	13.3
Frequency of pruning	once monthly	13	14.4
	once per a year	76	84.4
	Other	1	1.2

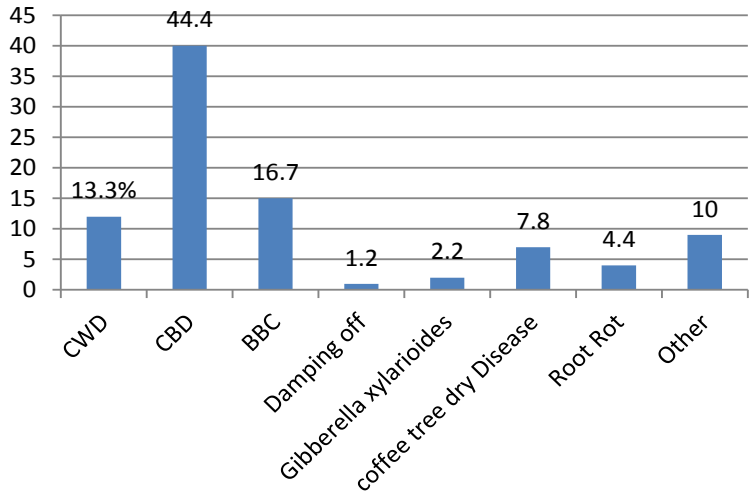

Figure 2. Type of disease in study area in percentage.

Type of coffee disease

It was identified that majority of coffee farmers responded the prevalence of disease like coffee wilt disease (CWD), coffee berry diseases (CBD), BBC, damping off, *Gibberella xylarioides*. From such diseases 44.4% of the farmers mentioned that the area has been widely threatened by coffee beery disease followed by BBC and CWD as shown in Figure 2. As the consequence of this, the quality and quantity of coffee might have decreased considerably. This finding goes in line with the report that mentions CBD, *Colletotrichum kahawae*, CWD, *G. xylarioides*, coffee leaf rust (CLR) and *Hemileia vastatrix* as the major diseases reducing production and quality of coffee in Ethiopia (Zeru et al., 2005). Diseases attack 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 and influence the final quality (Gole, 2015).

According to this survey, result showed that 51.5% of respondents use cultural practices to prevent coffee diseases, whereas, the other respondents use other mechanisms to prevent coffee disease (Table 3). The surveys also revealed that farmers of Gedeo zone are not using any type of chemical as control mechanisms. Instead, farmers have some indigenous knowledge and experience to control the diseases. This includes planting coffee trees under shade to reduce transpiration and make them less stressed (not to be easily attacked by the disease) and application of farm yard manure and/or compost. Moreover, frequent cleaning and burning of fallen leaves, fruits and plant debris are methods used by farmers.

Type of coffee weeds and control mechanism

The weed is found to be a serious problem which reduces the productivity and quality of coffee in most areas. As indicated in Figure 3, majority of the coffee plantations in the study areas are infected by soft weed (66.7%), couch grass (7.8%) and a combination of soft weed and couch grass (25.5%). Therefore, it is true that

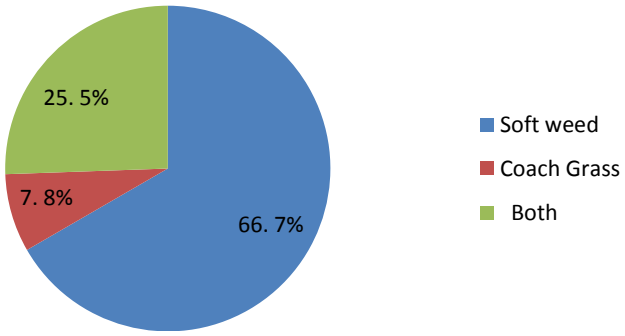

Figure 3. Types of weed present t in the study area.

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 Franca and Oliveira (2009). To control this weed problem, the study indicated that most of the respondents used slashing mechanisms (52.2%), whereas, 44.6% of the respondents used hand weeding to control weed and the remaining 2.2% of respondents used IPMS method (Figure 4).

Controlling shade level

Farmers in the study area grow coffee both with and without shade in the field. This survey revealed that 98.9% of farmers use shade tree, whereas, about 1.1% of farmers entirely do not use shade in order to cultivate coffee plant as shown in Figure 5. According to the result, majority of the farmers considered in the study used shade for coffee production which indicates that the farmers are following the right practices. 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. As reported by Geromel et al. (2008), shade tree is one of the main factors responsible for the quality of coffee bean. For example, fruits from coffee grown under shade are characterized by larger bean size than those grown under full sun conditions. Also, they reported that shade has different effects depending on the geographical location of coffee tree.

Harvest and post-harvest factors

One of the main factors affecting quality of coffee is harvesting method. An inadequate method of harvesting is responsible for the widespread failure to maintain the inherent quality of coffee produced in Ethiopia (Alemayehu, 2014), harvesting method highly significantly influenced all raw quality attributes (Ameyu et al., 2017).

In addition to harvesting system, maturity affects quality of coffee. According to Bertrand et al. (2006), early picking of red cherries gives the best coffee cup and physical quality of *C. arabica*.

According to the survey, coffees were harvested at full maturity stage by 94.9% of the farmers; whereas, 77.8% of the farmers practiced selective hand picking and 86.9% of the farmers in the study area performed the activity by using both family and daily laborer as shown in Table 4. As indicated by Ameyu et al. (2017), selective method of harvesting was better in producing superior quality beans in all parameters. Therefore hand picking only red cherries is one means for accomplishing high quality of the produce. According to Garo et al. (2016) survey result, striping is much faster than picking only red ripe cherries; by doing so, farmers are harming their coffee quality besides decreasing the potential buds which will result in a good yield in the coming season. Coffee cherries which had contact with ground (soil) resulted in earthy flavor in the final cup taste and also the raw coffee quality was less attractive.

During harvesting practice, costs of laborer indicated by 58.6% of the farmers, and labor force which is mentioned by 38% of the farmers were found to be the main constrains (Table 4). As to the stage of maturity and fruit picking, the right practices were performed which maintain inherent coffee quality. In line with this for *C. arabica* in Costa Rica, early picking of red cherries gives the best coffee as it is mentioned by Bertrand et al. (2006) and such superior quality is achieved as the cherries were allowed to ripen on the tree to full maturity before harvesting (FAO, 2010). In addition to producing high quality coffee, uniformity of selectively harvested beans has advantages for processing (Boot, 2006). Furthermore, Endale et al. (2008) pointed out that low caffeine content was found in bean harvested at immature stage (unripe).

Processing and drying

The chemical composition of green coffee and thus the final coffee quality are correctly determined by the mode of post-harvest treatment, that is, the wet and dry processing. Thus, processing is a crucial activity in coffee production and plays a crucial role in quality determination (Mburu, 1999), and the methods 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). According to Musebe et al. (2007), 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 the result of Musebe et al. (2007), it can be concluded that wet processing

Table 3. Disease control mechanisms in study area.

Controlling mechanism	Frequency	Percent
Quarantine	6	6.7
Sanitation and mechanical	37	41.1
Cultural method	46	51.1
Other	1	1.1

Table 4. Harvesting of coffee in study area.

Variable		Frequency	Percent
Harvesting practice	Selective	68	75.6
	Strip	8	8.9
	Collecting	14	15.5
	Total	90	100
Harvesting stage	Fully maturity stage	85	94.4
	Green stage	3	3.3
	Immature stage	2	2.2
	Total	90	100.0
Constrain during harvesting	Time	2	2.1
	Labor force	37	41.1
	Money to pay for labor	50	55.6
	Others	1	1.2
	Total	90	100.0
Who harvest	Own family	3	3.3
	Daily laborer	10	11.1
	Both	77	85.6
	Total	90	100

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.

As indicatde in Table 5, the majority (56%) of the farmers in the study area prepared coffee by using a dry processing method and 32% of farmers used wet processing method. In agreement with this, Alemseged and Yeabsira (2014) mentioned dry processing as the age-old method of processing coffee and is still used in many countries where water resources are limited. According to Ameyu et al. (2017) dry processed method coupled with drying coffee on mesh wire was best in producing coffee beans with high raw quality. In contrast, dry processing using bare ground produced inferior coffee for all raw quality attributes. Drying beds can be made of mesh wire, wood posts, or any suitable local material covered in a material like burlap or nylon netting (Alemseged and Yeabsira, 2014). Most of the farmers (90%) did drying on wooden and bamboo made bed in study area. This shows that the farmers in the study area are exercising the right drying method.

Coffee beans are supposed to be stored with a moisture content of 11–12% which needs to be determined by using moisture tester. However, 94.9% of the farmers in the study area measured moisture content and 98.9% of them use local method (teeth) to determine moisture content. Thus, using local method does not allow measuring the required amount of moisture content in the coffee bean. Drying is considered an important step in quality coffee production since moisture levels higher than 12% can promote microbial growth and mycotoxin formation (Getachew et al., 2015).

Packaging and storing

As indicated in Table 6, farmers in the study area used both jute bags and plastic bags as packing materials. The result however, showed that 67.7% of the interviewed farmers used plastic bags. Such practices are in contrary to the proper packaging which uses jute bags that enable maintaining the inherent quality of coffee.

Table 5. Processing and drying of coffee in study area.

Variable		Frequency	Percent
Method of coffee processing	Dry	49	56.6
	Wet	31	32.3
	Both	10	11.1
	Total	90	100
Drying coffee	On cemented	1	1.0
	On wooden and bamboo	81	90.9
	On ground	8	8.1
	Total	90	100
Checking the moisture content	Yes	85	94.4
	No	5	5.6
	Total	90	100
Method of checking moisture	Local method (teeth)	89	98.9
	Other	1	1.1
	Total	90	100
Time before processing	1-2 days	58	64.4
	3-5 days	8	8.9
	For 1 week	15	16.7
	1 hr	9	10
	Total	90	100

Table 6. Packing and storage of coffee in study area.

Variable		Frequency	Percent
Packing bag	Jute bag	28	31.1
	Plastic bag	61	67.8
	Clay pot	1	1.1
	Total	90	100
Separate storage house	Yes	61	67.8
	No	29	32.2
	Total	90	100
Reason for separate storage house	To avoid contamination	67	74.4
	For have free store	23	25.6
	Total	90	100
Time before marketing	Less than 4 months	30	33.3
	Greater than 4 months	60	66.7
	Total	90	100

Storage is one of the most important and crucial stage in processing of any agricultural commodity. The assessments result showed that 67.8% of the interviewed farmers stored the product in separate storage to avoid contamination as shown in Table 6. 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.

Table 7. Transporting and marketing of coffee.

Variable		Frequency	Percent
Cash shortage	Yes	39	43.3
	No	51	56.7
	Total	90	100
Selling at flower stage	Yes	9	10
	No	81	90
	Total	90	100
Mix differently harvested	Yes	2	2.2
	No	88	97.8
	Total	90	100
Transportation	Separately	85	94.4
	With other products	5	5.6
	Total	90	100
Reason for separate storage	To avoid contamination	79	87.8
	Easy to transportation	11	12.2
	Total	90	100

They may be bleached out in color and lose some desirable flavor (Belay et al., 2016).

Among the respondents (Table 6), 60.6% of the respondent stored their coffee for more than four months which worsen coffee quality. In the same token, length of bean storage affects cup quality (Yigzaw, 2005). Similarly, Obiero (1996) reported that storing dried parchment coffee for more than six months resulted in woody flavor, and Wintgens (2004) further described such green coffees as *aged* that may suffer loss acidity. Moreover, the relatively high content of glucose present in dry and wet processed green coffees stored beyond 4 to 5 months decreased markedly (Woelore, 1995).

Transport and marketing coffee

Transportation needs to be done in such a way that involves no contamination. According to the field survey which is indicated in Table 7, 93.9% of the farmers transported coffee bean separately and 80.8% of the farmers mentioned that they are aware of such act in minimize contamination. The result obtained from this study showed that 55% of the farmers in the area don't have shortage of cash that force them to sell coffee at flowering stage; as a result, 86% of the farmers don't sell coffee at its flowering stage. The outcome of the assessment also indicated that 97% of the farmers in the area pointed out that they don't mix differently harvested coffee at the time of selling. In general, transportation and marketing of coffee were done as per the standard of the right practices.

Institutional factors

Descriptive statistics of the field survey study result revealed that from a total of 90 coffee farmers interviewed, substantial number of farmers (78.9 and 65.6%) responded the provision of support (such as improved seeds, raised coffee seedlings, etc.) and training from the respective Agricultural and Rural Development Office (ARDO), respectively as described in Table 8. On the contrary, the study revealed that 71.1% of the coffee farming family suffered from shortage of money at harvesting stage of coffee, whereas only 28.9% responded differently. This might be one of the factors that contribute to the decline in coffee quality due to premature harvesting of coffee to ensure cash sources for their families. This result was in agreement with the findings of Mulugeta (1999), Admassu et al. (2008) and Alemayehu et al. (2008). Mulugeta (1999) reported that access to credit, farm size, supplementary inputs, technical and institutional support like the extension service determine the adoption of technologies to maintaining quality of coffee.

Descriptive statistics of the field survey study result revealed that from a total of 90 coffee farmers interviewed, 70% of them had shortage of time, whereas, 30% of them encountered no shortage of time during peak coffee harvesting period as shown in Table 8. This implies that majority of farmers are not able to harvest their own coffee on time, probably due to other farm activities/overlapping of operations. This result is also in line with the finding of (Anwar, 2010).

Table 8. Institutional factors in study area.

Variable		Frequency	Percent
Support from district agriculture and rural development office	Yes	59	65.6
	No	31	34.4
	Total	90	100
Cash shortage	Yes	64	71.1
	No	26	28.9
	Total	90	100
Time constrains during harvesting	Yes	63	70
	No	27	30
	Total	90	100
Training access	Yes	71	78.9
	No	19	21.1
	Total	99	100

Table 9. Access for training about coffee quality for traders in study area.

Variable		Frequency	Percent
Training access	Yes	42	89.3
	No	5	10.6
	Total	47	100.0
Tanning duration	Before a month	5	10.6
	Before 6 month	12	25.6
	Before a year	30	63.8
	Total	47	100
Market advisor	Yes	17	36.2
	No	30	63.8
	Total	47	100
Reason for lack market advisor	I have not heard	26	55.3
	Am not interested	4	8.5
	It is costly	17	36.2
	Total	47	100

Response of coffee traders

Survey results in the study area revealed that 89.3% of the sampled coffee traders had received extension services in maintaining coffee quality in particular, while remaining 10.6% did not get any type of service. Most traders (63.8 %) had access for such type of trainings before a year and the others (36.2%) before a month or before 6 months. Such types of trainings have roles in maintaining coffee quality.

In study area, in order to buy and sell coffee, 63.8% traders did not get advice from market advisers, whereas 36.2% of respondents had market advisers. As indicated in the study, traders had many reasons about market advisers; 55.3, 36.2 and 8.5% of traders responded they have not heard about it, are not interested and it is costly, respectively, as presented in Table 9.

Coffee producing farmers and traders in the studied Woredas have no coffee moisture testers; hence, both farmers and traders use their sense organs to determine moisture contents of the coffee as shown in Table 10. The result in Table 10 shows that 89.36% respondents determine moisture content by their sense organs which mean by crashing with their teeth, 10.64% test by other

Table 10. Moisture tester users and method of testing in study area.

Variable		Frequency	Percent
Moisture taster	Yes	7	14.9
	No	40	85.1
	Total	47	100
Method of testing	Crashing with teeth(local method)	42	89.36
	Other	5	10.64
	Total	47	100

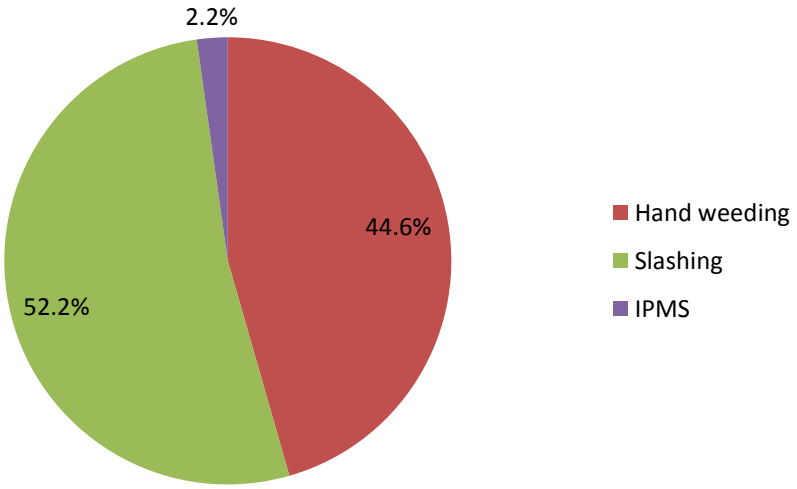

Figure 4. Mechanism used to prevent prevalent coffee weeds in the study area.

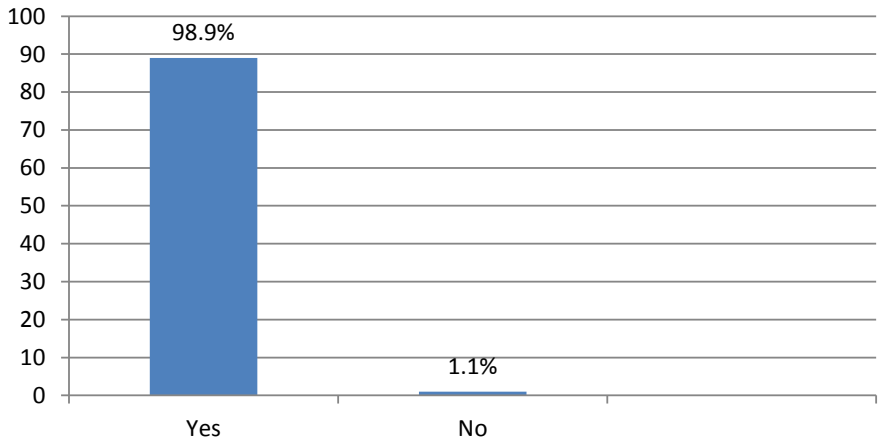

Figure 5. Controlling shade levels in study area.

methods. Drying is considered an important step in quality coffee production, since moisture levels higher than 12% can promote microbial growth and mycotoxin formation (Reh et al., 2006; Getachew et al., 2015).

Conclusion and recommendation

In this survey assessment it can be concluded that like owned old coffee trees, various diseases, plastic bags

packaging, storage more than four months, shortage of money at harvesting time and traditional way of coffee moisture testers have their roles in determining the coffee quality under Gedeo zone of coffee production areas. Therefore to overcome the problems affecting the quality of coffee production in the zone, it is better to work with farmers to replace old coffee trees with new ones, and the need for further researches concerning the control mechanism of the diseases. Many researches indicated that wet processing method is preferable to dry processing method; however in the zone, more than half of the processor used dry processing method, therefore, actions should be taken to use wet processing method. Farmers' perception and adoption of technology also have influence on quality of coffee; so, it is important to give different opportunities for the producers to adopt different technologies and give enough awareness for the farmers to change unreal perceptions.

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CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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