academicJournals

Vol. 11(24), pp. 2157-2165, 16 June, 2016
DOI: 10.5897/AJAR2015.10449
Article Number: 90FF1DC58987
ISSN 1991-637X

http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Assessment of harvest and post-harvest factors affecting quality of Arabica coffee in Gamo Gofa Zone, Southern Ethiopia

Gezahegn Garo[1*], Sabura Shara[1] and Yohanes Mare[2]

[1]Department of Horticulture, Arba Minch University College of Agricultural Sciences, P.O. Box 21, Arba Minch, Ethiopia.
[2]Department of Rural Development and Agricultural extension, Arba Minch University College of Agricultural Sciences, P.O. Box 21, Arba Minch, Ethiopia.

Received 25 September, 2015; Accepted 3 February, 2016

The quality of coffee produced in Gamo Gofa zone is declining from time to time due to improper harvesting and post-harvest management practices. Consequently, coffee produced under home garden is recognized as forest coffee at national market. Therefore, this study was conducted during 2012-2013 with the objective of assessing factors affecting coffee quality during and after harvest. Totally, 160 household respondents were used from three Woredas for data collection from relevant stakeholders, that is, farmers, middlemen (agents and traders) coffee processors and extension workers. Secondary data on coffee grades was also collected from the Ethiopian Commodity Exchange (ECX) coffee inspection laboratory located at Wolaita Soddo. Finally, quantitative data was analyzed by employing SPSS (version 20). The results indicated that most of respondents (79.4%) harvest their coffee at majority red ripe stage. Concerning harvesting method, 51.3% of respondents practice selective hand picking, while the rest 48.1% harvest by striping on the ground and collect together with previously dropped cherries. However, appropriate harvesting materials which were reported to have no contact with other chemicals were used by 95% of respondents. From post-harvest handling point of view, coffee drying places (69.4%), lack of appropriate drying (53.8%) and method of harvesting (48.1%) were the top three factors which are significantly affecting coffee quality in Gamo Gofa zone among others. However, 95% of respondents used appropriate harvesting materials, that is, local containers which were reported to have no contact with other chemicals. The results of ECX coffee grading showed that majority of coffee received grade seven, eight and nine out of nine scale commercial grades. Even through, inherent quality of coffee being grown in Gamo Gofa zone is good with bold beans. Thus, improvement on the way people harvest and handle their coffee to maintain inherent coffee quality in Gamo Gofa zone is recommended.

Key words: Coffee quality, harvest, post-harvest, forest coffee, Gamo Gofa.

INTRODUCTION

Coffee is produced in more than 70 countries and is the mainstay of most of these countries, accounting for over a large proportion of their total export earnings. Over 97% of the total coffee production in the world is, however, produced by 45 producing countries. For most of these coffee producing countries, it is the major source of

foreign currency earnings as well as a significant proportion of tax income and gross domestic product. Ethiopia produces large volume of coffee beans every year with 397, 500,000 kg in 2014 alone, ranking first in Africa and fifth in world (ICO, 2015).

Coffee growing and drinking spread around the world starting in the Horn of Africa, specifically Southwestern highlands of Ethiopia are the birth place and home to Arabica coffee. The majority of coffee produced in Ethiopia is forest-based traditional coffee production systems which mainly include: forest coffee, semi-forest coffee, garden coffee and plantation coffee. The level of management intensities vary from a little (none) on forest coffee to recommended agronomic practice on plantation coffee. Accordingly, over one million small-scale coffee farming households produce about 90% of Ethiopia's coffee. Moreover, about 25% of the Ethiopian population depends, directly or indirectly on coffee production, processing and marketing (Esayas, 2005).

It is estimated that 40% of coffee quality is determined in the field, 40% at post-harvest primary processing and 20% at secondary/export processing and handling including storage (Richard, 2007). Ethiopia is known to have broad diversities of coffee varieties each with its own unique liquor attributes: aroma, taste, and flavor, that vary significantly among the different coffee growing regions owing to different botanical, ecological, and environmental conditions in different areas. There is a growing commercial interest in the international market to trace and access single origin coffee, pure and unmixed with other origins in the specialty coffee concept.

Quality is a determining factor in the price of coffee beans. In fact, in Ethiopia, the quality determines whether it can be exported or must be sold locally. Moreover, quality defines whether the coffee will be bought at a standard commodity price or may acquire a "specialty" price, which is much higher. Generally, coffee quality comes from a combination of the botanical variety, topographical conditions, weather conditions, and the care taken during growing, harvesting, processing, storage, export preparation and transport (ITC, 2002). Interestingly, the quality of Arabica coffee in Ethiopia has its own reputation, not only because of the richness in coffee genetic diversity, but also in agro-ecology and vegetation covers. Ethiopia's wet-processed coffee is well known for its high quality in the world market. Thus, there is a focus in the country to have more wet-processed coffee. The Southern Nations, Nationalities and People Regional State (SNNPRS) is the largest producer of wet-processed (washed) coffee which accounts for more than 60% of the washed coffee produced in the country (ECXA, 2008). However, in Gamo Gofa zone, there is no single wet-processing station, all of coffee produced in the zone is processed in dry method (unwashed coffee).

Gamo Gofa zone is one of coffee producing areas in Southern Nations, Nationalities and People Regional State (SNNPRS), which is previously considered as a place where wild coffee existed and one of the coffee originating places. Despite the favorable climatic conditions, irrigable land and ample amount of irrigation water, long history of coffee production in Gamo Gofa midlands, coffee quality and productivity is declining from time to time due to several improper pre-and post-harvest management practices. Currently, there is no any forest coffee in Gamo Gofa zone, entire coffee is produced under home garden categories with shading (agroforestry systems); however, it is recognized as forest coffee at national level. For this reason farmers and traders are getting unfair value for their product, since minimum or no attention has been given to pre-and post-harvest management practices in the area though, coffee grows in suitable agro-ecology to have maximum coffee quality. Moreover, coffee produced in near boarder to Gamo

Gofa zone, like Yirgacheffee and Sidama brands are now internationally recognized and registered as property right to Ethiopia with their distinct character/flavor and taste (IPO, 2008). Therefore, coffee from this area is always sold at premium prices both at international and domestic markets, because of its distinctive fine inherent quality was maintained with appropriate pre and post-harvest management practices. In current situation production and supply of coffee with excellent quality seems more crucial than ever before, therefore it urges the zone to help producers get out of the coffee crisis by improving their coffee quality. Therefore, this research is concerned with identifying harvest and post-harvest factors which could be responsible for the decline in the quality and receipt of the brand forest coffee.

RESEARCH METHODOLOGY

Study area

This assessment work was conducted in Gamo Gofa zone, Southern Ethiopia in a year 2012-2013 at the three Woredas, namely; Geze Gofa, Bonke and Kamba. They are located 278, 54 and 115 km away from Arba Minch town, capital of the zone, respectively. Coffee is produced currently in all 15 Woredas in the zone, of which five (Melokoza, Bonke, Kamba, Geze Gofa and Boreda) are the major producers. The selected Woredas are accessible and supposed to represent the three agro-ecological zones where coffee is produced. The mean annual temperature of Geze Gofa and Bonke Woredas is in a range of 12.6 to 27.5°C, 10.1 to 27.5°C and the rainfall ranges from 1401 to 1600 and 810 to 1600 mm/annum, respectively. The average temperature and rainfall of Kamba Woreda is 10.1 to 27.5°C and 801 to 1600 mm/annum. The altitude of Geze Gofa, Kamba and Bonke ranges

*Corresponding author. E-mail: gezahegn_garo@yahoo.com.

Table 1. Harvesting stages and harvesting methods of coffee used in the area.

Harvesting stages	Frequency	%	Harvesting methods	Frequency	%
All red ripe	1	0.6	Selective hand picking	82	51.3
Majority red ripe	127	79.4	Stripe on ground and collect in bulk	56	35.0
Mixed yellow and green	29	18.1	Collect dropped cherries from the ground	21	13.1
Dried on tree	2	1.3	Other method	1	0.6
At green stage	1	0.6	-	-	-
Total	160	100	-	160	100

from 1500 to 3000, 501 to 3500, 800 to 3500 m.a.s.l, respectively. However, majority of the coffee is produced in the middle altitudes of the woreda.

Sampling techniques

Three Woredas and three Kebeles from each Woreda were selected purposively based on level of production among the 15 Woredas of the zone. Thirty key informants were drawn from all category, that is, middleman (traders' agents and traders) and extension workers (development agents [Das] and Woreda and zonal level experts). From the three Woredas, 130 household farmers were selected for interview following the sample size determination procedures of probability proportional to size technique to point out their views on coffee quality and how they handle their coffee after harvest. Totally, 160 respondents were used for the whole study.

Data collection

The assessment was conducted at farmers, trader and processors level. It involved both quantitative and qualitative data. For primary data acquisition, questionnaire was prepared and administered to concerned stakeholders, namely, extension workers (front level DAs, experts at Woreda and zonal level), middleman (traders' agents and traders), and coffee processors.

Farmers were interviewed to generate major coffee harvesting and post-harvest handling practices in the area and also key informant interview was held with farmers and DAs in three Woredas, to strengthen information gathered from interviewed farmers on harvest and post-harvest handling problems that contributes reduction in coffee quality in the area. Additionally, focus group discussion was held with farmers to strengthen and cross-check the data obtained from different stakeholders.

Secondary data on the amount of coffee delivered to central market as well as grades the coffee received was collected from central market in Addis Ababa and coffee inspection center of Ethiopian Commodity Exchange laboratory located at Wolaita Sodo.

Data analysis

Quantitative data collected from different sources was analyzed using SPSS version 20 software. 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

Harvest related factors

Coffee harvesting stages and methods used

It is widely agreed that traditional hand pricking and husbandry labor, as opposed to mechanical harvest, produce the best quality green coffee by decreasing the percentage of defects in coffee batches. Harvesting stages and methods practiced in the study area is shown in Table 1.

The result indicated that most of the respondents (79.4%) harvest their coffee at majority red ripe stage (Table 1). This implies that in the study area, majority of the farmers harvest their coffee at better stage to maintain coffee quality. A significant number (18.1%) of farming households harvest their coffee at mixed yellow and green stages. According to Adriana et al. (2009) in order to maintain and protect the coffee beverage quality, aroma, thickness of the brew, taste and flavor as well as acidity in cup analysis, coffee should be harvested at red ripe stage whether it is processed in dry or wet-method. Though, in this area coffee is processed in dry method only, it is possible to maintain inherent coffee quality without deterioration by harvesting red ripe cherries. In line with this, an assessment done in Jimma zone Gomma Woreda indicated that, harvesting stage is currently not a major problem when coffee quality is concerned as a result of comprehensive effort exerted to reduce harvesting unripe cherries in the area (Techale et al., 2013).

Concerning harvesting method, surveyed farmers exercised commonly three methods of harvesting (Table 1), that is, selective hand picking (51.3%), striping on the ground and collecting in bulk (35%) and collecting from the ground which was dropped from the tree (13.1%). During the coffee harvesting, most practices were focused on quantity and speed, not quality. Around 48% of respondents in the area were harvested only once, and all ripe and unripe beans are striped together. 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

Table 2. Materials used for harvesting in the study area.

Material used	Frequency	%
Basket made of bamboo	103	64.4
Local wooden containers	50	31.3
Plastic sacks	6	3.8
Other material	1	0.6
Total	160	100

Table 3. Coffee drying methods practiced in the study area.

Method of coffee drying	Frequency	%
Raised wire mesh beds	1	0.6
Cemented ground	1	0.6
Mats made of bamboo	47	29.4
Ground leveled with mud	38	23.8
Ground leveled with cow dung	73	45.6
Total	160	100

contact with ground (soil) resulted in earthy flavor in the final cup taste and also the raw coffee quality was less attractive.

Materials used for harvesting and method of coffee drying

From the survey, it was revealed that around 95.7% (Table 2) of the respondents used appropriate harvesting materials, that is, local containers (bamboo and wooden made) which were reported to have no contact with other chemicals. However, 3.8% of respondents used plastic sacks. They need to avoid using plastic/polyethylene sacks for harvesting since it has an opportunity to contaminate coffee quality especially when the container is used for transporting grains and/or chemical fertilizers. Generally, in the research area, harvesting material was not the main problem of coffee quality.

Postharvest related factors

Methods of coffee drying

With regard to coffee drying methods, about 69.4% (Table 3) dry their coffee on the ground leveled with mud and cow dung.

As the result confirmed, use of raised wire mesh beds and cemented ground for coffee drying is very small in the study area. These were used by the traders who collect non-dried and partially dried coffee from farmers and brokers and dry by their own efforts. The finding showed that use of inappropriate drying methods can be considered as one of the main problems contributing to low coffee quality in the study area. In disagreement with present result, 49.9% dry on raised drying beds and 2.5% dry on cemented floor in south western Ethiopia (Richard et al., 2007), drying coffee on the ground by large number of farmers (48%) was also a problem in this area. The appropriate drying method for coffee is on raised wire mesh beds, cemented ground and if not, better to use mats made of bamboo. As coffee is a hygroscopic commodity, it can easily absorb foreign materials from inappropriate post-harvest management areas. In line with this, the secondary data from ECX (Tables 6 and 7) indicated that coffee supplied from Gamo Gofa zone has got an average grade eight, even if coffee from this area is inherently larger in bean size (bold beans). This result is in line with Getachew et al. (2015), who reported drying coffee on mesh wire and bamboo mats with thin layer thicknesses earned better raw quality attributes. Given the potential problems associated with drying on this surface, and its negative image, the practice of direct drying of coffee on ground leveled with mud and cow dung should be strongly discouraged.

Methods moisture content determination and mold development

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 (Table 4).

The result in Table 4 shows that half of the respondents (51.3%) determine moisture content by its sound, 32.5% test by crashing with their teeth and around 13.1%

Table 4. Moisture content determination method used and mold developed while coffee was sold to traders.

Moisture determination method	Frequency	%	Mold developed	Frequency	%
Using machines	1	0.6	Yes	84	46.9
Crushing with teeth	52	32.5	No	75	52.5
By its sound	82	51.3	No answer	1	0.6
Counting drying day	3	1.9	-	-	-
Without considering moisture content	21	13.1	-	-	-
Other methods	1	0.6	-	-	-
Total	160	100	-	160	100

farmers store their coffee without considering moister content, at the end which resulted in mold development. 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). Generally, degree of dryness was tested with two methods: dental and digital. The dental method involves peeling the parchment of an individual bean and biting it with incisors. If it is easily dented or even cut by the bite, it is not dry. If a hard bite hardly dents the bean, it is dry. The dental method is subjective and non-accurate method. The digital method relied on a digital coffee moisture meter (tester), when correctly calibrated; it is the best method to determine moisture content of coffee. The other problem identified in the area is that farmers add some water, while they sell coffee to the traders to increase weight of their coffee. If traders do not dry coffee bought from the farmers within 24 h, there will be a chance of mold development. This adds to the mold already developed in farmer's storage.

Farmers in the study area (46.9%) sale their coffee after it has developed molds due to storing of coffee without appropriate dryness. However, 52.5% of farmers sold their coffee without mold development (Table 4). Coffee must be dried so that it has a moisture content of 11 to 12% for processing or storage. At this level, coffee beans will preserve their inherent quality, mold development is limited and minimal breakage will occur during hulling, grading and exporting. Hence, the exact moisture content of the coffee has not been determined for more than 99.4% of the respondents, which could be the most important reason for the observed mold development. The different moisture content determination methods used in the study areas are not effective enough to maintain the inherent coffee quality.

Types of coffee sold to different parties in the study area

In Ethiopian conditions, fresh red ripe cherry coffee was sold to a place where there is wet processing station, but still it is great advantage on the coffee quality point of view if traders ("*Akirabis*") buy fresh red ripe cherries and dry it in their own facilities to minimize the contamination during post-harvest handling and poor storage at farmer's level. The result indicated that 20% of respondents sold their coffee at fresh red ripe stage to suppliers who are willing to dry on their own facilities, because there is no wet processing facility in Gamo Gofa zone. However, substantial number of farmers (78.6%) sold their coffee at dried stage (Table 4). Selling at dry stage by itself has no problem, but different faults are committed by farmers during drying processes that have negative effect on coffee quality. Therefore, coffee quality would be better maintained if farmers sell red ripe cherries to suppliers, who will dry the coffee on their drying facilities to reduce contamination due to inappropriate drying by the farmers. With regard to processing methods, wet method better maintains inherent coffee quality than the other methods over different locations and genotype and resulted in better coffee cup quality (attributes like acidity, body and flavor) and bean physical quality (attributes like odor) as compared to the dry processing method (Mekonen et al., 2009; Anwar, 2010).

The result in Table 5 indicated that only 38.9% respondents assured that coffee in the area was sold to certified traders. The left 7% of respondents argued that coffee produced in the area was used for local consumption. Basically, 50% of coffee produced in the country is used for local consumption; exceptionally green bean consumption in Gamo Gofa zone is lower because majority of producers used leaf as a beverage which reduces leaf area to fruit ratio. This may have contributed to deterioration in coffee quality and reduction in coffee productivity in the area. This is in agreement with findings of Vaast et al. (2006), who indicated that a larger leaf area-to-fruit ratio (better bean-filling capacity) linked to superior cup quality.

According to rules and regulation of coffee marketing in Ethiopia, coffee sold to the commercial market should be traceable to its growing origin, in order to regulate coffee quality. Thus, coffee suppliers are expected to have trading license from their respective regions. They are responsible to supply the coffee collected from coffee producing origin to the auction centers for quality inspection and auction for world markets. Ethiopia exports its coffee based on their areas of origin (type),

Table 5. Types of coffee sold to different parties by farmers.

Types of coffee sold to traders	Frequency	%	Majority of coffee sold to	Frequency	%
Fresh ripe cherries	33	20.6	*Certified traders	63	39.4
Dried cherries	125	78.1	Locale consumers	12	7.5
Green bean	2	1.3	different areas through smuggling	85	53.1
Total	160	100	-	160	100

*Local traders who supply coffee to central market, suppliers (“Akirabs”).

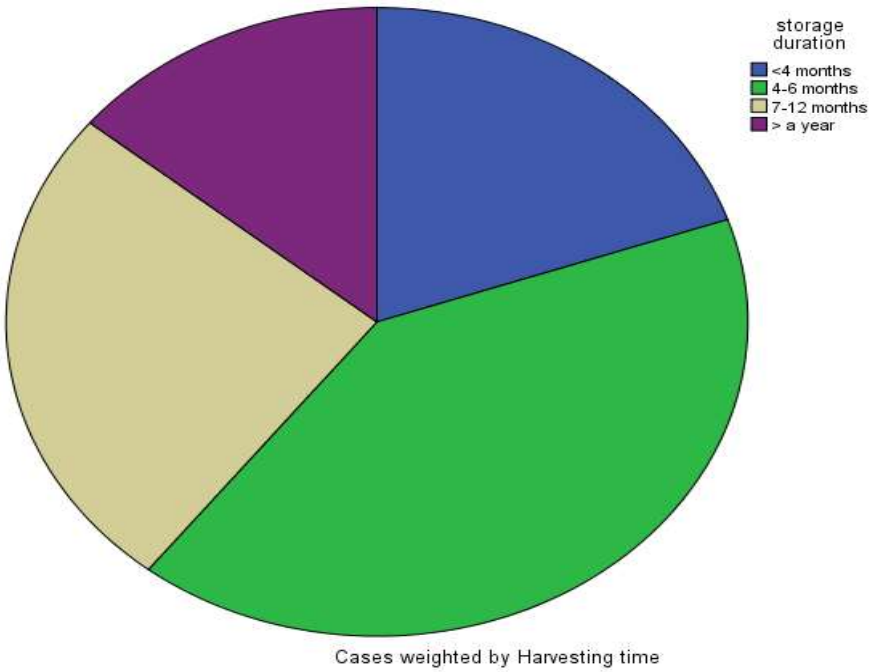

Figure 1. Variation in coffee storage duration in study area.

which are known for their own distinct quality and agronomic characters (MoARD, 2008). The result confirmed that, 39.4% of respondents sale their coffee to certified trader, but more than half (53.1%) of respondents (Table 5), perceived as coffee from this area has been transported to different areas through smuggling. This affects not only the volume of coffee supplied from Gamo Gofa zone to central market, but also its quality associated the handling practices of farmers and smugglers. Moreover, smuggling of coffee to other areas can affect the coffee quality of specific origin as it adulterates the coffee with which it is mixed.

Coffee storage duration in the area

Coffee storage is an important step, since the dried coffee can easily absorb bad flavors or moisture that degrades the quality from the storage area. Once the samples reached their target moisture, farmers or traders should put into a cool dry area away from the potential contaminants, such as cow dung, soils, chickens and smoke sources. The moisture levels were checked frequently to ensure that the levels had equilibrated and stabilized at the target moisture levels. 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. Majority (40.8%) of farmers in the study area store coffee for about 4 to 6 months, 25.4% for about 7 to 12 months, 19.7% stores for <4 months and 14.2% stores coffee for more than a year (Figure 1). According to Wintegens (2004), green coffees stored for a longer period described as ‘aged coffee’ may suffer a loss of their acidity, which is needed for a coffee to have a specialty coffee grade. On the other hand, length and condition of bean storage also affect cup quality (Yigzaw, 2005). Moreover, long time storage

Table 6. Grades and amount of coffee supplied in a year 2004 E.C (2011/2012) from different woreds of the zone.

Coffee Grades	Woreda								Total		%
	Denba Gofa		Arba Minch		Mellokoza		Geze Gofa				
	Unwashed		Unwashed		Unwashed		Unwashed				
	Bags	kg	Bags	kg	Bags	kg	Bags	kg	Bags	kg	
1	-	-	-	-	-	-	-	-	-	-	-
2	-	-	120	10200	-	-	-	-	120	10200	0.75
3	-	-	720	61200	-	-	-	-	720	61200	4.48
4	60	5100	240	20400	-	-	60	5100	360	30600	2.24
5	240	20400	60	5100	-	-	60	5100	360	30600	2.24
6	-	-	120	10200	-	-	420	35700	540	45900	3.36
7	900	76500	60	5100	480	40800	2280	193800	3720	316200	23.13
8	2220	188700	-	-	4200	357000	1320	112200	7740	657900	48.13
9	600	51000	-	-	960	81600	300	25500	1860	158100	11.6
UG (under grade)	-	-	-	-	240	20400	-	-	240	20400	1.49
Local (1-5C)	180	15300	240	20400	-	-	-	-	420	35700	2.61

Summary of ECX Wolaita Sodo coffee inspection laboratory 2004 E.C. Grade 1&2 is a specialty coffee with excellent quality, grades from 3 up to UG are exportable grades but UG is poorest of exportable grades.

Table 7. Grades and amount of coffee supplied in a year 2005 E.C (2012/13) from different woreds of the zone.

Coffee Grades	Woreda								Total		%
	Denba Gofa		Arba Minch		Mellokoza		Geze Gofa				
	Unwashed		Unwashed		Unwashed		Unwashed				
	Bags	kg	Bags	kg	Bags	kg	Bags	kg	Bags	kg	
1	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-
3	-	-	327	27595.89	-	-	-	-	327	27595.89	3.49
4	60	5104.2	876	74804.69	-	-	-	-	936	79908.89	10.10
5	-	-	641	54503.87	-	-	-	-	641	54503.87	6.89
6	165	13986.15	73	6212.11	-	-	60	5084.2	298	25282.46	3.19
7	-	-	-	-	300	25281	480	40933.6	780	66214.6	8.37
8	268	22729.96	-	-	2249	190808.1	1473	124890.1	3990	338428.16	42.80
9	-	-	-	-	1393	117648.3	270	11480.9	1663	129129.2	16.30
UG	-	-	-	-	84	7201.92	120	10208.4	204	17410.32	2.20
Local (1-5C)	210	18162.5	244	20483.65	209	14241.9	-	-	663	52888.05	6.68

Summary of ECX Wolaita Sodo coffee inspection laboratory 2005 E.C. Grade 1&2 is a specialty coffee with excellent quality, grades from 3 up to UG are exportable grades but UG is poorest of exportable grades.

under high relative humidity and warm conditions increase bean moisture content and consequently reduce quality in terms of raw and roasted appearance as well as liquor (Woelore, 1995). Even under adequate or optimal storage conditions, coffee beans deteriorate with age. This phenomenon is accelerated when the environment is hot and/or humid and the bean takes off-flavor due to the oxidation of its own fats. If longer storage is sought, it is better to store at a temperature blow 20°C and 65% relative humidity. The generally accepted time for green coffee storage under normal conditions is one year.

As shown in Figure 1, 60% of respondents stored their coffee up to 6 months. This storage duration would be better to maintain the quality of coffee in the study area, but above one year storage duration practiced by 15% of respondents does not seem to be appropriate as the storage conditions do not meet the normal standards.

Grades of coffee from the study area

The coffee supplied to the auction centers from the

Table 8. Major factors affecting coffee quality in the area in their order of importance.

Order	Major factor	Problem faced	% of HH respondent
1	Coffee drying place	Drying on ground leveled with mud and cow dung	69.4
2	Coffee transportation out of the origin	Mixing of coffee from different origin and miss handling of coffee beans	54.1
3	Storage condition	Mold developed on coffee	53.8
4	Method of harvesting	Striping and collecting from the round	48.1
5	Storage duration	About 4-6 months	40.8

different part of country is inspected to set standards and grades. The grades and standards are used to categorize the coffee supplied based on its quality by coffee quality inspection laboratory.

The secondary data from Ethiopia Commodity Exchange (ECX) supported the miss harvesting and post-harvest handling practices of coffee in Gamo Gofa zone. Results indicated that coffee supplied from this zone scored lower grades (Table 6). The best grade scored was grade 2 with only one sample, that is, 0.75% of the coffee supplied in 2011/2012 production year. The majority of coffee supplied scored grade seven, eight and nine 23.13, 48.13 and 11.6%, respectively out of the coffee supplied in same production year. The same conditions was repeated in the year 2012/2013 from coffee grade point of view, that is, grade seven, eight and nine with 8.37, 42.80, and 16.30%, respectively shared the majority weight of coffee supplied in the year to inspection laboratory. Not only the quality declined but also the volume of coffee supplied to the central market decreased in 2012/2013. The two year data showed that grades of coffee supplied from Arba Minch (Kamba, Bonke, Boreda and Arba Minch Zuria) woreda is relatively better than coffee supplied from Gofa areas (Denba Gofa, Geze Gofa and Mellokoza). Even though Mellokoza is the major supplier of coffee in Gamo Gofa zone, its quality is much lower (below grade six). Inappropriate harvesting and post-harvest handling practices could have reduced grades of coffee from this area among other factors. This is in agreement with findings of Alemayehu and Esayas (2008) who pointed out that 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.

Problem ranking

As indicated among harvest and post-harvest handling practices in the area, coffee drying places (69.4%), storage condition(lack of appropriate drying) (53.8%),and method of harvesting (48.1%) are the top three factors significantly affecting coffee quality in Gamo Gofa zone (Table 8).

Conclusion

The coffee categorized as forest coffee at national market could be due to the existence of maximum primary defects but currently no coffee is growing in the forest in the area. The coffee grown in Gamo Gofa zone has competitive agro-ecological advantages like that of Sidama and Yirgacheffe locations in southern Ethiopia, to have maximum coffee quality. However, according to annual summary of ECX (Ethiopian Commodity Exchange), majority of coffee in the area has been receiving significantly lower grades i.e. grade six, grade seven and grade eight. Inappropriate harvesting methods, lack of appropriate drying and drying place are the major factors that could be limiting coffee quality and lowering market prices supplied from this area. To maintain quality of coffee, great effort is needed in creating awareness, encouraging use of raised beds, drying to proper moisture level and use of suitable storage facilities which inhibit the growth of molds. Additionally, it is important to promote wet processed coffee in the area to reduce influence of post-harvest handling practices from the farmer's side in a view of specialty coffee promotion. Thus, improvement in quality leading to receipt of its own brand name is important to drive maximum benefit from coffee sector. In addition, research in pre-harvest coffee husbandry is needed to reach to a comprehensive recommendation.

Conflict of Interests

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

The authors wish to thank Arba Minch University for financial support. Supports of Ethiopian Commodity Exchange (ECX) in delivering secondary data on coffee quality is highly acknowledged. Special thank goes to Mekonen H/Michael and Wadillo Wana, ECX quality

control staffs. Farmers, extension staffs and coffee traders deserve heartfelt thanks for their willingness in providing the required information.

REFERENCES

Alemayehu T, Esayas K, Kassu K (2008). Coffee development and marketing improvement plan in Ethiopia. In Proceedings of the National Workshop of Four Decades of Coffee Research and Development in Ethiopia, Aug pp. 14-17.

Anwar A (2010). Evaluation of coffee quality and its problem in Oromia regional state. MSc thesis, submitted to post graduate school of Jimma University College of Agriculture and Veterinary Medicine.

ECXA (2008). Ethiopia Commodity Exchange Authority. Understanding commodities to be traded at Ethiopia commodity exchange. Analysis of coffee supply, production, utilization and marketing issues and challenges in Ethiopia, Coffee profile 1.

Esayas A (2005). Molecura genetic diversity study of forest coffee tree population in Ethiopia: Implication for conservation and Breeding. Doctoral thesis, Alnarp, Sweden.

Franca AS, Oliveira LS, Franca AS (2009). Coffee processing solid wastes: current uses and future perspectives. Agric. Wastes 9:155-189.

Getachew E, Berhanu T, Ali M, Tesfaye S, Yehenew G (2015). Influence of sun drying methods and layer thickness on quality of midland arabica coffee varieties at Gomma-II, Southe West Ethiopia. Glob. J. Agric. Sci. 3(2):203-212.

ICO (2015). International Coffee Organization. Total Production by exporting countries. Available at: http://www.ico.org/prices/po-production.pdf

IPO (2008). Intellectual Property Office of the United Kingdom.

ITC (2002). International Trade Center. Coffee, product and market development, an exporter's guide. UNSTAD / WTO. Geneva.

Mekonen H (2009). Influence of genotype, location and processing methods on the quality of coffee (*coffea arabica l.).* Msc. thesis, Hawassa University, Ethiopia.

MoARD (2008). Ministry of Agricultural and Rural Development. Sustainable production and supply of fine Arabica Coffee to the World. Addis Ababa, Ethiopia.

Nicholas P (2007). Ethiopia's coffee sector: a bitter or a better future? J. Agr. Change 7(2):225-263.

Reh CT, Gerber A, Prodoillet J, Vuataz G (2006). Water content determination in green coffee- Method comparison to study specificity and accuracy. Food Chem. 96:423-430.

Richard M, Charles A, Mitiku M (2007). Primary coffee processing in Ethiopia: Patterns, constraints and determinates. Afr. Crop Sci. Conf. Proceed. 8:1417-1421.

Techale B, Musema A, Kasahun M (2013). Prevalence of some coffee quality problems in Gomma Woreda, Jimma Zone. Int. J. Agric. Sci. 3(8):621-627.

Vaast P, Bertrand B, Perriot J-J, Guyot B, Génard M (2006). Fruit thinning and shade improve bean characteristics and beverage quality of coffee (*Coffea arabica* L.) under optimal conditions. J. Sci. Food Agric. 86:197-204.

Wintegens JN (2004). Coffee: Growing, processing, sustainable production, a guide book for growers, processors, traders, and researchers.

Woelore WM (1995). Parchment arabica coffee storage. In: the proceedings of the 16th International Scientific Colloquium on Coffee, Kyoto, Japan. pp. 565-573.

Yigzaw D (2005). Assessment of cup quality, morphological, biochemical and molecular diversity of *C. arabica* L. genotypes of Ethiopia. PhD thesis, University Free State. P 97.