

Review on Coffee Production and Quality in Ethiopia

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Abstract: Coffee is one of the world's most significant agricultural commodities. Ethiopia is the origin of Arabica coffee (*Coffea arabica* L.) and contains a diverse genetic pool. The goal of this review is to provide an overview of Ethiopian coffee production, production systems, and quality. Coffee production is critical to the Ethiopian economy, with around a quarter of the people relying on it directly or indirectly for survival. Ethiopia's main product, coffee, is the country's economic backbone. Ethiopian coffee output is between 400,000 and 550,000 metric tons per year, depending on weather and soil conditions. Coffee, Ethiopia's principal export, is the country's economic backbone with the majority growing in the country's south, southwest, and east. Ethiopia has four techniques of coffee production: forest coffee, semi-forest coffee, and forest coffee. Coffee quality is a yardstick for the coffee industry. Despite good climatic conditions and a diverse range of indigenous coffee cultivars, coffee quality has been dropping owing to a variety of inadequate pre-and post-harvest methods. Despite ideal climatic conditions and a diverse range of indigenous coffee kinds for quality development, coffee quality has been deteriorating owing to a variety of inadequate pre-and post-harvest practices. Lack of competitiveness, infrastructure, proper access to services, insufficient value addition, effective knowledge transfer and research, competitiveness, and unpredictability of rainfall are all major challenges to Ethiopian coffee production, and coffee marketing, pricing instability, and restricted market access have all been cited as major concerns. Enhancing infrastructure and institutional facilities, as well as upgrading coffee manufacturing techniques that include the introduction of new coffee varieties. As a result, enhancing coffee quality required the use of proper agronomic and climatic conditions, as well as the adoption of proven crop varieties.

Keywords: Coffee, Ethiopia, Methods, Quality, Production

1. Introduction

Coffee is grown in over 70 countries and is the mainstay of most of them, accounting for a significant percentage of their overall export profits. However, 45 coffee-producing countries account for more than 97 percent of global output. For the majority of these coffee-producing countries, it is the primary source of foreign currency earnings as well as a substantial percentage of tax revenue and GDP. Ethiopia is one of the countries that are significantly reliant on coffee, being the world's sixth-largest producer [1].

Agriculture is extremely important to Ethiopia's economy. The coffee sub-sector of agricultural production has a significant influence on the country's economy. Arabica coffee is the most important source of foreign currency profits and contributes significantly to GDP [2].

Arabica coffee accounts for the lion's share of foreign

exchange earnings, accounting for up to 35 percent of total GDP. Coffee farming is important for the country's cultural and socioeconomic well-being. About a quarter of Ethiopia's population (15 million) is dependent on coffee cultivation, processing, and marketing, either directly or indirectly [3].

In Ethiopia, 764863.16 ha of land was set aside for coffee cultivation, yielding 494574.36 tons with average productivity of 0.64 tones ha⁻¹ in the 2018/19 Meher Season, with South Nation Nationalities and Peoples Regional State (SNNPR) accounting for 30% of the total production [4]. Oromia leads Ethiopia's top 25 coffee-producing districts, with 18 of them, while the remaining top coffee-producing districts are in the South Nations, Nationalities, and Peoples Regional State [5].

Ethiopia's coffee industry has a promising future [6]. The country has the right height, the right climate, enough workers, and fertile land. It can manufacture and provide quality specialty coffee on a long-term basis, with the

capacity to create all coffee kinds from diverse coffee-growing regions throughout the world. Other coffee production prospects in Ethiopia include significant national and worldwide demand for the commodity, growing private sector interest with great investment potential, and strong backing from both regional and federal governments [7].

Ethiopia's most significant export commodity is coffee, which is the country's economic backbone. Ethiopia's coffee exports reached a new high of almost 917 million US dollars in the 2017/18 marketing year (United States Department of Agriculture [8]).

Coffee is grown in Ethiopia at elevations ranging from 550 to 2,750 meters above sea level. Arabica, on the other hand, thrives and produces best between 1,300 and 1,800 meters above sea level, with annual rainfall ranging from 1,500 to 2,500 mm and optimal minimum and maximum air temperatures of 15 and 30 degrees Celsius, respectively [9]. Despite the country's great variability and the huge number of varieties introduced, most farmers continue to use their landraces. Furthermore, variations that have been officially issued are likewise site-specific. The average green coffee bean yield per hectare per year is 0.7 t ha⁻¹, which is much lower than the global average of 0.8 t ha⁻¹ and the Brazilian average of 1.3 t ha⁻¹, respectively.

This might be due to a variety of physical, biological, and human-made reasons, one of which is the shortage of high-yielding cultivars available to growers. In the manufacturing of coffee, biological and institutional variables play a larger influence. The main limitations to coffee production were diseases, insect pests, a lack of market knowledge, a lack of physical infrastructure, a lack of better coffee varieties, and insufficient extension services [10].

Additionally, poor management techniques, low soil fertility, and low prices are all considered key coffee production limitations. Climate change is expected to have a significant impact on population dynamics as well as the development of agricultural insect pests and illnesses. Temperature changes have a direct and substantial impact on insect growth, reproduction, and survival [11].

When coffee infections are not addressed, they result in significant losses. Disease-causing organisms infecting the coffee crop resulted in a 57 percent reduction in output, according to Cerda et al. [12]. Coffeeberry disease (CBD), coffee wilt disease (CWD), and coffee leaf rust (CLR) are the most commercially important pathogenic coffee illnesses, according to Jima et al. [13], whereas physiological disorders such as coffee branch dieback are caused by pseudomonas

syringe other non-pathogenic agents. Similarly, significant yield losses in coffee production were caused by CBD and branch dieback. Insect pests such as the Anesthesia bug and the coffee blotch miner, on the other hand, are the most common and cause significant harm. Diseases and insect pests are causing significant crop losses, according to an evaluation conducted in Eastern Ethiopia. On a few producers' coffee farms, CBD is a serious illness, but CWD is considered minor. Similarly, the coffee stem borer and coffee berry borer were important insect pests that harmed coffee production in Eastern Ethiopia. In contrast, insect pests such as coffee trips, green scale, and coffee cushion scale have been identified as major coffee production constraints in the country [10].

Ethiopia has conducted several studies on coffee production, processing, and marketing issues. However, they are unable to reach all coffee-producing areas in Ethiopia, particularly in southern Ethiopia. As a result, this work was carried out to cover undisturbed coffee-producing areas in southern Ethiopia, and viable solutions to issues and proposals for possibilities were developed.

As a result, the agronomic, socioeconomic, and environmental difficulties and opportunities in Ethiopia's coffee-growing regions must be investigated, gaps found, recorded, and appropriate solutions recommended. Thus, this review aims to look at the production, production system and quality of Ethiopian coffee.

2. Coffee Production and Production System in Ethiopia

2.1. Coffee Production in Ethiopia

Over 4 million small-scale farmers cultivate coffee. Farmers who grow and produce stimulant crops like coffee are more numerous than those who grow fruits [15]. At various stages throughout the value chain, it employs 15 million people or about 15% of the country's population. The vast majority of it is grown on tiny pieces of land, usually less than half a hectare. Ethiopia is the world's sixth-largest producer of coffee, accounting for 4% of global output. It is also Africa's greatest producer, accounting for around 40% of the continent's output [16]. From 2012/13 to 2016/17, the number of coffee growers grew and then decreased. The overall amount of land dedicated to coffee cultivation has risen during the years studied but at varied rates. Table 1 also revealed that coffee yields in the nation had fluctuated over the previous six years.

Table 1. Estimated number of holders, area, and yield of coffee over six years.

Year	Number holders of	Areas (Ha)	% Δ in areas	Production (quintals)	% Δ in production	Yield (Q/Ha)	% Δ in yield
2012/13	4,217,916.0	528,751.1	-	3,739,406.4	-	7.07	-
2013/14	4,546,785.0	538,466.8	2.0	3,920,062.2	5.0	7.28	3.0
2014/15	4,723,483.0	561,761.8	4.0	4,199,801.5	7.0	7.48	3.0
2015/16	5,273,483.0	653,909.7	16.0	4,145,964.5	-1.0	6.34	-15
2016/17	6,455,194.0	700,476.6	7.0	4,690,911.2	13.0	6.70	6.0
2017/18	5,019,513.0	725,961.2	4.0	4,492,298.0	-4.0	6.19	8.0

Source: own computation from CSA of 2012/13; 2013/14; 2014/15; 2015/16; 2016/17; 2017/18. NB: represents change [14].

Figure 1 clearly shows that the trend of coffee yield has been declining. A negative number for the yield trend line indicated that yield has decreased during the preceding 25 years. In 1999 and 2012, the greatest and minimum quintal

yields per hectare were 8.65 and 5.2 quintals, respectively. The low value of R-square in the yield trend line indicates that the yield trend line did not match the data or that yield variance was significant in Ethiopia during the last 25 years

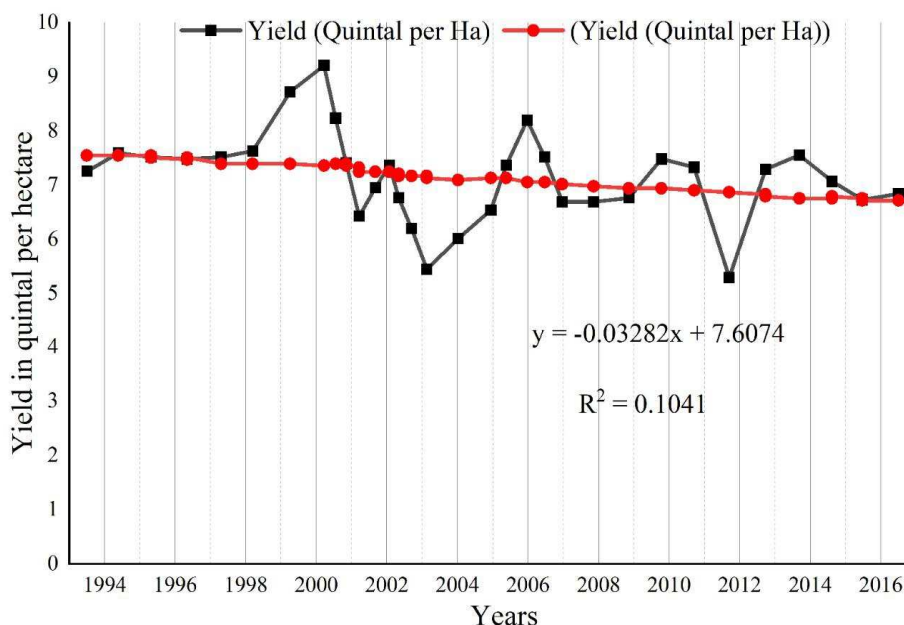


Figure 1. Trends of coffee yield over 25 years in Ethiopia Source; (from FAOSTAT, 2019) [17].

2.2. Coffee Production System in Ethiopia

The west and southwest, as well as the southern, eastern, and central areas of Ethiopia, are the major coffee-growing regions [18]. Based on management level, vegetation, structural complexity, and agronomic approaches, Ethiopian coffee production systems may be classified into four categories: forest coffee (FC), semi-managed forest coffee (SFC), garden coffee (GC), and plantation coffee (PC) [19-21].

- 1) *Forest coffee system*, which includes simple coffee gathering and forest production, where coffee trees are simply protected and tended for convenient picking.
- 2) *In the semi-forest coffee system*, where farmers slash weeds, lianas, and competing shrubs, thin forest trees, and fill open spaces with local seedlings. Both systems predominate in south-western Ethiopia and Bale. They account for 5 and 35% of national coffee production, respectively [22].
- 3) *The garden coffee system* is a further step in the cultivation process. Seedlings are taken from forest coffee plantations and transplanted closer to farmers' dwellings. In this system, coffee is grown in smallholdings under a few shade trees, usually combined with other crops and fruit trees. The garden coffee system predominates in the south (Sidamo), in the west (Wellega), and in the east (Harerge and Arsi). Very small-scale coffee growing in the marginal zones of northern Ethiopia such as Gojam and Welo can also be included under this category. Garden coffee accounts for about 50% of national production.

- 4) *plantation coffee system*, where coffee is cultivated after land clearing with systematic soil preparation and seedling planting, and managed to maximize the volume of production and productivity. This sector includes a few large private and state farms mainly located in the southwest, as well as many smallholder plantations spread all over the coffee-growing areas. It accounts for about 10% of national production.

These four systems, as well as intermediate or mixed circumstances, exist in Ethiopia like nowhere else on the planet. Furthermore, they are not separated from one another. For example, in forest coffee and semi-forest coffee systems, the coffee genotypes, which are commonly referred to as "wild coffee" in the literature, are produced directly from forest coffee trees. The planting material in the garden coffee system is the product of a complicated process of movement, exchanges, and selection by farmers, as well as adaptability to conditions that are sometimes geographically and ecologically remote from its native home [23].

2.3. Coffee Quality

The International Organization for Standardization (ISO) defines quality as the ability of a set of intrinsic qualities of a product, system, or process to meet the needs of consumers and other interested parties (ISO, 2000) [24]. These innate traits are referred to as "attributes." There are several ways to express quality. According to ITC [1], the quality of a coffee parcel is determined by a mix of botanical variety,

topographical circumstances, meteorological conditions, and the care given throughout growing, harvesting, storage, export preparation, and transit. In the case of coffee, however, the concept of quality and the qualities evaluated have been questioned.

Nowadays, according to Lorey et al. [25], this definition varies along with the production to consumer chain:

- 1) *At the farmer level*: coffee quality is a combination of production level, price, and easiness of culture;
- 2) *At the exporter or importer level*: coffee quality is linked to bean size, lack of defects, regularity of provisioning, tonnage available, physical characteristics, and price;
- 3) *At the roaster level*: coffee qualities depend on moisture content, stability of the characteristics, origin, price, biochemical compounds, and organoleptic quality. It should be noted that each consumer market or country may define its organoleptic qualities;
- 4) *At the consumer level*: coffee quality deals with price, taste, and flavor, effect on health and alertness, geographical origin, environmental and sociological aspects (organic coffee, fair trade, etc) [25].

The ISO (2004a) established a quality standard for green coffee (ISO 9116 standard) [26]. It needs a variety of details, including the coffee's geographical and botanic origins, harvest year, moisture content, total faults, the proportion of insect-damaged beans, and bean size. These ISO standards describe measuring techniques for a variety of these characteristics, including flaws, moisture content, bean size, certain chemical components, and sample preparation for cup tasting. In his study on quality, the researcher must consider all of these factors. We'll go through four key quality criteria to show the challenges and restrictions that must be overcome to enhance coffee quality. Three of these, moisture content, physical, and organoleptic qualities, are employed throughout the manufacturing chain, but the fourth, "health quality," is becoming increasingly important to customers.

2.4. Major Factors Affecting the Coffee Quality

Coffee quality is a complicated feature that is influenced by several elements including species, genetic characteristics, ambient circumstances, storage conditions, industrial processing and beverage preparation, and consumer taste. The coffee business places a premium on coffee quality. Coffee quality is affected by a variety of factors, including genotype, climatic conditions, soil characteristics of the location, agronomic practices, harvesting time, post-harvest processing processes, grading, packaging, storage condition, and transportation [27].

2.4.1. Genetic Factor

Coffee quality is heavily influenced by the genetic origin of plant species. Coffee's genetic makeup was compared to four qualities (acidity, body, taste, and fragrance), all of which are suitable as selection criteria for genetic enhancement of total liquor quality [28]. Furthermore, Abiyot [29] said that different coffee genotypes may be used to assess cup quality with the help of experienced coffee

tasters. Bezawit [30] made a similar discovery about the importance of genotype cross environmental interaction effects on the coffee bean and, ultimately, the product's liquid quality.

2.4.2. Climatic and Soil Factors

Altitude, daily temperature fluctuations, rainfall quantities and distribution, and physical and chemical properties of soil all have a substantial impact on coffee quality, according to Alemayehu et al [31]. Although temperature and rainfall impact coffee throughout ripening and flowering bean growth, climate, height, and shadow all have a role [32]. At higher elevations (low air temperature) or under shade, the ripening process of coffee berries takes longer, allowing for more time for complete bean filling. As a result, the delayed maturation process should play an important part in defining good cup quality, as it ensures the complete expression of all biochemicals. As a result, the delayed maturation process should play an important part in defining good cup quality, as it ensures the complete expression of all biochemical stages necessary for beverage development [30]. On rich volcanic solids, the role of soil types has been studied. Coffee brews' perceived acidity has long been considered as an essential characteristic of coffee quality. However, a high level of acidity might be regarded as a flaw [33]. Coffee cultivated at very high altitudes and in mineral-rich volcanic soil has been linked to acidity. Fayera [32], on the other hand, discovered that if all other factors remain constant, high-altitude coffee is of higher quality, but lowland coffee is bland with a lot of body. Furthermore, coffee grown at higher elevations is more acidic and has a superior fragrance and flavor. Total rainfall, relative humidity with maximum and lowest impacts on air-water vapor concentration, and storage durations all have a significant impact on the storability and quality of stored parchment coffee, and prolonged storage may result in lesser quality beans [27].

2.4.3. Pre and Post-Harvesting

Coffee cultivated with a lot of nitrogen fertilizer had a worse quality, was lighter, and was thinner than coffee is grown in unfertilized areas. An overabundance of nitrogen raises the caffeine level of the drink, making it bitterer. The amounts of phosphate, calcium, potassium, and magnesium in the soil have little effect on the caffeine and chlorogenic acid content of the beans [33].

Shade trees, according to Adugna [34], do not improve cup quality, but they do improve the appearances of green and roasted coffee beans, as well as the acidity and body of the brew, especially for those grown in sub-optimal (low altitude) conditions, by promoting slower and balanced fillings and uniform ripening to berries. Shade did, however, increase sugar concentration, which is a good thing. Cup quality is determined by the age of the plants, in addition to agronomic practices. Young tree samples are likely to be light and thin, but with a delicate flavor, whereas elderly tree samples have a powerful flavor and a harsh character.

Shade, on the other hand, increased sugar content, which is an essential element in the deterioration of coffee fragrance. Cup quality is determined by the age of the plants, in addition

to agronomic practices. Young tree samples are likely to be light and thin, but with a delicate flavor, whereas elderly tree samples have a strong flavor and harsh features. Trees of a medium age yield fruit with good flavor, acidity, and body [34]. The primary variables impacting natural coffee quality, according to Anwar [35], include harvesting techniques. Traditional hand picking and husbandry labor, rather than machine harvest, is commonly accepted to provide the finest quality green coffee by reducing the percentages of faults in coffee batches.

According to Elias [35], claimed that immature/unripe coffee beans have low caffeine content, whereas overripe coffee beans have high caffeine content. This could be due to caffeine metabolism and biodegradation being slower at the immature and overripe stages of fruit development, respectively.

2.4.4. Storage

Dry coffee quickly degrades in quality when stored unless adequate precautions are followed. Although parchment coffee deteriorates slower than coffee, quality degradation occurs quickly under adverse conditions. During storage, quality deterioration is mostly caused by increases in the bean's moisture content, deteriorating of the raw look of the bean by color fading or tainting, or the introduction of disagreeable tastes by storage insect infestation [36].

3. Conclusion

This review examines the work of several academics that looked at coffee production, production systems, and quality from various perspectives. Coffee is an economically significant agricultural crop in Ethiopia, accounting for the majority of the country's export earnings. Coffee is Ethiopia's most important product, and it is grown in nearly every part of the nation, providing a significant source of revenue for coffee farming households. Ethiopian coffee production is vital to the country's economy, with roughly a quarter of the people relying on it directly or indirectly for their livelihood. However, Ethiopian coffee production is mostly concentrated in the country's south, southwest, and east. Depending on climate and soil conditions, yearly output ranges from 200,000 to 250,000 metric tons. Forest coffee, semi-forest coffee, garden coffee, and plantation coffee are the four types of coffee produced in Ethiopia, accounting for 10%, 35%, 50%, and 5% of total coffee production, respectively. According to this review, key obstacles to coffee production in Ethiopia include a lack of competitiveness, infrastructure, appropriate access to services, low-value addition, adequate knowledge transfer, rainfall unpredictability, pricing instability, limited market access, a lack of market promotion and incentive mechanisms, and a low price have all been identified as key issues in Ethiopian coffee marketing. Despite good climatic circumstances, a diverse range of indigenous coffee varieties for quality development, and a long history of production in Ethiopia, coffee quality has been falling owing to several poor pre-and post-harvest management methods. This is still done by the majority of

coffee producers/farmers, from whom a greater proportion of the product is acquired; these attributes, as well as organoleptic quality, determine the final grade.

4. Recommendation

- 1) Since coffee is an Ethiopian natural gift resource that generates and sustains revenue at the individual and national levels. Furthermore, it contributes significantly to the country's total Gross Domestic Product (GDP) by increasing foreign direct investment and export share as compared to other products and services.
- 2) The government should unreservedly and consistently support the coffee sector to capacitate coffee production, production system, quality, and marketing, as well as to address the major barriers to capacity building, infrastructure, adequate knowledge transfer and research, low-value addition, and appropriate access to services.
- 3) Improving physical and institutional amenities such as research institutes, market data, roads, and transportation.
- 4) This work suggests that value chain methodologies should be used to evaluate Ethiopian coffee production, production system, quality, and marketing.
- 5) Developing and extending better coffee varieties, as well as other relevant agronomic techniques, to enhance coffee production technology.
- 6) Development of additional improved coffee varieties from the local landraces,
- 7) A multivariate examination of environmental variables and quality characteristics to the region's various coffee production systems.
- 8) Development of cost-effective and environmentally friendly post-harvesting and processing methods in each area.
- 9) The government should increase producers' (farmers) share of the final retail price by increasing market competition and licensing additional merchants.

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