



Coffee plantation conversion for housing development to meet housing demand. This is a result of unprofitability in the coffee sector compared to housing sector

Photo credit: Kennedy Muthee/World Agroforestry



Innovation pathways in the coffee sector in Ethiopia and Kenya

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Highlights

- Coffee supports the livelihood of over 4 million smallholder households who produce about 95% of coffee in Ethiopia and 60% in Kenya.
- However, most smallholder producers' earnings are low due to decreased production levels and international price fluctuations contributing to high poverty levels around coffee-producing areas.
- Innovations involving the promotion of good agricultural practices (GAP), marketing, value addition and institutionalization/farmer organization are much needed.
- Strategies to boost the adoption of these innovations include incentives on technology transfer, institutional strengthening, agricultural inputs subsidy and policy support on finance.

1. Introduction

Coffee is a major commodity supporting African countries economies in terms of foreign exchange, employment creation and income generation at small-scale farming levels. Globally, Arabica coffee (*Coffea arabica L.*) and Robusta (*Coffea canephora Pierre ex A.Froehner*) constitute 70% and 30% of total production, respectively (Ngugi et al 2021). Coffee, as an export commodity, generates substantial revenue at the national level through exports. The commodity also creates decent jobs for millions of people domestically and abroad during processing and value addition. Globally, over US\$ 200 billion was reported as coffee revenues between 2017 and 2018 (Panhuysen and Pierrot 2020). Despite this remarkable growth, coffee prices have fluctuated over the years, posing a major challenge, especially to small-scale producers who depend on the cash crop as the main income source as argued by Sambuo and Mbwaga (2017).

The nature of the challenges facing the sector and the continued reliance of smallholder producers on coffee calls for innovation to support over 25 million households and 60 million people globally who rely on the commodity as their main livelihood source (Sachs et al 2019). Smallholder producers and other players in the sector have been ‘experimenting’ with numerous innovations that, if properly contextualized and supported, could help avert the crisis that those households relying on the sector could face.

Given the large number of rural farmers relying on coffee to earn an income, it is a key opportunity to help attaining various sustainable development goals (ICO 2019). These include SDG 1 on poverty reduction; SDG 8 on decent work and economic growth, with millions of jobs created along the coffee value chain. SDG 12 (*Responsible consumption*) and 13 (*Climate action*) also have very strong relevance to the coffee sector. The lack of responsible consumption, which creates wastes, is among the key challenges the sector is trying to address. Climate impacts of the commodity production systems (especially related to the conversion of forest land to commodity crops) is becoming a major concern for the coffee sector. The coffee sector also refers to other SDGs such as SDG 9 (*Industry, innovations and infrastructure*) and SDG 15 (*Life on land*), but more indirectly (ICO 2019).

This chapter aims to widely look at innovations in the coffee sector in two case study countries -Ethiopia and Kenya along the product chains – such as production, marketing, value addition, and farm conversion. Further, the scales of innovations and the associated challenges are discussed, along with actionable recommendations on how to address them. The chapter adopts a case study approach in which an in-depth look at the innovations from multiple angles will be undertaken. The case studies selected are the coffee sector in Ethiopia and Kenya. The two countries are selected as case studies because coffee is a valuable agricultural commodity undergoing different innovations due to the great amount of attention it receives culturally and economically.

1.1. Evolution of the coffee sector in Kenya and Ethiopia

Coffee is an important cash crop for Ethiopia and Kenya. Coffee production (both Arabica and Robusta) in both countries is favored by conducive environmental factors such as rainfall, temperature, altitude and soils. FAOSTAT (2021) data establishes an increasing trajectory of green coffee production (in hectareage) and harvesting (tonnage) between 2000 and 2018 in Ethiopia from around 300,000 to slightly below 750,000 ha (Figure 6.1). However, the same period recorded a decreasing trajectory in terms of coffee production area in Kenya from around 170,000 to about 110,000 ha, with harvests stagnating at around 50,000 tons over the two decades.

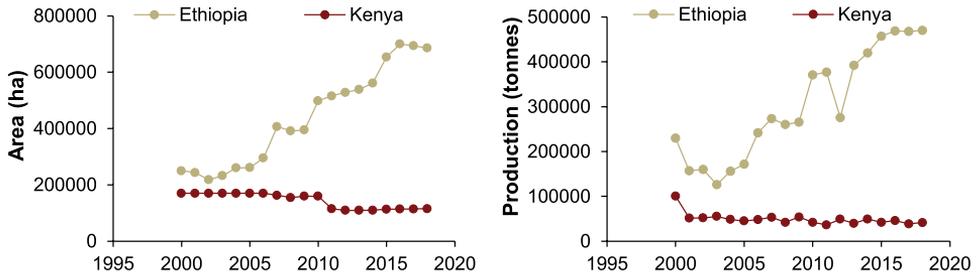


Figure 6.1: Coffee harvest area and total production of green coffee in Ethiopia and Kenya between 2000 and 2018 (Source: Authors' computation based on data from FAOSTAT 2021)

Green coffee export volumes seem to have stagnated for both countries- Ethiopia, at approx. 150,000 - 200,000 tonnes per year despite increasing hectareage; and Kenya at about 50,000 tonnes per year (Figure 6.2). For Ethiopia, the green coffee export volume has been unstable, especially with declines observed between 2007-2009 and 2016-2018, while Kenya maintained a stable but low volume of green coffee exported. For both Ethiopia and Kenya, coffee export value is mainly derived from green coffee with minimal contribution of the roasted one. The emerging investment in roasting coffee may increase the share of roasted coffee in the earning from coffee.

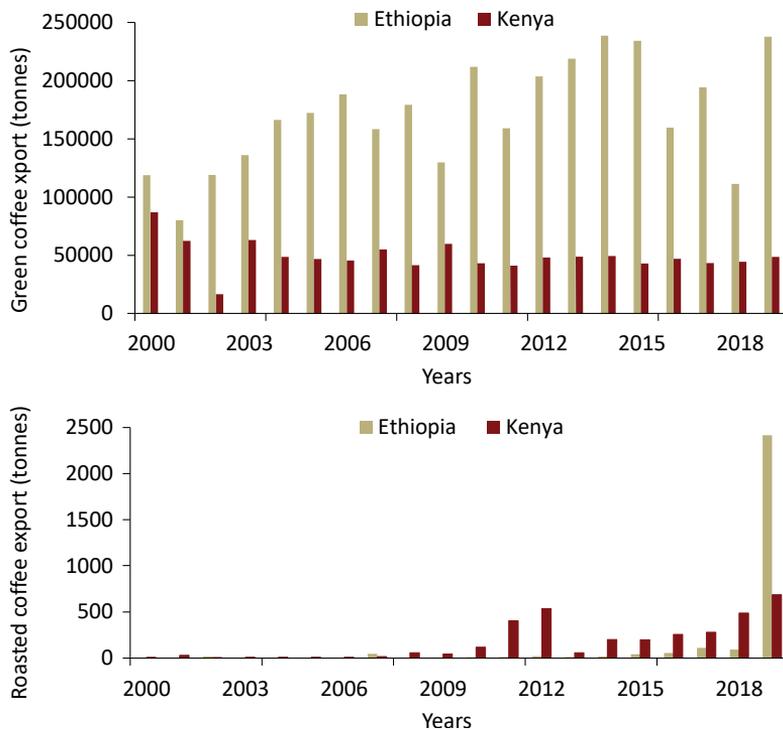


Figure 6.2: Export values and production quantities of traded green and roasted coffee for Ethiopia and Kenya from 2000-2019 (FAOSTAT 2021)

A summary of crucial milestones in the evolution of the coffee sector in Ethiopia and Kenya is presented in Figure 6.3. In Kenya, coffee was first grown in 1893 around Bura in Taita Hills, then in Kibwezi (under irrigation) in 1900, and soon after in Kikuyu, Kiambu in 1904 (ICO, 2019). These first attempts were mostly by European settlers until the 1930s when coffee could be grown outside the European settled areas, leading to its introduction in Meru and Kisii under a controlled planting scheme. After independence from colonial rule, production expanded widely in areas found suitable for the crop. As of 2018, coffee was Kenya’s fourth-largest export income earner and directly contributing to the livelihoods of over 700,000 smallholder producer households (ICO 2019).

The context of coffee in Ethiopia dates much earlier than that of Kenya. Ethiopia is the provenance of arabica coffee and remains the largest producer in Africa as well as the source of coffee genetic resources globally. Coffee supports close to 4 million households in Ethiopia (Minten et al 2019), although the main institutional investments in developing the sector only commenced in the 1960s. Since then, the country’s coffee sector has been going through numerous institutional and operational reforms aimed at improving sectoral performance and increasing smallholders’ profitability.

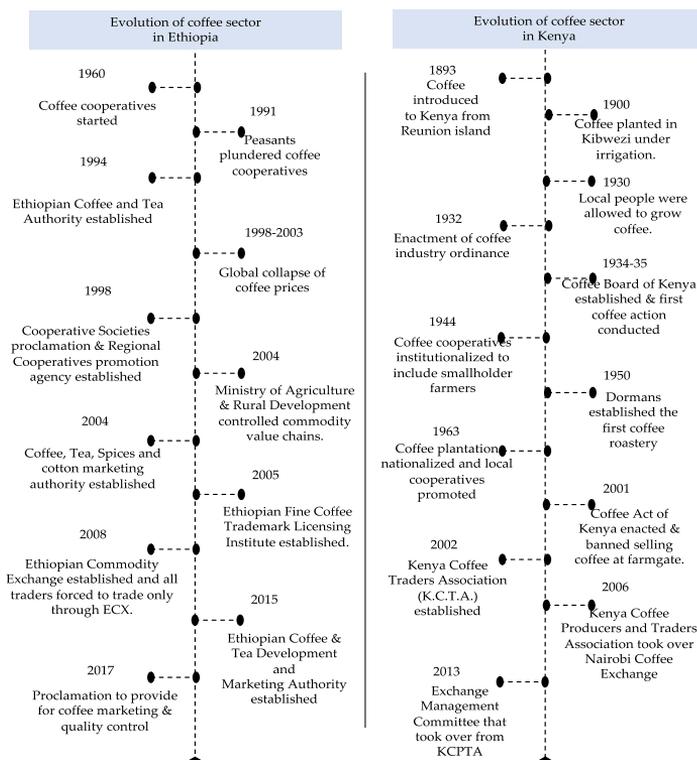


Figure 6.3: Evolution of the coffee sector in Ethiopia and Kenya largely from an institutional reform perspective

2. Characterizing coffee production systems

There are different coffee production systems, including forest coffee, semi-forest coffee, small-scale coffee farming and large-scale coffee plantations (Table 6.1). Forest coffee (wild) grows under the canopy of tall trees in unmaintained forest ecosystems that are less modified and influenced by humans. The only human activity in this system is simply picking the coffee berries for use and sale by community members residing around the forest. Semi-forest (or agroforest) coffee, on the other hand, is grown under forest conditions with some level of human modification forest structure, including opening-up top tree canopy, managing plant density, clearing weeds and pruning the coffee plants to maximize yields. In this model, community members manage rather than domesticate coffee landscapes to boost coffee productivity.

Garden coffee is planted by smallholder households around homesteads and usually inter-planted with other crops and, at times, other tree species to optimize farm productivity. Farmers select part of the coffee harvest for local consumption and sell surplus production. Trees provide shade and other nutrients to the small-scale coffee gardens. Plantation coffee involves large scale establishments of improved coffee varieties, usually grown in a mono-cropping system. Table 6.1 provides a summary of the four coffee production systems in Ethiopia.

Table 6.1: Characteristics of coffee production systems in Ethiopia

Production systems	Characterization	Dominant producer types	Area (ha)*	Annual production (tons)*
Forest coffee	Native wild vegetation of coffee in forested areas	Local community	175,000.00	70,000.00
Semi-forest (or agroforest) coffee	Dominantly grown in managed landscapes within forestlands	Local community with management and harvesting plans	400,000.00	244,000.00
Garden coffee	Grown in homesteads and farms close to homes	Small-scale farmers	300,000.00	210,000.00
Commercial plantation	Mechanized coffee farming usually produced at larger scale	Large-scale farmers and investors	25,000.00	25,000.00

* Modified from: Feyissam et al (u.d)

Kenya's coffee production revolves around garden coffee (albeit without direct local consumption) and commercial plantation types, either under full sun or shaded in an agroforestry model. Kenya's coffee is grown in the rich volcanic soils in the highlands, which gives the mild arabica coffee a unique taste and aroma. Common varieties produced include SL 28, SL 34

(medium to high altitudes), K7 (lower altitudes) and Ruiru 11 (all altitudes) (KARLO 2016). The main flowering period is between February and March, while the early flowering period is September and October. The main cherry harvesting period is from September to November, and early crop harvesting is between May and July. Coffee early auction is from July to August.

2.1. Shaded coffee vs full sun coffee

Coffee can be grown under shaded or full sun surroundings. Globally, about 25 percent of the world's coffee is managed under close to full tree shade, 35 percent under partial shade and 40 percent under full sun conditions (Alves et al 2016). Many coffee varieties prefer shaded environments, including arabica, which provides most of the world's specialty coffee. Robusta beans have been adapted to grow well in the sun, however.

Many farmers have traditionally grown coffee within natural or managed forest landscapes. Still, the area under full sun production has increased dramatically over the years as farmers seek to increase yields by converting shade-grown farms. Full sun production systems were introduced with the intent to increase yields and profits. Farmers can plant sun-grown crops at a higher density, although this stresses the surrounding environment and increases deforestation. The conversion of shade coffee into full sun coffee is also detrimental to the quality of coffee as Prado et al (2018) notes. It compromises the potential of the production systems to conserve biodiversity and ecosystem services such as pollination and pest control. Shade-grown coffee is a more sustainable approach and mimics the natural way coffee used to grow underneath forest canopies.

In Kenya, agricultural technical officers aiming to maximize coffee yields have promoted full-sun systems with coffee plants managed as multiple stems as opposed to shaded coffee (Njoroge and Kimemia 1994). Shaded coffee under *Grevillea robusta* and managed as single stems were previously introduced in Kenya but failed to get support from formal extension services due to fears of disease incidences. Farmers, nonetheless, still retain a wide variety of tree species on coffee farms, such as *G. robusta*, *Vitex keniensis*, *Cordia africana*, *Trichillia emetica*, *Persea americana* and *Macadamia tetraphylla*. These species are not grown primarily for shading coffee but rather for their various products and services (Carsan 2012).

3. Typologies of coffee sector innovations

The coffee sector has seen numerous innovations currently widely practiced in the two countries (Table 6.2).

Table 6.2: *Characterizing features of major innovation pathways*

Innovation clusters	Innovation interventions	Main drivers of innovation	Familiarity and skill requirement	Applicable scale
Agronomic innovations	Farm rejuvenation	Old farms with low productivity	Common, high	Local to large scale
	Vegetative propagation	Old farms with low productivity	Rare, High	Local at farmer levels
	Coffee rust management	Disease prevalence	Common, medium	Local to largescale
	Forest and semi-forest coffee production	High-value biodiversity friendly coffee demand	Rare, Low	Local to medium scale production
	Coffee agroforestry	Land scarcity and need for diversification	Less common, high	Local at smallholder levels
Marketing innovations	Labeling (geographic indication)	Cultural connectivity and incentivizing smallholder producers	Exceedingly rare, Medium	Local and landscape level
	Certification - Fair trade coffee, Organic coffee, etc.	Environmental damages due to coffee production	Rare, high	Local to global
	Ethiopia Commodity Exchange and Nairobi Coffee Exchange	Increasing the benefit for smallholder producers	Rare, high setup skills	Local to global
Value addition (processing innovations)	Cleaning, roasting and packaging	Generate more income by adding values	Common, medium	Household, cooperative, national
	Traditional coffee brewing culture	Cultural needs and global market collapse	Common, low	Local to national
Creating/strengthening institutions	Formation of coffee producer cooperatives and unions	Increasing bargaining power of smallholder coffee producers	Common, medium	Local

Each of the innovations is characterized by the advancements they need and the predominant operational locations at which they occur, as indicated in Figure 6.4.

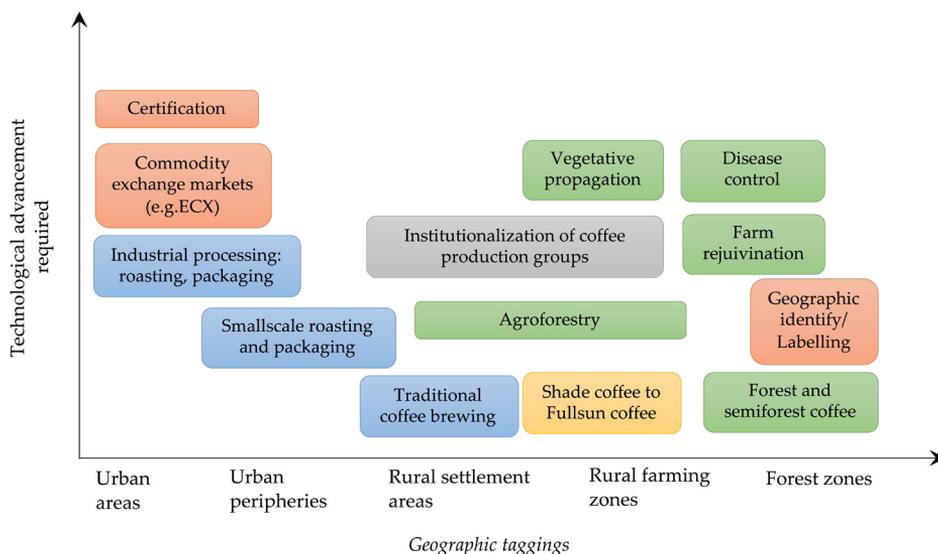


Figure 6.4: Characterization of the innovation pathways by location and technological advancements needed. Note: Light red – Market innovations; Light blue- Value addition; Light yellow – farm conversions; Light green – production innovations. ECX stands for Ethiopia Commodity Exchange

The innovations are also largely driven by various actors who control different elements of the coffee sector. Figure 6.5 indicates the various actors along the coffee value chains.

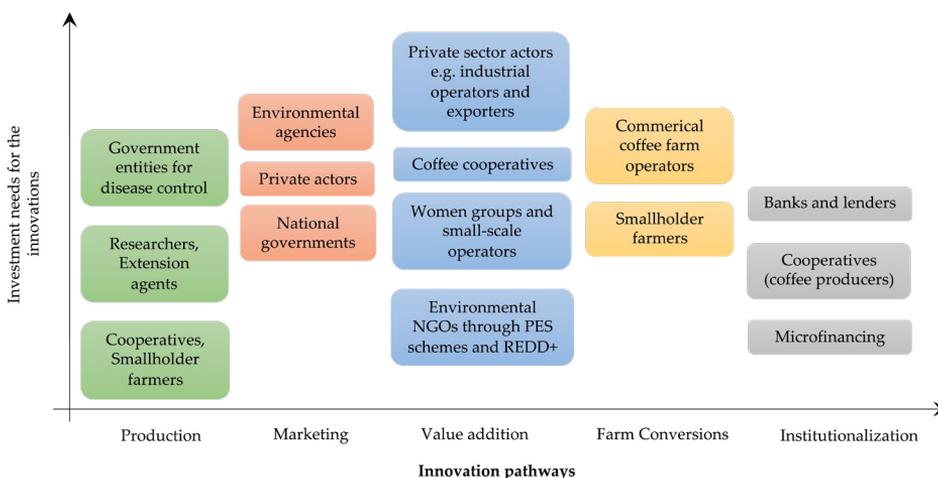


Figure 6.5: Characterization of the key players in the Ethiopia coffee sector

Sections below present details of each of the innovation pathways described above.

3.1. Agronomic innovations

These are innovations that occur at the coffee production (farm) level, which broadly aim to boost the quality and quantity of beans. They include farm rejuvenation, vegetative propagation, agroforestry, and management of coffee diseases.

3.1.1. Farm rejuvenation

Low coffee yield in Ethiopia and Kenya is mainly due to environmental factors such as poor soil qualities, aging trees, poor coffee bushes management and unimproved local varieties (Bote 2016). The problem with aging trees is not only that they produce less, but they also make picking less efficient. The single most important innovative solution to address this problem is farm rejuvenation by stumping existing trees. In both countries, rejuvenation has resulted in an improvement in coffee quality.

Rejuvenation offers the opportunity to replace unhealthy trees to ensure that coffee diseases are curbed at early stages. Healthy seedlings have a high likelihood of earning the farmer a higher net return. Farm rehabilitation also includes sustaining soil cover and moisture through weeding and cutting down climbing trees as well as maintaining cover crops between coffee trees. Canopy management is also a common coffee farm restoration activity that opens trees to sunlight and stimulates flowering while reducing the plant's susceptibility to pests and diseases. An additional rehabilitation practice is pruning of coffee trees which entails removing the bottom, small, diseased, dead and dry branches as well as unnecessary suckers (Gokavi et al 2021). Pruning gives the tree a good shape and height that allows it to yield an optimum number of berries that are also easy to harvest. Further, it trains the plant to utilize available nutrients in fruiting instead of excess branches and stems.

Though many farmers recognize the importance of rejuvenation (especially by stumping), they rarely practice it because it results in harvest and income loss in the first years. Some innovative solutions to safeguard farmers against such backdrops, among others, include,

- *Phased rejuvenation by area*: dividing the coffee farms into subplots that can be sequentially rejuvenated every 2-3 years to avoid complete income loss.
- *Phased rejuvenation by age*: selective stumping of the oldest trees at specified density within plots.
- *Replacing less productive stems*: selective removal of stems that are not producing beans optimally.
- *Replacing diseased stems*: eliminating, cleaning and replacing the diseased trees.

- *Complete field rejuvenation* done in some fields if the household has multiple coffee plots.
- *Conditional cash transfers (CCTs)*: initiating programs that transfer cash to poor households, on condition that those households make pre-specified investments such as stumping all or a percentage of the coffee trees and participating in training on modern coffee cultivation practices. Such a training package could include proper tree density/shading and spacing, weeding, pruning, disease and pest management practices, and adequate harvest and post-harvest practices at the farm-level.

3.1.2. *Vegetative propagation*

Vegetative propagation refers to the asexual reproduction of new plants from parts of mother plants, including stems, bulbs, leaves and roots of some plants, through fragmentation and regeneration process. There are several methods of vegetative propagation for coffee.

- **Propagation by cuttings:** This process entails harvesting single node suckers from clonal mother plants at an angle below the node and ensuring to retain a pair of leaves (Magesa et al 2018). Success is more assured if suckers are harvested in the morning when humidity is relatively high. The prepared cuttings are then planted in propagators with a recommended depth of 2 to 4 cm and spaced at 4x4cms. The planted cuttings form the callus within 3-6 weeks, followed by root development within 8-10 weeks, after which they are ready for planting. The planting materials produced through this process have a similar genetic composition to the mother plant. Hence, it's common to produce coffee cultivars resistant to diseases such as coffee berry disease and coffee leaf rust.
- **Propagation by grafting:** Buds of a desirable coffee variety are grafted onto 10-12 months pencil-thick stock seedlings (with the graft area tied with a polythene tape). The resulting seedling is placed in a propagator to heal in readiness for planting.
- **Propagation by tissue culture:** Tissue culture is how tissues, cells or organs are extracted from the donor plant and cultured in an artificial medium outside the mother plant (Ibrahim and Tresniawati 2020). Tissue culture in coffee involves the generation of plantlets using parts of coffee plants, including leaves and buds. The process of tissue culture is not well developed in Kenya at the farm level; thus, largely limited to well-equipped laboratories and specialized facilities.

3.1.3. *Coffee Agroforestry*

Coffee agroforestry systems integrate different varieties of trees for shade, fruits, and timber in coffee stands (Figure 6.6). By their shade, trees provide temperature regulation to coffee plants, reducing the physiological stresses related to daytime air temperatures. This role of non-coffee trees in coffee stands depends on the density and species of shade trees, intensity

of solar radiation, temperature variation, soil characteristics, and water availability within the coffee agroforestry system (Verburg et al 2019). The tree species farmers are likely to include in coffee farms depend on factors cited by Lamond et al (2019) as including local knowledge of tree species, values and benefits attributed to the tree species, farm size, and livelihood needs of the farmer.

Coffee agroforestry systems can either be simple or complex. Simple agroforestry systems contain 2 to 5 tree species besides coffee and usually form a single layer canopy, while complex agroforestry contains over 5 species besides coffee, forming multiple layers of the canopy (Riyandoko and Roshetko 2017).

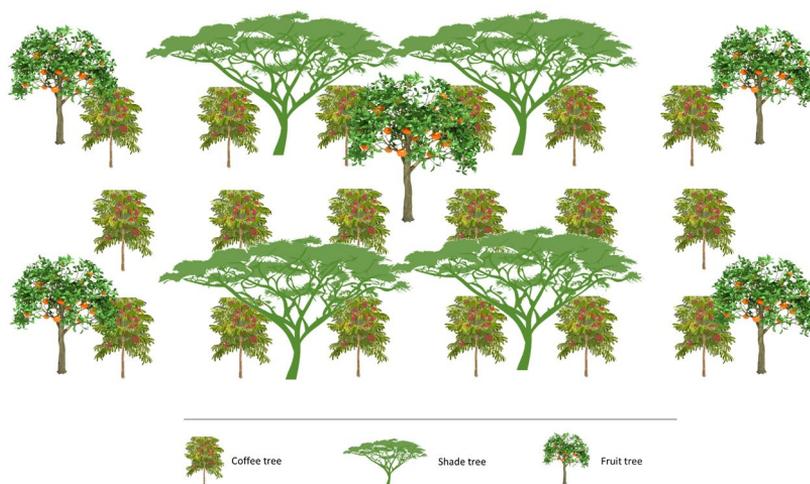


Figure 6.6: A schematic of a coffee-agroforestry scheme in South-west Ethiopia

The most critical elements of coffee agroforestry systems are shade trees. The most preferred shade trees in Ethiopia include *Albizia schimperiana* Oliv., *A. gummifera* (J.F.Gmel.) C. A. Sm, *Acacia abyssinica* (Hochst.) ex. Benth. and *Millettia ferruginea* (Hochst.) Baker (Hundera 2016) and there are places where *Cordia africana* is also used. In Kenya, up to 59 tree species have been observed in coffee agroforestry systems, with exotic tree species being more abundant (Pinard et al 2014). The management of the shade from such trees is crucial. Riyandoko and Roshetko (2017) developed a set of principles useful to follow in establishing coffee agroforestry systems based on ICRAF’s experiences from Indonesia, one of the leading coffee producing countries in the world. This includes:

- 1 Identify proper shade tree species to provide ideal temperature for coffee growth and production. Shade trees should be planted at least one year before the coffee is established
- 2 Select the suitable species for integration into the system based on their added economic values

- 3 Ensure that the trees and coffee plants have the right spacing both vertically and horizontally. Proper space management should be done through continuous farm management
- 4 Ensure proper timing for planting of both shade and coffee trees
- 5 Ensure appropriate plan for managing and routinely monitoring the coffee agroforestry farm through pruning of coffee trees, pests and diseases management, and application of the right fertilizers, among other practices
- 6 Use the recommended harvesting and post-harvesting techniques to minimize farm losses

3.1.4. Coffee disease management

Coffee rust disease remains a major challenge in coffee production. It is caused by the fungus *Hemileia vastatrix*, and it manifests through symptoms such as yellow spots on the leaves, and eventually, it falls. The disease and its impacts are accelerated by factors such as changing climate, amount of rainfall, foliage amount on the tree, and intensity of the infection, according to KARLO (2016). Other diseases of economic importance include coffee berry disease and coffee wilt disease. Coffee wilt disease, for example, has the potential to spread across different plants, causing massive losses. In a typical year in Kenya, farmers spray their crop protectively against Coffee Berry Disease (CBD) from April.

Several disease management options have emerged during the last century. The first option is cultural control, which includes establishing coffee trees at the right spacing to minimize the spread of diseases, judicious fertilizer application to supply the right quality and quantity of nutrients and optimal shading (KARLO 2016). Disease resistant varieties such as Ruiru 11 in Kenya have also been developed to manage coffee rust disease. Use of chemicals is recommended in case of disease occurrence, through fungicides applied at the right time and in judicious quantities, considering health and environmental impacts of the selected chemical option.

3.2. Marketing innovations

3.2.1. Labeling (geographic indication)

Food labelling involves national labelling, development of international norms, setting standards and guidelines for the product, inter alia, distinguish products from their competitors, avoid consumer deception, and avoid unfair competitors (Albert 2010). Different countries have developed diverse coffee labelling innovations for their geographical identity and market protection. Labelling has become an increasingly important tool for associating a product to the

geographic location it is sourced from. For instance, most of the coffee produced in the larger American region is distinguished by unique production cultures, soil characteristics, climatic conditions, production altitudes and target markets.

In Africa, Ethiopia has one of the most successful coffee industries, with its coffee produced in distinct agro-ecological zones that range within 550-2400 m asl attitude and 5°C - 28°C temperature, with over 900 mm annual rainfall and well-drained soils that are suited for high quality coffee production (Ram 2017). Recognized as the birthplace of *Arabica* coffee, Ethiopia enjoys many competitive advantages in the international specialty coffee market, including genetic diversity, renowned origins, high quality cup profile and low production costs. About 8% of the total coffee production is certified for the international market with specialty trademark brands such as *Sidamo*, *Yirgacheffe*, *Sheka*, *Kaffa*, *Wollega (Nekemte)* and *Harrar*. Ninety-five per cent of the coffee produced in the country is claimed as organic as it grows in the traditional organic cultivation system without pesticides and fertilizers. Kenya is yet to formally register a geographical identity for its coffee, but a brand initiative has commenced, albeit that it faces many challenges (Monroy et al 2013; Barjolle et al 2017).

3.2.2. Certification

Coffee certification is a strategy for positioning the product in the market. It sets the standards of coffee to assure consumers of the safety and quality and distinguish it in the market. Certification came in as a promising strategy to improve the smallholder farmers' benefits from coffee in the global market promoted either by private companies or voluntary agencies (Dietz et al 2020). Further, certification ensures that coffee is produced in the right social, environmental and economic context and is safe for human consumption. However, certification can be cost prohibitive, especially in emerging economies. Coffee certification is a recent phenomenon in East Africa that is expanding rapidly, currently accounting for 26% of the global certified coffee (Ruben and Hoebink 2015). There are several notable coffee certification labels globally that are applicable in the African context, as summarized below:

- Fair trade certification – aims to support farmers, especially in the developing economies, through enhanced market access and development of trade relations between producers and suppliers. Fair trade coffee is produced as per the set fair trade standards by a particular fair-trade organization, largely to cushion coffee farmers from the volatile market prices. This is achieved by setting the fair-trade minimum prices and giving the farmers premiums as incentives.
- Rainforest Alliance (RFA) – the RFA seal aims to integrate different sustainability standards, including social, economic and environmental, in the coffee production and processing process using the criteria set by Sustainable Agricultural Network (SAN). RFA has merged with the UTZ certification as of 2018.

- Smithsonian Bird Friendly – this standard was developed by Smithsonian Migratory Bird Center (SMBC) to preserve tropical agroforests for migratory birds. It sets criteria for robust shade and habitats standards, which includes canopy height (at least 12 meters high), layers of vegetation (at least 2 strata), integration of coffee with other woody species (at least 10 different species), and a minimum shade cover of 40% after pruning the trees.
- USDA organic – the US Agriculture Department set the organic standards to verify sustainable food production process in terms of harmony with nature, diversity support and enhanced soil health. Coffee certification under USDA organic seal ascertains that it is produced with no prohibited chemical substances, including synthetic pesticides and herbicides.
- UTZ certification – this certification focuses on the traceability and transparency of the coffee products along the supply chain - the producer to consumer.

3.2.3. The entry of coffee into the commodity exchange schemes

Ethiopia Commodity Exchange (ECX) is an Ethiopian multi-commodity exchange bringing together buyers and sellers of agricultural commodities, including coffee. It was officially launched in 2008/9 to link smallholder producers directly with the buyers at the national level, reducing the losses they incur to intermediaries (Tamirat 2013). According to ECX (2019), 29,784 tons of coffee was sold in March 2020, contributing 40% of trade volume and 60% trade value. ECX is the only functioning commodity exchange in the Least Developed Countries, linking over 2.4 million smallholder farmers to markets through agricultural cooperatives which has modernized the country's agricultural sector and the entire economy (ECX 2019). Despite commencing around the same time as the ECX, the Kenya Agricultural Commodity Exchange (KACE) has not lived to its billing. However, the government is contemplating launching a new warehouse receipt system.

Some of the outstanding coffee brands exchanged at ECX include Sidama, Yirgacheffe, Harar and Jimma, which are processed either through washing or sun drying. The Global Coffee Platform (2019) reports that 90% of Ethiopia's coffee is sold through ECX, with all export grades sold through ECX while local grades are largely traded in the local markets.

Notably, even though ECX was supposed to improve the benefit to the farmers, Ethiopian smallholders still get a low share of export prices of coffee at 60% (Minten et al 2019). Neighboring countries such as Kenya and Uganda have a higher than 70% share of the price going to the farmers.

3.3. Value additions through additional processing

3.3.1. Coffee roasting – an emerging venture to maximize benefits from coffee

A large majority of the coffee produced in Ethiopia was exported as green beans with minimal processing and value addition. However, the trend has changed, and there is currently a strong interest in adding value to coffee before it is exported outside to other countries. The roasting of coffee by numerous small and medium-sized companies is emerging as one of the emerging innovations.

Coffee roasting and grinding encompass turning dried coffee beans into dark brown beans through heating. Roasting accentuates the aroma and flavor locked inside the green coffee beans. It causes chemical changes as the beans are rapidly brought to very high temperatures, after which they are cooled. Roasted beans weigh less because of the demilitarization that happens during the roasting process.

After roasting, the crunchy beans are then ready to be ground and brewed. The emerging innovation around roasting is an alternative to retain the added value of the processing. Roasted and packaged coffee fetches almost seven times the retail price of green coffee (Haaij u.d). Numerous roasting companies are flourishing in recent years to take advantage of the additional benefit of roasting. The roasters are ranging from small-scale to large-scale enterprises.

3.3.2. Traditional coffee brewing culture as a revitalized innovation for job creation

Coffee culture in Ethiopia elevates coffee from a beverage that is merely started on a timer and brewed into to-go cups to a ceremony defined by a meaningful time to sit down to chat with friends and family. The ceremony is also an expression of respect to elders and represents a spiritual time of the day to give thanks for the blessings of life. The ceremony involves processing raw, unwashed coffee beans into finished cups of coffee. The dry coffee beans are roasted, ground and boiled, ready to be served. A tray of very small handle-less or glass cups is arranged close together. The ceremony performer pours the coffee in a single stream filling each cup equally.

The coffee ceremony has created significant job opportunities for unemployed women and young people. As more Ethiopians and tourists enjoy the cultural practices associated with the coffee ceremony, young unemployed girls and women are embarking on preparing and selling coffee in public places, cafeterias, restaurants, and hotels. Though proper statistics is still limited, the wider adoption of the traditional coffee brewing culture has boosted local consumption and even cushioned the coffee sector from the global price downfall in the last decade. For instance, analysis using FAOSTAT (2021) data revealed that, among the top four

coffee-producing countries in Africa, Ethiopia had the lowest average export-to-production ratio from 2008-2015 (0.57 Ethiopia, 0.70 Cote D'Ivoire, 0.94 Uganda and 1.06 Kenya; Figure 6.7). The export to production ratio for Kenya exceeds one mainly because of import contribution from neighboring countries which is re-exported to other nations through Kenya. Also, as opposed to Ethiopia, where most of the population consumes coffee, Kenyans widely prefer tea to coffee as a beverage hence directing most coffee production to export.

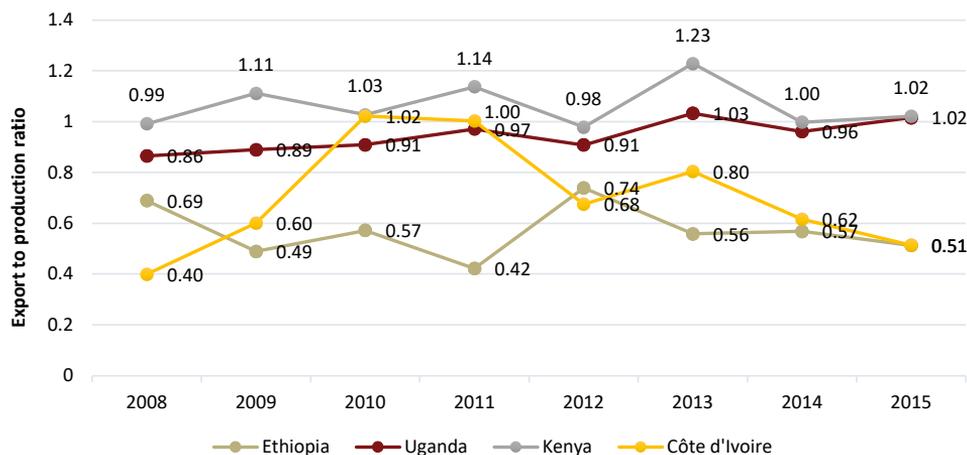


Figure 6.7: Coffee export to production ratio in selected African countries (based on FAOSTAT (2021) data computation)

3.4. Institutionalization of coffee producers

Across Ethiopia, there are more than 2 million smallholder farmers (SHF), of whom 63% have less than 0.5ha of coffee farms. Coffee farmers have found that organizing themselves into groups often called cooperatives or unions helps to have better bargaining power for their products and attract retailers and wholesalers who could be interested in large volumes of coffee. It was found that the selling price of coffee in cooperatives is 10% higher than that of the individual sellers who sell through a middle person who in turn sell to wholesalers and retailers. Currently, the country has about 160 coffee cooperatives (Kodama 2007). In Oromia region alone, more than 321,583 hectares of coffee farms are managed by Oromia Coffee Farmers Cooperatives Union. The government also promotes enrollment in cooperatives, but the organizations are still dogged by the bureaucracy that impacts farmers delivery of the beans during the selling of coffee and the associated delays in payment for the delivered coffee. According to a report by Global Coffee Platform (2019), such weaknesses have resulted in low subscription to the cooperatives and coffee unions that have only enlisted about 10% of the smallholders presently. The weaknesses of the cooperatives sustain the pathway of selling through intermediaries, which keeps smallholders below the poverty line due to the low prices

the small-scale collectors pay for the beans. The potential for the cooperatives to deliver better for the smallholders remains high if the management processes can be improved. Cooperatives could be a good platform to access financing, innovations (e.g., solar drying, recycled waste energy use, etc.), and improving bargaining power for the coffee beans.

Kenya also had a similar process of institutionalization with the old Kenya Planters Cooperative Union which lasted over 75 years, replaced with the New Kenya Planters Cooperative Union (KPCU). KPCU is accommodating over 750,000 smallholder farmers organized in about 300 cooperatives. Thus, the KPCU is a very influential organization.

3.5. A value-chain approach to coffee regulation

In Kenya, the post-independence coffee industry was driven by an all-purpose Coffee Board. In 2001, with legal reform, it morphed from marketing into a regulatory role. This change permitted other actors into coffee handling, under license from the Coffee Board. Smallholder growers were required to register with a co-operative society, which took delivery and pulping. Farmers, now able to uproot coffee, had to notify the cooperative or Board beforehand. The Crops Act (2013) was enacted to implement the 2010 Constitution. Counties regulate upstream coffee activities, including nurseries, growers, pulping stations, issuance of coffee movement permits, milling, coffee roasting licenses, and extension services to growers and primary processors (GoK 2013). Coffee policy making is a national function. The Agriculture and Food Authority (AFA) regulates independent coffee cupping laboratories, liqueurs, and buyers; and issues movement permits for purchased clean coffee. AFA regulates coffee imports and exports and registers coffee dealers (Coffee Regulations 2019, s.4). It registers smallholder growers' associations. (s.15, Crops Act).

Coffee is a scheduled crop, subject to special policy interventions: facilitation of marketing and distribution; efficient, economical transportation to reduce marketing costs; government supported research across the value chain; farmer training programs; experimental seed research; grading, sampling and industry codes of practice (s.8, Crops Act). Farmers are entitled to incentives (e.g., credit, tax breaks), inputs, extension, post-harvest support, marketing. Only the national government can levy taxes on coffee to avoid double taxation, except for county Cess. The Commodities Fund (s.10) has developed a lending policy for short, medium and long-term loans, providing sustainable credit and advances to farmers. The Warehouse Receipts System Act (2019) now provides a safe system for the deposit of coffee during marketing into licensed warehouses and issuance of receipts as ownership document (GoK 2019). A 2016 Coffee Taskforce report recommended the enactment of a geographical indications law to aid certification of Kenyan coffee based on unique origins for marketing as specialty goods. This will enhance value for farmers.

4. Challenges and Incentives for innovation in the coffee sector

4.1. Challenges facing the sector

Poor capacity to support the sector and the producers: There are numerous challenges contributing to the declining production of coffee in sub-Saharan Africa. Such includes the weak capacity of the countries to generate and disseminate technical knowledge to coffee farmers on ideal coffee varieties that can withstand climatic and non-climatic factors. Most of the institutions handling with research and development of coffee, including Coffee Research Institute (Kenya) and Jimma Coffee Research Center (Ethiopia), have spearheaded research on coffee varieties, but still lack modern technologies, facilities, human capacity and funding to be at par with technological evolution in the industry. This is coupled with a weak policy framework and legislation to promote coffee production, especially at the small-scale level.

Small scale farmers lag behind in coffee production due to traditional and poor agronomic practices since advisory and extension services on improving the practices are in short supply. The research, policy and practice gaps are also wide in the two countries due to poor coordination between producers and consumers of knowledge. Most coffee farmers live in poverty, typically for three reasons: the small size of their farms limits the number of coffee trees they can cultivate, their trees yield relatively few coffee cherries, and the coffee cherries they produce are sold at unpredictable and generally low prices. The relatively old age of most coffee stems is also of major concern as farmers still want to keep them despite low productivity. Farmers show resistance to uproot old trees and replace them with new coffee plants due to financial constraints, lack of credit facilities, lack of public support, unpredictable (and often falling) coffee prices and poor insurance penetration. These factors maintain the vicious cycle around low coffee yields.

Coffee farm conversions as an emerging threat to coffee's future: From a landowner or user perspective, when the value of a commodity declines, various strategies could be adopted – one may either wait for the market to improve rather than doing anything else or replace it with highly demanded commodities. With the plunge in global coffee prices witnessed over the last few decades, a considerable number of farmers have converted their coffee fields into other land uses to generate income for their households. In Kenya, Cameroon and even in parts of Ethiopia like the Harar area, a significant share of the coffee farms was changed into highly demanded commodity crops such as *Khat* (*Catha edulis* in Eastern Ethiopia bananas and others (Aklilu and Ludi 2010). The study also observed a shift from coffee to eucalyptus plantations in Jimma areas of Ethiopia drawn by higher income from Eucalyptus and the fast-growing of the tree species. In some countries (e.g., in Cameroon) coffee farms were abandoned and managed the trees after the prices plunged globally (Fonjong 2004).

At the time of such crisis, farmers and cooperatives were not cushioned to overcome such eventualities. For coffee farmers, the only means of coping with the price fall is to replace the farms with highly demanded commodities and food crops. This was a preferable innovation pathway at the system level that distracts from other livelihood alternatives that would have escalated environmental degradation, such as illegal logging.

4.2. Incentives for boosting transformative innovation in the coffee sector

In view of the above challenges, several incentives have the potential to transform the coffee sector in Kenya and Ethiopia. Some of them include:

- a Improved capacity, human resource, technologies and facilities to enhance research and development in the coffee sector. This may include more governmental and non-governmental funding to the sector.
- b Improved extension and advisory services, especially to the small-scale farmers who are the major producers of coffee. This may include improvement of the communication channels on how to improve agronomic practices and intensified site visits by the agricultural officers and co-opted farmer-to-farmer trainers to advise coffee farmers on the adoption of new technologies, such as new varieties, farm inputs, farm tools and value chain development.
- c Boosting the rate of returns in the sector can also be a major incentive. Measures such as setting the minimum market price may cushion farmers from losses, as has been the trend in Kenya in the past few years.
- d Incentivizing the sector can attract youth who are more productive and creative into the coffee production system. Further, they are more adaptive to technology compared to the elderly. This calls for incentives to encourage more youth in coffee farming.
- e Innovations to increase access to low-interest, flexible and accessible credit facilities and customized insurance services can transform the coffee sector and make it more productive and profitable.
- f More innovative research on coffee diseases at landscape levels is crucial in managing the crop, berries, profits and losses in the sector.
- g The government can also use innovative policies and public support to reform the sector. These include policies to support farmers access credit facilities and subsidizing farm inputs such as fertilizers to enhance accessibility by small-scale farmers.

5. Concluding thoughts

The coffee sector will continue to be a significant source of employment and income in Kenya and Ethiopia. It will play an important part in the future economic growth of the two countries. The sector's future depends on the ability of innovation systems to provide farmers with a new set of skills, tools and knowledge that address an increasingly diverse and complex range of needs, including improved coffee productivity and coffee quality assurance, as well as better responses to climate change. There are substantial challenges to overcome within the coffee sector of the two countries. To mention a few, price fluctuation and unreliable income, labor shortage, climate change, pest and disease, limited ability to value coffee, smallholder farmers' lack of access to finance and ineffective regulatory frameworks have been discussed as the most important challenges impeding growth in the coffee sector. To meet these challenges and respond to opportunities, the sector will need to identify, contextualize and embrace innovative approaches to improve productivity and production sustainably.

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