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The World of Coffee: 21st Century solutions for a commodity facing climate change risks

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Abstract

This paper examines the environmental impacts of climate change on the yields of Arabica coffee and the economic impacts on smallholder coffee farmers. In order to address these challenges, environmental and socio-economic solutions are proposed alongside a gap analysis of key coffee-related certification programs. As temperatures increase, farmers are forced to move to higher elevations to grow coffee, where less land is available for farming. These climate change outcomes are visibly affecting Central and South American countries, which are experiencing up to 2°C of warming above pre-industrial averages. Environmental risks may lead to smallholder farmers abandoning coffee production altogether, resulting in a decrease of supply and expertise for the coffee industry. Simultaneously, this industry is seeing increased demand from consumers for products with “green” certifications, but sustainability certifications do not offer a full-fledged solution for environmental and socio-economic concerns. This gap analysis focuses on four main sustainability certifications and aims to provide an understanding of why certifications fail to address environmental and socio-economic challenges. This study seeks to identify the factors that certification models should incorporate in their supply chain assessments to examine climate change threats and improve outcomes for farmers. Analyzing the different criteria for certifications shows: 1) Integrating environmental criteria within certifications is a resilient solution to addressing immediate climate change risks, and 2) mechanisms for protecting farmers against price volatility are required. The research shows the Rainforest Alliance’s certification program is currently best positioned to serve the needs of an increasingly at-risk sector.

Keywords: Agriculture, climate change, coffee, Rainforest Alliance, South America, smallholder farmers

The Economic and Social Backdrop of the Coffee Sector

The global coffee industry is valued at \$400 billion, and it continues to grow (Stanley, 2022). According to the Food and Agriculture Organization of the United Nations (FAO), coffee production is concentrated in countries with relatively low income levels and accounts for a sizeable portion of their respective export revenues (FAO, 2022). Further, approximately 125 million people worldwide depend on coffee for their livelihoods (Bruce-Lockhart & Terazono, 2019). Coffee as a commodity produces enormous economic value and yet, so little of that value is captured and returned to coffee farmers and their respective local ecosystems. For an average cup of premium specialty coffee, farmers only retrieve \$0.04 of the final purchase price (Bruce-Lockhart & Terazono, 2019). However, there are efforts to address this loss of value through sustainable coffee farming practices and the promotion of certification programs. This paper details how certification programs have evolved and the impact of adoption for producers, farmers, and consumers, beyond a simple “stamp of approval.”

Actors along the coffee supply chain have developed several systems over the years to preserve value for producers, especially smaller ones, in the absence of formal multilateral trade agreements. Mirroring trades in other commodities, merchants dealing in coffee have had opportunities to accrue wealth over the years. Since coffee farmers are mostly from very low-income countries, trading beans into global markets has exposed millions of small producers in developing countries to exploitation, initially from colonialists and eventually from multinational trading firms. This has led to financial instability for many in the industry, with 44 percent of the world’s smallholder coffee farmers living in poverty, even while their beans are sold for premium prices in American and European markets (Sachs, 2019).

Initiatives for more financially equitable outcomes for farmers are rooted in history. Activism on behalf of coffee producers began as early as the 19th century when campaigners publicly opposed the financial abuse of coffee farmers by Dutch colonists in the East Indies. However, the modern Fairtrade movement only began to take shape in the 1960s, when industrialized countries and multinational corporations faced increased criticism for extracting wealth from developing countries (Haight, 2011). Although there have been improvements toward the sustainability of the coffee value chain, severe profit-sharing inequality remains between upstream and downstream actors. These inequalities are exacerbated by increased volatility in pricing and the imminent threat of climate change, particularly for smallholder farmers who comprise 60 percent of global coffee production (Rapsomanikis, 2015).

Climate Change Threatens Coffee Production

Amongst all commodities, the coffee trade is especially vulnerable to climate change. Coffee is notoriously sensitive to small changes in climate and weather, and farmers are already starting to see the effects of disease, reduced yields, and inferior bean quality. The annual average land temperature

of the coffee belt¹ is now approximately 1.5°C higher than its pre-industrial average, and models predict an acceleration in this rise over the next 30 years. By 2050, according to some models, almost 20 percent of the coffee belt will have warmed by more than 4°C, which represents a limit of warming that cannot be offset by cultivating beans in shadier areas—a practice that currently helps to mitigate the effects of global warming (Sachs, 2019). Furthermore, at 4°C of warming, yields will decrease on average by 10 percent by 2050, while some harder-hit areas, such as Honduras, will incur losses upward of 25 percent (Sachs, 2019) (Figure 1). Additionally, by 2050, 75 percent of the land used for Arabica-grown coffee will be at risk of becoming economically unviable (Sachs, 2019). As temperatures increase, farmers are forced to move to higher altitudes and attempt to grow coffee where less arable land is available for farming.

In Central America, the minimum viable altitude is expected to increase by approximately 400 meters as a direct result of temperature increases (Sachs, 2019). Most of this warming is happening in Central and South America; models have shown that Brazil and Guatemala are already experiencing warming of 2°C above pre-industrial averages (Sachs, 2019). If warming continues at its current rate, coffee production will need to shift at an average of 58 kilometers per decade toward the poles in order to maintain current supply levels (Sachs, 2019). Moreover, there are limits to the viability of high-altitude farming, which is often characterized by reduced land availability and a resulting decrease in production. This economic volatility can also lead to farmers transitioning out of coffee farming and a consequential loss of expertise for the industry. Climate change considerations are paramount to establishing a sustainable coffee industry and particular attention should be given to efforts to increase foliage and canopy growth. Beyond ecological benefits, researchers have now proven that intermediate shade levels (30-50 percent coverage) produce higher yields (Jha et al., 2014).

¹ Between 25 degrees north of the equator and 20 degrees south (National Coffee Association)

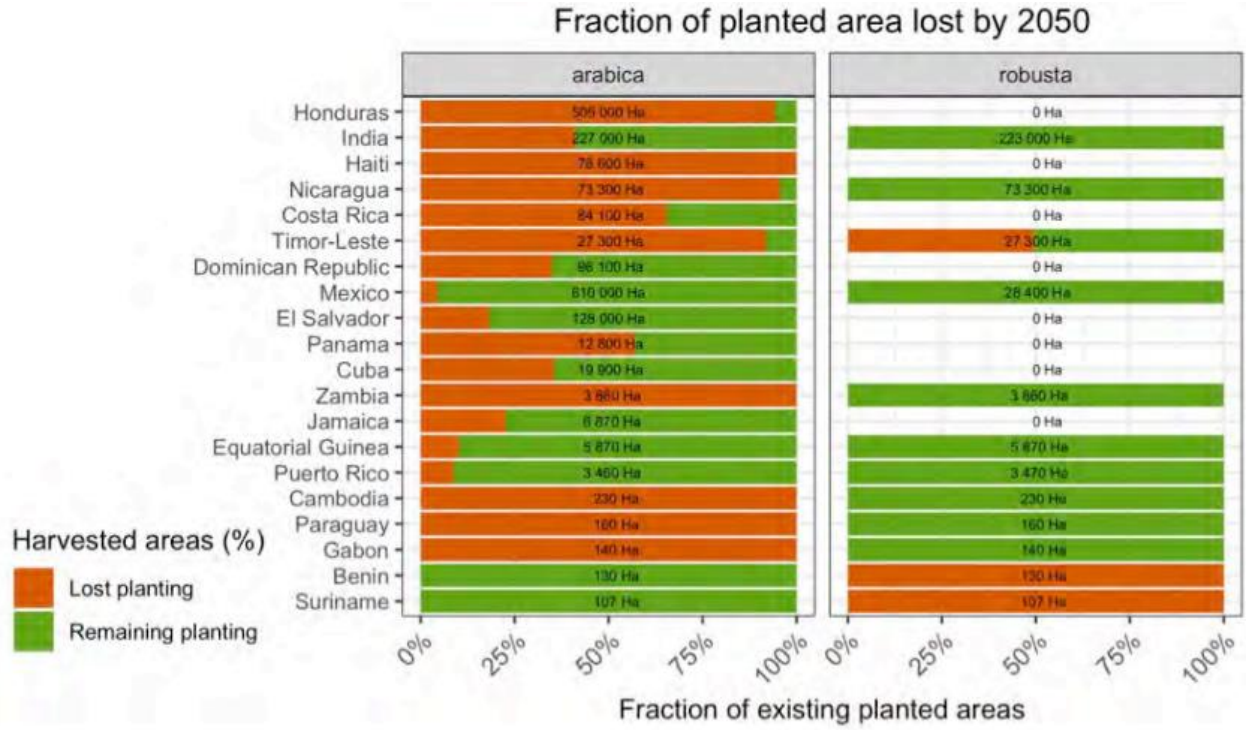


Figure 1. Projected Loss in Coffee Harvest by 2050. Source: Sachs, 2019.

A Sustainable Future for Coffee

Within the food and beverage sector, coffee is one of the fastest growing consumer beverages, estimated to grow at a compounded annual growth rate (CAGR) of 5.5 percent, between 2019 and 2024 (Sachs, 2019). This is expected to occur as sustainable supply becomes increasingly hard to come by. The need for integrated sustainability frameworks with a focus on environmental and socio-economic considerations in sourcing practices is crucial.

1. Environmental integration

- a. **Preserving biodiversity:** By promoting shade-grown cultivation, farmers increase local biodiversity, attracting a variety of plant species and allowing for better bird and pollinator habitats, which in turn provide ecosystem services for coffee plantations such as the reduction of plant diseases and pests. A study found that a single bird can help save between 10 kilograms and 29 kilograms of coffee per hectare from disease annually (Turner, 2019).
- b. **Implementing regenerative practices:** This approach looks to improve soil health on farms by using integrated pest management techniques and avoiding the use of pesticides. Herbicide-free farms are an important pathway to regenerative agriculture in coffee farms. Although challenging for farmers given increased labor requirements, over time the enriched soil and financial benefits from no longer purchasing herbicides benefits the coffee farms both environmentally and economically (Nerger, 2022).
- c. **Conserving Water:** This is a crucial element of promoting sustainability on coffee farms. Farmers can monitor the presence of wildlife, streamside vegetation, oxygen, and pH levels to ascertain water quality. Environmental practices should aim to restrict the use of agrochemicals and implement wastewater treatment which will reduce leakage of chemicals and contamination of waterways (Nerger, 2022).

There is no silver bullet to address the looming threat of climate change on the coffee industry and individual climate adaptation and mitigation strategies are crucial for farmers looking to address their own set of challenges. However, the environmental approaches mentioned set a valuable baseline for farmers to consider. Shade-grown cultivation, in particular, offers a unique adaptation and mitigation opportunity to reduce the detrimental effects of warming temperatures.

2. Social & Economic considerations

Economic instability for coffee farmers is a root-cause barrier to broader sustainability aims and a “just transition” for the sector. Without stable incomes, the aforementioned environmental solutions are unlikely to be implemented or even considered by smallholder farmers. Most of the current financial rewards for coffee production are not reaped by farmers. Increased transparency and traceability are paramount in order to allocate more capital upstream. Among smallholder coffee farmers, women are particularly vulnerable, making up 70 percent of the labor force but only 20 percent of decision-making positions (Sachs, 2019). Increasing access to capital and education for women can ensure better budget management outcomes, eventually leading to financial and health

benefits for entire families. Certifications must promote mechanisms that allow coffee farmers to capture more of the final retail price that downstream actors currently benefit from, with a particular lens on practices that promote gender equality.

A Gap Analysis of Major Coffee Related Certifications

The coffee industry is seeing increased consumer demand for more effective Corporate Social Responsibility (CSR) programs that guarantee compliance with certification requirements (Vogt, 2019). The gap analysis evaluates four main sustainability-driven certifications: Fairtrade International, Starbucks' C.A.F.E., Bird Friendly, and Rainforest Alliance. The analysis identifies the program with the highest potential to make a significant impact on smallholder coffee farms and makes recommendations for improvements.

1. Fairtrade International (Fairtrade)

Fairtrade International was founded in 1997 with the purpose of providing stable livelihoods for agricultural workers. Fairtrade USA, an offshoot of Fairtrade International, will not be tackled in this analysis as it is focused on larger farms and plantations.

Environmental alignment:

There are generic environmental standards that promote environmental protection, but the certification's binding criteria is limited to non-cultivation of virgin forests, genetically modified organisms, and references to a prohibitive chemical list. There are suggestive measures but no criteria requiring shade-grown cultivation, regenerative agriculture, nor water conservation. Environmental alignment is limited for the Fairtrade certification as it primarily focuses on alleviating poverty for upstream actors.

Social and Economic alignment:

One of the cornerstones of the Fairtrade certification is its protection of smallholder farmers who are often vulnerable to exploitation due to market price volatility. By ensuring a minimum of \$1.40 for 1 pound of washed Arabica unroasted coffee or \$1.68 for coffee that was certified as organic, farmers are given a more stable source of revenue. This means that if the market price for a pound of Arabica falls below this amount, smallholder farmers are assured a set price, and if the market price is above \$1.40, they benefit from the higher price (Fairtrade, 2019).

The certification also attempts to increase financial stability for farmers by facilitating relationships between producers, roasters, and retailers. In turn, this can promote pre-harvest financing and enable long-term contracts (Vogt, 2019). Fairtrade is currently the only certification that targets pricing in smallholder coffee farming.

However, there are implementation issues. Many economists believe that more than \$1.40 per pound of coffee is needed to compensate farmers fairly (Haight, 2011). Additionally, certification costs can offset the added income from price security (Vogt, 2019). Hence, one of the main critiques of Fairtrade is that the certification program is not living up to its goal of reducing poverty. Further, Fairtrade's environmental requirements are much less stringent than other programs. Another concern is that Fairtrade coffee does not have a quality grade requirement (Haight, 2011). Farmers typically need to sell both Fairtrade and non-Fairtrade coffee due to insufficient demand for the certified variety. This can create an incentive for a farmer to sell the lowest quality coffee at a guaranteed Fairtrade price and higher quality coffee at market price, illustrating further the complexity inherent in designing certifications (Haight, 2011) (Figure 2).

Certification Program	Production (tons)	Sales (tons)	% sold under standard
Fairtrade	430,000	128,000	30 %
Organic	248,767	133,163	54 %
Rainforest Alliance	265,565	129,846	49 %
UTZ Certified	715,648	188,096	26 %
AC Association	1,782,052	152,708	9 %
AAA	247,114 ²⁰²		
CAFÉ Practices	457,339	222,550	49%
Total adjusted for multiple certifications	3,300,000	840,000	25 %

Source: BASIC based on IISD (2014) data²⁰³

Figure 2. Percentage of Production Sold Under Main Sustainable Standards Source: Haight, 2011.

2. Starbucks' Coffee and Farmer Equity (C.A.F.E) Program

Starbucks partnered with Conservation International in 1999 to promote sustainable sourcing practices in coffee farming which later developed into its internal sustainability initiative known as C.A.F.E., which focuses on environmental leadership, social impact, economic accountability, and bean quality (Starbucks Practices, 2016). The program is a point-based system which tracks 185 indicators for larger producers and slightly fewer for smaller farms (Craves, 2015).

Environmental alignment:

Over 40 percent of the indicators relate to biodiversity efforts, the protection of water and soil resources, and environmental monitoring. In light of climate considerations, the plan rewards shade-grown coffee, but does not make this a mandatory requirement. Points are provided for integrated pest management, but agrochemicals can be used as a last resort (Craves, 2015).

Social and Economic Alignment:

Starbucks looks to increase transparency and traceability in its supply chain by requiring suppliers to submit proof of payments to farmers and indicate the value of each purchase. Starbucks has created an incentive-based mechanism for farmers who meet its environmental indicators. For example, if a farm satisfies 60 percent of the stated indicators, they become “Preferred” (i.e., priority) suppliers. If a farm satisfies 80 percent, they become “Strategic” suppliers, earning a \$0.05 premium per pound for one year (Duda et al., 2007). Once either of these statuses are achieved, they remain valid for three years without further audits.

C.A.F.E.’s sustainability plan is a step in the right direction but does not allow for consistent or predictable incomes for smallholder farmers. Further, the company is not required to buy from “Preferred” or “Strategic” suppliers, and there is no minimum pricing policy.

3. Bird Friendly Coffee Association

The Bird Friendly Coffee Association is the most demanding certification from an environmental standpoint but lacks socio-economic protections. Its primary goal is to protect vital bird habitats. Smithsonian scientists developed the certification in the 1990s in response to steep declines in migratory bird populations due to industrialized farming (Smithsonian's National Zoo, 2018).

Environmental alignment:

Bird Friendly has the highest agri-environmental standards among existing certifications, and farms must be certified as “organic”. The Bird Friendly criteria requires farms to maintain 40 percent canopy cover, 11 different tree species, and a canopy height of at least 12 meters, which has demonstrated a direct correlation with increased animal biodiversity (Smithsonian's National Zoo, 2018). Research at The Earth Institute of Columbia University has shown increased biodiversity

benefits associated with shade-grown coffee, such as the protection of mammals (Caudill & Rice, 2016) and an increase in the number of bird species from 60 to 200, when compared with sun-grown coffee (Smithsonian's National Zoo, 2018).

Social and Economic Alignment:

The certification lacks the necessary social and economic considerations that would enable smallholder coffee farmers to successfully implement the required environmental criteria.

4. The Rainforest Alliance

The Rainforest Alliance (RA) was established with the protection of forests in mind. It successfully uses pre-competitive collaboration by leveraging relationships with governments, policymakers, and other non-profit organizations to improve environmental, economic, and social conditions across the supply chain. Over time, RA has expanded its scope to include broader goals in terms of economic and social sustainability but still holds more of a focus on environmental issues. RA uses the Sustainable Agriculture Network (SAN) to certify farms and promote beneficial agricultural practices.

Environmental alignment:

Within the certification's core requirements, new plants are selected on the basis of a climate risk assessment. Crop diversification, intercropping, and the utilization of different rooting depths are all strict requirements to enhance soil health (Rainforest Alliance, 2021).

RA works with farms to reduce the use of pesticides and promotes integrated pest management techniques. Other requirements include enhancing natural vegetation, protecting wildlife and biodiversity, and reducing water usage and on-farm greenhouse gas emissions. While there is no obligation for shade-grown cultivation, the certification requires native vegetation cover after six years of participation (Rainforest Alliance, 2021).

Social and Economic alignment:

RA recently launched its new 2020 certification program, which aims to implement a more robust and innovative multi-stakeholder methodology (Rainforest Alliance, 2021). The new framework's approach is one of shared responsibility, where every actor in the supply chain has a more significant role to play, which can relieve the burden on farmers.

The new framework uses a data-driven approach where smart meters enable farmers to set their own environmental targets. Producers can then demonstrate their efforts and be rewarded by selling their coffee at higher prices. This technology also means that audits can happen in real-time, and RA is able to target higher-risk regions. RA can leverage insightful data to follow cashflows throughout the supply chain and potentially close living income gaps (Rainforest Alliance, 2021).

Although RA's framework addresses social concerns, fair treatment and good working conditions are not binding for audit purposes (Vogt, 2019). While the criteria has no tolerance for the worst form of child labor, it still allows for "light work" from the age of 12 and "full work" from the age of 14 (Rainforest Alliance, 2021). Furthermore, farmers are still susceptible to volatile coffee prices as RA has yet to offer a minimum price.

Recommendations & Conclusion

All of the assessed certification programs have strengths and weaknesses. However, of the four analyzed, RA is best-positioned to provide a complete set of solutions beyond solely environmental criteria through its systems-thinking approach. Most importantly, the certification's new framework takes a holistic approach to improve environmental, economic, and social outcomes. Additional focus is recommended in the areas outlined below.

Environmental Leadership

There are coffee production yield gaps that can be closed, provided better agricultural practices are in place. RA should continue to engage in rehabilitative and restorative practices. The benefits of shade-grown coffee have been highlighted, and RA should mandate this practice as a priority. Currently, the natural vegetation cover recommendation meets a much lower threshold. RA should also partner with research providers, such as universities and leading industry organizations, to include coffee varieties, in its environmental criteria, that show resistance to climate change without a detriment to bean quality.

Social Responsibility

RA should engage in on-the-ground conversations with upstream stakeholders to better understand their needs and concerns. In regions that have experienced child labor, RA should demand audits by third-party, independent bodies. Additionally, RA imposes mandatory schooling for large farms only. This requirement should be extended to smaller farms as well (Rainforest Alliance, 2016). If schools are inaccessible due to the remote nature of certain geographical areas, RA should work with local government agencies to improve access to education.

Economic Considerations

Coffee prices are unlikely to increase as Brazil's high coffee productivity levels maintain low prices (Sachs, 2019). Coffee laborers (often migratory) are particularly susceptible to changes in market demand and work in horrific conditions (Sachs, 2019). As they are paid by the volume of coffee cherries harvested, they can make as little as \$2 per day (Zamora, 2013). Fair pricing needs to be improved for farmers and farmworkers to ensure decent standards of living. RA should establish a minimum price that considers climate risk, and demand that farmers be guaranteed this threshold. RA should leverage its data-driven supply chain to enable transparency and ensure that money flows to both farmers and farmworkers. Particular attention should be given to small acreage farms that are most at-risk from economic instability. As e-commerce technologies become increasingly available to farmers, the use of distributive ledgers may facilitate the efficient tracing of transactions throughout

the supply chain and ensure farmers and farmworkers benefit financially. However, these types of initiatives require upskilling of the workforce and should not marginalize farms that do not have access to connectivity.

In order for the coffee industry to move toward sustainable outcomes and address the looming threat of climate change and warmer weather patterns, smallholder farmers must be empowered to build environmental resilience without sacrificing economic gain. By understanding the needs of the local communities surrounding coffee production, only then can genuine sustainable practices within the coffee industry advance. To that end, close collaboration between smallholder farmers and organizations such as certification providers, NGOs, large corporations, and local governments is crucial.

With regard to certification providers, these entities are well-positioned to enable sustainable growth and assist in the implementation of “green” practices that account for the economic and social well-being of communities. The four certification programs assessed all incorporate key sustainability issues. However, the Rainforest Alliance’s certification program looks to work closely with local communities and is best positioned to ensure long-term environmental, social, *and* economic sustainability.

While certifications can have a significant impact as outlined in this analysis, these programs alone will not be enough to tackle the fundamental problem of climate change and growing income inequality within the coffee sector. Governments, international organizations, and key stakeholders will benefit from leveraging existing frameworks to advance equality and enable a “just transition” in the coffee sector alongside long-term sustainability.

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