Coffee and Climate Change: Predicaments and Possible Solutions for Farmers in Latin America

The Predicament

As the effects of climate change worsen and global temperatures rise, only about 50% of land viable for production of Coffea arabica and Coffea canephora is estimated to still be viable for production by 2050 (Bunn et al., 2015). These two coffee species encompass the majority of international coffee consumption, and their loss poses a significant threat to the livelihoods of coffee farmers in countries that produce most of the world’s coffee (Columbia, Ethiopia, Mexico, Vietnam, Indonesia, Brazil). Coffee plays an important cultural and economic role in many of these countries, and farmers need to find new ways of adapting their crops and increasing their income in order to protect their livelihoods and way of life. Such strategies include the adoption of integrated agroforestry practices, community-based coffee cooperatives, and breeding new coffee varieties that are better suited to warming climate conditions.

Warming temperatures, unpredictable rainfall, and an increased presence of insect and fungal pests are decreasing global coffee yields at an alarming rate. The ideal temperature for growing coffee is around 64-70 degrees Fahrenheit, and temperatures outside that range can cause the fruit of the coffee plant (called cherries) to ripen prematurely, decreasing the quality of the coffee bean (seed of the coffee fruit) significantly (Scott, 2015). Temperatures above 86 degrees Fahrenheit can stunt the growth of coffee and make plants more susceptible to disease.
Coffee plants grown at lower elevations are being hit particularly hard by increased heat stress, while those grown at higher elevations are faring better, as higher elevations offer cooler temperatures and buffer the plants from the worst effects of heat. As coffee plants takes about 3 to 5 years to begin producing beans, many of the low-elevation coffee plantations already in production are likely to struggle as temperatures continue to rise. Additionally, with climate becoming less predictable and seasonal indicators being less reliable, farmers report being unsure of when to harvest coffee beans, adding further uncertainty for how to continue farming (Bilen et al., 2023).

The coffee rust fungus, *Hemileia vastatrix*, has been a particularly destructive pathogen for coffee crops that has also had an impact on farmer migration patterns in Latin America. Coffee rust fungus produces powdery orange spores on the leaves of coffee plants, has a high mortality rate, and has likely been increasing in prevalence as a result of warming temperatures that create more favorable conditions for the fungus. During a particularly intense year of coffee rust fungus in Guatemala from 2006 to 2007, a study found that families of smallholder coffee farms were twice as likely to migrate during this period, including families that did not have a previous history of migration. The study found a clear correlation between tremendous coffee crop losses and this increased rate of migration (Dupre et al., 2022). As more and more people are displaced because of coffee crop losses, a humanitarian crisis is likely to unfold, making it plain that the future of the coffee industry has consequences on a global scale.

Coffee is an extremely important crop for the countries that produce it, and an estimated 100 million people depend on coffee production for their livelihoods (Bunn et al., 2015). Although the coffee plant is not native to South and Central America, it has become a part of the
region’s cultural and economic identity. The region has a long and complicated history with coffee production since the plant was introduced by Spanish conquistadores in the 1700’s, who created large coffee plantations that exploited Indigenous inhabitants for labor (Perfecto et al., 2019). While large-scale coffee plantations do still exist, much of the coffee grown in Latin America comes from small-scale coffee farms, usually family-owned and in many cases generationally inherited. The echoes of colonial exploitation still impact the region to this day, as many coffee farmers make significantly less money than what their coffee is sold for in Western markets; prices are often controlled by buyers and distributors, not the farmers whose labor produces the commodity (Folch & Planas, 2019).

Possible Solutions

While the pressures farmers are facing may seem insurmountable, there are strategies that can be implemented to minimize these impacts. The adoption of agroforestry practices provides one method for coffee farmers to increase their production, diversify their income, and use their land in a more sustainable way. In South and Central America, coffee plants (which grow as a shrub) were traditionally grown under tree canopies with a diversity of trees and other plants providing ecological diversity and nitrogen fixation that led to higher soil fertility. However, as global demand for coffee increased, new full-sun varieties of coffee plants were developed that grew more cherries at a faster rate than shade grown varieties (Perfecto et al., 2019).

Although this method of farming produces higher coffee yields, it accelerates deforestation, requires heavy inputs of artificial fertilizer, and produces plants that are less resilient to pests and disease. This overall makes for a riskier investment since farmers are reliant on only one crop as their source of income. In a study conducted by (de Souza et al., 2012),
farms in Brazil that planted shade tolerant varieties of coffee, paired with leguminous trees and other cash crops such as sugarcane, bananas, wood, cassava, and avocados were able to make significantly higher profit margins than full-sun, monoculture coffee farms. By planting coffee under shade, farmers also reduce the amount of heat the plants are exposed to, acting as a buffer against the worst effects of warming temperatures. Additionally, using shade-tolerant varieties has an added ecological benefit of reducing the need for deforestation, since these plants do not require open space like the full-sun varieties do.

Increased efforts are also being made by plant breeders to produce new hybrid varieties of coffee that cross traditional and wild varieties found in Ethiopia and Kenya – where the coffee plant is endemic. Plant geneticists have been able to develop F1 hybrids that produce 26-61% more coffee beans than traditional varieties, as well as a more robust flavor profile (Kahsay et al., 2023). These hybrid varieties are also more resistant to drought, pests, and disease, but they have also been shown to be more labor intensive to maintain and require increased use of inorganic fertilizer.

Coffee breeding programs show promise to add another tool to develop resiliency towards climate change, but these efforts need to be acted upon quickly. A 2019 survey found that 60% of wild coffee species were at risk of extinction, and 45% of species had not been collected and held in any known germplasm repository (Davis et al., 2019). Efforts need to be made to collect as many wild coffee species as possible, as soon as possible. This will guarantee a larger, more diverse gene pool for selecting favorable traits in breeding programs that can bolster resistant coffee plants. To apply many of these breeding practices, an organization called World Coffee Network has developed a global breeding network that aims to share germplasm.
among coffee breeders, introduce hybrid coffee varieties to farmers, and conduct field evaluations of how these varieties fare in practice (Schlossberg, 2021).

Most coffee farmers do not reap the benefits of coffee’s commercial success as a global commodity and are unable to negotiate a reasonable price for their crop from buyers and distributors (LaPorte, 2013). Fair Trade organizations were developed in an attempt to spare farmers from the worst of this price inequity, and farmers who are able to produce crops at a certain verifiable standard are able to sell their beans to Fair Trade organizations for a guaranteed price per pound. However, Fair Trade organizations have faced much criticism over the years, as opponents argue that the guaranteed price per pound is still not high enough to actually bring farmers above the poverty line, and that much of the extra costs consumers pay for Fair Trade coffee do not directly go to farmers, but rather to inflated administrative and distribution costs (Valkila et al., 2010). Additionally, because it requires coffee produced to be at a certain standard, many Fair Trade organizations inherently favor farmers that have a certain level of education and resources for their crops, and opponents argue that it takes profits away from farmers in poverty that do not have the resources to meet these standards (Haight, 2011).

While Fair Trade coffee has a questionable effect on the well-being of coffee producers, case studies have shown that farmers who are a part of local cooperatives have been able to produce high quality products with ethical pay for workers. Areas such as Chiapas, Mexico, have been successful in implementing mutual aid-based cooperatives that are not affiliated with official Fair Trade organizations (Folch & Planas, 2019). These community-based cooperatives pool together resources to process and distribute coffee and ensure that farmers who participate are treated with fairness and dignity. When farmers sell their crop in its green, un-roasted and
unprocessed state, they make significantly less money than if they processed it themselves, and having access to sell their beans in a processed state for a reasonable price has allowed farmers to cut out exploitative middlemen and receive more for their crop. With this increased income, some farmers have also been able to open their own coffee shops and sell coffee to tourists, adding more diversity to their income and decreasing their reliance on global supply chains that underpay them for their labor and skills (LaPorte, 2013). Through local organization and grassroots cooperation, coffee can be used as a tool of economic freedom and independence for small scale growers.

Integration Challenges

While there are many strategies farmers can adopt to lessen the impacts of climate change on their farms, there has been an unfortunate lack of outreach and support for these farmers to implement these necessary changes. Despite the significant body of research produced concerning the effects of climate change on coffee production, most farmers in South and Central America do not grow F1 hybrid coffee plants or utilize agroforestry practices (Kahsay et al., 2023; Perfecto et al., 2019). Much of the research into these adaptation strategies is inaccessible to the farmers who need it; either because it is written in scientific jargon, difficult to find, hidden behind paywalls, or not made available in the language that the farmers speak (Eise, 2022). There is a severe lack of education and implementation of these strategies, and many are not being effectively communicated to farmers. Scientific findings are not helpful if they cannot be adequately communicated and practically applied to the populations who can benefit from them.
There is a similar lack of outreach and support from government agencies as well as the global scientific community. In Colombia, many coffee farmers have reported receiving almost no support from government agencies on how to adapt their farms to a changing climate, creating a spiraling sense of helplessness and despair in many farmers about what they should do as crop losses become more common (Eise & Rawat, 2021). Coffee farmers are also limited in what adaptation strategies they can apply because of financial constraints; the farmers who are just barely getting by cannot afford the initial costs required to implement changes, even though those changes will likely allow them to earn more money in the future, a cycle in which poverty begets poverty with no way out. For farmers to be able to successfully adapt, information about the effects of climate change must be made more available, and government agencies need to provide financial support specifically for long-term adaptation strategies to help farmers overcome these initial barriers.

There is no singular solution that can help farmers adapt their crops and avoid poverty; possible solutions are intertwined with one another environmentally, economically, and socially, and all these factors need to be addressed for solutions to be effectively implemented. Human-induced climate change has altered our environment in an irreversible way, and these environmental changes will have a cascading effect on global economies and social stability for coffee producing countries. By trying to mitigate some of the environmental effects of climate change (using plant breeding to improve resilience of crops and implementing agroforestry practices to improve biodiversity), it is possible that coffee farmers can also prevent some of the worst of the economic and social impacts. These solutions are also dependent on economic policies that allow for research, funding, and implementation of climate change adaptation strategies, as well as policies that regulate the price of coffee as a global commodity. As coffee
production is impacted by climate change, the effects will significantly impact the lives of consumers and producers alike on a globally unprecedented scale.
Bibliography


