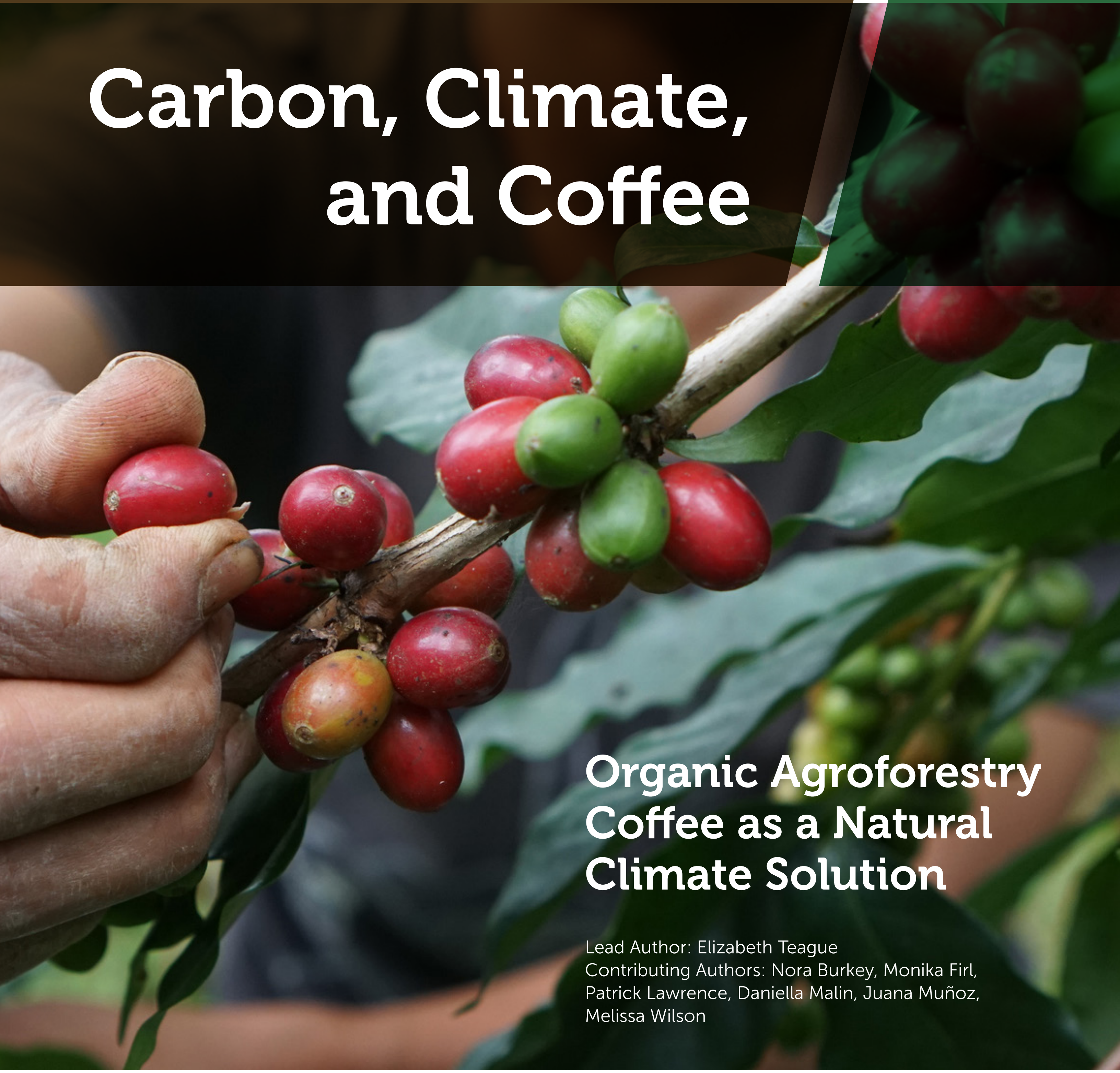
Carbon, Climate, and Coffee



Organic Agroforestry Coffee as a Natural Climate Solution

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Introduction

The specialty coffee industry sits at the intersection of dual crises: the climate crisis and a livelihood crisis. Climate change threatens the future viability of coffee as a crop. Changing weather patterns are already decreasing coffee production and quality; as these changes accelerate, an estimated 50 percent of current coffee-growing area may become unsuitable for the crop by mid-century.[1] Meanwhile, rising production costs and volatile commodity prices mean coffee producers do not reliably earn a profit. In particular, many of the estimated 12.5 million smallholder coffee producers do not earn a living income from their coffee farms and increasingly struggle to support themselves and their families.[2]

Fortunately, the specialty coffee industry is aware of these crises and is starting to act. Over the last five years, commitments to reduce greenhouse gas (GHG) emissions to mitigate the climate crisis have proliferated across the sector. Many actors have committed to reducing their emissions to "net zero" by 2050 or earlier; others have carbon goals within larger initiatives related to regenerative agriculture or biodiversity conservation. Similarly, the concept of living income has gained traction as a core tenet of sustainable supply chains, with multiple communities of practice emerging and an increasing number of buyers adopting goals related to greater value distribution to producers.[2]

For many in the industry, the two front lines of climate action and improved producer livelihoods remain separate areas of work. Yet the climate and livelihoods crises are interdependent and must be solved for together. Without sufficient resources recognizing their labor, coffee producers cannot invest in climate action, whether related to decarbonization or—more urgent for producer communities—adaptation to shifting farming conditions and increasingly severe climate shocks.

There is, however, an opportunity to leverage the symbiotic nature of these two front lines by recognizing that climate action can improve producer livelihoods if pursued in a manner that centers producer voices and prioritizes their needs. Leading coffee farmers have already demonstrated that regenerative agroforestry practices—such as planting shade trees and applying organic compost to build soil health—lead to numerous social and economic benefits. In addition, these practices can draw down carbon from the atmosphere and increase resilience to climate shocks. Yet the industry largely does not recognize the value generated by agroforestry practices, including contributions toward corporate net zero and/or supply resilience objectives. Should the industry compensate producers for their work to combat climate change, they could support producer livelihoods and climate action in concert.

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In 2019, Cooperative Coffees—a cooperative of 23 community-based coffee roasters—presented an initial roadmap to turn this vision into a reality. Through their "Carbon, Climate, and Coffee Initiative," the roaster cooperative established a fund to compensate producer partners for the environmental benefits generated by their farming practices. As Cooperative Coffees wrote in 2020, "Smallholder producers are the solution to climate change, not the cause. Paying them for their environmental efforts is key to promoting carbon sequestering activities they currently perform while incentivizing more effort in the future."

To realize their vision of carbon-based payments for producer partners, Cooperative Coffees needed to answer three questions:

1. How can we collect highly technical carbon data from hundreds of smallholder producers? As a trader working with fair trade- and organic-certified smallholder producer organizations, Cooperative Coffees relies on their suppliers' internal control systems to collect data from individual producers and report aggregated information. While producer cooperatives already collect comprehensive production and demographic data from farmer members, they had limited or no experience with carbon accounting prior to this project.

2. What is the carbon footprint of our suppliers? Benchmark carbon footprint data exists for coffee, but most represent "average" national or global production systems rather than the small-scale, organic, agroforestry production systems that characterize Cooperative Coffees' supply chain. Moreover, most footprints do not account for carbon removals associated with coffee production, thereby misrepresenting the crop's climate impact. As World Coffee Research concluded in 2021, "We should consider that there are no accurate estimates of coffee's carbon footprint."

3. How can we translate carbon performance into just compensation for producer partners? Compensating producers for their carbon performance is considered a form of "insetting"—an investment in carbon reductions or removals within one's own supply chain.[3] Few guidelines exist on how companies should design insetting interventions, and fewer still on how companies should price carbon-based incentives for suppliers.[4] As a result, Cooperative Coffees needed to design their own approach to compensating producer partners, which presented both challenges and opportunities.

To answer these questions, Cooperative Coffees partnered with six producer organizations and four industry allies also working at the intersection of producer livelihoods and climate action: producer organizations CAC Pangoa (Peru), CENFROCAFE (Peru), COMSA (Honduras), Manos Campesinas (Guatemala), Norandino (Peru), and Sol y Café (Peru); and the Cool Farm Alliance, Root Capital, the Sustainable Food Lab, and The Chain Collaborative.[5] Together, with funding from EcoMicro housed in the Inter-American Development Bank, we designed and piloted a carbon insetting approach to compensate producers for their work as climate and environmental stewards. The pilot used the Cool Farm Tool, a greenhouse gas calculator, to measure producers' carbon performance—including its new methodology tailored to perennial crops like coffee. This project was the first to test the new Cool Farm Tool perennials methodology for smallholder coffee production, presenting an opportunity to contribute novel primary data to the industry.[6]

In total, the project worked with 253 coffee producers across Guatemala, Honduras, and Peru, representing around two percent of the six cooperatives' aggregate membership. Producers managed small coffee farms: on average, 1 hectare in Guatemala, 2 hectares in Honduras, and 3 hectares in Peru. All farmers were fair trade and organic certified, and all produced coffee under agroforestry conditions, with an average of 140 shade trees per hectare. Sixty-five producers (25 percent of project participants) were women. As participating producers likely were not representative of each cooperative's full membership, project results should be seen as illustrative of the potential carbon performance of organic, agroforestry coffee production rather than indicative of the performance of each cooperative.

In the following executive report, we share learning related to our three original project questions, as well as reflections and recommendations for others interested in climate action within coffee supply chains. For more information, including detailed analysis of carbon footprint results, please refer to the accompanying technical report.

Key Findings

Organic, agroforestry coffee production can be an important natural climate solution, mitigating climate change by sequestering more carbon than it emits each year. While agroforestry's potential to combat climate change by drawing down carbon has been documented,[7] this project is one of the first initiatives to quantify carbon removals as well as emissions associated with agroforestry coffee systems.[8] Of the farms assessed, 55 percent scored as "carbon negative" via the Cool Farm Tool, with a median carbon footprint of -3.8 kilograms (kg) of carbon dioxide equivalent (CO_2e) per kg of green bean equivalent (GBE) coffee produced. Another 20 percent of farms scored near carbon neutral, generating between 0 and 1 kg CO_2e per kg GBE. Overall, farms reported a median carbon footprint of -0.6 kg CO_2e per kg GBE.[9]

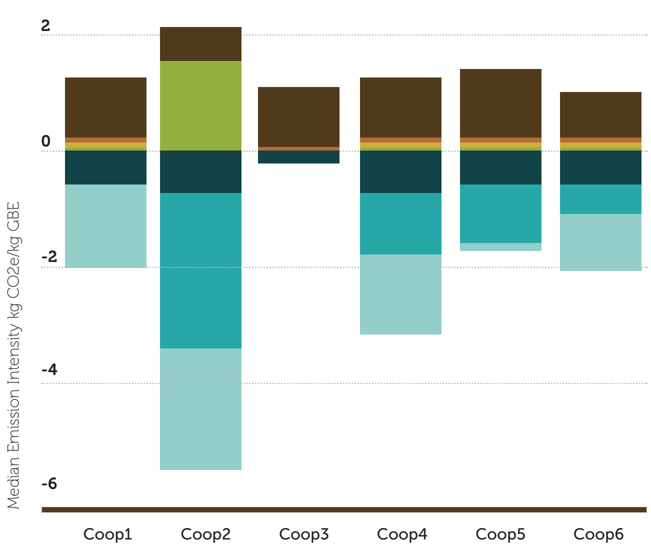
Carbon emissions were primarily driven by land use change, followed by burning or composting of pruning residue; given producers' minimal use of fertilizers, emissions from fertilizers played a smaller role. If producers reported conversion of forests to coffee farms during the 20-year period of analysis, the resulting carbon emissions were significant, generally an order of magnitude higher than emissions from any other source. Forest conversion was most common across the four Peruvian cooperatives, between 16 and 77 percent of farms surveyed were reportedly forested areas 20 years ago. Notably, Peruvian producers reported that much of the land had been deforested by other actors, mostly loggers; when converted by cooperative members, local regulations prompted farmers to clear the land to secure land titles. We discuss implications for producer compensation models below.

Aside from land use change, burning or composting organic material from pruned coffee trees generated the most emissions—an interesting counterpoint to the removals associated with chipping and mulching these same materials.

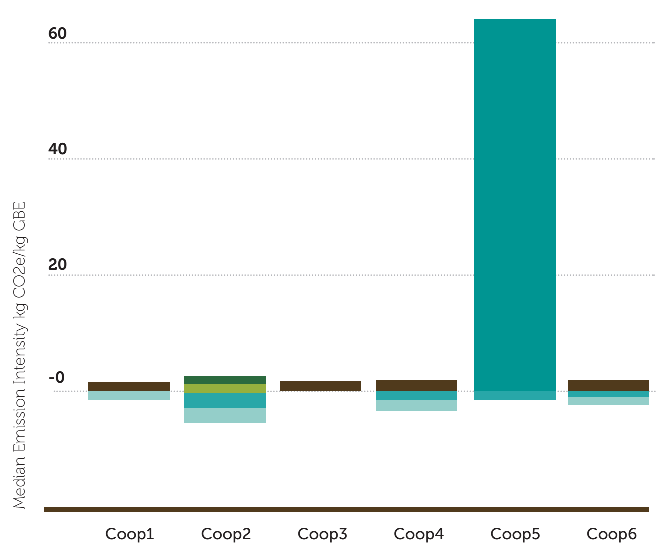
Findings related to fertilizer emissions were minimal, demonstrating the carbon benefits of organic farming systems. In conventional systems, chemical fertilizer use often represents a leading source of emissions. For example, according to Cool Farm Tool data collected from conventional Arabica coffee farms in Colombia and Honduras, fertilizer production and application accounted for over 80 percent of the average farm footprint.[10] Within the project sample, however, emissions from organic fertilizer production were essentially zero; emissions from organic fertilizer application were modest and usually more than offset by the resulting increase in soil carbon.

Carbon removals were primarily driven by organic fertilizer use, regular pruning of coffee trees and mulching of pruning residue, and the incorporation of shade trees. The magnitude of impact and relative importance of these management practices varied significantly across the six participating cooperatives. Interestingly, shade trees generally sequestered less carbon than residue management or application of organic fertilizers, although shade trees contributed

1. MEDIAN EMISSION INTENSITY BY EMISSIONS SOURCE BY PRODUCER COOPERATIVE, EXCLUDING EMISSIONS FROM LAND USE CHANGE



2. MEDIAN EMISSION INTENSITY BY EMISSIONS SOURCE BY PRODUCER COOPERATIVE, INCLUDING EMISSIONS FROM LAND USE CHANGE

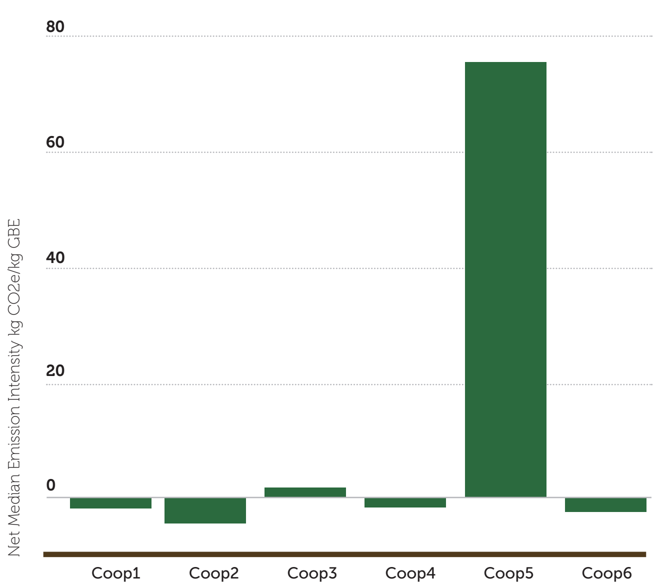


indirectly when producers chipped the pruning residue and spread the chips as mulch. Land use change also contributed to carbon removals in select cases, when producers converted farms from annual crops like maize, generally not grown under agroforestry systems, to shaded coffee production. Of note, the Cool Farm Tool does not account for forest areas managed by producers outside of coffee-growing areas, as they fall outside the scope of a coffee carbon footprint.

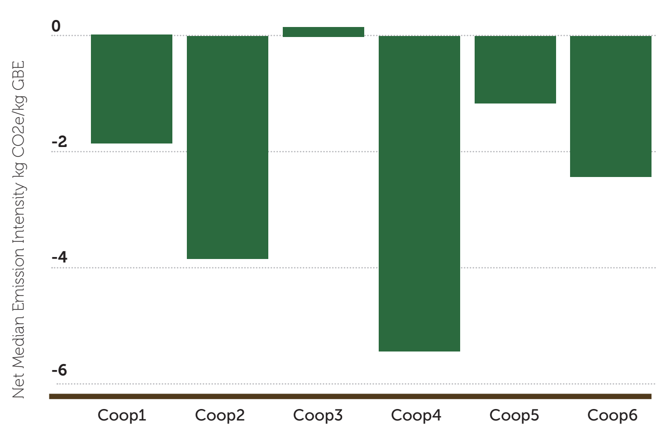
Carbon results were extremely variable, demonstrating the importance of site-specific data collection for baselining. The carbon footprint of farms varied significantly within each cooperative, even across cooperatives in the same country. As a result, we see meaningful differences in key carbon metrics across cooperatives, such as the emissions intensity per unit of coffee produced, the percent of farms operating at carbon negative versus carbon positive, and total emissions generated. Other users of the Cool Farm Tool have seen similarly variable results with smallholder coffee producers.[11] At a time when primary carbon footprint data for coffee supply chains remains limited, this variability highlights the ongoing importance of site-specific data collection to understand the carbon performance of different coffee supply chains.

Carbon measurement at the farm level requires material new investment by producers, even within certified supply chains. Project partners originally sought to incorporate the Cool Farm Tool survey into annual compliance monitoring for producers' fair trade and organic certifications, but we found insufficient overlap in content between the two tools. As a result, we designed a separate digital survey to be administered by cooperative staff. Data collection generally required an extra visit of at least one hour[12] to each participating farm, plus additional time to travel to remote communities. In total, producer organizations spent several extra weeks in data collection, which represents time away from other responsibilities for both cooperative staff and producers. Beyond data collection, cooperatives also invested time in training surveyors and in aggregating and cleaning data. In order to scale carbon data collection across their membership, some cooperatives expressed a need to hire additional, specialized staff going forward. While data collection and management should take less time in the future as staff and producers become more familiar with the content, it still represents a new cost in time and resources.

3. MEDIAN NET EMISSIONS INTENSITY BY PRODUCER COOPERATIVE, INCLUDING LAND USE CHANGE EMISSIONS



4. MEDIAN NET EMISSIONS INTENSITY BY PRODUCER COOPERATIVE, EXCLUDING LAND USE CHANGE EMISSIONS



A Path Forward

Project results demonstrate the important role organic, agroforestry coffee production can play in reducing and storing carbon emissions. Additionally, agroforestry systems provide multiple other environmental and livelihood benefits, ranging from biodiversity conservation to diversified income and food security for producers. Yet agroforestry coffee farms have been disappearing over the last several decades. Today, approximately 24 percent of the world's coffee area is managed under traditional, diverse shade and 35 percent under limited shade, representing a decrease of around 20 percent since the 1990s.[13] Coffee producers face an increasingly dire confluence of challenges, including rising production costs, commodity prices often below the cost of production, and climate change. If unaddressed, these challenges may prompt producers to abandon coffee.[14] Our organizations have already encountered coffee smallholders turning to cacao, pineapple, sweet potato, ginger, or urban migration because they do not see a future in coffee.

We believe carbon pricing can help change this trajectory for the benefit of people and the planet. As the world races to achieve net zero, much of the attention in agricultural supply chains has rightly been focused on transitioning high-emission producers to lower-carbon practices. In specialty coffee supply chains, for example, many initiatives focus on (re) introducing agroforestry models in origins where full-sun, monoculture coffee has become the norm. This work is critical. At the same time, there is a need to help existing agroforestry producers conserve and improve their farms, which provide important benefits to producer communities, supply chains, and the environment.

Specifically, we encourage coffee industry actors interested in net zero, resilient supply chains to **provide preferential pricing to good carbon performers–on top of living income prices–to incentivize producers to maintain and further improve regenerative, agroforestry systems**. Preferential pricing refers to the practice of buyers offering better prices for supply characteristics they value, such as quality. A price premium tied to good carbon performance would recognize the value of low-carbon or carbon-negative coffee to buyers' sustainability commitments and overall supply resilience. Beyond the importance of recognizing its inherent value, carbon pricing could incentivize producers to adopt or sustain good carbon practices, such as mulching organic matter, that involve additional costs in inputs or labor.

To implement carbon pricing, however, coffee industry actors need this data at scale and guidance on how to use carbon footprint data within their operations. During our pilot, we collected carbon footprint data for two percent of the farmers represented by our six cooperative partners—scaling across each cooperative's full membership or an entire smallholder supply chain appears daunting with the tools available today. Yet we see the following opportunities to work toward scaled carbon measurement and, most importantly, scaled carbon compensation for coffee producers:

How to collect highly technical carbon data from smallholder farmers:

- **Partner with producer organizations to collect, report, and (most importantly) act on carbon accounting data.** This project originated from discussions with producer cooperatives who wanted to better understand, be recognized for, and improve their efforts to support climate-friendly, regenerative coffee farms. These cooperatives play a critical role in smallholder supply chains, providing market access, agronomic training, financing, and other support to otherwise hard-to-reach farmers. Because they are owned and largely led by producers, they also uniquely understand producers' context and needs. By partnering with these critical actors in smallholder supply chains, the project was able to collect data from hundreds of producers across Guatemala, Honduras, and Peru. More importantly, cooperatives' insights were critical to other project partners contextualizing carbon footprint results and identifying opportunities for action aligned with producers' needs. Collaboration and learning across the supply chain requires including producer voices throughout the process, ensuring producers have access to their own carbon data, and investing time in joint analysis and interpretation of results so producers can make informed decisions.

- **Build fit-for-purpose data collection tools for rural communities.** Many smallholder producers live in communities without internet or cellular data access, making online data collection tools impractical. Moreover, some producers are not literate, meaning self-administered surveys are not accessible. Project partners designed for these realities by developing a mobile Cool Farm Tool survey to be administered offline by cooperative staff, with results uploaded once staff reached a site with internet access. When choosing our data collection system, we prioritized adaptability, so that questions could be modified based on local context; ease-of-use for cooperative staff managing data collection; and compatibility with other systems, most notably the Cool Farm Tool web application and cooperative data collection systems managed through Root Capital's Cultivar data platform.[15]

• Co-develop and share carbon footprint benchmarks to inform industry decarbonization efforts while reducing data collection burden for producers. We see an opportunity for industry actors to collaborate pre-competitively to create and share carbon footprints for different coffee supply chain segments. Coordinated research would provide buyers and other industry actors with data to advance corporate climate strategies without overburdening producers with duplicative data requests. Encouragingly, several platforms are already promoting the creation of industry carbon benchmarks, including the Cool Farm Alliance, the Sustainable Coffee Challenge, and USAID Green Invest Asia.[16] These efforts will also help build the evidence base for organic, agroforestry coffee as a natural climate solution, adding nuance to the magnitude of impact and the key drivers of carbon emissions and removals across coffee origins.

• After developing baselines, focus scaled data collection on key drivers of emissions and removals. The full Cool Farm Tool requires high-resolution data on every aspect of crop production. Yet we and other Cool Farm Tool users[17] have found that a handful of practices drive the majority of coffee production's carbon footprint, although which set of practices varies by context. After using the full Cool Farm Tool to establish a baseline for a particular supply chain, we recommend focusing recurring data collection on the main drivers of emissions and removals to reduce the time and cost burden for producers and supply chain partners. Using this simplified approach, we see significant potential to integrate carbon accounting and reporting into certification standards, as recommended by groups like the Value Change Initiative.

How to translate carbon performance data into compensation for producer partners:

• Consider compensation models based on producer typologies or performance categories rather than individual results. As the science and best practice around carbon measurement and compensation continue to evolve, and as the coffee industry continues to gain visibility into the carbon footprint of specific supply chains, there is a potential to consider carbon valuation based on performance categories (e.g., low-, medium-, and high-emissions) rather than site-specific individual results. For example, buyers could pay a premium to all low-carbon organic, agroforestry producers to recognize their contributions related to decarbonization and supply resilience. Such a premium would resource producers to maintain and improve their agroforestry farms, while sending a market signal to higher-emitting producers to invest in carbon reductions or removals. In terms of practicality and scalability, a premium based on performance categories could leverage less precise, but directionally accurate carbon data focused on key drivers of results (as mentioned above), significantly reducing the costs and complexity of data collection and reporting for producers and supply chain partners.

• Discount land use change when considering compensation for producers. As with many agricultural products, deforestation represents a significant source of emissions for coffee production globally. In fact, given the nature of coffee as a tropical tree crop, all coffee farms likely originated from conversion of tropical forests. Current carbon accounting standards, however, usually only count deforestation emissions if they occurred within the last 20 years, meaning newer coffee farms report significant land use change emissions while "legacy" coffee farms report none. While important for net zero accounting, we believe such a system does not support forward-looking action, especially when working with producers across multiple geographies with different deforestation histories. Within this project, the partners decided to treat deforestation emissions as a "sunk cost" for all coffee production, excluding deforestation from footprint analysis for the purpose of considering incentives or other support for producer partners. This allowed us to focus on practices that producers can adopt or change now and into the future.

- **Account for systematic barriers limiting the carbon performance of marginalized producers.** Systemic inequities such as limited access to land, education, or productive inputs may limit some producers' ability to achieve better carbon footprints and therefore performance-based incentives. For example, women producers are less likely to participate in agricultural training due to additional child-rearing and home-making duties, resulting in lower practice adoption, lower yields, and lower income—and perhaps in higher carbon footprints than their male peers. In addition to supporting existing good actors, compensation models should consider how to meet the needs of the most marginalized producers, for example through complementary investments in tailored training, to promote equitable climate action.

- **Pay for carbon data collection as well as for carbon.** As noted above, carbon measurement represents a meaningful new data collection and reporting cost for producers and producer organizations, above and beyond current reporting for certifications or other supply chain sustainability initiatives. Producer organizations look to supply chain partners requesting carbon data for their own business needs to help cover these new costs. Producers also request support in turning carbon data into climate action, for example through training on how to interpret carbon footprint results or funds to introduce new technical assistance activities focused on good carbon practices.

While our project focused on carbon emissions, we recognize carbon represents only one aspect of environmental performance. Many in the coffee industry are expanding their ambitions beyond net zero to pursue a "nature-positive" future—a world where we halt and reverse nature loss so that ecosystems can begin to recover.[18] Under a nature-positive approach, industry actors might measure biodiversity levels, soil health, or water quality alongside carbon and consider compensation models across these interrelated indicators. Project partners welcome this trend, as it could address limitations of a narrow focus on carbon—for example, overlooking the environmental benefits of forest stands planted and conserved by farmers outside of their coffee plots. While quantitative methodologies to measure progress toward nature-positive goals remain extremely nascent, project insights related to carbon measurement and compensation for smallholder coffee farmers could be transferrable to broader environmental compensation models.

Conclusion

This is the decade for action. As we rapidly approach the 2030 deadline to achieve a key net zero milestone and the United Nations' Sustainable Development Goals, the actors most responsible for climate change bear a responsibility to decarbonize in a manner that does not further jeopardize vulnerable communities. We see significant potential for carbon or broader environmental payments to help address the interrelated crises of climate change and poverty in smallholder coffee communities—if implemented in partnership with producer communities and in a manner that centers their needs.

The Cool Farm Alliance, Cooperative Coffees, Root Capital, the Sustainable Food Lab, and The Chain Collaborative express our gratitude to our producer organization partners: CAC Pangoa, CENFROCAFE, COMSA, Manos Campesinas, Norandino, and Sol & Café—and to the 253 producers who shared their time, data, and expertise with us. Without their critical contributions, this project would not have been possible. We also thank EcoMicro and the Inter-American Development Bank for their generous support of this work over the last three years. We look forward to continuing to explore models that improve both climate action and producer livelihoods, and we invite collaboration with others on this journey.

Endnotes

1. Panhuysen, S. and Pierrot, J. (2020). Coffee Barometer 2020. Bunn, Christian, et al. (2015) "Multiclass classification of agro-ecological zones for Arabica coffee: an improved understanding of the impacts of climate change". PLoS One
2. Living income is defined by Sustainable Food Lab as "the net income a household would need to earn to enable all members of the household to afford a decent standard of living."
3. Carbon benefits generated through insetting interventions may or may not be verified as carbon credits or offsets, depending on how companies wish to claim the benefits. In this project, Cooperative Coffees did not seek to generate carbon credits; rather, they sought to report supply chain carbon benefits against their own corporate carbon footprint in service of a net zero commitment in place at the start of this project.
4. Readers interested in emerging guidelines may wish to reference the International Platform for Insetting and the Value Change Initiative.
5. Over the three-year project, partners played the following roles: Cooperative Coffees initiated the project, designed the model and provided the funds for carbon compensation. The Cool Farm Alliance provided the carbon measurement tool, the Cool Farm Tool, including a cutting-edge methodology tailored to perennial crops like coffee. Root Capital led the development of a digital Cool Farm Tool survey with the six cooperative partners, provided training on the digital tool, and managed data aggregation. The Sustainable Food Lab analyzed Cool Farm Tool results and captured project learning to inform ongoing improvements to the perennials methodology. The Chain Collaborative led narrative reporting, communications, industry engagement, and gender assessment. The six cooperative partners were instrumental throughout the project, from identifying the initial opportunity with Cooperative Coffees, informing the digital Cool Farm Tool survey design, collecting carbon footprint data from individual producers, interpreting carbon footprint results, and identifying opportunities for future work. Please refer to the technical report for more details.
6. As of the publication of this report, the Cool Farm Tool methodology for perennial crops remains a prototype, subject to ongoing modification and improvement by the Cool Farm Alliance. Future changes in the Cool Farm Tool perennials methodology could affect carbon footprint results for coffee production, including the results shared in this report.
7. Project Drawdown
8. Through the Cool Farm Tool's new perennial cropping module, the project was able to account for sources of carbon sequestration or carbon removals not previously assessed in earlier versions of the Cool Farm Tool or by many other GHG calculators. Specifically, the new perennial cropping module accounts for carbon removals associated with shade trees and with a broader set of management practices related to organic residue (e.g., organic material from pruned coffee trees); earlier versions of the Cool Farm Tool used a simplified methodology that accounted for one type of organic residue managed in one way, and that did not consider residue end-of-life. Due to modeling limitations, the new Cool Farm Tool perennials module uses a simplified method for estimating increases in soil carbon, and is only able to differentiate between broad classes of tree species. See accompanying technical report for details.
9. These results include emissions from land use change, including conversion of forest to coffee farms. See page 6 for discussion of land use change dynamics.
10. Rainforest Alliance (2023, May 24-25). Rainforest Alliance Case Study [Conference presentation]. Cool Farm Annual Meeting, Lambourn, Berkshire, United Kingdom.
11. Caravela Coffee (2023, May 24-25). "We Go Above and Beyond" [Conference presentation]. Cool Farm Annual Meeting, Lambourn, Berkshire, United Kingdom.
12. Visits sometimes took up to four hours per farmer when farmers managed multiple, non-contiguous coffee farms; were located in particularly remote communities; or did not speak Spanish, requiring cooperative staff to translate the Spanish questions in the Cool Farm Tool survey into the relevant indigenous language.
13. Jha, Shalene et al. (2014). "Shade coffee: update on a disappearing refuge for biodiversity". BioScience
14. Panhuysen, S. and Pierrot, J. (2020). Coffee Barometer 2020.
15. Root Capital's Cultivar Data Platform is the organization's proprietary technical infrastructure for data storage and analysis that allows integration to other databases; it is used in support of Root Capital clients.
16. Enveritas (2023). "Establishing carbon footprint baselines for robusta coffee production in two key origins: Central Highlands, Vietnam and Southern Sumatra, Indonesia."
17. For example, Cool Farm Tool findings from a project managed by USAID Green Invest Asia found that three practices accounted for at least 90% of emissions in the two Robusta coffee origins evaluated: fertilizer production and use, energy use for irrigation, and residue management in Vietnam; and fertilizer production and use, transportation, and residue management in South Sumatra, Indonesia.
18. IUCN (2022). Towards an IUCN nature-positive approach: a working paper. IUCN Leaders Forum, Jeju, South Korea.