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PRACTICE NOTE

Building a Climate Resilient Future for Costa Rica's Coffee Farming Communities

A Case Study of the Coto Brus Region

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Authors

Stefanie Tye
Delfina Grinspan

Layout

Julie Moretti
julie.moretti910@gmail.com

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LIST OF KEY ABBREVIATIONS

ASOMOBI	Organized Women's Association of Biolley (located in Coto Brus)
CATIE	Tropical Agricultural Research and Higher Education Center
Coffee NAMA	Nationally Appropriate Mitigation Actions for the Coffee Sector
Fonascafé	National Coffee Sustainability Fund
GAT Sur Alto	Southern Territorial Action Group (NGO and microfinance institution)
ICAFFE	Coffee Institute of Costa Rica
IMAS	Interagency Institute for Social Assistance
INA	National Institute of Learning
INDER	National Rural Development Institute
INFOCOOP	National Institute for Cooperative Development
INS	National Insurance Institute
MAG	Ministry of Agriculture and Livestock
MEIC	Ministry of Economy, Industry and Commerce of Costa Rica
MINAE	Ministry of Environment and Energy
PREPdata	Data visualization platform created by the Partnership for Resilience and Preparedness
PROCOMER	Ministry for the Promotion of Costa Rica's Foreign Trade
SIMOCUTE	National Land Use, Land Cover and Ecosystem Monitoring System
SINAMECC	National Climate Change Metric System

HIGHLIGHTS

- Approximately 3,000 smallholder coffee farmers live and work in the Costa Rican region of Coto Brus. Like many coffee farmers globally, they are highly vulnerable to climate change impacts, which are projected to intensify and shift the geographical locations suitable for arabica coffee.
- Produced in collaboration with the Costa Rican government, this case study used desk research, interviews, and field visits to understand how coffee farmers' climate resilience can best be enhanced in the short, medium, and longer terms.
- Coto Brus has begun implementing adaptation measures thanks to farmer associations and cooperatives; farmer-to-farmer knowledge exchanges; supportive and complementary institutions that facilitate strategic cross-sectoral alliances; and national and international programs for sustainable practices.
- Measures such as replanting farms with climate-resilient coffee varieties, using new technologies, and diversifying incomes emerge as promising adaptation options. However, in some situations, these measures will not transform the coffee sector to the extent needed to adapt to intensifying climate change impacts.
- Recommendations to further build critical climate resilience focus on providing frequent technical support and trainings to strengthen farmers' capacities to successfully invest in adaptation measures; improving communications between key actors; expanding peer-to-peer learning efforts; strengthening the evidence base on effective adaptation measures; and mapping transformative pathways for longer-term resilience.

EXECUTIVE SUMMARY

SUMMARY

WRI applied the framework it developed in *Transforming Agriculture for Climate Resilience: A Framework for Systemic Change* (Carter et al. 2018) to assist Costa Rica in mapping out short-, medium-, and long-term adaptation pathways that are inclusive, equitable, and participatory. The framework underscores that, in some situations and locations, *incremental* adaptation measures will prove insufficient in the years to come to fully reduce growing risks from climate change impacts. In these situations, more fundamental, or *transformative*, changes—which may entail creating pathways toward new systems more suitable for changing climate conditions—will be needed to maintain the communities’ livelihoods in the long term. Such changes will often include shifting the mix of crops grown and livestock raised in particular areas, employing substantially new technology at broad scale, and/or altering the production landscape from one type to another.

The first year of technical assistance focused on stakeholder engagement, research, and in-country discussions via workshops to introduce the concept of transformative adaptation and establish a dialogue on climate adaptation, vulnerabilities, and impacts. These discussions were held with coffee producers, cooperatives, ministry officials, research organizations, financing entities, and the private sector, among others. Findings from these conversations would serve to inform MAG’s Coffee Program, with the additional aim of being used to inform the drafting of a national coffee strategy. The first year included a blog post to showcase transformative adaptation in action¹ and culminated in a final internal report shared with ministry counterparts.

The focus of the second year of the project reflects MAG and MINAE’s desire to share the challenges and lessons learned from the coffee-growing region of Coto Brus to better inform, guide, and finance climate resilience efforts for these communities, while extracting insights for other coffee-growing regions in the country.

The Coto Brus district, located in the Brunca region,² is one of the country’s eight coffee-growing areas identified by the Coffee Institute of Costa Rica (Instituto del Café de Costa Rica; ICAFE) and one of the smallest contributors to national production. Coto Brus was chosen by government counterparts in response to smallholder farmers’ requests for support and because this area has been experiencing a rapid decline in coffee production and is highly vulnerable to climate change. In the second year, WRI conducted research, expert interviews, farm visits, and a full-day workshop in Coto Brus with key stakeholders.

MAIN FINDINGS

- By 2050, absent adaptation measures, up to half of the areas currently suitable for coffee cultivation in Coto Brus are predicted to become unsuitable across both low and high emissions pathways scenarios (Ovalle Rivera 2018). Central areas are projected to be more adversely affected while a few locations are projected to see an increase in suitability.
- Efforts to increase Coto Brus coffee farmers’ resilience by addressing the most immediate climate change impacts have begun. However, few farmers incorporate adaptation into their planning and huge implementation gaps persist, despite a broad awareness of sustainable practices. According to interviewees, some farmers are further behind than others—especially smallholders with more limited resources.
- Despite the benefits of medium- and long-term planning to accomplish the large-scale transformative changes the coffee sector will need to adapt to intensifying climate impacts, most producers and the sector are integrating smaller, short-term, incremental adjustments that might not be sufficient in the long term.

RECOMMENDATIONS

- Promote promising adaptation options identified by local stakeholders, provide regular technical follow-up, and support farmers in exploring additional medium- and longer-term measures.
- Establish baselines and monitor the impacts of adaptation measures. Building the evidence of farms' vulnerabilities while tracking the results of adaptation efforts can help maximize the allocation of limited resources over the short, medium, and long terms and inform where and when transformative pathways (Carter et al. 2018) will be needed. Transformative pathways are coordinated sequences of short-to-long-term actions or projects intended to prepare agricultural systems for unprecedented climate conditions. This point is particularly relevant for MAG, ICAFE, and MINAE.
- Map when and where coffee is likely to lose viability in the coming decades and explore transformative and equitable pathways toward climate resilience, with stakeholder participation (particularly relevant for MAG, ICAFE, and MINAE). At-risk farmers should be supported to experiment with different crops, technologies, and even livelihoods like ecotourism that will serve them better over the longer term.
- Reinforce existing institutions and enabling factors to increase the uptake of adaptation measures and build greater resilience in Coto Brus. These include strengthening farmer associations and cooperatives, as well as farmer-to-farmer learning; promoting more strategic cross-sectoral alliances; and strengthening support for programs focused on sustainable practices.
- Develop farmer-tailored business administration skills trainings and guidance to build farmers' capacities to manage costs and access credit and financing, so they can more easily invest in adaptation measures.
- Create open communication channels within and across public and private entities to help bridge crucial information flow gaps around climate risks, existing vulnerabilities, and options to support the implementation of adaptation measures. Providing producers with clear, complete, and practical information on different financing options is also essential.

INTRODUCTION

About 80 percent of the world's coffee is produced by 25 million smallholder farmers who, like farmers in Coto Brus, Costa Rica, are highly vulnerable to climate change impacts and in need of urgent support to adapt (Fairtrade Foundation 2020). A further 100 million rural and seasonal workers along the global coffee supply chain depend on this crop for their incomes (Fairtrade Foundation 2020). By 2050, experts project that climate change will reduce the global areas suitable for growing coffee by about 50 percent, across emissions scenarios, placing millions of livelihoods at risk (Bunn et al. 2015; Pham et al. 2019).

In the southern Costa Rican canton of Coto Brus, farming communities have been harvesting coffee for generations. To this day, coffee continues to be the main economic activity of the district of over 43,000 people and is an important part of its cultural identity (INEC 2011). Although Coto Brus is one of the country's smaller and more remote coffee-producing regions, its farmers face many of the same challenges as those in other parts of Costa Rica—and coffee-growers worldwide. Coffee's low profitability, the advanced age of coffee trees, and other challenges such as a lack of generational succession make coffee production increasingly difficult, causing some farms to be sold, abandoned, or reused for other activities. Of the nearly 39,000 coffee farmers in the country, 91 percent are smallholder producers with farms smaller than five hectares (ICAFE 2019). In 2009, the number of coffee growers in Costa Rica was close to 50,000, representing a 22 percent decrease over 10 years (ICAFE 2019). These dynamics are reflected in Coto Brus, where the coffee production area decreased from 10,200 hectares in 2003 to 8,700 in 2017, and the number of producers fell from 6,400 to 3,200 in the same period (ICAFE and INEC 2018b).

On top of global declines in coffee prices and rising operating costs, Coto Brus growers must now contend with a rapidly changing climate, which they are currently experiencing in the form of irregular rainfall, warmer temperatures, and the appearance and spread of coffee pests and diseases (see Figure 1).

Figure 1 | **Diseased Coffee Plant in Coto Brus, Costa Rica**



Efforts to promote climate adaptation in Costa Rica's coffee sector are nourished by the country's deep commitment to climate action, driven by policies and strategies such as the National Adaptation Plan (2018–2030) and the National Decarbonization Plan (2018–2022). The foundations laid by these and other national policies in terms of, for example, capacity development, financing enablement, and government coordination have helped advance the integration of climate change across sectors. Moreover, the NAMA Café—although focused on mitigation and achieving a carbon-neutral coffee sector—has played an important role in generating new collaborations between the Ministry of Agriculture and Livestock (Ministerio de Agricultura y Ganadería; MAG), the Ministry of Environment and Energy (Ministerio de Ambiente y Energía; MINAE), and the Coffee Institute of Costa Rica (Instituto del Café de Costa Rica; ICAFE) on the topic of climate change, creating opportunities for adaptation activities and capacity building.

The Need for More Ambitious, Transformative Changes to Tackle the Coffee Climate Crisis

Incremental adaptation interventions intended to preserve existing coffee production, such as introducing disease-tolerant coffee varieties, improved shade management, and improved water and soil management, are essential to building the coffee sector's resilience and should be scaled up nationally and globally. These types of actions are generally what is included under the umbrella term *climate smart adaptation*. Nevertheless, in some situations and places, the severity of climate change impacts may make it impossible to keep the production of coffee and certain other crops viable even if incremental measures are widely applied. These locations may require more fundamental and systemic changes to *where, how, and whether* coffee is grown and commercialized, which could involve its replacement with other crops and activities in areas where the climate becomes unsuitable.³ These situations will call for more *transformative* changes over the medium and long terms such as switching to alternative crops or exploring new livelihoods, like ecotourism.

Prior World Resources Institute (WRI) research (Carter et al. 2018) defined *transformative* adaptation for agriculture as consisting of intentional alterations in response to or anticipation of climate change impacts that often have one or more of the following characteristics:

- 1) Significantly shifting the geographical locations where specific types of crops and livestock systems are located
- 2) Changing so many aspects of food production and marketing systems that fundamentally different types of agricultural landscapes result
- 3) Broadly applying methodologies and technologies that are significantly new to a particular region or production system

Box 1 | Defining Resilience

Resilience is the ability of social, economic, and environmental systems to cope with a hazardous event, trend, or disturbance, responding in ways that maintain both essential functions, identities, and structures as well as the ability to adapt, learn, and transform. In other words, resilience is the ability of a social, economic, or environmental system to cope with great change or disruption.

Source: Definition adapted from IPCC 2018.

Longer-term adaptation planning through a transformative lens can encourage stakeholders to rally around a common vision of what is most desirable and possible for a future with significantly different climatic conditions, and to design an action strategy that lays the groundwork to achieve that vision, in a manner that is inclusive, equitable, and prosperous for everyone. It can also help to guide government and private sector investment strategies.

Research and in-country discussions and workshops with a spectrum of stakeholders carried out over the two years of this project reveal that many aspects of the coffee sector are already undergoing autonomous transformations (i.e., those without broad-scale strategic planning) as coffee production loses viability. Indeed, the need for such changes in the face of climate impacts is acknowledged in Costa Rica's National Adaptation Plan, which defines transformation as a "structural change in the institutional, cultural, technological, economic and ecological dimensions of a system" (Government of Costa Rica 2018b). Numerous ministry and farmer stakeholders interviewed by WRI deem the current coffee production model outdated and unsustainable, and question its long-term viability and profitability in certain locations. Climate change is certainly not the only challenge coffee producers face, and adaptation is not the only change needed: Many stressed the need to improve the business model, marketing, and branding for Costa Rica's high-quality coffee. These perceptions are primarily driven by economic concerns, but keeping coffee production profitable will become even more difficult with climate change.

Coto Brus Case Study: An Opportunity to Expand Resilience Efforts Locally and Beyond

This case study delves into the coffee-growing district of Coto Brus to better understand ways to build upon and expand adaptation efforts for the coffee sector and strengthen its overall resilience. The paper begins by describing the context, including climate change impacts on the coffee sector, regional priorities, and sustainable development challenges. Identification and evaluation of adaptation options for the sector follow, with insights on capacities and limitations gleaned during the 2019 workshop, in which the region's coffee farmers, government

Box 2 | A Note on Gender and Social Inclusion within This Report

In recognition of the importance of **gender and social inclusion** dimensions, throughout this paper "producer(s)" and "farmer(s)" refer to both men and women who produce coffee. Although women rarely own their own farms, they often play an essential role in managing them. The authors also acknowledge that each producer can face different challenges based on personal characteristics such as age, disability, ethnicity, and gender. These may contribute to increased barriers to accessing training and financial resources, or securing land tenure. Even though in the text we refer inclusively to men and women coffee producers, in certain key passages of the document we draw attention to situations in which gender-based differences may be particularly important.

officials, technical experts, and other key stakeholders participated. Next, we discuss enabling factors that can accelerate adaptation in Coto Brus and illustrate how two groups of farmers are paving a way forward through innovation and strategic alliances. We then summarize opportunities to access financing and support for the implementation of adaptation activities before concluding with recommendations.

Like Costa Rica, top coffee-exporting countries—including Brazil, Vietnam, Colombia, Indonesia, Honduras, Ethiopia, and Uganda—still have much work to do when it comes to building the climate resilience of the sector. Through this paper, the authors hope that other coffee communities might learn from and be inspired by Coto Brus’s experience adapting to new climate realities.

METHODOLOGY

Methods to gather data comprised desk research, in-person and telephone expert consultations, field visits to coffee farms, and a workshop with key stakeholders organized in Coto Brus. WRI began by reviewing relevant materials and literature, such as Brunca regional development plans, studies of changing coffee suitability due to climate change, and reports provided by stakeholders from other coffee workshops in Coto Brus and other locations across Costa Rica. A total of 17 local and national experts were interviewed, including MAG and ICAFE regional staff and extension agents; various other regional government officials; representatives from nongovernmental organizations (NGOs), a large coffee exporting company (CAFINTER), and financing entities (the National Institute for Cooperative Development [El Instituto Nacional de Fomento Cooperativo; INFOCOOP] and Southern Territorial Action Group [GAT Sur Alto]); and coffee producers from the two coffee cooperatives in the region (Coopesabalito and Cooprosanvito). We also visited several coffee farms.

Most interviews took place in person when WRI visited Coto Brus and San José in August 2019.

WRI and MAG jointly designed and coordinated a participatory workshop to raise awareness of adaptation and understand how different adaptation options could be evaluated to inform adaptation planning. The workshop took place at the processing plant of Exportaciones Aromas Coffee, a coffee farmer association in Pittier, on August 13, 2019. Over 40 stakeholders participated. Approximately half of them were coffee producers and the rest representatives from several government agencies, the private sector, NGOs, and academia. More details on the key actors in the coffee sector and the workshop can be found in Appendices A and B. It is important to note that this group of coffee producers is not necessarily representative of the full range of diversity (e.g., socioeconomic, organizational) or level of expected climatic impacts in Coto Brus. Therefore, the findings of this study are not intended to be conclusive, but rather to contribute an additional perspective to enrich and promote adaptation planning in Coto Brus.

This case study leverages knowledge and relationships from a previous year of technical assistance, which facilitated buy-in, information gathering, and mapping of actors. The information obtained from the sources mentioned was then synthesized and analyzed. Data on climate risks and other factors such as protected areas and projected water stress were visualized on the platform PREPdata as an additional method to help identify critical areas and potential trade-offs.

The representation of coffee producers in the study is key to both the credibility and the pertinence of its findings. Methods and findings were additionally validated by the government counterparts at MAG and MINAE, which have been excellent partners throughout the lifetime of the project and formed part of a robust list of 16 internal and external reviewers for this paper.

COFFEE PRODUCTION IN COTO BRUS, BRUNCA: GENERAL CONTEXT, PRIORITIES, AND CLIMATE CHALLENGES

Trends in Climate and Coffee Production in Coto Brus, Brunca

Coffee cultivation constitutes 70 percent of the economy of Coto Brus and is the principal livelihood for the majority of its rural households (MAG AEA San Vito 2019).⁴ Today, the canton has 8,700 hectares of coffee and 3,000 primarily small- and medium-sized farms, producing approximately 144,800 bushels⁵ a year (average for the harvests from 2013–14 to 2018–19) (MAG AEA San Vito 2019; ICAFE and INEC 2018b).⁶ Coffee farms in Coto Brus measure less than five hectares on average, and 85 percent of them are located at altitudes between 800 and 1,200 meters above sea level (ICAFE 2018).

Traditionally, coffee producers deliver the coffee fruit (also known as cherries) to a cooperative, which processes and markets the coffee for all its members, without differentiation in quality. By national law, the producer receives 75 percent of the price at which the cooperative or processing plant sells the coffee. In Coto Brus, however, most producers deliver their coffee fruit to the private company Proexcafé. Around 1,200 producer families deliver the coffee fruit to the local cooperative, Coopesabalito (the other cooperative, Cooprosanvito, closed due to financial and management problems). Here, the coffee fruit is processed for sale to the Costa Rican Coffee Institute or in some cases directly to exporters. A smaller group delivers it to *microbeneficios* (see Box 3), while a few coffee growers independently process and sell coffee.

Coffee production in Coto Brus and Costa Rica as a whole has been declining over the last 15 years (ICAFE and INEC 2018a; ICAFE and INEC 2018b). During the most recent coffee harvest, 2018–19, Coto Brus suffered an 18 percent reduction in production

compared with the previous year, with 110,705 bushels harvested (ICAFE 2019). According to interviews with local extension officers, the continued decline has severely impacted the local economy, fueling persistently high poverty, unemployment rates, and outmigration—trends that are reflected at the regional level according to development plans for the region of Brunca.⁷ At the field level, an important impact has been the replacement of coffee with pastures for grazing livestock, especially in lower elevation areas.

The most commonly cited factors behind this production decline, as expressed by both producers and extension agents, are the volatility and sharp decrease in coffee prices (low or null profitability), the old age of the plants (low productivity), and the increased incidence of pests and diseases (low productivity). It is important to note that these factors are closely linked, since the decrease in coffee prices reduces farmers' incomes, impacting their ability to invest in the replanting of coffee groves and other farm management activities (Granados Carvajal et al. 2017). This, in turn, makes the coffee groves more vulnerable to plagues and diseases

Box 3 | What Are Microbeneficios?

A **microbeneficio**, or **micro-processing plant**, is a small enterprise in which the producer undertakes some of the steps of processing the coffee fruit—in particular, removing the pulp and drying the grains—which would normally be done by a processing facility/business (in Spanish, a *beneficio*). This allows the farmer to deal directly with coffee buyers, sell a more finished product, and store dried coffee beans to wait for better prices when needed.

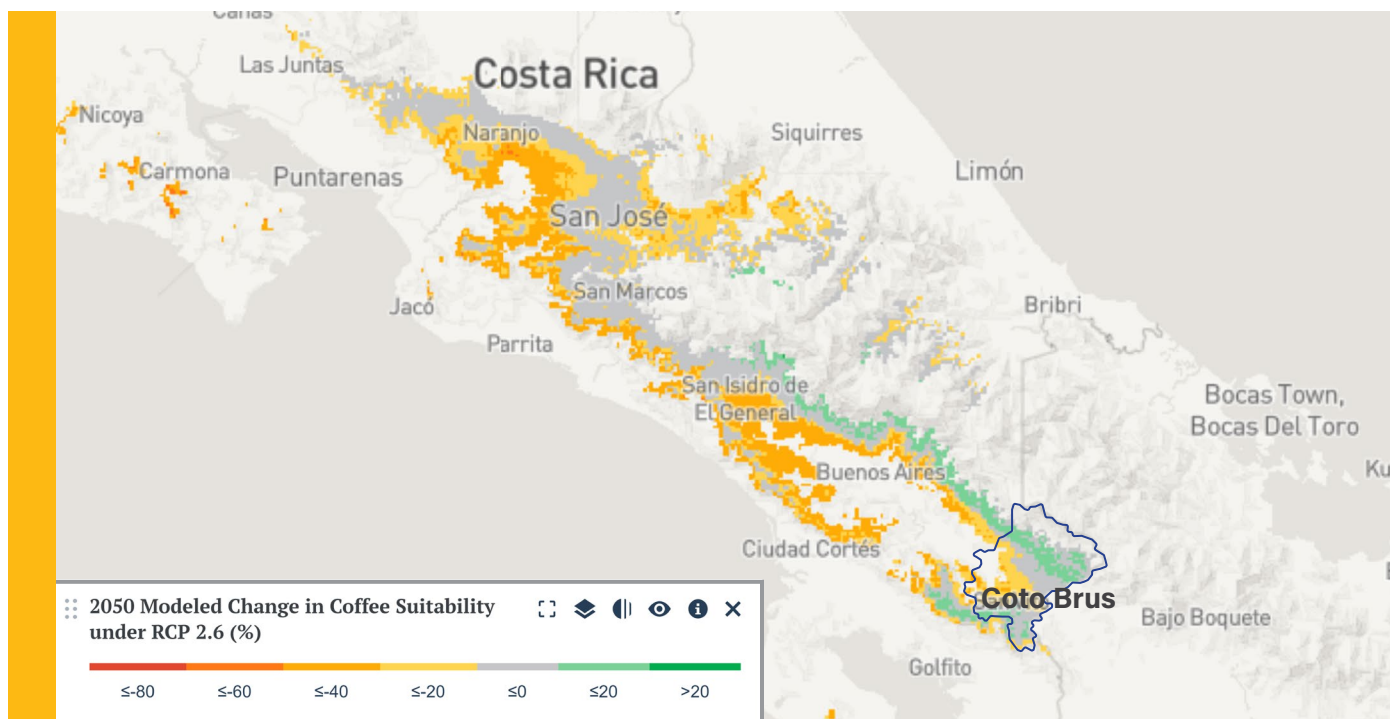
(Granados Carvajal et al. 2017). Other factors identified included mismanagement, low capacity among farmers to manage rising production costs, and increasing variability in precipitation patterns. Temperatures in Coto Brus range from 18 degrees Celsius (°C) to 26°C over the year, with rains occurring from April to November (ICAFE 2018). Extension officers interviewed noted that rising temperatures and increasingly variable rainfall are creating ideal conditions for coffee pests and diseases to thrive, an observation backed up by the literature (e.g., see Viguera et al. 2017). An extension officer at ICAFE summarized a perception widely shared by interlocutors and workshop participants: “Before, [farmers’] preoccupation was to produce and keep coffee groves healthy; the needs were much fewer and prices were good. Today, the climate has changed, there are more diseases, lower profitability; there is

a need to replant groves with new resistant varieties. Today, [farmers’] priority is to improve productivity with new varieties and good agricultural practices.”

In this context, efforts are being made by the multiple regional institutions that support farmers in Coto Brus to promote diversification of farms and of the sector, recognizing that despite these challenges, coffee is central to the local economy and deeply rooted in the culture.

The current state of coffee cultivation in the canton will continue to be affected by changing climatic conditions in the future. Annual temperatures in Costa Rica are set to increase between 1.2°C and 3.6°C under all emissions scenarios (RCP 2.6, RCP 4.5, RCP 6.0, and RCP 8.5)⁸ in all months of the year by 2050 (Ovalle Rivera 2018). Technical guidance from the

Figure 2 | Like most of Costa Rica, large parts of Coto Brus are projected to experience a lower suitability for growing coffee by 2050 if no adaptation measures are taken



Notes: The district of Coto Brus is outlined in blue. The green areas indicate increasing suitability for growing coffee, while the grey areas reflect no change. Yellow and orange areas reflect decreases in coffee suitability. RCP stands for Representative Concentration Pathway, a projection trajectory adopted by the United Nations of the atmospheric concentration of greenhouse gases given a certain level of effort to reduce emissions. This figure shows a low emissions scenario (RCP 2.6) with low climate impacts; that is, optimistic estimations of future emissions reductions. To explore and interact with these data and other climate scenarios, please visit the online platform PREPdata.org.

Source: Ovalle Rivera (2018) to learn about the suitability study, and IUCN and UNEP-WCMC (2017). Visualized on the PREPdata platform.

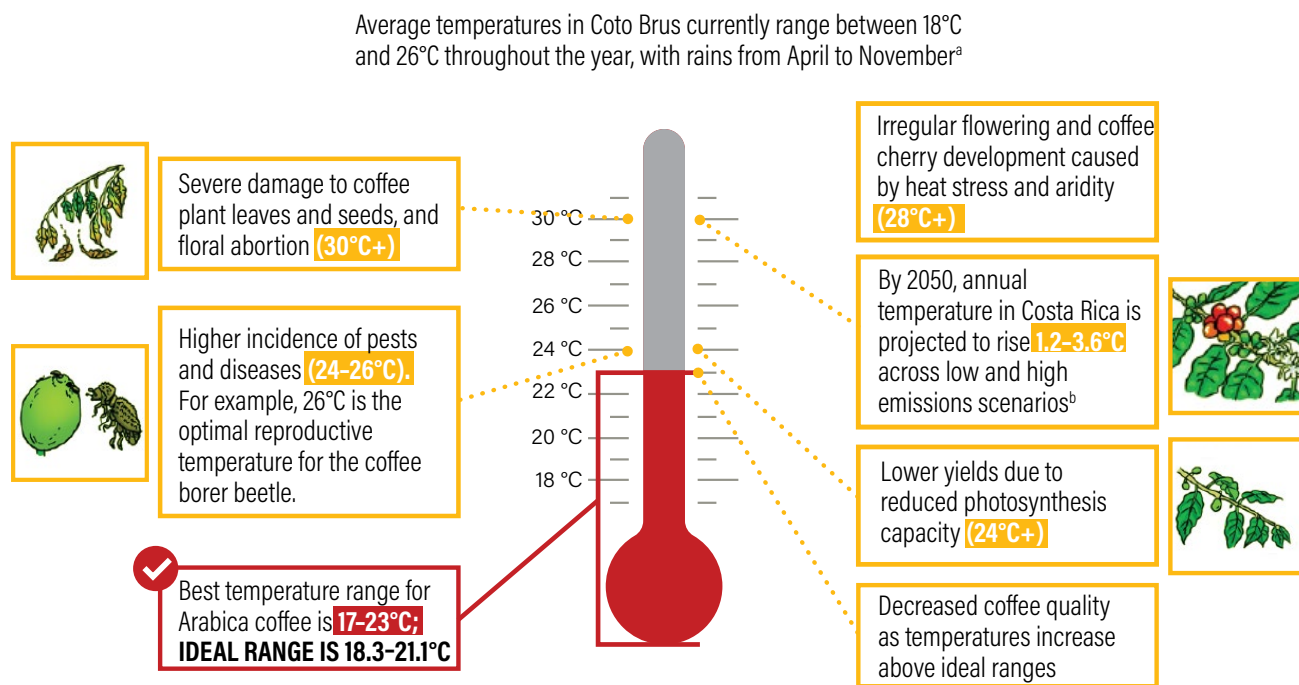
Ministry of Agriculture and Livestock indicates that suitable climatic conditions for growing arabica coffee are median annual temperatures between 17°C and 23°C, with the ideal range between 18.3°C and 21.1°C (Mora 2008). This means that many areas within the canton will become less suitable for coffee production (Figures 2 and 4). In terms of rainfall, the ideal annual precipitation is between 1,600 and 1,800 millimeters (mm), with minimum precipitation close to 1,000 mm and precipitation above 3,000 mm deemed unsuitable for the crop to be profitable (Mora 2008; ICAFE 2011). In general, arabica requires distributed rainfall and a well-defined dry season that lasts three to four months to ensure good flowering and a well-defined harvest period (Mora 2008). Increasingly variable rainfall (i.e., more intense droughts and wet years) will also make coffee production more challenging over the coming decades.

Global downscaled climate projections under low (RCP 4.5) and high (RCP 8.5) emissions scenarios predict that the region of Brunca will see an increase in extreme heat and extreme precipitation days under both scenarios (NEX 2015). These increases will be moderate toward 2050 and more severe by 2080. Some of the expected impacts on arabica coffee cultivation (on a global level) can be observed in Figure 3, and include the following:

- Erratic flowering patterns and longer harvest periods, due to changed seasonality in rainfall
- Loss of fruit, root damage, and soil erosion due to extreme precipitation events
- Higher incidence of pests and disease, like the coffee berry borer and coffee leaf rust (Viguera et al. 2017)

By 2050, many of the areas currently suitable for coffee cultivation in Coto Brus are predicted to become less suitable across low and high emissions scenarios. Even in the most optimistic emissions scenario, the

Figure 3 | Arabica Coffee Temperature Sensitivity and Impacts: Just a few degrees of warming will negatively impact coffee production



Notes:

a. ICAFE 2018.

b. Ovalle Rivera 2018.

Source: Adapted from Viguera et al. 2017.

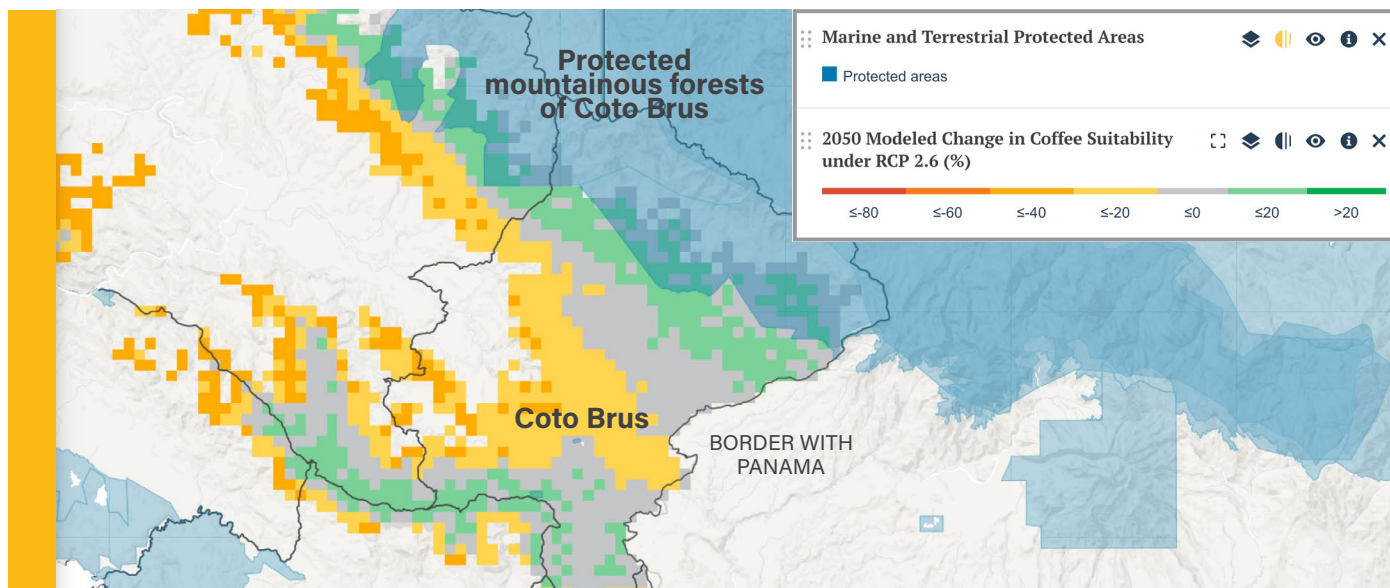
central, lower-elevation zones near the capital, San Vito, and to the west (where the elevation is lower, see Figure 4) will suffer declines in coffee suitability of up to 40 percent in certain areas (Ovalle Rivera 2018). Nevertheless, as Figure 4 shows, an increase in coffee suitability is predicted in higher-elevation areas of the canton; for example, to the south and in the vicinity of and within the protected area La Amistad International Park (Ovalle Rivera 2018). This is corroborated by ICAFE, which estimates that with a 2°C rise in temperature over the next 50 years, suitable coffee-growing areas will rise in elevation by approximately six meters every year (ICAFE 2011). This could imply a risk of conflict with other land uses at higher altitudes, where there are many protected areas, with implications for ecosystem services and other national and regional objectives (we discuss this issue further in the sections below). To learn more about how suitability for coffee growing is predicted to change in Costa Rica under four climate scenarios, and about the methodology used for this assessment, see Ovalle Rivera (2018).

These data are complemented by Coto Brus farmers’ observations of the impacts they are already experiencing, including increased temperatures, increased disease pressure, and erratic flowering. At the farm level, these climate-related challenges are closely linked to economic challenges like low prices, lack of labor, and rising production costs, endangering the productivity of the farms and, for many producers, their ability to continue producing coffee. There is a widely shared perception among farmers and other stakeholders that, given these and the economic challenges mentioned above, there is a need to transform the coffee production and commercialization model.

Regional and Sustainable Development Priorities in Coto Brus

When planning efforts to adapt farmers’ livelihoods to new climatic conditions, it is essential to consider the sustainable development challenges and priorities of the region. This can guide assessments of the co-benefits and trade-offs of different adaptation options, helping to prioritize among them, and ensure coherence in the

Figure 4 | Close-up map showing how large parts of Coto Brus are projected to experience a lower suitability for growing coffee by 2050 if no adaptation measures are taken



Notes: The green areas indicate increasing suitability for coffee growing (by 20 percent), while grey reflects no change. However, it is important to note that some of these green areas overlap with Protected Areas like La Amistad International Park to the north. Yellow and orange areas reflect decreases in coffee suitability, by about 20 percent and 40 percent, respectively. As in Figure 2, this is a low climate impact scenario. RCP stands for Representative Concentration Pathway, a projection trajectory adopted by the United Nations of the atmospheric concentration of greenhouse gases given a certain level of effort to reduce emissions. To explore and interact with these data and other climate scenarios, please visit the online platform PREPdata.org. Sources: Ovalle Rivera (2018) to learn about the suitability study, and IUCN and UNEP-WCMC (2017). Visualized on the PREPdata platform.

efforts of different institutions. Development plans focused on the region of Brunca or district of Coto Brus⁹ highlighted the following development challenges and priorities, which were echoed during the workshop and in conversations with producers and stakeholders:

- **Generating opportunities for high added value production, taking advantage of technological innovation and the natural and cultural richness of the territory.** It is important to note the great value attached to La Amistad International Park. Some producers link the park to the health of farm ecosystems (e.g., pollination, biodiversity) and many consider it a factor that distinguishes the Coto Brus territory and the quality of its coffee, as well as an important resource for developing rural ecotourism.
- **Generating opportunities, with dignified income, for young people** to continue working in the coffee sector and in the canton more broadly, which is linked to generational handover and knowledge transfer.
- **Promoting sustainable production systems** to increase the competitiveness of Coto Brus agriculture and protect water and soil resources. While local and regional development plans do focus on the promotion of economic alternatives both within and outside of agriculture (e.g., tourism, horticulture, entrepreneurship)—with some programs targeting the inclusion of women, small producers, or vulnerable groups—what is still missing is an understanding that coffee production is likely to become impossible in some areas and that planning for long-term alternatives should begin now.

During the workshop, participants were furthermore asked to reflect on the factors that exacerbate their vulnerability to climate-related impacts on coffee production, which can also help guide the selection and implementation of adaptation options (see Appendices B and C). The factors most frequently mentioned included the following:

- Lack of generational handover and youth outmigration
- Advanced average age of producers
- Lack of labor
- Producers' indebtedness
- Lack of adequate capacity to plan investments

CLIMATE ADAPTATION IN COTO BRUS: CURRENT EFFORTS, GAPS, AND POSSIBLE WAYS FORWARD

Efforts to increase coffee farmers' resilience to current and future climate impacts in Coto Brus are underway. Although large implementation gaps remain, with more farmers in need of adaptation assistance, existing efforts can provide a good basis on which to build a systemic approach to the planning and implementation of climate adaptation strategies. The current state of climate change adaptation in the canton, as well as the needs and opportunities for future adaptation measures, were evaluated by producers, government officials, and representatives of local NGOs and universities during the August 2019 workshop (see Appendix A for workshop details and Appendix B for a list of the 18 adaptation measures assessed). In five small groups of about eight people each, the workshop participants were asked to evaluate four to five adaptation options per group based on their current frequency of implementation in Coto Brus, the principal actors responsible for implementing them, their relative costs and benefits, and the support required from extension officers. This assessment was complemented by conversations with coffee producers, government officials, and NGO representatives.

Current Adaptation Efforts and Gaps

The main factor motivating current adaptation efforts in Coto Brus is the decrease in productivity of coffee groves—due to inadequate management, the old age of coffee groves, and pest and disease pressure. Forecasts of future climatic scenarios do not appear to influence current adaptation decision-making by coffee farmers. As expressed by the workshop participants, this is in part due to **limited awareness of climate change**,¹⁰ which in turn is linked to the limited capacity of supporting institutions to directly reach a large number of farmers. This highlights the importance of fostering opportunities that allow farmers to learn from each other (see Section 5). It may also be related to the lack of disaggregated scientific information on climate change and of appropriate channels for its dissemination, both reported to constitute gaps in the use of knowledge for climate change adaptation in Costa Rica (Morales 2018).

The adaptation measures most frequently deployed at present include the **use of shade trees, use of live fences, and access to credit and financing** (more on financing in Section 6).¹¹ It was often noted that the proper management of shade trees can be complex and laborious, and is therefore not practiced very frequently, which can negatively impact production. At the same time, it was also noted that the right trees, when well-managed, fulfill many functions. For instance, nitrogen-fixing trees increase nutrients in the soil and provide organic matter for fertilization, reducing the need for external fertilizers. Shade trees can also contribute to biological pest control, pollination, and moisture regulation and reduce soil erosion (Jha et al. 2011; Verburg et al. 2019; Jackson et al. 2012).

Another important measure to reduce climate risks is the **replanting of coffee groves with arabica varieties resistant to the most common plagues and diseases**. The coffee leaf rust crisis of 2012 and the high levels of plague and disease that farms have experienced in recent years have sparked a lot of interest in using varieties that are both tolerant of the main plagues and diseases and highly productive.

ICAFFE develops new varieties (a process that takes on average 17 years) and experiments with imported varieties (Vargas 2020). However, it is important to note that replanting parcels—with resistant and traditional varieties—requires long-term planning, investment, and, in the case of the new varieties, new management methods and knowledge (e.g., required amounts of shade, fertilizer, water).

As a result, groves are not being renovated as frequently as extension officers recommend, a challenge that a number of actors—from public sector agencies and initiatives such as Fonescafé and the National Rural Development Institute (Instituto de Desarrollo Rural; INDER) to NGOs like GAT Sur Alto and Fundecooperación, and private company CAFINTER—are seeking to address by mobilizing financial resources. It is also important to note that there may be a conflict between replanting coffee groves with leaf rust—resistant and high-yielding varieties, and increasing the amount of shade on the farm as these varieties require more sun. Additionally, although it is recommended that groves be replanted every 15–20 years, new strains of the coffee leaf rust can develop more quickly and affect previously resistant varieties. Therefore, cultivating a single variety could pose a risk to producers. This, coupled with the fact that high-yielding varieties often entail higher production costs and may produce a lower quality coffee, highlights the importance of considering the unique circumstances of each producer when defining appropriate adaptation measures.

Other measures, such as **improving soil management** (e.g., terracing, using cover crops, contour planting of hedgerows), **improving water management** (e.g., collecting rainwater and protecting springs and creeks), and **using early warning systems**, were deemed to be used less frequently, though the workshop participants cited several examples of their implementation (see Figure 5 below for an example).¹² Furthermore, the Ministry of Agriculture and Livestock, through the certification program Bandera Azul Ecológica, promotes many of these and other sustainable agricultural practices that can help build farms' adaptive capacities.

Figure 5 | Armando Navarro Explains the Climate Adaptation Measures He Has Implemented on His Coffee Farm, Including Terracing



More transformative, or systemic, measures, such as **shifting to robusta coffee in lower elevation areas,¹³ shifting arabica coffee cultivation to higher elevations, and replacing coffee with more resilient crops**, are currently very uncommon or nonexistent. This reflects the fact that, given local stakeholders' perceptions of climate impacts and their understanding of projections over the near and medium terms, these measures do not yet seem justified.

Shifting to robusta coffee was deemed by producers and other stakeholders to be unfeasible on account of its low quality and low prices—which could exacerbate the current price crisis that has deeply affected the canton's coffee sector. It was also judged to present a reputational risk for the canton at a time when some producers are making a big push to market higher-quality coffee (for example, via the Bandera Azul Ecológica certification). Nevertheless, it would be important to analyze the costs and benefits of a transition to robusta or other agroforestry products to generate

evidence and better understand in which situations the advantages could outweigh the disadvantages. In addition, new research questions how tolerant robusta actually is to high temperatures (Kath et al. 2020).

Shifting coffee to higher elevations, meanwhile, was noted to have occurred on the farms of producers who already owned land at these elevations and simply added more parcels there or replaced their lower elevation parcels. Beyond these changes, cultivating coffee at higher elevations will be severely limited by the high cost of acquiring new land. In addition, much of the area projected to become more suitable for coffee cultivation in the future is located in the protected areas of La Amistad International Park (as shown in Figure 4). Therefore, as climate impacts intensify, there could be more pressure to deforest in protected areas and buffer zones. This would imperil the function of forest ecosystems in strengthening the adaptive capacity of producers (e.g., through biological pest control, pollination, water and soil

erosion regulation) (Verburg et al. 2019). It could also entail significant costs for Indigenous peoples, as well as costs related to biodiversity loss and greenhouse gas emissions. Therefore, efforts should be made to proactively consider how and where biodiversity-friendly coffee growing in higher altitude areas could be promoted. This would require a close collaboration between MAG, MINAE, the National System of Conservations Areas (Sistema Nacional de Áreas de Conservación; SINAC), and ICAFE. At the same time, there should be an active exploration of alternatives for lower elevation areas—such as shifting to robusta and other agroforestry products like cacao, vanilla, or tropical fruits—to sustain farmers’ livelihoods without fomenting changes to more intensive land uses that might be more vulnerable in the future.

Proximity to the park, and the landscapes and biodiversity it sustains, is an important element of the strategy underway to differentiate Coto Brus coffee. It is also linked to two other, potentially transformative, adaptation measures proposed for consideration during the workshop: **payment for ecosystem services at the regional level and sustainable rural ecotourism** as diversification strategies. Both were considered promising avenues to diversify incomes and mitigate risks to farming families but will require capacity-building, greater coordination between landscape-level actors, and institutional and regulatory support (Verburg et al. 2019). Diversification of farm incomes more generally (e.g., through the commercialization of timber, fruit, or spices) is currently an uncommon strategy among coffee farmers in Coto Brus, although diversification with crops for the family’s own consumption (e.g., beans and bananas) is very common.

Finally, while it is true that the area under coffee cultivation in the canton has sharply declined in favor of pasture for livestock grazing, this has been driven by the low profitability of coffee cultivation and farmer bankruptcy, not the relative climate resilience of pastures. Replacing coffee with more resilient crops is otherwise a very uncommon strategy and one that is not seen as either necessary or viable by producers, largely owing to the strong cultural connection with coffee in the canton and lack of sufficiently developed

markets for alternative crops like vegetables and tropical fruits. However, developing these markets is the objective of specific actions in the territorial and regional development plans, which may open new opportunities for climate adaptation—particularly transformative adaptation—in the future.

















Another adaptation measure that is not currently implemented in the canton, but that may offer a viable option in the future, is the crop insurance offered by the National Insurance Institute, which now gives discounted rates for coffee farms that implement adaptation measures. Few producers in the canton are aware of this option and more could be done to promote it.










Table 1 summarizes the trade-offs, costs, and benefits associated with some of the adaptation measures discussed above, as they were evaluated by participants during the workshop. The full table is too large to include in the body of this chapter but can be found in Appendix C.

Incremental Measures in the Context of Emerging Broader Changes

Alongside these incremental measures to adapt coffee cultivation to current climate impacts (e.g., pest and disease pressure and increasingly variable precipitation patterns), broader changes in the business model of coffee production in Coto Brus are emerging. The coffee price crisis and the need to improve profitability are driving coffee farmers to shift toward higher value-added production, improved traceability of the product to their farms, and direct commercialization by producers—for example, by building their own micro-processing plants—all in an effort to produce higher-quality coffee, with a higher price point and greater profit margins for producers. This broader change is not a climate adaptation effort; however, by increasing their incomes, these actions can help farmers accumulate funds to invest in adaptation measures and sustain their livelihoods in a more challenging climate. While the scale and effectiveness of these changes remain to be seen, by helping to develop farmers’ capacities to plan for and manage longer-term changes and supporting agencies’ capacities to promote and facilitate such long-term planning,

Table 1 | **Local Stakeholders' Perceptions of Trade-Offs, Costs, and Benefits Associated with Adaptation Measures**

ADAPTATION MEASURE	COSTS/TRADE-OFFS	BENEFITS
Introduce new arabica varieties more tolerant to the most common plagues and diseases	<ul style="list-style-type: none"> Requires experimentation, new knowledge and practices Monetary costs associated with acquiring new varieties and higher input/fertilizer needs Uncertain resilience in the long term 	  
Strengthen awareness of climate change	<ul style="list-style-type: none"> Requires coordination among stakeholders and consistent support from extension agents Requires new capacities and knowledge 	 
Employ sustainable agricultural practices	<ul style="list-style-type: none"> Start-up costs/investment Labor requirements for maintenance 	    
Diversify farmers' incomes	<ul style="list-style-type: none"> Challenges with commercialization Potentially high investment needed 	 
Introduce new technologies	<ul style="list-style-type: none"> High cost 	 
Provide access to credit and financing	<ul style="list-style-type: none"> Medium-high cost to producers Guarantees and other requirements can be prohibitive and risky for producers High interest rates in the short term 	 

 Higher productivity
  Lower incidence of disease, lower need for fungicides
  Improved food security
  Improved farm management
 Resilience benefits (More resilient in the short and medium terms; improved preparedness and ability to plan among farmers)
 Environmental benefits
  Promotes entrepreneurship
  Investments for improved productivity and quality
 Economic benefit (Improved household socioeconomic situation; higher income and reduced risk of loss of income)

Source: Information collected by the authors during the workshop activity in August 2019.

these changes can provide a foundation upon which to build more transformative adaptation actions.

Barriers and Limitations

As farmers seek to implement the adaptation measures described, they and supporting institutions face several barriers and limitations that should be addressed to improve adaptation planning. First, there is a **well-recognized need to strengthen farmers' capacities to manage their operating**

costs, develop farm management plans, and monitor investments. This is primarily evidenced by the many farmers who have established micro-processing plants to improve their profit margins in response to low prices, but who have struggled greatly in commercializing the product and managing the business. Coffee farmers and other local stakeholders share the perception that building administrative and management capacities is needed to plan and implement other short- and long-term changes in the coffee sector, including adaptation interventions.

A lack of such capacities is furthermore linked to an important dual challenge: **the danger of indebtedness**, which was highlighted as a factor that exacerbates the vulnerability of farmers to future climate impacts, and having **limited capital**, which limits small farmers' abilities to invest in adaptation measures. **Insufficient management skills** affect not only individual farmers but also cooperatives across the country, according to INFOCOOP,¹⁴ with coffee cooperative Cooprosanvito's bankruptcy offering an example in Coto Brus.

Fortunately, the need to address these challenges is acknowledged among the multiple organizations that serve coffee farmers in the canton. Both public—INDER; Ministry for the Promotion of Costa Rica's Foreign Trade (Promotora del Comercio Exterior de Costa Rica; PROCOMER); Ministry of Economy, Industry and Commerce of Costa Rica (Ministerio de Economía, Industria y Comercio de Costa Rica; MEIC)—and private organizations (GAT Sur Alto, Fundecooperación) are mobilizing to address these challenges, in coordination with the agronomic technical assistance provided by MAG and ICAFE. The program Bandera Azul Ecológica, which provides guidance on cost management to promote and facilitate the implementation of sustainable agricultural practices, also aims to build farmers' management skills. Nonetheless, large gaps remain and, despite the variety of capacity-building opportunities available, several institutions including MAG and ICAFE recognize that they are able to reach only a limited number of all the coffee farmers in Coto Brus; for instance, the local ICAFE office estimates the institute reaches approximately 20 percent of the canton's producers.

This capacity-building challenge is linked to another limitation: **information and financing opportunities are scattered** among multiple local actors. Indeed, some producers—with a lot of initiative and leadership—have been successful in seeking out opportunities to strengthen their capacities in business management and marketing, and other skills. One farmer shared that information is available but that finding it takes a substantial amount of effort and initiative that may not be available to all farmers, especially those who are older, less educated, or less technologically savvy (e.g., have difficulty accessing

information online). Similarly, information about the various sources of financing options available to producers, and their costs and requirements, is highly fragmented. Perhaps reflecting on this situation, some farmers interviewed stressed the importance of sharing information with each other.

Another limitation of a more systemic nature that was highlighted during the workshop with producers is **the lack of incentives to engage in sustainable practices** (like using organic fertilizers, cover cropping, and protecting creeks and springs). The government program Bandera Azul Ecológica is an emerging effort to fill this gap by promoting sustainable agricultural practices in the market. Similarly, the exporting company CAFINTER has partnered with several farmers and is helping them prepare for Rainforest Alliance certification, which they hope will help them obtain a price premium in recognition of their sustainable practices. However, in the absence of such partnerships, international certifications are cost-prohibitive for small farmers. Other incentive structures of interest to coffee producers—like payments for ecosystem services (PES) linked to forest and biodiversity conservation—will require more systemic efforts, regulation, and cooperation across ministries and levels of government. Experiences from other countries show that incentive schemes must be well designed and adapted to the local context to effectively and equitably benefit producers (Villegas 2016). It would be helpful for both local institutions (like the offices of MAG and ICAFE) and researchers to have access to data regarding the participation of coffee producers in PES schemes and their results. This would enable an examination of how to ensure that PES benefit the highest possible number of producers, and whether and how these services might be expanded to other farm management activities (in addition to reforestation). Efforts to develop a system of “recognition of the eco-benefits generated by farms”—included within the framework of the National Decarbonization Plan—could present a good starting point (Government of Costa Rica 2018a).

Finally, another important limitation is the **lack of monitoring and documentation of adaptation and other sustainable practices and their impact** on farms, farmers' livelihoods, ecosystems,

and other resources. Robust baselines, well-defined indicators for monitoring and evaluation, impact assessments, and cost-benefit analyses are lacking at the national level and for adaptation generally (Morales 2018). This is perceived by MAG as a barrier to informed and evidence-based project design and implementation of climate adaptation in the sector. An INDER representative echoed this concern, providing the example of the Ecosystems Pillar of the territorial development plan. This pillar contains many themes relevant for agricultural adaptation, but due to a lack of monitoring and observational data, and therefore limited ability to “make the case” for adaptation, very few projects have been proposed and financed.

Possible Ways Forward: Adaptation Options for Short-, Medium-, and Long-Term Time Horizons

Workshop participants were invited to evaluate adaptation measures based on six factors determined in concert with Ministry of Agriculture and Livestock counterparts (see Figure 6 for a depiction of the activity):

1. Feasibility
2. Relative cost
3. Potential benefits
4. Barriers
5. Implementation time
6. Support required from extension officers

Figure 6 | Workshop Participants Assess Different Adaptation Options in Small-Group Activity



Considering the six criteria, each small group was asked to select the two adaptation measures it deemed most promising over the next 1 to 5 years, 5 to 10 years, and 10 or more years. Farmers considered more than just measures tied specifically to climate change impacts to be appropriate adaptation options; measures that would generally improve farm management were also included as potential ways of building resilience. These choices were plotted along a transformative pathway to identify how coordinated sequences of short- and medium-term actions or projects could be aligned over the coming years to prepare the local coffee production system for a range of climate impact scenarios of different intensities depending on emissions. The adaptation options initially selected were the following:

- Strengthening climate change awareness
- Implementing sustainable agricultural practices
- Using new arabica varieties with higher climate resilience (e.g., tolerant to higher temperatures, or to the most common plagues and diseases)
- Introducing new technologies (e.g., cover crops to reduce soil erosion and improve fertility and humidity)
- Diversifying farmers' incomes (e.g., with other agroforestry products, timber trees, or ecotourism)
- Improving access to credit and financing
- Completing traceability (i.e., the capacity to trace a final product to the farm or parcel where the coffee was grown)—while this option was not offered as a climate adaptation measure, one group added it. We include it here as an indication of local stakeholders' current understanding of climate impacts, climate adaptation, and local priorities

When considering adaptation options, workshop participants most frequently listed measures that could raise coffee prices and household incomes, making farmers more resilient to both poor harvests due to climate change impacts and other types of shocks. Potential co-benefits that workshop participants foresee from the implementation of these adaptation measures include the following: improving coffee quality or adding value in other ways; improving productivity or efficiency of production; reducing

risks, costs, and reliance on external inputs; and improving farm management. Other factors that local stakeholders deemed important in their consideration of adaptation options for the sector included whether they could help generate employment and economic opportunities in the canton; promote the use of local inputs; contribute to building the canton's reputation for high-quality, environmentally friendly coffee; and promote effective associations of producers.

Reflecting upon the perceived urgency of implementing these actions and/or the difficulty inherent in assessing scenarios further out in the future, the workshop participants selected all of these options for implementation in the short term and under scenarios of low climate impacts. This confirms findings by Granados Carvajal et al. (2017) that coffee farmers in Coto Brus generally plan farm activities for the short term; i.e., within the next one to five years at most.

When encouraged to consider adaptation options that could be appropriate for higher climate impact scenarios and implementable in the short term, workshop participants focused on measures related to farm management (e.g., agroforestry and improved shade management). Considering moderate to high climate impact scenarios and implementation in the medium to long term, participants proposed measures related to research and development, and regulatory changes (e.g., improving the regulatory framework to encourage sustainable production and marketing alternatives).

Three adaptation options seemed promising to workshop participants under any impact scenario: *greater access to credit and financing; use of more heat-, drought-, pest-, and disease-tolerant and climate-resilient arabica varieties; and improved soil and water management.*

This transformative pathway reflects the discussions between participants during the workshop and serves as a living tool for this community's adaptation planning. Because adaptation is context-specific, pathways will vary from place to place and should be enriched by a wide spectrum of stakeholder perspectives. The transformative pathway designed by this group of stakeholders and additional details about the workshop are included in Appendix A.

FACTORS FOR ENHANCING CLIMATE RESILIENCE IN COTO BRUS

This section discusses key factors that are already present in the coffee-growing region of Coto Brus that can facilitate adaptation planning and implementation, and could be built upon to support longer-term transformative measures when and where needed. These factors are already helping to accelerate uptake and scaling of adaptation actions, as well as sustainable practices more generally, and could be strengthened to speed up the implementation of incremental and transformative adaptation options for more farmers. However, it is important that key actors such as MAG and ICAFE ensure that poor and marginalized groups also have access to and support for these opportunities. Currently, farmers with more resources and larger farms have greater access to information and finance.

As suggested by expert consultations, field visits, and workshop discussions, factors that can enable resilience include the following: well-organized coffee farmer associations; peer learning; the existence of an ecosystem of public institutions that provides complementary support; cross-sectoral alliances; and the availability of sustainability programs to reach higher-priced and more stable markets. How these elements are being leveraged and improved upon in Coto Brus can also be highly relevant and useful for other coffee-growing regions, nationally and globally. At the end of this section, Box 4 highlights the resilience efforts of two coffee associations in Coto Brus—one of them a women's association—that have taken advantage of these enabling factors to overcome hurdles and help their practices and businesses succeed.

Well-led farmer associations and cooperatives can leverage their collective power to scale up adaptation efforts and explore new transformative pathways. Farmers who have joined a group formalized as an association or cooperative are better able to organize their efforts

to produce and commercialize coffee, and to share the best available information on climate risks and successful practices. They are also able to lower their financial risk, since each member can contribute or pool smaller amounts toward large investment opportunities. The ability to minimize risk could prove essential in undertaking more expensive, longer-term system shifts—such as investing in alternative crops or building ecotourism infrastructure—needed to keep up with climate impacts.

It is essential for these groups to be well-managed and transparent, and for them to have strong memberships and leaders who can provide direction and negotiate novel alliances with public entities to advance adaptation efforts. Likewise, members need determination and savvy to learn and navigate innovative ways of coffee production and commercialization. For example, a producer association in Coto Brus has leveraged its collective power to submit project proposals to government ministries and negotiate better deals with companies (e.g., negotiate bulk prices on fertilizers customized for each farm's soil profile and acquire drip irrigation technologies). Associations' ability to sell high-quality or single-origin coffee in larger volumes also makes them more attractive to exporters, as a single farmer's harvest might be too small for a sale deal. Moreover, farmer associations can leverage the trust and solidarity between members to showcase the results of adaptation measures and facilitate peer support. Members who aim to replace coffee with climate-resilient crops could also share their methods and lessons learned experimenting with new crops, technologies, or systems. These advantages notwithstanding, discussions with experts reveal that many farmers prefer to work individually, without stating exactly why (perhaps due to high transaction costs, competitiveness, or other reasons).

Two coffee associations in Coto Brus and the neighboring canton of Buenos Aires are making great strides in adapting to climate change while simultaneously improving their profitability via changes in production and commercialization. Their efforts have been favored by several enabling factors but, above all, by a determination to overcome setbacks and a strong passion for the coffee business.

ORGANIZED WOMEN'S ASSOCIATION OF BIOLLEY (*Asociación de Mujeres Organizadas de Biolley; ASOMOBI*). ASOMOBI was founded in 1997 by a group of women in a sewing class who decided to buy, process, and sell high-quality coffee. Initially facing sharp skepticism from men in the community and government, ASOMOBI has flourished even as many coffee farms in the area have gone out of business. The group's success is partially due to diversifying their business by engaging in ecotourism and their consistent attention to quality and sustainability—for instance, their restaurant and lodging house, built in 2002, has a Sustainable Tourism Certification. They work to educate coffee farmers in sustainable practices, encourage them to participate in the Coffee NAMA (Nationally Appropriate Mitigation Actions for the Coffee Sector) and Bandera Azul Ecológica programs, and even grow tree seedlings themselves to incentivize tree plantings in the coffee groves. In 2019, they also installed solar panels with financial support from PROCOMER to provide energy for their coffee processing and roasting. Ten ASOMOBI women are now cultivating their own coffee (owning another step in the supply chain) with climate resilience in mind: planting shade trees, installing new irrigation systems for use in dry periods, and diversifying the crops with fruit, timber, and basic grains.

EXPORTACIONES AROMAS COFFEE. Led by coffee farmer Armando Navarro, this small group of 10 farmers mostly in their 30s (quite young, considering the average age of a coffee farmer is 57) was brought together in 2014 by their shared passion for coffee farming and similar struggles to maintain the profitability of their farms. They are piloting a unique public-private partnership with government institutions to finance, with the help of a grant and a special permit, the construction of a coffee processing plant capable of servicing dozens of farmers and ensuring the traceability of coffee beans to the specific farm lot from which they were sourced. The group also has an agreement with the company CAFINTER to receive drip irrigation technology and technical assistance, and test greenhouse technologies and new varieties. They also participate in the Bandera Azul Ecológica program, actively join adaptation workshops, and strive to keep their hard-won business skills up-to-date. The group knows that, as climate impacts intensify, managing farm costs, implementing adaptation interventions, and excelling at commercialization are crucial to staying in business.

Farmer-to-farmer learning and information sharing inspires other farmers to implement adaptation measures and sustainable practices.

For example, Exportaciones Aromas Coffee leader Armando Navarro has traveled to several regions of Costa Rica and even abroad to South America to share with other coffee farmers the tools and strategies that the farmers in his association have harnessed to improve their farms, livelihoods, and adaptive capacities. Entrepreneurial farmers who work with MAG, ICAFE, and other institutions also share their knowledge and best practices with their peers and neighbors, inside and outside of organized institutional events. A MAG technical expert told WRI in Coto Brus that reaching coffee producers who are more tolerant of experimentation first can gradually pave the way for others to be positively influenced. Some farmers in Coto Brus are keenly aware of the importance of sharing information with each other in the face of the deep challenges affecting the sector and

the interventions they will require. Given the reality of limited government resources and staff, farmer-to-farmer exchanges—especially targeting farmers who are well-known and connected with their peers—can have a positive “contagion” effect to spread information on climate risks and possible adaptation options, including how and where support can be found. Such an outreach strategy to mobilize farmers is imperative, given that MAG and ICAFE cannot reach every single farmer. Special efforts should be made, however, to identify and reach groups of farmers that may be excluded from informal information-sharing networks.

A dynamic ecosystem of supportive institutions is in place to increase actors' understanding of climate risks, support the implementation of resilience measures, and embark on transformative pathways. A rich variety of institutions in Costa Rica provide information and financing opportunities for adaptation planning

Figure 7 | Coffee Farmer Lainekel Zamora Gómez Is a Member of a Farmer Association



and action, and conduct capacity building and technical follow-up support. Although they frequently work with limited resources, public institutions relevant to the coffee sector are well-coordinated and relatively well-informed of each other's activities; most have regional and local offices as well. An overview of this web of actors is provided in Appendix D.

ICAFFE develops early weather and pest disease warnings that are distributed to regional ICAFFE and MAG extension agents in Coto Brus who then connect with individual farmers. Individual farmers with cellphones can also sign up for these alerts via text messaging. ICAFFE and the Tropical Agricultural Research and Higher Education Center (Centro Agronómico Tropical de Investigación y Enseñanza; CATIE) test new climate-resilient coffee varieties and work with MAG so that groups of farmers can do further piloting and distribute subsidized seeds.

MAG works in concert with INDER, ICAFFE, the National Institute of Learning (INA), and others to build farmers' adaptive capacities via workshops, trainings, and demonstrations. For example, at least three adaptation workshops have been carried out in Coto Brus by MAG, the Cooperatives Consortium (Consortio de Cooperativas; COOCAFFE), and others. These present an opportunity to share information on projected climate impacts and start conversations on

whether transformative adaptation may be needed, and how such shifts can be gradually planned.

The National Development Bank (Sistema de Banca para el Desarrollo; SBD), the People's Bank, and microfinance NGOs provide some financing for farmers to implement adaptation interventions, of which replanting farms with disease-resistant coffee varieties is the most common. The Organized Women's Association of Biolley (Asociación de Mujeres Organizadas de Biolley; ASOMOBI) obtained financing from the Interagency Institute for Social Assistance (Instituto Mixto de Ayuda Social; IMAS) to build a lodging house for their ecotourism venture and from MAG to buy coffee processing equipment and a car.

The regional office of MEIC assists farmers in registering their products (sanitation and brand registries). Similarly, the regional office of PROCOMER helps farmers build their capacities to commercialize their products directly with exporters, while INDER and GAT Sur Alto help farmers develop management skills and access financial resources. The exporting company CAFINTER also brings similar capacity-building support to the farmers they work with.

Extension agencies are a key element and crucial for accelerating adaptation action, but limited staff and resources prevent them from reaching

every single farmer. The existence of a robust, well-coordinated ecosystem of supporting actors is therefore critical to making the best use of resources and complementing existing gaps.

Coffee producers and other key actors can form strategic cross-sectoral alliances to spur adaptation action. Coffee farmers organized in small-to-medium-sized formal associations have allied with public, private, and academic institutions (including companies and NGOs) to acquire financing and resources to enhance their adaptive capacities. The association Exportaciones Aromas Coffee partnered with the international company CAFINTER to implement drip irrigation, test greenhouse technologies, and receive regular technical assistance in return for a nonbinding arrangement to sell the resulting harvest to CAFINTER. The coffee foundation COOCAFE partnered with Fundecooperación and CATIE to publish a climate adaptation and mitigation technical manual, conduct vulnerability assessments, and provide tailored

adaptation assistance to 24 model farmers across the country, including three in Coto Brus. As climate impacts increase and intensify, the formation and strengthening of such novel alliances will become ever more important to spur and scale up innovative adaptation actions and to ensure no producer is left behind.

Participation in national and international programs for sustainable practices can help farmers attain higher prices for their coffee and introduce or scale adaptation interventions. The national Bandera Azul Ecológica Program requires that farmers engage in environmentally friendly practices such as agroforestry, improved soil and water management, and recycling of waste materials. Such practices, though not always implemented with climate resilience in mind, are ultimately no-regret actions that can enhance farmers' resilience to climate shocks. The program has low entry requirements and participation has been the deciding factor for sale deals in numerous cases, according to farmers.

Figure 8 | House of Joy Daycare Facility Visited by the Authors in August 2019



Membership in an association can also help distribute participation costs in programs and certifications.

Coffee producers in Coto Brus are also seeking international certifications through the Coffee NAMA framework. At the national level, the Carbon Neutrality Country Program managed by the Climate Change Office recognizes greenhouse gas mitigation practices undertaken by organizations in the coffee sector, such as cooperatives (Vargas 2020). While this program does not yet recognize individual farmers, it will in the future (MINAE n.d.). By engaging in sustainability, coffee farmers who attain these certifications improve resource management on their farms and fetch higher market prices for their products, thus increasing profitability and helping to build an economic buffer for when climate impacts or other hard times arise. Improved profitability can also lead to more funding for investments in adaptation efforts. However,

while certifications can promote climate adaptation goals and sustainable practices, these programs are generally not designed to catalyze transformative or landscape-scale changes (Verburg et al. 2019).

A small group of farmers—including Exportaciones Aromas Coffee—are also participating in a program called Houses of Joy, which provides a daycare and occasional health checks for seasonal workers' children during the months of harvest (see Figure 8). While studies focusing on the conditions faced by female seasonal workers in Coto Brus are lacking, these early experiences suggest positive impacts for reducing women's labor burden and improving children's care during the coffee harvest. This program is not a certification, but the producers hope that it will help them differentiate their coffee, in addition to improving conditions for their workers.

Box 5 | Key Factors and Promising Climate Adaptation Practices in Other Coffee Farming Communities of Latin America

Different coffee-growing communities are beginning to plan and implement climate adaptation measures. The cases below reflect some of the enabling factors that have been key in Coto Brus, showing instances of coordination (especially public-private partnerships), the introduction of new technologies or mechanisms, and the inclusion of associations and coffee families.

COLOMBIA. Since June 2018, a collaboration between the insurance company Blue Marble Microinsurance, Nespresso, and cooperatives has been testing a new type of insurance to protect thousands of coffee growers from extreme weather conditions. It uses satellite technology to identify farms affected by drought or extreme precipitation and then automatically distributes funds to affected coffee growers. Thanks to new government subsidies, the program is growing and costs for farmers are falling.^a

GUATEMALA. Several international institutes are conducting research with members of the Barillense Association of Farmers (Asociación Barrillense de Agricultores; ASOBAGRI), a cooperative of more than 1,200 organic coffee-producing families, to improve coffee's resilience via local cultural practices. For example, a model is applied to predict which tree species are both most suitable under different climatic conditions and best able to diversify income. Another model is employed to evaluate and mitigate soil erosion.^b

MEXICO. The coffee sector of the Sierra Madre de Chiapas has a strategy for adaptation, mitigation, and reducing vulnerability to climate change developed through a broad alliance of institutions (public, academic, and international) and producer families. The strategy seeks to articulate an effective commitment from society, governments, companies, and international organizations, proposing concrete measures in six priority areas. For example, the strategy proposes to include a vulnerability reduction methodology across the board in all development projects to be implemented with coffee growers. It also seeks to promote awareness and commitment of actors throughout the coffee chain to establish a differentiated payment to producers who use climate- and environmentally friendly practices. Finally, the strategy aims to establish a common fund among multilateral institutions, governments, foundations, and the private sector to advance the various parts of the strategy and promote exclusive funds for vulnerability reduction.^c

Notes:

a. Gatto 2019.

b. Christel et al. 2016.

c. Morales et al. 2011.

OPPORTUNITIES AND CHALLENGES TO ACCESSING FINANCING FOR ADAPTATION ACTIVITIES

Financing Options Available to Farmers for Adaptation Measures in Coto Brus

Options to finance adaptation measures on coffee farms in Coto Brus are available, from public, nonprofit, and private sources (see Table 1). Awareness of these diverse options, however, is quite fragmented and there are still large gaps in farmers' abilities to access available funds, loans, insurance, and lines of credit. Likewise, producers and other key actors need guidance on how to take better advantage of different mechanisms.

Funds for adaptation measures—and other sustainable agricultural practices—in Coto Brus are mainly available as loans. These are provided by INDER, SBD, Fundecooperación, and GAT Sur Alto.¹⁵ INDER also provides direct investments (non-reimbursable) for one year with monitoring and technical assistance for five years following the investment to ensure its sustainability. The project “Promoting Adaptation in Coffee Farms of Cooperatives in the COOCAFE Consortium”¹⁶ provided in-kind support to producers such as seeds, seedlings, and tools. This project was implemented by COOCAFE, Fundecooperación, and CATIE with funds from the Adaptation Fund and management by MINAE. It is expected that Fonascafé—the National Coffee Sustainability Fund approved by the national government in 2019 through Law 9630 in response to the coffee leaf rust crisis of 2012—will soon begin disbursing loans for replanting coffee groves. However, uncertainty still exists regarding both the total amount of funds to be allocated under Fonascafé and the amount that will be provided in each loan.

The activity most frequently financed through these options is replanting coffee groves; Figure 9 shows two varieties of coffee saplings waiting to be planted. Other activities include improving shade

management, building micro-processing plants, and implementing practices to obtain the Bandera Azul Ecológica certification. Fundecooperación also funds crop insurance coverage for its clients, noting that the majority of farmers are uninsured.

It is important to consider that traditional microfinancing options could be insufficient when it comes to promoting transformative adaptation measures. In addition to these financing options, transformative adaptation would benefit from more diverse schemes (given the strong structure of the institutions in Costa Rica)—for example, revolving funds distributed by cooperatives, subsidized credits for sectors of economic activity that pollute, and special funds for transitions to other crops or livelihoods.

External funding is another possibility. Under the NAMA Café and through the NAMA Facility, coffee farmers selected to implement climate mitigation and adaptation measures receive external financing that is sponsored by foreign governments. A multi-sectoral collaboration (2015–2021) between the Adaptation Fund, Fundecooperación, MAG, and MINAE has leveraged nearly US\$10 million in international funds and an additional \$5.5 million in national funds to improve the climate resilience of the agriculture and other key sectors (Adaptation Fund 2019). Financing schemes that articulate and commit other actors in the coffee agribusiness to support the resilience of producers could also be explored. For example, Colombia is experimenting with innovative agricultural insurance schemes subsidized by exporters, insurers, and cooperatives (see Box 5). By exploring these options for adaptation, one could learn from and enhance the “strategy for financing and attracting investment for transformation” of the National Decarbonization Plan (Government of Costa Rica 2018a).



Challenges Farmers Face in Accessing Adaptation-Relevant Financing and Funds

Despite the range of financing options, small producers are still largely underfunded. Most of the stakeholders who commented on this situation linked this to the extensive documentation and lengthy processes required by some funders (especially public and commercial banks) and farmers' inability to meet these stringent requirements. Farmers must complete unfamiliar paperwork, such as providing proof of how they are administering all of their farm's operating costs and revenues over long periods. If farmers do not have savings, sufficient equity, or credit history, they must place their farm as a guarantee—and risk losing what is often their only home if the loan is not repaid. This loss is a risk that very few are prepared to take.

Fundecooperación, which has more credit resources than it has been able to allocate, even expressed that the more urgent need is not to make more funds available, but to connect them more effectively with producers. A producer corroborated this point, explaining that it was easier to work with this

organization than with a commercial or national bank, because the former has fewer requirements, is more flexible, and works closely with producers to ensure the success of their applications and investments.

Locally based funders—like GAT Sur Alto and INDER—and Fundecooperación are seeking to bridge this gap by providing training and assistance in the development of investment and business plans, in the tracking of cash flows, and other areas. Another example of addressing this challenge is the partnership between CAFINTER and SBD whereby CAFINTER's technical assistance and purchasing contracts with producers serve to fulfill the bank's guarantee requirements. This program was first piloted in other regions of Costa Rica and is only recently being implemented in Coto Brus.

A similar capacity gap was also noted for cooperatives. According to INFOCOOP, a frequent issue is not whether the cooperative can obtain funds, but whether it can effectively plan and execute the investment. The danger of indebtedness through fund mismanagement was also highlighted by some producers and local stakeholders.

Table 2 | Financing Options Available to Coto Brus Coffee Farmers for Adaptation and Sustainable Agriculture Practices

NAME OF FINANCING ENTITY	TYPE OF FINANCE	INTEREST RATES	BARRIERS TO ACCESS	SUPPORT PROVIDED, IF ANY	ADAPTATION PROJECTS AND ACTIVITIES FINANCED
Rural Development Institute (Instituto de Desarrollo Rural; INDER)	Non-reimbursable grants and credits	8% on loans; but with new credit regulations, interest rates could be lower in certain cases; for example, for women or for investments with a positive environmental impact	Not having a lease or title to land or property Credit history or investment activity categorized as "high risk" Lack of experience accessing finance or engaging in proposed activities	Connecting producers with institutions that can provide capacity-building or technical assistance	Replanting of coffee groves, farm management, machinery, inputs and infrastructure
Ministry of Agriculture and Livestock (Ministerio de Agricultura y Ganadería; MAG)	Grants (and in-kind support)	<i>Not applicable</i>	<i>Insufficient data</i>	<i>Insufficient data</i>	Machinery, technology
National Insurance Institute (Instituto Nacional de Seguros; INS)	Agricultural insurance	New: Insurance rate may be 5–35% lower with the implementation of adaptation measures	Historically high insurance rates System is not viewed as very agile Perceived by farmers as an additional cost without proportionate benefits	<i>Insufficient data</i>	Adaptation measures eligible for discount include soil conservation, monitoring and control of plagues and diseases, soil analyses and use of organic fertilizers

Source: The authors, based on information gathered during interviews and personal communications with stakeholders.

An additional challenge is that the activities funded through existing financing options may not match up with all the producers’ needs. For instance, one farmer expressed that while he was able to access some financial resources, he has not been able to fund all of his needs, which include replanting groves, building a new stable to feed his cows with the coffee pulp, and acquiring a tractor. In this respect, locally based funders INDER and GAT Sur Alto, and Fundecooperación with its experience working with producers through its projects program, are better placed to know and respond to farmers’ needs. A study to better understand what adaptation-related activities are being funded by these options and which implementable activities remain unfunded could shed light on where efforts should be made to close the funding access gap.

Table 2 summarizes the options currently available to Coto Brus farmers to finance adaptation and sustainable agriculture practices. For each option, the table briefly presents the characteristics that were most frequently mentioned in conversations with farmers and other stakeholders (e.g., type of finance, interest rate, barriers to access). Its aim is to build a shared awareness among local stakeholders of the options currently available to fund farm-level adaptation measures. Among these options are new regulations to promote greater climate resilience by lowering insurance rates when adaptation options are implemented (see the row for INS in the table) and special interest rates to encourage actions that will have a positive environmental impact and support vulnerable groups like women (see the row for INDER).

Table 2 | Financing Options Available to Coto Brus Coffee Farmers for Adaptation and Sustainable Agriculture Practices (Continued)

NAME OF FINANCING ENTITY	TYPE OF FINANCE	INTEREST RATES	BARRIERS TO ACCESS	SUPPORT PROVIDED, IF ANY	ADAPTATION PROJECTS AND ACTIVITIES FINANCED
Fundecooperación	Loans through the program “Crédito a su Medida” (Custom-Made Credits) Loans with a focus on climate change adaptation; e.g., “Ganadería PRO+CLIMA” and “Agricultura PRO+CLIMA” Loans with agricultural insurance from INS	Basic interest rate +8.75% yearly in CRC (Costa Rican <i>colones</i>) Basic interest rate or basic interest rate +5% yearly in CRC if subject to guarantee from FIDEIMAS (state program dedicated to offering financial opportunities to small enterprises) The annual insurance rate for agricultural insurance from INS may be included in the loan	Distance between Fundecooperación’s office in San José and Coto Brus—however, Fundecooperación has advisors based in different areas of the country Negative credit history High degree of indebtedness among producers	Administrative support and capacity-building Follow-up with producers Customized loan repayment schemes Administrative support and capacity-building during the application process to improve producers’ access to these loans	Replanting of coffee groves, farm diversification, good agricultural practices, improved seeds, agroforestry, agricultural insurance, micro-processing plants, roasting and other machinery
GAT Sur Alto	Loans for small farms (2–3 hectares)	Low	<i>Insufficient data</i>	Administrative support and training Follow-up with producers	Replanting or expansion of coffee groves with new varieties
National Development Bank (Sistema de Banca para el Desarrollo; SBD)	Loans	6–11%	Extensive documentation and paperwork required Greater need for business administration skills	<i>Insufficient data</i>	<i>Insufficient data</i>
CAFINTER (private exporting company)	Development bank loans (and in-kind support)	6%	<i>Insufficient data</i>	Technical assistance and follow-up In partnership with the SBD, CAFINTER helps farmers meet the requirements to access the bank’s loans	Replanting or expansion of coffee groves with new varieties; machinery and inputs

Source: The authors, based on information gathered during interviews and personal communications with stakeholders.

RECOMMENDATIONS AND NEXT STEPS

Six key recommendations emerge from this case study to increase the short-, medium- and long-term climate resilience of the coffee sector. While these recommendations are specific to Coto Brus, the insights and lessons learned may be useful to inform adaptation planning and implementation in other regions of Costa Rica as well as in other coffee-growing countries.

- ***Support the implementation, with regular technical follow-up, of promising adaptation options identified by local stakeholders to make coffee production more climate resilient.***

This includes supporting farmers in evaluating adaptation options with long-term time horizons in mind. The adaptation options may include diversifying incomes, replanting farms with climate-resilient coffee varieties, and introducing new technologies and methods that can improve resilience by stabilizing or increasing productivity and farmers' incomes. This will require greater investment in research, from both the public and private sectors, to more comprehensively identify necessary adaptation measures (Niles et al. 2020). The evidence generated would set the foundation to guide producers and other actors in the coffee value chain toward a resilient future.

- ***Establish baselines and monitor the impacts of adaptation measures (particularly relevant for MAG, ICAFE, and MINAE).***

Building an evidence base of farms' climate vulnerabilities and adaptive capacities and tracking the results of adaptation measures as they are implemented could allow farmers and the organizations that support them to understand how to allocate limited resources most effectively, help those in greatest need, and make the case that adaptation is a worthwhile investment of time and resources. This information will also help them evaluate the breadth of investments that will be needed and understand the economic benefits that may result. Furthermore, documenting the specific challenges and opportunities

faced by farmers as they implement adaptation options could also inform a more systematic analysis of the acceptability of the options in light of trade-offs (for instance, via a choice-modeling approach). It is important that the evidence collected be disaggregated by socioeconomic group, gender, age, or other factors of vulnerability to make it clear how adaptation measures are affecting different producers. Involving farmers—including women and people of different ages and educational backgrounds—in data collection would also help ensure that the knowledge and indicators subsequently produced will be meaningful to them and more readily used in their decision-making. CATIE has piloted a methodology for carrying out farm-level vulnerability diagnostics, as well as an initial evaluation of adaptation measures on coffee farms; new efforts to establish baselines and monitor adaptation options should learn from and build on these. Additionally, these efforts should align with and reflect the work being undertaken by MINAE to develop indicators for the National Adaptation Policy and through the National System of Climate Change Metrics (Sistema Nacional de Métrica del Cambio Climático; SINAMECC). ICAFE and MAG could consider how the communication tool being developed by ICAFE—called CR CAFÉ—could be used (with due privacy protections) to collect and systematize data on farms' climate vulnerability and the effects of adaptation measures implemented.

- ***Map out when and where coffee may no longer be viable over the coming decades and explore equitable transformative pathways toward climate resilience, with stakeholder participation (particularly relevant for MAG, ICAFE, and MINAE).***

At the institutional level, it is essential to better understand and take greater consideration of when, where, and how the limits of incremental adaptation may be reached. In turn, it is important to raise awareness at the local level to make it possible to plan for and support a

transition to more climate-resilient livelihoods with the necessary and informed engagement of local actors. It is essential to analyze risks in an integral fashion and to develop complementary processes that include and commit diverse actors and sectors to ensure sustainability (Granados Carvajal et al. 2017). Adopting a transformative adaptation perspective aids in evaluating the short-term costs in light of long-term benefits. By identifying these situations early, it will be easier to build stakeholders' awareness, incorporate their priorities, include the most vulnerable, implement gradual interventions over a longer time frame, and ensure that limited public and private resources are used to maximum effect. This could include credit policies that strategically support coffee growing in certain areas and not in others, thus incentivizing the transition to other activities or crops. MAG's Agroecological Zoning (Zonificación Agroecológica; ZAE)¹⁷ project is piloting suitability mapping for several priority crops, including coffee, and will integrate climate projections; this project could be used to test how crop suitability mapping can inform transformative adaptation planning.

- ***Develop farmer-tailored business administration and commercialization skills trainings as well as guidance to increase uptake of adaptation measures over different timeframes.*** Field activities for this project underscored the importance of regional and local offices of key ministries, ICAFE, and microfinance organizations providing guidance and follow-up support to build farmers' capacities to manage their operating costs. Developing these skills will increase farmers' abilities to assess different adaptation investments and options, manage expenses and timeframes, and access finance. In turn, greater financial sustainability will enable farmers and farmer associations to invest in adaptation interventions (both short and long term) and better weather climate shocks.
- ***Create open communication channels to share information and raise awareness about climate risks, and scale up adaptation efforts.*** Bridging existing gaps in the flow of information across and between institutions and the private and nonprofit sectors will help ensure that all available resources, funding, and knowledge are being used to maximum effect. More systematic efforts to raise awareness of

projected climate change impacts and the adaptation resources available to farmers could include, for instance, communication campaigns through telephone or social media done collaboratively between institutions, including agricultural extension, academic, scientific, and communication institutions. The communication tool CR CAFÉ, for example, might be used to communicate with each producer individually via mobile phone about the expected climate impacts in their area and provide recommendations for risk reduction. Another opportunity includes identifying farmers interested in financing or certain types of technical support, which could be communicated to microfinance institutions, public entities, or others that can match these needs. It is also very important to ensure that local stakeholders have access to accurate and up-to-date data and information on production levels and incidences of pests and diseases, including historical data. At the national level, there is an opportunity to use existing data management and publication initiatives, such as SINAMECC and the National Land Use, Land Cover and Ecosystem Monitoring System (Sistema Nacional de Monitoreo de la Cobertura y Uso de la Tierra y Ecosistemas; SIMOCUTE), to promote better use of public data by both public and private sector actors.

- ***Expand and scale up peer-to-peer learning between farmers within and between regions.*** Research done for this project highlighted the opportunity for institutions, associations, and cooperatives to facilitate more local, regional, and national participatory venues and events for farmers to showcase their adaptation efforts, including transformative adaptation measures, with their peers. These gatherings and even on-site demonstrations of model farms could take place not only in Coto Brus, but also between coffee-growing regions. Another strategy is to support "champion" producers—those who can influence their communities and networks—through leadership training related to climate adaptation. The potential for a positive "contagion" effect is high. Given the Ministry of Agriculture and Livestock's limited capacity, such initiatives become more feasible through cross-sectoral collaborations—and could perhaps even be funded via exporters looking to expand the availability of high-quality, climate-resilient coffee.

APPENDICES

Appendix A. Overview of Workshop and Field Visits Held in August 2019

On August 13, 2019, MAG, MINAE, and WRI convened a diverse group of stakeholders in the coffee sector, especially those who work in or produce coffee in the Coto Brus canton, at the new coffee processing plant in Fila Méndez to discuss and share solutions to enhance the sector's climate resilience (see Figure A1 below).

The invitations to the workshop were coordinated between MAG and WRI, with the help of the sustainable development NGO Fundecooperación, which also provided the names of six coffee producers. Around 40 participants attended the workshop; approximately half were local coffee producers (many from the coffee cooperative Coopesabalito) and the remaining comprised representatives of government institutions (MAG, ICAFE, INDER, MINAE, INA, and the Ministry of National Planning and Economic Policy (Ministerio de Planificación Nacional y Política Económica; MIDEPLAN), the nonprofit sector (Fundecooperación, GAT Sur Alto), and academia (National University for Remote Education; UNED). The average size of the farms of participating producers (based on the answers of 17 of the producers who provided this information) is 6.8 hectares and the median, 4 hectares.

The workshop consisted of several interactive activities and discussions in five small groups and in plenary. Among the topics presented and discussed were climate risks and impacts in Coto Brus; priorities of the communities in the region; evaluation of adaptation measures; and reflections

on implementing different short-, medium-, and long-term solutions. One activity centered on evaluating the list of adaptation options in Appendix B (chosen with MAG, but participants were free to add any they perceived as missing), while another focused on selecting the most promising measures and placing them on a transformative adaptation pathway (see Figure A2). There were also several presentations and experience exchanges, including presentations by Mario Chaves Rodríguez on the Bandera Azul Ecológica program, Armando Navarro on the efforts of the associated group Exportaciones Aromas Coffee, and Bernie Acuña on the closure of the Cooprosanvito coffee cooperative.

In the days before and after the workshop, WRI was guided by the regional MAG office to four small-to-large coffee farms. Like producers at the workshop, these farmers voiced the need to gradually implement larger changes in farm management, production, and the current business model. The producers reported a certain level of concern about climate impacts that they already experience (pests, higher temperatures, variability of rainfall, and changing flowering times) and potential future impacts. This concern has led these producers to implement certain adaptation and conservation measures (sustainable practices) motivated by the desire to improve both the quantity and stability of production, and the final price of the product. These measures include managing soil quality and erosion (leguminous trees, terraces, contours, cover crops), harvesting rainwater, and protecting water resources. During the workshop, producers and other stakeholders recognized that, as climate impacts increase in severity, larger changes would be needed, and they were introduced to some of these options—one of which may include switching out of coffee entirely (see Section 4).

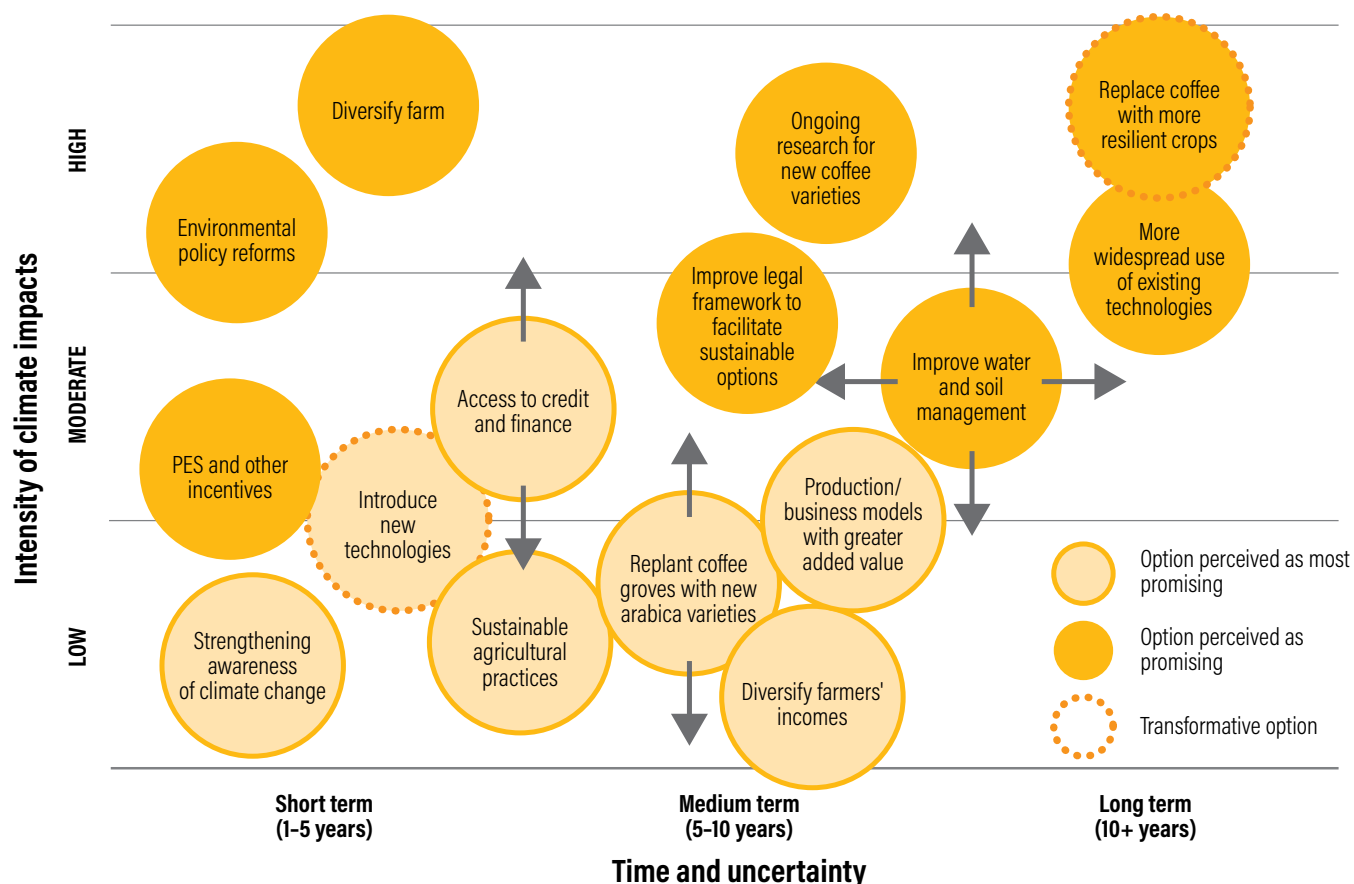
Figure A1. Opening Session of the Workshop in Coto Brus



Appendix B. List of Adaptation Measures Evaluated during the Workshop

- Improve water management
- Replace current coffee plants with more resilient varieties
- Replace coffee with new or alternative crops that are more climate resilient
- Raise awareness of climate impacts
- Engage in sustainable production practices
- Employ early warning systems for weather, pests, and diseases
- Strengthen cooperatives; e.g., by providing more technical and financial support
- Diversify producers' incomes
- Introduce new technologies
- Provide adequate shade tree management
- Move coffee cultivation upslope
- Ensure access to harvest and crop insurance
- Improve soil and erosion management
- Introduce trees that can block strong winds
- Use live fences to help retain humidity, lower soil temperatures, and diversify farms
- Ensure access to credit and financing
- Ensure 100 percent traceability of the coffee bean to the farm it came from, making it much likelier for farmers to attain a higher market price, which can therefore help stabilize farmers' incomes (this measure was added by participants during the activity)
- Switch to robusta coffee at low altitudes

Figure B1. Transformative Pathway of Adaptation Measures Created by Workshop Participants



Notes: As time horizons increase (i.e., from the short to the medium to the long term) so does the uncertainty associated with climate impacts. Two measures—introducing new technologies and introducing more resilient crops—fit under this paper's definition of transformative adaptation. The arrows indicate how some measures were deemed to be important across time horizons and intensity of climate impacts. PES stands for payments for ecosystem services. Source: Information collected by the authors during the workshop activity in August 2019.

Appendix C. Costs/Trade-Offs and Benefits of Adaptation Measures

Table C1. Costs/Trade-Offs and Benefits of Various Adaptation Measures as Evaluated during the Workshop

ADAPTATION MEASURE	COSTS/TRADE-OFFS	BENEFITS
Introduce new arabica varieties more tolerant to the most common plagues and diseases	<ul style="list-style-type: none"> ■ Requires experimentation, new knowledge and practices ■ Monetary costs associated with acquiring new varieties and higher input/fertilizer needs ■ Uncertain resilience in the long term 	<ul style="list-style-type: none"> ■ Higher productivity ■ Lower incidence of disease, lower need for fungicides ■ More resilient in the short and medium terms
Use shade trees (with adequate shade management)	<ul style="list-style-type: none"> ■ High monetary and labor costs associated with shade management (pruning of trees) ■ Risk of negative impacts on coffee production if not adequately managed 	<ul style="list-style-type: none"> ■ Lower need for external inputs ■ Regulates the farm microclimate ■ Less soil erosion ■ Pruning residues for other farm/household uses ■ Mitigates storm run-off
Replace coffee plants with new or alternative crops that are more climate resilient	<ul style="list-style-type: none"> ■ High risk due to unavailability of clear alternatives ■ Potentially high investment needed ■ Uncertainty and lack of experience with alternatives 	<i>No data</i>
Strengthen awareness of climate change	<ul style="list-style-type: none"> ■ Requires coordination among stakeholders and consistent support from extension agents ■ Requires new capacities and knowledge 	<ul style="list-style-type: none"> ■ Improved preparedness and ability to plan among farmers
Employ sustainable agricultural practices	<ul style="list-style-type: none"> ■ Start-up costs/investment ■ Labor requirements for maintenance 	<ul style="list-style-type: none"> ■ Improved food security ■ Improved household socioeconomic situation ■ Improved farm management ■ Higher product value ■ Environmental benefits
Employ early warning systems for weather, pests, and diseases	<ul style="list-style-type: none"> ■ Low cost to producers ■ Challenges with communication 	<ul style="list-style-type: none"> ■ Improved preparedness
Strengthen cooperatives; e.g., by providing more technical and financial support	<ul style="list-style-type: none"> ■ Low cost to producers 	<ul style="list-style-type: none"> ■ Supports more efficient production
Diversify farmers' incomes	<ul style="list-style-type: none"> ■ Challenges with commercialization ■ Potentially high investment needed 	<ul style="list-style-type: none"> ■ Higher income and reduced risk of loss of income
Introduce new technologies	<ul style="list-style-type: none"> ■ High cost 	<ul style="list-style-type: none"> ■ Higher productivity ■ Reduced production costs
Move coffee cultivation upslope	<i>No data</i>	<i>No data</i>
Provide crop insurance	<i>No data</i>	<i>No data</i>
Improve soil and erosion management	<ul style="list-style-type: none"> ■ Low cost to producers 	<ul style="list-style-type: none"> ■ Higher productivity ■ Lower input needs
Improve water management	<ul style="list-style-type: none"> ■ Potential high labor costs 	<ul style="list-style-type: none"> ■ Availability of water for irrigation ■ Control of pests and diseases ■ Fertilizer management
Introduce trees that can block strong winds	<ul style="list-style-type: none"> ■ Low cost to producers ■ Typically uses non-native tree varieties 	<ul style="list-style-type: none"> ■ Protects coffee groves from strong winds

Table C1. Costs/Trade-Offs and Benefits of Various Adaptation Measures as Evaluated during the Workshop (Continued)

ADAPTATION MEASURE	COSTS/TRADE-OFFS	BENEFITS
Use live fences to help retain humidity, lower soil temperatures, and diversify farms	<ul style="list-style-type: none"> ■ Low cost to producers 	<ul style="list-style-type: none"> ■ Crop diversification ■ Lower soil erosion
Ensure access to credit and financing	<ul style="list-style-type: none"> ■ Medium-high cost to producers ■ Guarantees and other requirements can be prohibitive and risky for producers ■ High interest rates in the short term 	<ul style="list-style-type: none"> ■ Promotes entrepreneurship ■ Investments for improved productivity and quality
Switch to robusta coffee in lower-elevation areas	<ul style="list-style-type: none"> ■ Low quality and low prices ■ Reputational risk for canton 	<i>No data</i>

Source: Information collected by the authors during the workshop activity in August 2019.

Appendix D. Key Actors in Costa Rica’s Coffee Sector

Figure D1. Web of Key Actors in Costa Rica’s Coffee Sector (non-exhaustive)



Note: NGO stands for nongovernmental organization.

Source: The authors.

ENDNOTES

- 1 The blog post, authored by Rebecca Carter and Stefanie Tye, is titled “Thanks to Climate Change, Oranges Are Becoming the New Coffee in Some Parts of Costa Rica,” and can be found on WRI’s website: <https://www.wri.org/blog/2018/08/thanks-climate-change-oranges-are-becoming-new-coffee-some-parts-costa-rica>.
- 2 The district, or canton, of Coto Brus is one of the six cantons located in the region of Brunca.
- 3 See Läderach et al. (2017) for a discussion of these scenarios in the Nicaraguan coffee sector context.
- 4 Livestock, horticulture, and, on a smaller scale, basic grains and tropical fruits constitute 20 percent; the remaining 10 percent consists of retail and services.
- 5 Coffee production statistics in Costa Rica are commonly reported in *fanegas*, here translated as “bushels.” One *fanega* of coffee is the equivalent of 250 kilograms, or 2.5 quintals.
- 6 The statistics on production levels and area are for the canton Coto Brus. Statistics for the number of producers, however, are for the “coffee-growing region” Coto Brus, which consists primarily of the canton of Coto Brus plus small coffee-growing areas in surrounding cantons.
- 7 Plan de Desarrollo Rural del Territorio Buenos Aires-Coto Brus, 2015–2020 (National Rural Development Institute [Instituto de Desarrollo Rural; INDER]), and Región Brunca Plan de Desarrollo 2030 (Ministry of National Planning and Economic Policy [Ministerio de Planificación Nacional y Política Económica; MIDEPLAN]).
- 8 Representative Concentration Pathways (RCPs) are projections of the atmospheric concentrations of greenhouse gases, given different levels of efforts to reduce emissions. RCP 2.6 represents the scenario with the greatest efforts to reduce emissions, while RCP 8.5 represents the scenario with the lowest level of efforts to reduce emissions.
- 9 Plan de Desarrollo Rural del Territorio Buenos Aires-Coto Brus, 2015–2020; Región Brunca Plan de Desarrollo 2030; Plan Nacional de Desarrollo y de Inversión Pública del Bicentenario, 2019–2022; Universidad Nacional de Costa Rica, Plan Estratégico Sede Regional Brunca, 2017–2021.
- 10 Although “climate change awareness” and “access to credit and financing” are mechanisms rather than measures that enable the implementation of various types of adaptation actions, we include them in the workshop activities as measures to reveal the perceptions of attendees of their prevalence, the actors who should establish them, and the barriers they encounter.
- 11 These were qualified as “very common” activities by at least four of the five small groups of farmers and other stakeholders that participated in the workshop. Shade trees help reduce temperatures, while live fences are another ecosystem-based adaptation measure that uses trees or other plants to surround parcels, helping to retain humidity and lower soil temperatures within them.
- 12 The small groups were split on the frequency of these options, with some groups characterizing them as “very common” and others as “not common at all.”
- 13 Growing robusta coffee in Costa Rica was prohibited between 1988 and 2018, when the government authorized ICAFE to grow it in marginal areas. Although coffee-growing areas in Coto Brus are not currently considered marginal, shifting to robusta coffee was included in the workshop discussions as the group sought to explore adaptation options for the long term.
- 14 INFOCOOP is the national agency regulating cooperative associations in Costa Rica.
- 15 Banco Popular was also mentioned as a source of credit for the coffee-processing activities of ASOMOBI, but no information was given regarding its financing of farm practices.
- 16 In Spanish, “Impulsando la Adaptación en Fincas Cafetaleras de Cooperativas del Consorcio COOCAFE.”
- 17 ZAE is headed by MAG’s National Institute of Innovation and Transfer in Agricultural Technology (El Instituto Nacional de Innovación y Transferencia en Tecnología Agropecuaria; INTA).

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ABOUT THE AUTHORS

Stefanie Tye is a research associate with the Climate Resilience Practice at WRI. She works on a range of topics, including transformative adaptation in the agriculture sector, mainstreaming adaptation, and providing countries with technical assistance on strengthening climate resilience. Contact: stye@wri.org

Delfina Grinspan is a research analyst with the Governance Center and Climate Program at WRI. She conducts research and supports in-country technical assistance projects related to climate data transparency, adaptation in the agricultural sector, and alignment between the sustainable development and climate agendas. Contact: delfina.grinspan@wri.org

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We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

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We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.

ABOUT THIS PAPER

This case study directly responds to a request for technical assistance to build resilience in the coffee sector from the Costa Rican Ministries of Agriculture and Livestock (Ministerio de Agricultura y Ganadería; MAG) and Environment and Energy (Ministerio de Ambiente y Energía; MINAE). This assistance began in February 2018 and concluded in February 2020. Through the NDC Partnership, ministry officials requested World Resources Institute's (WRI's) technical assistance in conducting desk research, a workshop, and interviews to create this case study of the challenges and opportunities that climate change presents to the coffee-growing region of Coto Brus. Its purpose is to build a common understanding of and greater clarity on actions that coffee producers, nongovernmental organizations, cooperatives, funders, and relevant ministries can take to improve the sector's climate resilience and long-term sustainability. The recommendations proposed in this paper focus on inter- and intra-sectoral coordination and capacity development to support adaptation planning, rather than the specific technical measures available to adapt coffee production to a changing climate.

Despite the case study's local focus, the authors believe the lessons and experiences shared in this paper are relevant for other coffee-growing regions and countries where coffee producers are facing the effects of climate change, and hope that it will serve as a tool and inspiration for accelerating adaptation action.

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SUITE 800
WASHINGTON, DC 20002, USA
+1 (202) 729-7600
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