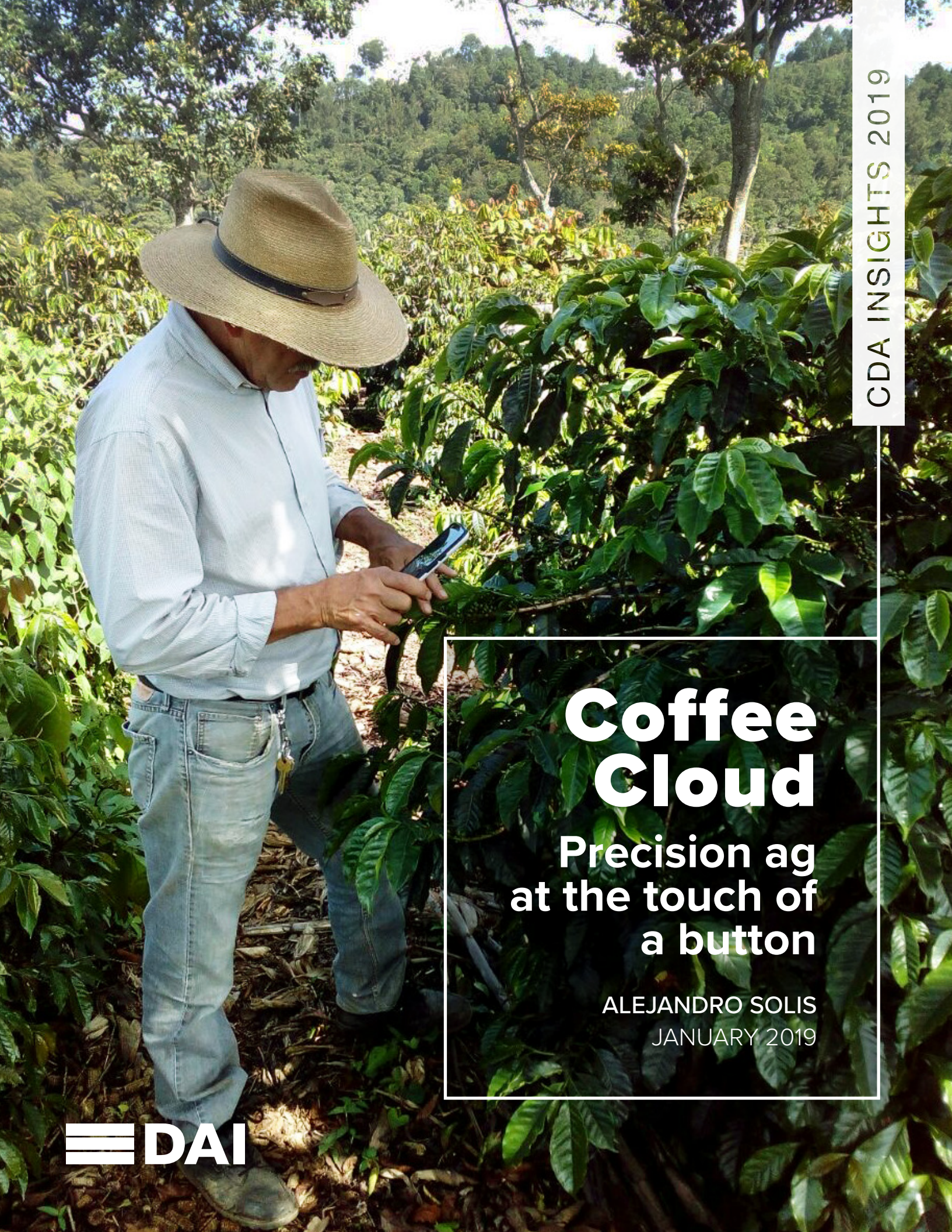

CDA INSIGHTS 2019

Coffee Cloud

Precision ag at the touch of a button

ALEJANDRO SOLIS

JANUARY 2019

DAI

CENTER FOR DIGITAL ACCELERATION

The Center for Digital Acceleration helps our clients integrate digital tools and approaches across their portfolio through research, design, and implementation. Our work covers a cross section of sectors including health, governance, agriculture, education, and economic growth.

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The opinions expressed are those of the author and do not necessarily represent the views of any government or donor agency associated with the content of this paper.

Cover photo: A member of ANACAFE using the application.

Photography: ANACAFE

Design: Jennifer Geib | jennifergeib.com

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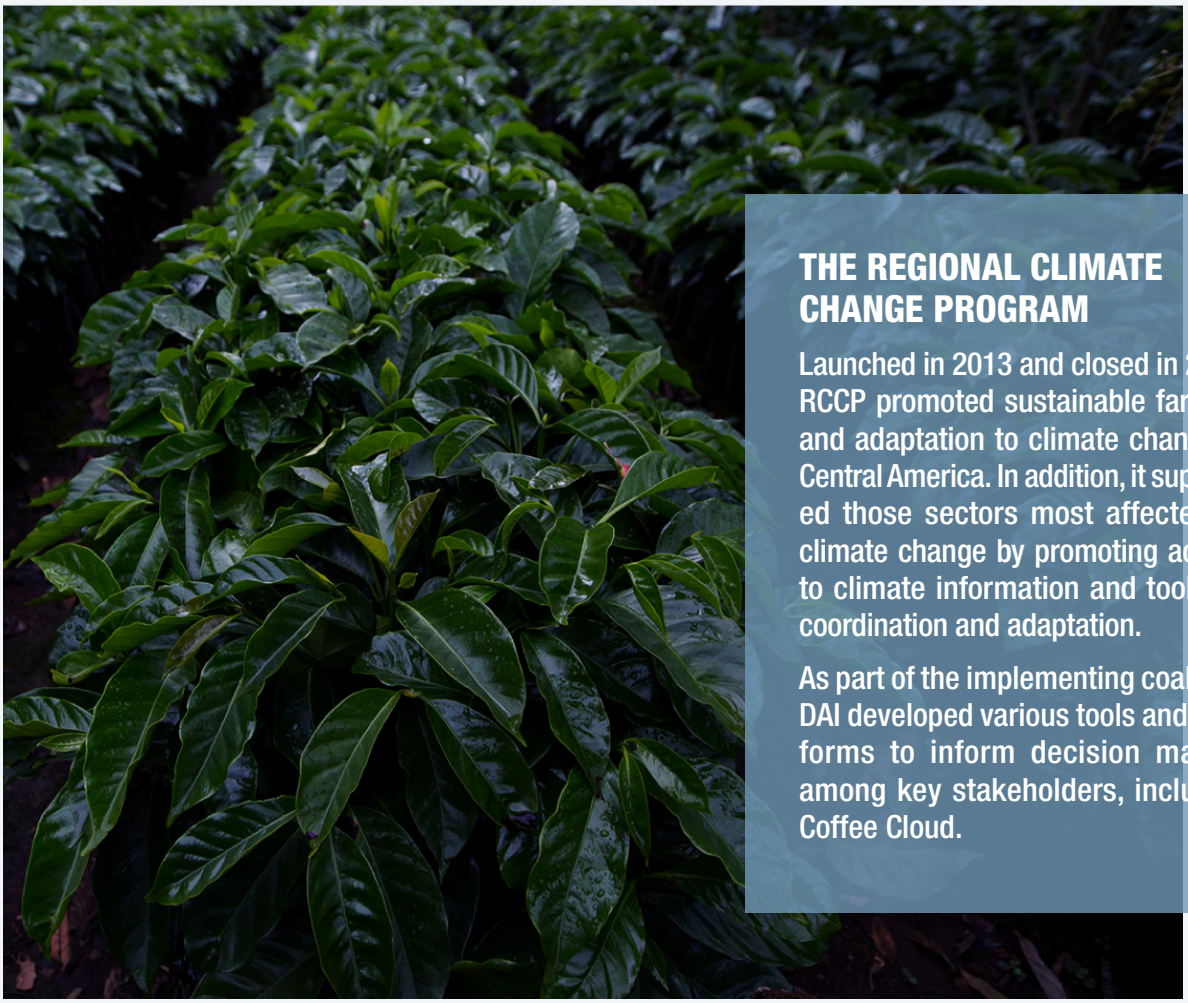
Executive Summary

From 2013 to 2018, DAI formed part of the coalition that implemented the U.S. Agency for International Development (USAID) Regional Climate Change Program (RCCP) across Central America. As part of this regional coalition, DAI developed a series of applications to promote climate adaptation among the sectors most affected by climate change.

One of these applications was Coffee Cloud, which places key climate information and crop recommendations into the hands of coffee farmers. Over time, this application evolved into a broader digital project that not only provides information but also helps producers monitor the health of their crops.

Throughout the design and implementation of Coffee Cloud, DAI worked closely with coffee producers and other key stakeholders to encourage their ownership of the application, establish sustainability plans, and create business plans that have helped to expand uptake at the regional level and promote ongoing improvements to the tool. Currently, Coffee Cloud is active in four Central American countries and supports more than 5,000 coffee producers.



THE REGIONAL CLIMATE CHANGE PROGRAM

Launched in 2013 and closed in 2018, RCCP promoted sustainable farming and adaptation to climate change in Central America. In addition, it supported those sectors most affected by climate change by promoting access to climate information and tools for coordination and adaptation.

As part of the implementing coalition, DAI developed various tools and platforms to inform decision making among key stakeholders, including Coffee Cloud.

Introduction

Climate variation has been a constant factor in the development of human agriculture. However, in recent years the magnitude of these variations has altered the physiological and agronomic development of crops, causing confusion about the best ways to manage crops and counteract pests. These variations are part of a global trend climate change, a complex phenomenon that will require effort at all levels of society to mitigate and solve.

Between 2013 and 2018, DAI was part of an integrated consortium that formed the USAID RCCP. This consortium was led by the Center for Tropical Agricultural Research and Higher Education (CATIE), and included the International Union for the Conservation of Nature (UICN), Cooperative for Assistance and Relief Everywhere (CARE), Terra Global Capital, and DAI. DAI's role was to create a regional data center and tools for decision making spanning agriculture, food security, ecosystems, carbon, energy, and risk management.

Following a process of macroeconomic and value chain analysis, DAI determined that the coffee sector was among the most affected by climate change, and so decided to design and implement a tool that coffee farmers across the region could use to make timely decisions to better manage the risks and crop diseases caused by climate change.

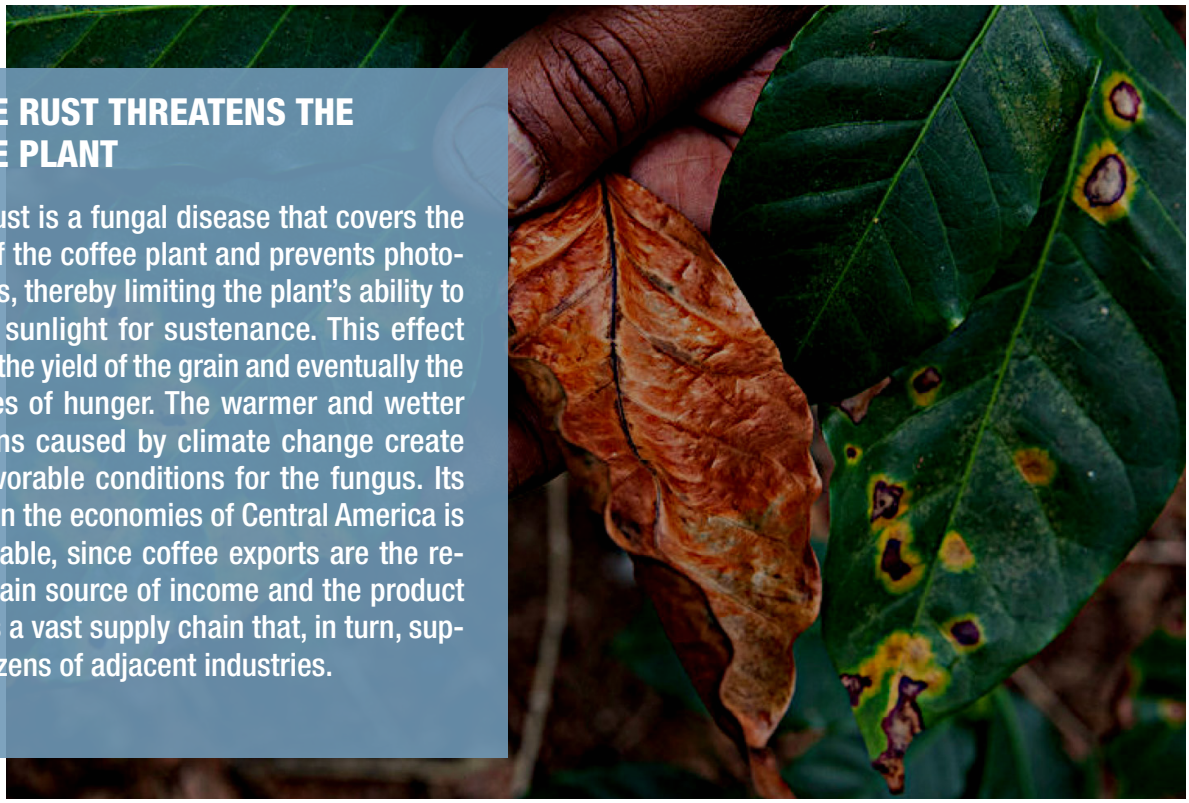
The producer was the center of the design process, with input from the technicians and coffee institutes around the region.

Strategic Partners

Over the past 200 years, the economic development of Central America has been powered by the growth of the coffee economy (ICAFE, 2017). This growth has been coupled with the development of an institutional structure that supports and organizes the work of farmers at regional and local levels. This structure is the result of the work of the Regional Program for the Technological Development and Modernization of Coffee Cultivation (PROMECAFÉ), which promotes technological exchange and research among the region's coffee institutes.

PROMECAFÉ includes various Central American and Caribbean governments and international organizations[1], and has established a network of cooperation and management with the intent to develop new technologies for coffee growers across the region, aiming to address the two greatest threats to the region's coffee economy: the fruit borer (*Hypothenemus hampei*) and coffee rust (*Hemileia vastatrix*).

In 2015, in San Jose, Costa Rica, PROMECAFÉ hosted a diagnostic workshop on the use of climate data, where it was determined that Guatemala's National Association of Coffee (ANACAFE) and the Coffee Institute of Costa Rica (ICAFE) would be two of the principal partners in the development of this new strategic approach.



COFFEE RUST THREATENS THE COFFEE PLANT

Coffee rust is a fungal disease that covers the leaves of the coffee plant and prevents photosynthesis, thereby limiting the plant's ability to process sunlight for sustenance. This effect reduces the yield of the grain and eventually the plant dies of hunger. The warmer and wetter conditions caused by climate change create more favorable conditions for the fungus. Its impact on the economies of Central America is considerable, since coffee exports are the region's main source of income and the product supports a vast supply chain that, in turn, supports dozens of adjacent industries.

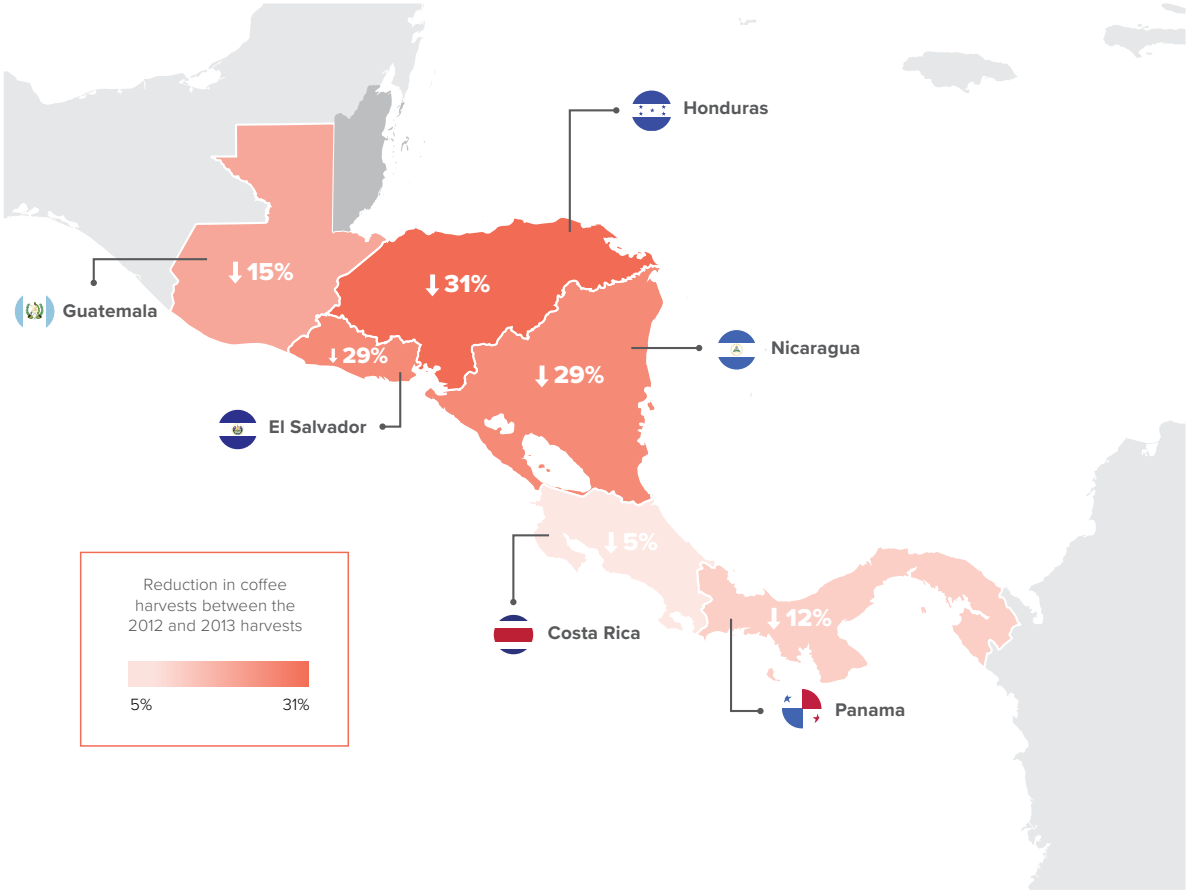
1 PROMECAFÉ has worked with organizations such as USAID, IDB, AECID, CIRAD, FONTAGRO, FAO and OIRSA, among others.

Economic Impact of Coffee Rust

For more than 100 years, coffee rust has menaced the global coffee industry, including in Central America (IICA, 2016). A lack of collaboration and communication between coffee producing countries has been a contributing factor to the devastation caused by coffee rust, which has affected the livelihoods of farmers throughout the region (Virginio, 2015).

For example, during the harvest of 2012–2013, coffee rust in Central America was responsible for the loss of 15 percent of the total product generated. Honduras and El Salvador were the countries with the highest losses, losing 31 percent and 23 percent of their product, respectively (see Figure 1).

FIGURE 1. REDUCTION IN COFFEE HARVEST BETWEEN 2012 TO 2013 HARVESTS[2]



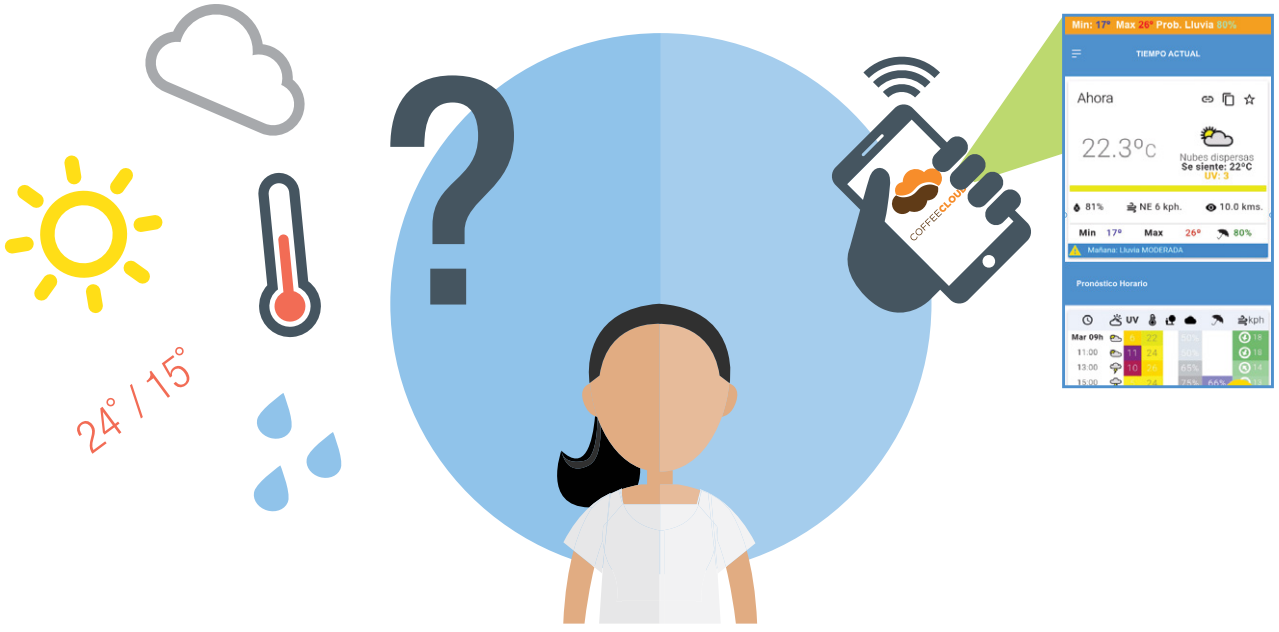
According to the Inter-American Institute for Agricultural Cooperation (IICA), the decline in coffee production across Central America resulted in the loss of 265,000 jobs between 2012 and 2013, causing lasting economic damage to the people of these countries, especially in rural areas.

2 Data provided by the coffee institutes or agriculture ministries of the relevant countries (IHCAFE, ANACAFE, ICAFE, MAGFOR and PROCAFÉ) within the framework of a project titled "Controlling Coffee Rust in Mesoamerica," implemented by CATIE, CIRAD, and PROMECAFÉ, and financed by the Government of Norway.

Disconnect between Information and End Users

Until recently, climate information used in the coffee sector cited only the monthly and annual values of rainfall as well as average temperatures. This information was provided by national meteorological and hydrological services or collected on individual farms for research purposes. The data was generally analyzed to compare rainfall distribution to the various stages of development of coffee plants, and then used to create general recommendations for fertilization and disease mitigation; or it was used to explain alterations during the flowering and fruit formation phase resulting from atypical weather conditions.

More recently, motivated by the climate variations that have affected the coffee industry, certain coffee institutes in the region—those with research units—began formally monitoring the principal factors that constitute the climate, such as temperature, precipitation, relative humidity, wind speed, and solar brightness. This data enabled the creation of a climate database for coffee-producing regions, with the intent that this database would help researchers explore the nexus of climate and harvest. As part of this process, a network of meteorological stations was established by ICAFE, the Coffee Institute of Costa Rica, in 2008 and has been used since to explore the connection between weather conditions and the disease known as *ojo de gallo*, or American leaf spot (*mycena citricolor*) (Barquero et al., 2013).



Coffee Cloud modules provide the producer with information about the farm, as well as meteorological and epidemiological data, and recommendations and official notices.

Use of Mobile Technologies and the Internet

Based on our knowledge of Internet penetration and mobile access data from a variety of sources, DAI chose to bridge the gap between farmers and climate data using a smartphone application. According to the *Study of Social Networks in Central America and the Caribbean* by iLifebelt, a Guatemalan consulting firm, Central America alone already has 22 million Internet users (KONT, 2018).

The boom in mobile telephony and the reduction in the cost of smartphones and data packages are driving uptake of these technologies, and coffee producers are no exception. For example, training workshops conducted by RCCP and delivered to more than 400 coffee growers in Guatemala between 2016 and 2018 found that 80 percent of growers carried a smartphone. The remaining 20 percent said they did not because they did not see the business case to own one (ANACAFE, 2019).

Another factor DAI took into account in the decision to build a mobile application was the generational change happening on farms throughout the region. Younger generations feel little motivation to take on farming due to a perceived lack of opportunities to use new technology in agriculture, especially among small and medium-sized producers.

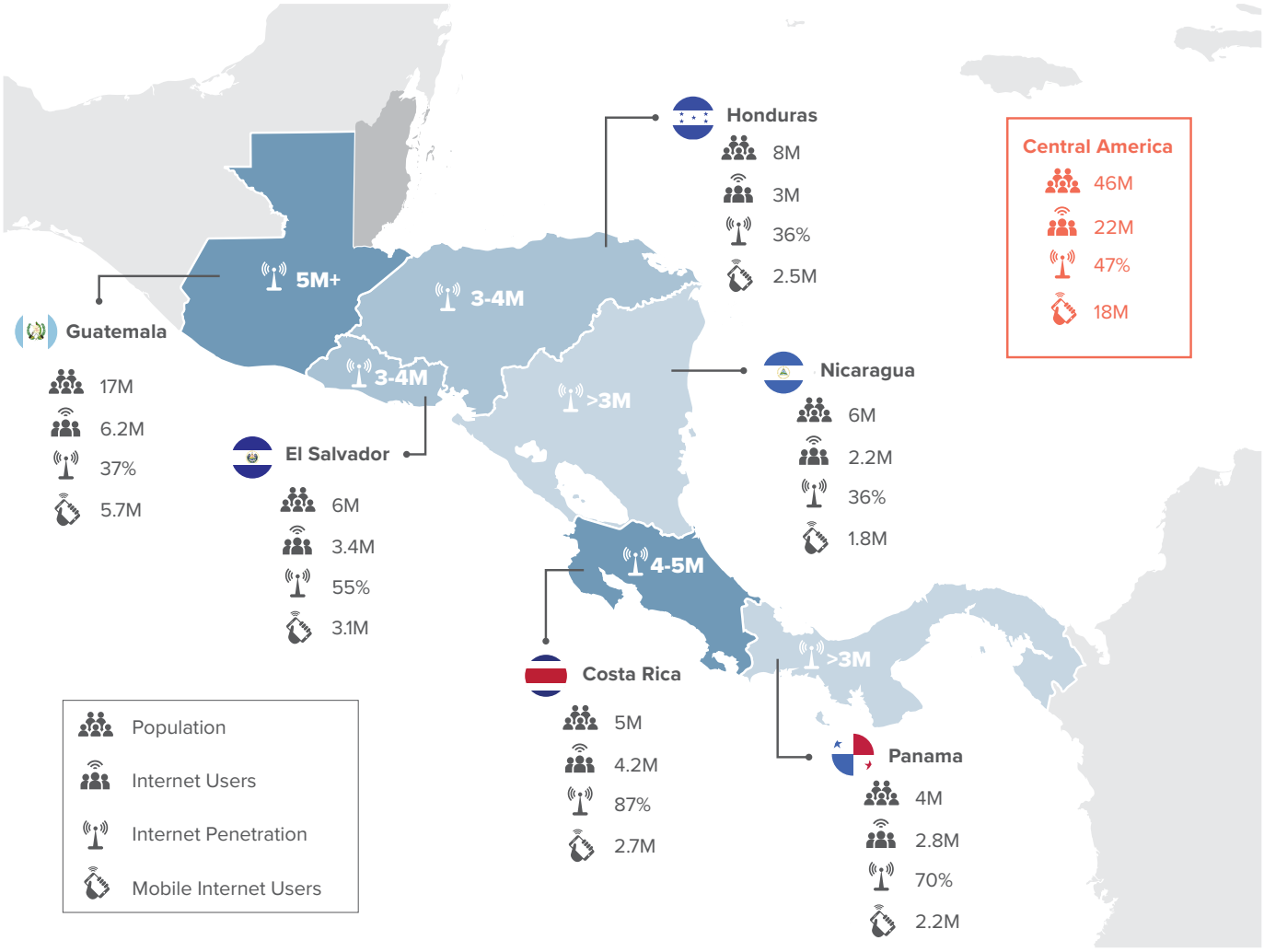
COFFEE CLOUD: AN APPLICATION TAILORED TO THE COFFEE SECTOR

Coffee Cloud is an application that allows coffee institutes and producers in the region to have access to climate information. The application also allows them to understand the situation of their plantations to make informed decisions about the management of their crops.

After its first version, Coffee Cloud continued with the development of a set of modules for crop diseases and farming practices.

A recent Google study on opportunities in Central America shows 41 million Internet users across both Central America and the Caribbean, which represents 53 percent of the total population of this region (Figure 2). This figure has increased by more than 20 percent over the past five years, and, according to the report, that growth trend is expected to continue unabated.

FIGURE 2. INTERNET USE & PENETRATION IN CENTRAL AMERICAN COUNTRIES



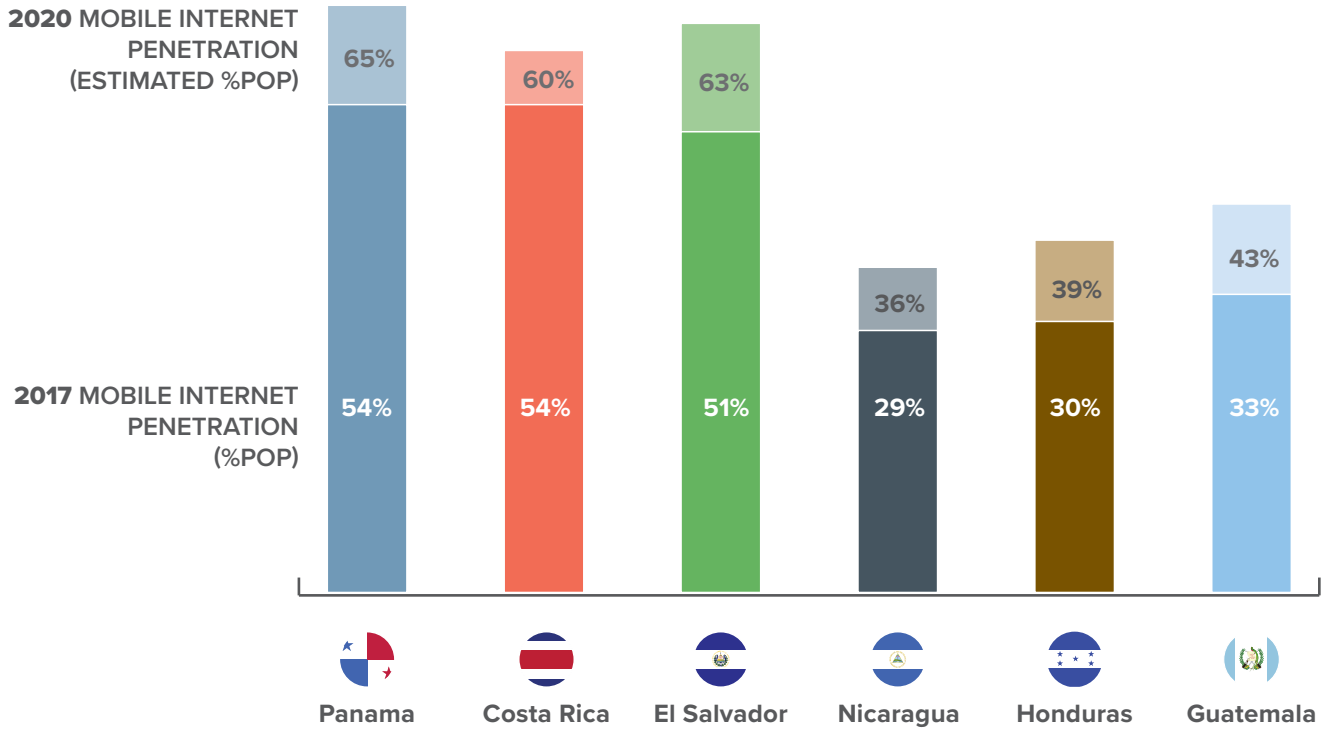
Adapted from Digital in 2017: Central America—We are Social 2017 and GSMA Intelligence 2017

“The way the information is presented makes it so user friendly. The farmer, the technician, the official, in short everyone who accesses Coffee Cloud, will find relevant, updated data presented in a way that’s easily accessible.”

– Mario Chocooj
Centro de Investigaciones en Café, ANACAFE

Central America has improved its connectivity in line with the expanded access to and penetration of mobile phones. This trend is illustrated in the same Google study, which indicates that approximately 47 percent of the region's population has access to the Internet through a mobile phone. The same study projects that by 2020, 60 percent of the inhabitants of Costa Rica, El Salvador, and Panama will have mobile access to the Internet, followed by Guatemala with 43 percent, Honduras with 39 percent, and Nicaragua with 36 percent, reflecting an increase of more than 10 percent per year, as shown in Figure 3.

FIGURE 3: CURRENT PENETRATION OF MOBILE INTERNET IN CENTRAL AMERICA AND PROJECTION TO 2020



Adapted from GSMA Intelligence.

Coffee Cloud: From the Region to the Coffee Plantation

Taking into account the region's digital ecosystem and the challenge presented by coffee rust, DAI worked hard to develop an application that would bridge existing information gaps yet could be easily managed by end users—coffee producers.

Coffee Cloud was built using a human-centered design approach to share regional climate information with government institutions, research institutes, and coffee producers. The application produces information specific to each farmer's crop to facilitate data-driven decision making about the management of those crops. Seeking to facilitate local adaptation to climate change, Coffee Cloud offers enormous benefits for the coffee industry:

- **It was created with and for farmers:** Its design process focused on user input to create a customized, demand-driven solution.
- **It enables two-way communication:** The app allows coffee farmers to communicate in real time with the government coffee institute in their country.
- **It works quickly:** By using historical weather information and a predictive model, Coffee Cloud readily links information generated by meteorological services and coffee institutes with the sector and individual farmers.
- **It is official:** The data comes from reliable, secure, official sources.
- **It is a data collection tool:** Farmers input information to get customized advice, and this information is central to the tool's ability to serve as an early warning system for the entire coffee industry.

The Tool That Became a Community

Due to the participatory approach of the design process and the nature of the application itself, which is completely open source, Coffee Cloud is replicable in any coffee-producing country. As a result, Guatemala, through ANACAFE, and Costa Rica, through ICAFE, have made Coffee Cloud the official tool for their member farmers, and they serve as technical promoters in the development of the application.

The tool was further expanded to El Salvador and Honduras after the Borlaug Institute's Resilient Coffee project—implemented by Texas A&M University and funded by USAID—discovered it. Soon after, the UNEX coffee company in El Salvador and the CAPUCAS Cooperative in Honduras also adopted the tool for their networks of farmers.

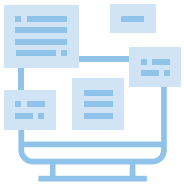
“The coffee rust calculator, helped me optimize time and resources.”

– Gamaliel Hernández
Guatemalan Coffee Farmer

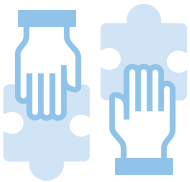
Design Process

In creating Coffee Cloud, DAI applied a design thinking methodology, engaging coffee farmers as users and as the fulcrum of the design process. Two farmer workshops generated the initial inputs required to develop and implement the tool. The entire process, from design to implementation, took roughly 12 months. Following are key elements of this process:

Mapping possible users: Aiming to understand the national and local context, DAI mapped potential users to grasp the dynamics of the decision-making processes throughout the coffee value chain and ecosystem. Among the identified users were national associations, cooperatives, technical analysts, extension agents, and, obviously, farmers, who are the pillar of the tool and the reason it exists.

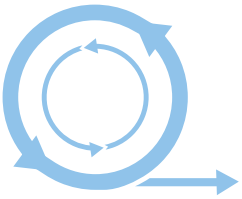


Digital context: DAI sought to understand what similar tools are common at the regional and national levels, as well as their strengths, weaknesses, limitations, integration possibilities, and opportunities for expansion. Only two tools with a similar focus were identified: SATCafé, made by FAO, and the Early Warning System, from OIRSA. The main distinction between Coffee Cloud and these tools is that Coffee Cloud was designed with a focus on farmers, as opposed to researchers and government officials.

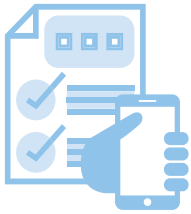


Social stimulus: With the aim of involving civil society, the RCCP participated in NASA's *International Space Apps Challenge Hackathon*, which gives young people the tools and mentorship they need to utilize NASA satellite data to address problems in their communities, including challenges related to the cultivation of coffee. Participation in the hackathon allowed DAI to generate important, implementable ideas such as the use of data collection services offline in low-connectivity areas.

Human-centered design: The design process focused closely on farmers. Through design thinking workshops, DAI sought to define farmers' requirements and their social, economic, and technological conditions, as well as their interaction with other farmers, ensuring that the tool would respond to these factors. This process also helped to build a sense of ownership and knowledge of the tool from the beginning of the process among participants. Testing and validation of the tool was carried out in the field with farmers in Guatemala and Costa Rica.



Agile implementation: With all necessary information about users and requirements defined, DAI contracted a team of software development specialists, including a project manager, three software developers, and an expert on agrometeorology. The team managed the project with rapid design sprints, creating modules for farmer registration, coffee rust analysis, weather information, communications, and a control panel.



Testing and launch: DAI tested stable versions of the app in the field with farmers. This approach opened a space for new ideas around the user interface and for solving problems with various versions of operating systems. Some changes had to be made in the data collection model after farmers suggested more intuitive methods of data input. Finally, the tool was officially launched in May 2017.

The process of designing a tool for use at a regional level is quite complex. By the end of this process, seven countries were included (Costa Rica, the Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua, and Panama), each of which has distinct cultural and technical characteristics and expectations, despite their geographical proximity. Due to this diversity, the process of design and development, which began in 2016, was extended across 18 months until DAI achieved the desired tool (Figure 4).

FIGURE 4: IMPLEMENTATION TIMELINE FOR COFFEE CLOUD

NASA International Space Apps Challenge Hackathon

MAR 2017

JUL 2016

Design thinking workshops to engage users

Technology Used

Coffee Cloud was developed on an open-source basis using MEAN Stack technology (MongoDB, ExpressJS, AngularJS, and NodeJS), a collection of JavaScript-based technologies. This development stack ensures the entire platform would be agile and easy to expand and improve.

Taking into account the need for replication of the tool in other countries around the region, the application was published under the Massachusetts Institute of Technology's permissive, free license for computer software, which imposes few limitations on code reuse and strong general license compatibility (Open Source Initiative, 2019).

JUN 2017

Consultant team including agrometeorologist and three software developers

DEC 2017

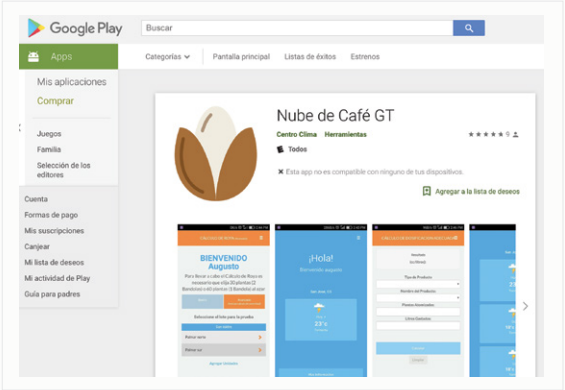
Public version launches on Google Play and Apple Store

JUL 2017

Trainings in Guatemala

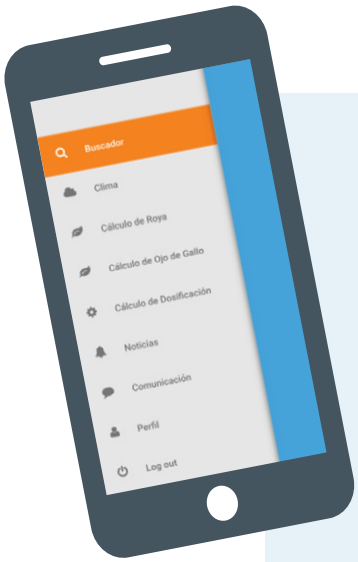
SEPT 2017

Test version published on Google Play



Use of the Tool

Coffee Cloud's success is partly due to its wide-ranging functionality and customizability based on the needs of each national coffee institute, including bidirectional communication, data history, climate information, and information on farmers and crop management. Taking into account all of these functions, DAI developed modules for coffee rust, *ojo de gallo*, pest prevention, extension visits, and vulnerability mitigation.

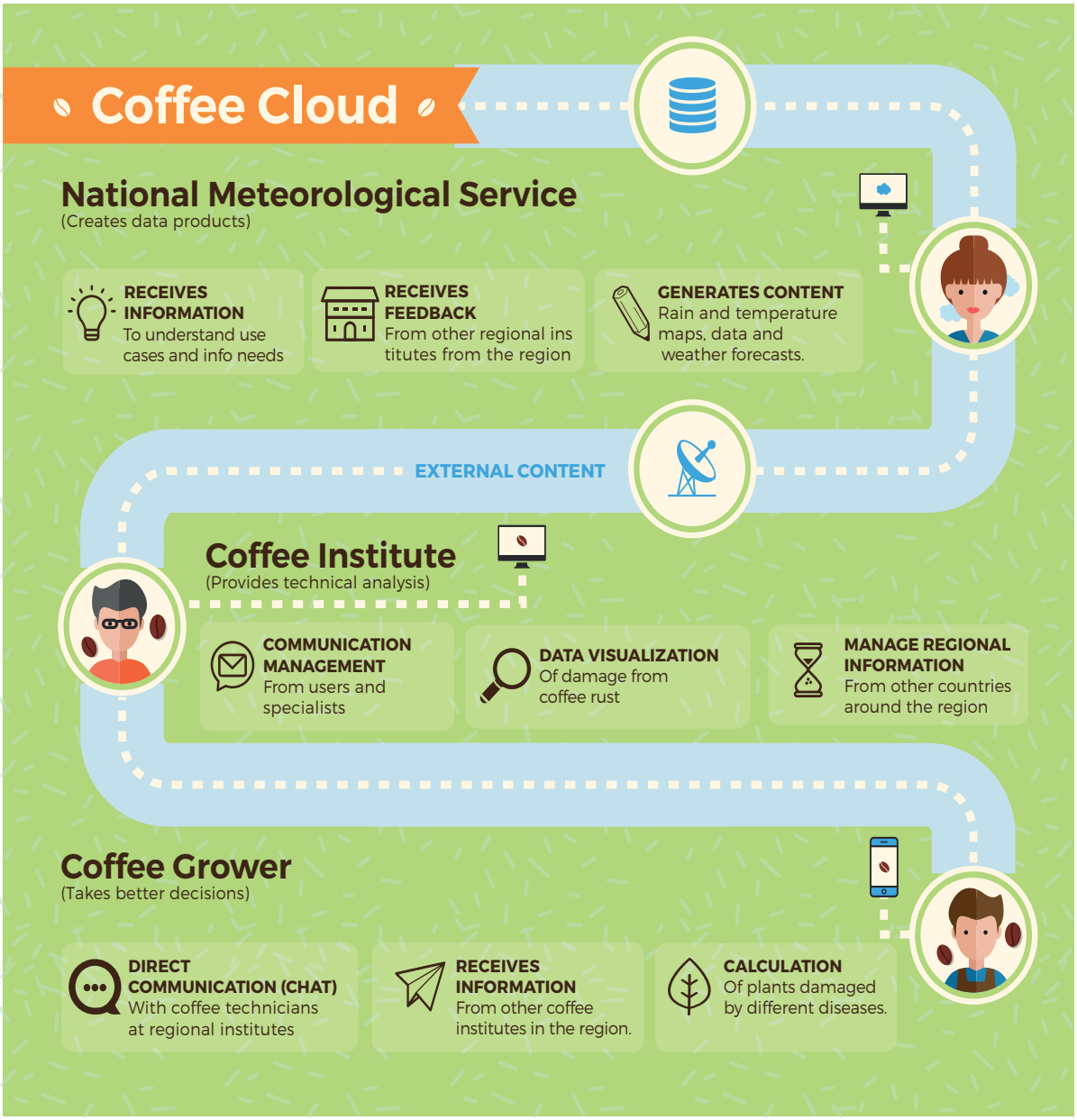


COFFEE CLOUD MODULES

- **Coffee rust calculator:** Using the total count of leaves and the count of those leaves affected, the incidence of disease is calculated and recommendations are made to the farmer, depending on the season.
- ***Ojo de gallo:*** Using the total count of fruit and number of fruits affected, the incidence of disease is calculated and recommendations are made, according to the time of the year.
- **Pest prevention:** In three basic steps, coffee growers are shown the best ways to apply agrochemicals.
- **Visit tracker:** This module tracks field technicians' visits to Coffee Cloud users' farms and keeps notes within the application.
- **Vulnerability:** The specific risk to each farmers' crop is calculated by means of a methodology validated by CATIE.

The tool is designed to be administered at a national or regional level, based on the management capacity of the organization that implements it. Currently, Coffee Cloud has more than 5,000 active users in Guatemala, Honduras, El Salvador, and Costa Rica. The tool is most powerful when linked to other key actors in the agricultural ecosystem—such as technicians and coffee analysts at the national coffee institutes, as well as meteorologists and climatologists—for the purpose of analyzing information shared by farmers and providing recommendations based on that information (Figure 5).

FIGURE 5. COFFEE CLOUD INFORMATION FLOWS



Source: RCCP, 2017

One of RCCP's goals was to distribute climate information among coffee farmers and thereby reduce the incidence of crop disease across the entire Central American region. However, the design process revealed that simply disseminating climate information does not guarantee that Coffee Cloud will have its intended impact. So, DAI presented the tool to farmers not only as a source of key climate information, but also as a series of modules to help them more effectively manage their coffee farms.

Strategic Alliances

Upon launch, Coffee Cloud's wide-ranging applicability and replicability drew the attention of the private sector, international organizations, and other donors.

Institutions that Contributed to Coffee Cloud

Coffee Cloud won the support of various institutions and organizations that have since contributed resources to improve the platform (see Figure 6). This support was not channeled through DAI, but rather provided by partners.

FIGURE 6. ORGANIZATIONS AND ASSISTANCE RECEIVED TO IMPROVE COFFEE CLOUD

Organization	Assistance	Results
National Coffee Association of Guatemala (ANACAFE)	Provided technical experience and human resources for the design and development of the application, and the establishment of a feedback mechanism	Adopted the project and included it in its institutional sustainability plan, assigning funds for its maintenance and development
Costa Rican Coffee Institute (ICAFE)	Offered technical experience in the biological and physiological management of coffee rust, and participated as one of the experimental users of the tool	Through GIZ, supported the integration of Coffee Cloud into its systems
Gesellschaft für Internationale Zusammenarbeit (GIZ)	Through ICAFE, supported the integration of the tool at the institutional level	Integrated the tool into its institutional databases
UTZ (Coffee Certification Program)	Through ANACAFE, this Dutch agricultural cooperation and certification organization provided funds to improve the application	Supported training and improvements in the use of Coffee Cloud
Inter-American Development Bank (IDB)	Through its Multilateral Investment Fund (MIF), the IDB established an initiative with ANACAFE and provided funding to support the initiative	Supported activities to improve the application in Guatemala
Ministry of Environment and Natural Resources of Guatemala (MARN)	Through its Environmental Observatory, MARN assisted with access to information outputs for the version of the tool in Guatemala	Provided meteorological information at national and regional level
National Institute of Seismology, Volcanology, Meteorology and Hydrology of Guatemala (INSIVUMEH)	Provided access to weather information in Guatemala	Provided meteorological information at national and regional level
Weather Underground / Clima Ya	Provided real-time and short-term forecasts for the Coffee Cloud mobile application in all its versions	Provided information and weather data in real time

A Coalition Model

Since inception, this project has mirrored the Global Development Alliance (GDA) partnership mechanism, in which funding from USAID is complemented by private businesses with an interest in the impact of the work. Under this model, partners work together to develop and apply resources to promote targeted business interests as they align with local economic development priorities. The GDA model has been implemented in this sector through an alliance in which ANACAFE invested funds to complement USAID's investment through RCCP, with the aim of achieving sustainability, adoption, and promotion of Cloud Coffee in Guatemala.

The success and sustainability of the tool are the result of a development process that engaged the end users closely, taking into account their strengths and weaknesses.

Other Sustainability Models

When a solution is too expensive for farmers, it fails. Accordingly, in addition to the development assistance provided through RCCP and other mechanisms of support to Coffee Cloud, a number of other support mechanisms were applied:

Sponsorship: In the search for sustainability, sponsorships are one area of opportunity that makers of tools like this can explore for innovative partnerships. Certain coffee and agrochemical companies showed some interest in sponsoring the application given their interest in early warning of disease, proper crop management, and the relationship between disease and the price of coffee. However, this interest has not yet resulted in concrete sponsorship action.

Custom modules: Some coffee-related organizations have also created their own information modules using the application's open source code, based on their work with coffee farmers in the field.

Development community: Coffee Cloud is demand-driven and its impact can be measured in its adoption and use. A key part of this success has been the community of people and institutions that participated in its development. An online community is defined by flat hierarchy and the ability of its users to voluntarily organize around the achievement of a goal. In the case of Coffee Cloud, community members were highly organized, to the point that their operational efficiency often mirrored that of a traditional hierarchical organization.

A Regional Vision Applied Locally

Although Coffee Cloud was born of needs across the region, the engagement and local development process had to be customized for each country, as each country presents unique cultural characteristics and governance mechanisms. Each country's coffee institute hosts periodic forums, and it is in these forums that the Coffee Cloud platform has been shared, its data promulgated, and cross-regional measures discussed and jointly adopted.

After DAI launched the application in Guatemala and Costa Rica, other countries took note of the system's strengths: its modular design, the fact that it allows each host organization significant control over what information is shared with which actors, and the ease with which it can be improved and updated. Based on this observation, El Salvador and Honduras expressed interest and implemented Coffee Cloud. Guatemala's adaptation is a strong example of how to improve and extend the tool, as the country—faced with the growth of other crop diseases—has invested to expand the crop protection module. Also, as part of its work on the development of a regional early warning network, the Central American Program for Unified Management of Coffee Rust (PROCAGICA) is considering using Coffee Cloud to monitor and evaluate the disease.

DAI's application of human-centered design; rapid implementation, iteration, and validation; and user engagement yielded the expected results: a project that has expanded gradually and whose users have adopted the tool as their own. At the June 2018 *Cracking the Nut* conference in Guatemala, USAID/Guatemala recognized Coffee Cloud as emblematic of the impact digital tools can have in the development of agriculture in that country.

The Future of Coffee Cloud

Coffee Cloud's managers are constantly improving the tool, creating new modules and adaptations to better tailor its information to the interests of each of their organizations.

Other institutions in the agricultural field—including the basic grains and cocoa sectors—have expressed interest in adapting Coffee Cloud to their products and ecosystems, given the easy implementation of the tool and the opportunity to tailor it to the agronomic interests of each crop in each environment.

Additionally, various initiatives using blockchain—a database structure in which data is grouped into a transparent, immutable series—to improve the traceability of coffee have shown interest in using Coffee Cloud as a way to access niche users. However, the decision to implement and expand Cloud Coffee remains in the hands of its administrators in each country.

DAI abides by the Principles for Digital Development, including the mandate to "reuse and improve," where projects are encouraged to adapt existing products, resources, and approaches to their unique circumstance, rather than starting from scratch. In line with this principle, DAI hopes Coffee Cloud can be adapted and replicated in other projects and sectors, so that the international development community can continue to learn, improve, and generate impact for the world's marginalized populations.

Coffee Cloud was financed by the Government of the United States. Its code is open source and scalable.

Coffee Cloud: Precision ag at the touch of a button

Additional Resources

Important Links

Internet address: http://www.coffeecloudapp.com

GitHub repository for Coffee Cloud Project: https://github.com/accionclima1/coffeecloud-anacafe

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ACKNOWLEDGEMENTS

The author wishes to thank the following people and institutions:

Kristen Roggemann, Galia Nurko, and other colleagues in DAI's Center for Digital Acceleration for their invaluable contributions and unconditional support.

Roberto Prado, for editing the document in its original Spanish and Steven O'Connor for editing the English version.

Adam Fivenson, for translating the document to English from its original Spanish.

The technical team and implementers of the Regional Climate Change Program (RCCP), for their trust and close collaboration, as well as the follow-up to the implementation of Coffee Cloud.

The Tropical Agricultural Research and Higher Education Center (CATIE), particularly Ana Deisy Lopez, Celina Mena, and Luis Diego Chinchilla.

Miguel Barquero, from the Coffee Institute of Costa Rica (ICAFE), for his important contributions.

The National Coffee Association of Guatemala (ANACAFE), especially Mario Chocooj, for supporting and believing in the initiative from idea to launch. Coffee Cloud would not have been possible without his collaboration.

Finally, the American people and the U.S. Agency for International Development, particularly its Regional Mission for Central America (USAID/CAM), for promoting this initiative.

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