

Voluntary Report – Voluntary - Public Distribution

Date: August 31, 2021

Report Number: CO2021-0019

Report Name: Cacao for Peace Update 2018 to 2020 - Harvest Time

Country: Colombia

Post: Bogota

Report Category: Policy and Program Announcements, Market Development Reports

Prepared By: FAS Bogota Staff

Approved By: Casey Bean

Report Highlights:

On January 15, 2016, USDA and USAID executed a participating agency program agreement (PAPA) titled Cacao for Peace. The objective of the project is to improve the cacao value chain in Colombia by strengthening key agricultural institutions in the public and private sectors. From July 2018 to December 2020, many of CfP's activities produced positive outcomes for the Colombian cacao sector. The initiative's agricultural extension efforts quadrupled producer yields. CfP sponsored educational and research opportunities for five Colombian professionals with master's degrees pursuing PhDs. CfP's cooperative research launched a Geographical Information System (GIS) web application to optimize cacao production in the Sierra Nevada de Santa Marta region. The program's institutional technical assistance area produced an analytical study of the cacao supply chain, receiving over 137,000 views. Until December 2020, CfP has leveraged \$1.9 million from various partners to complement its mission.

Contents

Background Information	3
Program Overview	3
Geography	4
Partners	5
Agricultural Extension	6
Education	9
Cooperative Research	10
Institutional Technical Assistance	14

Background Information

Cacao for Peace (CfP) is a 5-year, \$5 million capacity-building program funded by USAID-Colombia that began in January 2016. CfP aims to strengthen Colombia's vital agricultural institutions for cacao production in the public and private sectors. The program targets four capacity-building areas including: 1) Agricultural Extension; 2) Education; 3) Cooperative Research; and 4) Institutional Technical Assistance. With USAID funding, the initiative leverages USDA's technical expertise and resources to implement innovative capacity-building activities. As the lead implementer of Cacao for Peace, USDA-FAS possesses the agency to identify and deploy experts from USDA agencies, U.S. land grant universities, and other international and local institutions.

CfP seeks to make Colombia a world leader in cacao production. Doing so provides the multi-billion-dollar U.S. chocolate industry a new and reliable supplier of cacao as an alternative to West African producers. Making Colombia a top cacao producer also provides Colombian farmers with a viable alternative to illicit crop cultivation. Bolstering Colombia's cacao production capabilities also boosts the nation's rural economy, benefits the environment, and contributes to the Colombian peace process.

While cacao is native to the Andean region, Colombia lags substantially behind top West African cacao producers. In 2020, the Ivory Coast produced 2,034 of the 4,724 tons of cacao produced worldwide. In comparison, Colombia grew approximately 63 tons of cacao. While the average cacao yield in Colombia is low at 450 kg/ha, industry experts believe that cacao is an underdeveloped commodity in Colombia with potential to increase in both average yield and global market share.¹ Violence and lawlessness have negatively impacted agricultural investments and growth in rural Colombia. Growth in the cacao sector, assisted through programs like CfP, has substantial promise for being an engine for job creation and inclusive economic expansion in Colombia. Small-scale farmers with low incomes consist of most Colombian cacao producers. According to Fedecacao, the Colombian National Federation of Cacaoteros, approximately 65,000 cacao family producers are operating in Colombia. Fedecacao estimates that the cacao industry is responsible for employing 165,000 workers directly and indirectly. As cacao comprises a critical cornerstone within the rural economy of Colombia, increasing cacao yields and cacao farmers' incomes represents a strong indicator that supporting the cacao industry provides opportunities for rural and economic development.

Program Overview

CfP has three high-level goals: 1) boost cacao output and exports from Colombia to the United States to ensure the U.S. confectionery industry continues to have a reliable source of cacao, 2) develop the U.S. fine flavor chocolate market through increased access to fine flavor and fine aroma Colombian cacao and 3) contribute to rural stability and peace in Colombia. To achieve these goals, CfP will strengthen Colombia's public and private institutions in the cacao sector by:

¹ Purdue University and CIAT, Cacao for Peace. "An Analysis of the Supply Chain of Cacao in Colombia," October 2018, Page 99.

- 1) increasing in-country capacity for agricultural extension services to increase yields and cacao farmer incomes;
- 2) sponsoring educational opportunities for cacao researchers to obtain post-graduate degrees and training;
- 3) strengthening local cacao research capacity for the development of new practices and inputs; and
- 4) providing institutional, technical assistance to promote self-reliance.

By meeting its three high-level goals, CfP expands longer-term opportunities in Colombia's cacao sector, deliberately employing methods that spread the benefits of investments, economic growth, and development to help Colombia's cacao become more competitive and profitable. In addition, the U.S. chocolate industry will benefit from additional access to fine aroma, fine flavor cacao, which is a differentiator for the industry's products.

Geography

CfP activities take place in the United States and Colombia.

CfP conducts agricultural extension in the Sierra Nevada de Santa Marta region (Guajira and Magdalena) and Tierralta and Valencia, Córdoba.

Education activities take place at Pennsylvania State University and Purdue University.

Research activities are underway at the USDA Agricultural Research Service (ARS) Center in Beltsville, Maryland; Mosquera, Cundinamarca; Rionegro, Santander; and Palmira, Valle del Cauca.



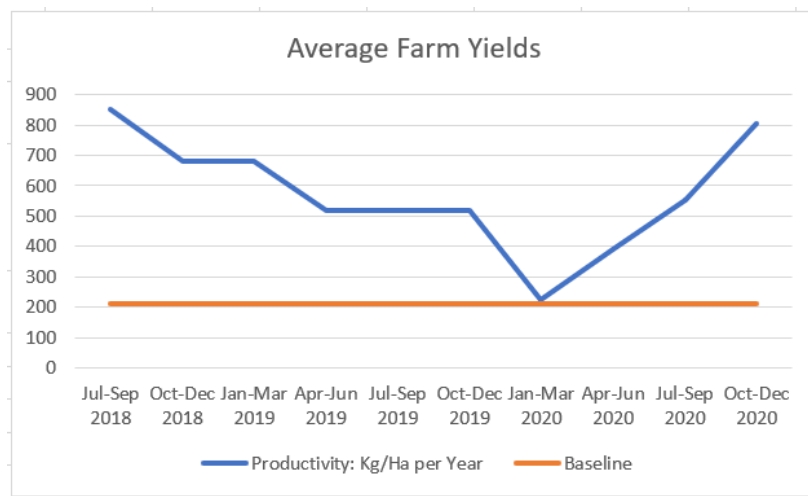
Figure 1 – Activities in Colombia

Partners

Partner	Agricultural Extension	Education	Cooperative Research	Technical Assistance
Agrosavia – Colombian Agricultural Research Service within Ministry of Agriculture and Rural Development		✓	✓	
Agricultural Research Service (USDA)		✓	✓	✓
Alliance Bioversity International CIAT	✓		✓	✓
Colfuturo		✓		
Fedecacao	✓			
Fulbright-Colombia		✓	✓	
Natural Resources Conservation Service (USDA)			✓	✓
Peace Corps	✓			
Pennsylvania State University		✓	✓	✓
Purdue University		✓		✓
Trade and Regulatory Capacity Building (FAS/Global Programs)			✓	✓
United Nations Office on Drugs and Crime	✓			

Agricultural Extension

From July 2018 to December 2020, CfP-assisted farms' cacao yields fluctuated significantly due to a prolonged drought that impacted the Sierra Nevada de Santa Marta region. In September of 2018, CfP farms yielded 852 kg/ha per year on average, four times more than the baseline of 211 kg/ha per year. Due to the drought, average yields declined, bottoming out at 221 kg/ha per year in March 2020. However, due to the CfP extension team's efforts and more favorable weather conditions, by December 2020, average yields had increased to 804 kg/ha per year. Projections suggest yields may continue increasing up to 1,000 kg/ha per year.



Cacao farmer training and capacity building for agricultural extension: In 2016, CfP initiated farmer training and agricultural extension activities in a collaborative effort between the United Nations Office on Drugs and Crime (UNODC), the Colombian National Federation of Cacaoters (Fedecacao), and the U.S. Peace Corps. CfP worked with the UNODC through November of 2019, then transitioned to working with the Alliance of Bioersivity International, CIAT, and Fedecaco. CfP collaborated with Peace Corps until the COVID-19 pandemic outbreak in March 2020, when the Peace Corps evacuated volunteers.

The cacao farmer communities assisted by the program have significantly benefitted from the continuous trainings over the past four years. Notable extension activities during the 30-month reporting period included on-site farmer training and off-site group training delivered in-person or via phone. Training activities cover good agricultural practices, including: soil sample collection and analysis, soil conservation, fertilizer selection and application, irrigation, pruning, grafting, pollination, integrated pest and disease management, cacao harvest and



Photo: CfP supported cacao producer with his harvest.

post-harvest management, cacao nursery development, records management, climate change adaptation, annual work plan development, and cacao association administration.

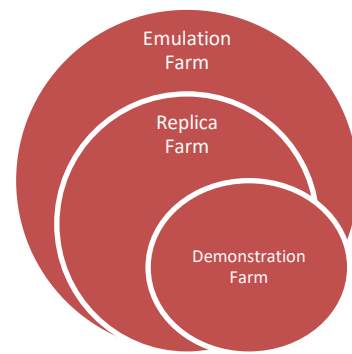
In March 2020, CfP transitioned to a virtual extension model, providing virtual technical assistance to adapt to the COVID-19 pandemic. Virtual technical assistance activities include telephone and video calls to cacao producers, to track and update cacao farm profiles, which include farm diagnostics, signed farmer commitments, and cultivation recommendations. In response to the prolonged drought, the CfP extension team prioritized efforts to help farmers manage plant water stress by providing technical guidance on implementing agricultural practices like strategic pruning, no-till techniques for soil moisture maximization, strategic fertilizer application, as well as sapling bag and shade cloth use. At the end of the drought, it was clear that at least 75 percent of farmers needed to replant. In addition, irrigation workshops, training, and supplies were provided to CfP-supported farms to cushion yields during volatile weather. In March 2020, improved weather conditions and CfP farm-tailored technical assistance contributed to a quadrupling of the average baseline yield.

From March to December 2020, the CfP extension team made 903 phone/video calls to farmers. These calls ensured cacao crop needs were met and resulted in cacao farmers implementing 378 targeted interventions. As a testament to the farmers' commitment to CfP, farmers invested \$13,000 of their resources in farm inputs to support the interventions. These interventions align with the CfP extension model and allow farmers to be eligible for Good Agricultural Practices (BPA, Spanish acronym) certification from the Colombian Ministry of Agriculture. BPA certification sets up farmers for the successful commercialization of their cacao harvest.

Cacao Innovation Farms (CIFs): In Colombia, public or private cacao demonstration farms conduct extension activities. Demonstration farms benefit from abundant resources, ideal cultivation conditions, and are not constrained by cacao's seasonality. Cacao farmers in Colombia operate on limited budgets, face challenging conditions, and depend on rain patterns. Consequently, farmers find it difficult to relate to traditional demonstration farms, and technology adoption rates are low.

CfP-supported farms, otherwise known as cacao innovation farms (CIFs), rely on the impute and involvement of farmers to improve the understanding, implementation, and use of new cacao cultivation technology on their land. CIFs receive support from multiple government and non-government actors including: USAID, USDA, UNODC, the Alliance of Bioversity International and CIAT, U.S. Peace Corps, U.S. Land Grant Universities, Fedecacao and others. These actors deploy their own resources in a coordinated and strategic manner. Currently, CIFs serve as demonstration and training centers for the cacao producers. They promote agronomic practices throughout the cacao season and economic development in the surrounding communities. CfP hopes that in the future, the farms will serve as on-site platforms for extension activities led by the international community or Colombian public or private sectors actors.

CfP's CIF model is centered around a three-layered approach comprising of demonstration farms at the center, followed by replica farms and finally emulation farms. CfP demonstration farms receive CfP training, technical assistance, and agricultural inputs such as fertilizer and tools. Replica farms are farms that receive CfP tr



Graphic: CfP extension model

inputs. Emulation farms neighbor CfP demonstration and replica farms and have adopted CfP extension training, technical assistance, and input practices. One crucial aspect of CIFs is that CfP only supports one hectare of the farm. Doing so encourages technology adoption on farms while discouraging reliance on the program. In June 2020, CfP surpassed its target of 105 farms, with 110 farms signed on to the program.

Support for the Cacao National Strategy – Food Safety Chapter: In November 2018, the government of Colombia (GoC) developed a “National Strategy for the Mitigation of Cadmium in Cacao.” The strategy seeks to address the food safety issue of cadmium absorption by cacao that negatively impacts cacao exports. Based on USDA-FAS feedback, the GoC renamed the “National Cacao Strategy – Food Safety Chapter (NCS-FSC)” to encompass all food safety issues related to the cacao supply chain. CfP supports the NCS-FSC’s traceability and food safety areas through agricultural extension activities. CfP provides technical support and consultations to create the following products and tools:

Food Safety Booklet: Food safety is vital to ensuring the health of consumers. Deploying food safety measures in the cacao sector enables cacao producers to meet sanitary standards and access domestic and international markets. Food safety is an interdisciplinary scientific field (i.e., chemistry, microbiology, statistics, epidemiology, public health, and food science, among others) focused on improving production, processing, handling, storage, transport, and food consumption to prevent food-borne diseases. In March 2020, a CfP consultant created a digital and printed version of the *Food Safety Booklet, Basic and Technical Concepts* to train farmers and stakeholders on concepts related to agri-food chains, food safety, risks and hazards, risk management, and institutions associated with the sanitary and phytosanitary system (SPS). The *Food Safety Booklet* is two booklets in one. The first booklet contains information geared towards farmers and the second tailors to technical experts. The digital version was disseminated to CfP-supported farmers with email access. In 2021, the print version will be finalized, printed, and distributed.

Food Safety Survey: To assess cacao producers’ knowledge of food safety, CfP carried out a phone survey. CfP conducted the survey, with support from the CfP extension team, determining that farmers require additional training to understand food safety issues, including cadmium absorption by cacao.

Food Safety Training (Workshops): In reacting to the COVID-19 global pandemic, CfP redesigned food safety workshops to be delivered virtually. CfP virtual workshops seek to train farmers on basic food safety concepts, preventive food safety systems, and the use of the CfP *Food Safety Booklet*. Training cacao farmers on preventive food safety systems is important not only for the farmers’ personal and economic benefits but also for their participation as a key component of the cacao supply chain. By training cacao farmers on the booklet, CfP aims to increase literacy around food safety issues and enable farmers to meet domestic and international sanitary standards, which may be a barrier to market access. Cacao producers’ increased access to markets may increase cacao producer incomes and promote stability and peace in rural regions of Colombia. In 2021, the CfP food safety team will conduct a pilot workshop to test the virtual model’s ability to reach farmers in remote areas of the country using a curriculum built around pre-recorded videos, WhatsApp, and other virtual learning tools. CfP will be rolled out at a workshop in Q2 FY21.

Education

In collaboration with Fulbright-Colombia, Pennsylvania State University (PSU), Colfuturo, and Purdue University, CFP has sponsored five Colombian professionals through their graduate education. An additional \$530,000 in funding has also been reserved for three additional graduates to pursue PhDs, using PSU funds. CFP also provides educational opportunities for cacao researchers and stakeholders to obtain post-graduate degrees and training. To improve access to post-graduate degrees and training in cacao research in Colombia, CFP partners with Fulbright-Colombia and Colfuturo (a Colombian non-profit



Photo: CFP-Fulbright scholars at Pennsylvania State University's commencement.

organization that promotes post-graduate degrees) to offer seven Colombian cacao research scholarships. These scholarships enable Colombian researchers/students to attend U.S. universities for

post-graduate degrees in academic subjects that support CFP objectives. The students' research seeks solutions to Colombia's cacao sector challenges. Scholars work with advisors to publish their studies. CFP incentivizes scholars to return to Colombia after their studies to work in the cacao sector. CFP facilitates regular calls between scholars to avoid duplicity and build on existing research. Financially, CFP sets aside funding to sponsor all five master's degree recipients partially. Additionally, Purdue and PSU have set aside funding to support the PhD candidates.

Cacao for Peace – Fulbright – Pennsylvania State University Scholarship (CFP-Fulbright-PSU)

Three CFP-Fulbright-PSU scholarship recipients completed their studies in the summer of 2019. They received their master's degrees in: Soil Sciences, Agricultural Extension and Education, and Horticulture. Two students combined their studies with a Master's in Science degree in International Agricultural Development, achieving a dual-title degree. The CFP-PSU-Fulbright Scholars contribute to CFP objectives through their theses research. 2019 CFP scholars' thesis topics include:

- Evolution of effector and other pathogenicity related genes in frosty pod rot fungus *Moniliophthora roreri* causing frosty root rot disease in *Theobroma cacao*;
- Evaluation of Cd remediation materials, plant indicators and mapping protocol for optimized cacao (*Theobroma cacao* L.) production;
- Evaluation of cacao projects in Colombia to explain their success drivers: a case study of Productive Partnership (PAAP).

All students submitted prepared publications at the end of Spring 2020.

Cacao for Peace – Colfuturo – Purdue University Scholarship (CFP-Colfuturo-Purdue)

Two CFP-Colfuturo scholarship recipients, attending Purdue University, completed their studies and research projects in August of 2020, receiving Master's in Science degrees in Agricultural and Biological Engineering and Horticulture and Landscape Architecture. One of these students is

continuing to a Ph.D. In addition, a third student is currently enrolled in a Ph.D. program and will graduate in the summer of 2021. All students transitioned to a virtual learning environment at the onset of the COVID-19 global pandemic. Like the CFP-Fulbright-PSU scholars, the CFP-Colfuturo-Purdue scholars' theses support the CFP objectives as demonstrated by their thesis topics.

CFP scholars' thesis topics include:

- Identification of key cocoa powder material attributes to improve Colombian cocoa powder performance and stability;
- Extension education as an approach to retain youth in rural cacao areas in Colombia;
- Methods for reducing the potential for cadmium uptake by cacao in Colombia.

Cooperative Research

One of USDA's greatest assets is its agricultural research capacity and its partnership network. CFP leverages this capacity and partner network to work on Colombia's most pressing cacao research needs. At the outset of the program, CFP partners PSU and AmCham Barranquilla conducted a cacao research symposium in Barranquilla, Colombia. The symposium assembled Colombian cacao researchers and industry stakeholders to identify the top cacao research priorities for Colombia. Ultimately, symposium attendees determined that research should prioritize cadmium mitigation and cacao yield increases moving forward. CFP utilized this research agenda to guide its programming. CFP designed three cacao research projects. These include:

- 1) collaboration between USDA's Agricultural Research Service (ARS) and the Colombian Agricultural Research Service (Agrosavia) to address these two priorities;
 - creation of a geographical information system (GIS) web application for optimized cacao production;
 - gene-editing project to eliminate the absorption of cadmium by cacao.

Agrosavia – ARS Collaborative Research



Photo: Former director general of Agrosavia, Juan Lucas Restrepo (Left) with Dr. Lyndel Meinhardt, USDA-ARS Cacao Research Leader of the Sustainable Perennial Crops Lab

CFP facilitated the partnership between USDA's Agricultural Research Service (ARS) and the Colombian Agricultural Research Service (Agrosavia) through a collaborative research agreement. The agreement outlines four main proposals for ARS and Agrosavia collaborative research. These include 1) a genetic analysis of Colombia's national cacao germplasm bank (housed at Agrosavia), 2) breeding activities to generate new cacao varieties with improved traits, such as high productivity, disease resistance, and limited cadmium uptake, including the evaluation of ARS cacao clones in Colombia, 3)

development of a cacao disease pathogen diversity scheme 4) programming to improve cadmium mitigation. In January of 2019, CFP signed a

cooperative agreement with Agrosavia to fund Colombia's specified cacao research areas. To achieve this, ARS signed an interagency contract with Agrosavia, agreeing to provide technical assistance. Agrosavia and ARS researchers are currently working together on the four agreed-upon activities.

Activity 1: Assess genetic diversity of Agrosavia's entire cacao collection (Germplasm Bank Reclassification).

Analyzing data from a Colombian National Cacao Germplasm Bank, ARS determined Agrosavia miscategorized 22 percent of their germplasm bank. To properly categorize the cacao germplasm bank, Agrosavia sampled the entire bank, collecting over 3,000 cacao leaf samples from its cacao germplasm banks in La Suiza, Santander, and 500 samples cacao germplasm bank in Palmira, Valle del Cauca. Agrosavia sent these samples to an ARS facility in Beltsville, Maryland, U.S., for genetic analysis and genotyping. Correctly classifying Colombia's germplasm bank allows cacao researchers to conduct more accurate field experiments and improve cacao breeding.

Activity 2: Develop breeding activities that will generate new cacao varieties with improved traits, such as high productivity, disease resistance, and limited cadmium uptake. Breeding activities included cacao clones shipped from ARS facilities to Colombia.

ARS researchers are transferring high yield and disease-resistant cacao clones from the U.S. to Colombia, for evaluation by Agrosavia. To support this work, CFP facilitated a material transfer agreement (MTA) between ARS and Agrosavia to transfer the clones. Agrosavia built a special quarantine facility to receive ARS's clones at its Palmira research center, using its own funding. The quarantine facility contains an anteroom and quarantine suite. This addition expands Colombia's ability to grow and breed new cacao varieties. The cacao quarantine facility at Agrosavia is approved by the Colombian Animal and Plant Health Regulatory Agency (ICA, Spanish acronym). The facility is currently growing seedlings that will be grafted onto cacao clones when they arrive. Agrosavia obtained an import permit from ICA for the shipment of cacao clones to Colombia. These cacao clones are resistant to *Moniliophthora roreri* (frosty pod), one of Colombia's three primary cacao diseases. While COVID-19 postponed the clones' transport to Colombia, ARS is currently seeking USDA Animal and Plant Health Inspection Service (APHIS) inspection to ship the clones to Agrosavia. Cacao clones will be grafted onto cacao plants in the quarantine greenhouse, then evaluated for yield and cacao disease resistance in a test plot at the La Suiza Research Center in Santander. Agrosavia established an agroforestry arrangement composed of temporary and permanent shade trees, 1,400 plantain plants, and 155 mulberry plants to prepare the plot. Once the ICA-established quarantine period is completed, the improved clones will be taken from the grafts and established in this lot.



Photo: Cacao plants in quarantined greenhouse ready to be grafted with USDA-ARS cacao clones. (Palmira, Colombia)

In November of 2020, ARS detected a cacao virus (Cacao Mild Mosaic Virus) in some of their cacao plants housed at ARS's quarantine facility in Miami, Florida. To ensure that the virus is not present in the cacao clones, ARS conducted multiple tests to determine the virus's presence. To date, all tests have been negative. The 26 clones selected to be sent to Agrosavia all tested negative for the virus. The

clones will be shipped to Colombia and housed in Agrosavia's quarantine facility, to be evaluated for one year.

Activity 3: Assess the common diseases of cacao and determine the biodiversity of these disease-causing organisms to understand their underlying biology better and improve disease control measures.

To study Colombian cacao pathogen diversity and determine the best locations for cacao disease resistance breeding, Agrosavia collected four different pathogens: Frosty Pod, Witches Broom, Black pod rot, and *Rosellinia* sp. In November 2018, Agrosavia researchers executed cacao disease pathogen collection trips focused on understanding pathogen diversity to better combat cacao diseases. Agrosavia collected diseased cacao samples from six farms in the department of Santander. These samples were analyzed to understand their underlying biology better and improve disease control measures. The samples were then processed, creating cacao disease isolates. Due to the Covid-19 lockdown in Colombia, the isolates' analysis was delayed but has resumed. Agrosavia shipped the isolates to ARS for analysis. ARS has since completed the analysis and is awaiting additional isolate samples. Additional collection trips were delayed due to COVID-19, but resumed between October and December of 2020. Samples were collected from the departments of Antioquia, Santander, Guajira, Magdalena, and Cesar.

Isolates were created and shipped to ARS for analysis. Of these samples, 89 isolates originated from *M. rozeri*, 16 isolates originated from *Phytophthora* sp. and 16 isolates originated from *Rosellinia* sp. Agrosavia complied with legal requirements by the National Authority of Environmental Licenses (ANLA, Spanish acronym) to obtain the export permit for the isolates to the United States. These samples were sent to ARS for analysis and will increase Agrosavia's cacao germplasm bank population for better cacao research and breeding. To promote Agrosavia's self-reliance, ARS trained Agrosavia researchers in Beltsville, Maryland, on the methodologies behind nucleic acid extraction to guarantee high-quality genetic analysis on cacao disease.

Activity 4: Cadmium mitigation.

Cadmium is a heavy metal in the soil that is toxic to humans and may be absorbed from the soil by cacao. ARS and Agrosavia designed two experiments that seek to address the issue of cadmium absorption by cacao. The first experiment evaluates four soil amendments for the reduction of cadmium absorption by cacao plants. Soil amendments were added to naturally contaminated soil. Soil samples were taken before amendments are added and 60 days after verifying each amendment's effect on bioavailable cadmium levels. The samples taken are being analyzed at the Agrosavia analytical chemistry laboratory. The second experiment measures cadmium absorption by grafting cacao plants to determine, through a series of physiological evaluations, if certain cacao plants (genotypes) result in cacao pods absorbing less cadmium than others. Grafted rootstocks were subjected to cadmium stress for five months and then evaluated. Presently, the results of the experiment are being analyzed.

In December of 2020, Agrosavia, ARS and University of Florida(UFL) scientists published a [peer-reviewed article](#), *Comparative effectiveness of activated dolomite phosphate rock and biochar for immobilizing cadmium and lead in soils*, in the scientific journal, *Chemosphere*. In their research, the authors analyze the impacts of activated dolomite phosphate rock (DPR), acid-activated dolomite phosphate rock (ADPR), and biochar to on immobilizing metals in two agricultural soils. Executing this article demonstrates the USDA's ability to work collaboratively with its technical agencies and U.S. land grant universities to strengthen the capacity of international researchers on shared challenges.

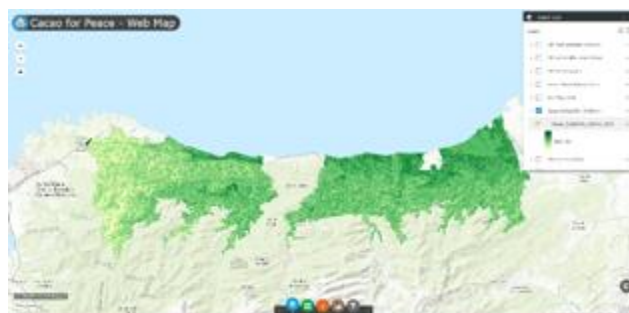
ARS's Dr. V.C. Baligar and Agrosavia's Dr. Andrea Montenegro have been collaborating since 2016, and their collaboration on this article is their latest joint effort. In addition to Dr. Baligar and Dr. Montenegro, Dr. Zhenli He from the University of Florida was brought on to help advance the research and co-author the article. In 2018 CfP funded Dr. Montenegro to travel to UFL and be trained by Dr. He on cadmium identification and analysis.

The article's main findings are listed below:

- The immobilizing effectiveness (immobilization of cadmium and lead) of amendments varied with metal and soil type.
- Activation with humic acid increased the immobilizing power of DPR for cadmium (Cd^{2+}) and lead (Pb^{2+}).
- The immobilization of metals by ADPR is related to increased soil pH and available phosphorus P.

CfP Geographical Information System (GIS) mapping project (6/1/2018 to 12/31/2020)

CfP assembled a team of soil, water, and cacao genetics experts to map a region of Colombia and determine its cacao suitability. The team, led by the Alliance of Bioversity International and CIAT, consisted of scientists from USDA's Natural Resources Conservation Service (NRCS) and Pennsylvania State University, with ARS serving in an advisory role. To complete the project, the team collaborated with Fedecacao, UNODC, Colombia's National Soil Survey Institution (Instituto Augustin Codazzi-IGAC), Agrosavia, and the Rural Agricultural Planning Unit (UPRA, Spanish acronym) of the Colombian Ministry of Agriculture and Rural Development.



Screenshot: Cacao suitability layer of CfP GIS Web Application

The scientists collected and analyzed field samples and created data sets to develop an ArcGIS web application with multiple layers. Layers accessible using the ArcGIS program include cacao suitability, cadmium content, water supply, cacao genetic varieties, and cacao characteristics. The CfP ArcGIS mapping project supports increased cacao production in the three communities located in the Sierra Nevada de Santa Marta region. The application may also support the private sector make informed cultivation decisions and help government officials design informed policies and assistance programs. CfP shared the application with the Colombian government, who have expressed interest in training to develop similar applications.

There is an [English version](#) and a [Spanish version](#) of the web application.

Reduction in Cadmium Absorption by Cacao through Gene Editing

CfP partnered with the Alliance of Bioversity International and CIAT to develop, through genome editing technologies, cacao plant varieties that do not absorb the heavy metal cadmium. These cacao varieties were produced using selective breeding cultivation techniques. As of December 2020, the program identified the gene responsible for cadmium uptake by cacao and is working on producing plants with the gene excluded from their genetic sequence. This project is critical to keeping the Colombian cacao industry in compliance with the January 2019 E.U. Regulations restricting the levels of cadmium content permissible in cocoa powder and chocolate imports. The European Commission introduced Regulation No. 488/2014, which sets maximum levels of cadmium in a range of foodstuffs,

establishing levels ranging from 0.1 to 0.8 mg/kg in cocoa and chocolate products (depending on the product and the percentage of total dry cocoa solids it contains). In California, a warning label is already required on products with more than 4.1 mg of cadmium per daily serving of a single product. Cacao produced in some Latin American countries, including Colombia, suffer from cadmium contamination and are limited in their market access as a result. The development of these cacao cultivars would help to prevent the disruption of cacao exports from Colombia and the corresponding loss of income for cacao smallholders. While COVID-19 delayed this research, progress has continued, and gene-edited plants are expected to be tested for cadmium absorption in a greenhouse setting by 2021.

Institutional Technical Assistance

All CfP activities collaborate with domestic Colombian institutions and actors to promote sustainable capacity building. The four CfP activities target specific institutional technical assistance needs. These needs include:

- Analysis of the Colombian cacao supply chain
- Establishment of maximum residue levels for cacao disease pesticides to prevent trade disruptions
- Cadmium analysis capacity building
- Technical guidance for the Food Safety Chapter of Colombia's National Cacao Strategy

Analysis of the Cacao Supply Chain in Colombia

CfP partnered with Purdue University, the Alliance of Bioversity International and CIAT to conduct an in-depth study of the cacao supply chain in Colombia. During the reporting period, the [English version](#) and the [Spanish version](#) were completed and disseminated via several channels. The versions are available on the [Purdue website](#) and were emailed to all stakeholders in Colombia. The [Spanish version](#) of the study on Purdue's website has been viewed over 137,000 times.

Cacao Disease Control and Maximum Residue Levels (MRLs) Definition

CfP collaborates with Rutgers University's IR-4 project, Agrosavia, and ICA to promote cacao disease control. The activity identifies and tests pesticides to combat cacao diseases and defines maximum residue levels (MRLs) for those pesticides to avoid cacao trade disruptions. CfP funding was used in coordinating pesticide residue field trials that emphasized research quality assurance. Rutgers University supported the project by finalizing the cacao field residue protocol, identifying site locations, application rates, sampling procedures, and timelines. This project assisted Colombian cacao researchers in preparing for future CfP cacao pesticide fieldwork. Additionally, the project has strengthened the country's capacity to scientifically support its sanitary and phytosanitary measures.

Improving Agrosavia's capacity for cadmium analysis

In August 2019, a cadmium laboratory expert was identified to work with Agrosavia's lab on analytical methods. CfP deployed cadmium residue expert Dr. Laurence Maurice to Agrosavia's labs to lead a week-long training. Dr. Maurice trained local staff scientists from Agrosavia and other institutions on the most current cadmium detection methods.

Technical guidance for the Food Safety Chapter of Colombia's National Cacao Strategy (NCS-FSC)

Before establishing the NCS-FSC, CfP identified the following food safety deficiencies in the cacao supply chain. These include:

- Contradictory food safety messaging at both theoretical and practical levels
- A lack of institutional presence in CfP supported departments (Cordoba, Guajira and Magdalena)
- Cacao producer confusion about basic concepts and responsibilities related to food safety
- The absence of food safety training materials
- A lack of knowledge about sanitary and phytosanitary (SPS) measures
- A knowledge gap regarding risk communication

CfP is helping the NCS-FSC address food safety deficiencies and other food safety issues through activities under its Agricultural Extension (page 6), Cooperative Research (pages 9-12), and Institutional Technical Assistance areas. Under Institutional Technical Assistance, CfP supported the NCS-FSC with the several publications. These include:

- A technical document on U.S. and E.U. Sanitary and Phytosanitary Measures (sanitary access requirements)
- A technical risk communication document
- Technical contributions to Colombian government food safety meetings and documents

U.S. and E.U. Sanitary and Phytosanitary Measures

The CfP food safety team created a technical document on U.S. and E.U. Sanitary and Phytosanitary Measures (sanitary access requirements) regarding safety for cacao and its products. Producers must guarantee compliance with international food safety standards ensure access to international markets. Consequently, it is essential to disseminate information that allows producers, entrepreneurs, and the country itself to comply with these standards. Compliance with these standards allows supply chain actors to identify and meet different required sanitary standards and access various markets. The technical document contains requirements and conditions for cacao exports to the U.S. and the E.U. In addition, it identifies institutions knowledgeable on cacao exports to the U.S.

Risk communication

The international perception of Colombian cacao being contaminated with cadmium is due to poor risk communication. Proper risk communication by government officials and private sector representatives is critical to ensuring the cadmium-cacao issue and other food safety issues are properly communicated in the future. CfP's food safety consultancy is preparing a technical document to promote risk communication for cacao supply chain stakeholders in the public and private sectors. This document will be sent to key stakeholders for technical review and feedback and later disseminated widely. The dissemination of this document will educate public and private stakeholders on the importance of communicating sanitary issues properly to prevent negative perceptions of Colombian cacao in the future. The perception of all Colombian cacao being contaminated with cadmium has negatively impacted the Colombian cacao brand. This negative impact may result in reduced incomes for cacao farmers.

Technical Contributions to Food Safety (Cadmium Information System) meetings and technical documents

- CfP's food safety consultant provided technical input on a Cadmium Information System proposal created by the Rural Agricultural Planning Unit (UPRA, Spanish acronym). The proposal consolidates methodologies for collecting, sharing, and using information related to possible external sources of contamination that compromise the food safety of cacao beans. CfP generated multiple proposal observations and recommendations; most of them were considered for the document's final version
- Swisscontact requested CfP input on its technical document "A basic guide to support the implementation of a traceability system." CfP provided input and helped disseminate the document. As a result of these CfP efforts, CfP will be invited to support traceability activities within the framework of the NCS-FSC.

Attachments:

No Attachments.