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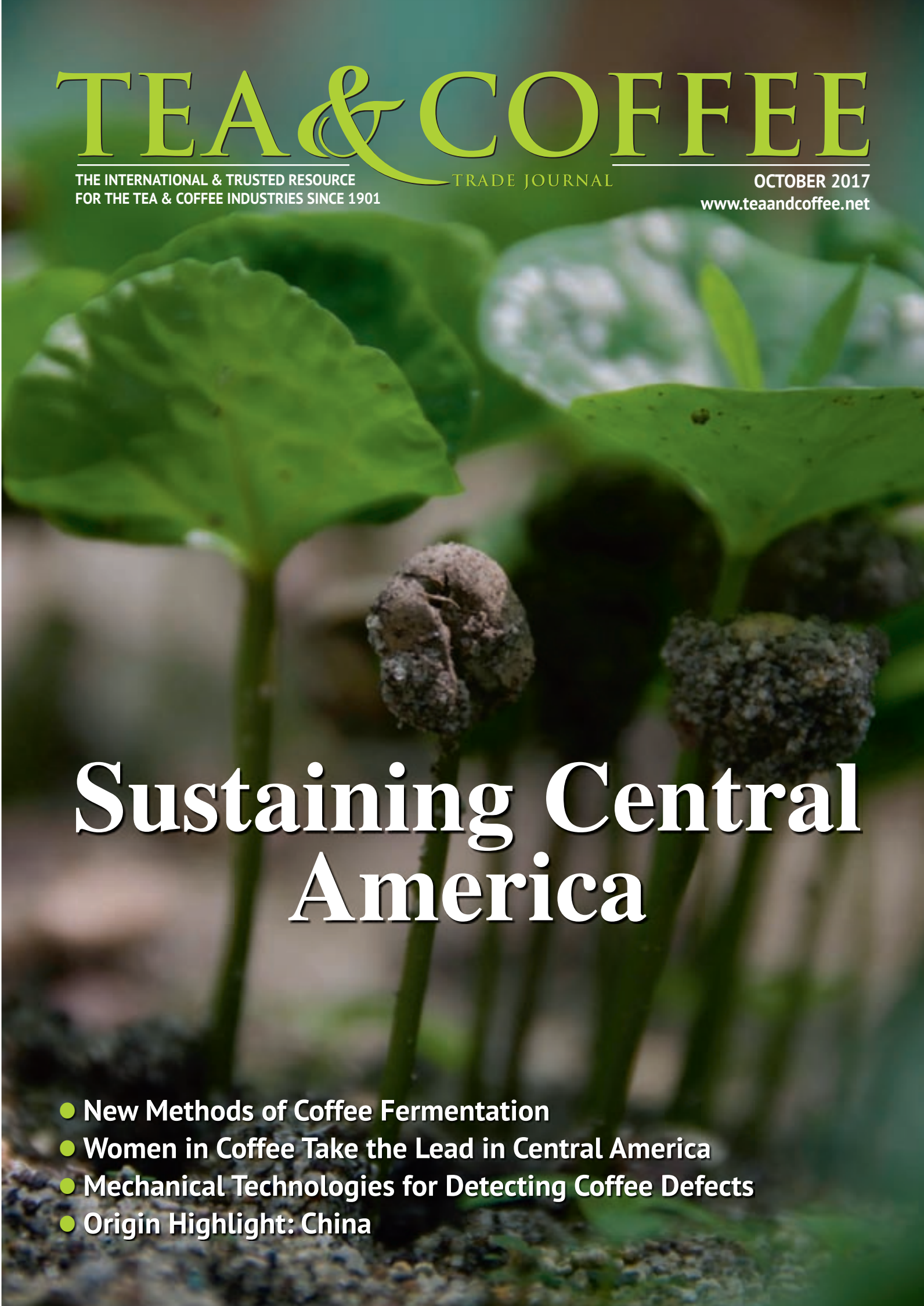

Sustaining Central America

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Central America's coffee growing regions consistently garner attention for exceptional cup quality and unique flavours. While responses to climate change are inherently location-specific, as adaptations must address the immediate conditions of each farm, the six nations of Central America are demonstrating how the collaborative development of customizable tools empowers everyone to adjust production techniques for the long term.

By Rachel Northrop

Sustaining Central America

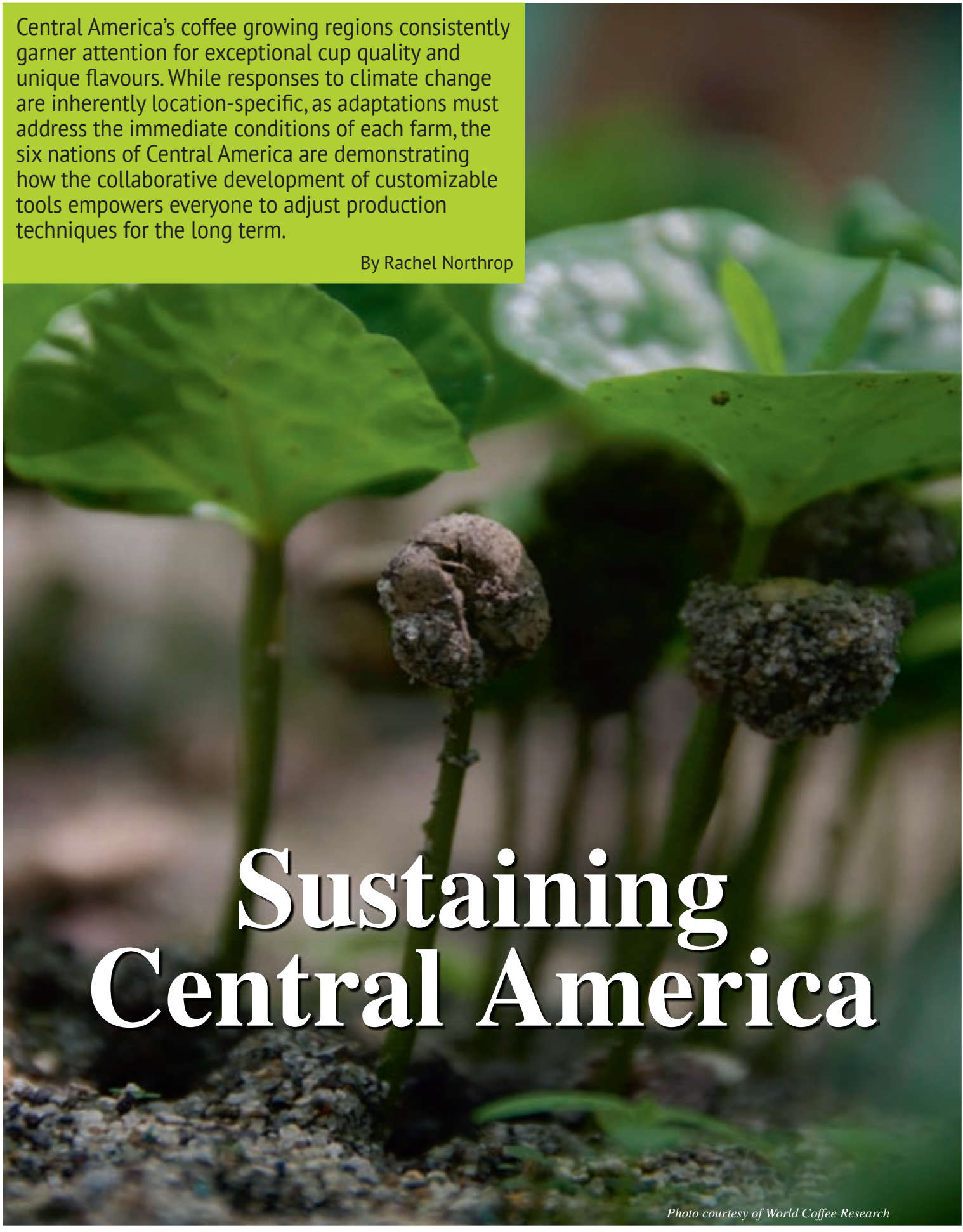

Photo courtesy of World Coffee Research

Central America's mountainous coffee lands are characterized by smallholder production, where activities like composting coffee cherry pulp to protect freshwater sources remain crucial to the sustainability of individual farms. Additionally, new institutional momentum is generating a critical mass of research to implement sustainable practices starting with the seeds and soil.

Breeding Strategic Seeds

Since its founding in 2012, World Coffee Research has been leading the effort to correct the paucity of genetic research in coffee by studying the performance of different varietals grown in different climates and implementing an intensive breeding program to enrich coffee's dangerously narrow genetic diversity.

Their first project was the *Catalog of Coffee Varieties of Mesoamerica and the Caribbean*, outlining the basic phenotypic characteristics and agronomic needs of each variety. Hanna Neuschwander, communications director for College Station, Texas-based World Coffee Research, explained that the catalog "puts information into hands of producers to allow them to make informed, professional decisions."

Four additional projects build on the data presented in the catalogue to diversify and improve coffee seed stock and farming practices through the Core Collection, the Central America Breeding Hub, the Seed Verification Program, and molecular breeding.

The Core Collection is a set of one hundred varieties selected by World Coffee Research from nearly 1,000 Arabicas housed at CATIE (Tropical Agriculture Research and Higher Education Centre, Turrialba, Costa Rica) because of their genetic diversity. Plants from the Core Collection will be used in breeding new varieties, and are especially useful for creating new F1 hybrid varieties, which benefit from maximum genetic distance between parent plants. Seedlings from the collection are available for distribution to national coffee institutes.

In Central America, WCR has also set up a breeding hub, collaborating with national coffee organizations on a high-tech breeding program for the region. The hub's first success is the creation of 46 F1 hybrids (created by crossing eight mother plants from the genetically diverse Core Collection with five established varieties, including Geisha, Marsellesa and Obata), which are now being evaluated at the WCR farm Flor Amarilla in Santa Ana, El Salvador, Starbucks' Hacienda Alsacia research farm in Poas de Alajuela, Costa Rica, and Hacienda Aquiarres in Turrialba, Costa Rica. The top-performing F1 hybrid varieties will be released for farmers in the region by 2023.

Photo courtesy of Coffee & Climate

Honduras Coffee & Climate farmers collect data.

To ensure that farmers can access healthy and genetically pure plants, WCR has also launched the first global standard for seed/plant quality, called WCR Verified. "There were three nurseries verified in a 2016 pilot study in El Salvador, Guatemala, and Nicaragua. The program verifies nursery standards for healthy, disease-free plants, genetic purity determined by DNA fingerprinting, education regarding agronomic performance of the plants, and breeder's rights," Neuschwander said. A third-party certifying group, NSF, verifies the seed stock first, followed by the nursery. The program officially launched in September 2017.

Benoit Bertrand, researcher with WCR, championed the transition from conventional breeding to molecular breeding in his presentation at the World Coffee Science Summit in San Salvador, El Salvador in May. Conventional breeding uses phenotypic selection, based on observable traits in the plants, and has historically prioritized yield, compact plant size, and pest and plague resistance. More recently, breeders have begun to also select based on drought and heat tolerance, and cup quality.

Molecular breeding speeds up the breeding process by identifying the specific genes or molecular markers responsible for those traits and selecting new varieties based on that. Molecular advancements in coffee breeding are essential to "developing and growing a combination of varieties that can help the farming system to be more resilient to pests and diseases, more productive and more profitable," wrote Bertrand.

Mobile phone-based data sharing network

Photo courtesy of CAFENICA

Cultivating Resilient Soil

Seeds represent technology that must be developed before farming begins, and soil preparation is another crucial step to ensuring that coffee production can be sustained over time, in a changing climate.

Dr Oliver Roupsard, researcher with CIRAD (Centre for International Research and Development, Paris) and CATIE outlined the potential for improved soil at his presentation at the World Coffee Science Summit. He reported that volcanic mountain soils (Andisuelos) can last up to five years without fertilization, without any effect on yield, due to important stores of inorganic nitrogen. Reduction in fertilizer use saves producers money, therefore contributing to financial sustainability, and reduces nitrous oxide emissions.

Roupsard suggested that fertilizations can be optimized given the type of soil to limit environmental impact and strategically invest resources. Sustainable production starts with a full assessment of available conditions and selection of available tools, like tailored inputs and seed varieties.

Conditions must be analysed over time. ECOM Sustainable Management Systems in Sebaco, Nicaragua tracks soil acidity in farms before and after they are converted to agroforestry. Per data presented by Dr Edgardo Alpizar of ECOM SMS, many farms planted with agroforestry systems have soils with optimum pH. This is a desirable outcome of sustainability projects, one where systems, such as agroforestry, regulate themselves and require less use of expensive, contaminating products.

Compiling Climate Data

Sustaining the future of coffee production happens locally, as every region experiences different realities and needs. Coffee's global network of supply chain actors is investing their collective resources to create tools that local organizations can then apply.

Coffee & Climate is a global development partnership of coffee companies and development organizations, initiated in 2010 and implemented by Hamburg-Germany based Hanns R Neumann Stiftung (HRNS). One of the research hubs is El Trifinio, at the border of El Salvador, Honduras, and Guatemala. Flemming Kohn, HRNS communications, explained, "We start by collecting data to understand how climate change has impacted coffee production and smallholders. We start to understand from farmers that they don't face one problem; they face many. There are micro-climatic conditions in Trifinio that create climatic hazards: drought, high temperatures, erratic rainfall distribution and others. With that information, we identify with them what impacts are created by the climate hazards and to identify promising adaptation practices that are tested together."

Measuring the impact of projects at the local level, such as planting temporary shade trees to shield seedlings from drought, generates recommendations for scaling up initiatives to the local or national level.

Cristian LeSage, general manager of exporter Boncafe in San Pedro Sula, Honduras, sees connections between monitoring, research, and eventual investment. "Productivity and quality are the areas that require investment and planning. The most evident risks are climate change and water sources. An important new tool is the development of a roya leaf rust monitoring early warning system that has produced early and continuous reports of the status of roya during a given crop."

Even more meaningful than data is the ability to share it in real time. Jose Aquiles Espinoza Fortin is a producer in Madriz, Nicaragua and participant in a climate resiliency project organized by CAFENICA, a non-profit based in Matagalpa, Nicaragua. "The project, Coffee Sector Resiliency in the Face of Climate Change is implemented by CAFENICA, Centro ▷

Humboldt, CIEETS, and financed by Lutheran World Relief," he outlined. "A network of extensionists and producers record climate phenomenon on their farms using a climate monitoring station to develop practical, useful attention to problems." The climate monitoring stations record 14 data points, including rainfall, soil humidity, air temperature, soil temperature and level of sunlight.

"This information allows us to analyse and implement forecasts of climate threats, like rain events and droughts, and phytosanitary risks, like increased chance of disease and plagues. This way we can outline the most opportune action for producers to take," said Martha Estela Gutierrez, executive director of CAFENICA. "Our network shares data using the CAFENICA platform through mobile applications, WhatsApp and SMS messages."

Implementing Agroforestry Systems

Data collection is essential for recording sudden climate events, but preventative measures move from responsive adaptation towards farms designed for mitigation. Agroforestry systems have proven to be one of the most sustainable models for coffee production, as they synthesize all strategies previously described.

Costa Rica's ICAFE (Institute for Costa Rican Coffee, San Jose) is leading the country's NAMA-Café initiative. "The Nationally Appropriated Mitigation Action (NAMA) is part of the United Nations Framework Convention on Climate Change and NAMA-Café is the first agricultural NAMA in the world. This project aims on reducing greenhouse emissions and providing adequate mitigation and adaptation," Maria Paz Lobo, projects director with ICAFE, told *T&CTJ*.

By assuring the incorporation of different types of trees in the coffee farms, the agroforestry systems fix CO_2 as secondary forests and limit fertilizer use due to the incorporation organic soil matter and creation of humus, reducing nitrous oxide emissions. Agroforestry systems reduce temperature, soil heavy in organic matter helps water to infiltrate rather than generate runoff causing erosion, which leads to a loss of nutrients and fertilizers, and the humus reduces evaporation, increases soil stability, and regulates the internal cycles of the coffee trees.

WCR researcher Bertrand focuses on the intersection between advanced breeding and agroforestry, specifically selecting and developing varietals that are optimized to perform best in agroforestry systems, which provide the previously mentioned mitigation and adaptation services to coffee farms and producers. The new BREEDCafs (BREEDing Coffee for AgroForestry Systems) program, a partnership between CIRAD, WCR, members of the European coffee industry, and academic institutions, aims to produce and commercialize varieties adapted to agroforestry. "The idea is to determine the molecular mechanisms of adaptation to agroforestry and pinpoint candidate genes for breeding highly productive varieties suited to agroforestry," Bertrand stated in the project's April press release.

Photo courtesy of CAFENICA

Data collected from producers with climate monitoring stations.

ECOM SMS's Marsellesa project is an example of resilient design, scaling up the production of coffee and timber in Nicaragua to produce a consistent cup profile that is fully traceable and sustainable. Marsellesa is a hybrid of a Timor Hybrid 832 and Villa Sarchi. Grafting Marsellesa into rootstock provides local employment, as does the preparation of coffee and timber species nurseries. Locally developed technological innovation creates resilient land, a valuable product for market, and the mitigation and adaptation benefits the integration of coffee and hardwoods, all making Nicaragua's coffee sector more sustainable.

In Panama, where research organizations are much less present, individual producers are pursuing similar goals at the level of individual farms. In Santa Clara, Joseph Brodsky owns Ninety Plus Gesha Estates. "We started with a 182-hectare property that was 30 percent forested and 70 percent cattle pasture with invasive grasses and no forest in 2009. While integrating the shade-loving Ethiopia Gesha variety in the under-story at low density, we have converted over 90 percent of the former pasture areas into primary forest. Some local tree species have continuous leaf fall, enhancing topsoil and fertilizing the coffee trees below. Panama, like Ethiopia, has coffee growing areas that are nearly contiguous with protected forests. Our objective is to

re-establish forest and human communities that reconnect to protected lands, by planting and working low-density coffee in the under-story."

Converting Waste into Resources

At Ninety Plus, the goal is to be off the power grid entirely by 2020. Brodsky has started the process by generating solar power, using organic fertilizers like chicken manure, and recycling filtered water post-processing to minimize usage and prevent contamination.

Costa Rica's NAMA-Café also includes parameters for converting waste into resources. Post-processing water contaminated with mucilage is sprayed on star grass, which can be used as cattle feed, and dried coffee cherry pulp fuels the dryers in the mills.

In La Labour Octotepeque, Honduras, Cooperative Cocafelol turns waste water into a tool for combating leaf rust. "We built the bioethanol plant with the goal of reducing environmental effects of water coming out of the mill, but today it has been converted into our source of foliar fertilizers that we use to prevent la roya," said Delmy Regalado, Cocafelol administration.

Researching and Developing

Nothing stagnant is sustainable, and there is ample trial, error, and observation needed to find solutions that will tackle diverse climate challenges where they arise in coffee production.

Cocafelol provides training to its members in organic production methods, application of the fertilizers the bioethanol plant produces, and leaf rust rehabilitation. LeSage of Boncafe sees another opportunity for Honduras to replace most mechanical drying with tunnel and patio drying. "Although this is not simple due to rainy climate during the harvest, it will reduce energy consumption and logistical costs."

Sustainable coffee production must be profitable, producing sufficient yields that deliver necessary quality. Like other tropical crops, Arabica coffee is especially vulnerable to changes in climate. However, this susceptibility is also its strength. Because the coffee industry, from seed breeders to retailers, has realized that research and collaboration are necessary to develop resiliency, resulting technology and tools in both nascent and usable stages exist to sustain coffee through changing climate conditions. Coffee can continue to be a leader in designing farming systems that both adapt to and mitigate environmental challenges while sustaining production for generations to come.

Rachel Northrop has been covering coffee for *T&CTJ* since 2012, while she lived in Latin America's coffee lands writing *When Coffee Speaks*. She is based in Brooklyn, NY. She may be reached at rachel.northrop@gmail.com.