Mario Ernesto Paroda Jaco shows off his bean plants on a farm in Canton El Coco, Chalchuapa, El Salvador. Photo : Katlyn Holland / CRS

Fertile Ground

IMPROVING SUBSIDY IMPACT WITH DIGITAL SOIL MAPPING

Fertilizer subsidies are a vital policy tool used by governments to boost agricultural productivity, support smallholder farmers, and enhance food security by making fertilizers more affordable. However, these subsidies can face a host of issues such as inefficacy, placing a financial burden on governments, inadvertently causing market distortions and contributing to environmental degradation. Integrating innovative approaches like Digital Soil Mapping (DSM) can help address these challenges by tailoring subsidies to specific soil needs, thereby improving the effectiveness of subsidies and ultimately enhancing farmer outcomes. In El Salvador, collaboration between the government, University of El Salvador, Catholic Relief Services, and farmers led to the nationwide use of digital soil mapping, which dramatically improved farmer livelihoods and food security while allowing limited government resources to be used more effectively.

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IN THIS BRIEF

The Role of Digital Soil Mapping

Digital Soil Mapping (DSM) involves collecting soil samples, analyzing them in a laboratory, and combining these results with geographic and climatic data to create detailed digital maps of soil properties. These maps provide crucial data about soil health, including pH levels and nutrient content, accessible through digital platforms. This technology helps to generate more precise recommendations on the type and amount of fertilizers needed for specific areas, optimizing fertilizer use and improving crop yields.

Benefits of information about soil health

Farmers can make informed decisions about the types and quantities of fertilizers to use, reducing costs and improving crop yields.

Allows for adaptation to rising fertilizer costs and climate change.

Supports governments to provide more efficient and effective fertilizer subsidies.

¨The attraction of this is that results can be obtained quite quickly. The economic investment is somewhat lower, and it can also be scalable. ¨
Abel Alexei Argueta, Faculty of Agronomic Sciences at the Universidad del Salvador

Supporting Farmers in El Salvador

Catholic Relief Services (CRS) has incorporated digital soil mapping in four programs in El Salvador: Water Smart Agriculture (ASA), Alianza Cacao, RAICES Ahuachapán, and RAICES Chalatenango. The use of digital soil mapping in these programs contributed to better decision making and cost savings with regards to the use of agricultural inputs and the promotion of appropriate practices to remedy soil health issues.

Because the need for digital soil maps extended beyond CRS programming, CRS prioritized collaboration with farmers and decision makers at the national level. CRS representatives networked at public events organized by government institutions and academia, initially targeting the Ministries of Agriculture and the Environment. Building relationships took time, but government and other key stakeholders eventually invited CRS staff to present on soil and water management and related issues at targeted events. This led to further meetings with government agencies and organizations interested in soil health. CRS emphasized capacity building through digital soil mapping and advocated for changes in public policy which would contribute to nationwide benefits for farmers.

A scientist analyzes soil samples at the CENTA laboratory in San Salvador. Photo : Katlyn Holland / CRS

The government of El Salvador allocates substantial resources to provide fertilizer subsidies aimed at improving agricultural productivity and supporting smallholder farmers. According to Mario Parado Jaco, the Manager of Research and Technological Development at El Salvador´s National Center for Agricultural and Forestry Technology (CENTA), over $35 million is spent on agricultural packages that include certified seeds of beans and maize, along with fertilizers. These packages are distributed to thousands of farmers across the country to help them cope with rising input costs and to boost food production. However, the traditional one-size-fits-all approach often fails to address the specific needs of different soil types, leading to inefficiencies and sometimes negative impacts on soil health. For instance, high levels of soil acidity and deficiencies in essential nutrients such as phosphorus and zinc were identified through soil sampling and analysis in certain regions. Existing subsidy packages did not remedy these problems, and in some cases, actually exacerbated them

CRS knew that El Salvador´s government was eager to address these gaps and proposed collaborating to solve the problem. In 2014, the Ministry of Agriculture through CENTA and other agencies, the University of El Salvador, the Ministry of the Environment and Natural Resources, CARITAS, AGUGOLFO and CRS formed the Digital Soil Mapping Management group. The mandate of this group was to provide technical capacities and national leadership to all institutions and users, including farmer institutions and grower associations. This was accomplished through sharing existing data from each institution to enable better mapping results, coordinating and promote data collection with other institutions such as Coffee Institute, and respond to user demands for information products. Capacity building was offered on how to read and use the information products. Support was provided by USDA (P. Owens & Z. Libohova) to further and adapt the DSM methodology for the conditions and needs in El Salvador.

The ¨magic formula¨ for encouraging effective collaboration with government is ensuring that any proposed action ¨coincides with the government´s agenda¨
- Jaime Tobar, CRS El Salvador´s Director of Water Smart Agriculture.

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The farm of Jesús Antonio Marquez in Chalatenango, El Salvador, who uses regenerative agriculture practices (left) next to the farm of his neighbor who uses conventional practices (right). Photo : Oscar Leiva Silverlight

Case Study: Chalatenango, El Salvador

The data from DSM was used to advocate for changes in fertilizer subsidy policies at multiple levels of government. Initial presentations to the agriculture committee of the legislative assembly and the Ministry of Agriculture highlighted the novel approach of using DSM to inform fertilizer decisions. As a result, the Ministry of Agriculture agreed to pilot the new fertilizer recommendations in three mountain municipalities, including the Commonwealth of La Montañona, Chalatenango.

In Chalatenango, the implementation of DSM revealed significant deficiencies in soil health that were not addressed by the existing fertilizer packages provided by the government and municipalities. The traditional fertilizer used, primarily ammonium sulfate, exacerbated soil acidity, negatively impacting crop yields and soil health.

“When we started to do all the digital soil mapping, we realized the deficiencies of the mountain soils and the agricultural package that both the municipalities and the central government were delivering did not respond to those deficiencies,” explained Juan Arnulfo Alberto, Manager of the Commonwealth of La Montañona, Chalatenango.

Between 2019 and 2020, approximately 3,000 fertilizer packages were distributed in Chalatenango incorporating the new formulations. Despite initial setbacks due to the COVID-19 pandemic, which delayed coordination efforts, local governments, including the seven municipalities in La Montañona, successfully adopted the new recommendations. These municipalities adjusted their fertilizer packages to include formulations rich in phosphorus, such as the 18-46-0 blend, and incorporated agricultural lime to address soil acidity. The initial results were promising. Farmers who applied the recommended fertilizers saw substantial improvements in crop yields. The use of DSM led to an average increase in yields

that varied between 46-77%, with outstanding cases showing increases of up to 400%. These improvements not only boosted food security but also enhanced the livelihoods of farmers, creating a more resilient agricultural sector.

The information provided by digital soil mapping can be used to take the guess work out of a key soil restoration practice known as the 4R´s – applying the right fertilizer in the right amount, in the right place, and at the right time. CRS has been working with farmers across Central America for the past decade to integrate regenerative agriculture practices including the 4R´s. Below are before and after photos of the farm of Jesús Antonio Marquez, a farmer in Chalatenango, El Salvador who has been incorporating the practices he learned from CRS technicians since 2015. Mr. Marquez is one of many farmers interviewed across the country who expressed enthusiasm for tools such as digital soil mapping that can help them understand the needs of their soil to produce better yields and conserve water.

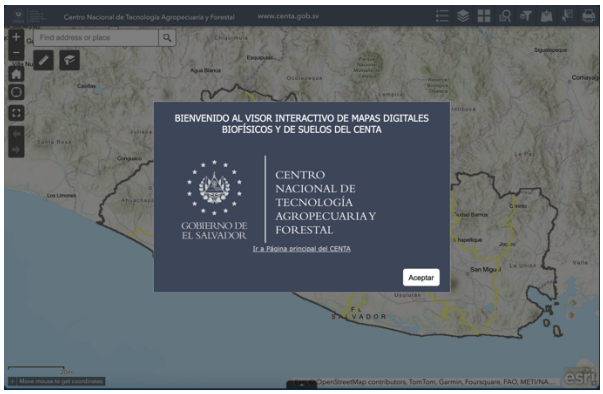
The farm of Jesús Antonio Marquez in Chalatenango, El Salvador in 2015 when he began to incorporate Water Smart Agriculture practices.
Photo : Oscar Leiva Silverlight

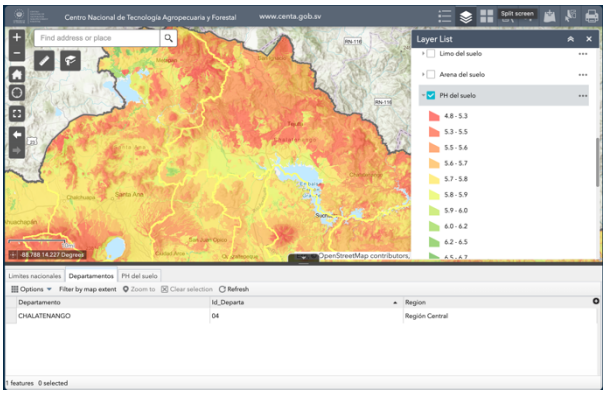
The farm of Jesús Antonio Marquez in Chalatenango, El Salvador in 2023, after 9 years of incorporating Water Smart Agriculture practices.
Photo : LKatlyn Holland/ CRS

¨With the mapping, what we have achieved is to determine what type of soil we have. We have discovered that we have acid soils, deficient in phosphorus, magnesium, a series of elements that we didn't even know we didn't have, and we used fertilizers that we bought at the cheapest price, we threw them away, and in reality we were not nourishing the plants or the crops", said Jesús Antonio Marquez.

Implementation and Results

Based on the success achieved in the pilots, DSM was rolled out at the national level. Digital soil maps are accessed via a web platform in El Salvador, which can be found on the CENTA website. ¨We have a digital mapping platform on the CENTA website, it is public, you do not have to pay anything. We have a manual of the studies of the physical properties of the soils, the technical staff has been given tools in Excel spreadsheets to be able to calculate the amount of fertilizers that have to be used according to the analysis of the maps, for what, which things are insufficient or which things are sufficient so as not to apply it¨ says CENTA technical advisor Edgar Mayen. The use of this technology has led to changes in the fertilizer subsidies provided to farmers in other municipalities.





In Morazán, the community of Cacahuatique Norte, in which about 6 municipalities participate, also generated changes in the content of the agricultural package, including inputs according to the needs identified with digital soil mapping.

In the coffee growing region of Ahuachapán, farmers are seeing the impacts of these changes in the form of increased income due to the effect of improved soil fertility not only on the quantity of coffee harvested, but also to the improvement in coffee quality.

¨In terms of the impact it has had on the increase in the quality of the coffee on this farm, initially we had a score of 84 points. Later, after all this process, we have achieved a score of 86-87 points. This has a lot to do with the selling price of the coffee. When we had 84 points, the price could be between 150 and 160 USD. But now with this increase in quality, the prices we have achieved are between 350 USD and up to 400 USD, depending even on the variety we are producing. All this has been thanks to the basis of the health and fertility of the soil, using digital soil mapping as a tool", said Sigfredo Corado Marquez, a coffee farmer in Ahuachapán.

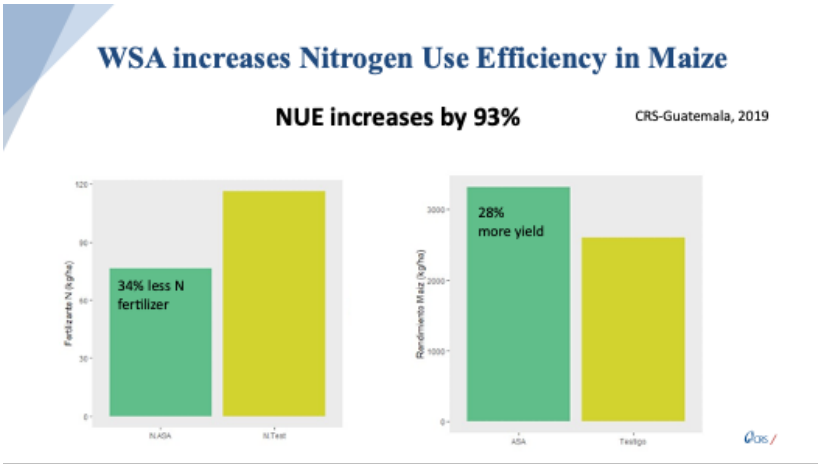
Coffee grows on the farm of Sigfredo Corado Marquez in Ahuachapán, El Salvador.
Photo : Katlyn Holland/ CRS

Cost-Benefit Analysis

The implementation of DSM not only improved the effectiveness of fertilizer subsidies but also demonstrated significant cost benefits for both governments and farmers. For governments, information generated through DSM means that resources are allocated more efficiently, reducing wastage and ensuring that subsidies directly address soil deficiencies. This leads to better returns on investment in agricultural support programs.

Juan Arnulfo Alberto noted that there is also a large savings for farmers because if they did not have access to the digital soil maps ¨each and every one of them would have to invest in an analysis¨.

¨This type of platform, this type of digital mapping, will make it possible to reduce fertilizers and elements that are not needed in an area, reduce production costs, increase production and productivity, especially in corn, beans, sorghum, rice and other vegetables and fruit trees", says Mario Parado Jaco. This assertion is supported by results obtained through CRS´ Water Smart Agriculture in the neighboring country of Guatemala, where nitrogen use efficiency increased dramatically by 93% after applying practices such as the 4R´s. Having the information to apply fertilizer precisely and strategically is a win-win for farmers, enabling them to achieve greater yields with less fertilizer and, consequently, lower financial investment.



The government of El Salvador and others in Central America have seen the value in digital soil mapping and the valuable information that it provides. Between 2015 – 2020, CRS invested roughly $600k USD in digital soil mapping throughout Central America (El Salvador, Guatemala, Honduras and Nicaragua). This funding has nearly doubled with around $500k USD being matched by national partners.

Broader Impact and Lessons Learned

The success in El Salvador demonstrates the potential of DSM to transform fertilizer subsidy programs. By tailoring fertilizer recommendations to the specific needs of the soil, governments can improve the effectiveness of their subsidies, leading to better outcomes for farmers and more sustainable agricultural practices.

The process also highlighted the importance of technical accompaniment and capacity building. Farmers were initially resistant to the changes, as they perceived the reduced quantity of fertilizers as a reduction in support. However, through training and demonstration plots, they were convinced of the benefits. Technical experts played a crucial role in monitoring the implementation and providing ongoing support to farmers, ensuring the success of the new fertilizer strategy.

"We had to convince them that a lower dose applied at a different time and in a different way was going to be a radical change in their production", said Alberto. "At first they told us we were crazy because they had been producing corn for years following their traditional methods. To persuade them, we used paired plots—one portion of the crop as they did and another portion as we recommended".

Technical accompaniment is important not only to encourage farmer adoption of the recommendations proposed by the digital soil maps but also in ensuring the continuity of this work.

"The important thing is that each agency appointed technicians to work on this issue and they are still working. This is an important strength in that the public institutions did not generate changes in the people who were appointed to accompany this process but rather there was permanence, continuity, and these people within their institutions seek to train others to be able to maintain digital soil mapping with more force", said Jaime Tobar.

Crop diversification shown in a corn field in Ahuachapán, El Salvador. Photo : Katlyn Holland / CRS

Scaling and Future Directions

The collaboration between CRS, local municipalities, and national government agencies underscores the importance of multi-stakeholder partnerships in bridging policy to practice and achieving sustainable systems change that is truly led by local decision-makers. As more countries recognize the value of DSM, there is potential for widespread adoption of this technology, leading to more efficient use of resources and scaled outcomes, including improved food and livelihood security.

The case of El Salvador illustrates how Digital Soil Mapping can revolutionize government-provided fertilizer subsidies, making them more cost-effective and beneficial for farmers. By providing detailed soil health data, DSM enables tailored fertilizer recommendations that address specific soil deficiencies, leading to higher crop yields and more sustainable agricultural practices. The DSM approach is applicable globally, and there are many translatable lessons for other countries and regions. The successful implementation of DSM in El Salvador sets a precedent, underscoring the importance of ensuring an effective interface between policy, research, and practice. This approach leads to positive outcomes for farmers, helps countries strengthen their agricultural sectors, and advances their efforts toward food security.