Cost-effectiveness of Water Smart Agriculture implementation in Central America

LESSONS FROM A PROJECT TO INCREASE AGRICULTURAL PRODUCTIVITY AND RESILIENCE THROUGH SOIL AND WATER RESOURCE RESTORATION IN FOUR COUNTRIES

CREDITS

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Since 2009, CRS has partnered with the Howard G. Buffett Foundation (HGBF) to expand conservation and Water-smart Agriculture models to Central America. CRS and our implementing partners received funding from HGBF between 2015-2021 to implement the services described in this report. HGBF also funded the external evaluation.

Cover photo: Lucía Vasquez Méndez picks coffee in Honduras. Photo by Oscar Leiva/Silverlight for CRS.

Contents

Acronyms and Abbreviations

CRS	Catholic Relief Services
DSM	Digital Soil Mapping
FFS	Farmer Field Schools
FUSADES	Salvadoran Foundation for Economic and Social Development
ha	Hectare (1 ha = 10,000 sq m) (1 ha = 2.47 acres)
HGBF	The Howard G. Buffett Foundation
NGO	Non-governmental organization
ROI	Return on Investment
ToT	Training of Trainers
WSA	Water Smart Agriculture
IRR	Internal rate of return

In El Salvador, Lorenzo Guevara Batres chops canavalia beans, a cover crop that helps improve soil fertility by increasing nitrogen levels in the soil.
[Photo by Oscar Leiva/Silverlight for CRS]

I. Background

POVERTY, LAND DEGRADATION, AND CLIMATE CHANGE – A GROWING HUMANITARIAN CRISIS

Soil and water resource degradation, coupled with an increasingly extreme and variable climate, threaten the food security and livelihoods of millions of smallholder farmers in the Dry Corridor of Central America.[1,2] Increasingly irregular rainfall, more frequent and intense drought, and intermittent extreme precipitation events and storms are predicted to continue and worsen over the next decades as the region becomes significantly hotter and drier.[3] These changes are felt most acutely in the Dry Corridor, a sub-region of dry, tropical forest where millions of smallholder farms produce staple crops like maize and beans. The Dry Corridor is one of the regions in the world most susceptible to increasing climate variability.[4] Building the resilience of smallholder farming systems through sustainable climate-adaptive approaches has become an essential humanitarian issue. Mounting evidence links a surge in Central American migration, beginning as early as 2010, largely to these increasingly frequent climate shocks and the subsequent escalation of poverty and food insecurity.[5]

THE CHALLENGE

Over the last decade, large areas of Central America increasingly experienced moderate to severe drought conditions, sometimes in consecutive years. These severe drought events have left as many as three million people in need of humanitarian assistance due to crop loss.[6] Rainfed farming systems produce 92% of the region's basic food crops[7] and more than half of these farmers are highly vulnerable and poor.[8]

THE RESPONSE – WATER SMART AGRICULTURE

CRS developed Water Smart Agriculture (WSA), or Agua y Suelo para la Agricultura (ASA), as an approach to simultaneously confront the challenges of land degradation, drought and erratic rainfall, low agricultural productivity, and poverty in Central America. Since 2015, CRS' Water Smart Agriculture Program for Mesoamerica has built solid evidence that water-smart management restores soil, conserves water and increases agricultural productivity, providing a solution to the economic and environmental problems associated with smallholder rainfed agriculture in the region. Sustainable soil management is at the center of WSA with the added benefits of safeguarding ecosystem services and biodiversity.[9]

CRS has implemented WSA methods in Central America since 2015. The first phase of the WSA program was implemented between 2015-2020. Phase one of the program reached nearly 3,000 smallholder farmers in El Salvador, Guatemala, Honduras and Nicaragua with training on WSA practices including on-farm side-by-side comparison plots to produce both visual and scientific evidence. The second phase of the program used the evidence from the first phase to scale the WSA tools and approaches to more farmers. Scaling WSA through building partnerships, influencing public and private investment, and continuing to build capacity to implement WSA through projects and programs is the strategic pathway to ensure 500,000 farmers in the region are actively implementing WSA practices by 2030.

CRS developed a rigorous WSA Cost Study as a tool to inform adaptive scaling for the benefit of smallholder farmers who would otherwise not have access to the financial or capacity building resources to establish these practices on their farms in a financially sustainable way for the long-term. The WSA Cost Study concludes that WSA creates a practical and cost-effective pathway to reach large numbers of smallholder farmers with environmentally sustainable agricultural practices that build resilience and productivity. The WSA approach with smallholder farmers combined with this rigorous cost study enables CRS to integrate WSA into multiple new and emerging projects and position WSA as one of CRS' flagship approaches in agricultural livelihoods to build resilience to climate change and strengthen food security through land restoration.

Francisco Sayes uses crop residues to cover and protect his newly planted corn in El Salvador
[Photo by Oscar Leiva/Silverlight for CRS]

II. The WSA Cost Study

The WSA cost study analyzed program finance and implementation data from 2015-2020. The cost study was completed by an external research firm, the Salvadoran Foundation for Economic and Social Development (FUSADES), referred to hereinafter as "the researchers". The researchers gathered both programmatic and financial data from CRS to complete the cost analyses.[10] The researchers collected the project financial accounting data from CRS and implementing partners to then analyze the costs to implement the program in terms of cost-effectiveness, cost-benefit and return on investment.

Cost studies of agricultural interventions are scarce, especially in the Central American region, as such this study aims to be a particularly relevant—and innovative—contribution. An extensive literature[11] review of 308 studies completed by the researchers indicated that the majority of relevant studies are concentrated in sub-Saharan Africa and South Asia and tend to focus on the provision of inputs (fertilizers and chemicals, seeds and planting materials, and machinery and equipment) as opposed to the effectiveness of conservation or regenerative agricultural practices.[12] The literature review also yielded some but not comprehensive data on the environment or ecosystem benefits derived from conservation agriculture practices.

The WSA cost study strives to understand how the investment in WSA can inform the design, scope and content for future investments in scaling soil and water conservation agriculture programs for smallholder farmers. The study provides critical information to target investments for efficiency and effectiveness of program interventions.

The WSA cost study creates a unique roadmap for governments, donors, researchers, agricultural experts and journalists who seek to understand the economic and environmental return on investment (ROI) for smallholder farmers in programs designed to address the interrelated social, economic and environmental issues aggravated by climate change.

METHODOLOGY

This cost study analyzes the five-year period 2015-2020 of the WSA program. Data were collected from on-farm activities with 3,000 farmers in El Salvador, Guatemala, Honduras and Nicaragua and the costs associated with the process of building farmer capacity to implement WSA practices. The data were collected in each country by way of monitoring the adoption of WSA practices in the demonstration plots and the impact on yields, soil health and income for smallholder farmers by comparing demonstration yields with the conventional comparison.

Definitions of Key Cost Study Concepts

Cost-efficiency Analysis: A comparison of program costs to units of output. The cost per farmer trained and supported per year (Figure 4), expresses the cost-efficiency ratio in this study.

Cost-effectiveness Analysis: A comparison of program costs to units of effectiveness or outcomes. This study used the Cost per unit of net income increased (Figure 5), cost per MT of CO2 captured, and cost per cubic meter of humidity retained (compared to baseline) as its key measures of cost-effectiveness.

Cost-benefit Analysis: A comparison of program costs and monetized benefits to both the individual farmers as well as society. In this study, we consider the specific monetary benefits of private benefits (increased income plus soil nutrient improvements); as well as public good benefits (Co2 and water retention). Also typically expressed as a ratio, Figure 6 reports benefit-cost ratios (numerator is the dollar value of benefits; denominator is the dollar value of costs).

Return on Investment (ROI): An expression of the change in dollar value of an initial investment over time, ROI is similar to the concept of cost-benefit and is often expressed as a percent increase or a multiple relative to the initial investment. In this analysis, the return is measured in terms of the monetized individual and societal-level benefits described above (see Table 2).

The financial data collected by the researchers from CRS and implementing partners was used to link costs to performance and benefits. Programmatic costs were captured from CRS finance records and spanned all relevant cost categories, including staff salaries and benefits, transportation, and equipment purchases.

Researchers also accounted for the value of capital goods (e.g. vehicles, office space and other overhead costs) used for program implementation.

The types of cost were grouped into three major categories:[13]

- Costs that CRS transferred in cash to implementing partners;
- Contributions from CRS to implementing partners, in the form of goods or services; and
- Funds used directly by CRS country offices for implementation.

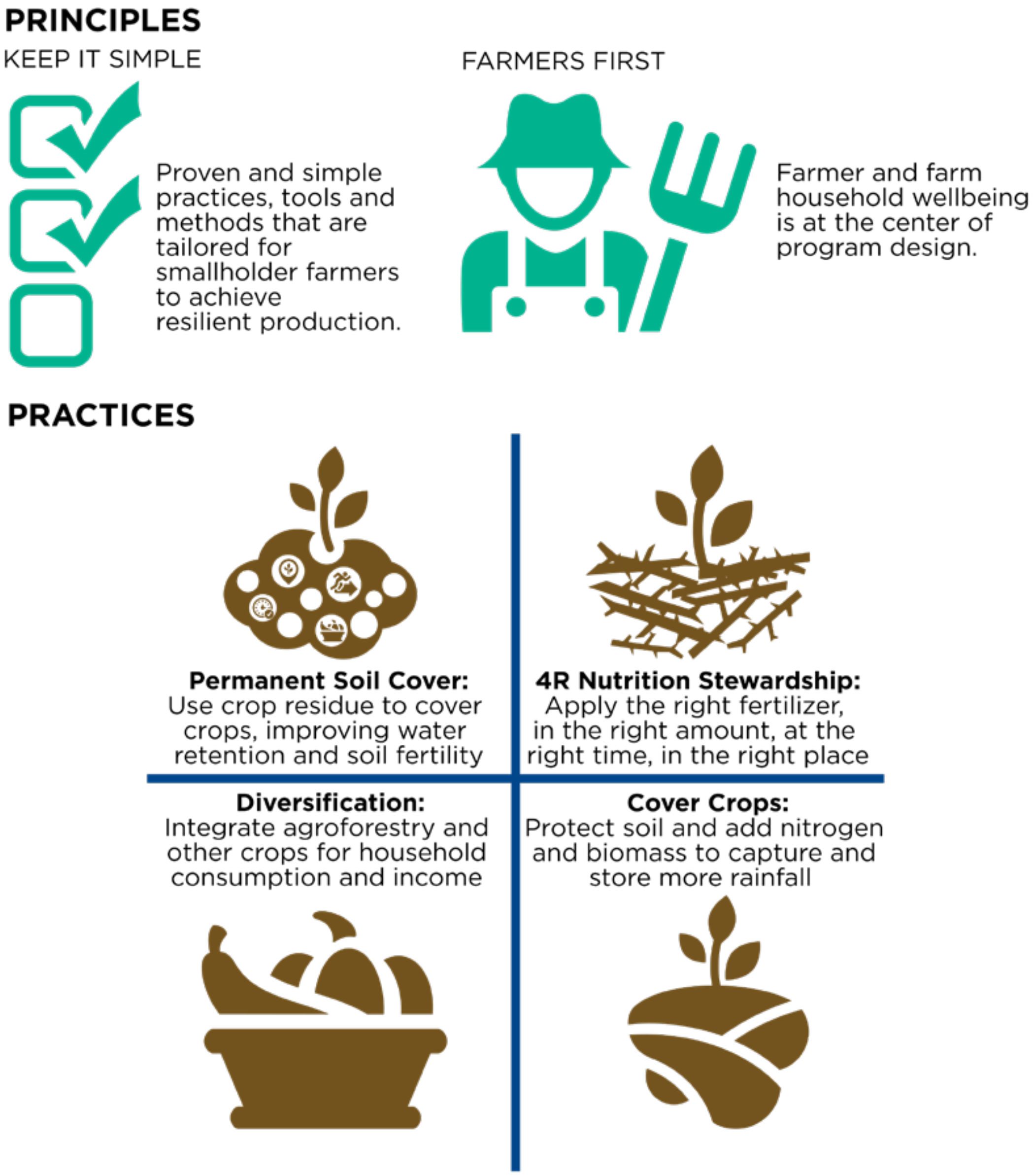
The cost analysis combined with the implementation and farm level data enabled the following level of analysis:

- Performance results including the rate at which farmers adopted WSA practices, the extension training model delivery, and improvements in yield and net income.
- The cost to achieve results (costs per farmer to adopt WSA practices on their own farms).
- The cost-benefit and time to achieve a positive return on investment, including ecosystem and climate adaptation benefits.

Esperidión Amaya, a small coffee producer in El Salvador, manages a shade grown coffee farm which helps decrease runoff and improve water infiltration. [Photo by Oscar Leiva/Silverlight for CRS]

Figure 1. WSA Principles and Practices

WSA practices increase productivity and build the resilience of farms to the effects of climate change by restoring soil health, improving soil fertility management, and nurturing the soil's role in harvesting and making more efficient use of rainfall.



DIGITAL SOIL MAPPING TO INFORM 4R NUTRIENT STEWARDSHIP

To support appropriate use of fertilizers, CRS worked with a diverse group of partners since 2014 to accelerate the use of digital soil mapping (DSM) in Honduras, Guatemala, El Salvador, and Nicaragua. DSM efficiently and effectively captures practical soil properties information to inform 4R Nutrient Stewardship (see Figure 1) and land management decision-making. In combination with other geospatial methods and tools, DSM facilitates natural resource impact monitoring from the farm to the watershed and beyond. Farmers, municipalities, and central governments can now use DSM for planning and budgeting of soil and landscape restoration interventions as well as for information services to support agricultural production on farms and across landscapes.[14] DSM efficiently and effectively captures practical soil properties information to inform 4R Nutrition Stewardship (see Figure 1) and land management decision-making.

HOW FARMERS LEARNED AND ADOPTED WSA PRACTICES

The WSA extension model established a corps of professional extensionists and lead farmer trainers to replicate and expand WSA practices to farmers. The WSA program trained over 60 extensionists from 10 local organizations in 4 countries. The trained extensionists worked closely with 400 lead farmers on intensively monitored demonstration plots. The extensionists and lead farmers facilitated Farmer Field Schools and supported participating farmers to implement their own replication demonstration plots. Farmer Field Schools are learning communities that utilize demonstration plots to apply WSA practices, learn from the results and create a learning feedback loop to benefit farmers. This cost study determined the investment needed to deliver this training and learning model by way of Farmer Field Schools to nearly 3,000 farmers.

PARTICIPANT FARMERS INCLUDED IN THE COST STUDY:

The WSA cost study selected 2,914 farmers with coffee, cocoa, maize, beans, pasture, or vegetable crops in El Salvador, Guatemala, Honduras and Nicaragua. The average farm size ranged from 1-2 hectares (2.47 - 4.94 acres) depending on crop type and farming system. The farmers were 85% male and 15% female, which is consistent with regional tendencies.[15] The average age range was 41 to over 60 for 75% of farmers, and the remaining 25% were between the ages of 18 and 40. Nearly 50% of farmers had no formal education or some primary school. The remaining farmers had completed middle school or high school, some vocational technical training, or other higher education. Overall, 30% of farmers were literate regardless of school level completion.

- Rainfed farming systems in El Salvador, Guatemala, Honduras, and Nicaragua

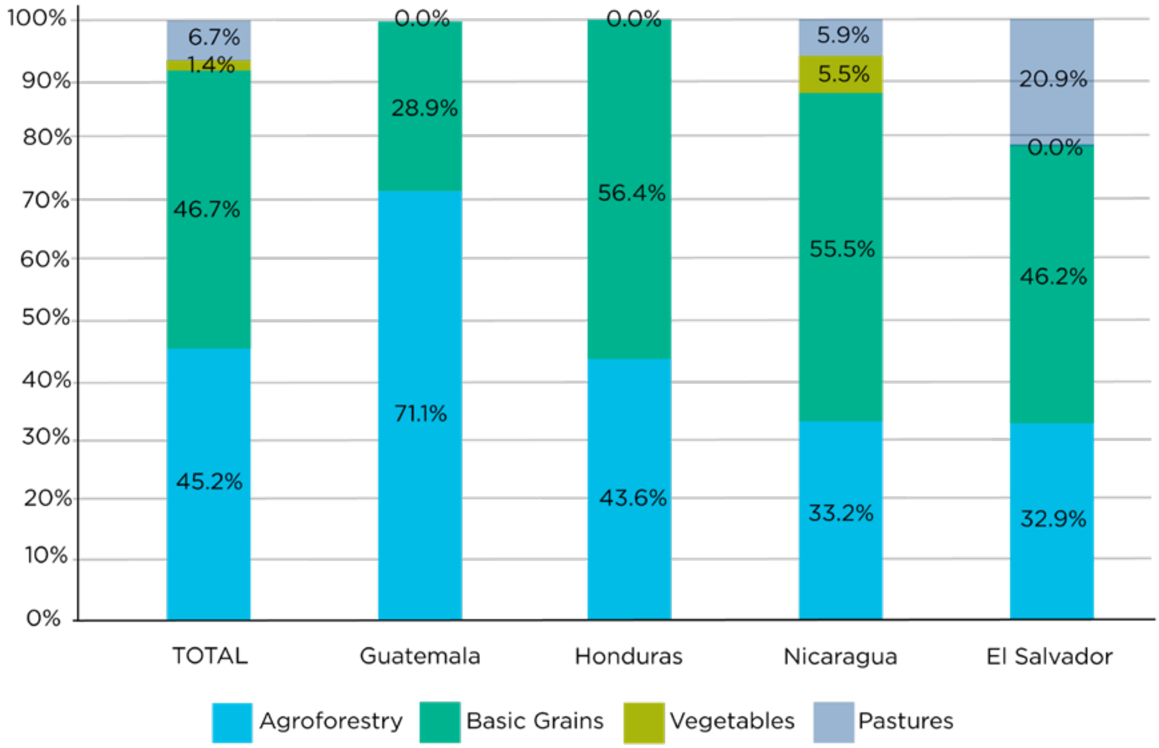
15% 85%

- 75% are age 40-60
- 25% are age 18-40

- 50% have no formal education or some primary school.

- 30% literate regardless of school completion

Figure 2. Distribution of on farm WSA plots by Crop (as %)

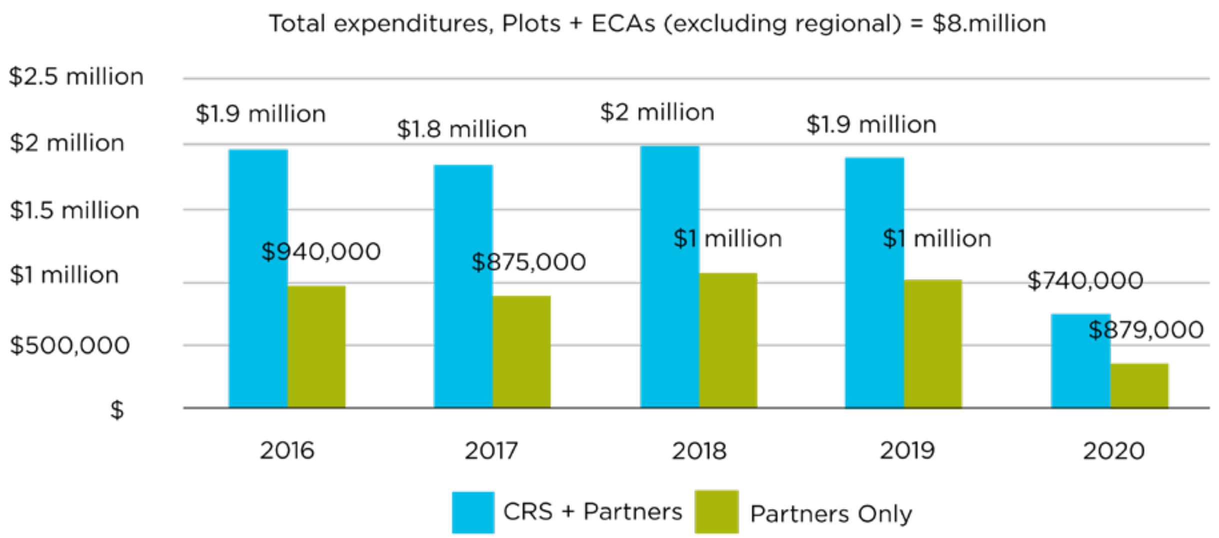


In Guatemala, Honduras and Nicaragua between 753 and 794 smallholder farmers in each country managed on-farm comparison plots and in El Salvador, 592 smallholder farmers managed farm plots. Basic grains such as maize was the primary productive system monitored by WSA (46%), followed by agroforestry which consisted of coffee and cocoa crops (45%). Guatemala had the highest concentration of participant farmers in agroforestry systems—approximately 70%. In Nicaragua, only 6% of the land is used to grow pastures. Vegetable crops were managed in Nicaragua only by 6% of the participating farmers.

COST STUDY RESULTS

The total value of the WSA project from 2015-2020 was $21.1m, including all project activities as well as CRS regional-level support extension training. The scope of this study focuses on costs related to Farmer Field School extension services and on-farm comparison plots. As such, we consider the $8.4m of expenditures shown in Figure 3 below as directly related to establishing comparison plots on farms, training farmers in WSA practices, and tracking the adoption of WSA practices – other expenses outside of this scope were excluded. Expenses are disaggregated by year, including transfers to local partners (cash and goods), direct support from CRS country staff and related overhead/capital costs that were required to implement WSA. Program costs decreased substantially in year five (2020) due to the conclusion of activities as well as the COVID-19 pandemic, rather than a decrease in implementation costs.

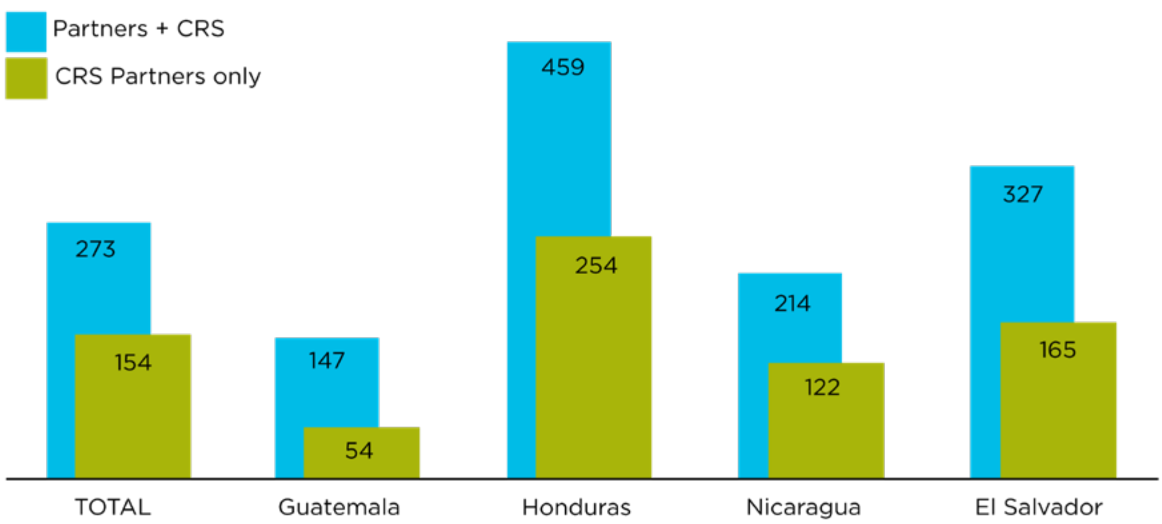
Figure 3. Implementation Costs for the 2016–2020 WSA program, per FY



COST EFFICIENCY

As depicted below in Figure 4, the annual cost per farmer averaged $273, which includes training via Farmer Field Schools and on-farm comparison plot methods, and CRS overhead support. Considering only the partner-level field implementation (no CRS overhead support, a more appropriate assumption, which may be a more appropriate assumption for future scaling), the annual cost per farmer was only $154. Since adoption rates of practices from farmer-to-farmer diffusion in communities was not measured, $273 is likely an overestimate of the true cost per farmer. The researchers reviewed similar programs in developing countries globally and found that average cost per farmer per year ranged from $33 to $400, which is consistent with WSA costs.

Figure 4. Measuring Efficiency: Cost per Farmer per Year



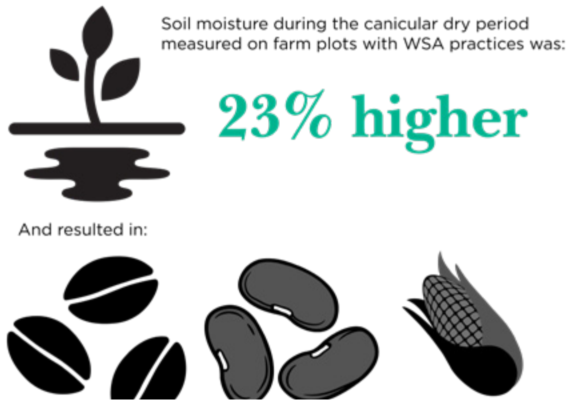
COST-EFFECTIVENESS

Cost-effectiveness was determined by analyzing the costs to achieve results in the WSA program, such as the cost per additional dollar of net farmer income, metric tons of CO2 captured, and the cubic meters of moisture retained. All of these metrics consider 2015 as the baseline year before WSA implementation (and expenses) began, and 2020 as the comparison endline year for both total costs and cumulative outcomes.

The researchers reported the average costs of obtaining key WSA outcomes as compared to baseline (see Figure 5, below). Taking both CRS country program and partner expenses into account, the average cost of increasing farmer net income by one dollar was $0.41 (or $0.20 when only considering direct implementation costs). Put another way, for every dollar invested by the WSA program, farmer income increased by $2.46.

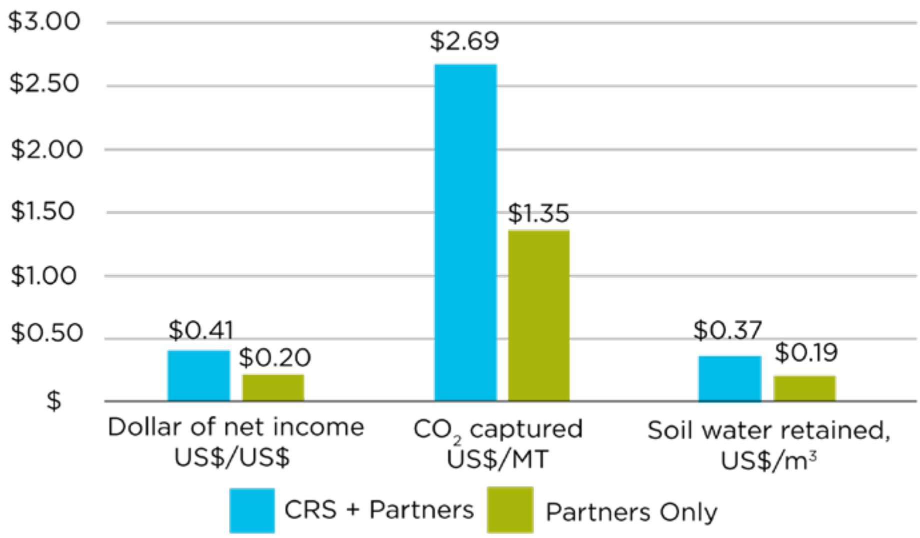
*the average cost of increasing net income by one dollar was $.41 (1/0.41 = $2.46)

The other key soil outcomes included carbon sequestration and moisture retention as a result of farmers implementing WSA practices. It cost CRS and implementing partners an average of $2.69 to sequester the equivalent of one metric ton of CO2 and $0.37 to generate a cubic meter of soil moisture.



Compared to what little literature exists, these values are highly cost-effective. It is important to note that the cost of capturing an additional metric ton of CO2 equivalent ranges from $1.56 to $4.05. This is less than the monetary equivalent of one metric ton of carbon which, according to varied sources reported by the researchers, can range from $10 to $35 in payments for ecosystem services[16,17].

Figure 5: Cost effectiveness: average cost per unit of outcome obtained (vs. baseline)



COST-BENEFIT

The cost-benefit analysis establishes if and when the monetary value of the resulting benefits exceed the costs – such as ecosystem and climate adaptation benefits. Beyond income gained through applying WSA practices, the project has recorded positive impact on eco-system health and climate adaptation through fostering natural climate solutions. WSA practices increased organic matter in the soil and moisture retention. The ecosystem benefits resulting from WSA practices were measured with environmental impact indicators to provide a broader analysis of the cost-benefit of the WSA program.

By the end of the fourth year of WSA program, the soil's organic matter (carbon levels) had increased 14% over the comparison grain plots. **Soil moisture during the canicular dry period[18] was 23% higher on average than comparisons, coffee yields were 28% higher, beans were 60% higher and maize yields were 43% higher.[19]** The WSA program measured two benefits associated with organic matter: the amount of carbon dioxide sequestered and the soil nutrients provided. The nutrients captured in the soil were determined to have an average value of $6.37 per hectare. Depending on the additional amount of C02 capture and moisture retained in the soil, the ecosystem benefits of an average WSA plot can be valued at $77.70 per hectare.

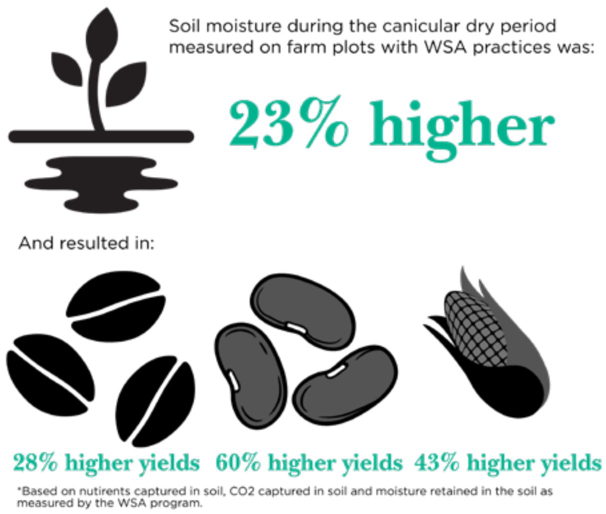


Table 1 below indicates the monetary values (and sources) of ecosystem benefits, as determined by various governmental and international entities. The researchers distinguished between private benefits (gains in soil nutrients that accrue primarily to the individual producer) versus public goods or benefits that benefit others (sequestered carbon and water retention). The indirect ecosystem benefits of WSA practices were evident in all countries, without including the monetary value of the captured CO2 (even achieving positive benefit-cost ratios in the short term). Although the economic valuation of this type of benefit is relatively new, these findings can be used to gain the attention of more public and private entities as to the potential carbon offsets, other climate finance mechanisms and recognition for the ecosystem services that can result from WSA practices.[20]

Table 1: Estimations for monetary value of environmental benefits

BENEFIT	MONETARY VALUE
Private Benefits (farmer level)[21]	
Nitrogen, Kg	US$ 1.14
Phosphorus, Kg	US$ 2.81
Potassium, Kg	US$ 1.69
Environmental benefits (societal level)	
C02 equivalent, MT[22]	US$ 10.00**
Retained moisture, m3[23]	US$ 0.10 (US0.05-US0.16)

** Other sources value between US$20 and US$35

Next, the researchers compared WSA expenditures to the monetized benefits of the program, assuming that both costs and benefits hold constant at 2019 (year 4) levels. Using net present value calculations and predominant discount rates in each country (e.g. present-day estimates of futures benefits), FUSADES researchers calculated benefit-cost ratios at 10 years of implementation. As depicted in Figure 6 below, the average estimated benefit-cost at 10 years, including partner and CRS country program costs, was 4.3. In other words, the value of the benefits generated by the project over that 10 year period will be 4.3 times greater than the costs over the same period. When considering only partner costs (a more plausible scaling scenario as INGO involvement can likely be reduced over time), the 10-year cost-benefit ratio was 8.6, ranging from 4.3 in Honduras to 14.4 in Nicaragua.

Figure 6: Estimated WSA Benefit-Cost ratios at 10 years

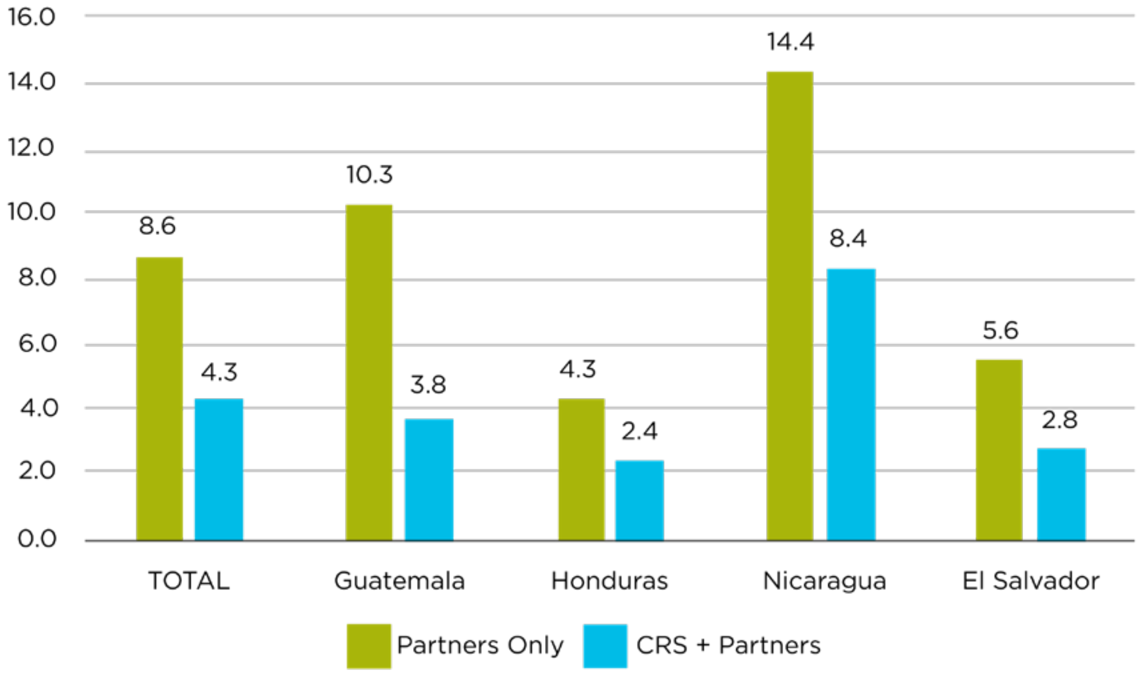


Table 2. Comparing Benefit Cost to Internal Rate of Return

	B-C RATIO AT 10 YEARS	CRS + PARTNERS: YEARS TO IRR>0	PARTNERS ONLY: YEARS TO IRR>0	CRS + PARTNERS: IRR AT 10 YEARS	PARTNERS ONLY: IRR AT 10 YEARS
Guatemala	3.8	4	1	84.0%	263.3%
Honduras	2.4	4	2	54.1%	124.8%
Nicaragua	8.4	2	2	110.2%	175.9%
El Salvador	2.8	4	1	60.3%	151.1%
Total	4.3	3.5	1.5	77.1%	178.8%

Measuring Carbon Sequestration

The price of organic carbon in the soil is calculated by measuring the carbon dioxide equivalent (CO_2) sequestered, which is about 3.67 times the amount of carbon in the soil. Carbon pricing captures the externalities of greenhouse gas emissions (GHGs) and its estimation can be classified into two categories: As an emissions trading system, in which emission quotas are allocated by auction or direct sharing by the government and as a tax on levy on C02 emissions covered at a price of less than $10 per hectare. The World Bank has standardized the value of a metric ton of carbon at US$10 per hectare.[24]

Measuring Soil Nutrients

Soil organic matter contains some of the nutrients found in fertilizers, so these prices can be used to estimate the benefits that farmers gain from organic matter in lieu of fertilizer. Using fertilizer prices and the percentage of nutrients in them, it is estimated that a farmer generates $8.79 in fertilizer for every 1% organic matter per acre per year, or $3.51 per 1% organic matter per hectare.[25]

Payments for Ecosystem Services

Payments for Ecosystem Services (PES) is an attempt at a financial valuation of the benefits ecosystems provide to humans. Ecosystem services is a perspective that challenges the idea that natural resources are free inputs for industry. PES can create incentives for the production of these services within an agroecosystem. A study of the U.S. agricultural sector predicts that a carbon price of $10 per metric ton would lead farmers to adopt land use and management practices, primarily conservation tillage.[26]

The Value of Water

According to a 2021 U.N. World Water Development Report the value of water for agriculture is typically 60% of food production ranges from US$0.05 to US$0.16. For high value crops like vegetables, fruits or flowers, prices are generally higher. Agriculture uses the major share (69%) of global freshwater resources. Water for food production is major driver of environmental degradation, including depletion of aquifers, reduction of river flows,[27] degradation of wildlife habitats, and pollution. 80% of crops globally are rainfed and therefore the use of water smart practices reduces the need for irrigation and prevents crop loss to drought.

RETURN ON INVESTMENT

The researchers also expressed the cost-benefit analysis results in terms of Return on Investment (ROI). A synthesis of the overall WSA program cost data including all activities related to experimental plots, field schools, extension training and operational expenses, concluded that the initial investment was recovered in 3.5 years. Specifically, this is expressed as the time until the internal rate of return (IRR, a measure of annual return) is greater than zero, or the time at which a particular investment would become profitable. As expressed above in Table 2, the benefit-cost ratio differs for each country as the implementation costs vary to some degree due to variable rates of yield increase, differences in mix of crops on each farm, the size of cultivated plots and the market prices for selling crops, in addition to the costs of program and implementation and different prevailing discount rates. If only partner costs are considered, the average time to IRR>0 was only 1.5 years. At 10 years, the estimated IRR with and without CRS country support was 77.1% and 178.8%, respectively.

Patricia del Carmen Martínez, a coffee cutter working on the Finca Germania in Guatemala.
[Photo by Oscar Leiva/Silverlight for CRS]

Key Takeaways for Policy Makers, Funders and Implementers

CRS developed Water Smart Agriculture as an approach to simultaneously confront the challenges of land degradation, drought and erratic rainfall, low agricultural productivity, and poverty in Central America. The promise of Water Smart Agriculture is the practice of restoring soil to manage water and increase yields. Water Smart Agriculture is catalyzing a conservation agriculture movement in Central America tailored for smallholder farmers dependent on rainfed farm systems. Rainfed farming systems produce 92% of the region's basic food crops[28] and more than half of these farmers are highly vulnerable and poor.[29]

This study suggests that WSA creates a practical and cost-effective pathway for smallholder farmers who would otherwise not have access to the financial or capacity building resources (extension training) to establish these practices on their farms. For example, when women farmers have access to extension services and agricultural inputs to manage their soils, they can improve basic grains yields by over 30% which has significant implications for food security in the region.

There are very few cost studies on agricultural practices, and even fewer that include environmental indicators. This cost study provides essential data for agricultural and farmer-serving institutions to inform the design, scope and contents of their future investments for scaling water smart agriculture programs. Investing in soil and water programs is good for the climate and a smart way to invest in the future. The ecosystem benefits of soil restoration could lead to financing solutions for farmers and the organizations that support them.

WSA is Cost-Efficient over a five-year intervention period: It costs $273 per farmer per year to establish on-farm WSA demonstration plots and provide extension training. This initial investment will decrease over time as farmer-to-farmer diffused training and learning takes hold in farming communities. A review of similar programs globally determined the average cost per farmer per year ranged from $33 - $400.

WSA is Cost-Effective because every project dollar invested, farmer net income increased by $2.46. This additional income is significant for food security and other family household needs.

WSA practices generate valuable eco-system services. It cost $0.37 to generate a cubic meter of soil moisture, making crops more resilient and climate adapted to drought in the Dry Corridor. It cost the WSA program $2.69 to sequester the equivalent of 1 ton of CO_2, which is less than the monetary value equivalent for one metric ton of carbon which can range from $10[31] to $35[32] in payments for ecosystem services.

WSA generates Ecosystem Benefits for Climate Adaptation: WSA generates benefits for climate adaptation including soil moisture and soil nutrients exceeding the costs after the first 3.5 years of implementing WSA practices. By the end of year 4 of the WSA program, the soil's organic matter (carbon levels) had increased 14% over the comparison grain plots and soil moisture during the canicular dry spell[33] was 23% higher than comparisons.[34] The soil nutrients captured in the soil were determined to have an average monetary value of $6.37 per hectare. Depending on the additional amount of $C0_2$ capture and moisture retained in the soil, the ecosystem benefits of an average WSA plot can be valued at $7.70 per hectare.

WSA delivers a positive return on investment: Investments in WSA practices are projected to generate benefits equivalent to over four times its costs over ten years, taking into account increased incomes and ecosystem services. WSA's annual rate of return on investment at ten years is estimated at nearly 80%.

Endnotes

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11 Note: FUSDAES reviewed 308 peer reviewed publications related to agricultural cost studies.

12 International Program for Impact Evaluation (December 2017). Map of evidence on agricultural innovation programs. Obtained from https://www.3ieimpact.org/evidence-hub/publications/evidence-gap-map/mapping-evidence-agricultural-innovation-programmes-

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