The Cost and Benefits of Water-smart Agriculture in Coffee:

A Cost-Benefit Analysis of Implementing Water-Smart Practices on Coffee Farms in Central America

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Abstract

The Water Benefits Calculator (WBC) represents a powerful decision-support tool that empowers land managers and other stakeholders to identify and prioritize the most beneficial, and, when coupled with cost of implementation data, cost-effective practices for a given context. This analysis explored the water benefits (increase in ET and storage, decreased runoff, etc.) and costs associated with the implementation of different mixes of water-smart practices on 16 farms in El Salvador, Nicaragua and Honduras. Over 13 different practices were modeled, representing an investment of $21,000. **On average, water benefits increased by 90% compared to pre-intervention scenarios.**

Introduction

Blue Harvest

Since 2014 CRS has been coordinating the Blue Harvest initiative in Central America to protect and restore drinking water resources for downstream communities via three objectives:

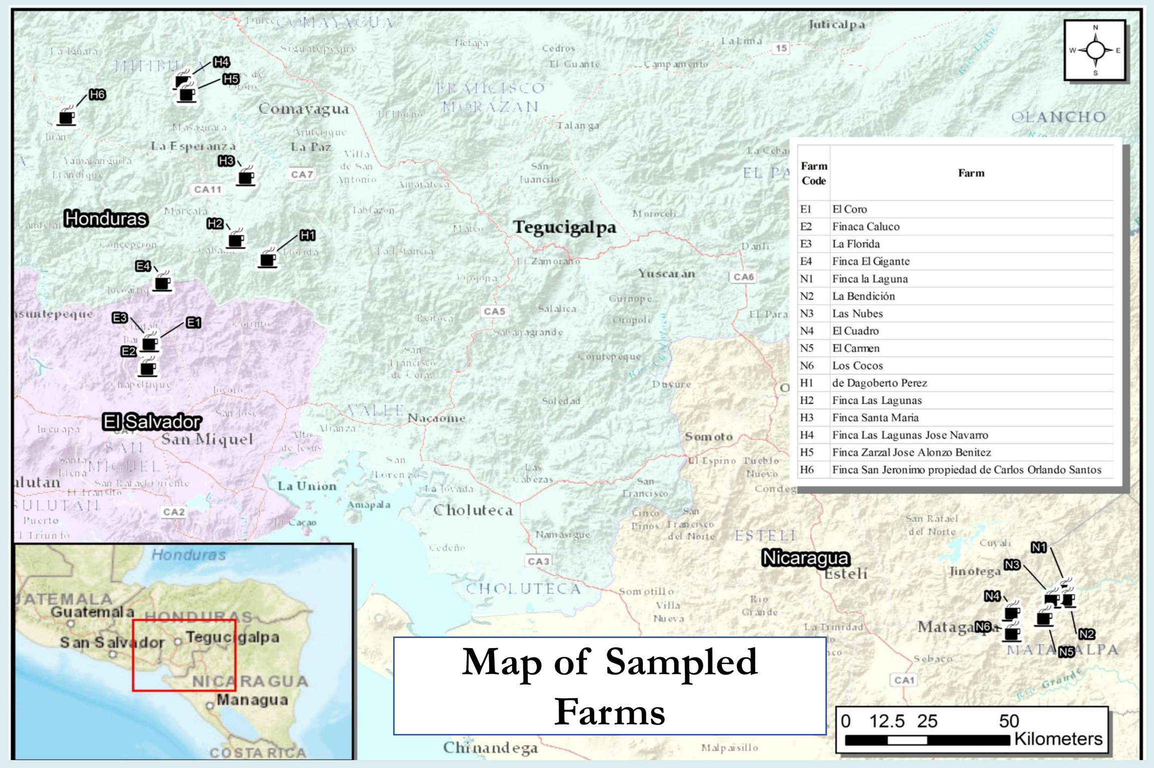
- **Promoting sustainable coffee-based agroforestry in critical watersheds**
- **Strengthening local governance for water resource management**
- **Improving access to high value markets**

Participating farmers have implemented practices with the potential to benefit water resources on over 6,300 hectares in El Salvador, Nicaragua and Honduras.

Study Objectives:

This study sought to quantify the hydrological benefits from common practices implemented through the Blue Harvest project and gather cost data to identify the following:

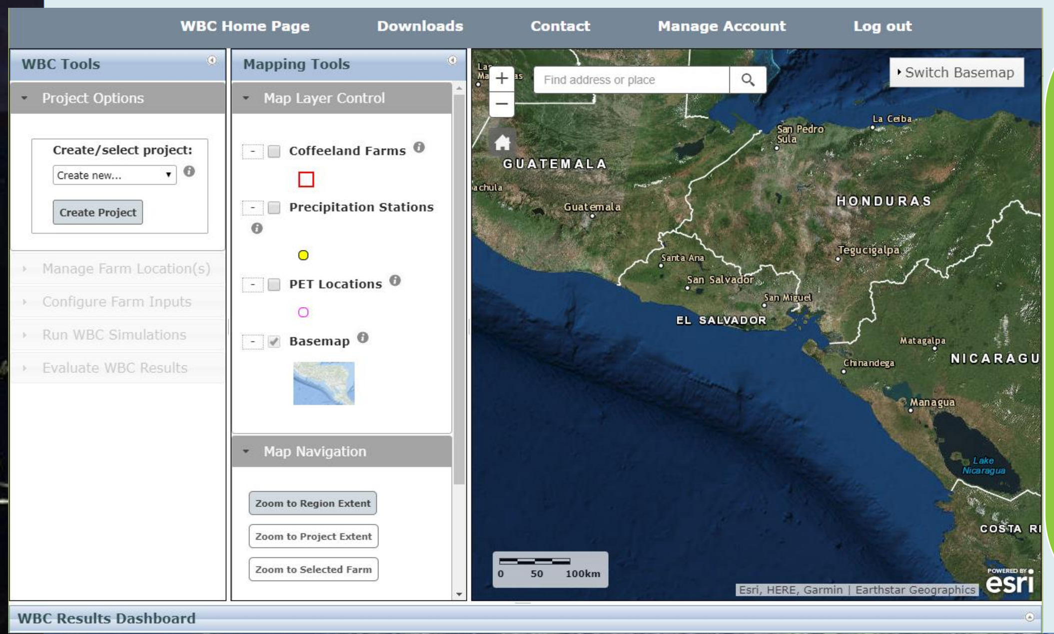
1. **Prevalence and cost of implementation of practices in each country**
2. **The mix of practices that generate the highest hydrological impact**
3. **Practices that provide the largest hydrological impact for the least cost**



Map of Sampled Farms

Water Benefits Calculator

In 2017 CRS and LimnoTech developed an online WBC tool open to the public. The Blue Harvest WBC framework was built upon the Hydrologic Simulation Program FORTRAN model and designed to quantify potential changes in hydrology (i.e., surface runoff, groundwater recharge) and sediment load from management interventions.



Who are WBC users?

- Land managers and extensionists who wish to prioritize interventions based on potential hydrologic impacts
- Private and public sector actors seeking to invest in improved water resource management and understand the potential returns on their investment

Methods

Component	Methodology
Evaluation of Water Benefits	The WBC simulated pre- and post-intervention scenarios based on unique topographic features and biophysical data from 16 Blue Harvest-participating farms in El Salvador, Honduras and Nicaragua to evaluate relative changes in hydrologic components such as groundwater recharge, soil water storage and surface runoff.
Practice Cost Analysis	Farm costs reported per manzana (0.7 hectares) included capital costs (materials and labor) and expected yearly operation and maintenance (O&M) costs.
Cost Benefit Analysis: Farm Portfolio Performance (FPP)	Analysis was performed at the farm-level and included the mix of practices, not a single practice. Only capital costs were considered in the analysis. The FPP measurement was developed to score a portfolio's performance using the incremental improvements per dollar spent in the five WBC water balance categories: (1) evapotranspiration (ET), (2) Runoff, (3) Interflow, (4) Groundwater outflow, and (5) Change in storage.

Results

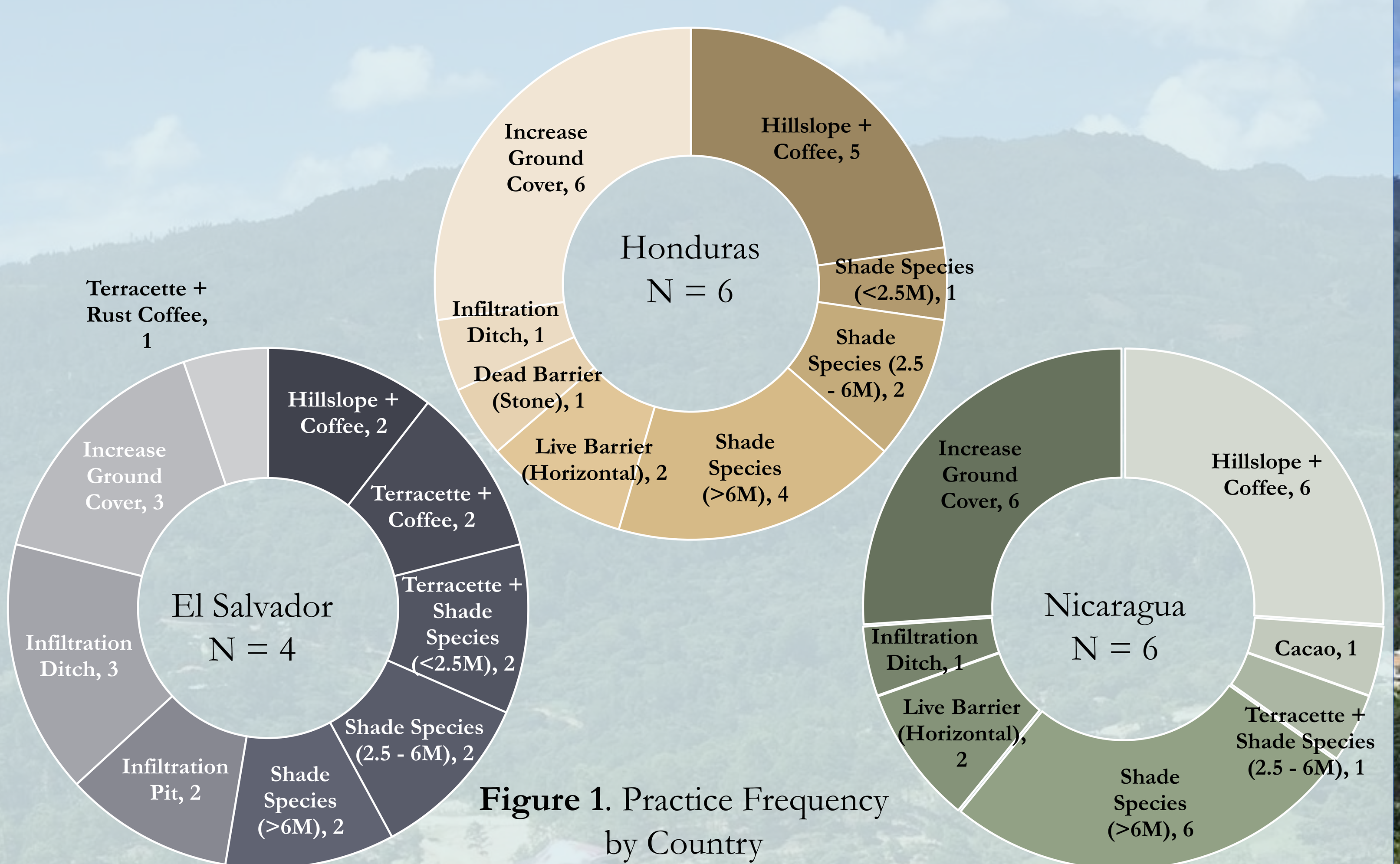


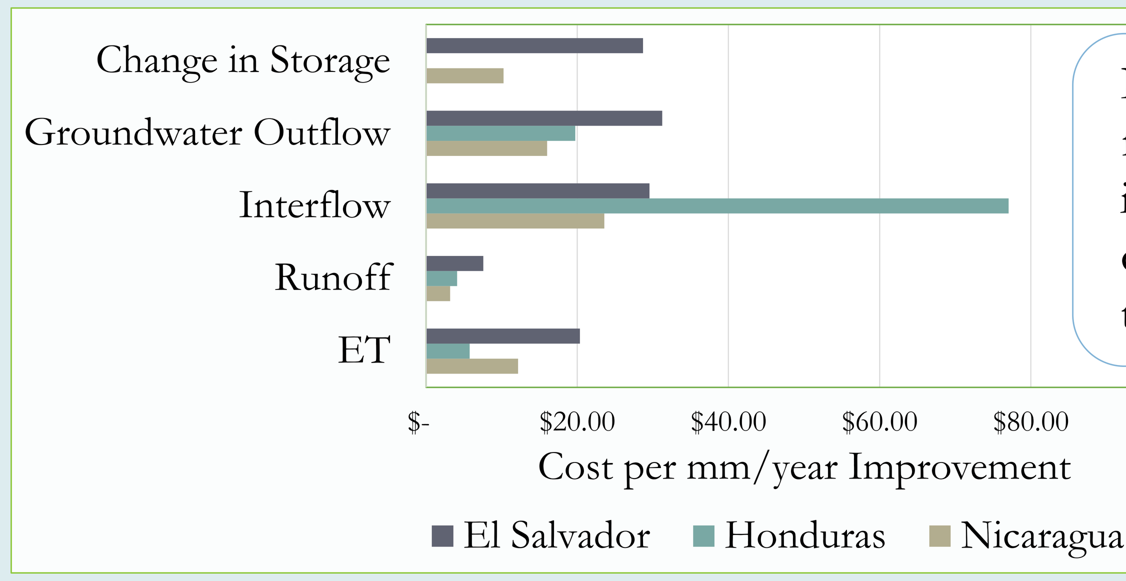
Figure 1. Practice Frequency by Country

Most common practices: increased ground cover, shade tree planting and coffee rehabilitation (Fig 1)
Most costly practices: renovation, infiltration ditches (Fig. 2)
Least costly: ground cover, terracettes, live barriers, shade management (Fig. 2)

Figure 2. Practice Cost by Farm

Impact of WBC Practices:

- Modeled WBC practices had a significant impact on the hydrology by increasing ET, interflow, groundwater outflow and water storage and decreasing runoff and sediment load.
- Implemented practices **reduced surface runoff by 84%** on average.



Reducing runoff followed by increasing ET is the cheapest measure to achieve.

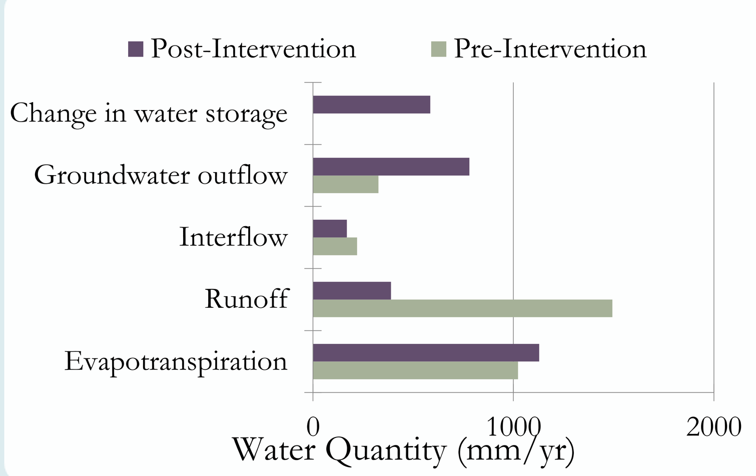
Figure 3: Cost per mm in hydrologic improvement

Farm: Finca la Laguna [N1]

WBC Project Name: Bonifacio Garcia ADDAC
Country: Nicaragua
Latitude: 13.067443
Longitude: -85.6744695
Elevation (masl): 637

Pre-intervention:
- Shade Species (>6M)
- Rust-affected Coffee
- Bare Hillslope

Post-intervention
- Infiltration Ditch
- Hillslope + Coffee
- Terracette + Shade Species (2.5 – 6M)
- Shade Species (>6M)
- Ground Cover 30-80%



Capital (Materials)	Capital (Labor)	O&M
$ 1176	$ 290	$ 180

FPP = 0.048

The mix of practices on this farm yielded the highest hydrologic impact for the lowest cost of all modeled farms.

Conclusions

- Although Nicaraguan farms scored the highest average FPP values, comparing among farms and countries was difficult given variability in physical characteristics, practice cost and weather.
- Overall, the different mixes of practices caused significant improvements to hydrology, including reducing runoff by 84%
- Large capital expenses associated with renovation activities may have inflated cost data. However, O&M costs appear to be low at 12% of total

Recommendations

The functionality and applicability of the tool could be enhanced via the following:

- Integrating cost data and tracking costs over a full production cycle to better capture recurring expenses and distribute capital investment across years
- Developing an algorithm to incrementally evaluate various practices and benefits for a farm. Currently, running multiple scenarios for many farms is time-prohibitive.
- Adding functionalities that will enhance use in non coffee-based agroforestry systems and across different geographies
- Monitoring pollutant loads to validate if practices mitigate stream degradation by reducing pollutants entering natural waterways

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