Food and Agriculture Organization of the United Nations

GLOBAL SYMPOSIUM on **SOILS** and **WATER**

02-05 October, 2023

Soil and water: a source of life

Water Smart Agriculture

A decade successfully restoring soils and revitalizing rainfed agriculture of smallholder farmers in the Central American dry corridor under a changing climate

Dr. Axel Schmidt et al. (CRS)

THE HOWARD G. BUFFETT FOUNDATION

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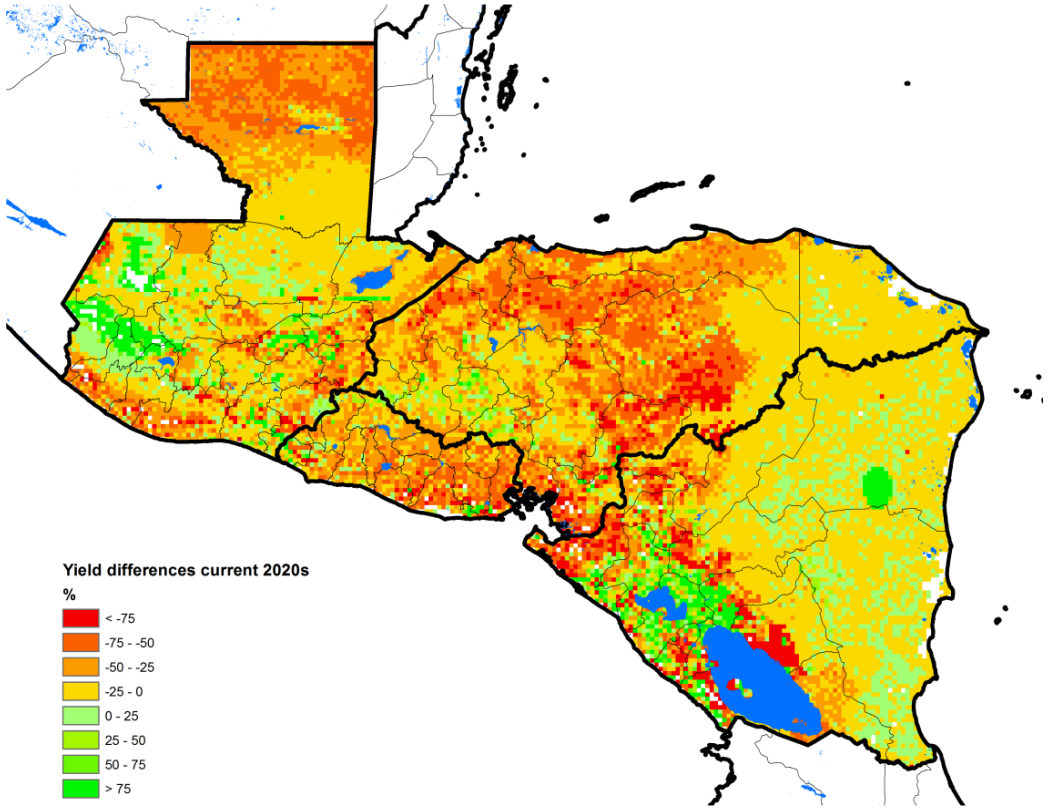
itps INTERGOVERNMENTAL TECHNICAL PANEL ON SOILS

GLOBAL SOIL PARTNERSHIP

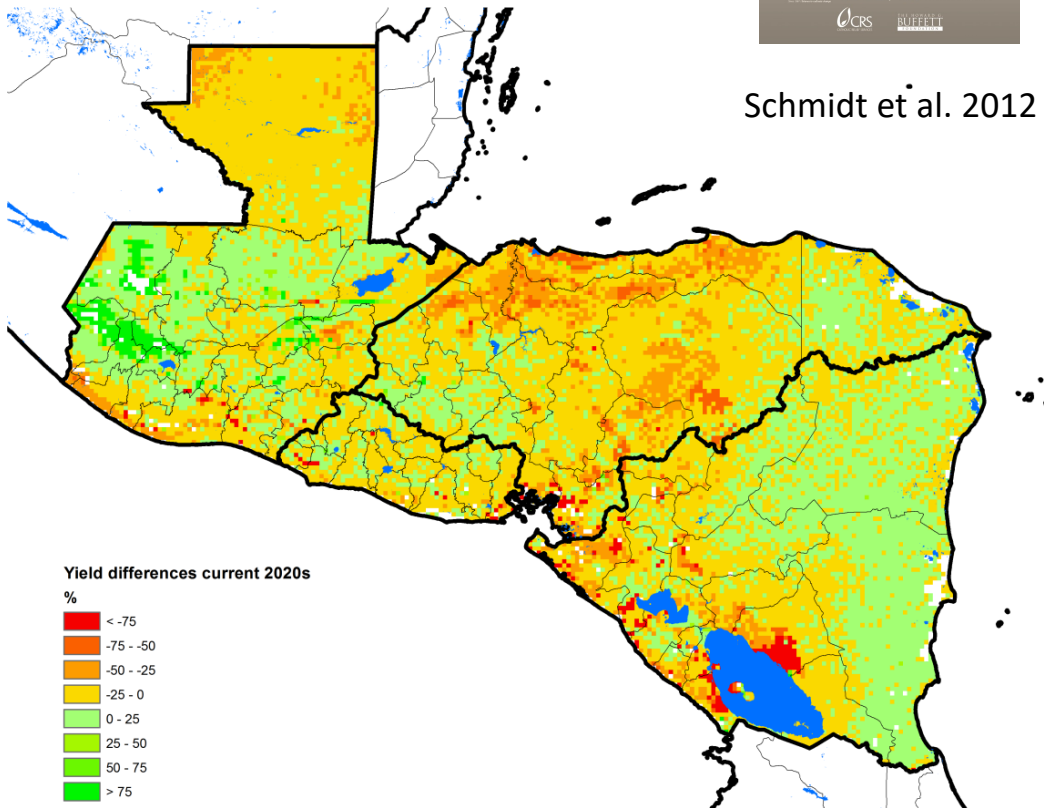
How did we start …?

Schmidt et al. 2012

DSSAT simulations revealed ….



Maize yield – " **bad** soil management " (- 2020s)



Maize yield – " **good** soil management " (- 2020s)

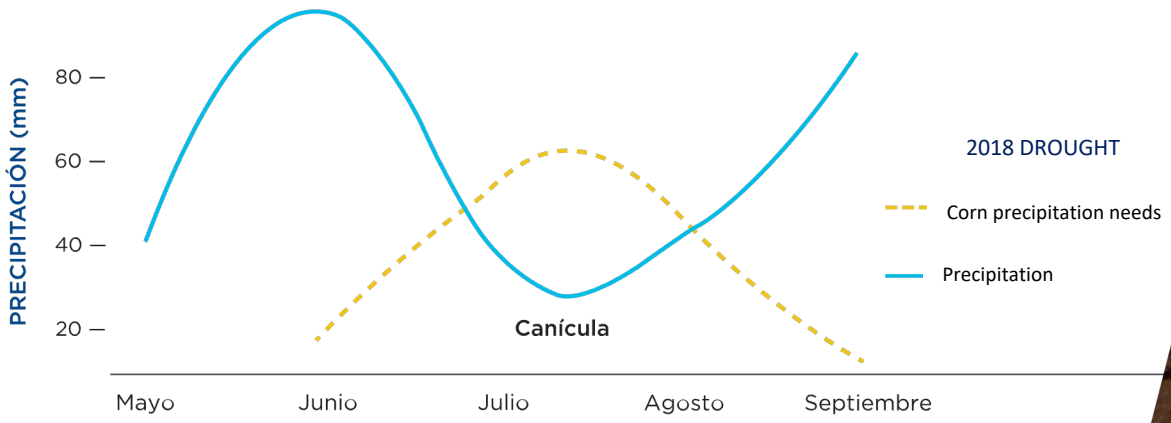
Predicted impacts on maize yields

Country	Degraded Soils		Well managed Soils	
	2020s	2050s	2020s	2050s
	% of variation			
El Salvador	-32.2	-33.5	-1.1	-1.8
Honduras	-29.5	-29.8	-11.7	-11.7
Nicaragua	-11.0	-11.3	-3.3	-4.0
Guatemala	-10.8	-11.0	0.5	0.4

Schmidt et al. 2012

Central America's Dry Corridor

Central America's Dry Corridor



74%
Degraded agricultural lands

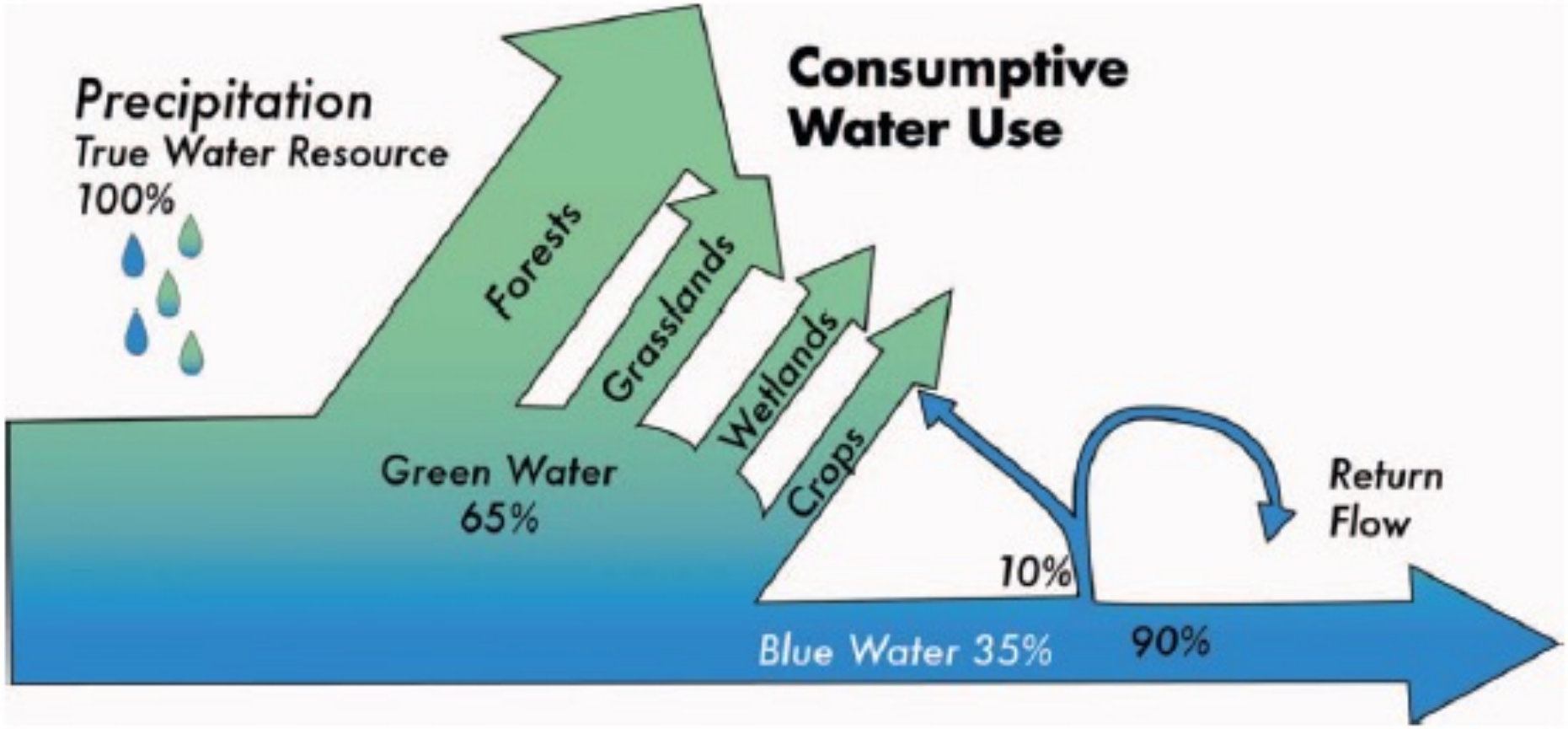
50-90%
Productivity losses of basic grains

1.6 M
People living with food insecurity

Source: Atlas centroamericano para la gestión sostenible del territorio.

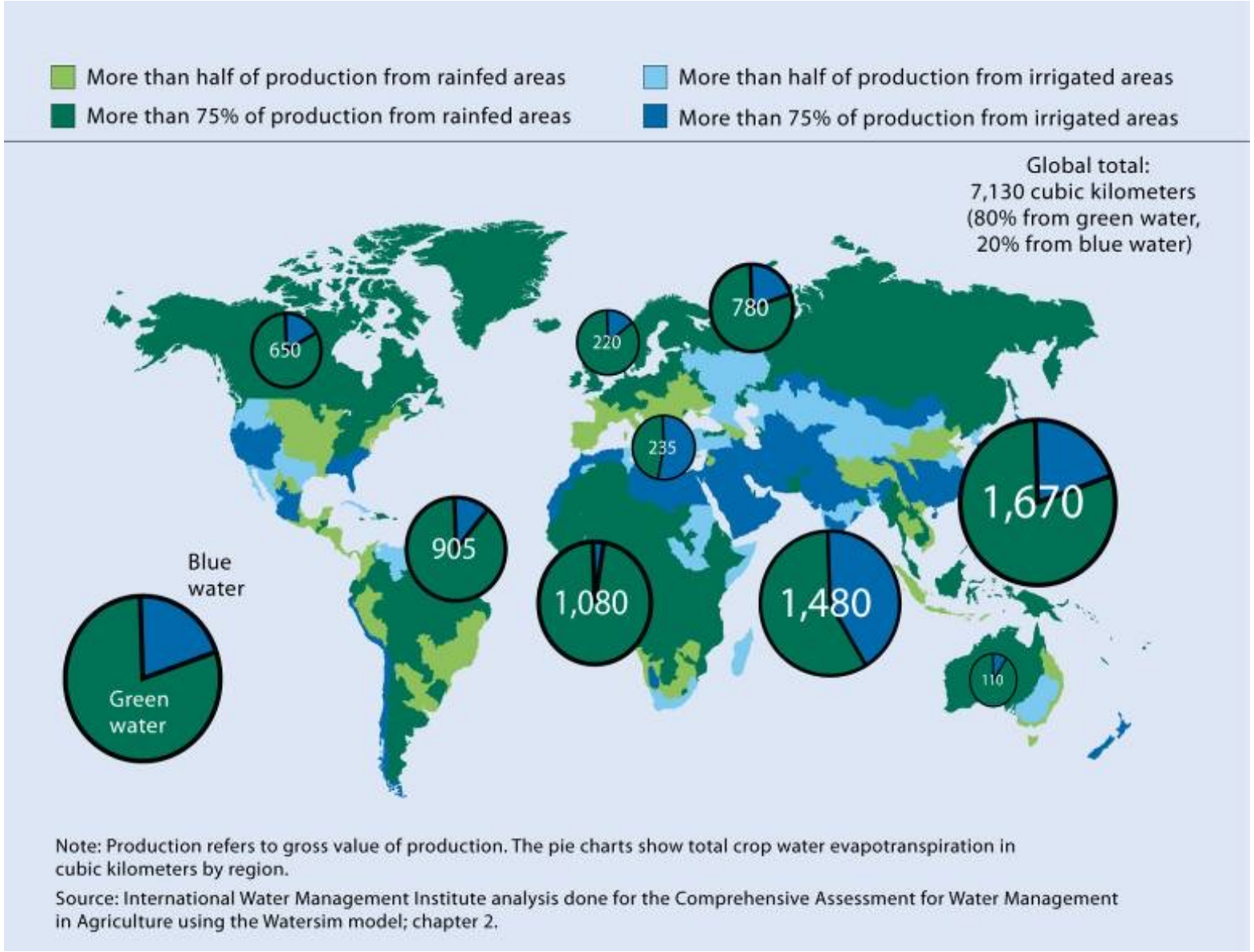
Fuente: FAO 2018

Green water paradigm – rainfed systems



Falkenmark & Rockström, 2010

Upgrade rainfed agriculture



The 20th century was the era of Nitrogen, the 21st century will be the era of Water

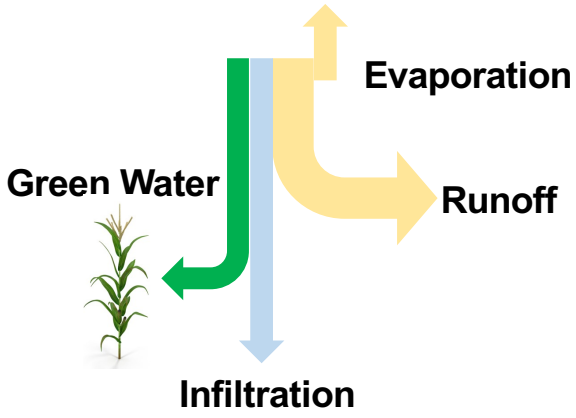
G. Kahnt, University of Hohenheim 1988

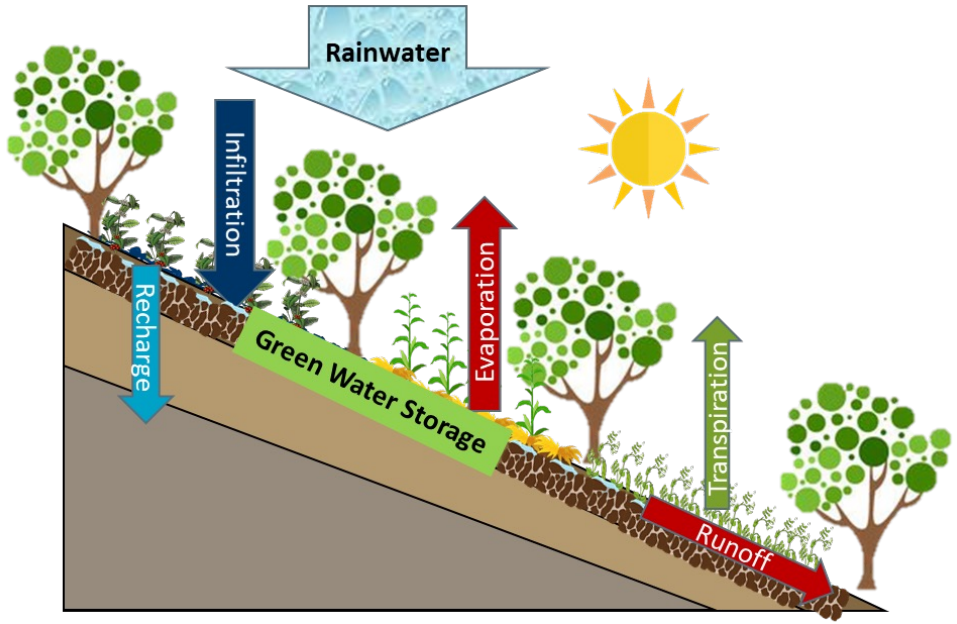
Molden, 2007. Water for Food Water for Life: A Comprehensive Assessment of Water Management in Agriculture

WSA – Manage Soil to Manage Water

Barron, 2012

Poorly-Managed Degraded Soils

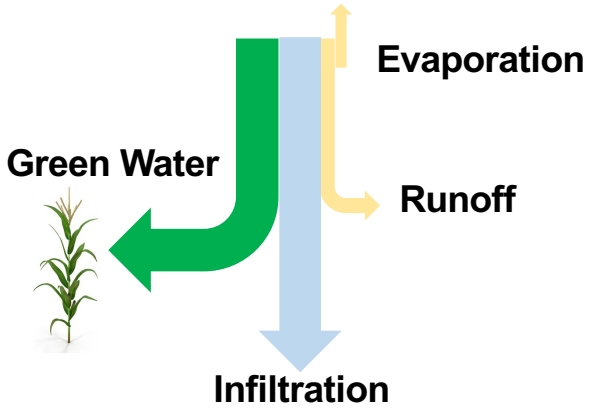




Soil Restoration

- ✓ Minimal Soil Movement
- ✓ Residue Retention/Permanent Soil cover
- ✓ Diversification, Cover Crops, Agroforestry
- ✓ Integrated Soil Fertility Management & 4R

Well-Managed Healthy Soils



(Falkenmark and Rockstrom, 2010; Foto: Diario La Prensa, 2013; Figura ISRIC 2017)

WSA/ASA - an integrated approach

- Based on conservation agriculture principles
- Draws on Integrated Soil Fertility Management (ISFM) & 4R
- Values classical agronomy
- Capitalizing on agroforest-crop-livestock system benefits
- Site-specific
- Knowledge-intensive approach for decision making
- Collaborative Experimentation & Continuous Learning Approach
- Builds on a competency framework

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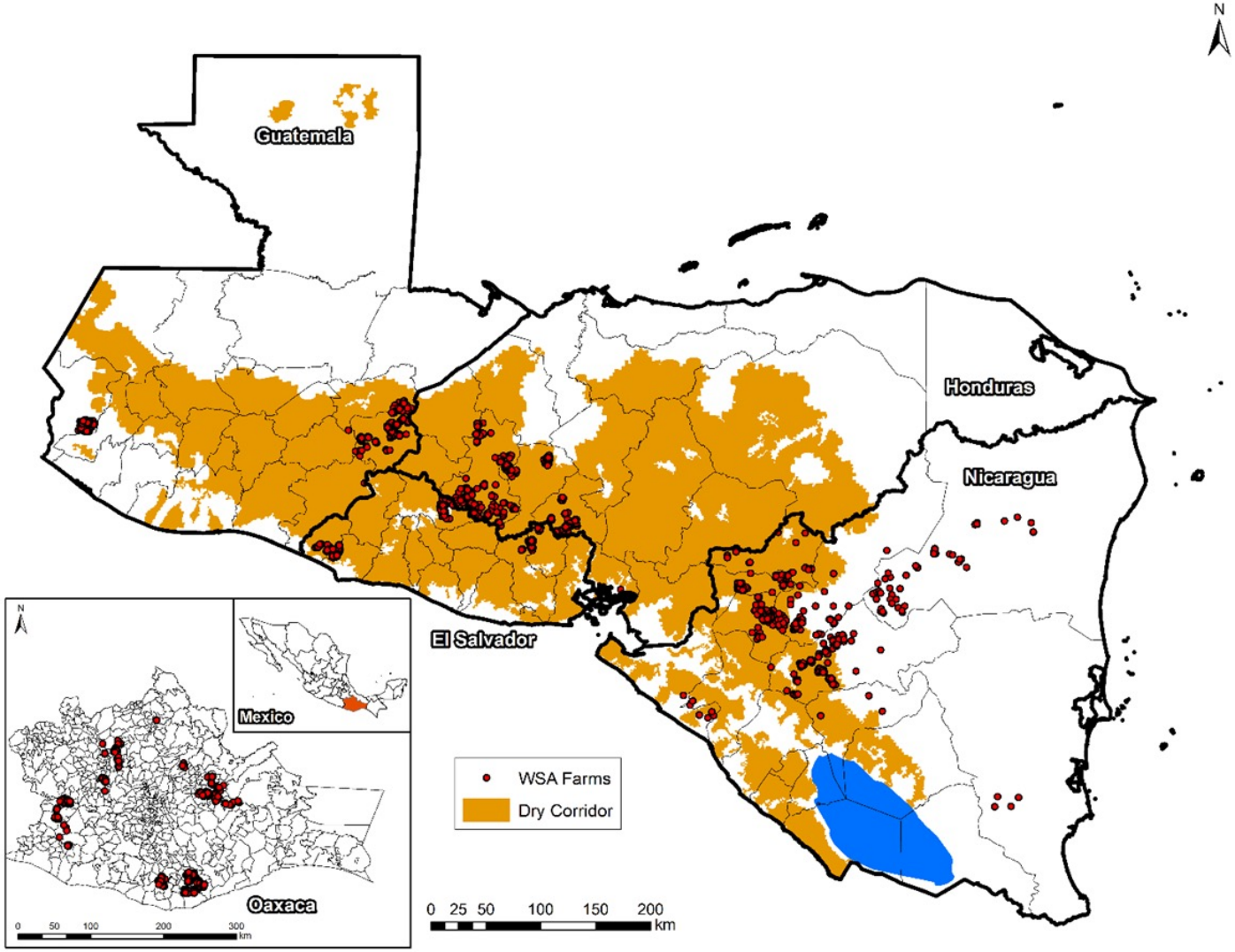
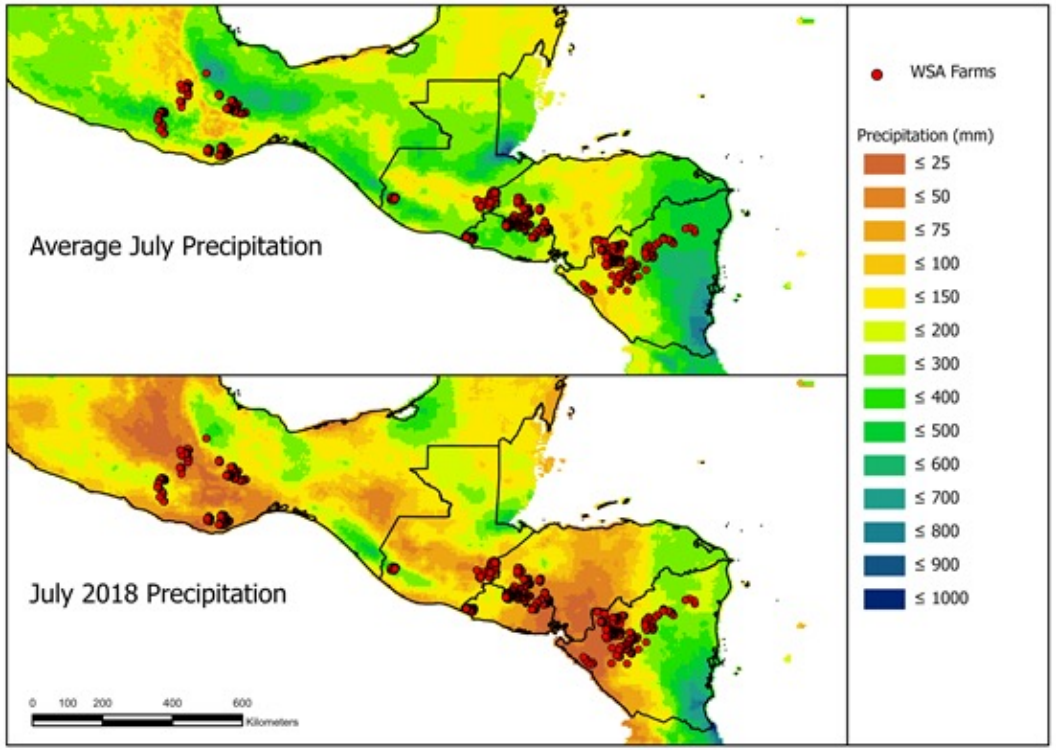
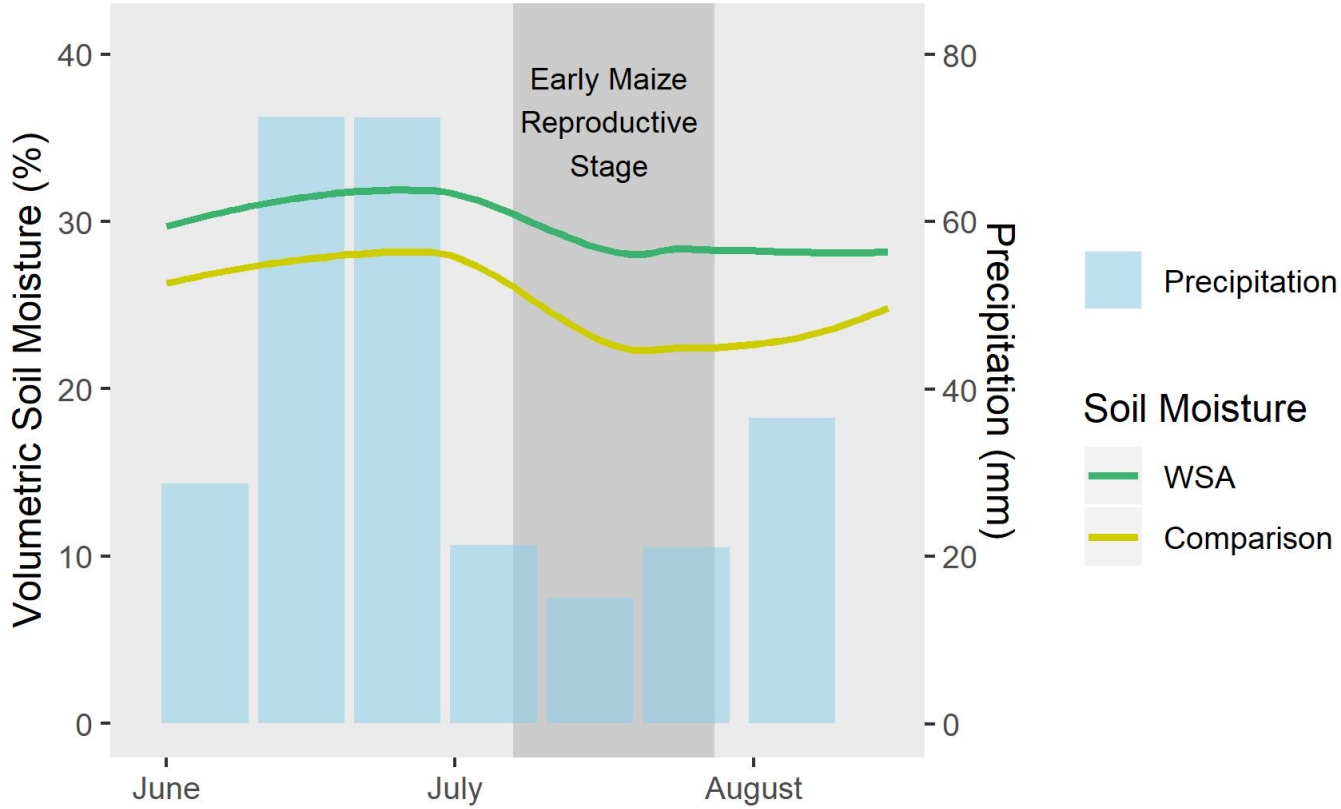
More than 3000 WSA farms in the region



WSA Increases Soil Moisture and Drought Resilience



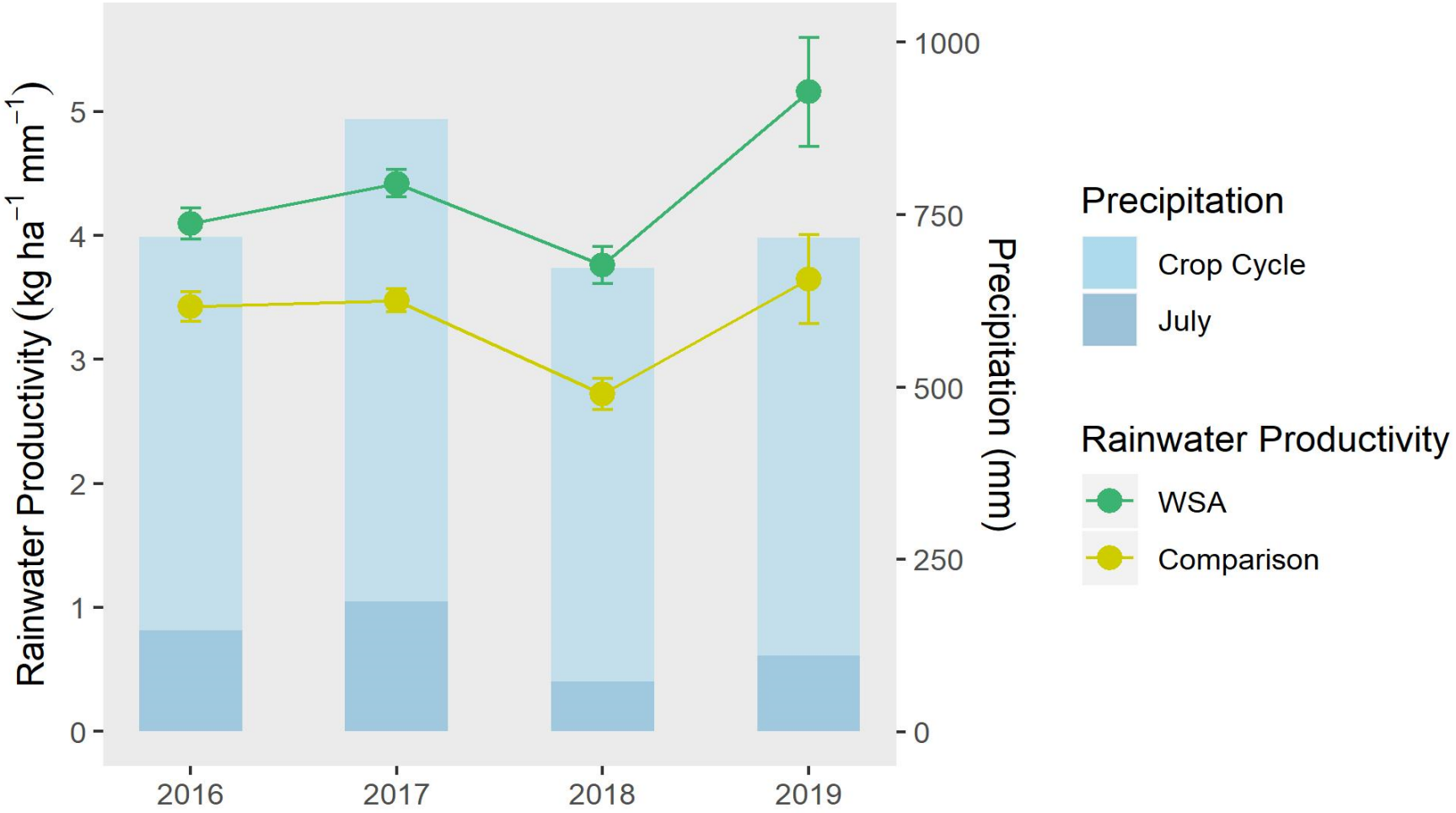
(CHIRPS precipitation data; Funk et al. 2014



Average increase in volumetric soil moisture (%) in WSA plots vs. comparison plots, during the 2018 Primera season in Nicaragua (N=44 farms). The average 2018 precipitation in the plots is shown by the blue bars and the early reproductive stage is indicated.

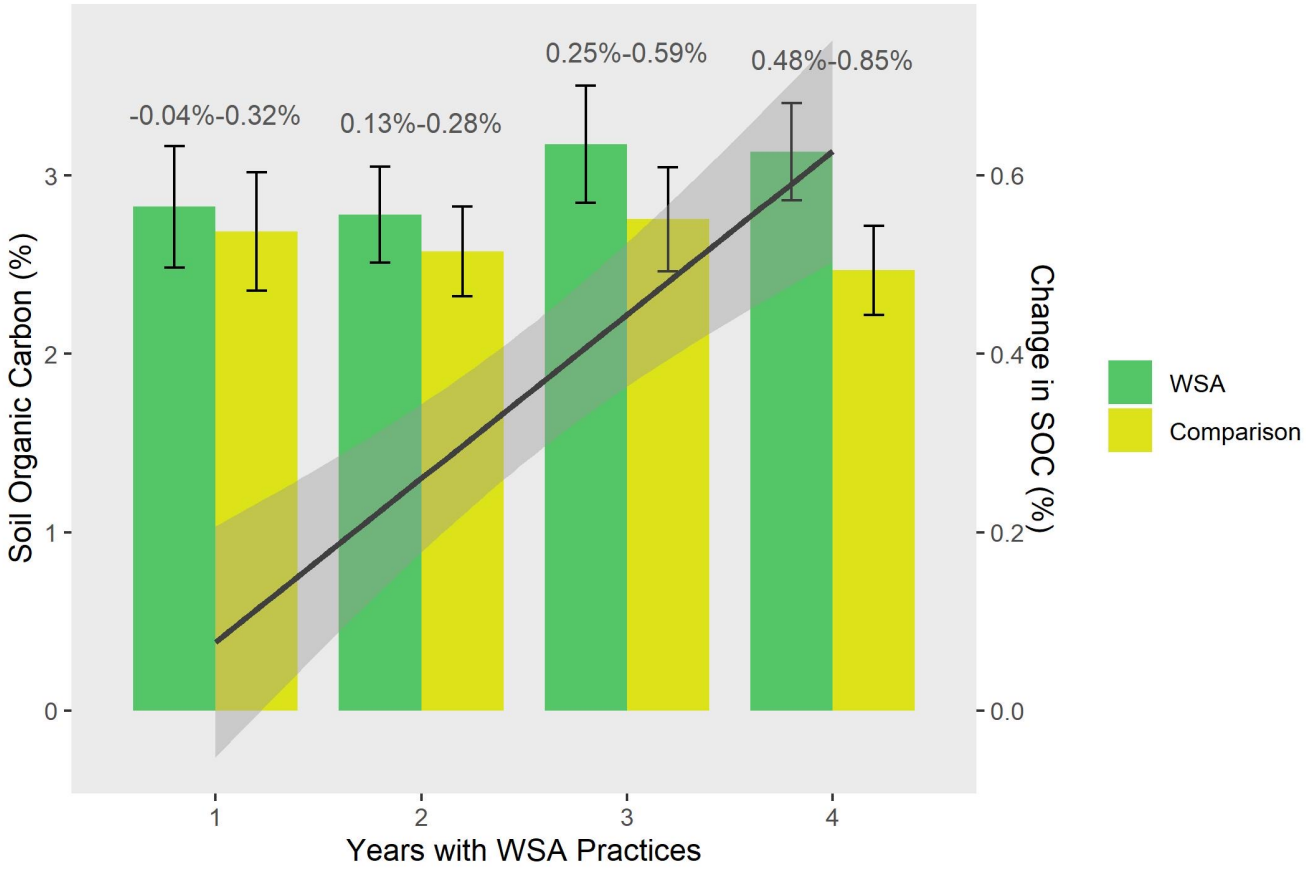
More Crop per Drop

WSA Increases Rainwater Productivity of Maize



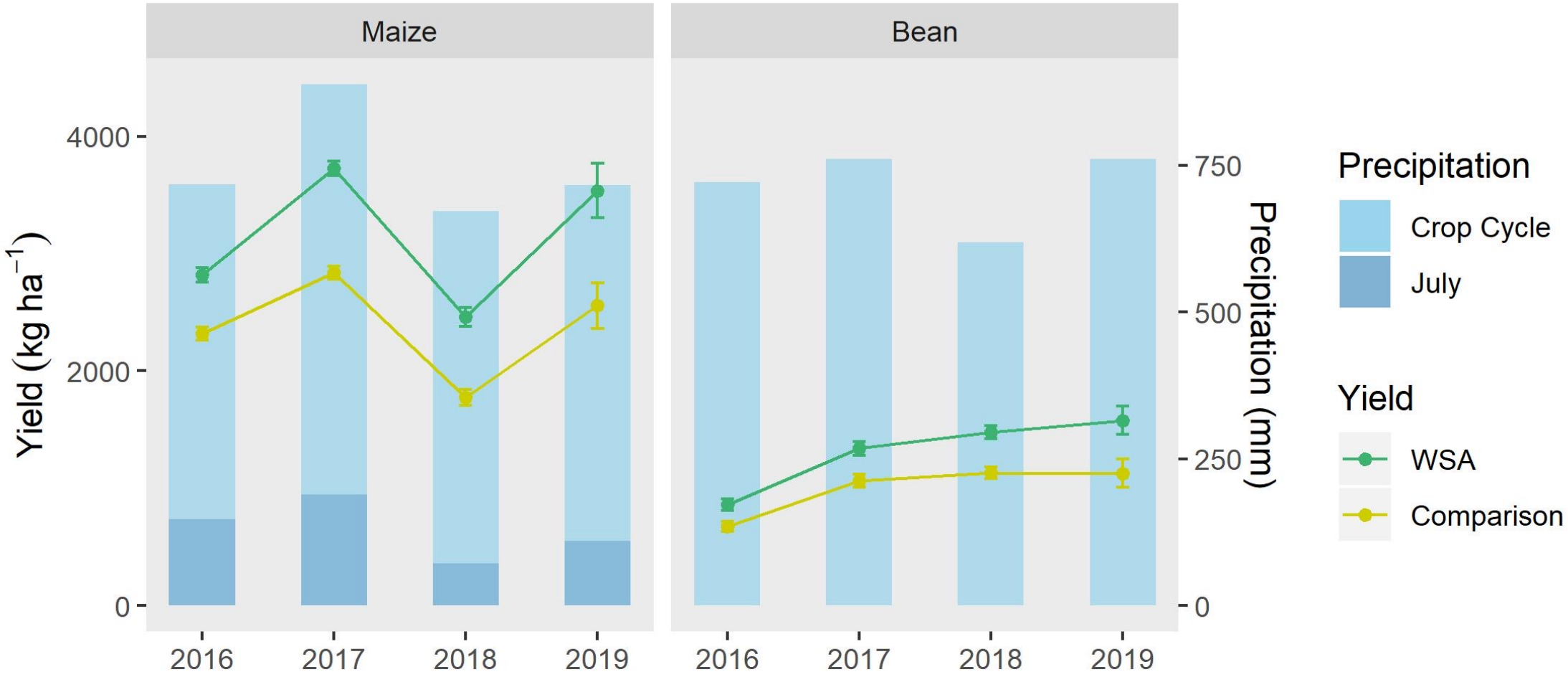
Rainwater productivity of maize in WSA and comparison plots in the dry corridor over the past four years 2016-2019 (N=1291 farmers). Precipitation during the maize season (May – August) and July precipitation (when the canicula dry spell typically occurs) is shown.

WSA Increases Soil Organic Carbon



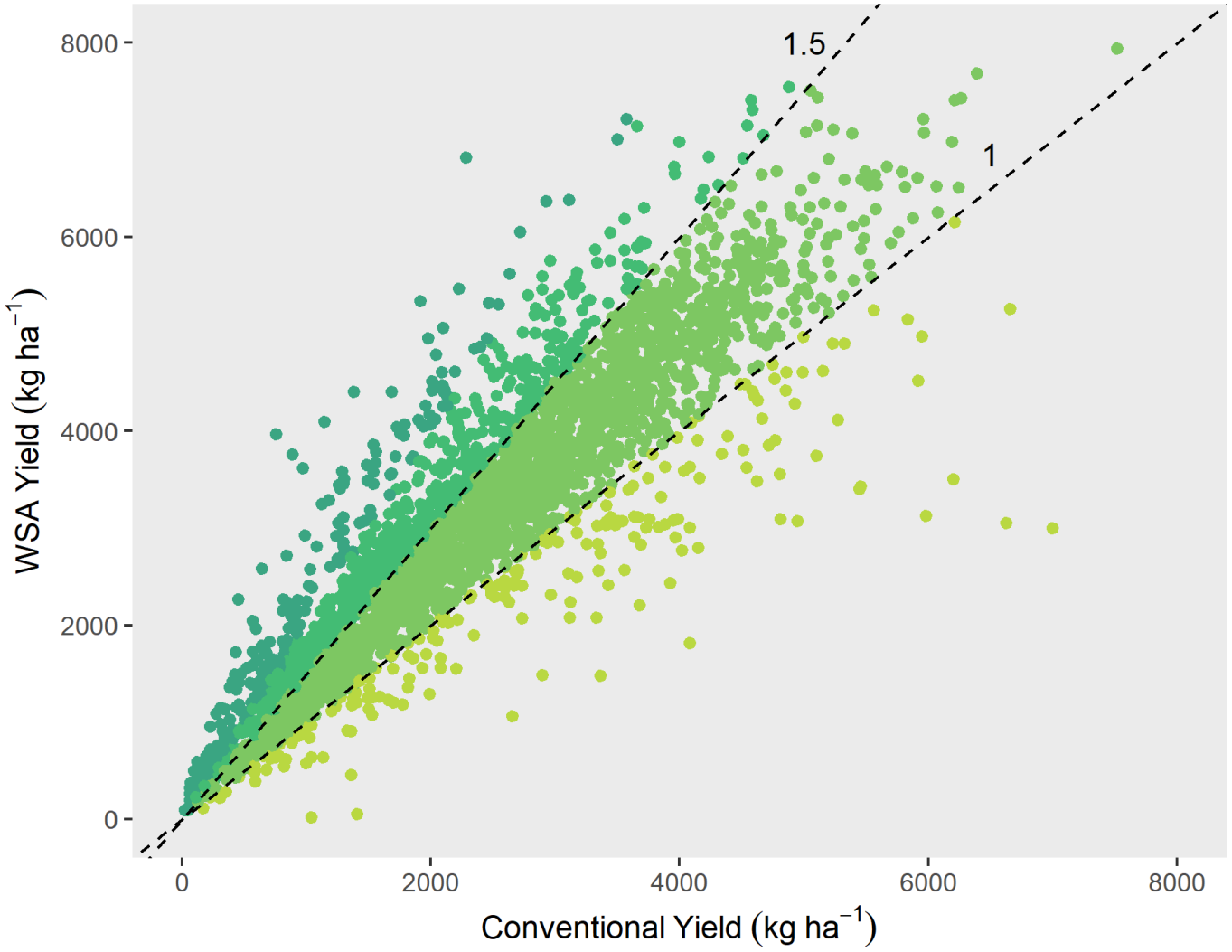
Soil Organic Carbon (%) in WSA maize-bean plots in Nicaragua after 1-4 years of WSA practice implementation. 95% CI and bars and values of mean difference shown. (Year 1, n=38; Year 2; n=55; Year 3, n=45; Year 4, n=47).

WSA Increases Food Production



Maize yield (kg/ha) in WSA and comparison plots in the dry corridor over the past four years 2016-2019 (N=1291 farmers). Precipitation during the maize season (May – August) and July precipitation (when the canicula dry spell typically occurs) is shown.

WSA vs. Conventional Maize Yield



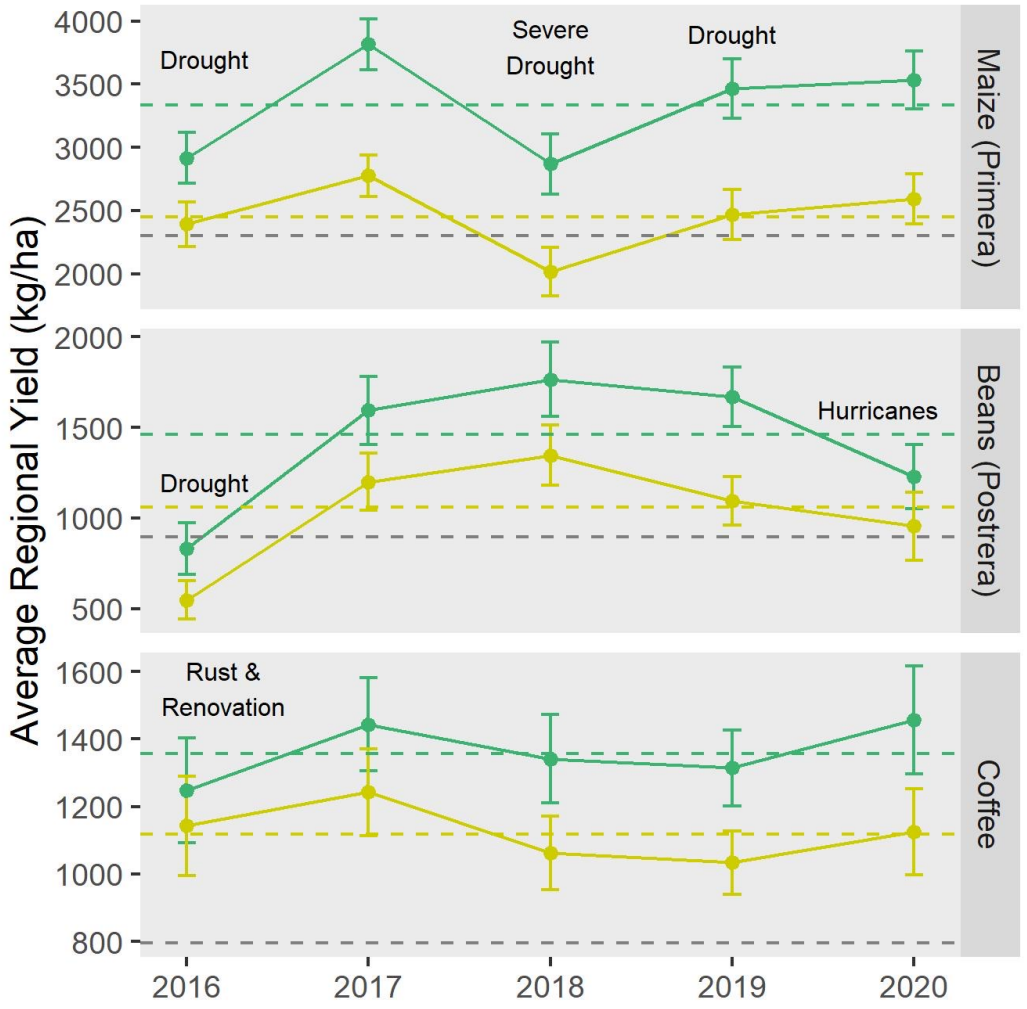
(n=3405 maize harvest years)

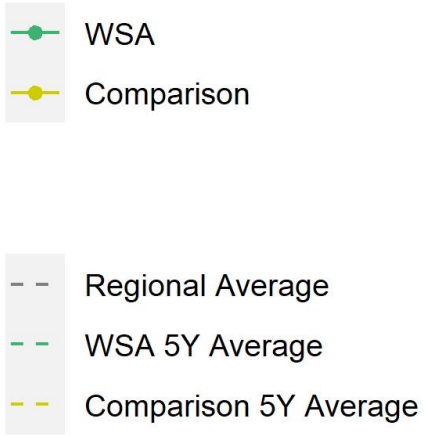
Average maize yields:
3.1 t ha^{-1} with WSA
2.4 t ha^{-1} with Conventional

31% increase in productivity

93% above 1
29% above 1.5x

WSA outperforms the average Central American yield despite climate variation



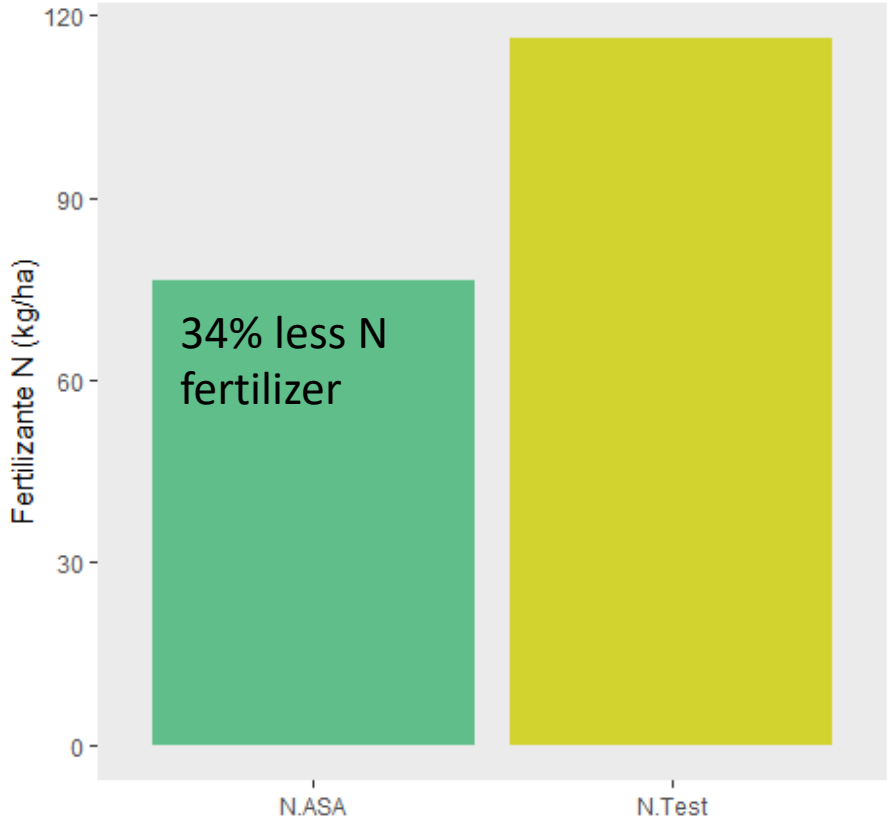


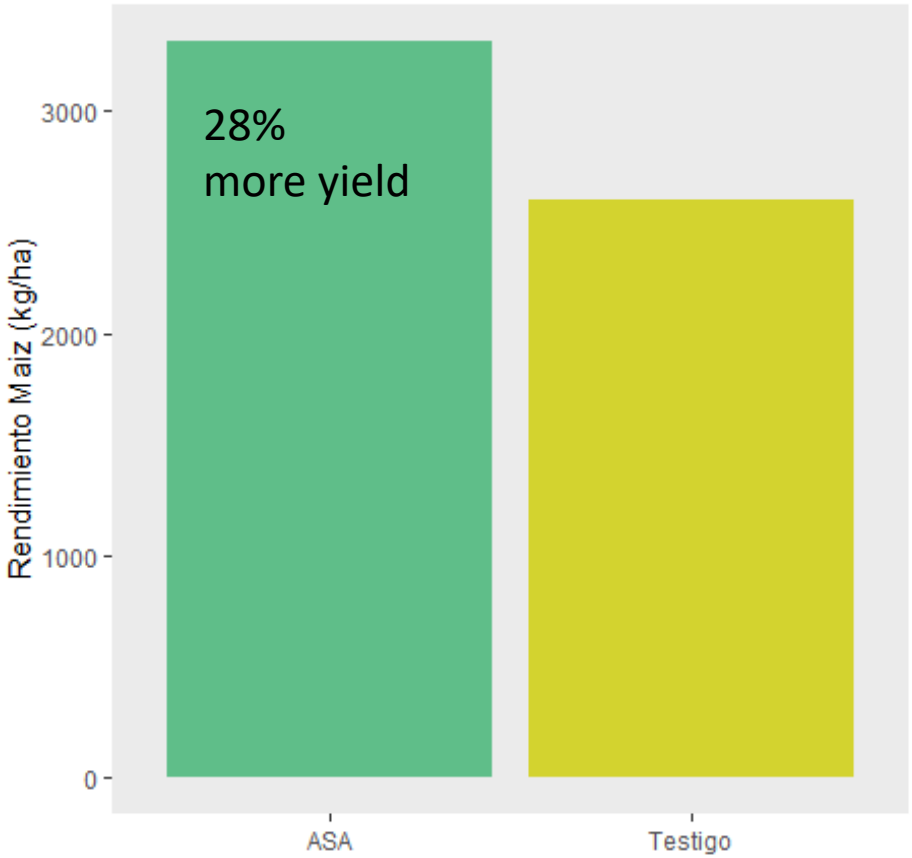
Average regional WSA and Comparison plot maize (primera/spring season), beans (postrera/fall season), and coffee yields over the 5 years of the WSA program. The five-year average yield for WSA and Comparison and the regional average yield for each crop are show with a dashed line. Major agroclimatic events that occurred in each crop cycle are indicated. The 95% confidence intervals of the mean yield values are shown (sub-sample of farms with data spanning the program; Maize, n=148; Beans, n=54; Coffee, n=92)

WSA increases Nitrogen Use Efficiency in Maize

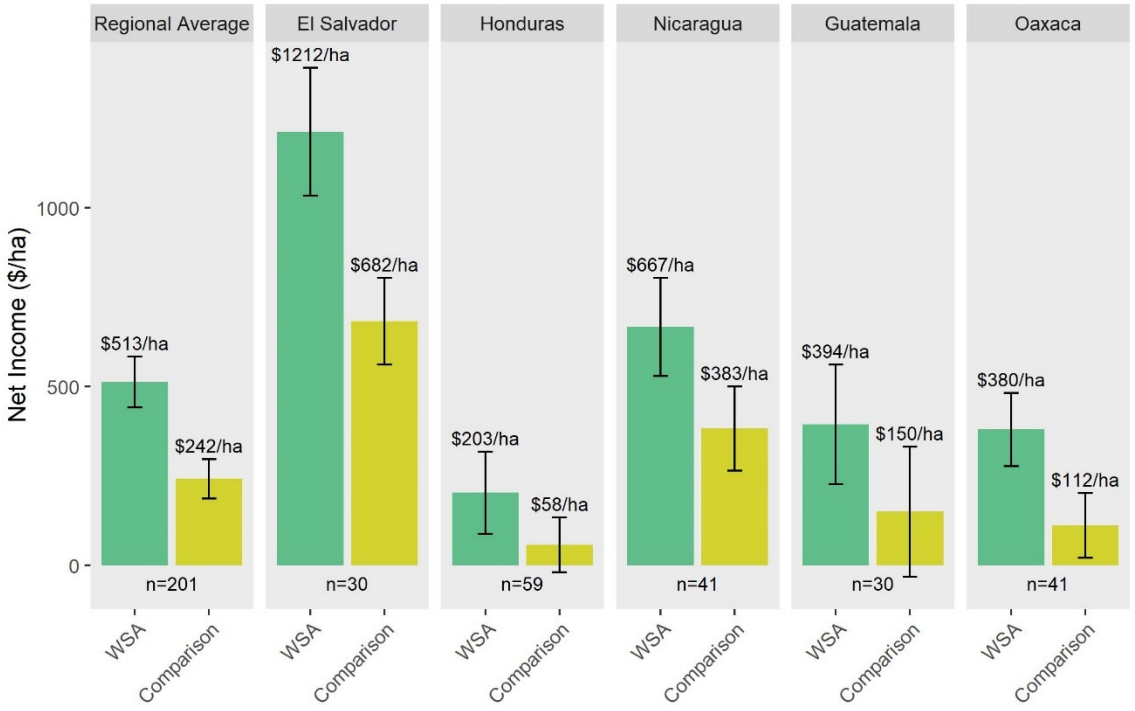
NUE increases by 93%

CRS-Guatemala, 2019

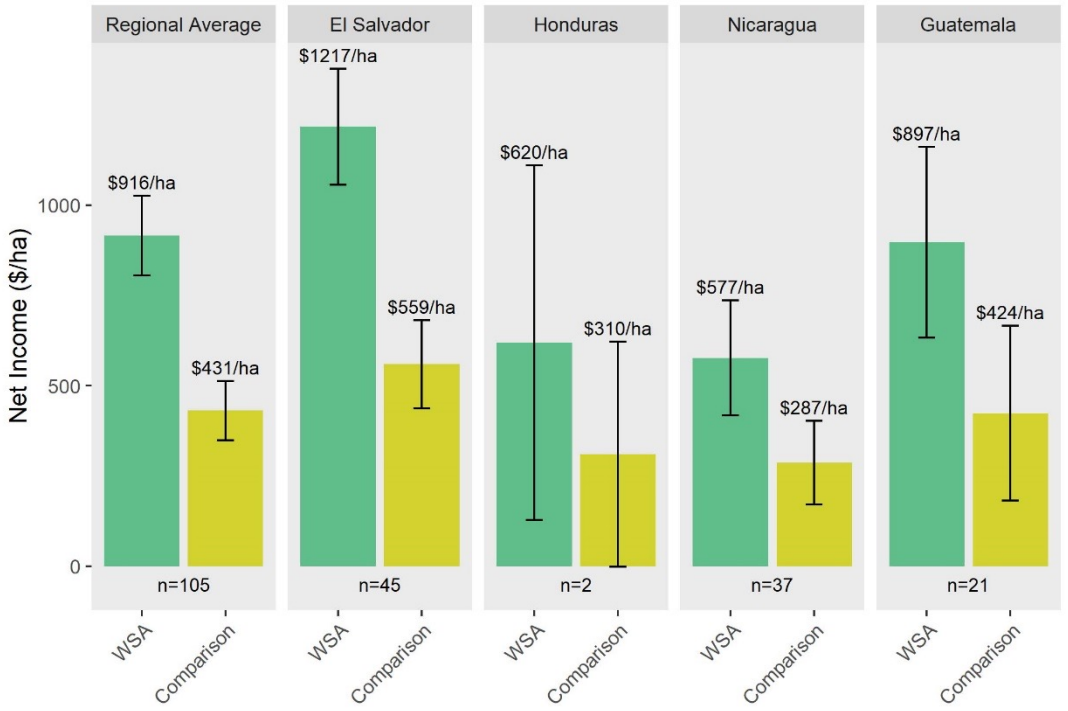




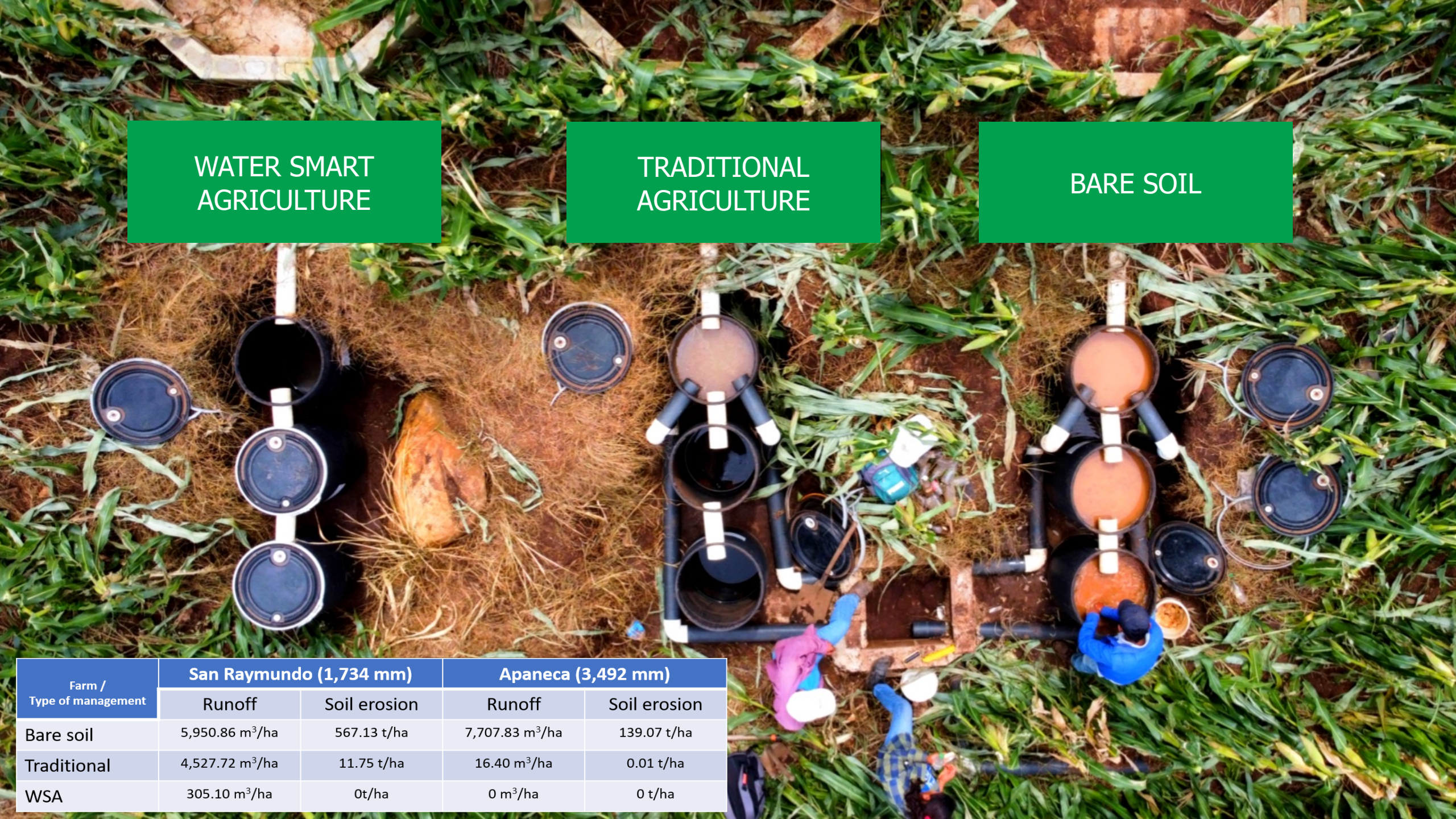
WSA pays off – net income doubles



Average maize yield (kg/ha) with 95% confidence intervals of the mean in 2019 WSA plots vs. comparison plots (n=201).

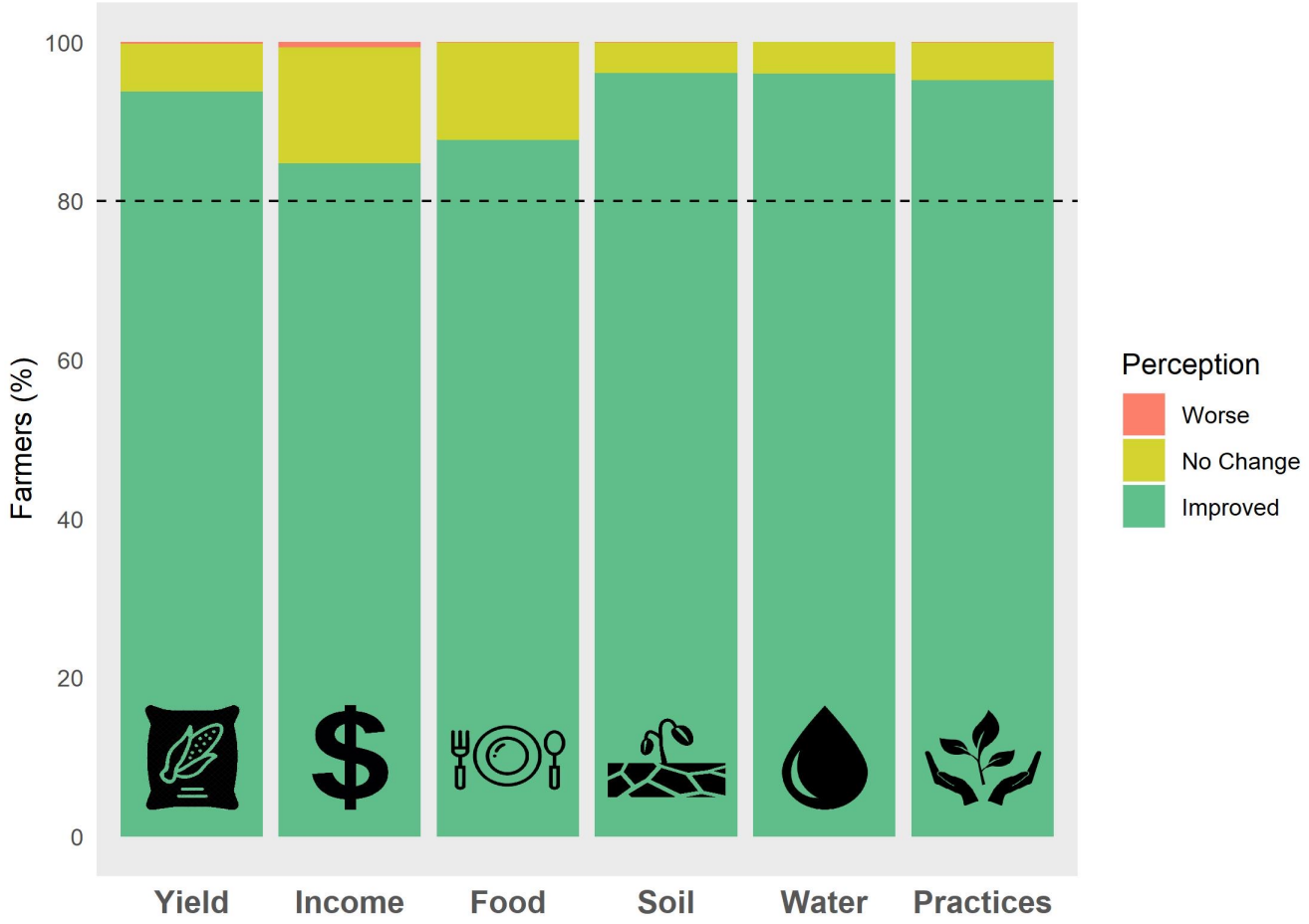


Average bean yield (kg/ha) with 95% confidence intervals of the mean in 2019 WSA plots vs. comparison plots (n=105).



Farm / Type of management	San Raymundo (1,734 mm)		Apaneca (3,492 mm)	
	Runoff	Soil erosion	Runoff	Soil erosion
Bare soil	5,950.86 m^3/ha	567.13 t/ha	7,707.83 m^3/ha	139.07 t/ha
Traditional	4,527.72 m^3/ha	11.75 t/ha	16.40 m^3/ha	0.01 t/ha
WSA	305.10 m^3/ha	0t/ha	0 m^3/ha	0 t/ha

WSA convinces farmers



Farmer perceptions of WSA practices and their impact on yield, income, food & soil (n=1,454)

Main Take-Aways

- Combining Conservation Ag principles & ISFM/4R with basic agronomic practices result in improvements in soil health, water and nutrient use efficiency, and translate into significantly increased productivity and economic benefits for smallholders, even in the short term.

- With WSA, smallholder farmers produce more, earn more and are more resilient to drought and weather extremes in the Dry Corridor of Central America.

- Potential to mitigate the impacts of climate change with C sequestration and improve food security in the region through land restoration.

- For successful land restoration, WSA built the evidence base (data) and capacity for sustainable soil management (tools, methods, DSM, training, competency model, collaborative learning and experimenting, delivery model).

Some thoughts to finalize …

- Water will be the main theme of the 21st century
- We need to manage our soils to manage water
- On-farm and landscape soil restoration secures also drinking water for the urban population
- Soil management and soil health are part of the solution to many global crises:
  - The food crisis
  - The climate crisis
  - The fertilizer crisis
  - The migration crisis

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