Climate-Smart Agriculture : A Global Outlook

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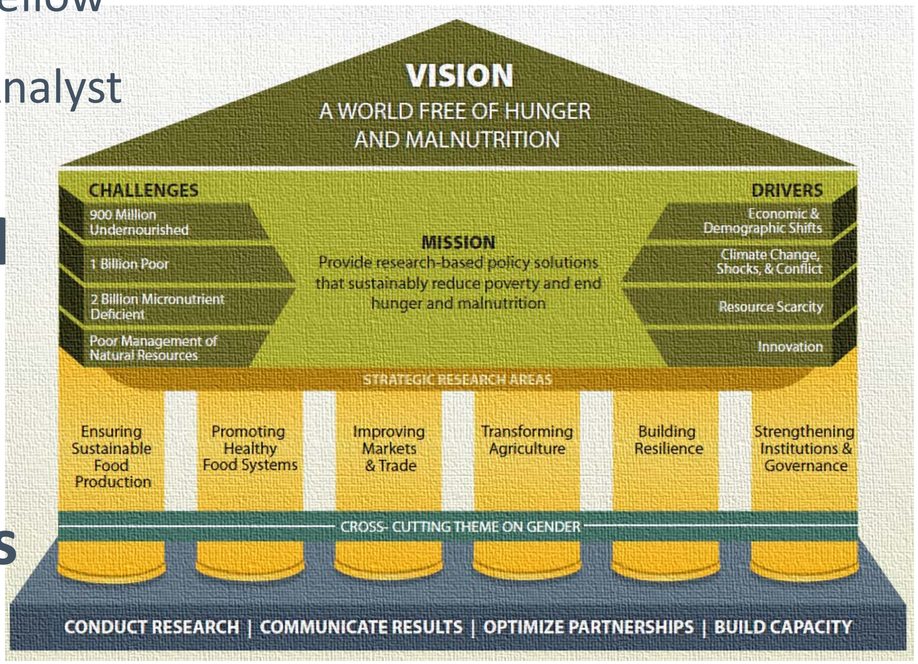
- **Ensuring sustainable food production**
- **Building resilience**
- **Strengthening institutions and governance**



Presentation Overview

- Effects of climate change on food production
- The concept of Climate-Smart Agriculture (CSA)
- An ex-ante economic impact assessment on global adoption of CSA practices
- Conclusions

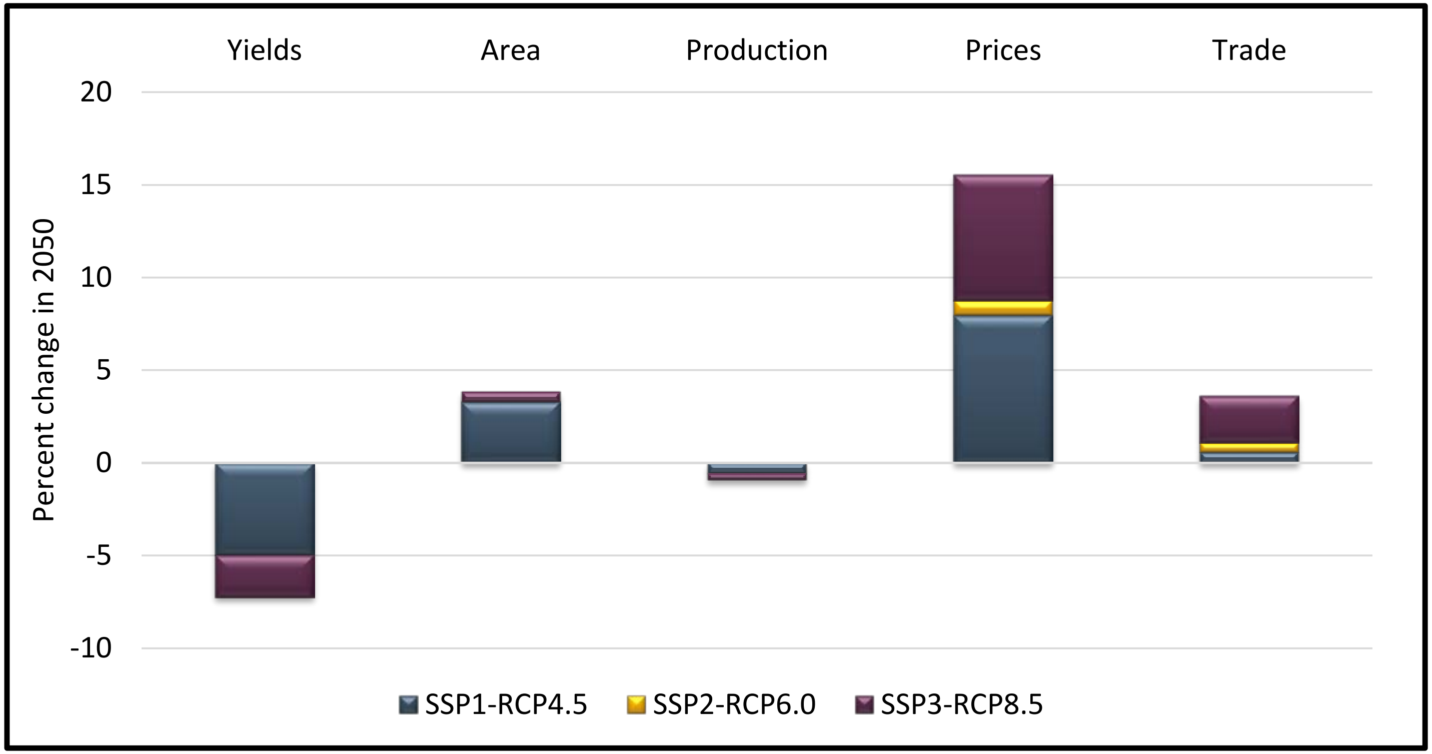
Effect of Climate Change on Food Production

Food Security Challenges are Unprecedented

- Population growth (UN-DESA 2013)
  - 2.4 billion more people by 2050 (total projected 9.6 Billion ± 1.3)
  - High projected population growth in the low-middle income countries
- Income growth in developing countries
  - More demand for high valued food (meat, fruits, vegetables)
- **Climate Change (CC) exacerbates existing threats generates new ones**

Climate Change Impacts in 2050

Average of 5 global economic models for coarse grains, rice, wheat, oilseeds and sugar



Wiebe et al, 2015

Agriculture and Climate Change

- Agriculture currently generates 11% of total GHG emissions.
- Developing countries collectively produce the majority of agriculture-related emissions globally and are where emissions are expected to rise the fastest (Smith et al., 2014).
- Agricultural emissions are also significant at national levels, contributing an average of 35% of emissions in developing countries and 12% in developed countries (Richards et al., 2015).

Sustainable Development Goal 2.3 “doubling agricultural productivity and incomes of small-scale food producers by 2030”

The Concept of Climate-Smart Agriculture

Climate-Smart Agriculture (CSA)

- Two concepts - climate change adaptation and mitigation - were combined in the term CSA.
- CSA was introduced in 2009 and became prominent a year later at the First Global Conference on Agriculture, Food Security and Climate Change (FAO, 2010).
- **Possibly, after the disappointing experience with the carbon markets, a way to include mitigation in policy talks without it to be the main goal**

Climate-Smart Agriculture (CSA)

- CSA is an integrative approach to address these interlinked challenges of food security and climate change
  - **Sustainably increasing agricultural productivity** to support equitable increases in farm incomes, food security, and development;
  - **Adapting and building resilience** of food systems and farming livelihoods to climate change at multiple levels; and
  - **Reducing greenhouse gas emissions** from agriculture, **where possible.**

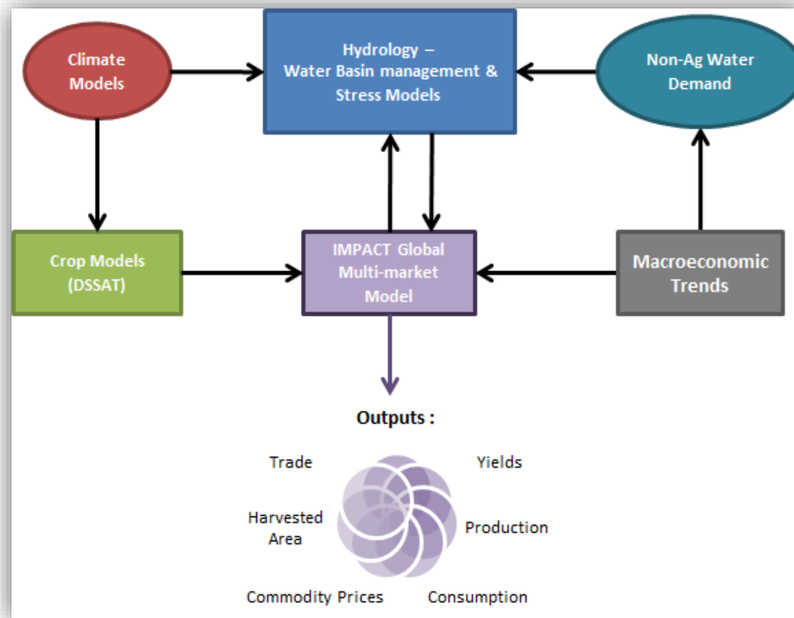
Effect of adoption of CSA on global economy

Global Adoption of CSA

- We investigate how adoption on a global scale of a series of CSA-compatible practices might affect global prices, world production, GHG emissions, and trade flows.
  - Conduct ex-ante economic impact assessment using IFPRI's International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) system of models
  - Simulate global adoption of CSA practices on Maize, Wheat, and Rice (~41% of global harvested area).

IMPACT System of Models

- **Outputs of climate models**
- **A suite of global water models (i.e. hydrology, water basin management, and water stress)**
- **The DSSAT cropping system model** to estimate crop yield responses under varying management systems and environmental conditions.
- **A global partial equilibrium, multi-market food supply and demand projection model**

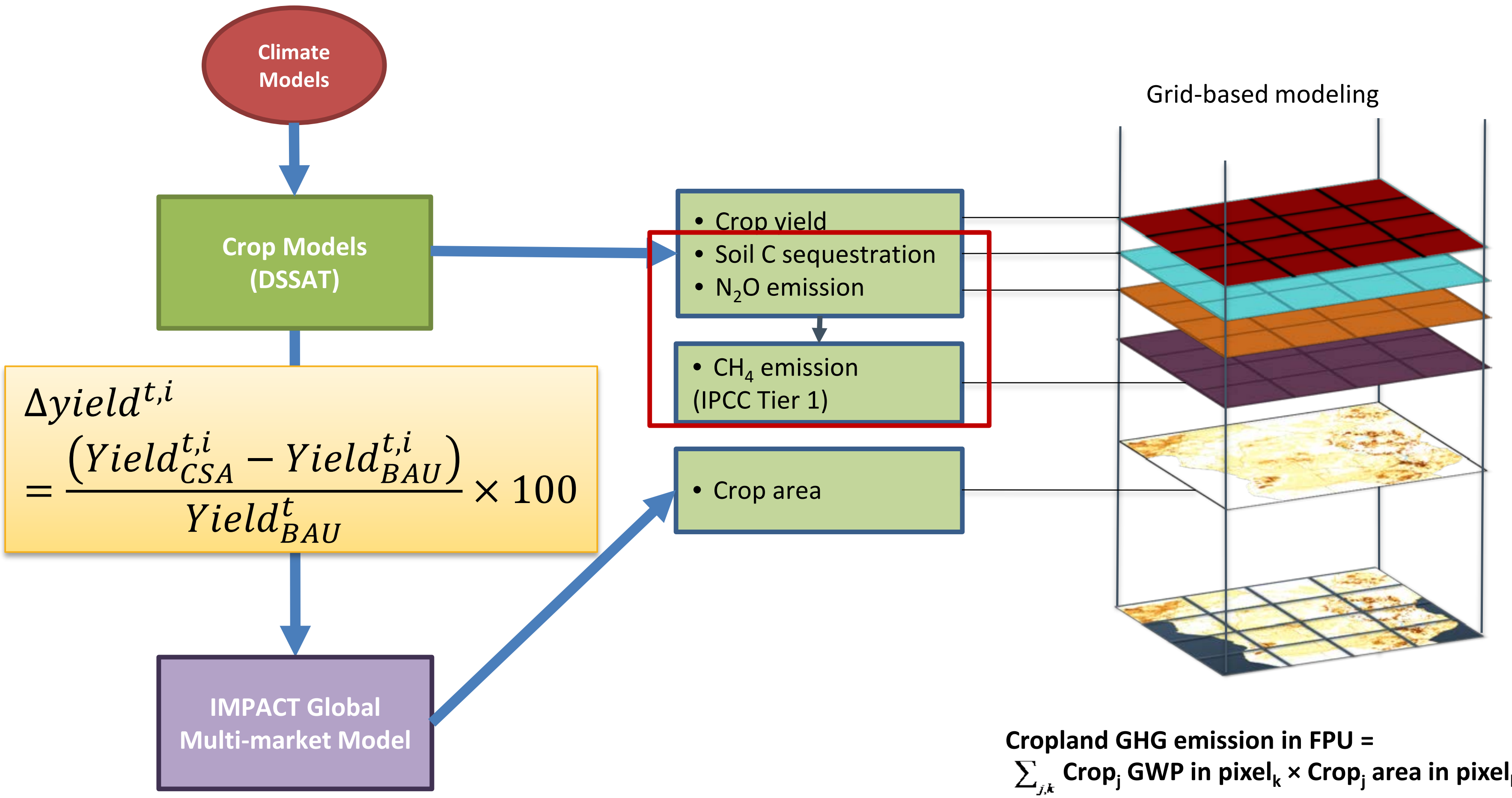


Robinson et al, 2015

Climate Data

- The Inter-sectoral Impact Model Intercomparison Project (ISI-MIP) provides gridded versions of GCM outputs relevant to agricultural modeling.
  - covers the period from 1960 through to 2099 on a horizontal grid with 0.5° × 0.5° resolution
  - Patterns of change from the ISI-MIP datasets are applied to a common and trusted set of baseline/historic climate data to allow for consistent comparisons and realistic baseline results.
- These gridded climate datasets comprise bias-corrected daily data for crop models

Yield and GHG Modeling



Scenarios

- Business-as-usual management practice
  - A reflection of current implementation of technologies assessed and assumes that farmers are consistently not adopting any of the specific technologies assessed in this study throughout the simulated period of 2011–2050
- Climate change projection
  - Climate change projections originate from running two global circulations models (GCMs), GFDL-ESM2M (Dunne et al. 2012), and HadGEM2-ES (Jones et al. 2011), **under a Representative Concentration Pathway (RCP) 8.5**.
- Socio-economic projection
  - **Shared Socioeconomic Pathways (SSP) 2:** This is a middle of the road scenario, which follows historical trends. Economic development continues, but is not uniform. Environmental degradation continues, but at a slowing pace.

CSA practices

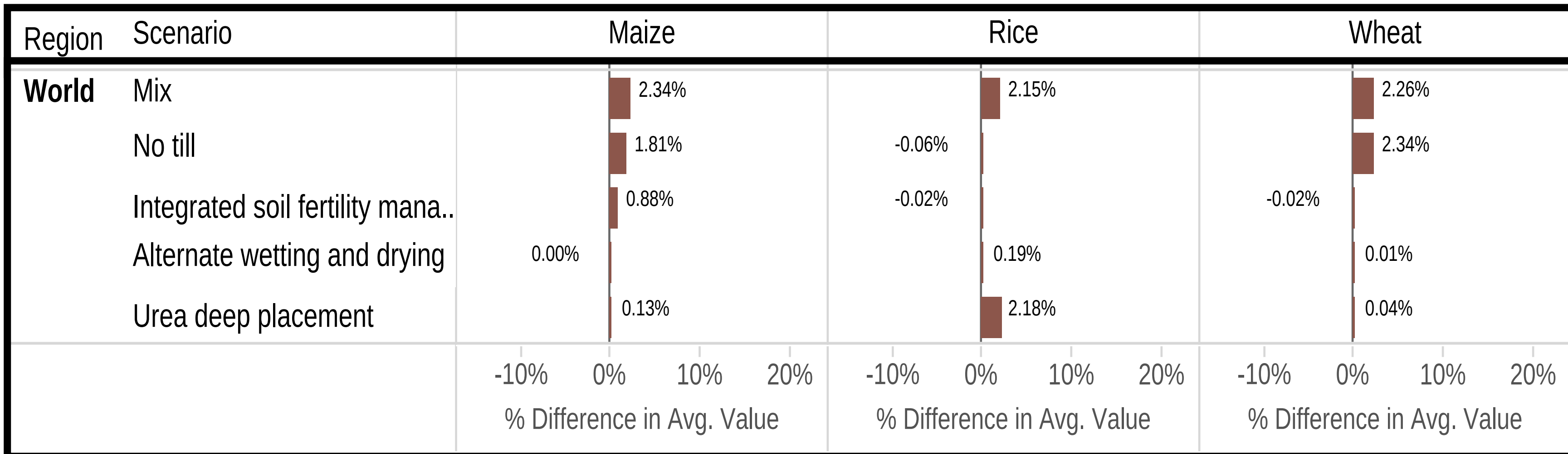
CSA technology	Definition	Crop	Potential effects on yields and GHG emissions	Socio-Economic Adoption Ceiling
No tillage (NT)	minimum or no soil disturbance, often in combination with residue retention, crop rotation, and use of cover crops	Maize, wheat	Positive or neutral on yields Uncertain effect on GHG emissions	70
Integrated soil fertility management (ISFM)	combination of chemical fertilizers, crop residues, and manure/compost	Maize, wheat	Positive effects on yields Variable effects on GHG emissions	40
Alternative wetting and drying (AWD)	repeated interruptions of flooding during the season, causing the water to decline as the upper soil layer dries out before subsequent re-flooding	Rice	Lower to no significant changes in yields High confidence in lower GHG emissions due to reduction of methane emissions	40
Urea deep placement (UDP)	strategic burial of urea 'supergranules' near the root zones of crop plants	Rice	Positive results on yields Reduction of GHG emissions	40

Important Assumptions

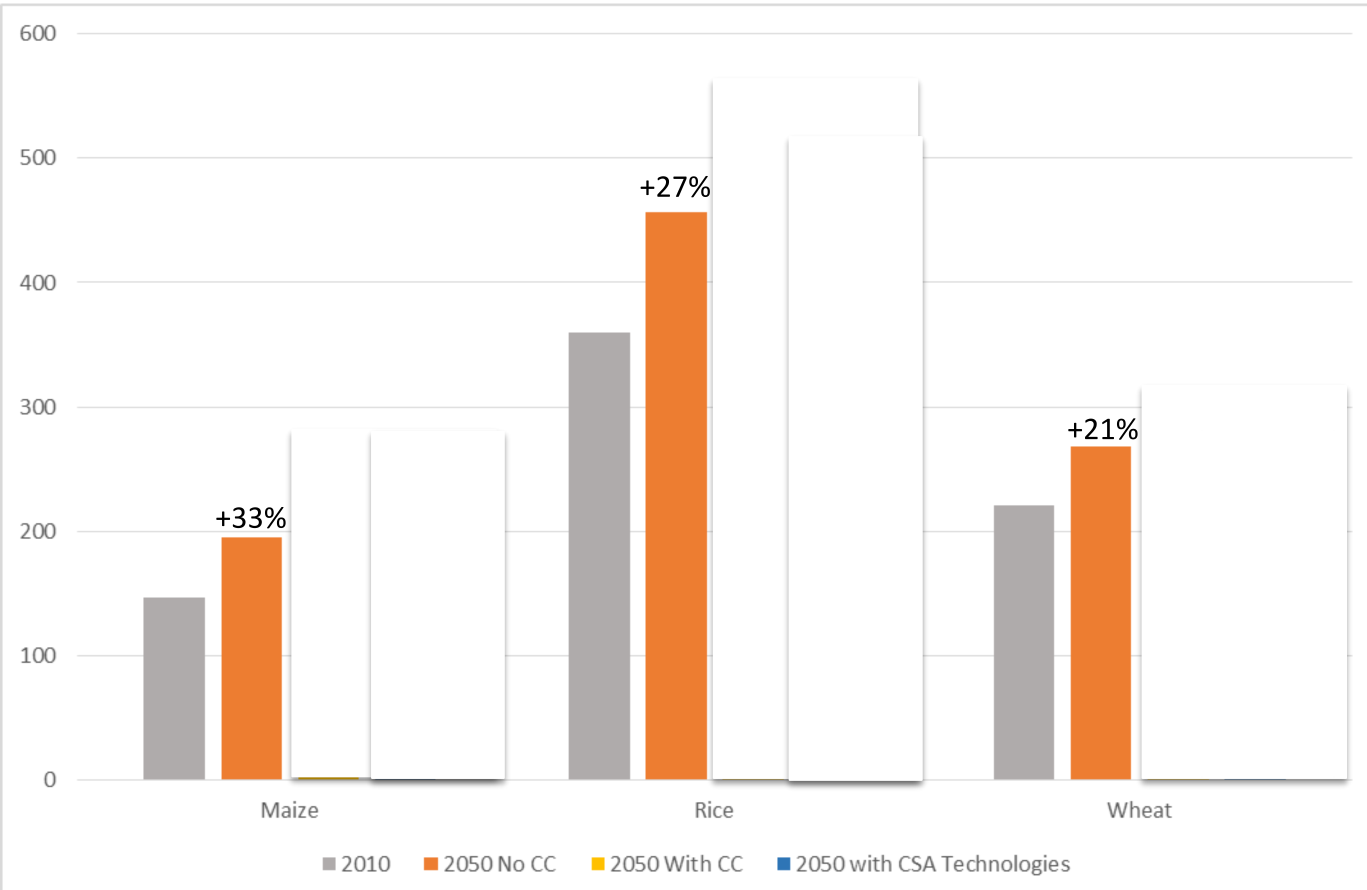
- Adoption of CSA practices can only occur where there is a positive yield effect compared to the BAU practices
- Mix adoption can occur when farmers have an option to choose any of CSA practices that produce the most positive yield effect compared to the BAU practices

Results: Yields

Changes in Yields in 2050 compared to BAU, GDFL × SSP2 × RCP8.5



Results: Prices



Changes in prices 2010 – 2050

GFDL scenario, SSP2, RCP 8.5

Climate Change exacerbate trends in price changes.
CSA mitigates these changes.

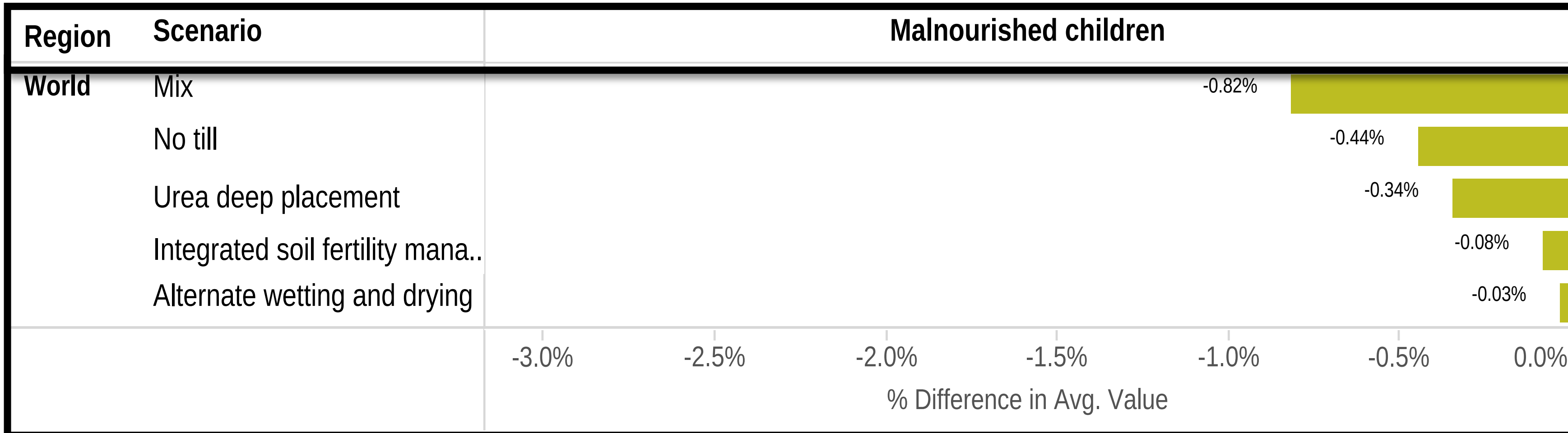
Results: Areas

Changes in Areas in 2050 compared to BAU, GDFL × SSP2 × RCP8.5

Region	Scenario	Maize	Rice	Wheat
World	Mix	-0.07%	-1.24%	-1.08%
	No till	-0.45%	0.08%	-1.07%
	Integrated soil fertility mana..	0.11%	0.05%	-0.25%
	Urea deep placement	0.15%	-1.33%	0.05%
	Alternate wetting and drying	0.01%	-0.12%	0.00%
		-10% -5% 0% 5%	-10% -5% 0% 5%	-10% -5% 0% 5%
		% Difference in Avg. Value	% Difference in Avg. Value	% Difference in Avg. Value

Results: Malnourished children

Changes in Malnourished children in 2050 compared to BAU, GDFL × SSP2 × RCP8.5



Results: Overall

Mix	Maize		Wheat		Rice	
	GFDL	HADGEM	GFDL	HADGEM	GFDL	HADGEM
Production (% change)	+2.34	+2.43	+2.26	+2.22	+2.15	+2.17
Price (% change)	-4.90	-5.38	-6.18	-7.25	-7.60	-7.95
Area (% change)	-0.07	-0.49	-1.08	-1.22	-1.24	-1.34
	GFDL			HADGEM		
Pop risk of hunger	-0.82%			-0.89%		

Results: GHG emissions

To meet the 2 °C goal:

- If we could start tomorrow we should reduce ~1 Gt CO_2 eq per year (Wollenberg et al. 2016).
- Given our assumed adoption rates CSA on Maize, Rice, and Wheat, crop production could contribute to the targeted yearly reduction in emission by 0.5-2%
- If 100% all suitable locations were to adopt CSA on Maize, Rice, and Wheat, crop production could contribute to the targeted yearly reduction in emission by 3-5%

Conclusions

Conclusions

- CSA has the potential to improve how agriculture responds to CC
- But CSA does not seem to contribute much to GHG emission reduction
  - If reducing emission is an true objective, more needs to be done including a more systemic view of agricultural development vis a vis other land uses
- CSA is supposed to be a different “approach” to agricultural production, not a prescribed set of practices, and it has the potential to foster a more comprehensive approach to increasing productivity in a changing climate
- When people talk about CSA they should be talking about which system is “smarter” given the local conditions

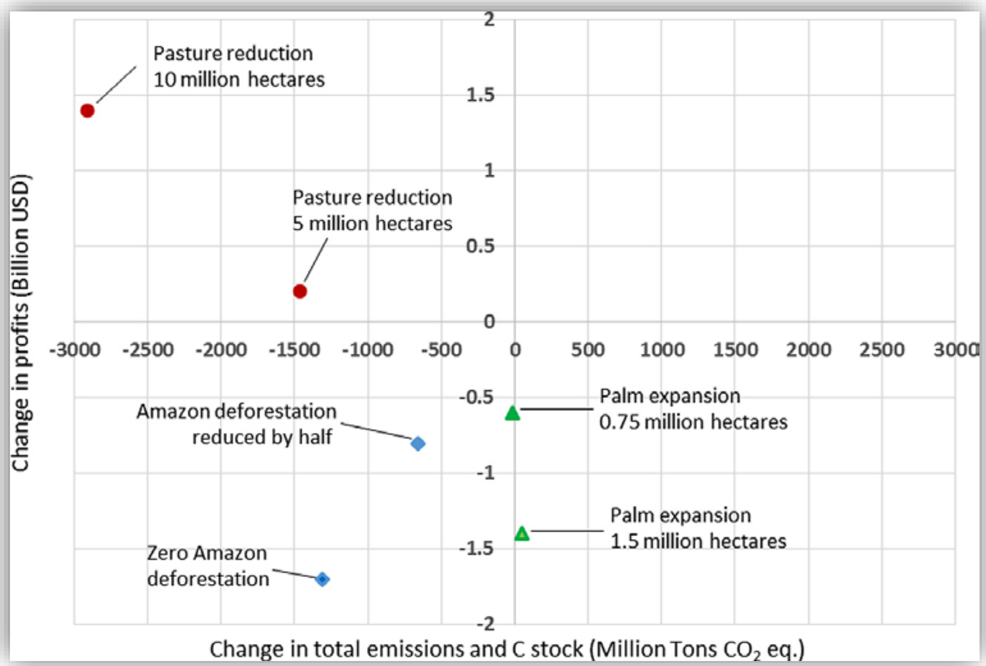
Conclusions

- Potentially can initiate dialogs that rarely happen across ministries
- Reinforce the importance of a multi-objective approach in agricultural policies
- However, the transition to CSA is afflicted by barriers that we know too well: risk, uncertainty, imperfect markets, etc.

Do not underestimate the power of opening a dialog across ministries

- Policy Comparison
  - Colombia included the contribution of AFOLU sector in the official INDCs which was presented and ratified at COP 21 in Paris

Trade-off between profits and GHG emission reduction



De Pinto et al, 2016

Thank You

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