Climate Change and Food Security Challenges. A Global Perspective

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CGIAR RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security CCAFS

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at a GLANCE

VISION

A world free of **HUNGER** *and* **MALNUTRITION**

MISSION

To provide research-based policy solutions that sustainably reduce poverty and end hunger and malnutrition.

What WE DO

IFPRI'S RESEARCHERS provide policy makers, donors, civil society, the private sector, and farmer organizations with rigorous, policy-relevant research.

IFPRI RESEARCHERS ANSWER QUESTIONS SUCH AS:

What policies help farmers manage scarce resources more sustainably?

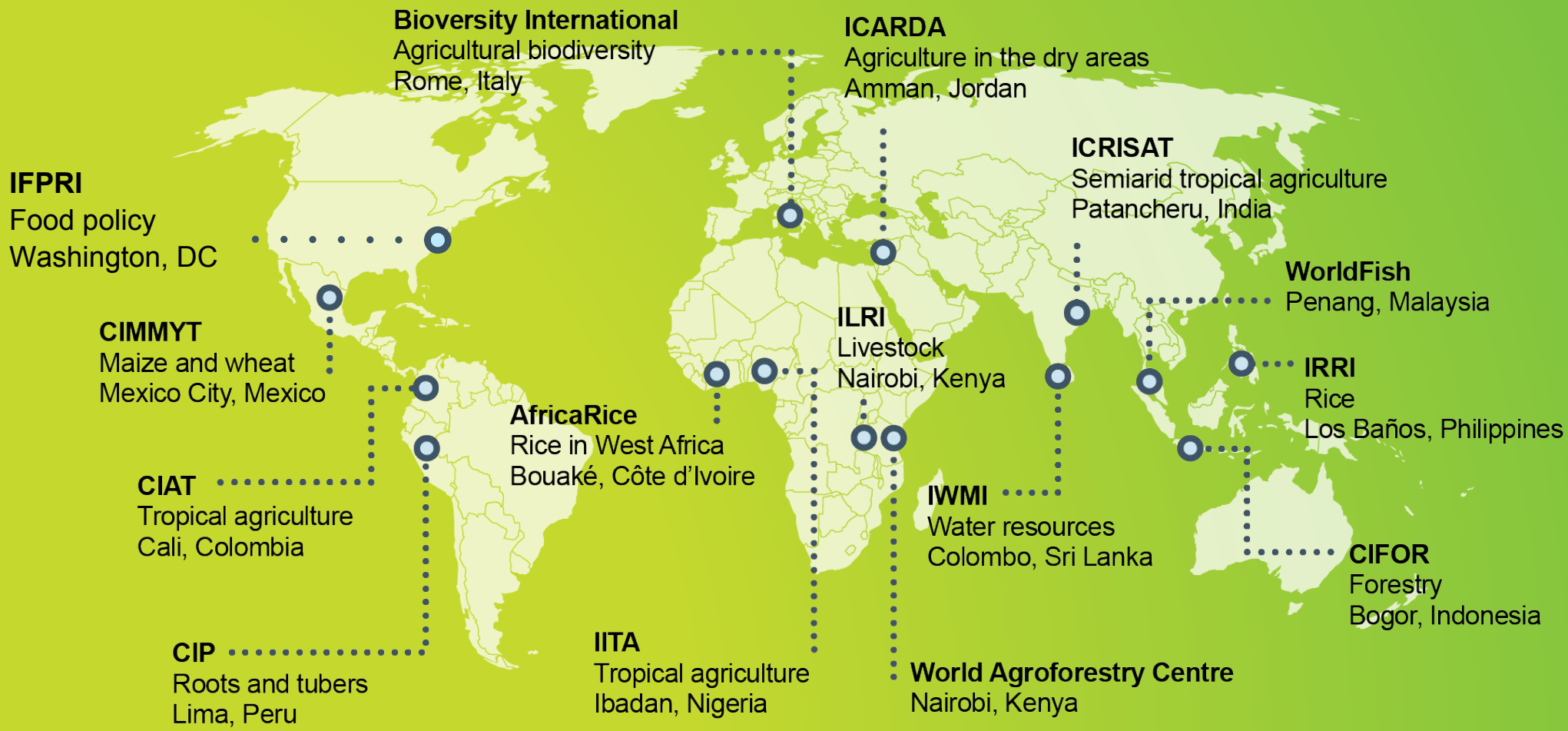
What investments can support lifelong nutrition and good health for rural and urban populations?

How can agricultural growth and rural development be made more equitable and inclusive?

Where WE WORK

IFPRI and CGIAR

IFPRI IS ONE OF 15 CGIAR RESEARCH CENTERS



Sharing our RESEARCH

IFPRI WORKS WITH PARTNERS including governments, multilateral organizations, civil society, the private sector, and universities and research institutions to inform and enhance the impact of its research. Research results and products are shared through our web site, publications, social media, open access data sets, analytical models and tools, videos, web platforms, seminars, and training and capacity building.

THE CHALLENGES

Agricultural development must meet multiple challenges

- Global hunger increased after nearly a decade of prolonged decline. The number of undernourished people globally rose from 777 million in 2015 to 815 million in 2016. Much of the worsening trend in global hunger can be linked to persistent conflicts, which have been exacerbated by climate shocks.
- We are losing the progress made since the global food price crisis in 2007/08
- There are years in which there is enough Maize, Rice, and Wheat to satisfy global needs but if one considers nutrition that is not enough.

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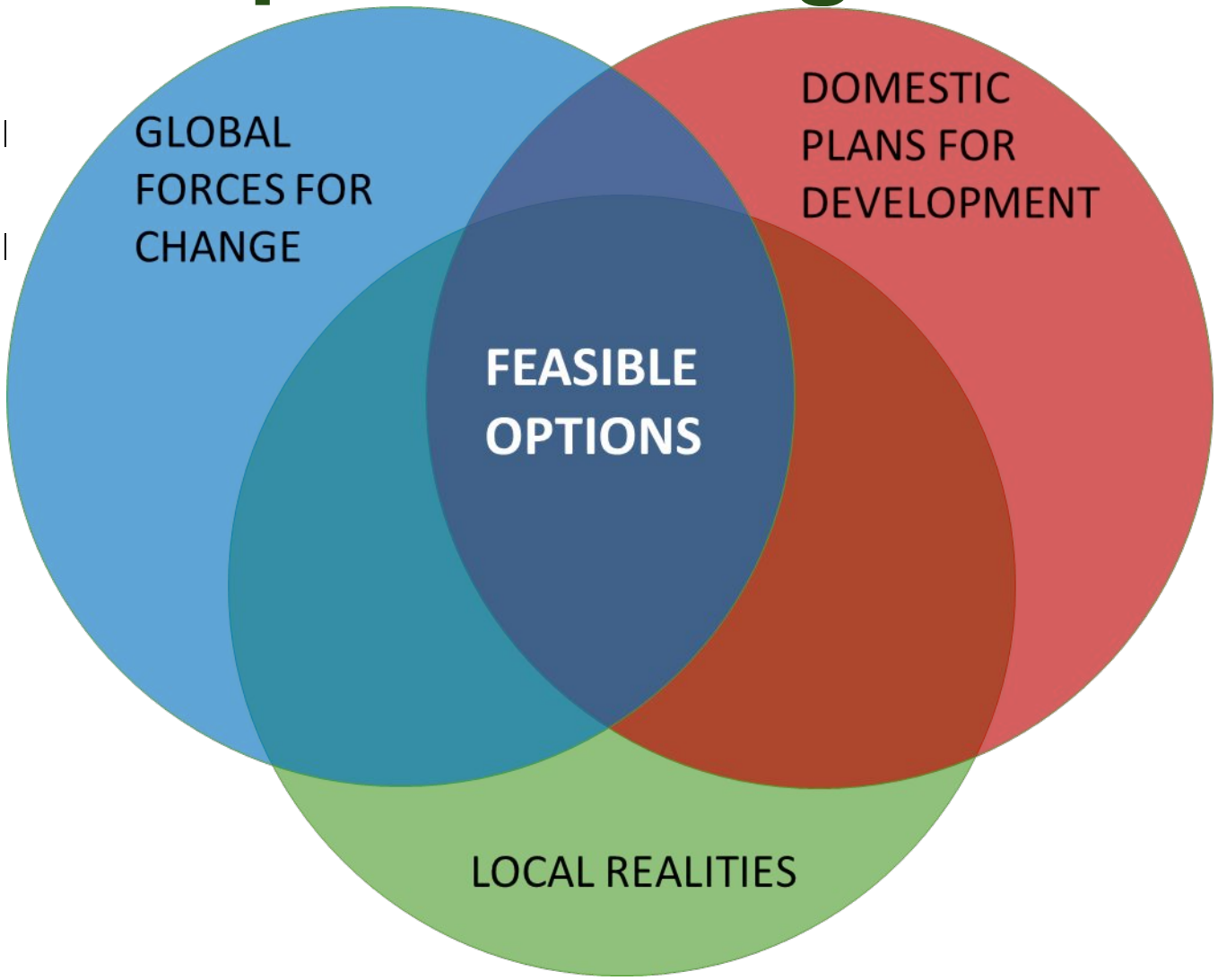
Agricultural development must meet multiple challenges



Policies need to be economically and politically sustainable

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Agricultural development must meet multiple challenges

- Answer the needs of today
- Support long-term policies that can deal with the contingencies of changing climate regimes

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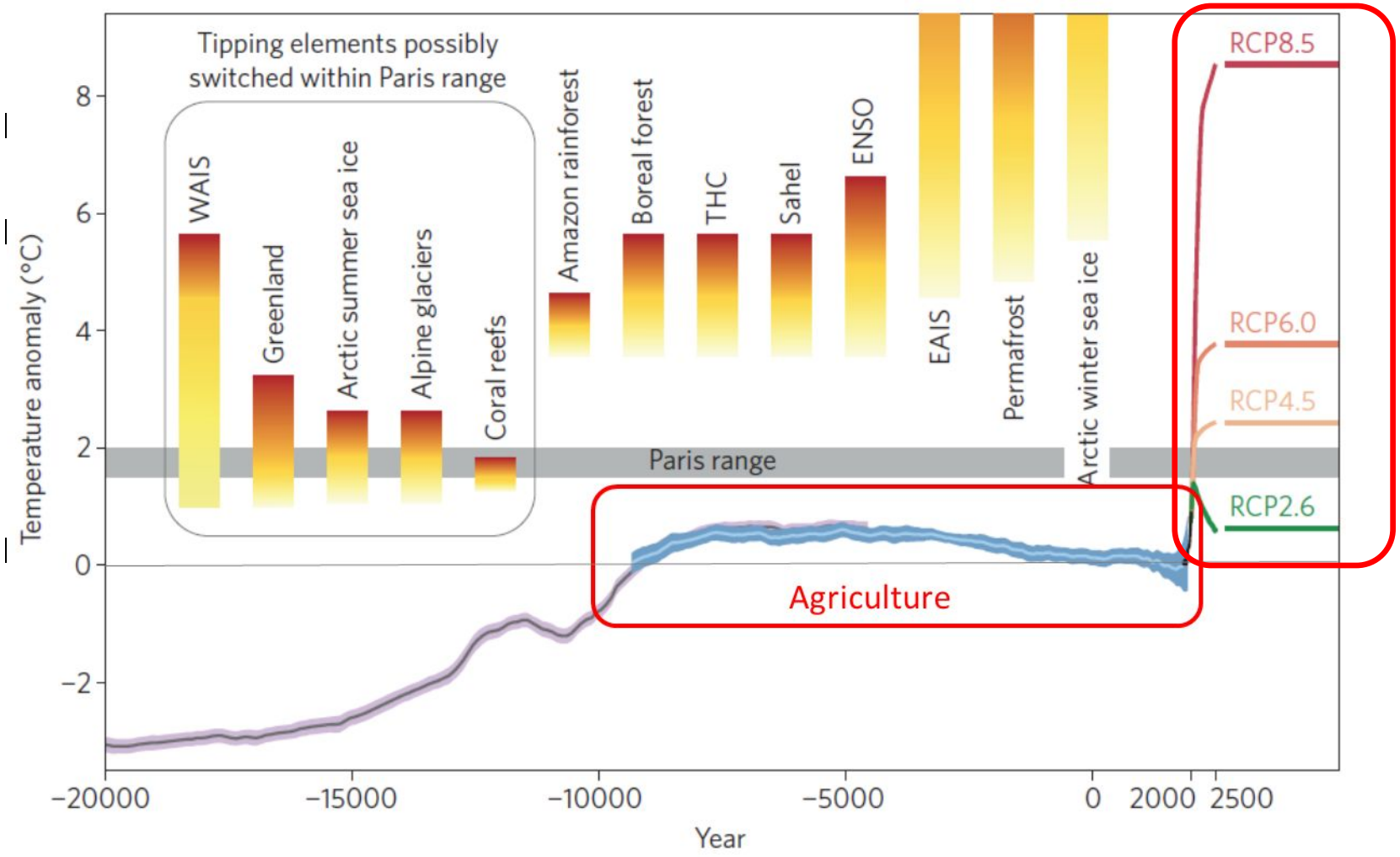
Agricultural development must meet multiple challenges



Source: Adapted from Schellnhuber et al. (*Nature Climate Change*, 2016)

Megatrends

De-globalization

Urbanization & rising middle-income population

Changing diets and nutrition

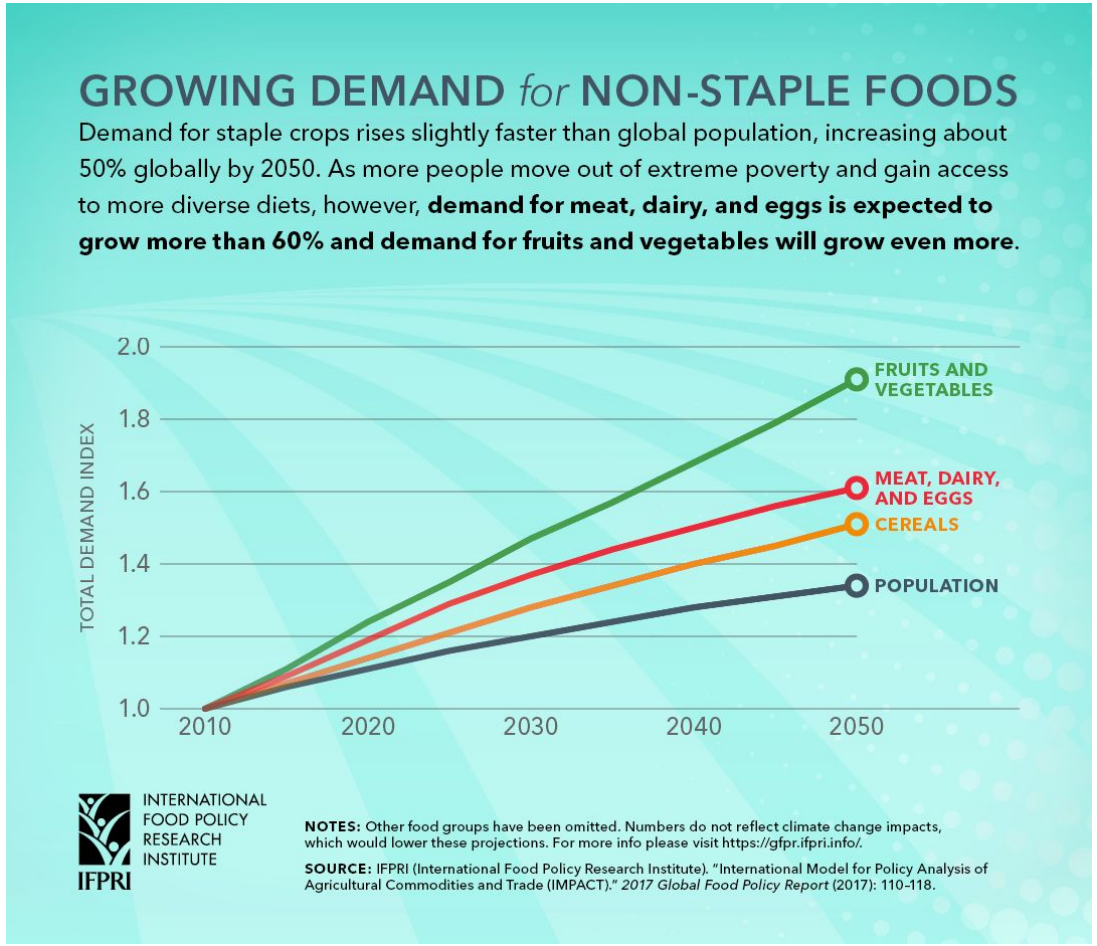
Climate change

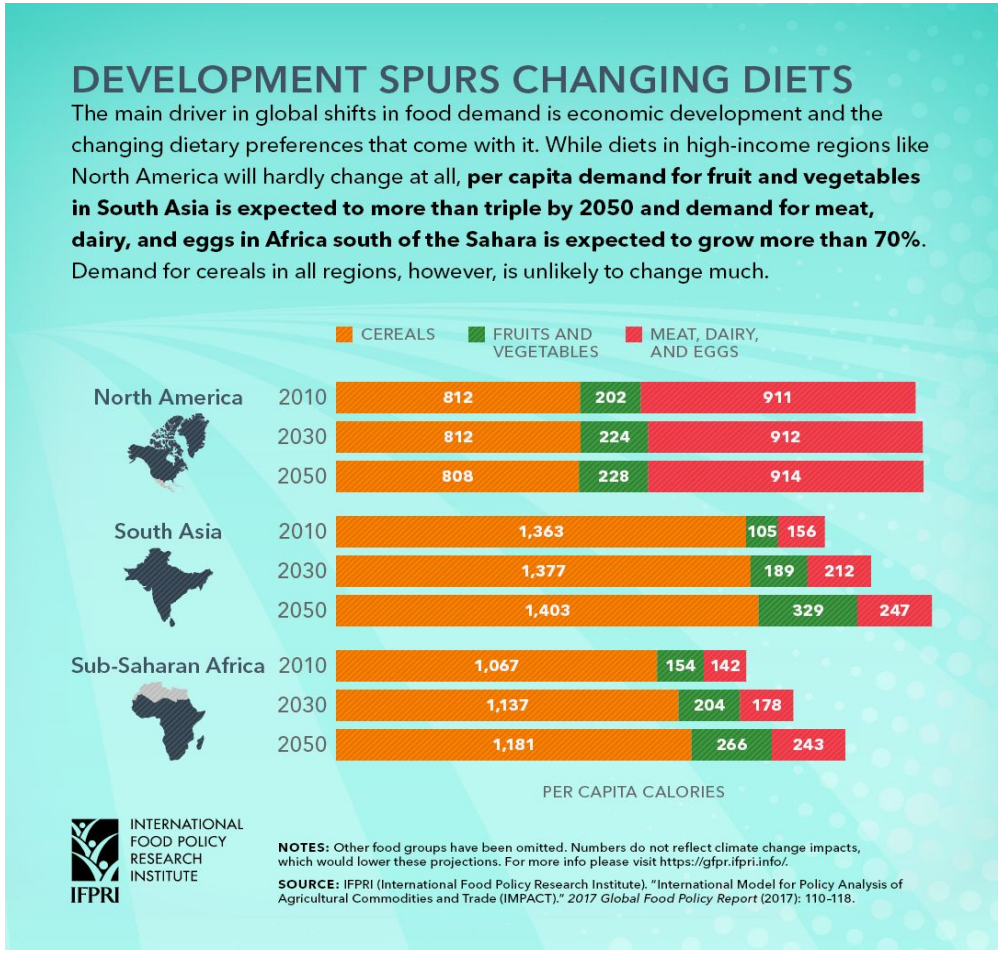
Technological innovations

Emerging economies

Source: Fan (2017)

Changing Patterns of Demand





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Climate Change: Agriculture as part of the problem

- Studies have consistently found that under most scenarios significant negative effects should be expected worldwide (Lobell and Gourdji, 2012; Wiebe et al. 2015; Mora et al., 2015; Pugh et al. 2016).
- Underdeveloped economic regions where food security is already problematic and populations are vulnerable to shocks are expected to suffer the worst consequences (Morton, 2007, World Bank, 2009; Rosegrant et al., 2014).
- When the interaction with other land uses is considered, anthropogenic land activities contribute more than a quarter of annual GHG emissions, the equivalent of 10 to 12 Gt CO_2 e per year, three fourths of which are estimated to originate in the developing world (Smith et al., 2014).
- Wollenberg et al. (2016) find that the **agricultural sector should reduce emissions by some 1 Gt CO_2e per year** to meet the goal of remaining below the 2 °C global warming.

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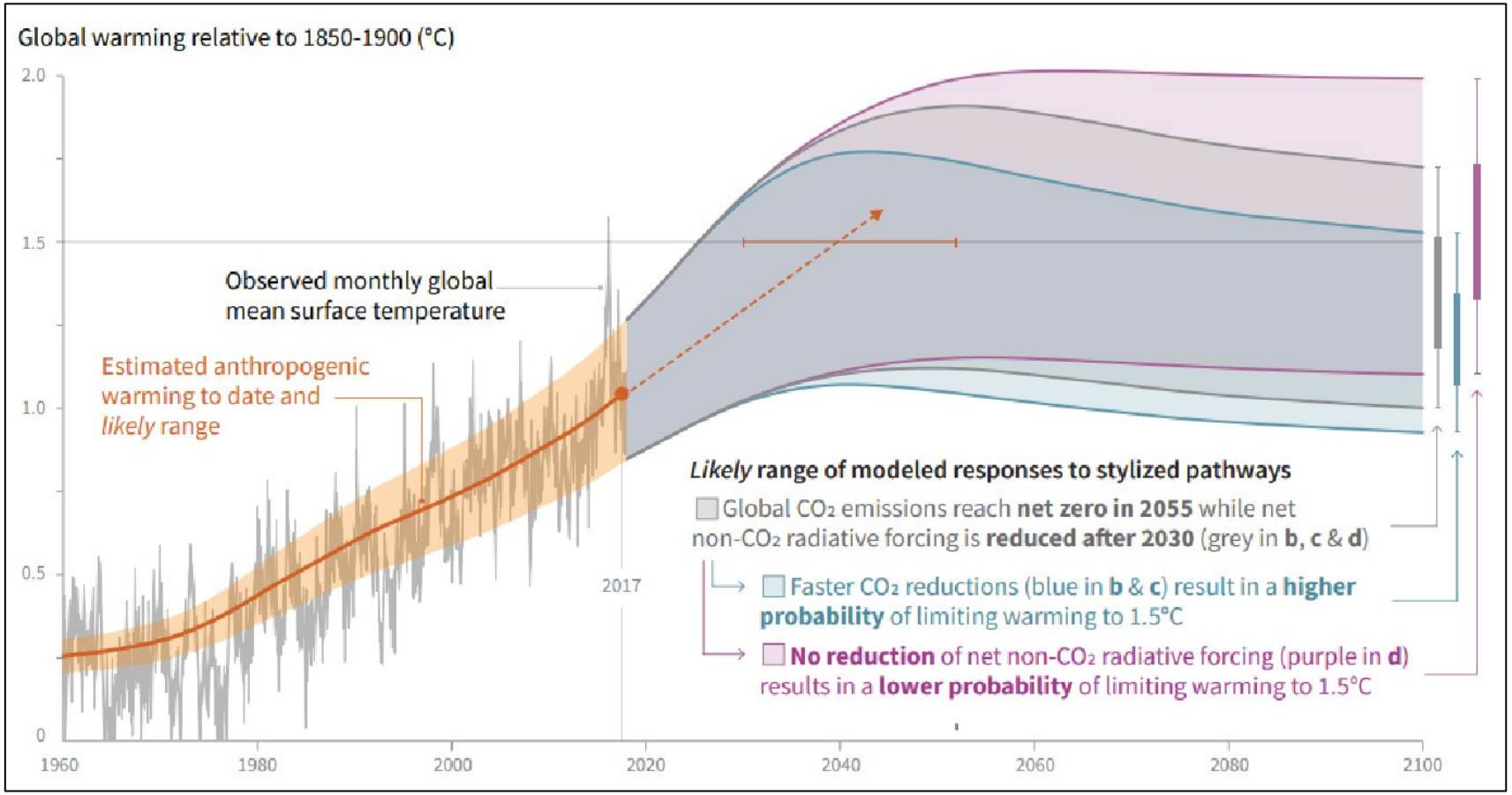
One more reason to worry….the latest one:

The *IPCC special report on the impacts of global warming of 1.5 °C.*

- *All but certain that we are going to reach the 1.5 °C*
- ***1.5 °C looks very much like we though 2 °C would look like***



Source: Global Warming of 1.5 °C. IPCC, 2018

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Reasons to worry…..
IPCC special report calls for a carbon tax

- Recent findings indicate that a carbon tax on GHG emissions may lead to significant tradeoffs between the reduction of emissions from anthropic activities, including the agriculture sector, and food security.
- Frank et al. 2017: “Using a scenario that limits global warming cost-efficiently across sectors to 1.5 ◦C, results indicate global food calorie losses ranging from 110–285 kcal per capita per day in 2050….. **this could translate into a rise in undernourishment of 80–300 million people in 2050**.”
- Hasegawa et al. 2018: “With the SSP2 socio-economic backdrop, the population at risk of hunger in 2050 increases by **24 million (2–56 million: the range represents variation across models hereafter)** with the climate impacts of the RCP6.0 scenario, compared with the baseline scenario. **This number increases by around 78 million (0–170 million) people with the combined climate impacts and emissions mitigation policies of the RCP2.6 scenario**.”

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The Role of Models Insights and New Developments

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How do we think about the future? The role of foresight modeling

- "All models are wrong, but some are useful" (Box, 1978)
- Scenario-based *projections* as opposed to *predictions*

  (can be inspected, modified, discussed by stake-holders)
- What makes a model useful
  - Open, include new input as becomes available
  - Transparent, explicit assumptions open to inspection
  - Flexibility, exploring alternative scenarios

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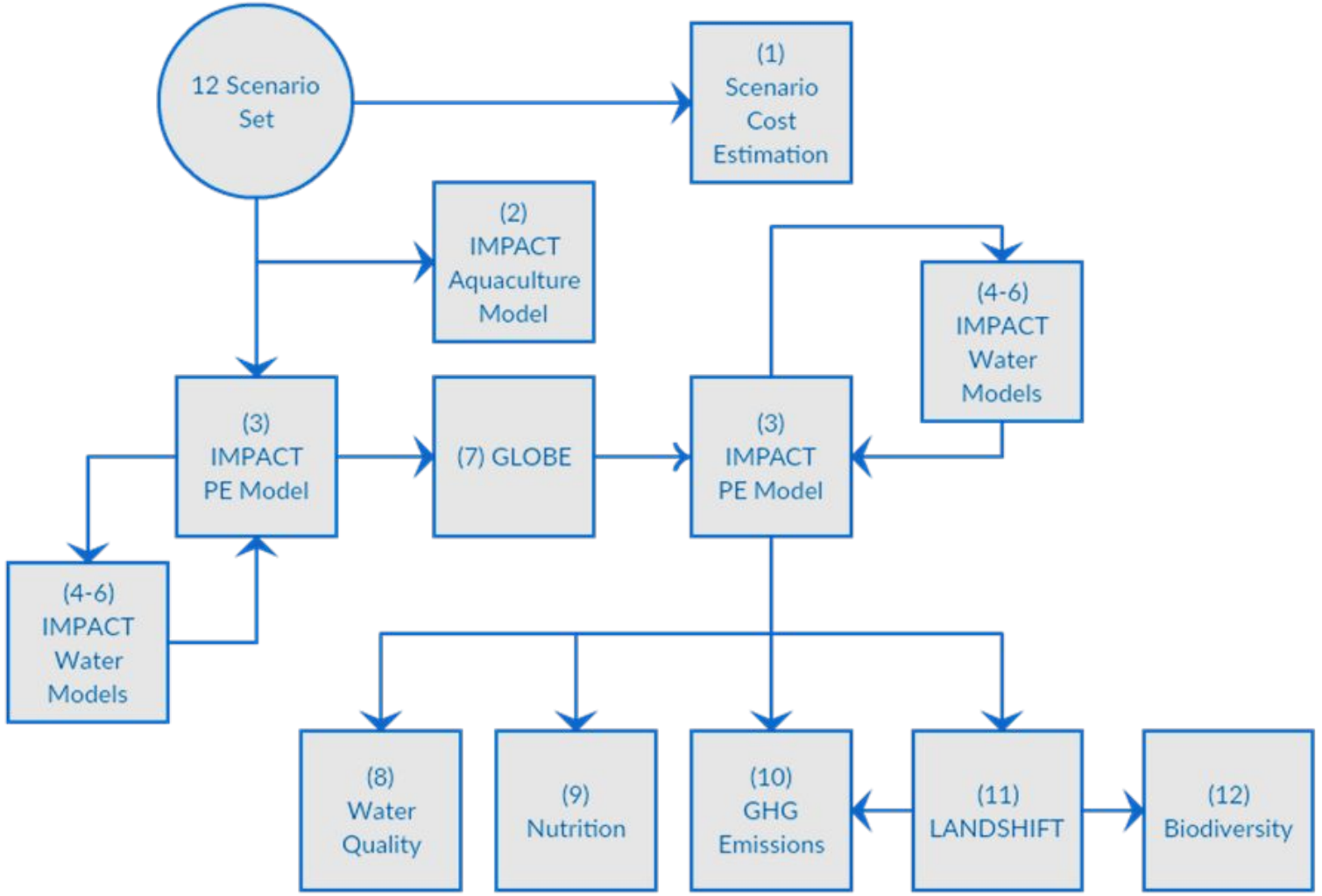
Global Foresight Modeling

Models are becoming increasingly complex and intra-disciplinary.

Multi-model ensemble that includes 12 models enabling us to consider the effects of interventions across a range of variables well beyond our previous capacity

Land use, full-economy effects, water quality, GHG emissions, and biodiversity



Source: Rosegrant et al. 2017

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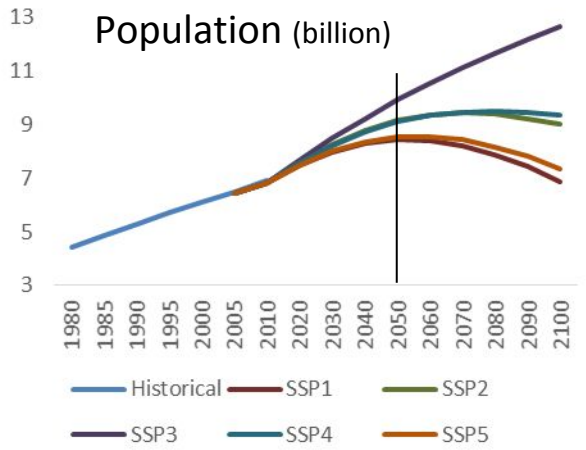
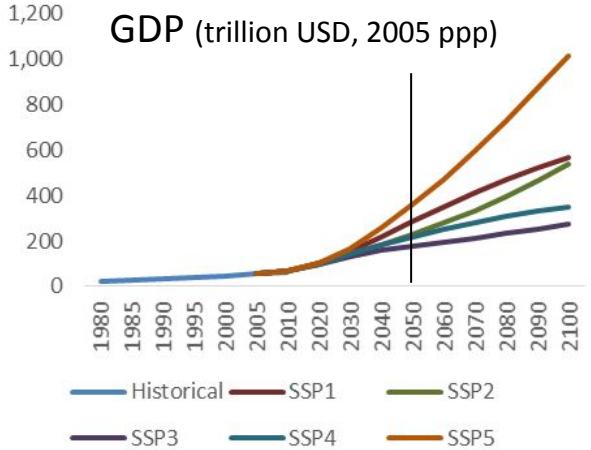
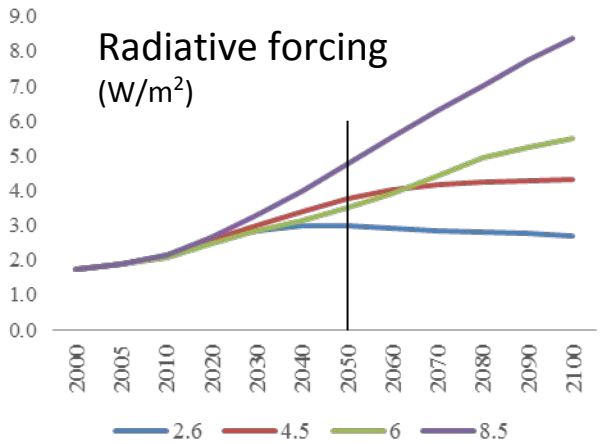
Socioeconomic and climate drivers

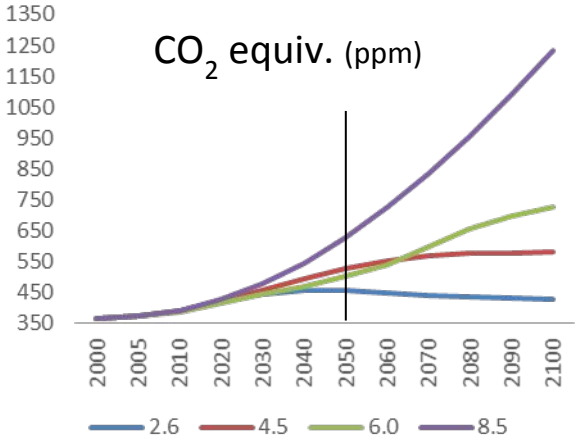
Shared Socioeconomic Pathways (SSPs)





Representative Concentration Pathways (RCPs)





Source: Downloaded from the RCP Database version 2.0.5 (2015). RCP 2.6: van Vuuren et al. 2006; van Vuuren et al. 2007. RCP 4.5: Clark et al. 2007; Smith and Wigley 2006; Wise et al 2009. RCP 6.0: Fujino et al 2006; Hijioka et al 2008. RCP 8.5: Riahi and Nakicenovic, 2007.

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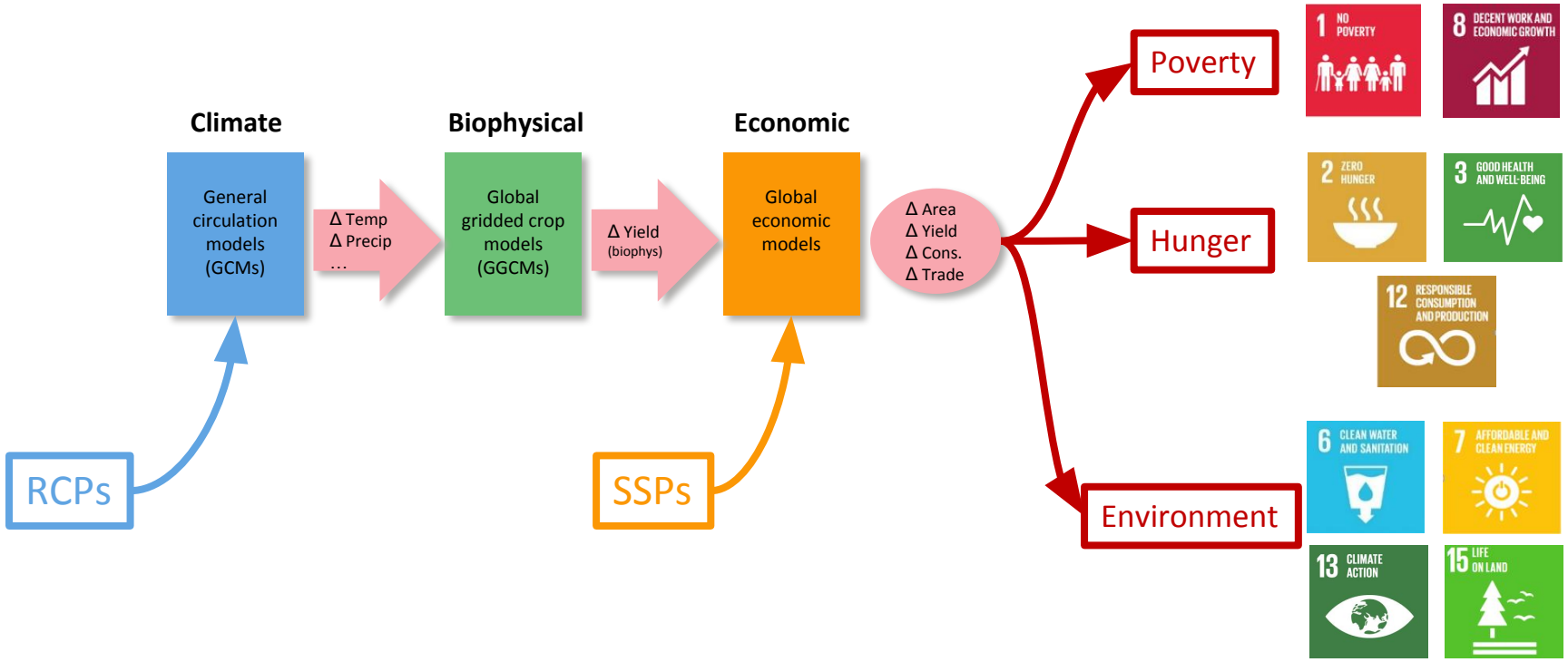
Modeling alternative futures for agriculture: *biophysical and socioeconomic drivers and effects*



Source: Adapted from Nelson et al., *Proceedings of the National Academy of Sciences* (2014)

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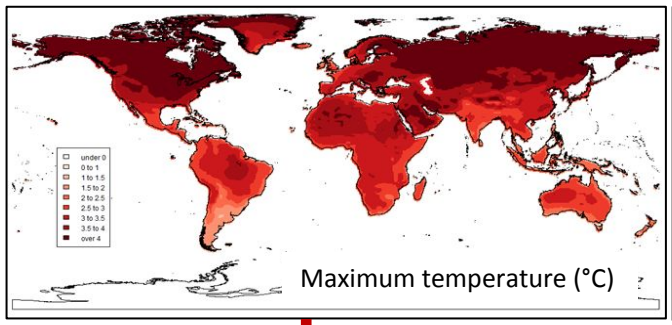
Estimating climate change impacts on yields

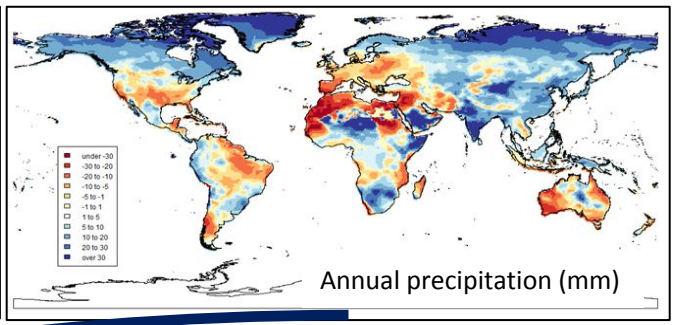
RCP
→ •8.5
•6.0
•4.6
•2.6

GCM
•GFDL
→ •HadGEM
•IPSL
•…

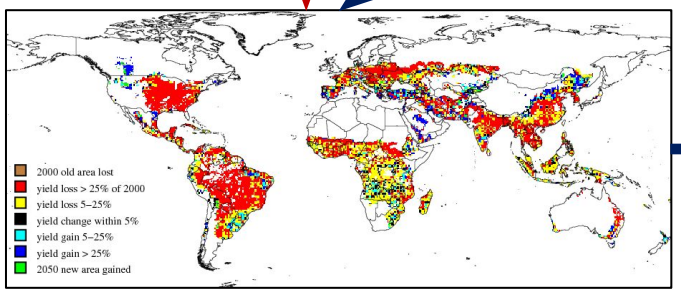
Crop
→ •Maize
•Potato
•Rice
•Soybean
•Wheat
•…

Crop model
•APSIM
→ •DSSAT
•ORYZA
•…



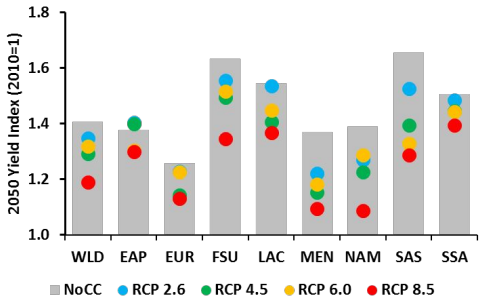


Year
•2010
•2020
•2030
•2040
→ •2050
•…



Change in rainfed maize yields before economic adjustments

SSP
•1
→ •2
•3
•4
•5



Change in rainfed maize yields after economic adjustments

Economic model
•ENVISAGE
•GLOBIOM
→ •IMPACT
•MAgPIE
•…

Source: IFPRI, IMPACT version 3.2, November 2015

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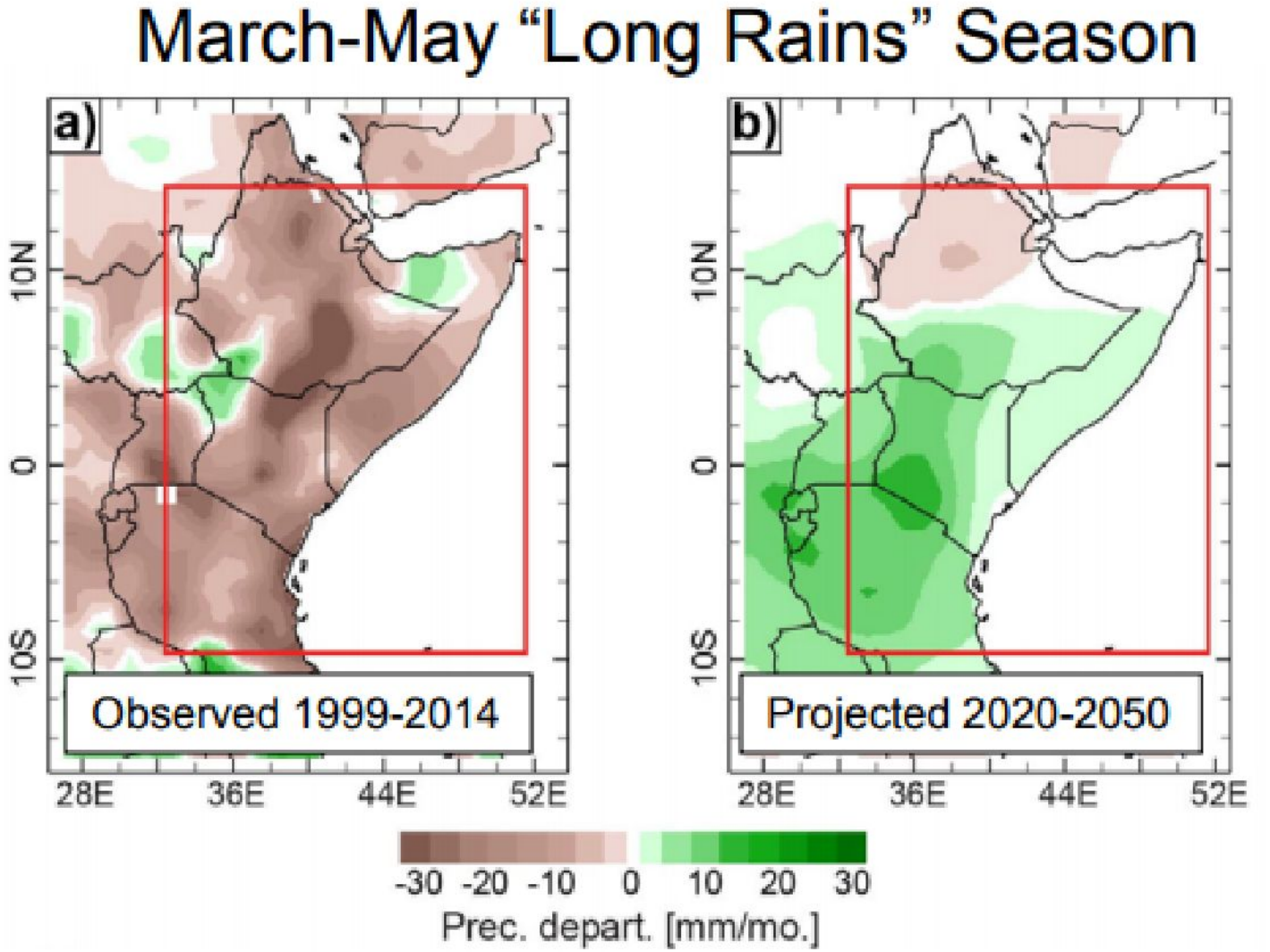
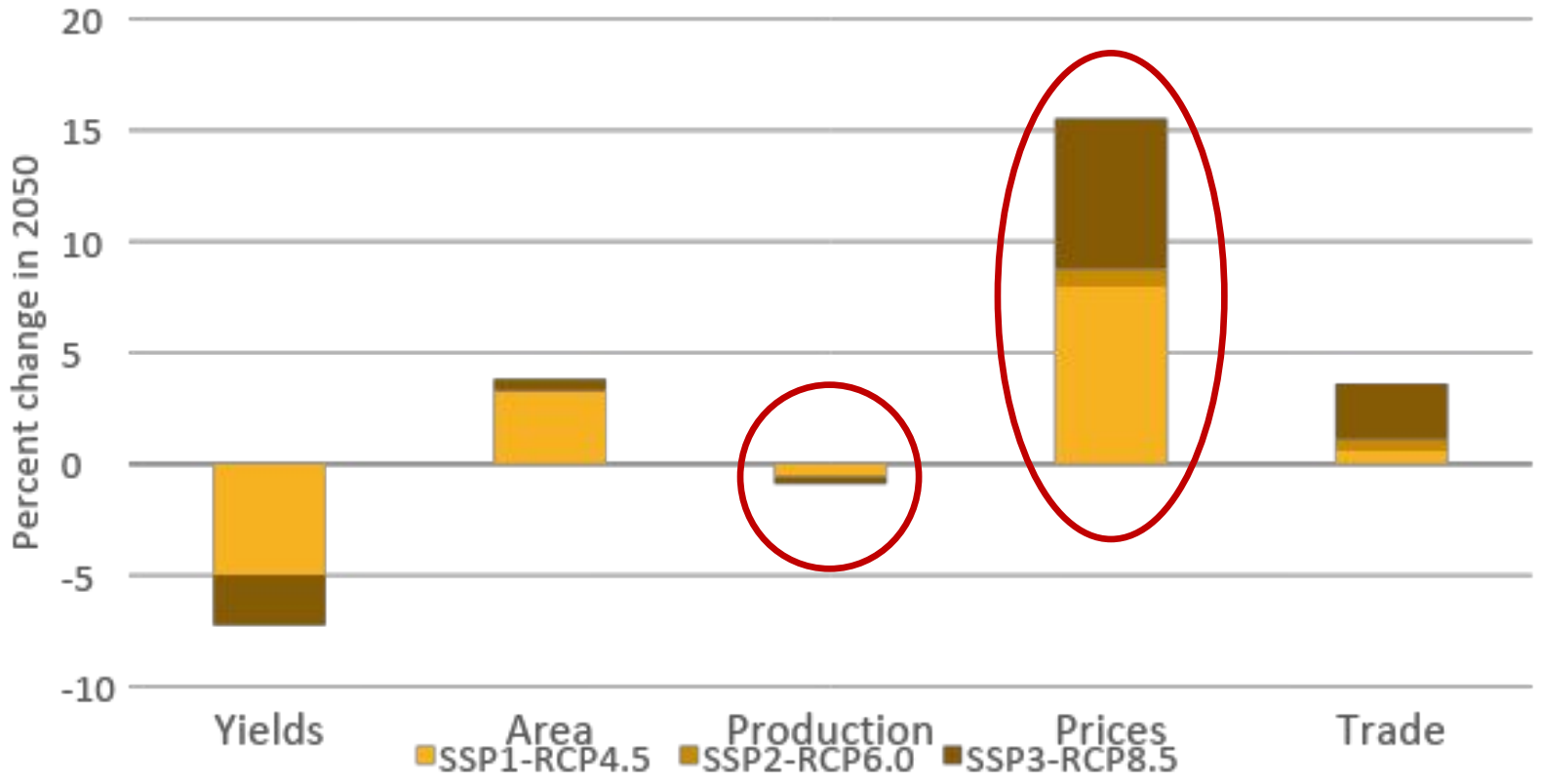
The Climate Paradox of East Africa: Eastern Africa by 2100



Source: Lyon, B., and N. Vigaud, 2015:

Climate change impacts in 2050

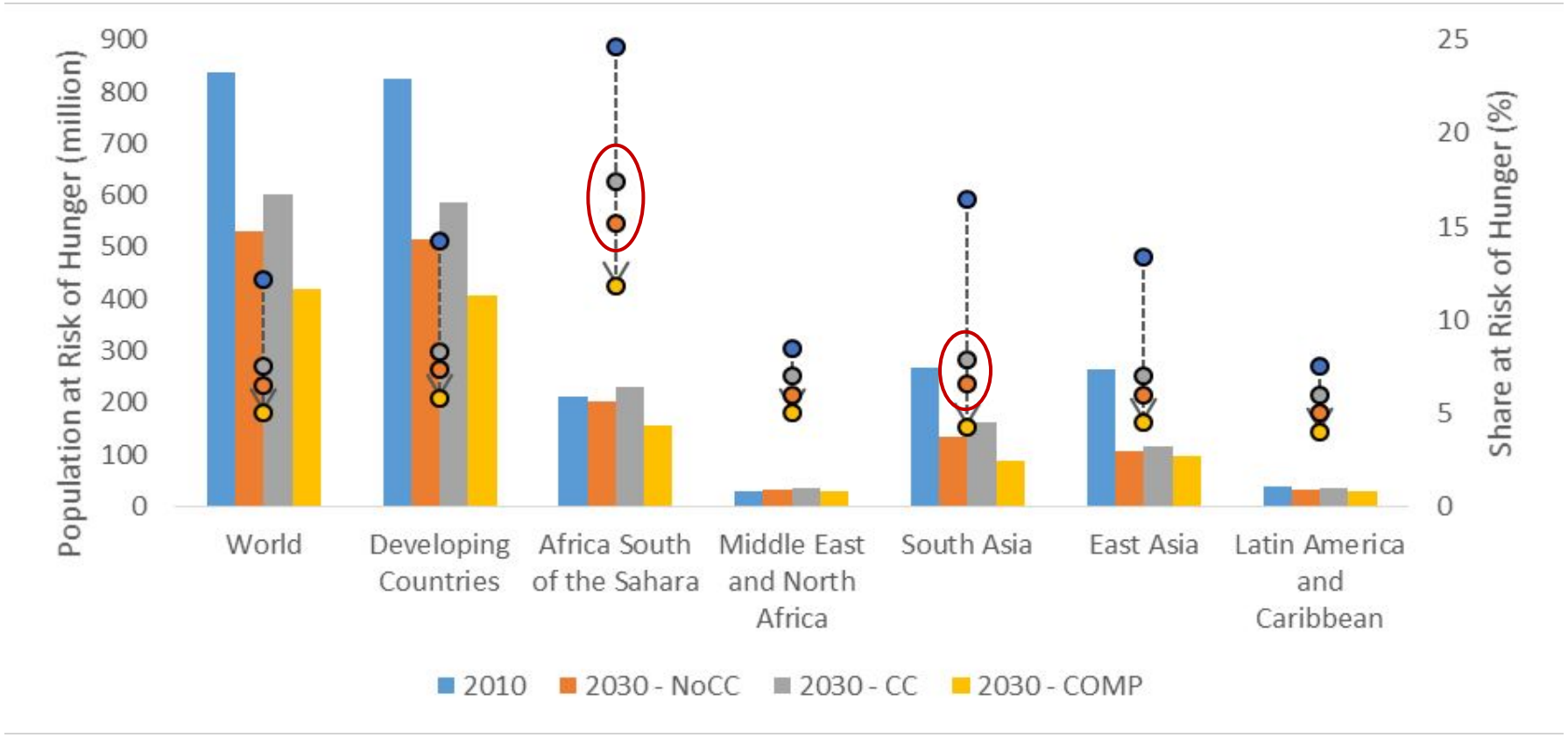
Average of 5 global economic models for coarse grains, rice, wheat, oilseeds & sugar



Source: Wiebe et al., *Environmental Research Letters* (2015)

Hunger in 2030 *by climate and investment scenario*

(Bars showing numbers on the left axis, dots showing shares on the right axis)



Note: 2030-NoCC assumes a constant 2005 climate; 2030-CC reflects climate change using RCP 8.5 and the Hadley Climate Model, and 2030-COMP assumes climate change plus increased investment in developing country agriculture.
Source: IFPRI, IMPACT model version 3.3 (Rosegrant et al. 2017).

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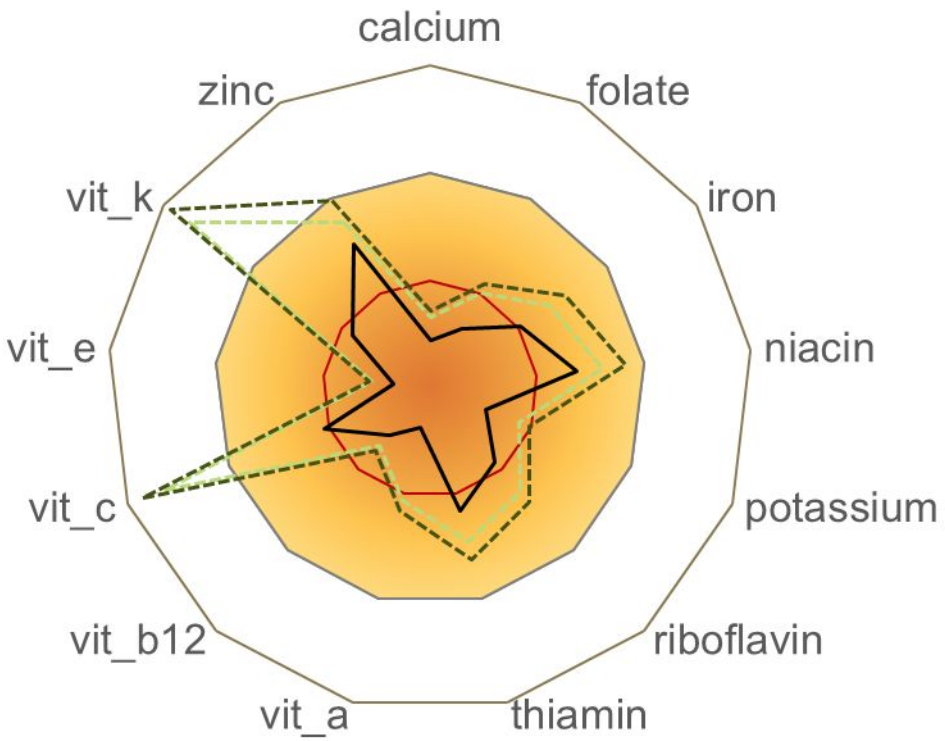
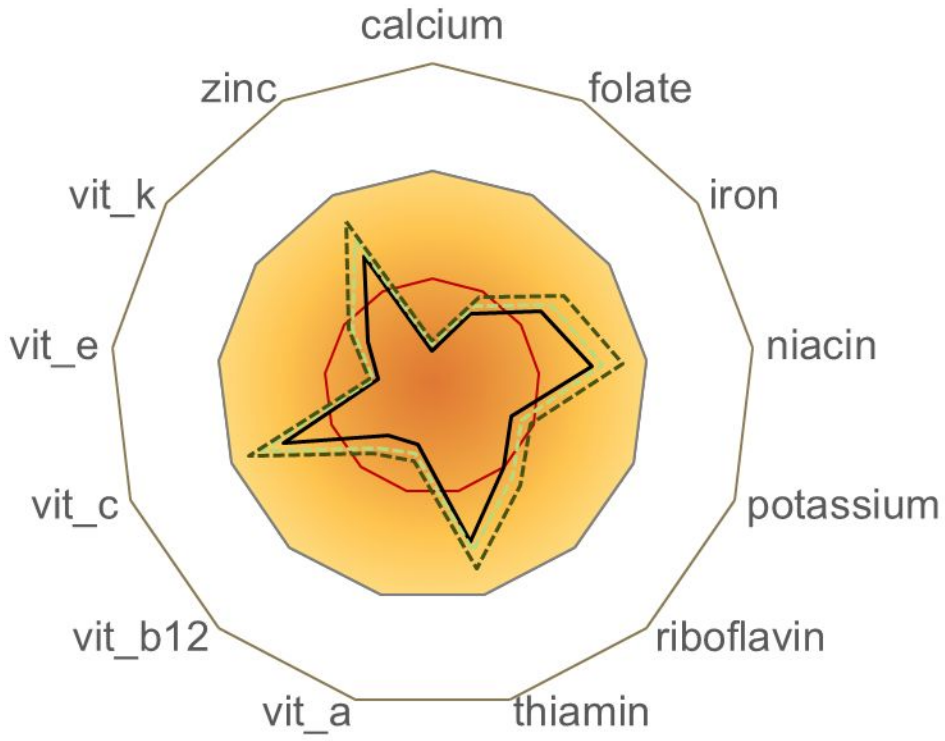
Beyond the calorie count: micronutrient availability, alternative scenarios

South Asia



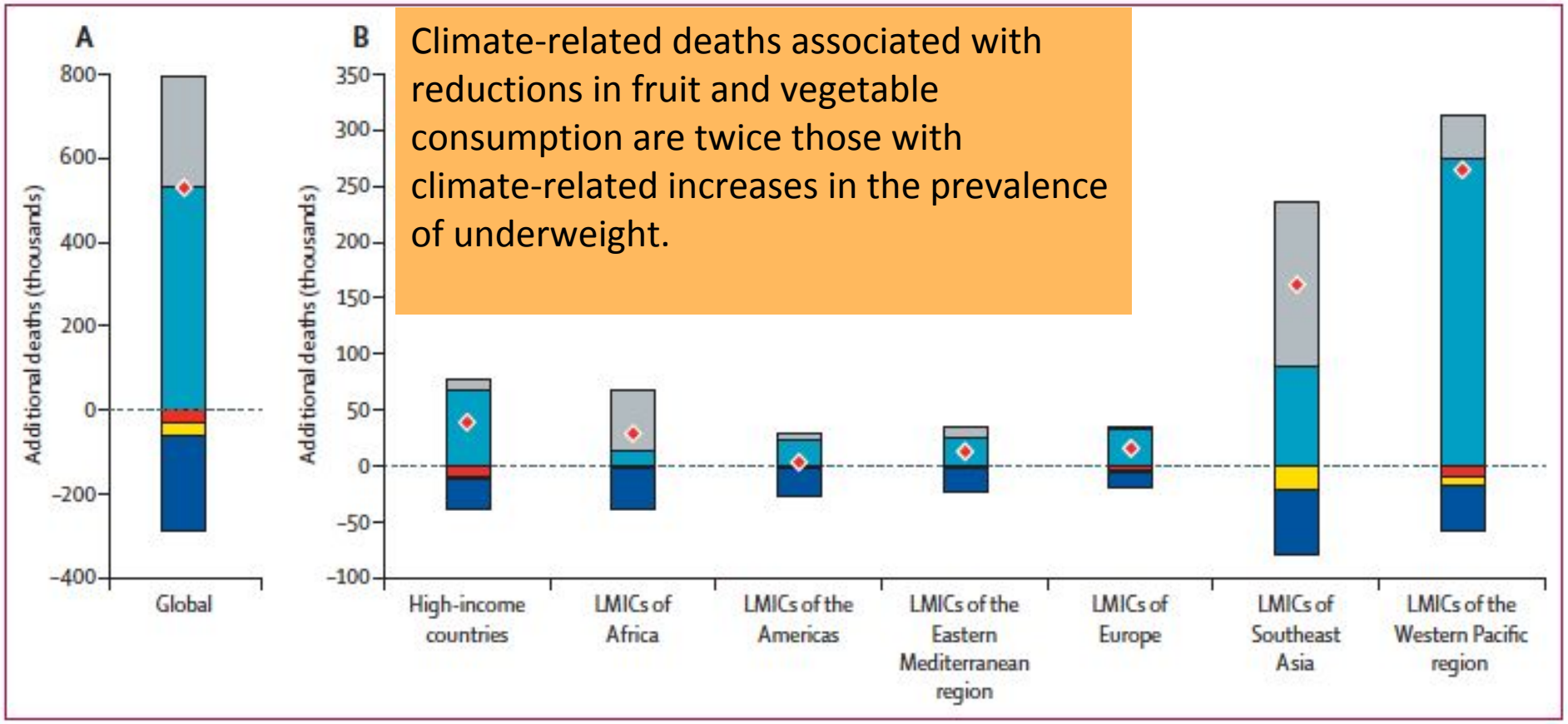
Africa South of the Sahara



Vulnerable Supply = RDA 2010 2050 REF_HGEM 2050 COMP

Source: IFPRI, IMPACT model version 3.3 (Rosegrant et al. 2017)

Beyond the calorie count: Number of deaths attributable to climate-related changes in weight and diets



Climate-related deaths associated with reductions in fruit and vegetable consumption are twice those with climate-related increases in the prevalence of underweight.

Figure 2: **Climate-related deaths (in thousands) in 2050 by risk factor**

(A) Climate-related deaths worldwide and (B) by region. The risk factors include changes in fruit and vegetable consumption, red meat consumption, and the prevalence of underweight, overweight, and obesity. The regional aggregates include all regions (global), high-income countries, and LMICs of Africa, the Americas, the Eastern Mediterranean region, Europe, Southeast Asia, and the Western Pacific Region. LMICs=low-income and middle-income countries. Confidence intervals are listed in appendix pp 67–70.

Source: Springmann et al. 2016.

What are our available responses?

- Current consumption and degradation of natural resources and ecosystems exceeds their regeneration rates and this pushes us against what are considered the safe planetary boundaries (Rockstrom et al. 2009, Steffen et al. 2015).
- Productivity-based solutions “à la green revolution” are not sufficient to answer to the multi-dimensional problems we are facing.

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Alternative investment scenarios
Developed with all of the CGIAR Centers and other partners

- Accelerating productivity growth through R&D
  - 5 variants: Medium, High, +NARS, +Research Efficiency, Regionally Focused
- Improving water management
  - 3 variants: Irrigation Expansion, Increased Water Use Efficiency, Increased Soil Water Holding Capacity
- Improving market efficiency
- Comprehensive scenario
  - Best elements of the above

Source: Rosegrant et al. 2017

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Tradeoffs and synergies under alternative scenarios *(percentage change relative to baseline in 2030 and 2050)*

Scenario	Avg. Annual Cost	2030						2050					
		Reduce Poverty	Food Security Health		Natural Systems Ecosystem Services			Reduce Poverty	Food Security Health		Natural Systems Ecosystem Services		
		GDP	Ag Supply	Hunger	Water Use	GHG	Forest	GDP	Ag Supply	Hunger	Water Use	GHG	Forest
MED R&D	1.4	0.7	1.4	-6.5	0.0	-5.5	0.03	1.9	2.7	-9.3	-0.2	-15.4	0.13
HIGH R&D	2.0	1.3	2.8	-12.4	-0.1	-7.5	0.04	3.4	5.7	-16.6	-0.4	-24.3	0.20
HIGH+NARS	3.0	1.6	3.7	-15.8	-0.1	-8.9	0.04	4.3	7.7	-20.2	-0.4	-26.5	0.22
HIGH+RE	2.0	2.6	6.4	-24.4	-0.2	-12.7	0.06	4.2	7.5	-20.0	-0.4	-26.9	0.22
REGION	2.5	1.1	2.4	-10.9	-0.1	-6.5	0.03	3.1	5.1	-15.4	-0.3	-22.6	0.18
Irrig Exp	3.5	0.1	0.1	-1.3	2.6	-1.8	0.01	0.2	0.2	-1.1	2.9	0.7	-0.01
IX+WUE	8.1	0.4	0.9	-4.5	-7.2	-1.9	0.01	0.5	0.9	-2.7	-7.5	-0.2	-0.01
ISWM	4.6	0.2	0.5	-2.1	-1.5	-0.5	0.00	0.5	0.9	-3.0	-2.9	-1.1	0.01
RMM	10.8	1.0	1.6	-5.8	0.1	6.4	-0.02	0.8	1.5	-4.2	0.0	8.9	-0.08
COMP	25.5	4.1	9.8	-30.6	-9.0	-11.5	0.07	5.7	11.5	-24.4	-11.0	-25.4	0.22

Source: IFPRI, IMPACT model version 3.3 (Rosegrant et al. 2017)

Key findings

1. Population and income growth will drive growth in demand
2. Food and nutrition security are projected to improve
3. **Climate change will slow this progress**
4. Markets and trade will help mitigate climate change impacts
5. Agricultural R&D will play a critical role
6. Different strategies involve different synergies and tradeoffs
7. **Complementary investments in other sectors are also needed**

Source: Rosegrant et al. (2017)

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Reasons to worry…..
IPCC special report calls for a carbon tax

- Recent findings indicate that a carbon tax on GHG emissions may lead to significant tradeoffs between the reduction of emissions from anthropic activities, including the agriculture sector, and food security.
- Frank et al. 2017: “Using a scenario that limits global warming cost-efficiently across sectors to 1.5 ◦C, results indicate global food calorie losses ranging from 110–285 kcal per capita per day in 2050….. **this could translate into a rise in undernourishment of 80–300 million people in 2050**.”
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CLIMATE SMART AGRICULTURE (CSA)

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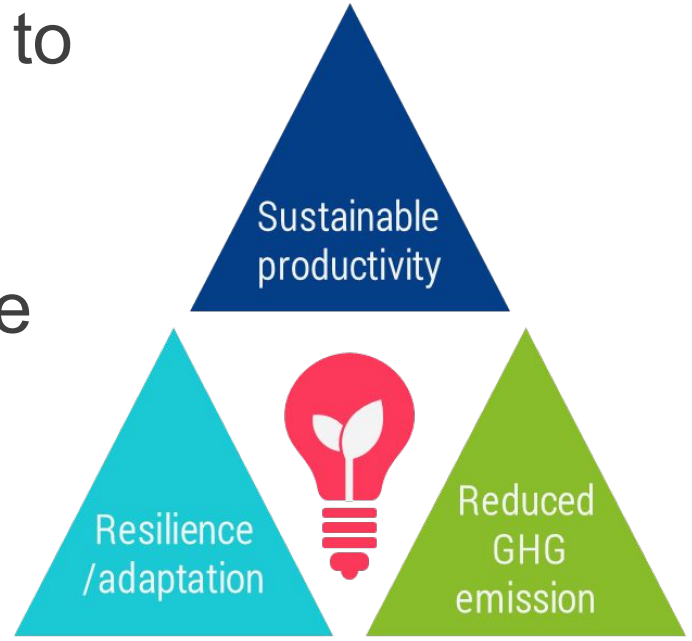
Climate-smart Agriculture

CSA is an umbrella term that includes many approaches, built upon geographically-specific solutions and characterized by a continuum of choices all aiming at making the agricultural sector better suited to handle the challenges of a new climate.

Three objectives:

- **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, **<u>where possible.</u>**



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Climate-smart Agriculture

CSA provides a framework for decision-making ranging from the farm to the policy level.

It offers a set of guiding principles to identify technologies, management practices and tools, and policies that enable farmers to meet the challenges of producing under changing climate regimes **by concurrently considering the three pillars and their trade-offs**

Often, people reduce CSA to a viable set of production practices and technologies for farmers to adopt in the field.

This would be a mistake!

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Most evidence points to the need to “think bigger” than field-level activities

Most often than not agriculture poses a problem insofar as it can cause deforestation while, comparatively, little damage is caused by its emissions (Li et al 2015,Gockowski and Sonwa 2011; Burney et al. 2010).

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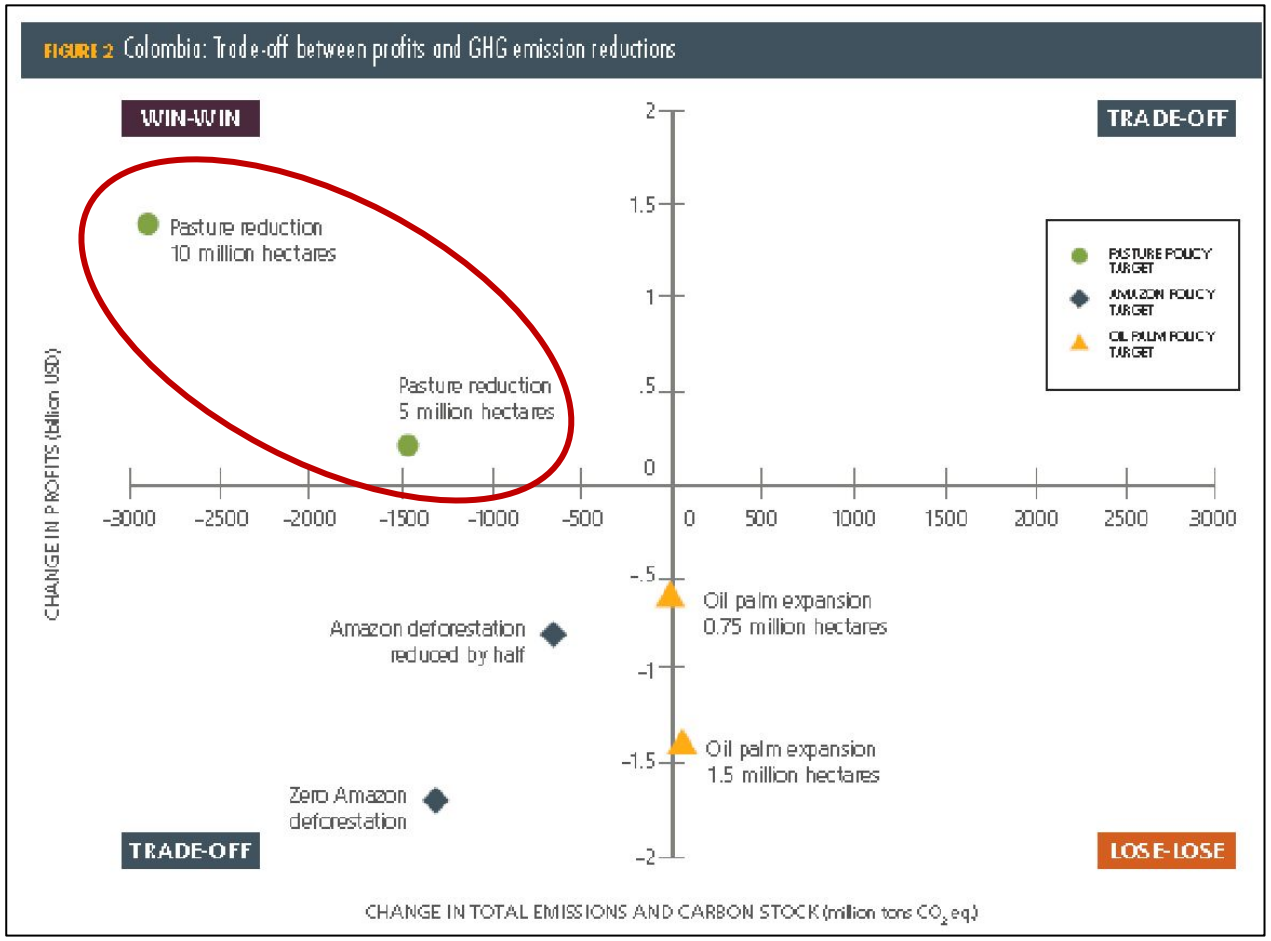
Policy Outcome Comparison - Colombia

Policies that act on the interface pastureland/livestock and forests are key to achieving economic growth in the next 20 years (average ~ $50 Million per year) and GHG emissions reduction (average 90 Million tons CO_2 e per year).

To accomplish this:

Land and property rights reform is a must.



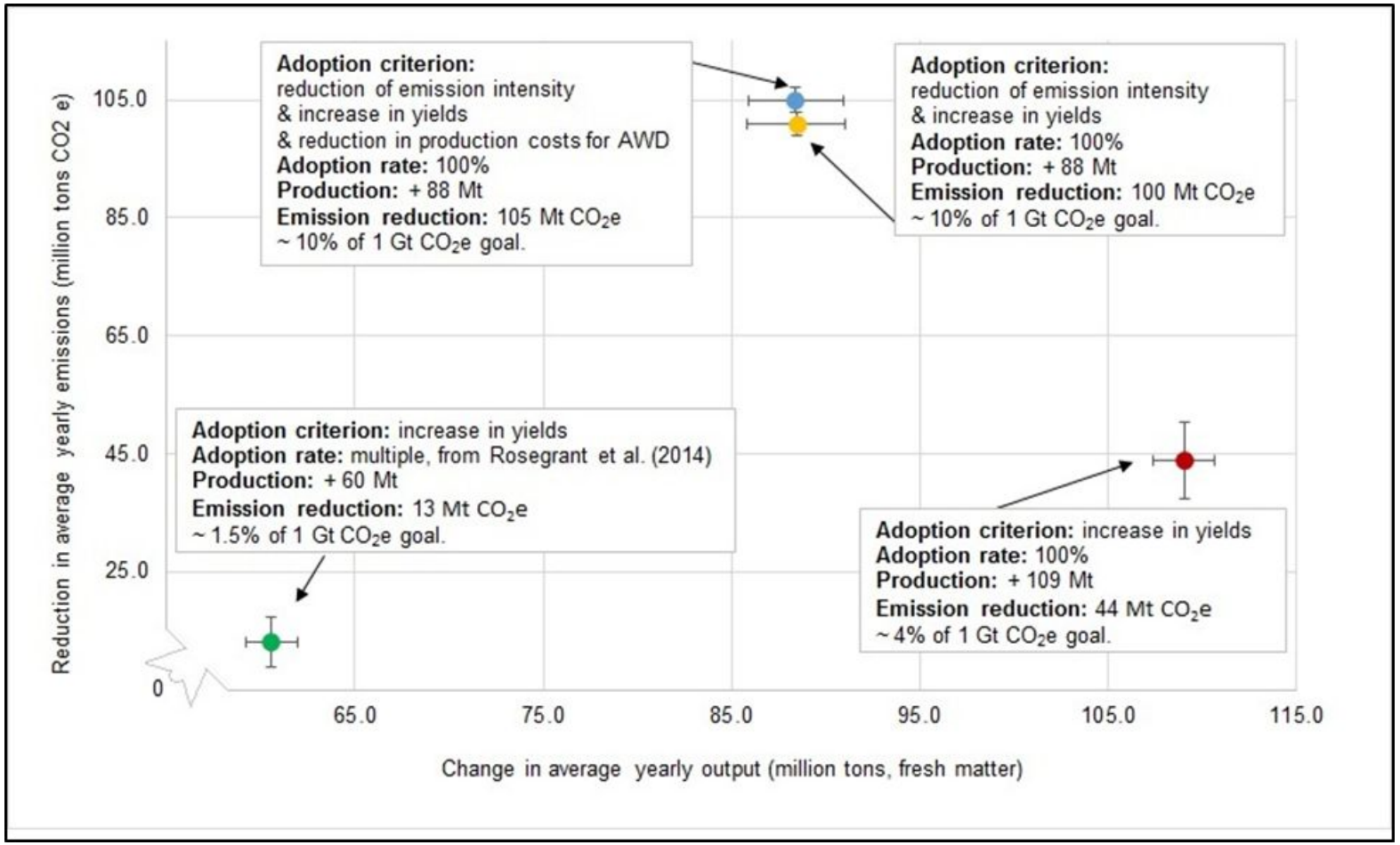
Source: De Pinto et al. 2016.

Climate-Smart Agriculture and crop production

Even CSA, when interpreted (reductively) as a set of agronomic practices and technologies: Best possible outcome considering maize, wheat, and rice (~41% of global harvested area and ~64% of GHG emission from crop production) ~ 10-13% of 1 Gt CO_2e goal.

To achieve higher levels of GHG emissions reduction:

Carbon pricing; "correct" pricing of inputs like water and fertilizers.



Source: De Pinto et al. In Progress

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Forest Landscape Restoration and CSA

Restoration goal of the Bonn challenge (move 350 million hectares of degraded and deforested land into restoration by 2030) is our benchmark.

The positive impacts are multifaceted and significant in size: A reduction in the number of malnourished children ranging from 3 to 6 million; a reduced number of people at risk of hunger, estimated at 70 and 151 million; reduced pressure for expansion of cropland; increased soil fertility; and reduced greenhouse gas emissions.

A forest landscape restoration approach that meaningfully integrates CSA can facilitate the implementation of restoration plans on large amounts of land.

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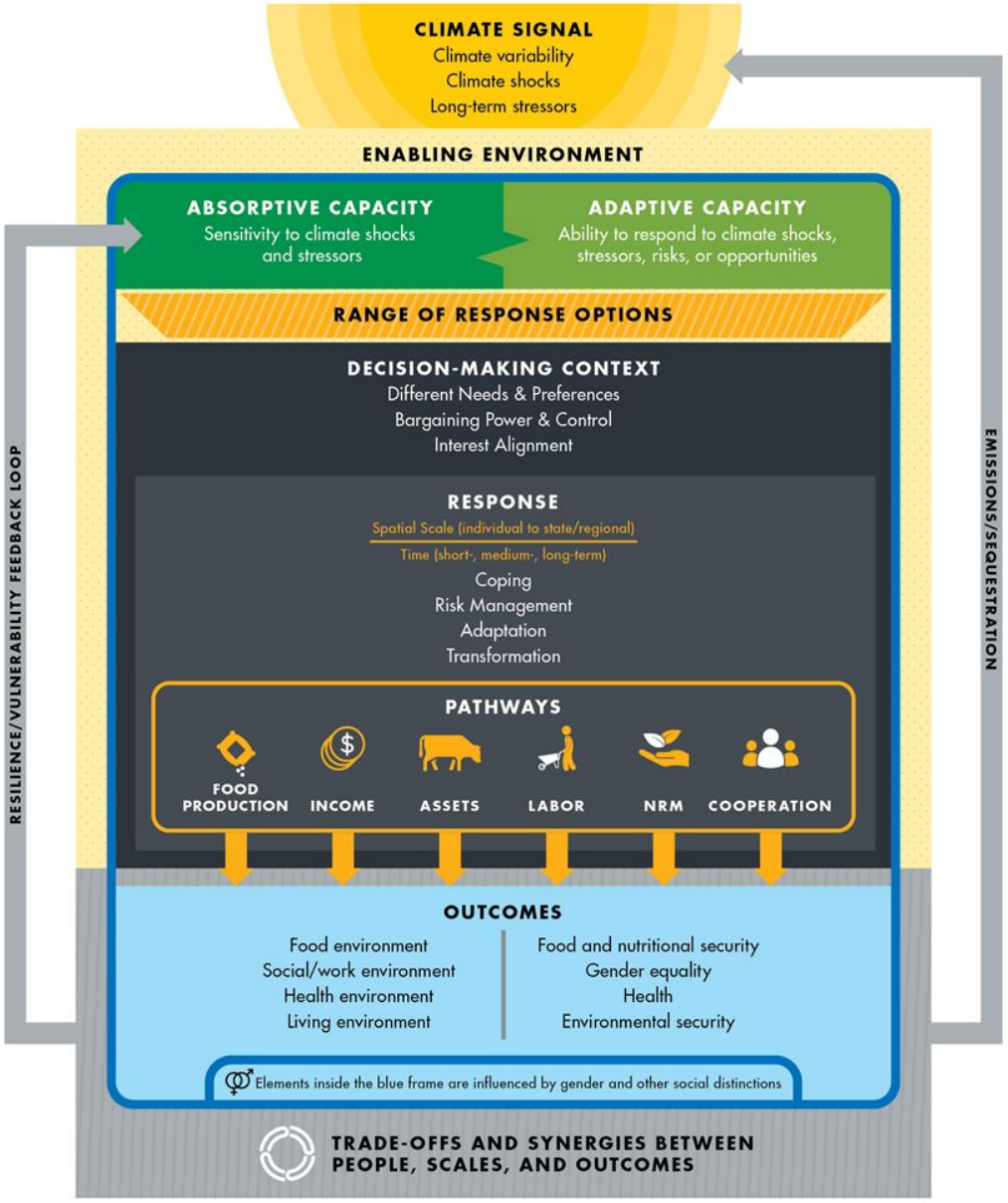
Gender, Climate Change, Nutrition (and Youth) framework

Little is known about the impact of climate change and climate-responsive agricultural approaches on men's and women's time use or key nutrition outcomes, such as child growth, micronutrient status and diet quality of women, children and households, and about how the adoption of climate smart agricultural practices at scale may influence the availability of micro- and macronutrient availability across value chains and landscapes.



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CONCLUSION

Some takeaway messages

- Significant opportunities to offset the negative effects of CC, spur economic development and wellbeing, protect ecosystems
- New technologies can be used to increase productivity and reduce GHG emissions (plant-microbe interactions; innovative breeding practices and “new crops” for a new climate; water- and nutrient-efficient practices)
- Frank et al. 2017 and Hasegawa et al. 2018 are most likely overestimating the negative effects of a carbon tax.

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To meet the goals of our recent treaties and agreements our frameworks must be inclusive

Must be enriched with system-thinking (interactions of agricultural land with carbon-rich environments e.g. forests and mangroves), and include agroforestry, crop-livestock and silvopastoral systems. Think through the value chain.

Must recognize the multiple pathways through which nutrition, health, gender equality influence the set of available climate change responses and other development outcomes.

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To meet the goals of our recent treaties and agreements our frameworks must be inclusive

Climate resilience, sustainable food systems, and healthy diets: Can we have it all?

Increasing productivity, soil protection and improving ecosystem services but also gender inclusion, smart-consumption, better nutrition are not just outcomes, **they are part of the solution.**

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Why is system-thinking useful?

- We create silos, we work in silos, we have policies that more often than not are developed in silos.
- The multidimensional challenges we face require policy coherence and multisectoral plans. Synergistic investments in other sectors beside agriculture are a must (rural infrastructure, including roads and electricity).

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Agroecology, CSA and more….

- Approaches like Agroecology, Climate Smart Agriculture, Forest-Landscape Restorations, Sustainable Land Management, etc. force us to think beyond single objectives;
- **They reinforce the importance of a multi-objective approach to agricultural development and facilitate the necessary dialogs across ministries that favor the development of coherent policies.**

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Thank you

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