

Climate Vulnerability of Farm Households: New Methods and Evidence

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Presented at Resources for the Future January 28 2015

Acknowledgements

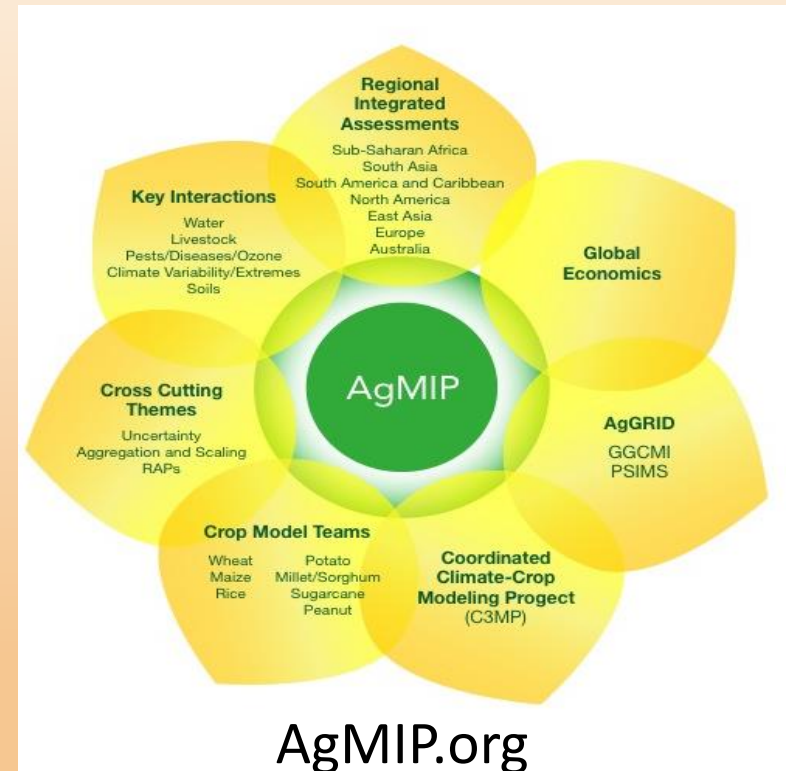
- AgMIP & collaborators (agmip.org)
- USDA Ag Research Service
- UKAID (DFID)
- USAID
- REACCH-PNA & collaborators

Themes

- A new “community of science” approach to agricultural systems research (AgMIP)
- New approaches & methods to regional and global climate change assessment
- Results from two new regional assessment studies
- Looking ahead ... US assessment, AR6, and beyond

Agricultural Model Inter-comparison and Improvement Project (AgMIP)

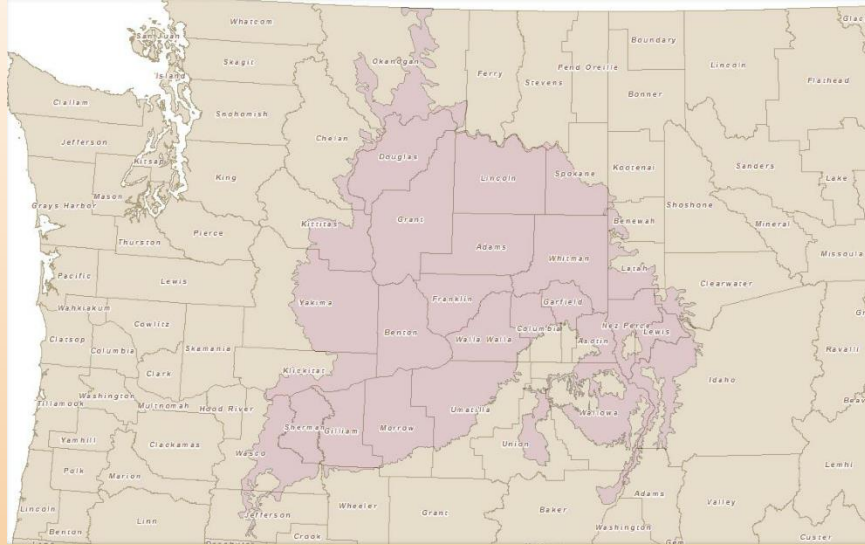
- A new **global community of science**: climate, water, soils, crops & livestock, economics, pests & diseases...led by:
 - Cynthia Rosenzweig, GISS and Columbia U
 - Jim Jones, U Florida
 - Jerry Hatfield, Ag Research Service, USDA
 - John Antle, Oregon State U
- More than 600 participating scientists
- Crop, livestock and economic model inter-comparisons
- Protocol-based regional and global integrated assessments
- Next Generation Ag System Models
- Sustainable Ag Systems



Ag, Food and Climate Change

- The Goal: sustainable food & nutritional security under future bio-physical and socio-economic conditions
 - National, local and household relevance (global?)
 - Beyond commodity production, to the entire food system
 - Assessment not yet feasible: major data and methodological challenges remain
- **Vulnerability**: who is at risk of loss, and who can gain?
 - Urban consumers: primarily price effects?
 - Rural ag households: production and price changes affect income, availability, stability
- Mitigation and adaptation: what can we do, sustainably?

REACCH - Regional Approaches to Climate Change in Pacific Northwest Agriculture



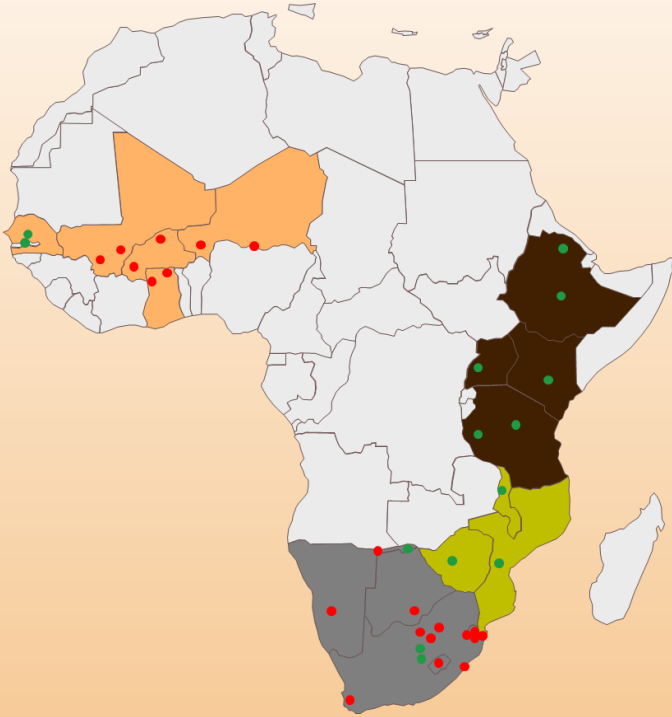
5-year project funded by USDA-NIFA
University of Idaho
Oregon State University
Washington State University
USDA-ARS
+ 100 scientists & students

Large-scale wheat-fallow and annual
cropped systems typical of
“industrial commodity agriculture”

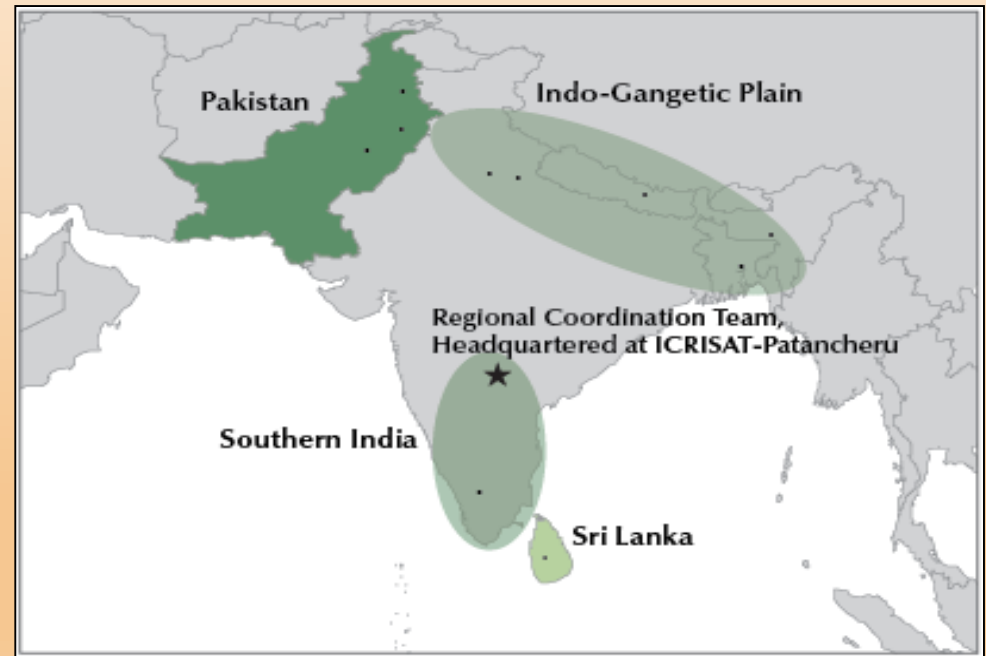


AgMIP Regional Assessment Teams

5-year project, DFID funded
8 regional teams, 18 countries, ~ 200 scientists
Data, models, scenarios designed &
implemented by multi-disciplinary teams &
stakeholders



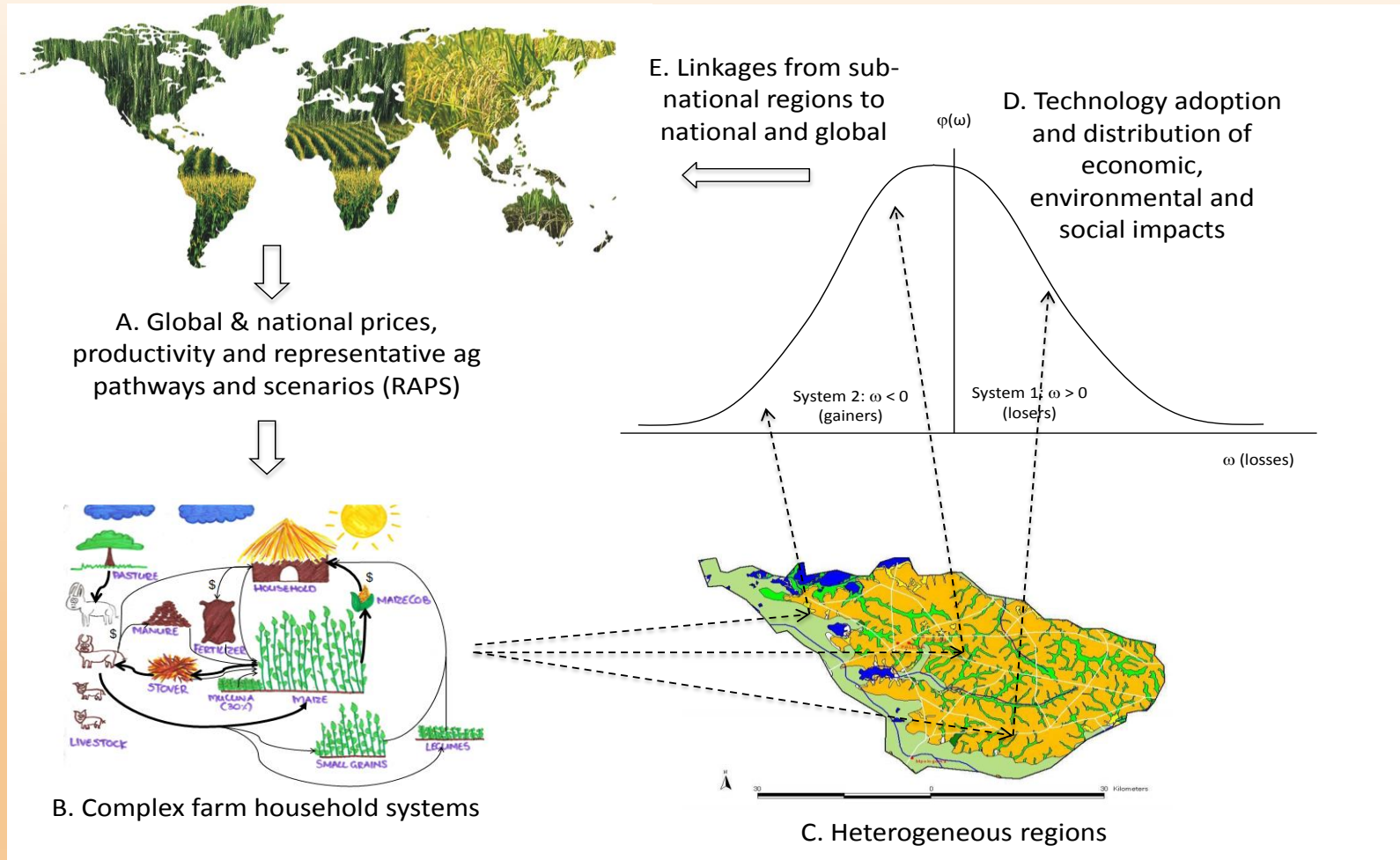
Small-scale, mixed crop and crop-livestock systems; principal crops vary by region (maize, millet/peanut, rice, wheat) typical of “semi-subsistence agriculture”



For the full AgMIP story:



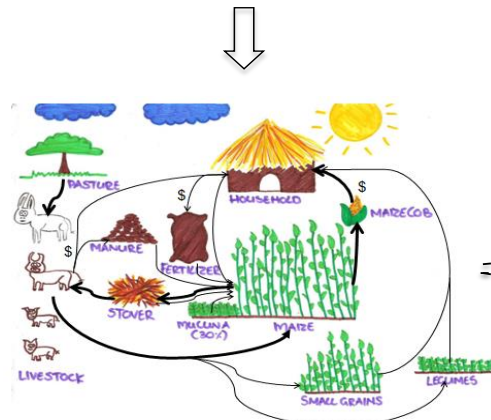
AgMIP regional integrated assessment method: *beyond average impact to vulnerability*



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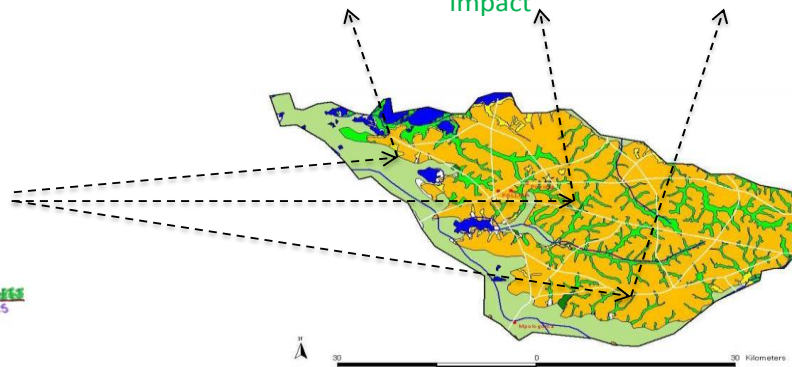
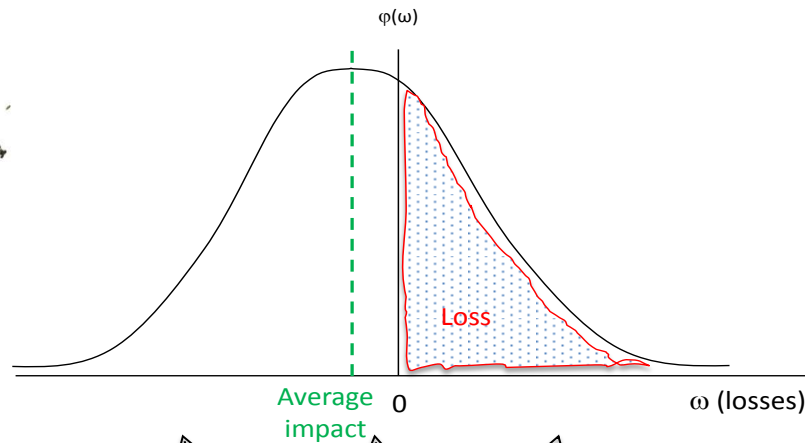


A. Global & national prices,
productivity and representative ag
pathways and scenarios (RAPS)



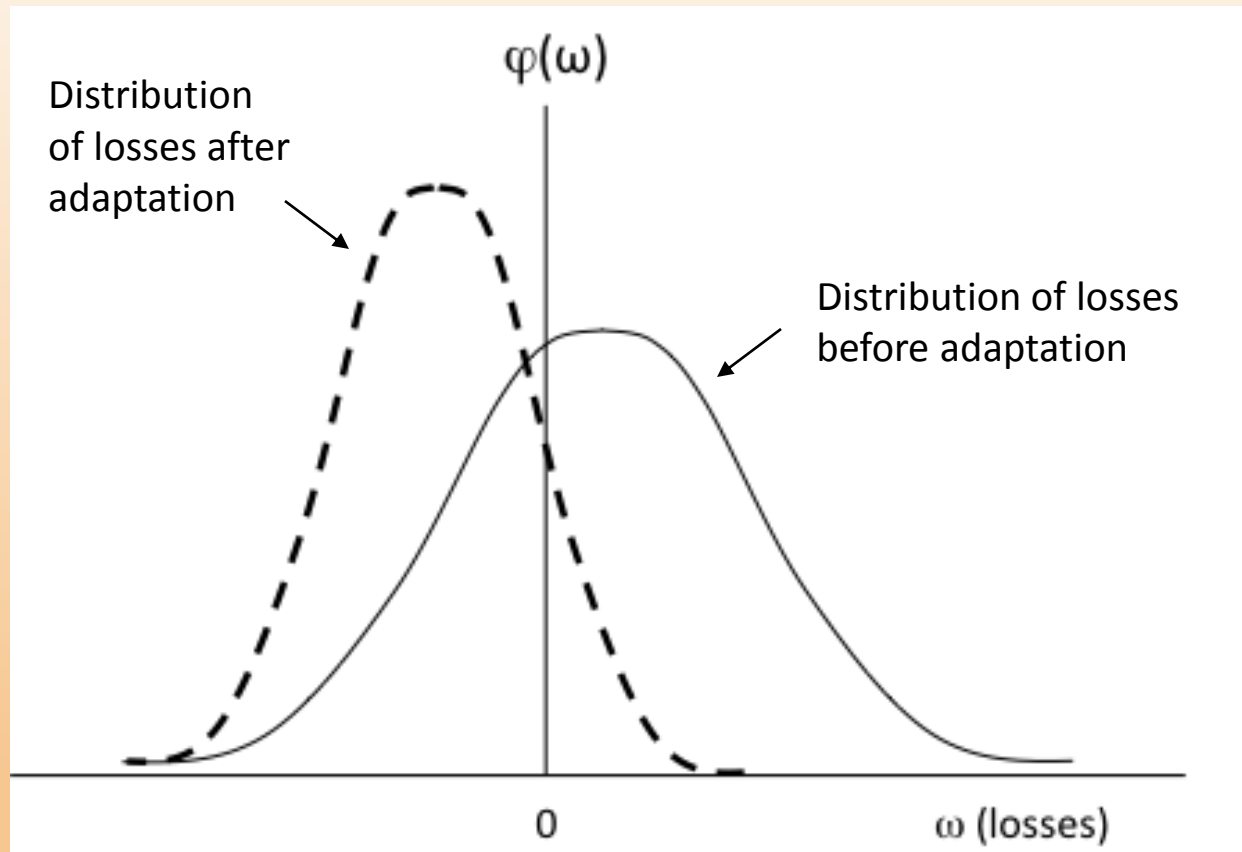
B. Complex farm household systems

TOA-MD model simulates gains and losses
tradeoffs.oregonstate.edu

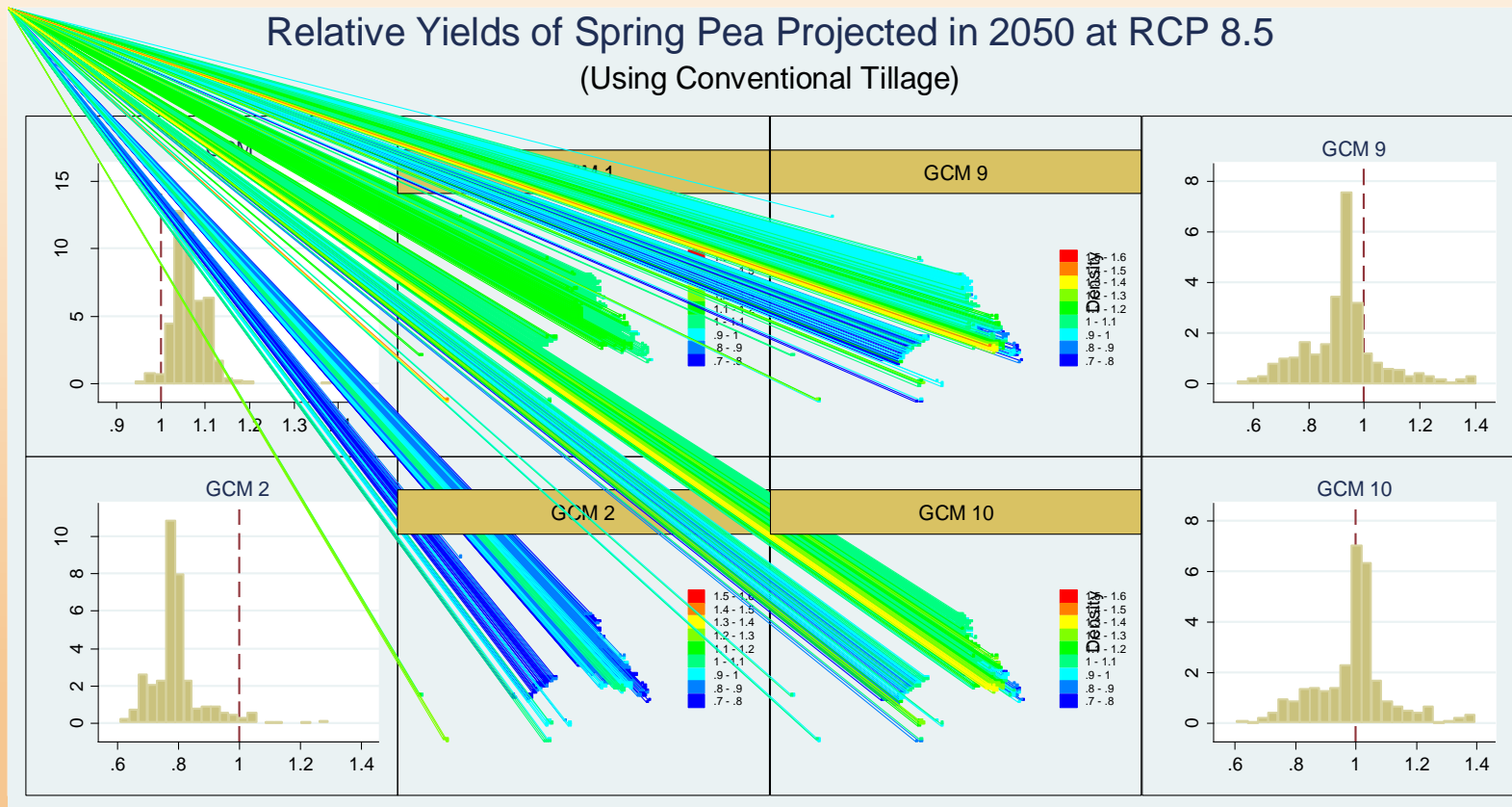
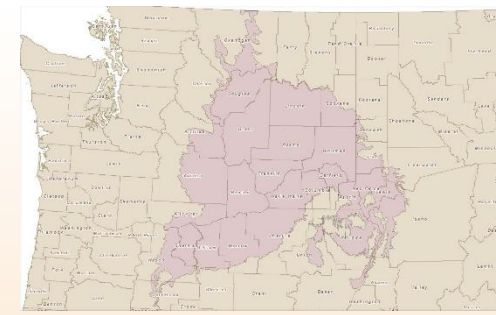


C. Heterogeneous regions

TOA-MD Model: vulnerability before and after adaptation



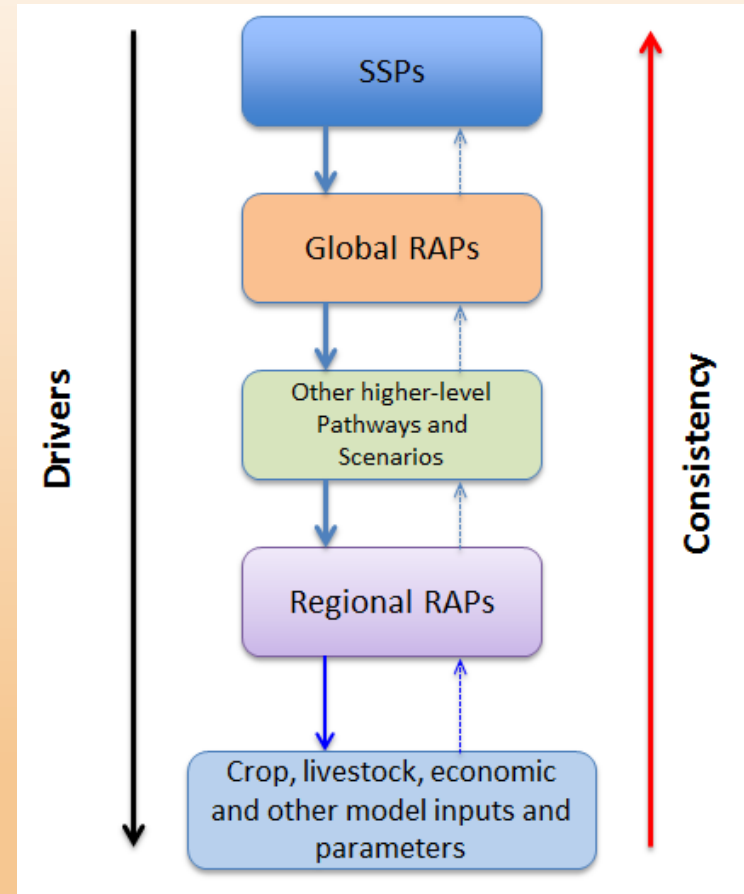
Relative yield distributions: *linking bio-physical and economic models to represent heterogeneity and vulnerability*



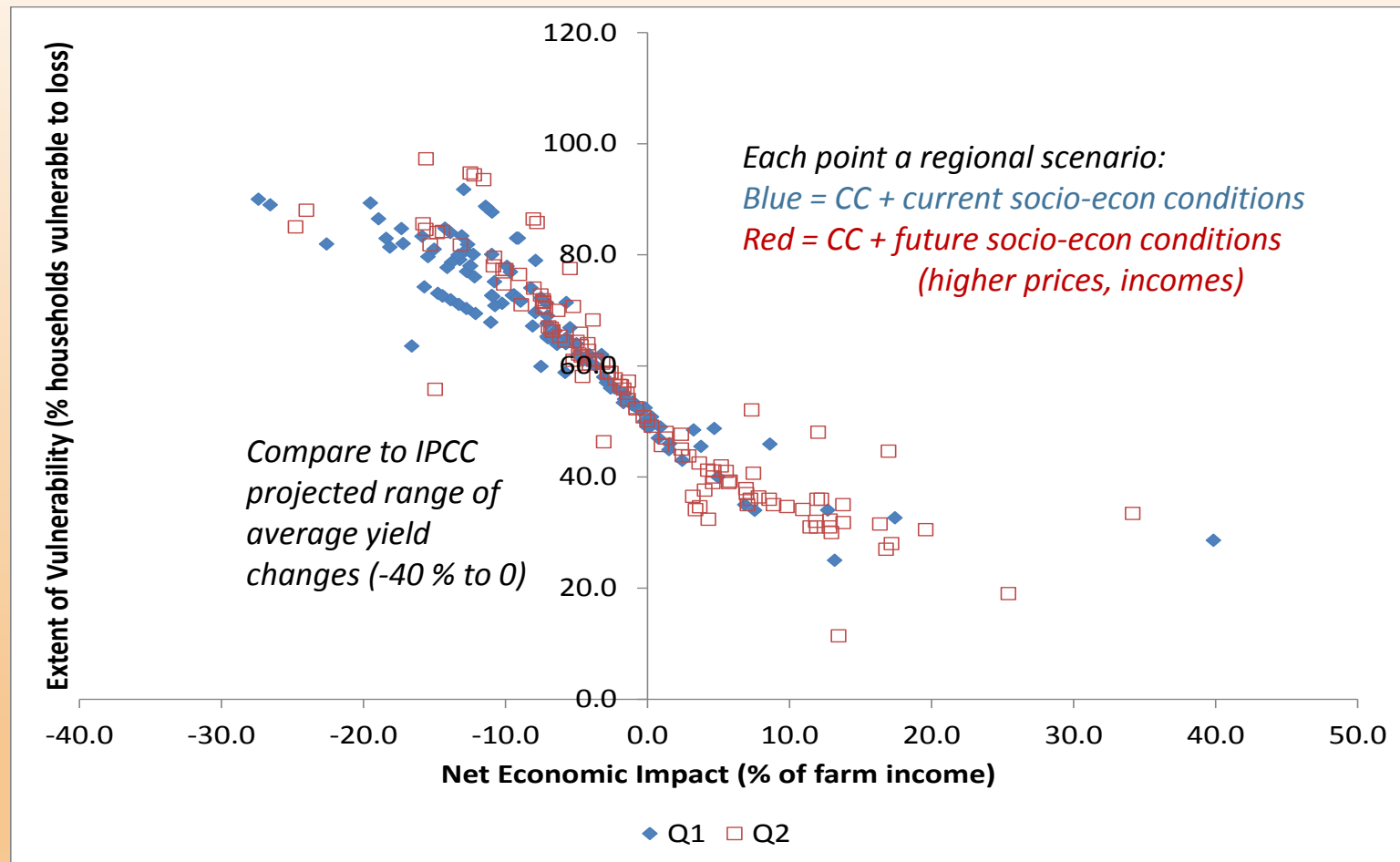
Source: Author and collaborators, REACCH-PNA Project

Representative Ag Pathways: *assessing CC impacts under plausible future bio-physical and socio-economic conditions*

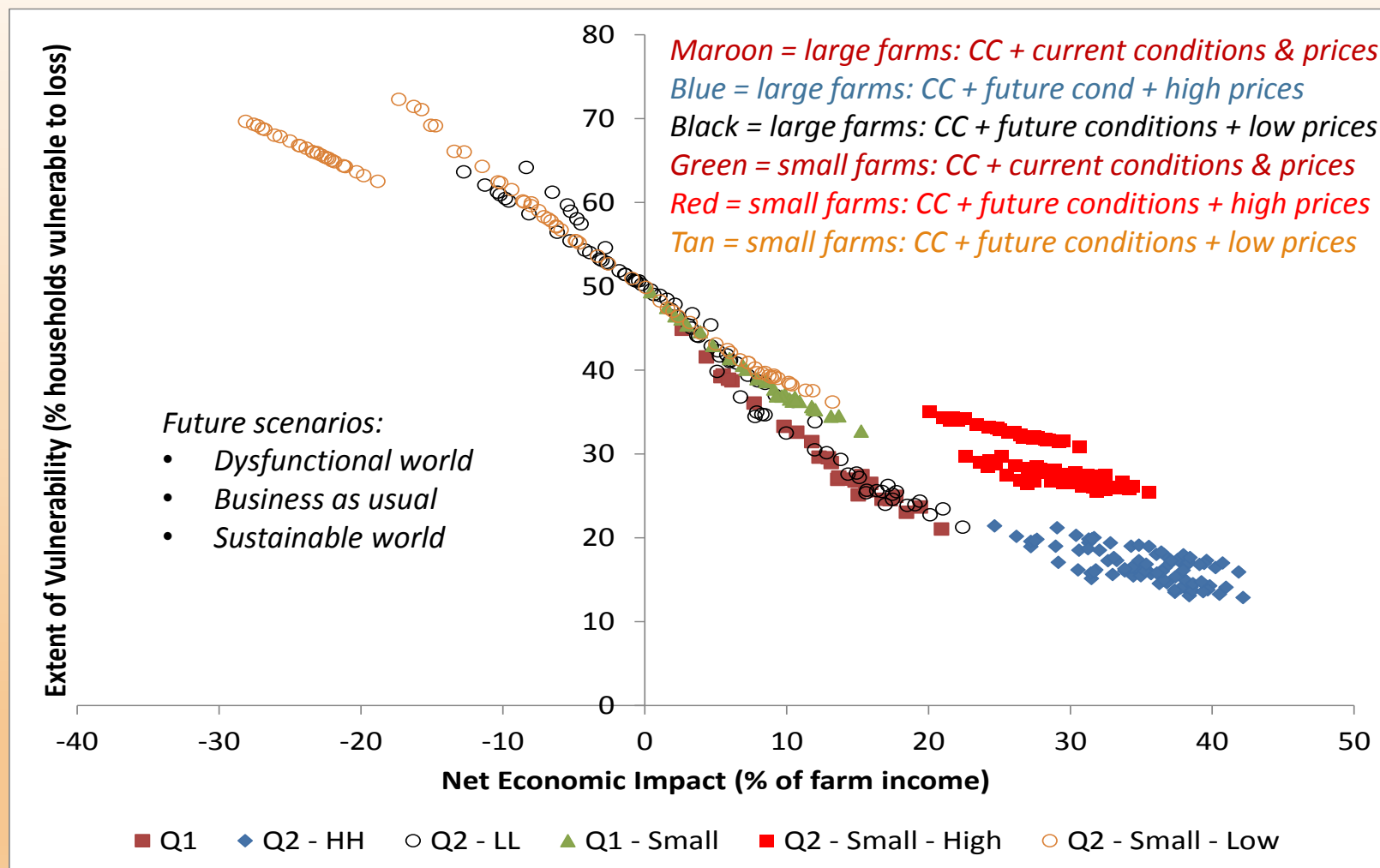
- Many regional assessments simulate impacts of future climate under *current* socio-economic conditions
- AgMIP RIA methods create plausible future scenarios
 - Global “Shared Socio-Economic Pathways”
 - Agriculture-specific bio-physical and socio-economic pathways (RAPs)
 - Created by regional teams with stakeholder input



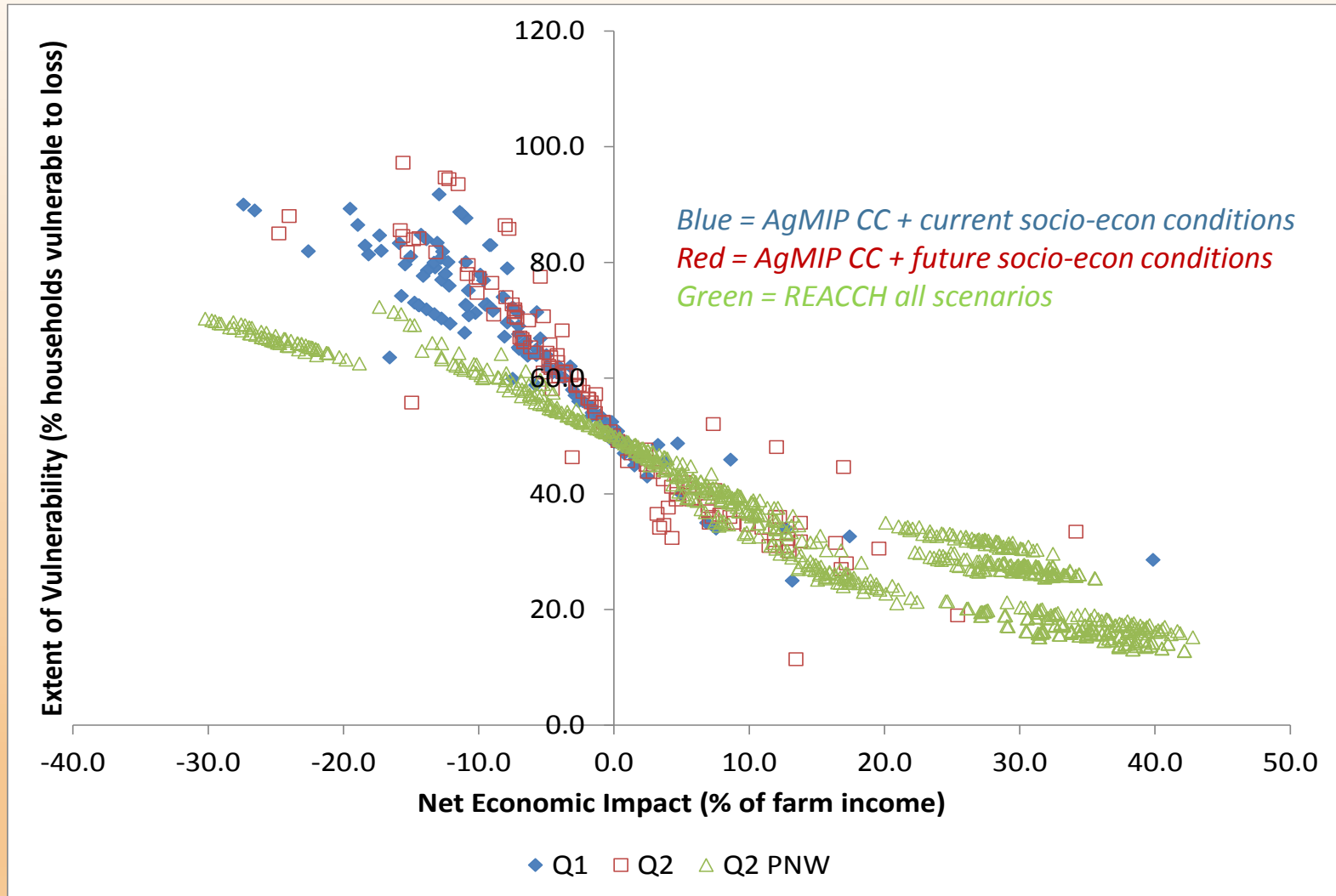
Extent of Vulnerability *without adaptation*: AgMIP Sub-Saharan Africa & South Asia Teams



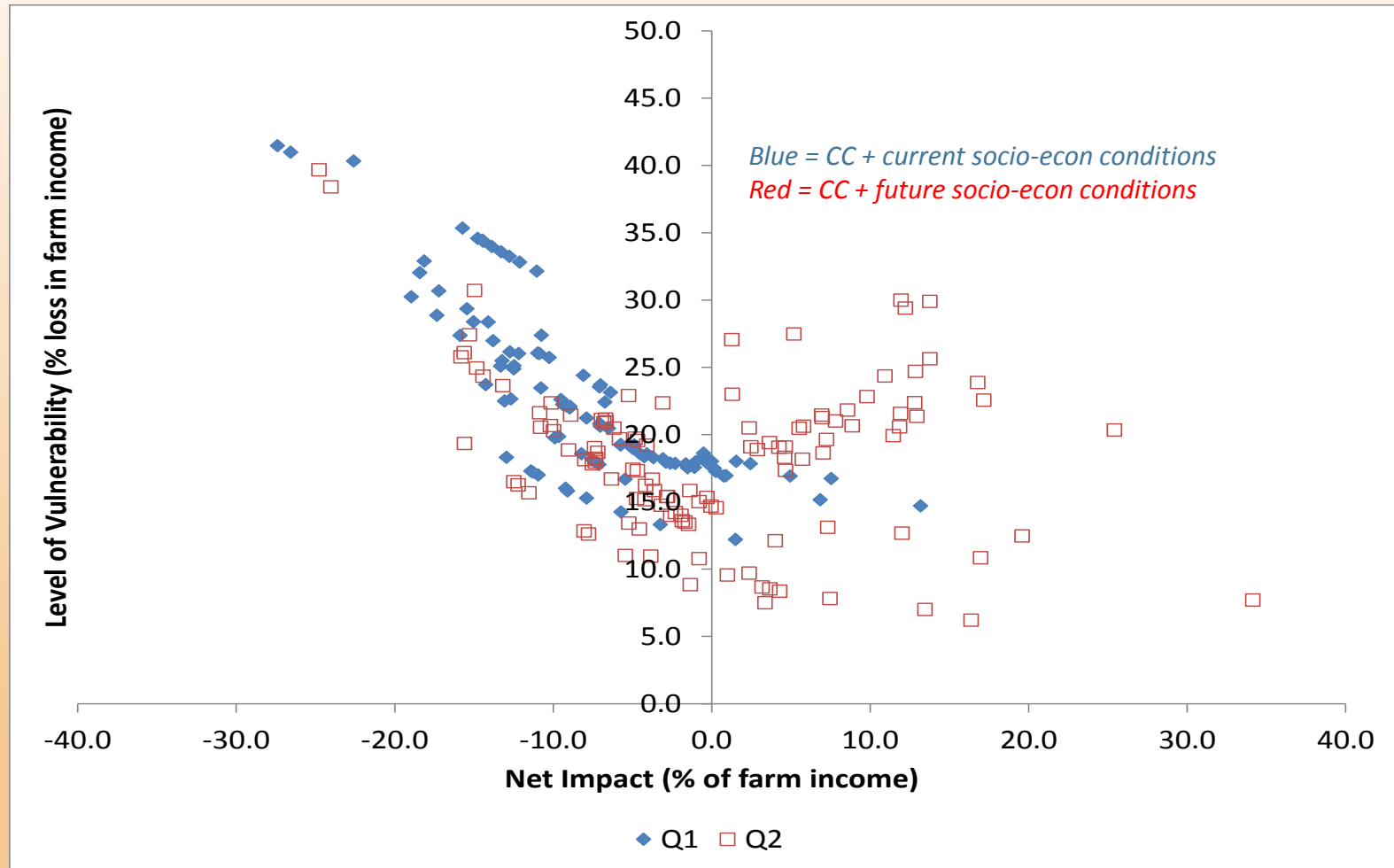
Extent of Vulnerability without adaptation: REACCH-PNA winter wheat – fallow



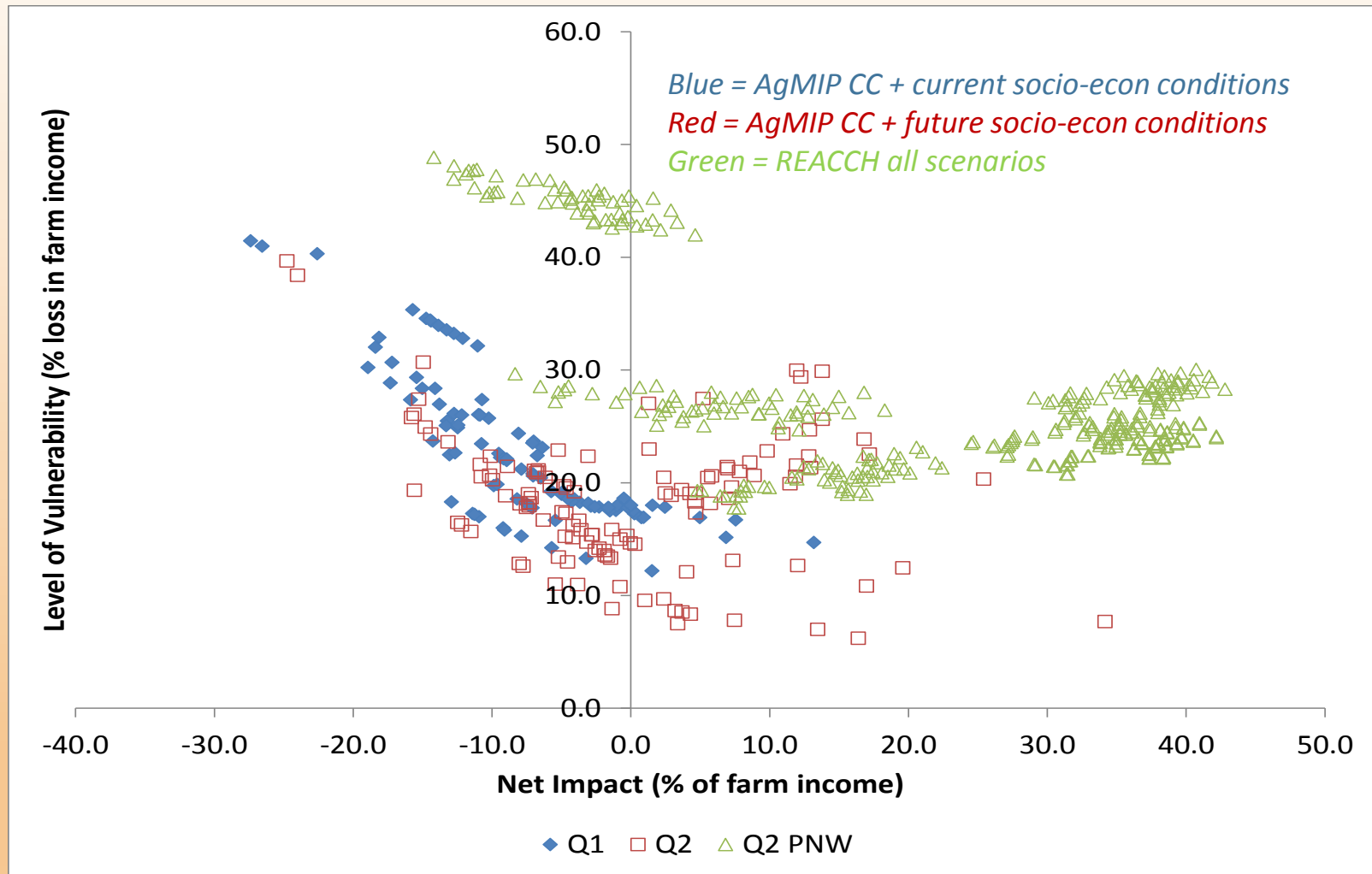
Extent of Vulnerability without adaptation: AgMIP Regions + REACCH



Magnitude of Vulnerability without adaptation: AgMIP Sub-Saharan Africa & South Asia Teams



Magnitude of Vulnerability without adaptation: AgMIP Teams + REACCH



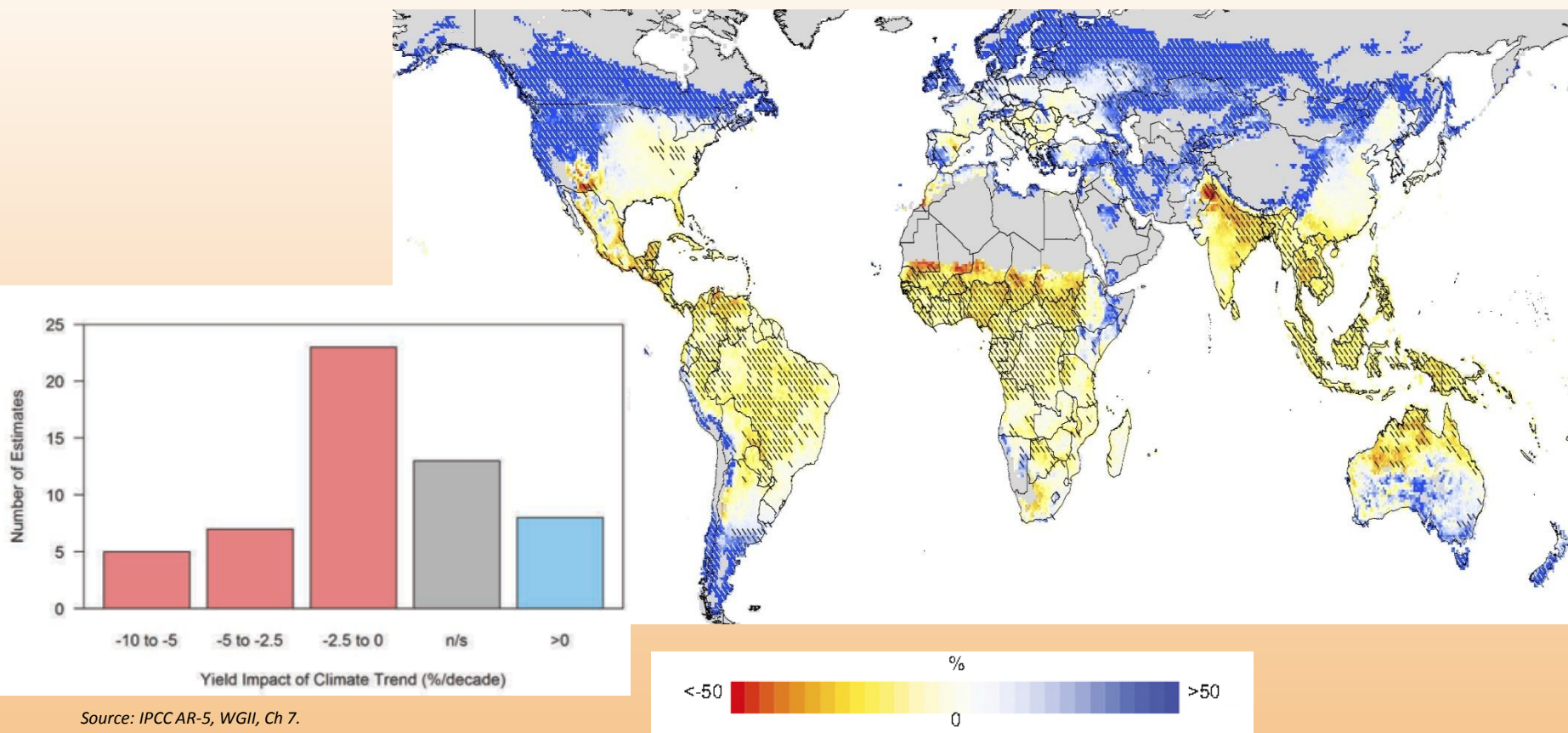
Taking Action: *Designing & Testing Meaningful Mitigation and Adaptation Strategies*

- Large-scale models lack sufficient detail for this purpose!
- Systems approach essential to design & test sustainable mitigation and adaptation options
 - Agronomic adaptation: variety choice, timing of operations, etc
 - Economic adaptation: intensive margin (within system crop choice, land allocation) and extensive margin (between system)
 - Sustainability: genetic, soil, water resources, health & nutrition, ...
 - Future society: industry structure, infrastructure, policy, institutions
- AgMIP Regional Teams, REACCH
 - strategies developed with local stakeholders
 - use plausible future scenarios..."Representative Ag Pathways"

Looking ahead...the AgMIP agenda

- Translating impacts on income into food & nutritional security, financial, environmental outcomes
- Expand coordinated regional-global integrated assessments
 - Protocol-based for transparency, comparability
 - New generation of modular, open-source, inter-operable models & data
 - Evaluation of climate, model, scenario uncertainty
 - Relevance: stakeholder-designed adaptation mitigation strategies
- Working with many partners towards next US assessment, AR6 and beyond!

Impact of CC on yields?

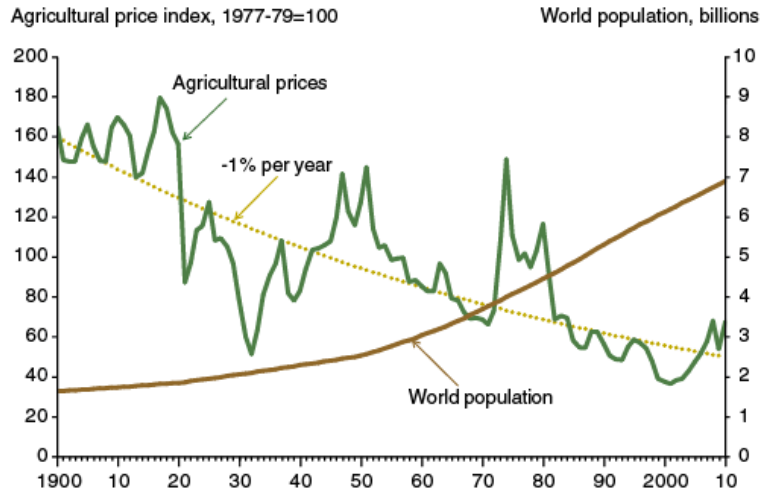


Source: IPCC AR-5, WGII, Ch 7.

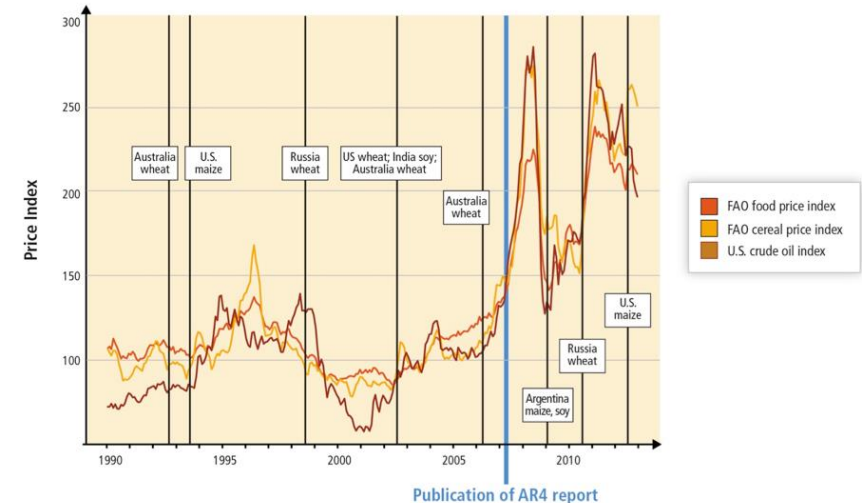
Median yield changes (%) for RCP8.5 (2070–2099 in comparison to 1980–2010 baseline) with CO_2 effects over five GCMs x seven GGCMs for rainfed maize (35 ensemble members). Hatching indicates areas where more than 70% of the ensemble members agree on the directionality of the yield change. Gray areas indicate historical areas with little to no yield capacity (Rosenzweig et al., PNAS 2013).

Are we at a turning point for agricultural prices?

Real agricultural prices have fallen since 1900, even as world population growth accelerated



Source: USDA, Economic Research Service using Fuglie, Wang, and Ball (2012). Depicted in the chart is the Grilli-Yang agricultural price index adjusted for inflation by the U.S. Gross Domestic Product implicit price index. The Grilli-Yang price index is a composite of 18 crop and livestock prices, each weighted by its share of global agricultural trade (Pfaffenzeller et al., 2007). World population estimates are from the United Nations.



Source: IPCC AR-5, WGII, Ch 7

- AgMIP global econ model inter-comparison (Nelson et al. PNAS 2014):
 - Without climate change, trend to 2050 highly uncertain (+/- 50%)
 - Effect of climate change likely positive, but also highly uncertain (0 to + 50%)
 - Results strongly determined by assumed productivity trends