Climate Change and Food Security:
Improving the Relevance and Credibility of Global and Regional Integrated Assessments

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Presented at the TradeM International Workshop, November 25-27 2014, Oslo Norway

Acknowledgements

- AgMIP & collaborators (agmip.org)
- USDA Ag Research Service
- UKAID (DFID)
- USAID
- REACCH-PNA & collaborators
- everyone else I forgot to mention …

Themes

- Many needs & opportunities to improve the relevance and credibility of global and regional integrated assessments
  - NextGen stakeholders: need to improve relevance, credibility & accessibility of models
- What do we know, and what do we need to know?
- Recent advances and challenges
- New initiatives

What we know (highlights)

- CMIP climate projections

- Importance of socio-economic conditions
  - new socio-economic pathways (SSPs)

- AgMIP/ISIMIP global gridded crop, global ag economic model comparisons

- Projections of food production, area, consumption, prices, trade under limited number of future conditions

- Regional studies (World Bank, EU, US etc.) of yields, economic impacts (but without socio-economic scenarios!)

# What we need to know (highlights)

- Climate: variability and extremes

- Crop & livestock models
  - pests & diseases
  - systems (crop-livestock; inter-crops)
  - linkages to economics & behavior

- Economic models
  - Global/national models
    - Understand differences
    - Dynamics & disequilibria

What we need to know (cont.)

- Farm/regional models
  - distributional effects & vulnerabilities
  - adaptation, adoption (info, expectations, …)
  - linkages to land use change, factor & product markets
- Ag pathways and scenarios (RAPS)
  - productivity trends
  - policy: domestic subsidy, environment, trade
  - inputs & cost of production
  - environmental linkages (soils, water)
  - farm size & structure, household size
  - infrastructure

Recent advances and challenges

But can we believe downscaled data for analysis of variability and extremes?
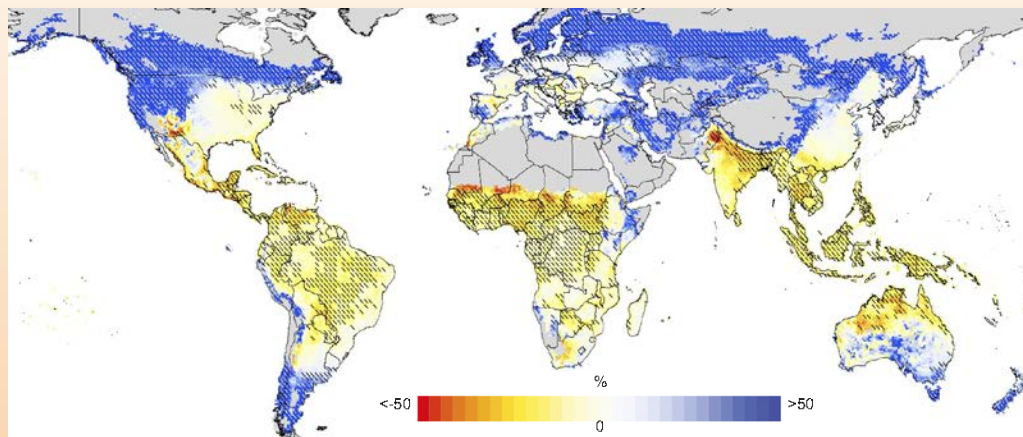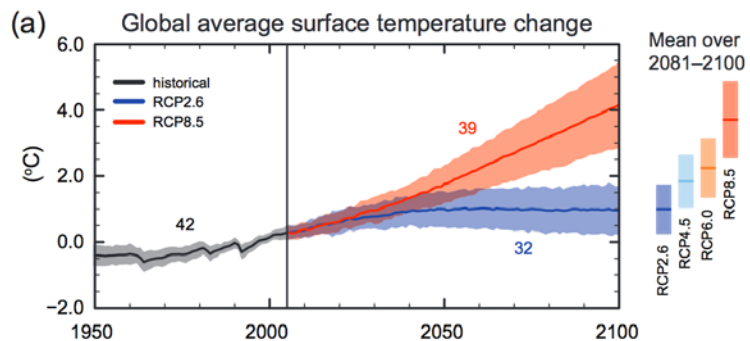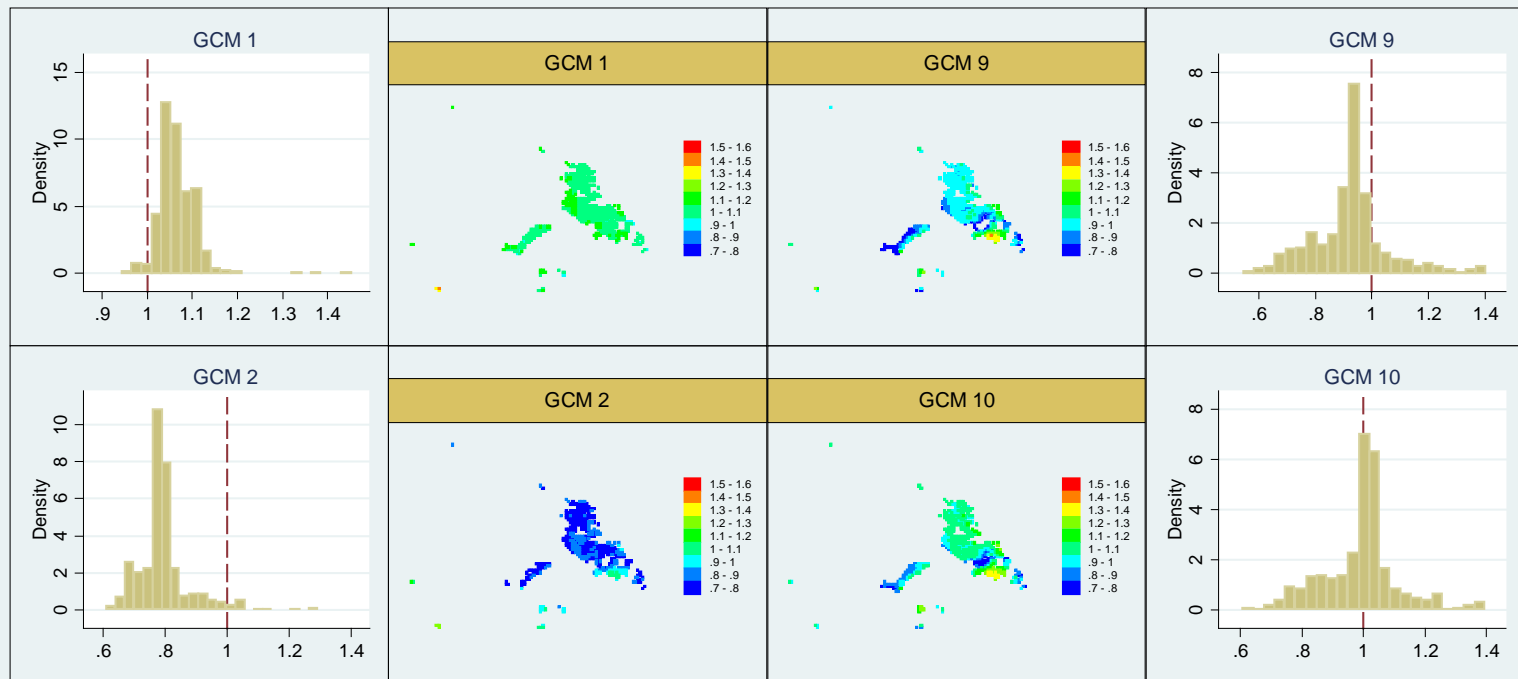

(Rosenzweig et al., PNAS 2013).
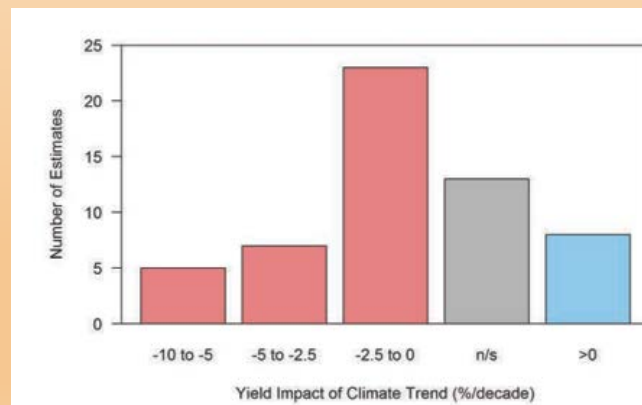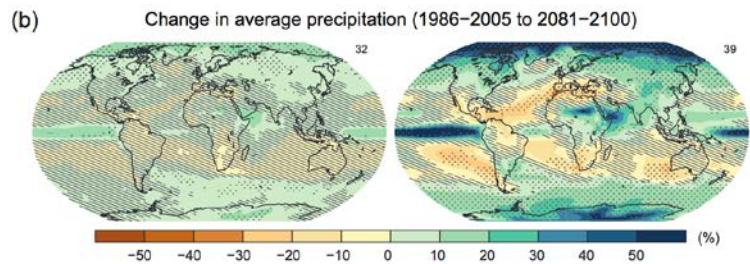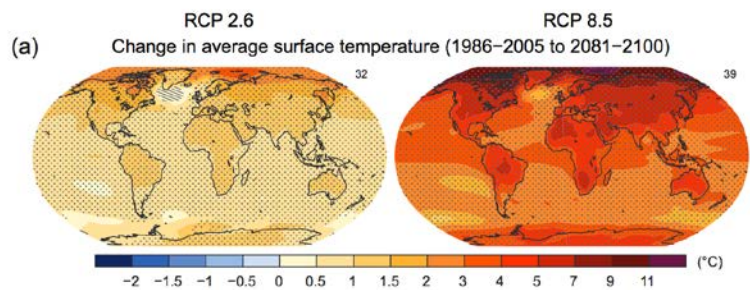
Source: IPCC AR-5, WGII, Ch 7.

Recent advances and challenges

Spatial coherence in downscaled yield simulations
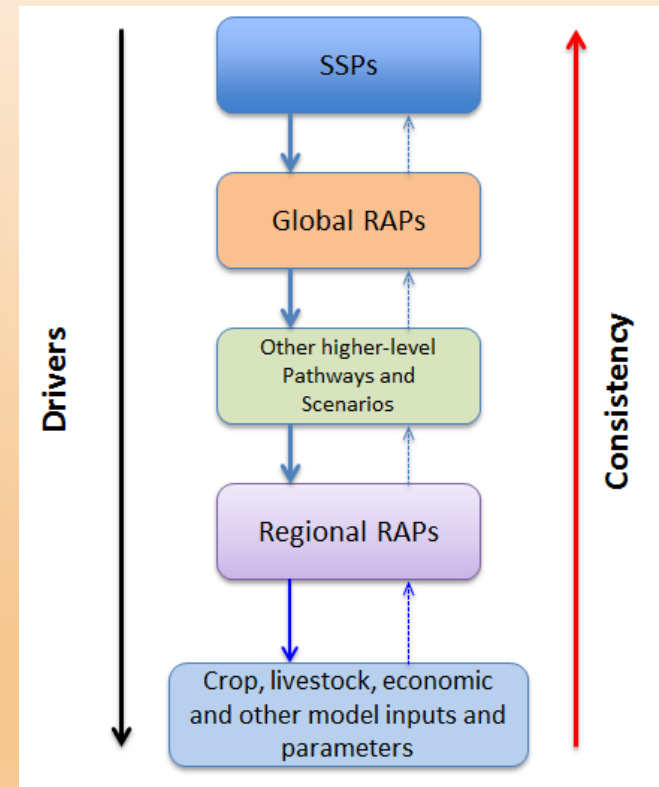
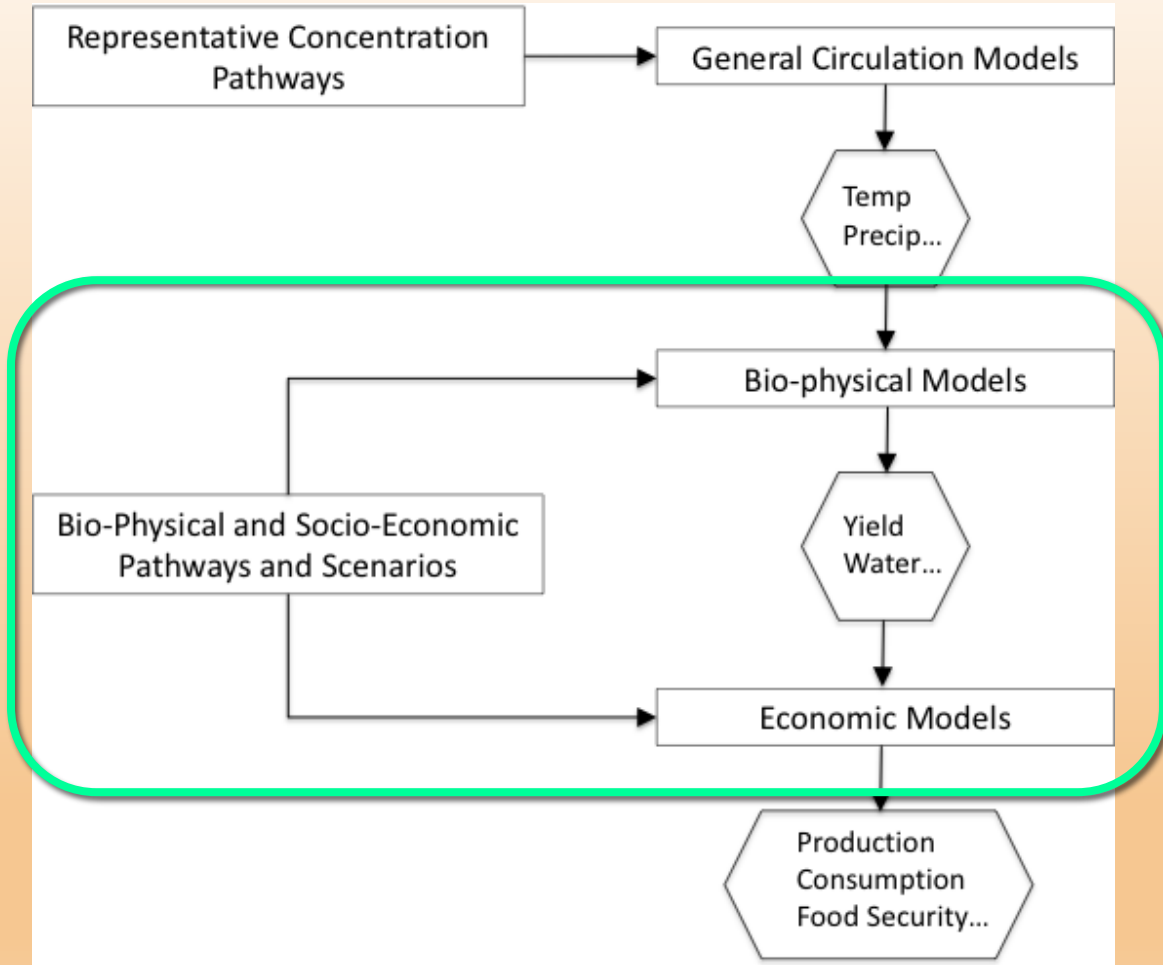High uncertainty in site-specific projections

Relative Yields of Spring Pea Projected in 2050 at RCP 8.5
(Using Conventional Tillage)

Source: Author and collaborators,
REACCH-PNA Project

Recent advances and challenges

Can we achieve consistency across models and scales? Adaptation? Dimensionality problem...

Variable	CLIP – R1 Zimb	CLIP – R2 Zimb	CLIP – R1 Mozamb	CLIP – R2 Mozamb	East Africa Embu, KE	West Africa R1 Nioro	West Africa R2 Nioro	SAAMIP South Africa	SAAMIP Namibia
Soil degradation									
Pest and diseases									
Extreme events									
Water availability									
Farm size									
Household size									
Herd size									
Livestock Productivity									
Fertilizer prices									
Fertilizer use									
Subsidies (inputs)									
Off-farm income									
Improved crop use									
Information availability									
Public invest in Agriculture									
Labor availability									

Direction and magnitude

No change	→
Small increase	↗
Moderate increase	↗
Large increase	↗
Small decrease	↘
Moderate decrease	↘
Large decrease	↘
Not included in RAP or under revision	⬡

Recent advances and challenges

Can we model long run trends?

Can we model short run departures from long run trends?

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

Agricultural price index, 1977-79=100   World population, billions
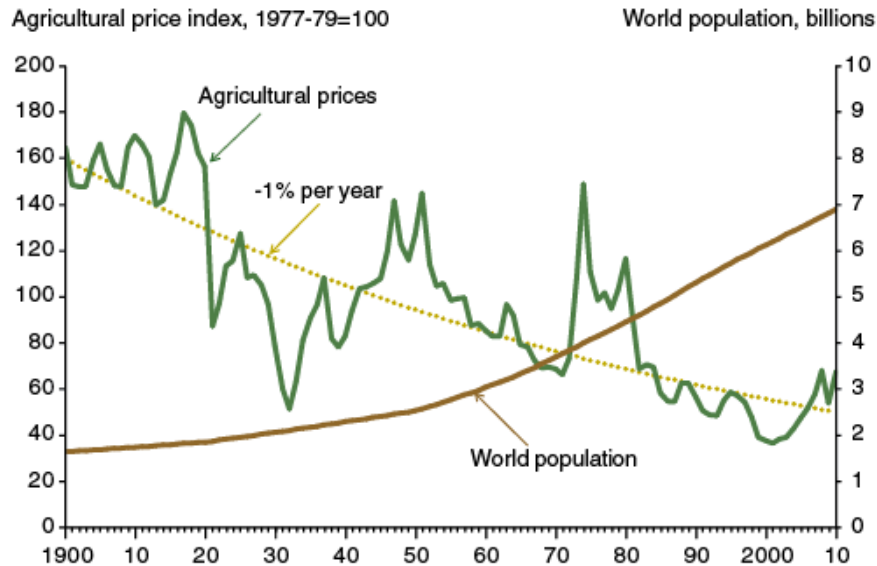
Source: USDA, Economic Research Service using Fuglie, Wang, and Ball (2012). Depicted in the chart is the Grilli-Yang agricultural price index adjusted for inflation by the U.S. Gross Domestic Product implicit price index. The Grilli-Yang price index is a composite of 18 crop and livestock prices, each 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.

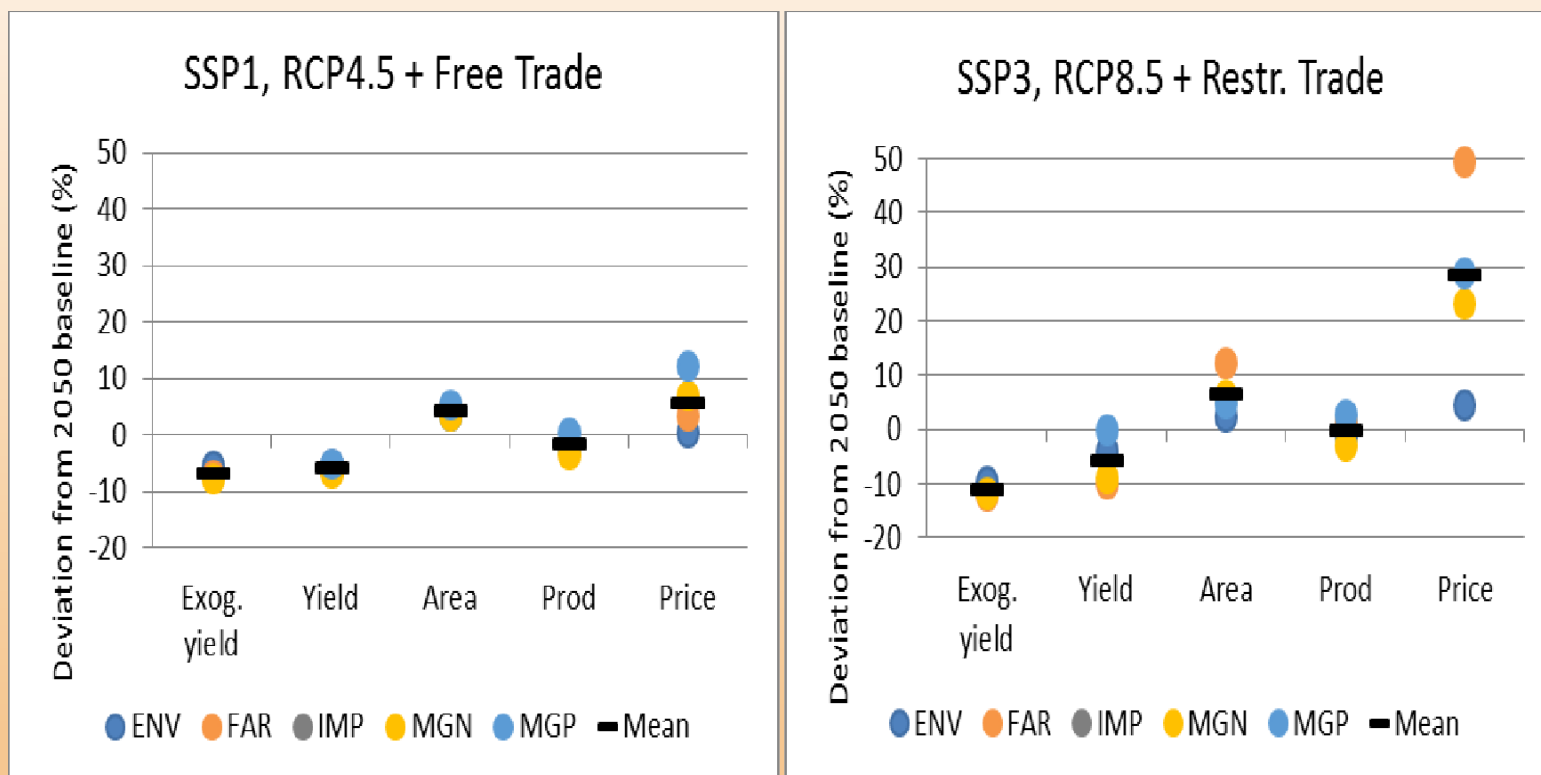11

Global Ag-Food System Projections
Projected impacts of climate change in 2050
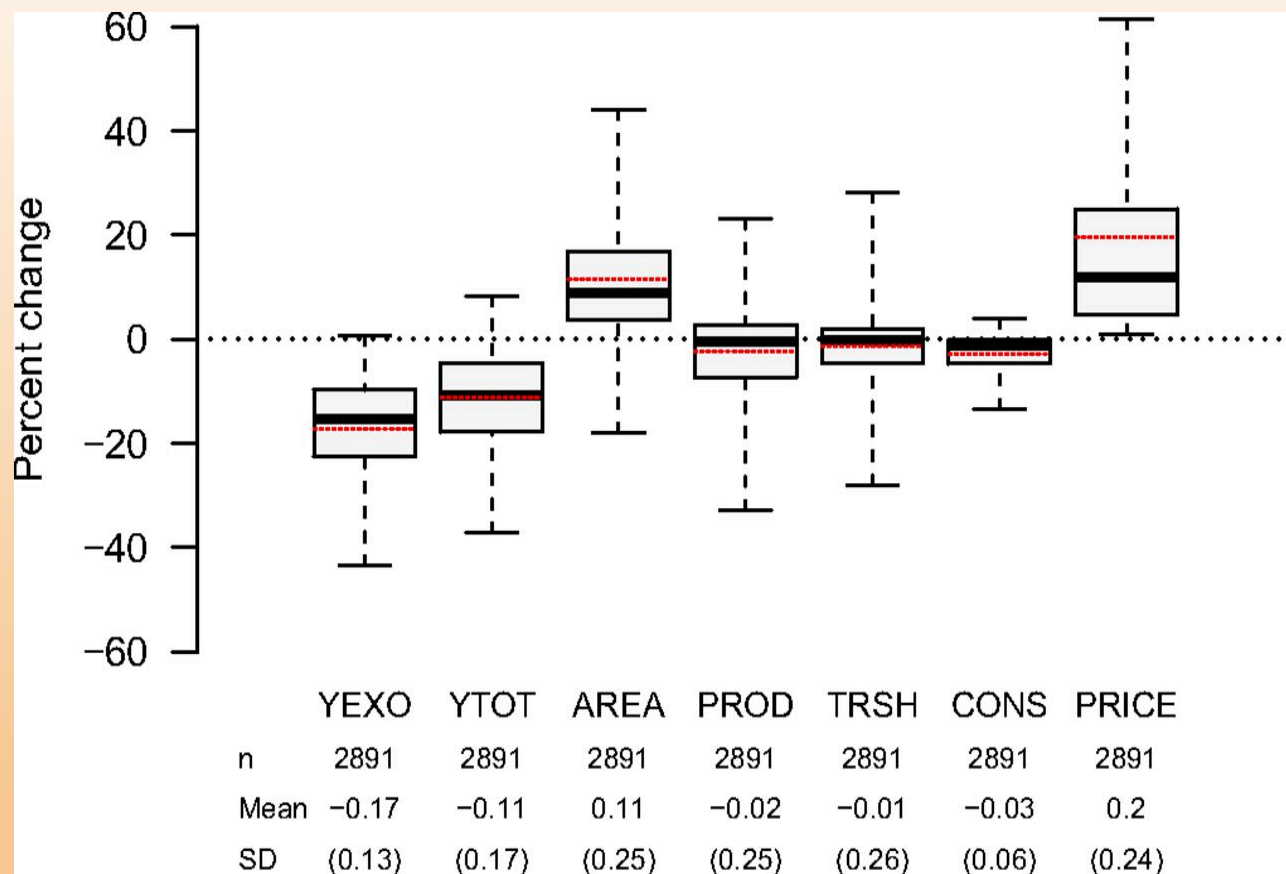
Key crop and economic model results from the AgMIP Global Agricultural Economic Model Intercomparison Study, across crop aggregates (n = 4), models (n = 9), scenarios (n = 7), and regions (n = 13). YEXO = yield effect of climate change without technical or economic adaptation, YTOT = realized yields with after management adaptation, AREA = agricultural area in production, PROD = total production, TRSH = net imports relative to domestic production, CONS = consumption, PRICE = prices (Source: Nelson et al. 2014).
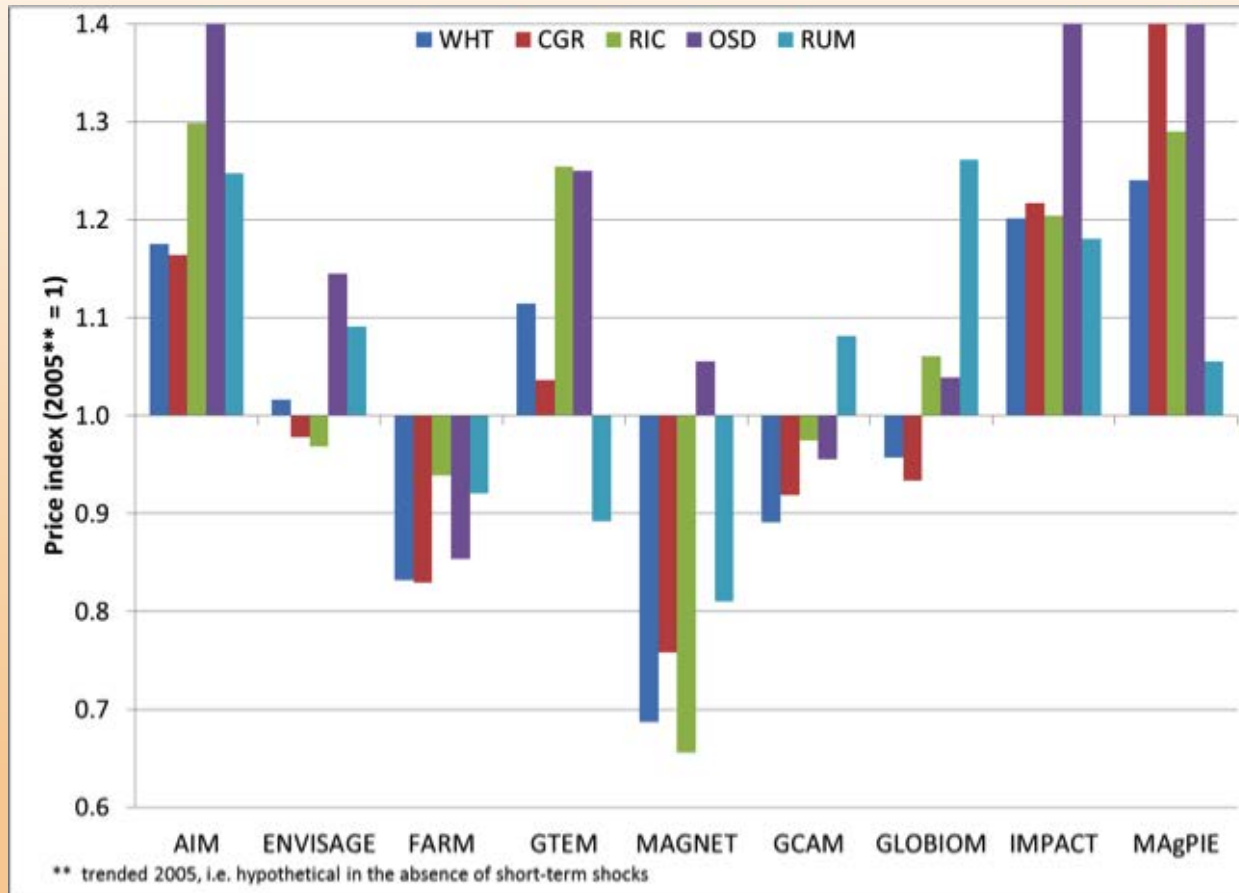
Global Ag-Food System Projections
Importance of agriculture-specific scenarios

Source: Wiebe et al. 2014

Global Ag-Food System Projections
Projected prices in 2050 without climate change

AgMIP Global Agricultural Economic Model Intercomparison, Projected Changes in Commodity Prices in 2050 without Climate Change (source: Nelson et al. 2014). WHT = wheat, CGR = coarse grains, RIC = rice, OSD = oil seeds, RUM = ruminant animal products.

Recent advances and challenges

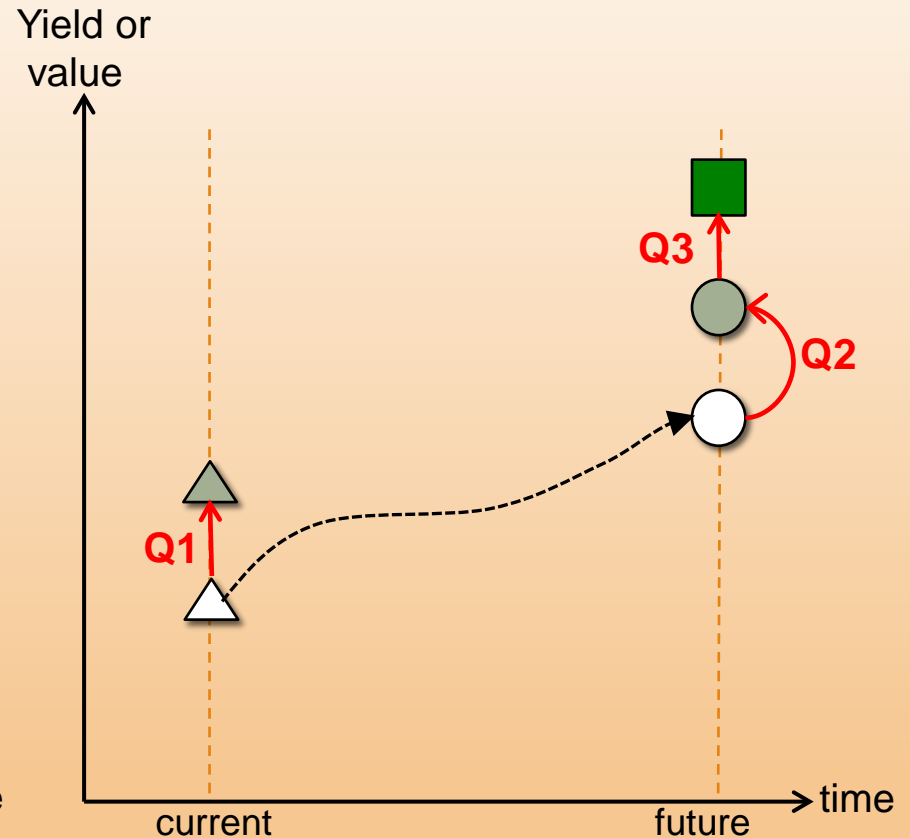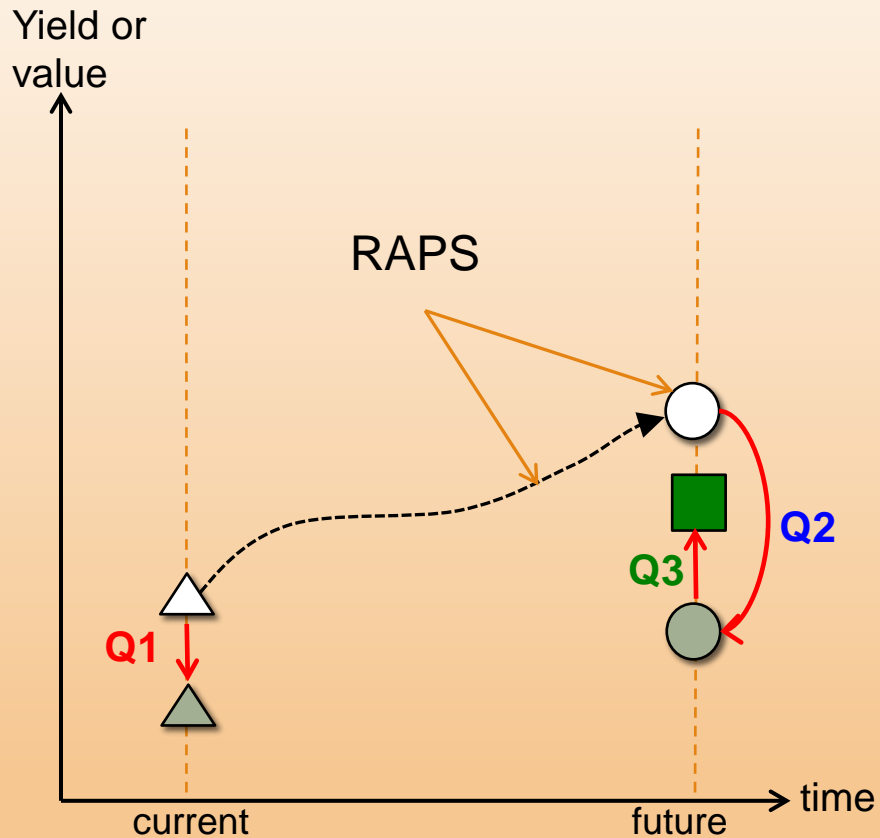- Most models project average aggregate (e.g., national) availability of major food commodities

- Models do not represent entire food system, vulnerability, or indicators of all dimensions of food security
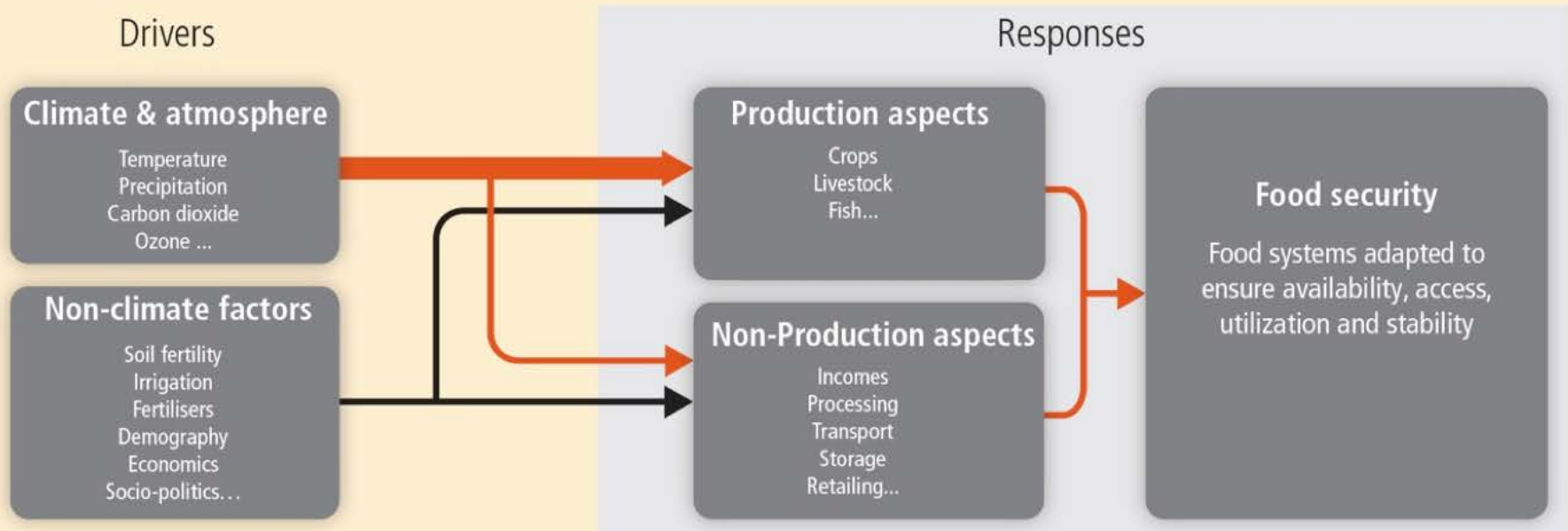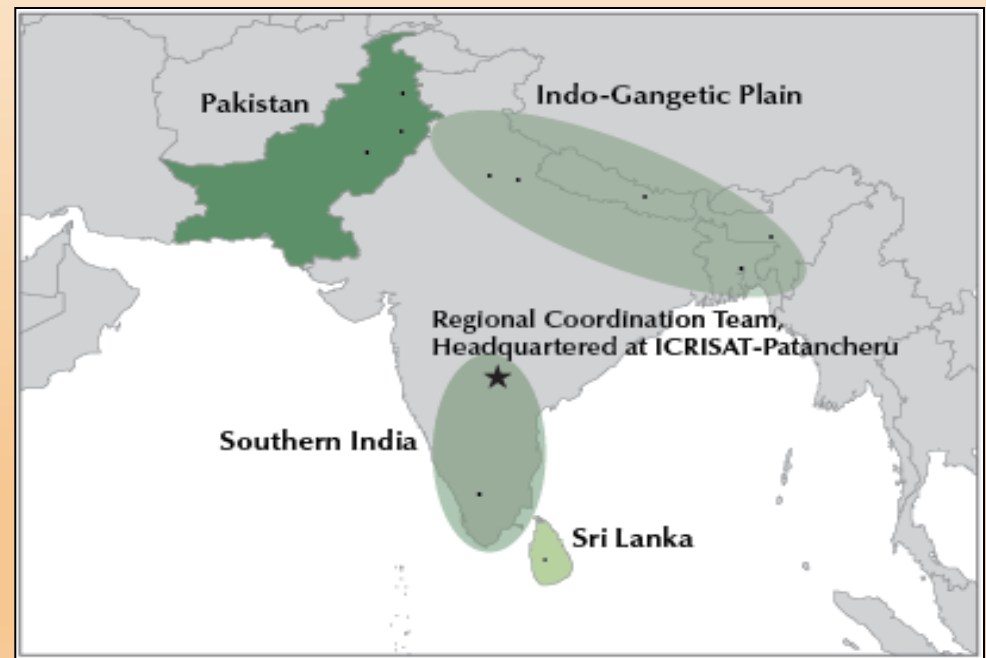

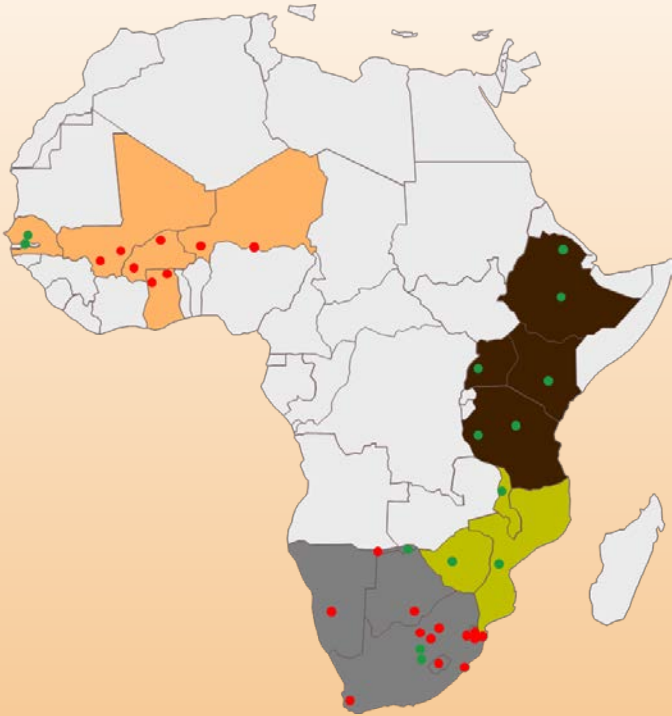*Source: IPCC AR-5, WGII, Ch 7.*

AgMIP RIA method

Can we distinguish the no-climate counterfactual trend from climate adaptations?
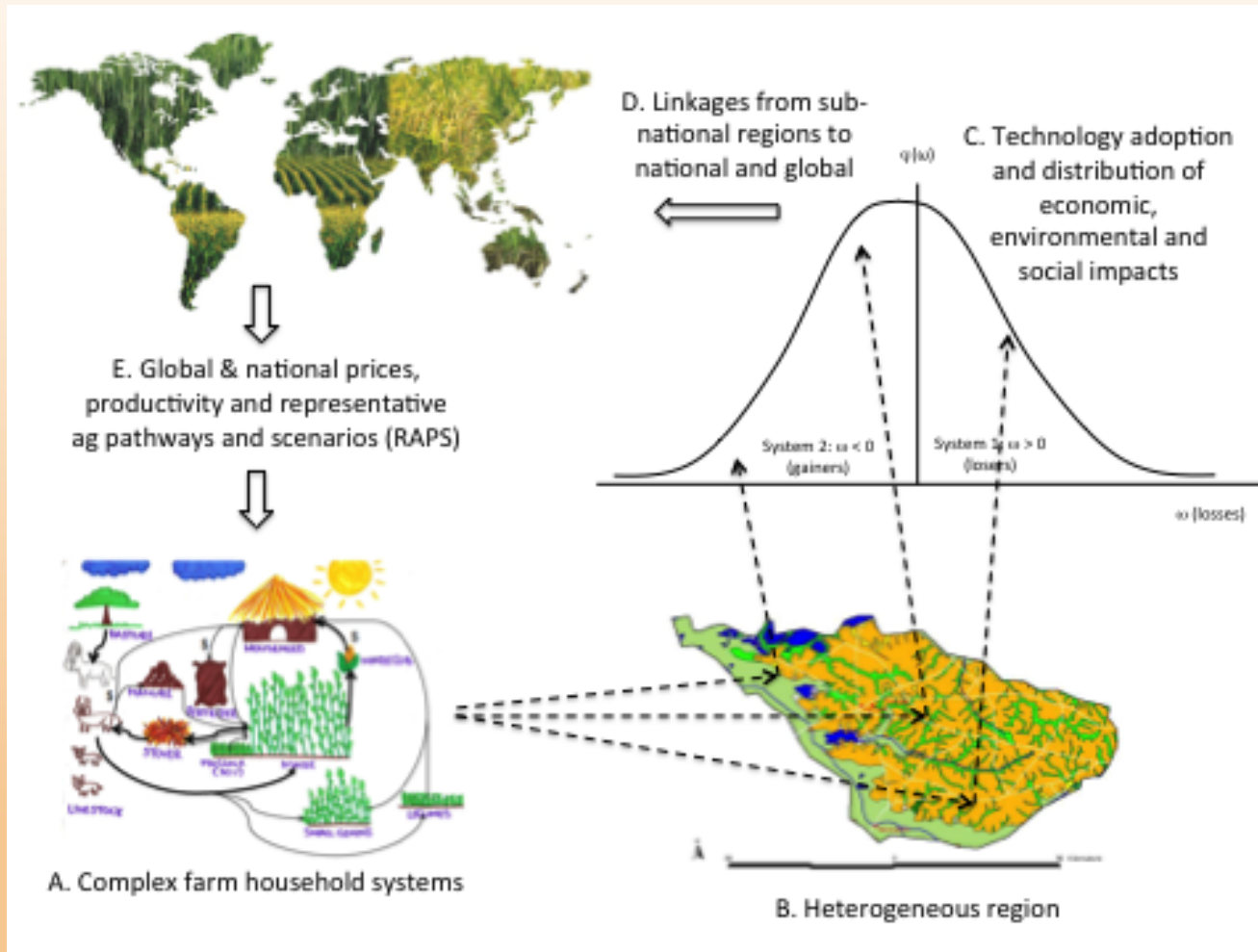
Vulnerability: AgMIP regional assessments

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

Forthcoming in Hillel, D. and C. Rosenzweig, eds. *Handbook of Climate Change and Agroecosystems*, 2014

AgMIP
The Agricultural Model Intercomparison and Improvement Project

Oregon State UNIVERSITY OSU

Vulnerability: AgMIP regional assessments

D. Linkages from sub-national regions to national and global

C. Technology adoption and distribution of economic, environmental and social impacts

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

System 2: α < 0 (gainers)   System 1: α > 0 (losers)

A. Complex farm household systems

B. Heterogeneous region

Can we combine field and farm-scale models (FSIM) with population-based models (TOA-MD) to improve regional integrated assessments?
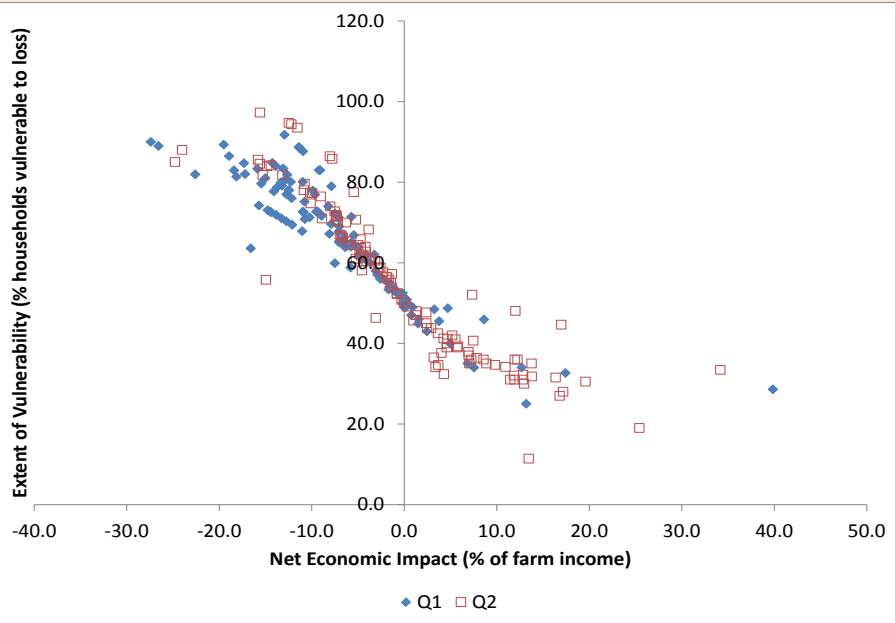
Vulnerability: AgMIP regional assessment method
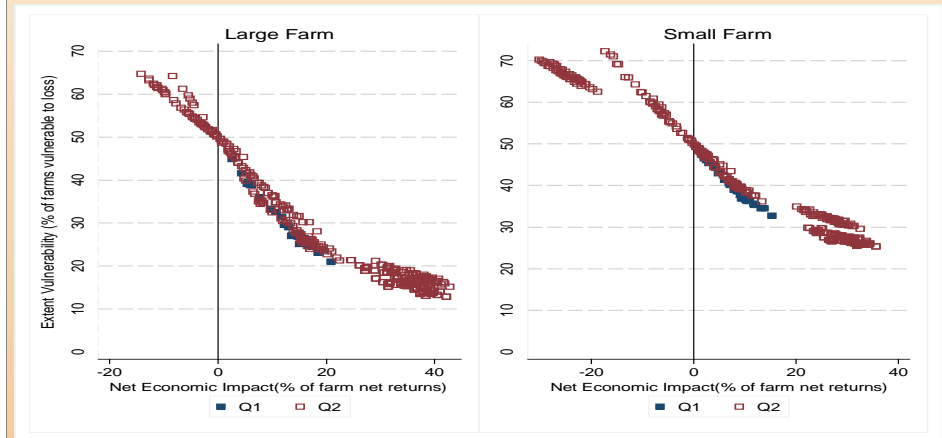*Importance of distinguishing average impact and vulnerability*
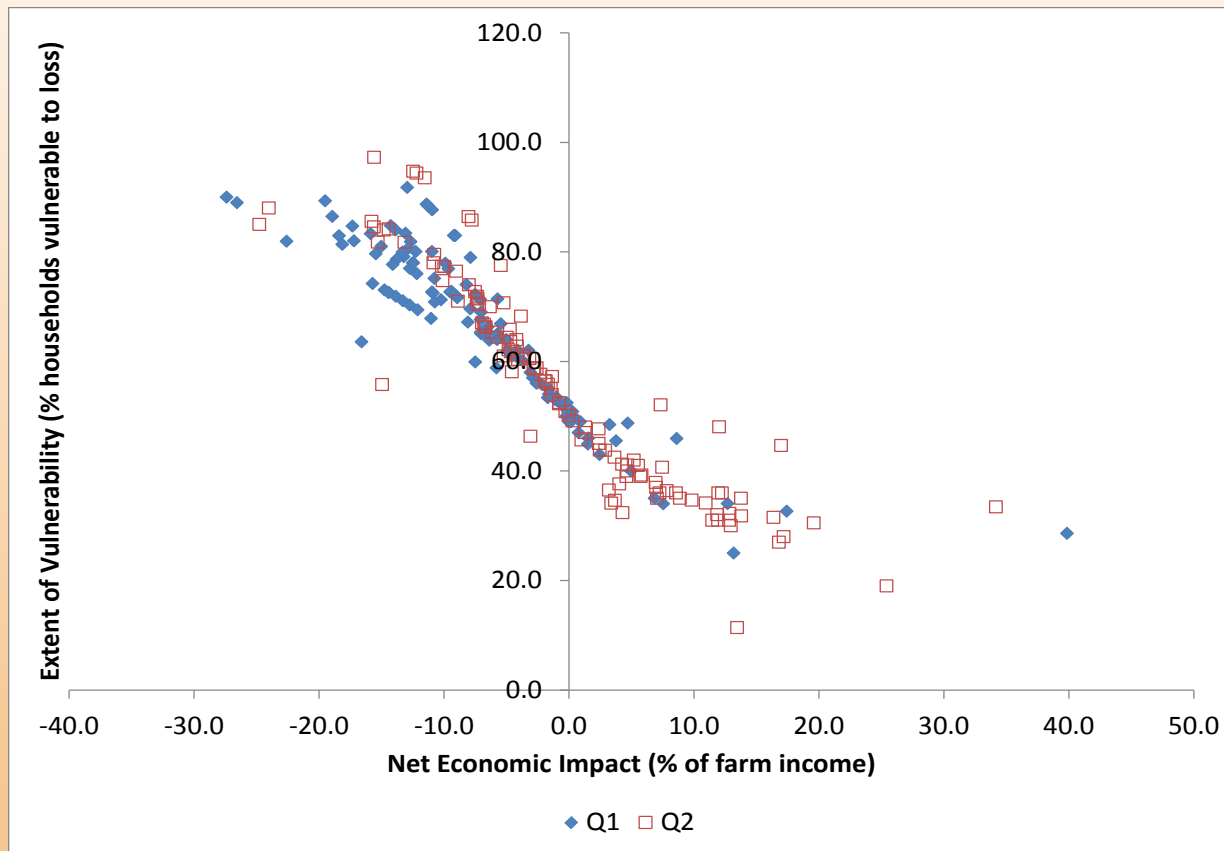
AgMIP Sub-Saharn Africa & South Asia

Vulnerability: AgMIP regional assessment method
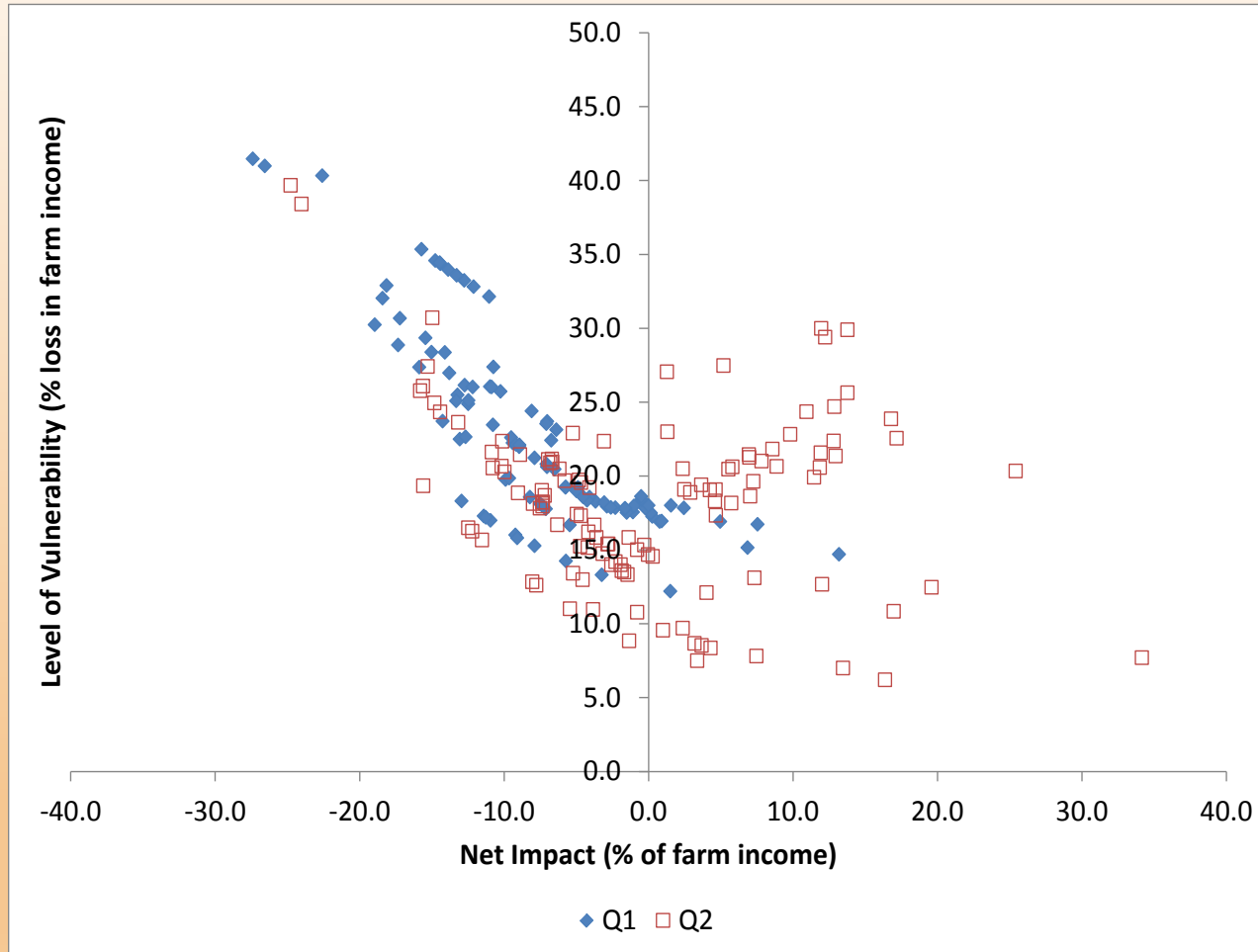*Importance of distinguishing average impact and vulnerability*

US Pacific NW Wheat

AgMIP Sub-Saharn Africa & South Asia

Vulnerability: AgMIP regional assessments
Importance of future socio-economic conditions to vulnerability

New Initiatives (AgMIP Phase 2)

- **Coordinated regional and global IA: towards AR6**
  - SSP extensions, global and regional RAPS
  - Linkages to RIAs: productivity, prices, adaptation
  - National IAV assessments
- **Sustainable agricultural systems**
  - Next Generation models – pilot study
    - Use Cases
    - Knowledge products linked to modeling platform
    - Model/module integration platform
      ◦ Modular bio-phys systems models
      ◦ Modular farm & population economic models
  - Climate Smart Ag & Sustainable Intensification
  - Sustainable Food & Nutrition Security