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

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- 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?

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

(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...

[Diagram showing flow from Representative Concentration Pathways to General Circulation Models, then to Temp Precip..., Bio-physical Models, Yield Water..., Economic Models, Production Consumption Food Security..., SSPs, Global RAPs, Other higher-level Pathways and Scenarios, Regional RAPs, Crop, livestock, economic and other model inputs and parameters.]
## AgMIP Regional Research Teams RAPs Trends Table: SSA

<table>
<thead>
<tr>
<th>Variable</th>
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<th>CLIP – R2 Zimb</th>
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### Direction and magnitude

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<td>Large increase</td>
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<td>Small decrease</td>
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<td>Moderate decrease</td>
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<td>Large decrease</td>
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<td>Not included in RAP or under revision</td>
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Recent advances and challenges

Can we model long run trends?
Can we model short run departures from long run trends?

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

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 Bell (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 (Plattanzeller et al., 2007). World population estimates are from the United Nations.

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

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?

Yield or value

RAPS

Q1

Q2

Q3

current

future

time

current

future

future

time
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
Vulnerability: AgMIP regional assessments

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-Saharan Africa & South Asia
Vulnerability: AgMIP regional assessment method

Importance of distinguishing average impact and vulnerability

AgMIP Sub-Saharan Africa & South Asia

US Pacific NW Wheat
Vulnerability: AgMIP regional assessments

Importance of future socio-economic conditions to vulnerability

![Graph showing the relationship between Net Impact (% of farm income) and Level of Vulnerability (% loss in farm income). Q1 and Q2 are indicated by different markers.](image-url)
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