AgMIP Town Hall

Alex Ruane and Cynthia Rosenzweig, NASA GISS
Page Kyle, PNNL; Bruno Basso, Michigan State University,
Jonathan Winter, Dartmouth College, and Senthold Asseng, University of Florida

AGU 2015 Fall Meeting
December 15, 2014
Crop Responses are Not Clear
(Meta-analysis by Challinor et al.,
Nature Climate Change and IPCC WG2)

Difficult to make sense out of incredibly diverse studies
The Agricultural Model Intercomparison and Improvement Project (AgMIP)
Provide effective science-based agricultural decision-making models and assessments of climate variability and change and sustainable farming systems to achieve local-to-global food security
AgMIP Approach Enables Testing of Farm and Policy Strategies

AgMIP is an international community of 800+ climate scientists, agronomists, economists, and IT experts working to improve models, data, and assessments of sustainable agricultural systems and future food security.

Rosenzweig et al., 2013 AgForMet
Protocols for new AgMIP Teams or Activities:

- Co-Led
- Written plan with short and long-term goals
- AgMIP protocols
- External science advisors
- Review & attribution
- Budget and funding strategy
- Quality assurance

Current and Prospective Activities

**Current**

- Coordinated Climate-Crop Modeling Project (C3MP)
- AgGRID
  - GGCMI
  - pSIMS

**Cross-Cutting Themes**

- Uncertainty Aggregation and Scaling
- Representative Agricultural Pathways

**Crop Model Intercomparison and Improvement**

- Wheat
- Maize
- Rice
- Potato
- Millet/Sorghum
- Sugarcane
- Peanut
- Biofuels

**Global Economics Assessments**

**Prospective**

- Food Security & Nutrition
- Sustainable Systems
- Land Use
- Gender & Livelihoods
- Mitigation
- Shocks and Extremes

**Key Interactions**

- Water Resources
- Livestock/Pastures
- Soils and Crop Rotation
- Pests/Diseases/Ozone

**Data and Tools**

- Data Translators
- ACE Database
- AgMIP Tools

**Regional Integrated Assessments**

- Sub-Saharan Africa
- South Asia
- Latin America and Caribbean
- North America
- East Asia
- Europe
- Australia

**Experiment-Model Interface**

- Crop-Water ET
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<thead>
<tr>
<th>Category</th>
<th>Leaders</th>
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<tr>
<td>Global Economics</td>
<td>Hermann Lotze-Campen, Keith Wiebe, Dominique van der Mensbrugghe</td>
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<td>Rice</td>
<td>Tao Li</td>
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<td>Wheat</td>
<td>Senthold Asseng, Pierre Martre, Frank Ewert</td>
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<td>Maize</td>
<td>Jean-Louis Durand</td>
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<td>Sugarcane</td>
<td>Abraham Singels, Fabio Marin, Matthew Jones, Peter Thorburn</td>
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<td>Bioenergy</td>
<td>David LeBauer and Gopal Kakani</td>
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<td>Potato</td>
<td>David Fleisher</td>
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<td>Livestock</td>
<td>Jean-Francois Soussana and Fiona Ehrhardt</td>
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<td>MACSUR/CropM</td>
<td>Reimund Rötter, Frank Ewert, and Martin Koechy/Martin Banse</td>
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<td>AgGRID/GGCMI</td>
<td>Christoph Mueller and Joshua Elliott</td>
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<td>C3MP</td>
<td>Alex Ruane and Sonali McDermid</td>
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<td>Data harmonization/IT</td>
<td>Cheryl Porter and Sander Janssen</td>
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<td>FACE-IT</td>
<td>Joshua Elliott and Cheryl Porter</td>
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<td>RAPs</td>
<td>Roberto Valdivia and John Antle</td>
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<td>Uncertainty</td>
<td>Daniel Wallach, Linda Mearns, Mike Rivington</td>
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<td>Crop ET</td>
<td>Ken Boote and Jerry Hatfield</td>
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<td>Aggregation and Scaling</td>
<td>Frank Ewert and Lenny van Bussel</td>
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<td>Stakeholder Engagement</td>
<td>Amy Solomon and Wendy-Lin Bartels</td>
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<td>Water Resources</td>
<td>Jonathan Winter</td>
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<td>Soils and Crop Rotation</td>
<td>Bruno Basso</td>
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<td>Maize/Millet</td>
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<td>Latin America</td>
<td>Eduardo Assad and Roberto Valdivia</td>
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<td>East Asia</td>
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<td>NextGen</td>
<td>John Antle, Cynthia Rosenzweig, and Jim Jones</td>
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<td>Coordinated Global and Regional Assessments</td>
<td>Cynthia Rosenzweig</td>
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<td>Maize model improvement</td>
<td>Thijs Tolenaar and Ken Boote</td>
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Donor and Partner Institutions
(a sampling)
Scope

Agricultural System Models and Data

Stakeholders

Coordinated Global and Regional Assessments

Pathways to Sustainable Farming Systems

Knowledge products and tools
(e.g., policy briefs, decision support dashboards) usable by stakeholders
Stakeholder-scientist co-generated systems research leads to improved capacity, climate risk information, pathways to sustainable agricultural systems, and food security.
Activities – Crop Modeling

- **Activity 1** – Sensitivity analyses (CO$_2$, temperature, rainfall, & management; 4 sentinel sites; standardized protocols)
  - Wheat team (Asseng, Ewert, Martre)
  - Maize team (Bassu, Durand, Lizaso, Boote)
  - Rice team (Li, Hasegawa, Zhu, Yin, Boote)
  - Sugarcane team (Singels, Thorburn, Marin)
  - Recent teams: potato (Fleisher, Quiroz), sorghum-millet (----), peanut (Singh)
  - New teams: bioenergy (Kakani/LeBauer), canola (Wang)
  - Soils (Bassu)

- **Activity 2** – Model Improvement (time-series and end-of-season data. Improve code!)
  - Water-ET
  - Maize Model Impr.
  - Tcanopy/heat stress - wheat

- **Activity 3** – Evaluate climate-smart adaptations/technology effects
AgMIP/ISI-MIP Global Gridded Crop Model (GGCM) Assessment

GGCMI now includes more than a dozen models

Phase 1: Historical period intercomparison
Phase 2: CTWN-A response

Rosenzweig et al., 2013

Modeled Changes in Corn Yield (2080s – present)
AgMERRA Historical Climate Data
Ruane et al., 2014; Agricultural and Forest Meteorology

AgMERRA features:
- improved solar radiation
- Improved precipitation variability
- fine spatial patterns of rainfall from satellites
- an adjustment to diurnal temperature range
- relative humidity at Tmax

AgMERRA better captures rainfall distribution and actual sequence of extreme events

Avg of Tmax and Tmin Biases (° C)

Precipitation Correlation (r)

Threat score for 1, 25, and 50mm precipitation events (%)

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- improved solar radiation
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- fine spatial patterns of rainfall from satellites
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- relative humidity at Tmax

AgMERRA better captures rainfall distribution and actual sequence of extreme events
All C3MP Submitted Sites and Major Croplands (Percentage Area)

- C3MP Site
- C3MP submitted site (1137 sites as of August, 2015)

Green = fractional crop land area data from Monfreda et al. (2008)
From McDermid et al., 2015
Several approaches to understand uncertainty in crop responses

**Mean % Change in Mean Maize Yield**
(126 Rainfed Maize Sites)

**Standard Deviation of % Change in Mean Maize Yield**

![Graph showing mean % change in mean maize yield and standard deviation of % change across sites](image)

$\Delta P = 0\%$ (proxy for climate change)

Preliminary results from C3MP; article forthcoming
Develop projects that assess the effects of climate change and variability on irrigated crops in the United States and throughout the world, as well as build collaborative opportunities to create a portfolio of research at the interface of water and agriculture within the AgMIP framework.
Activities

• Current:
  – NASA-funded AgMIP Water pilot project that links a hydrologic and crop model to simulate irrigated agriculture in California under future climate
  – AgMIP – USDA Economic Research Service Water Workshop, which brought together over 35 scientists to create strategies for improving the representation of water supply and demand in agricultural assessments
  – NIFA-funded Coordinated Agricultural Project (CAP) on Water-, Nutrient-, and Climate-Smart Agriculture

• Future:
  – Postdoctoral researcher (José López Bóbeda) starting in January
  – Global Collaborations – Link to national and international efforts at the water-agriculture nexus
  – More proposals – Continue to pursue funding to build individual projects that explore facets of climate impacts on water resources and agriculture

• Questions, comments, suggestions?
  – jwinter@dartmouth.edu
Soil and Crop Rotation

- To assess crop models variability in a long-term maize-fallow and wheat-fallow crop rotation under different management strategies.
- To evaluate the carry-over effects of the interactions between soil, climate and management on yield, and soil carbon, ET.

With the temperature increase models on average showed:

- Increase in Soil N-$\text{NO}_3^-$
- Decrease in SOC
Regional Integrated Assessment for Distributions of Farm Systems

AgMIP-DFID Regional Integrated Assessments:
7 teams across Sub-Saharan Africa and South Asia conducting multi-model integrated assessment of climate impacts, policy choices, and adaptation strategies

Diagram from Masikate et al., 2015

Rosenzweig and Hillel (Eds): Handbook of Climate Change and Agroecosystems; Imperial College Press, 2015
- Objective: multi-decadal simulation of the agricultural sector in the context of changes in broader interacting human/Earth systems

- Current work focuses on constructing “Representative Agricultural Pathways, ensuring consistency between models
AgMIP Data Activities

AgMIP Sentinel Sites

AgMIP Data
Harmonized Formats
Standards
Ratings
Archives
Climate Datasets

Focus on identifying data and making them more useful for applications

Boote et al., 2016 (forthcoming)
AgMIP Coordinated Global and Regional Assessment
Core Question: How can we manage risks of and develop resilience to extreme weather, climate change, and other disruptions for agricultural production and food security, now and in the future?

• Question #1: What are the capabilities of and limits to adaptation to extreme weather and climate change, now and in the future?
  • Key Topics: Technology trends vs specific adaptation strategies; Management; Genetics

• Question #2: What are the effects of agricultural mitigation policies, now and in the future?
  • Key Topics: Effects on land use and prices; Biofuels; Soil carbon

• Question #3: How does extreme weather and climate change affect food security/nutrition, now and in the future?
  • Key Topics: Availability; Access; Utilization/diet; Stability

• Question #4: How do policies affect agricultural production and food security, now and in the future?
  • Key Topics: Trade; Governance; Property rights; Institutions; Water; Land;
Building Blocks to allow telescopic scales, feedbacks, and details

Regional research on farming systems using biophysical and socioeconomic models

High-resolution gridded crop modeling for gap-filling and aggregation in each region

Production systems and regional economics to respond to price changes

Global economics with analysis of world and regional prices

Coordinated Global and Regional Assessments
CGRA Scenario Sets – Core Risk and Resilience Framing
Major New Developments in Agricultural Modeling Assessments

- **Disciplinary linkages**: Linked biophysical and economic models
- **Scale linkages**: Consistency from local to global scales
- **Resolution of human outcomes**: Connections to nutrition and health
- **Continuum of time scales**: current variability and extremes near- and long-term outlooks
- **Scenarios** of adaptation, mitigation, food policy, and food security
Join us!
- iCROPM Workshop
  Berlin, Germany
  March 14-16, 2016

- AgMIP6 Global Workshop
  Montpelier, France,
  June 26-28, 2016

For protocols, up-to-date events and news, and to join AgMIP listserve* – [www.agmip.org](http://www.agmip.org)
Discussion – Questions; Ideas; Opportunities?
1. Scientific Integrity

AgMIP projects and activities must be based on good science and public-good products.

2. Conflict of Interest/Bias

AgMIP Steering Council, Principle Investigators, Team Leaders, and Partner Leads identify possible conflict of interest (NAS) and biases.

Advocacy

AgMIP promotes the best science for development, evaluation, and application of agricultural models.

3. Open Data and Models

AgMIP endorses the use and development of open-source/open-access models, data and methods.

5. Participation

AgMIP is committed to community building and strives to enable its teams and members in their regions, activities, and funding applications. AgMIP activities are open to all interested researchers and facilitate transdisciplinary integration.

6. Attribution

AgMIP publications attribute all intellectual contributions, including those related to both models and data.

7. Flexibility

AgMIP is structured to facilitate the ongoing evolution of agricultural systems science.

8. Investment in Future of Systems Research

Encourage new field, younger scientists, uptake of methods to curricula for education.
Setup: Stakeholder Interactions Throughout!
- Building blocks self-organize
- Regions self-organize
- Science Integration Team determines driving scenarios
- Each region determines a network of representative crop/livestock modeling sites
- Crop/Livestock Teams identify additional sites of interest between regional networks
- Each region determines network of representative regional integrated assessments
- Climate team provides climate scenarios for each site/grid
- Regional experts work with global modelers to improve parameters

Execution:
- Crop/livestock modeling sites run by multiple models
- Global gridded models run
- Results compared and hybrid product created
- Global economic models run with hybrid crop/livestock drivers
- Reginal economic models run RIAs with global economic model prices
- Food security models and metrics created
- Results provided to central, public-facing database
~2020: IPCC AR6 published

2019: CGRA research published

2018: CGRA conducted

2017: Protocols finalized and CGRA begins

2016: Pilot projects for connections and protocols

2015: CGRA launch and coalition-building
AgMIP Core Research Questions:
Climate Change, Economic Development, and Adaptation

Q1: What is the sensitivity of current agricultural production systems to climate change? This question addresses the isolated impacts of climate changes assuming that the production system does not change from its current state.

Q2: What are the benefits of adaptation in current agricultural systems? This question addresses the benefit (e.g., economic and food security resilience) of potential adaptation options to current agricultural systems given current climate.

Q3: What is the impact of climate change on future agricultural production systems? Assessment of climate impacts on the future production system, which will differ from the current production system due to development in the agricultural sector.

Q4: What are the benefits of climate change adaptations? Assessment of the benefits of potential adaptation options in the future production system.
## AgMIP Regional Research Teams RAPs Trends Table: SSA (AgMIP, Phase I)

### SSP2, period 2050

<table>
<thead>
<tr>
<th>Variable</th>
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<td>Soil degradation</td>
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### Direction and magnitude

- **No change**
- **Small increase**
- **Moderate increase**
- **Large increase**
- **Small decrease**
- **Moderate decrease**
- **Large decrease**
- **Not included in RAP or under revision**