Data and Research for Sustainable Food Security

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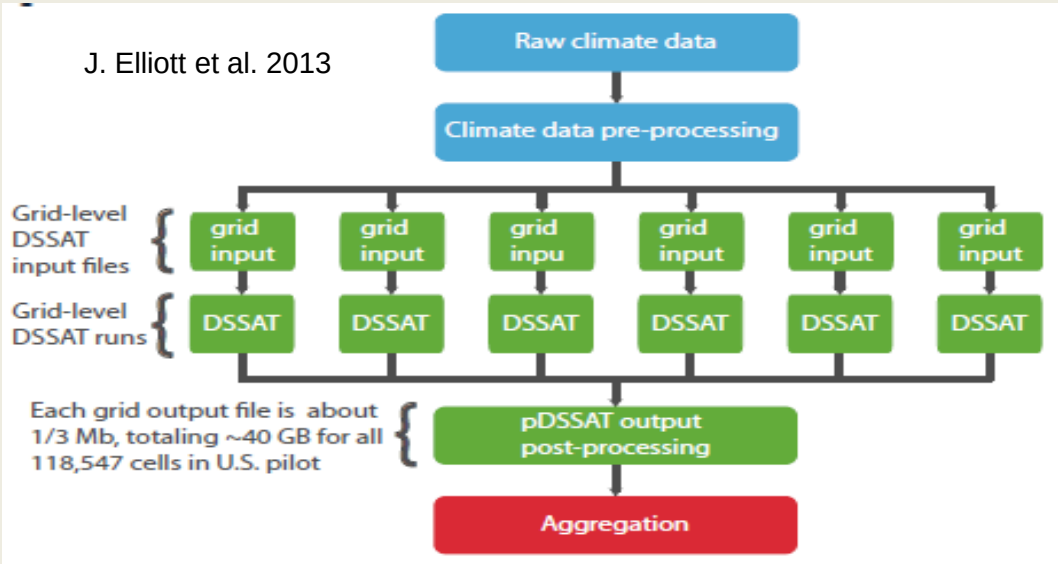
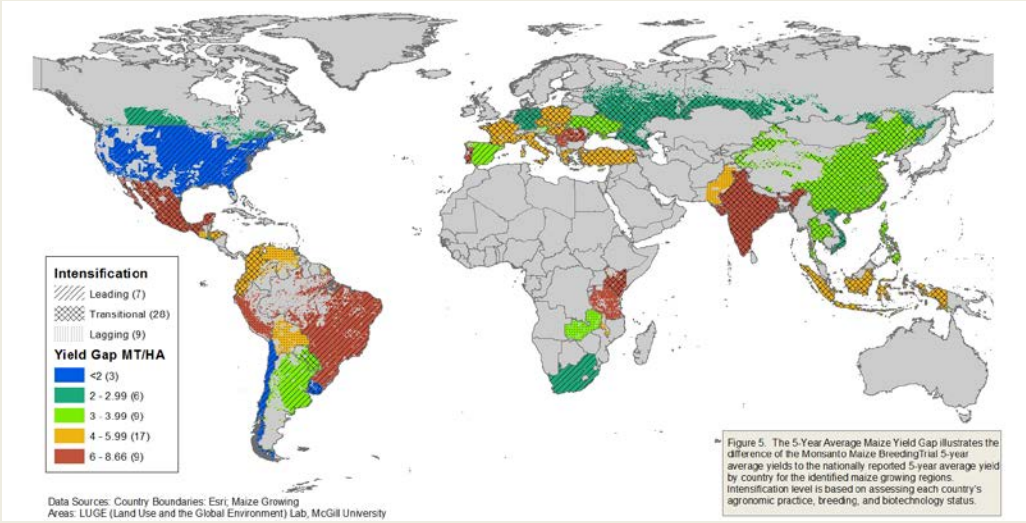


Food Security Challenge; Feeding 9 Billion People by 2050

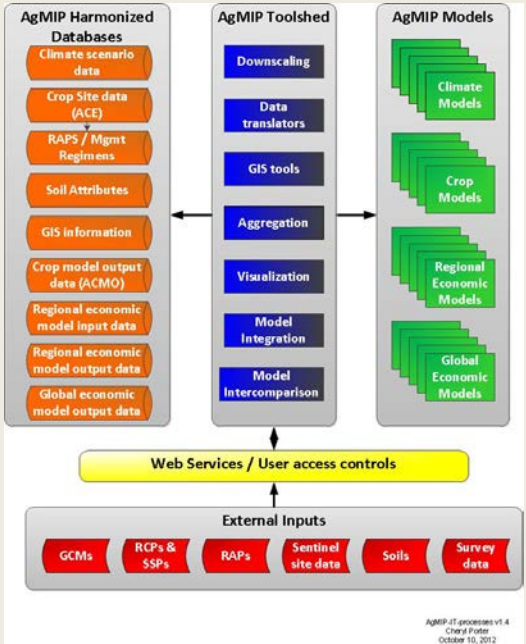
- Major global challenge
  - Now in many countries
  - Emerging as a global issue
- Causes
  - Poverty
  - Climate change & variability (drought, flooding, ...)
  - Increasing population (feed 9 billion by 2050?)
  - Limited water, land and energy
  - Political instability
  - Food distribution and trade
  - Spoilage
  - Food safety
  - Yield gaps
  - Soil and water quality



AgMIP The Agricultural Model Intercomparison and Improvement Project

Food Security; Big Data

- Critically important issue, globally and nationally
- Science-based agricultural models are essential tools
- Wide range of data needs, complex biophysical and socioeconomic data varying over space and time
  - Historical daily weather records
  - Climate change scenario data, downscaled to local conditions, daily
  - Soil properties; high spatial variability depend on management
  - Crop response data
    - Experiments, detailed observations
    - Yield & demonstration trials (public and private)
    - Farm surveys
    - Aggregate statistics of yield, production
  - Socioeconomic data, varying over space and time
    - Prices
    - Demand for food, price elasticities
    - Ag, water, energy, trade policies



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Factors that limit Big Data in Agriculture & Food

- Complexity of agriculture and food systems
- Spatial heterogeneity of systems due to natural and human factors
- Diversity of data collectors; limited culture re: standards, protocols for collecting, storing, and sharing data
- Limited experiences in large scale integrated assessments of agricultural and food systems
- Multiplicity of agricultural models with little effort to harmonize inputs, outputs
- Limited collaboration between public and private research, particularly addressing the need for large datasets
- Slow acceptance, limited past support for models needed for addressing food systems and future food security

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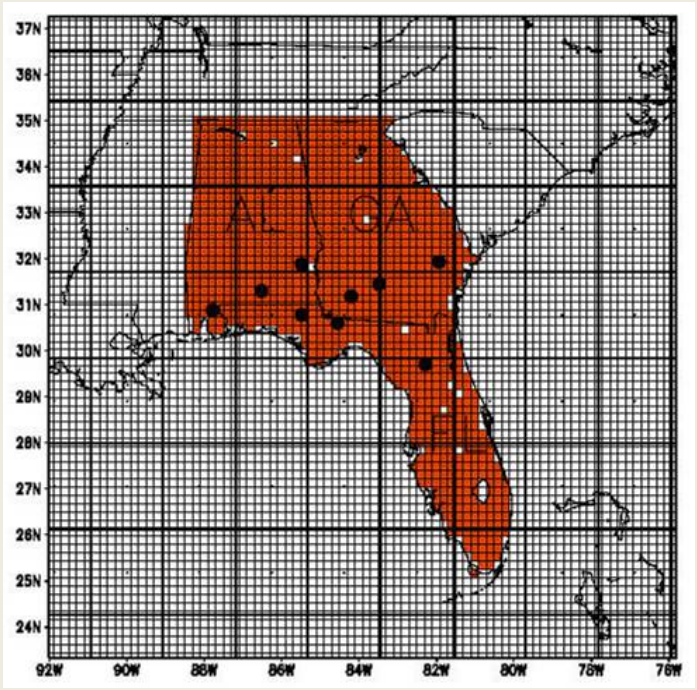
Integrated Climate Impact, Adaptation Assessments for Food Security



Climate Scenario

Daily Weather Inputs

Soil, Watershed Inputs

Crop, Hydrology Models

Management Inputs

Yield, Other Outputs

Economic Models

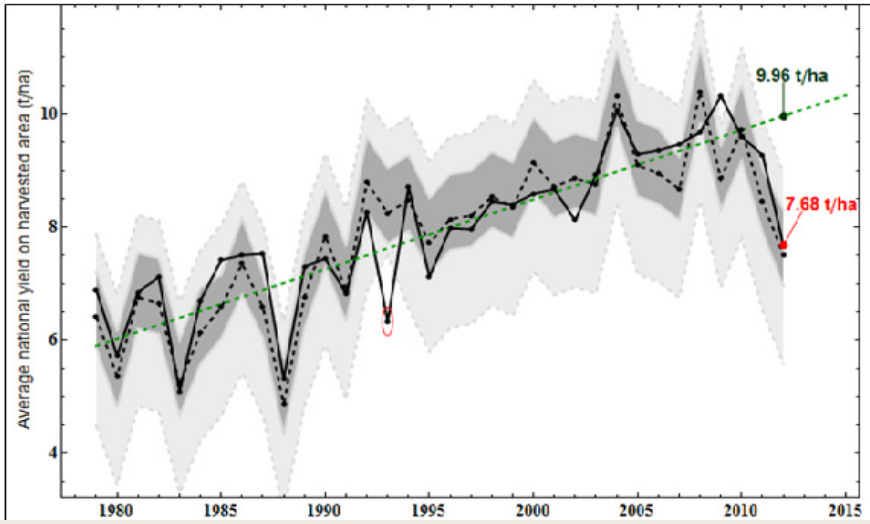
Prices, Demand, Elasticities

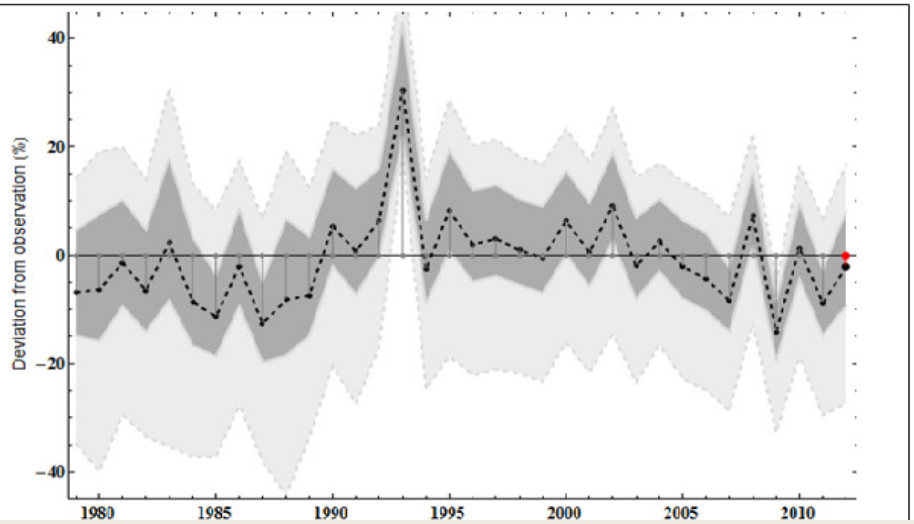
Economic, Poverty, Food Security

Example: Predicting US Corn Yield in 2012 Drought and Historical Yield Trend J. Elliott et al., 2013 (AGMIP)

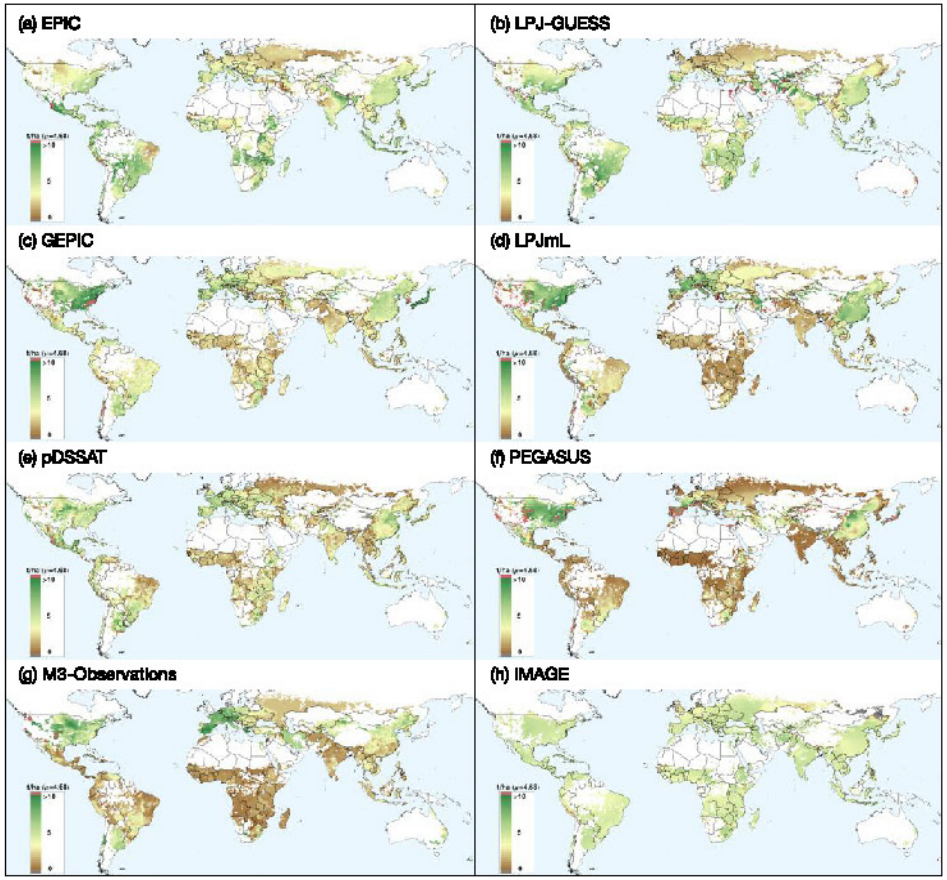
AgMIP – UF+: Harmonizing Crop Model Inputs Across Models & Databases

- Simulation results are aggregated to county level, compared to detrended NASS survey, bias-corrected, and projected onto the observed trend.
- We then aggregate these to state and national level.
- At national level the model performs very well in drought years 1983, 1988, and 2012 as well as in 1981, 1991, 1994, 1996-1999, 2001, 2003-2005, 2010.
- Big misses are 1993 and 2009. Smaller misses are 1985, 1987, 2002, 2007, 2008, 2011…





Multiple Model Simulation of Corn Yield, Globally (Rosenzweig et al., PNAS, accepted)



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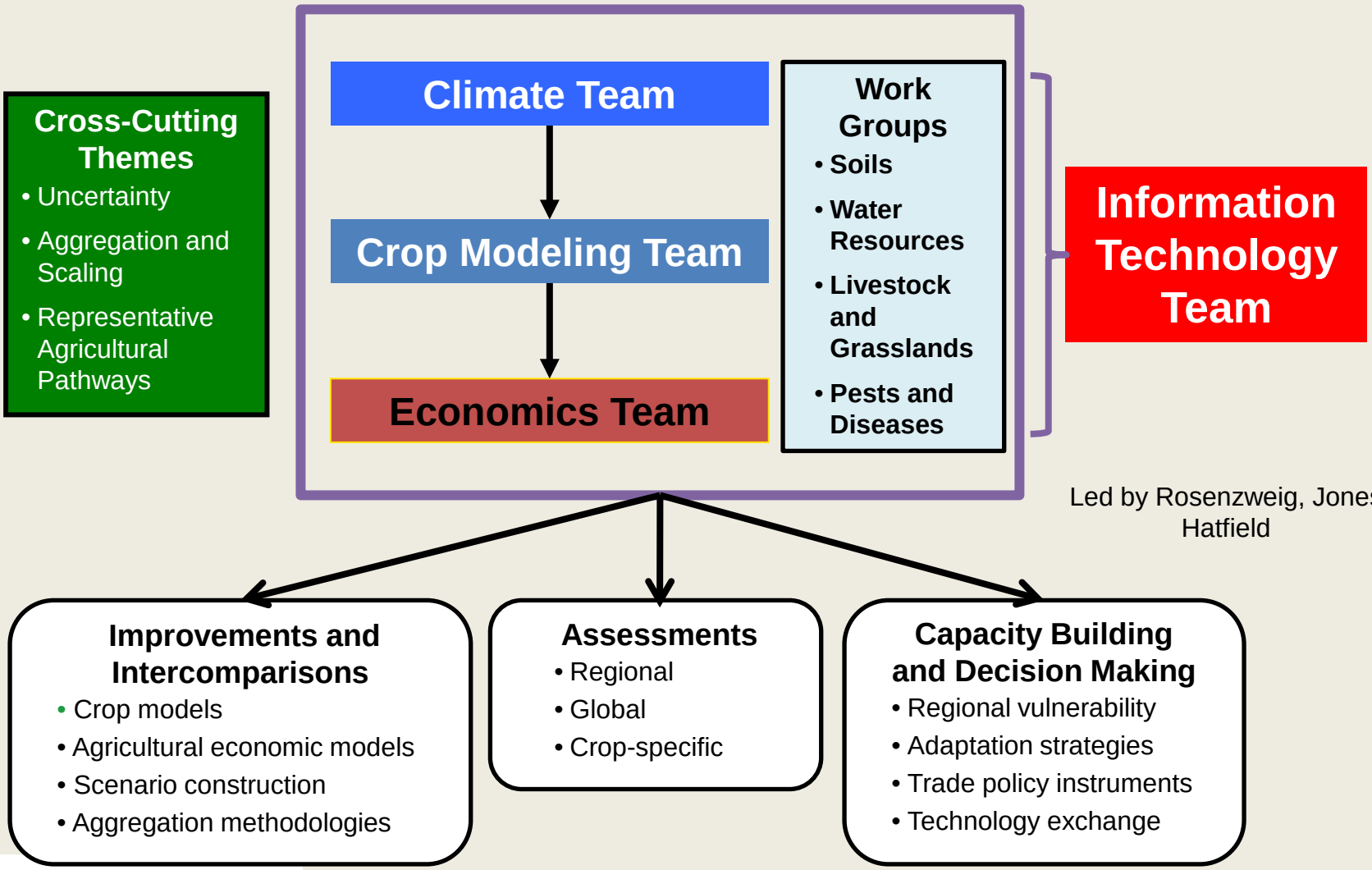
529 **Figure 3**: Average reference period (1980-2010) GGCM maize yield (a-e, h), rescaled to a common global average
530 to make the spatial patterns more apparent, and historical yield M3 observation set (g) (Monfredo et al. 2008).
531 Note because some models are calibrated and others are not and since some models simulate potential rather
532 than actual yields, its not possible to compare the absolute yields in the ensemble with observations.

Current State of Big Data in Ag & Food Security: AgMIP Community of Science



AgMIP The Agricultural Model Intercomparison and Improvement Project

Advancing scientific capabilities for assessing climate impacts and adaptation for agriculture, food security, and poverty