AgMIP's Trans-disciplinary Approach to Regional Integrated Assessment of Climate Impact, Vulnerability and Adaptation of Agricultural Systems

AgMIP The Agricultural Model Intercomparison and Improvement Project

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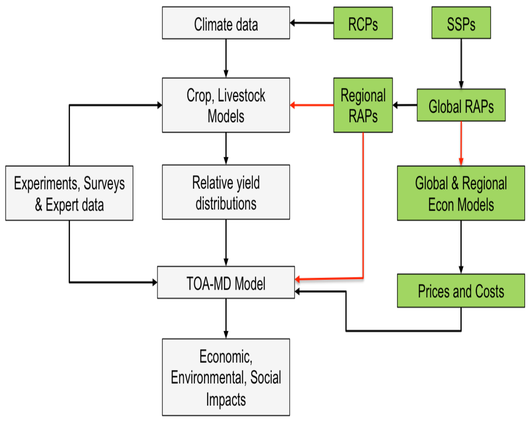
USDA UKaid from the British people

Key features of AgMIP's Trans-disciplinary systems-based approach

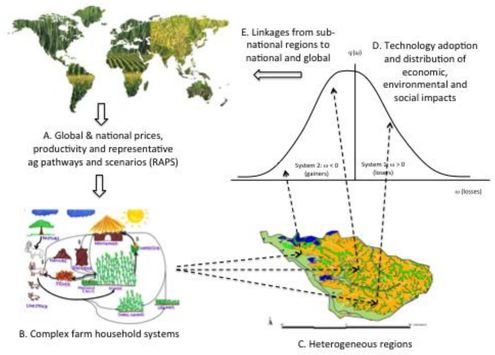
- A protocol-based approach: rigorously documented so results can be replicated and inter-compared, and methods improved
- Participatory: identification of impact indicators, choice of key systems, adaptations, design of future pathways and scenarios used
- A trans-disciplinary, systems-based approach: must include key features of current and possible future systems, including multiple crops, inter-crops, livestock, and non-agricultural sources of income.
- Heterogeneity: must account for the diversity of systems, and the widely varying bio-physical and socio-economic conditions
- Vulnerability: must be possible to characterize the impacts on those farm households that are adversely impacted by climate change, as well as those that benefit from climate change.
- Key uncertainties in climate, production system and economic dimensions of the analysis must be assessed and reported so that decision makers can understand them and use them to interpret the results of the analysis.

Climate Change Impact Assessment Framework



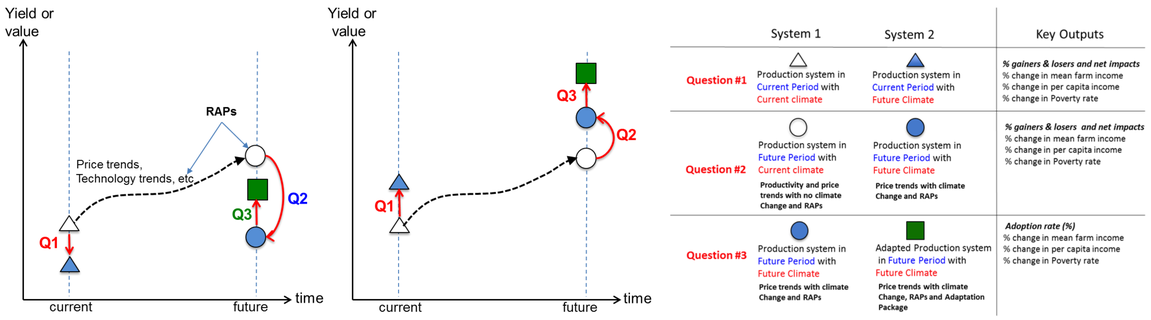
Parallel development of system design, data and modeling to couple crop & livestock models with an economic model

A Farm Household System Approach to Regional Integrated Assessment (RIA)



AgMIP RIA approach simulates climate change impact, vulnerability and adaptation through climate data, bio-physical simulation models and economic models representing a population of heterogeneous farm household systems. (A) RAPS together with global and national price, productivity and land use projections define the bio-physical and socio-economic environment in which (B) complex farm household systems operate in heterogeneous regions (C). Analysis of technology adoption and impact assessment is implemented in these heterogeneous farm household populations (D). This regional analysis may feed back to the country and global scales (E) (farm household diagram from Masikate et al. 2014).

AgMIP Core Research Questions and key Outputs



	System 1	System 2	Key Outputs
Question #1	Production system in Current Period with Current climate	Production system in Current Period with Future Climate	*% gainers & losers and net impacts* % change in mean farm income % change in per capita income % change in Poverty rate
Question #2	Production system in Future Period with Current climate. Productivity and price trends with no climate Change and RAPs	Production system in Future Period with Future Climate. Price trends with climate Change and RAPs	*% gainers & losers and net impacts* % change in mean farm income % change in per capita income % change in Poverty rate
Question #3	Production system in Future Period with Future Climate. Price trends with climate Change and RAPs	Adapted Production system in Future Period with Future Climate. Price trends with climate Change, RAPs and Adaptation Package	*Adoption rate (%)* % change in mean farm income % change in per capita income % change in Poverty rate

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 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

Q3: What are the benefits of climate change adaptations? Assessment of the benefits of potential adaptation options in the future production system

Towards Improved Methods for Climate Change Impact Assessment: The TOA-MD Model

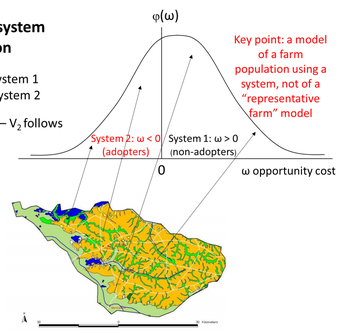
The **TOA-MD Model** is a unique simulation tool for **multi-dimensional impact assessment** that uses a statistical description of a heterogeneous farm population to simulate the adoption and impacts of a new technology, a change in environmental conditions, or ecosystem services supply. TOA-MD is designed to simulate what would be observed if it were possible to conduct a controlled experiment. In this experiment, a population of farms is offered the choice of continuing to use the current or "base" production system **(System 1),** or choosing to adopt a new system **(System 2)**.

System Choice

Opportunity cost, system choice and adoption

Given: V_1 = returns to system 1
V_2 = returns to system 2

Opportunity cost $\omega = V_1 - V_2$ follows distribution $\varphi(\omega)$

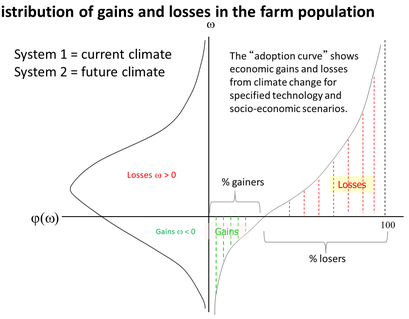


Map of a heterogeneous region

Assessing Climate Impacts

By interpreting opportunity cost ω as losses from climate change, the adoption model can be used to simulate the distribution of gains and losses in the farm population

System 1 = current climate
System 2 = future climate



Using the TOA-MD to Assess Climate Change Impacts and Adaptation

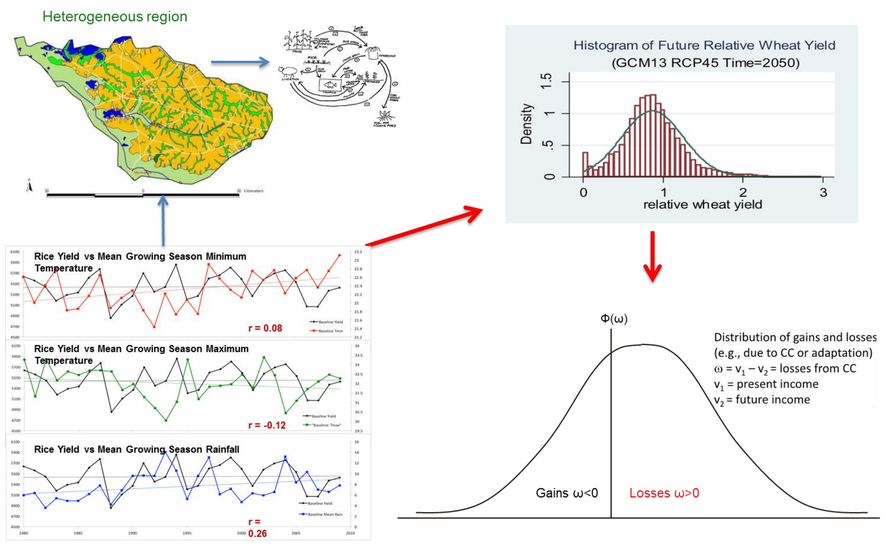
Step 1: Design RAPs and scenarios
- technical, economic, social, policy pathways linked to global SSPs

Step 2: Identify and characterize base system, adapted system(s)

Step 3: Quantify impacts of CC on base and adapted system(s) (Relative yields)

Step 4: Simulate impacts without adaptation
- impacts on farm net returns ("losers" and "gainers" from climate change)
- impacts on other economic (e.g., poverty) or non-economic (e.g., health, environment) indicators

Step 5: Simulate impacts with adaptation
- gains from adaptation
- economic and non-economic indicators



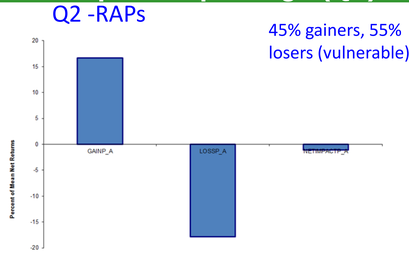
TOA-MD model simulated gains and losses (Q1 and Q2), and adoption rate of adaptation package (Q3)

Q1

30% gainers, 70% losers (vulnerable)

Q2 -RAPs

45% gainers, 55% losers (vulnerable)



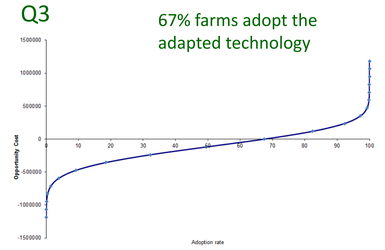
Example: Climate change impacts and adaptation. Rice-Wheat production system in the Punjabi region, Pakistan (results for one GCM and one crop model).

The results show negative net impacts (difference between gains and losses as a percent of net farm returns).These negative impacts are offset by future bio-physical and socio economic conditions (RAPs and trends). However it is important to note that while the net impacts seem to be low the percentage of vulnerable farms is still high (70% in Q1 and 55% in Q2).

The analysis also shows that about 67% of farms are likely to adopt the adapted technology (based on change in sowing dates and increased fertilizer use)

Q3

67% farms adopt the adapted technology



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Antle, John, Roberto O. Valdivia, Ken Boote, Jerry Hatfield, Sander Janssen, Jim Jones, Cheryl Porter, Cynthia Rosenzweig, Alex Ruane, and Peter Thorburn. 2014. *AgMIP's Trans-disciplinary Approach to Regional Integrated Assessment of Climate Impact, Vulnerability and Adaptation of Agricultural Systems*. Handbook of Climate Change and Agroecosystems. *Vol 4. Part I.* edited by D. Hillel and C. Rosenzweig. Forthcoming.

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