

AgMIP's Regional Integrated Assessment of Agricultural Systems: Assessing Impacts, Vulnerability and Adaptation across Scales

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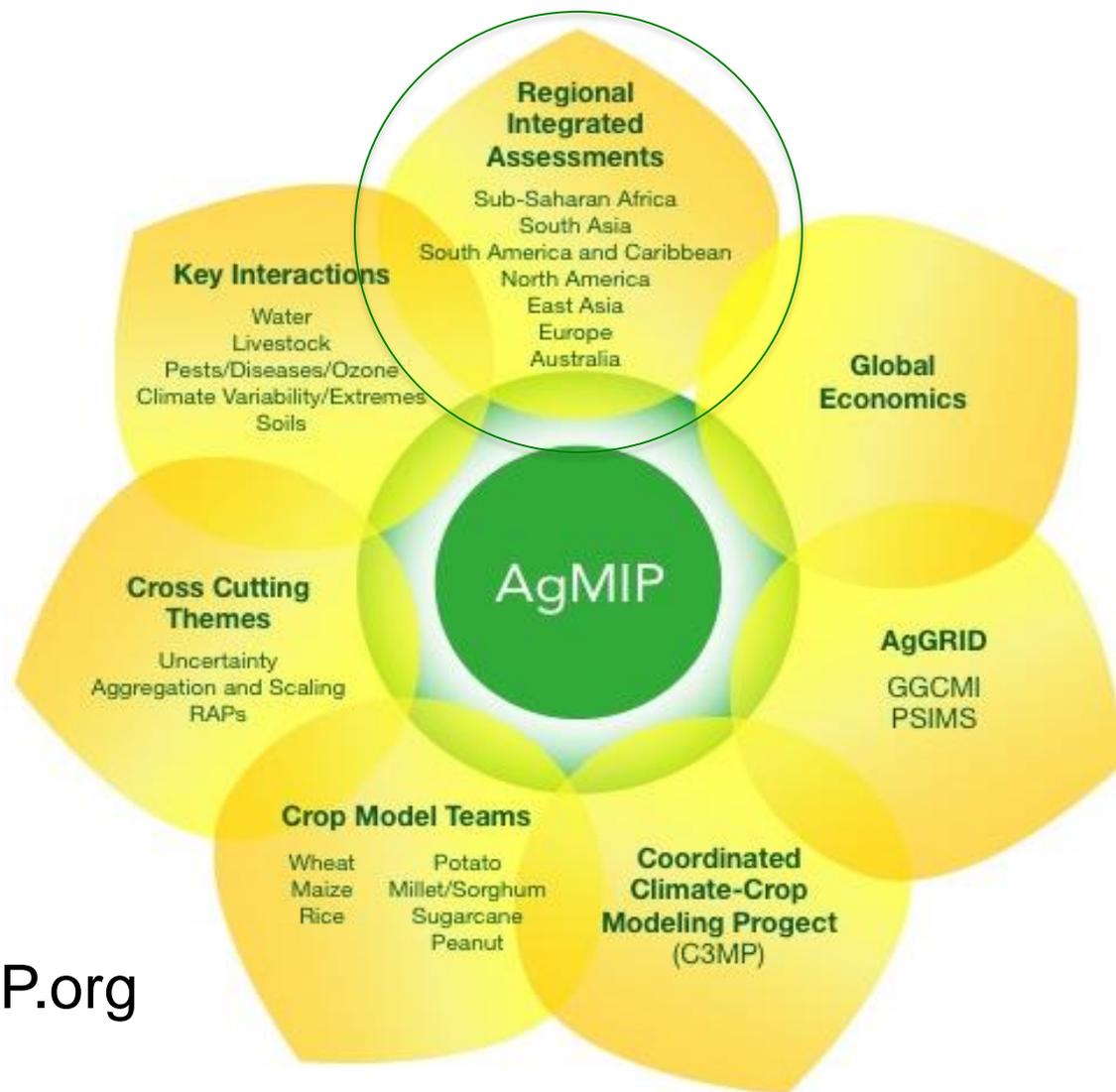


Agricultural Model Inter-comparison and Improvement Project (AgMIP)

- A new **global community of science**: climate, water, soils, crops, pests & diseases, livestock, economics...led by:
 - Cynthia Rosenzweig, GISS and Columbia U
 - Jim Jones, U Florida
 - Jerry Hatfield, Ag Research Service, USDA
 - John Antle, Oregon State U
- More than 600 participating scientists
- Crop, livestock and economic model inter-comparisons
- Regional and global integrated assessments
- Transition from “project” to “program”
 - USDA/ARS is institutional home in USG
 - MOUs with other projects (e.g., MACSUR in EU) and governments (Brazil, Peru, China, Korea ...)
 - Regional hubs (LA, EA, SSA, SA...)
 - Funding from federal agencies (USDA, AID, DOE, EPA), UKAID, private sector, NGOs



AgMIP Initiatives: how to improve the scientific quality and usefulness of integrated assessment of ag systems from farm to regional to global scales? Many challenges!



See AgMIP.org

- Key questions:
 - How can we do *meaningful* analysis of CC impact, adaptation and mitigation? *How do we look forward, not backward?*
 - How can we *communicate* to decision makers?

- What is meaningful?

Stakeholders want to know:

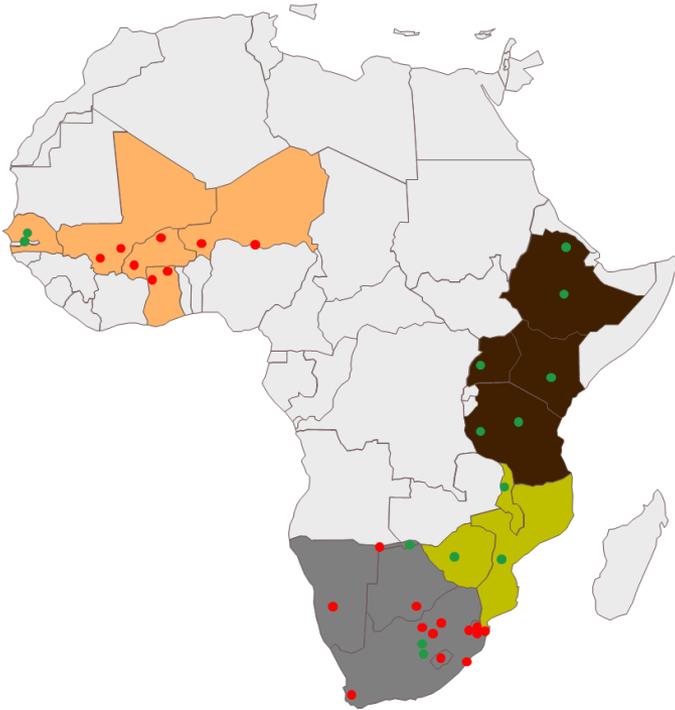
=> Impacts they care about!

(poverty, food security, health...its not just about yield)

=> What to do? What will it cost?

Stakeholders = farmers, crop breeders, farm advisers, research managers, policy makers...

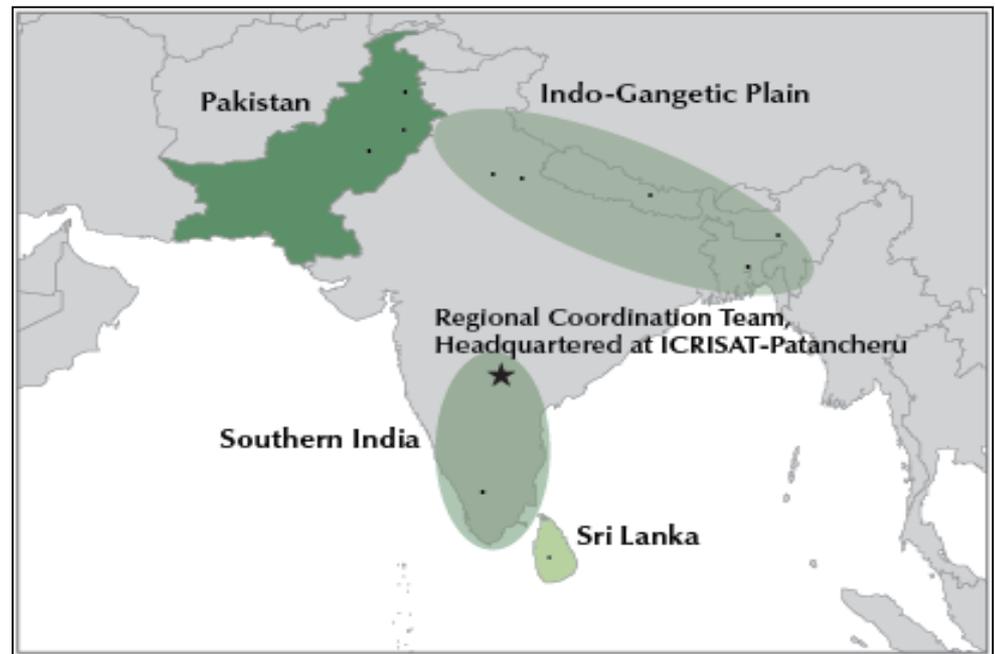
AgMIP Regional RIAs in SSA & SA



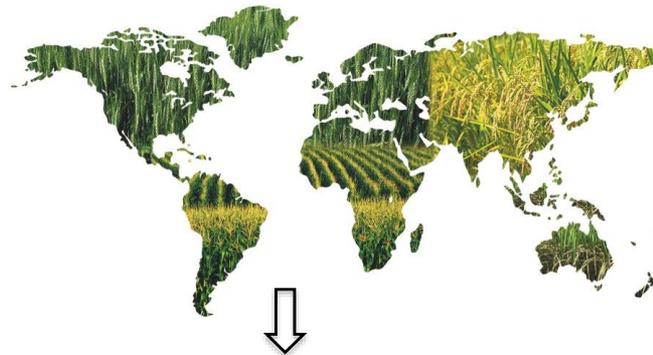
5-year project, DFID funded
8 regional teams, 18 countries,
≈ 200 scientists

Data, models, scenarios designed & implemented by **multi-disciplinary teams & stakeholders**

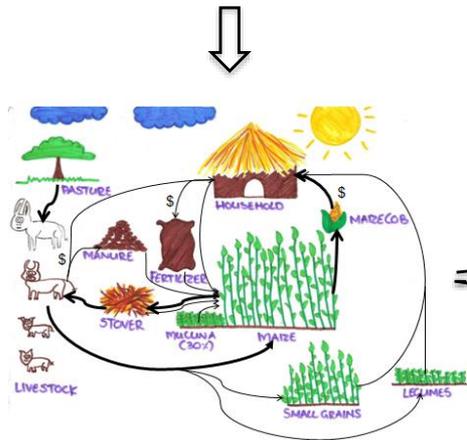
Forthcoming in Hillel, D. and C. Rosenzweig, eds. *Handbook of Climate Change and Agroecosystems*, 2014



AgMIP's RIA Approach: Scales



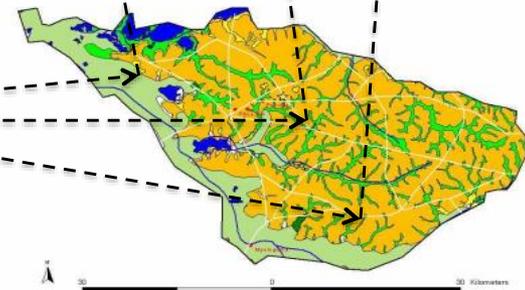
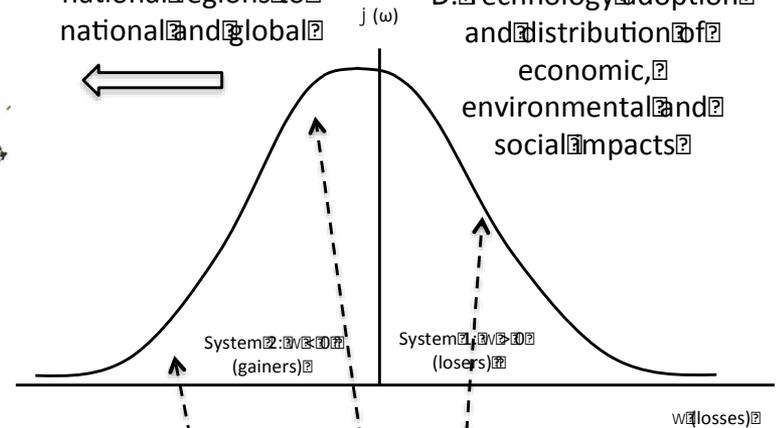
A. Global & national prices, productivity and representative ag pathways and scenarios (RAPs)



B. Complex farm household systems

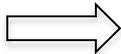
E. Linkages from sub-national regions to national and global

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



C. Heterogeneous regions

Adaptation Packages



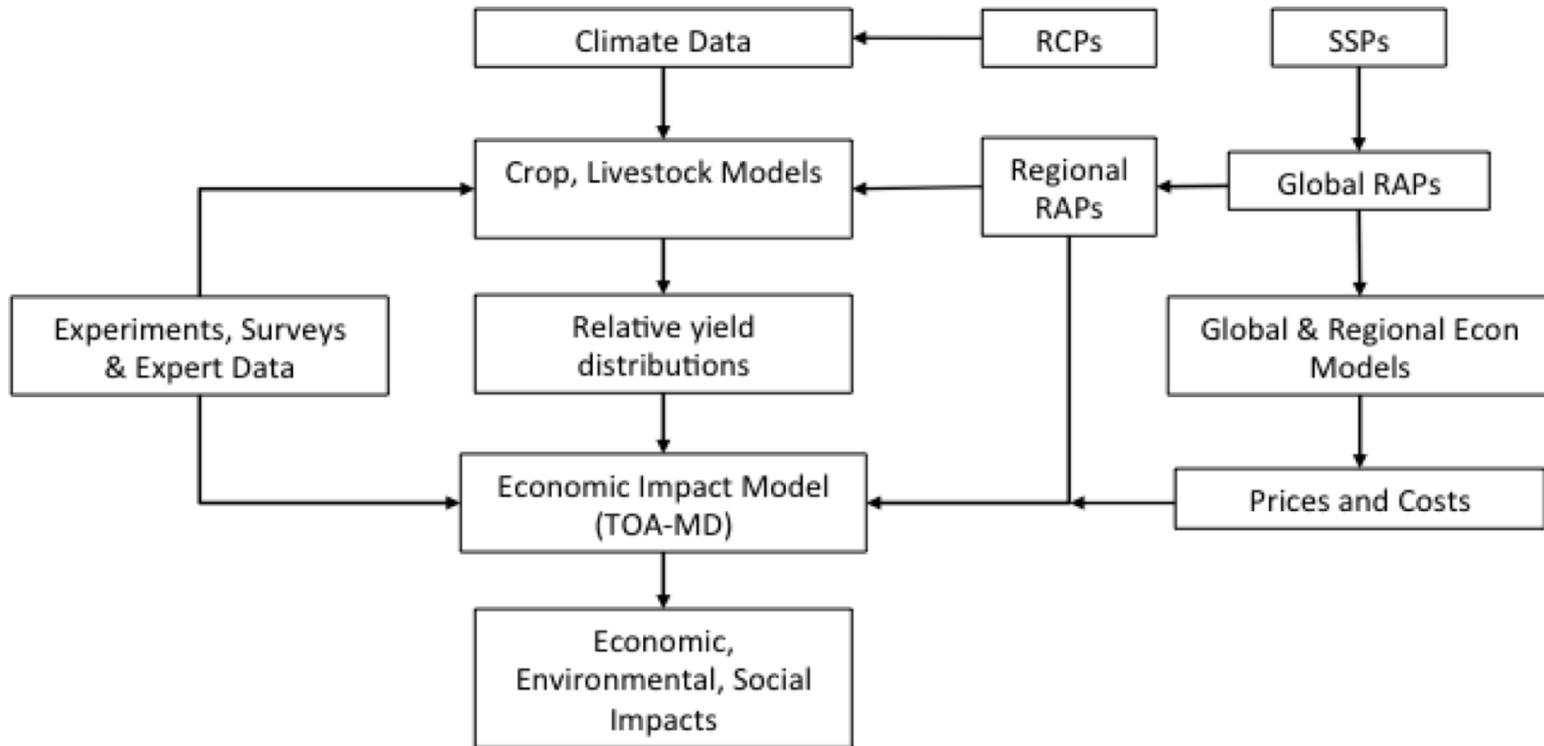


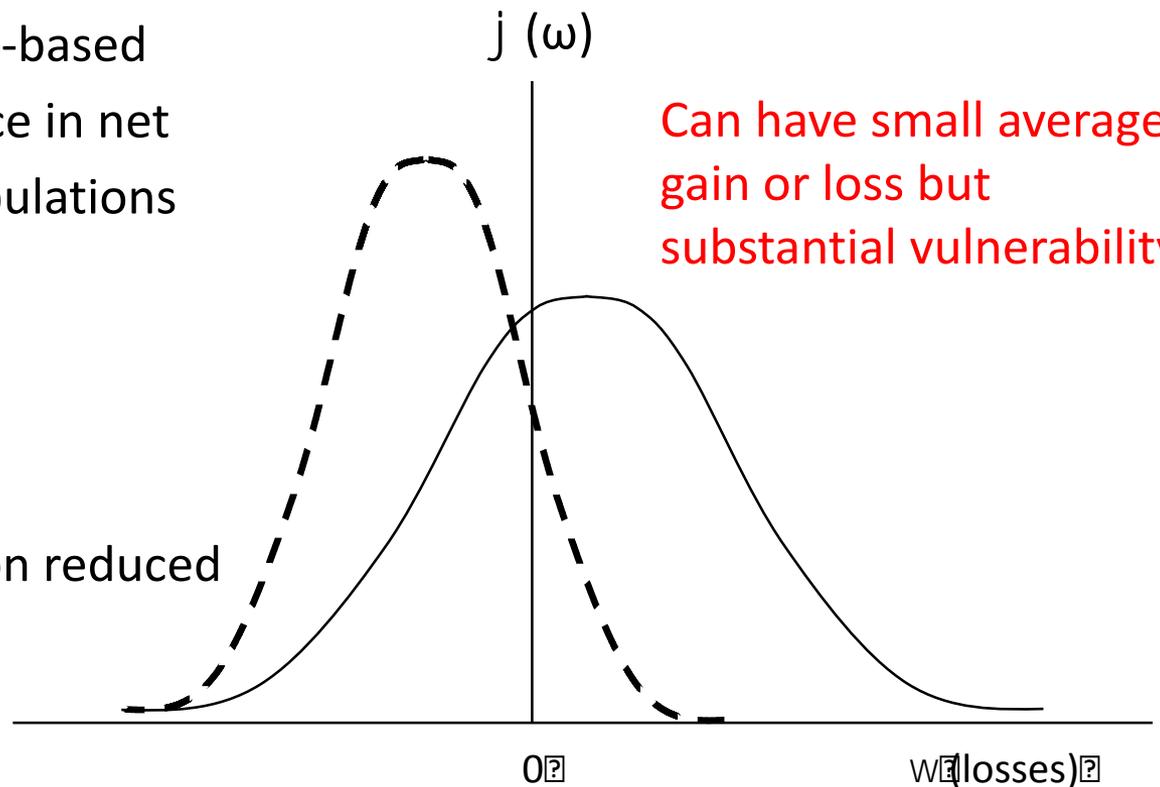
Figure 2. The AgMIP Regional Integrated Assessment Framework. Note: RCP = Representative Concentration Pathway. SSP = Shared Socio-Economic Pathway. RAP = Representative Agricultural Pathway. TOA-MD = Tradeoff Analysis Model for Multi-Dimensional Impact Assessment.

- Most CC impact assessments based on individual crop yields or aggregate commodity production/value (region, nation, globe)
- Observation: Ag activities are part of heterogeneous, complex bio-phys & socio-econ systems
- Modeling of impact, vulnerability & adaptation requires characterization of systems
 - Includes: crops, livestock (& some aquaculture), non-ag activities of the household, etc.

- Hypothesis: High degree of **bio-physical & socio-economic heterogeneity** plays a key role in assessing CC impact, vulnerability & adaptation in ag systems

- Most analysis averages data at level of political units such as counties, districts etc or larger
- E.g., in US & Kenya crop-based systems: > 80% of variance in net returns/ha in farm hh populations is WITHIN such units

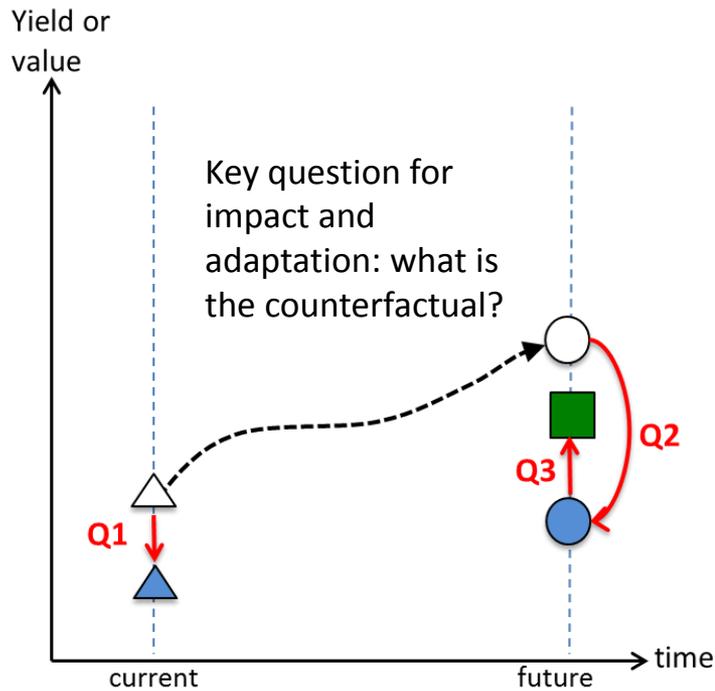
Effect of adaptation on reduced vulnerability to loss



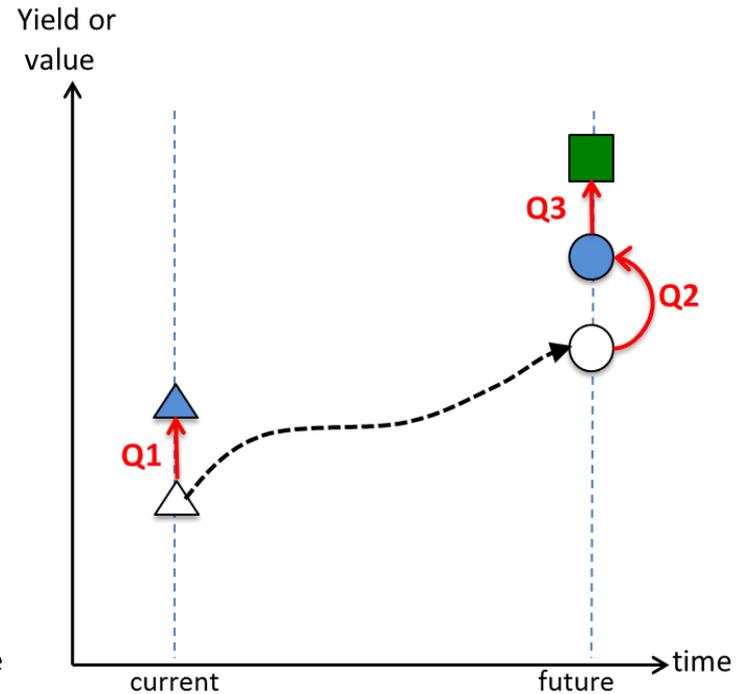
- A “parsimonious” model designed for *ex ante* impact assessment via simulation experiments using observational, experimental and scenario data
 - simulates heterogeneous ag systems using the “Roy model” logic of the micro-econometrics literature
- Can address the “three questions” of CCIA:
 - Q1: what is climate sensitivity of current systems?
 - Q2: what are *future* climate impacts w/o adaptation?
 - Q3: how useful are prospective adaptations in the future?
 - what is the economic potential for adoption of alternative systems, what are their economic, environmental and social impacts?

Antle, J.M., J.J. Stoorvogel and R. Valdivia. 2014. New Parsimonious Simulation Methods and Tools to Assess Future Food and Environmental Security of Farm Populations. *Philosophical Transactions of the Royal Society B* 369:20120280.

The Three Questions of CCIA

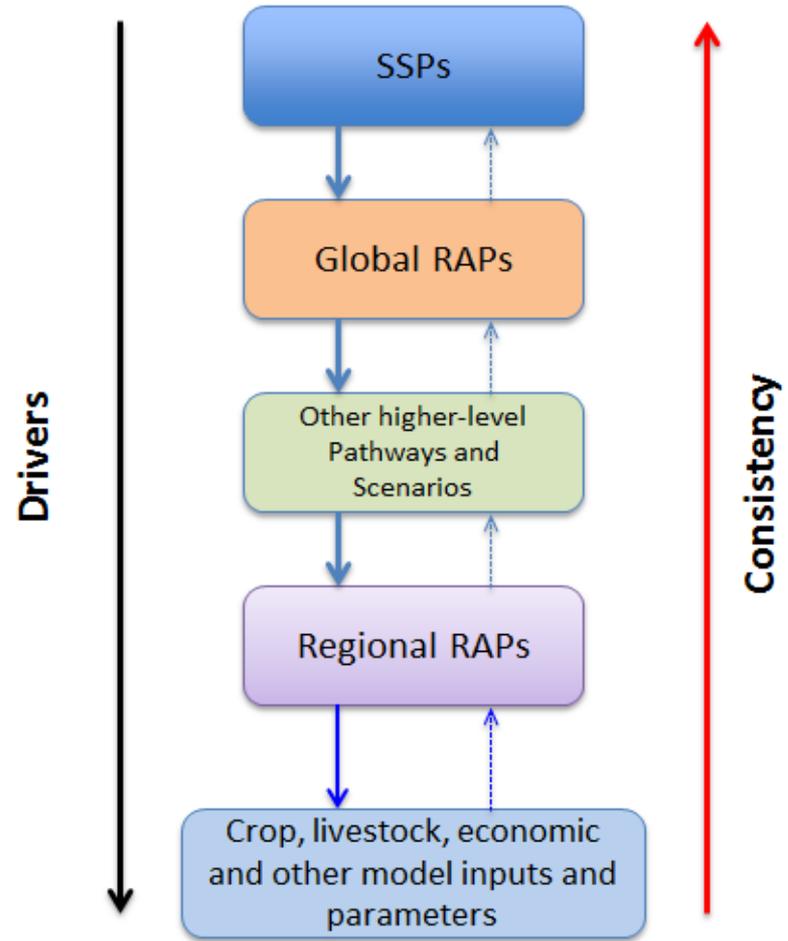


Negative impacts



Positive impacts

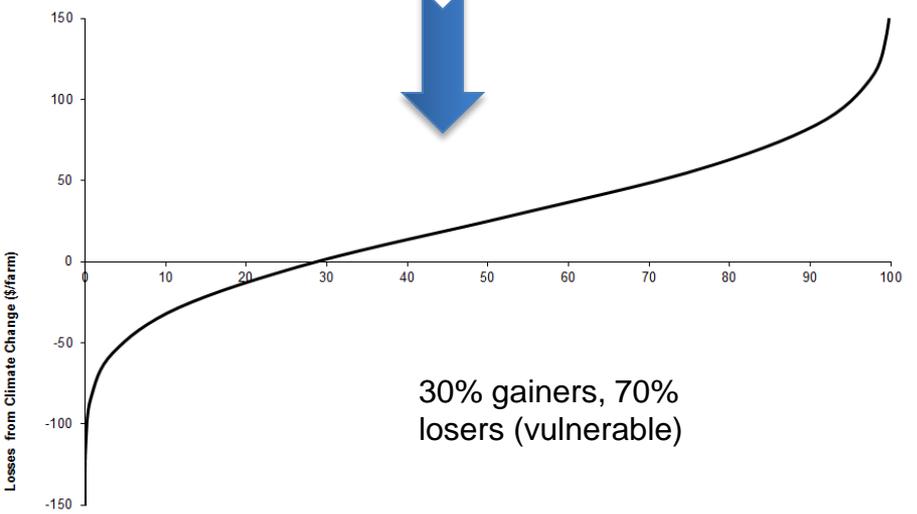
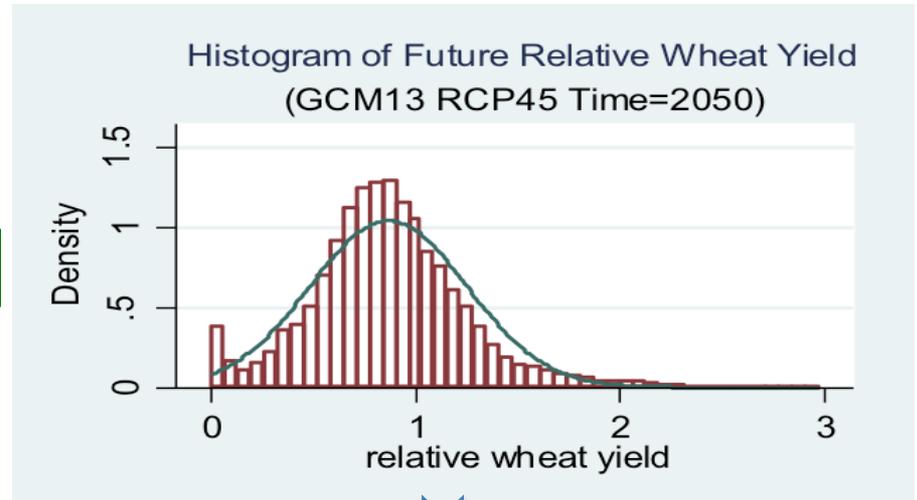
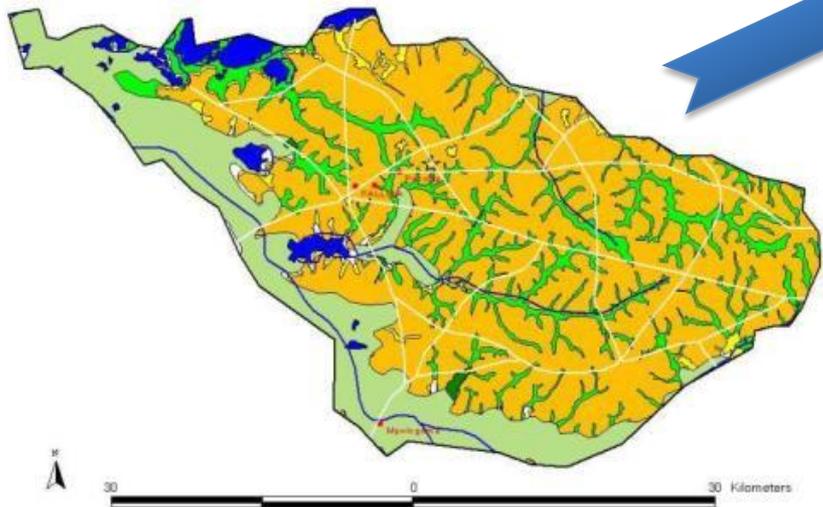
- Many regional economic impact assessments impose future climate and assess adaptation under *current socio-economic conditions*.
- Key finding of earlier global studies & AgMIP regional studies is importance of future scenarios to impact & vulnerability assessments



- Random relative yield model:
- Y_{st} = time-averaged farm-level yield for
 - system s = current, future, adapted
 - climate t = current, future
- X_{st} = simulated value of Y_{st}
 - For Q1: $R1 = X_{cf}/X_{cc}$
 - For Q2: $R2 = X_{ff}/X_{cc}$
 - For Q3: $R3 = X_{af}/X_{cc}$
- Assume:
 - For Q1: $Y_{cf} = R1 \times Y_{cc}$
 - For Q2: $Y_{ff} = R2 \times Y_{cc}$
 - For Q3: $Y_{af} = R3 \times Y_{cc}$
- **Use site-specific soils, climate and management data** with statistical or process-based crop or livestock models to estimate X_{st} & generate spatial distributions of projected yields for Q1, Q2 Q3.

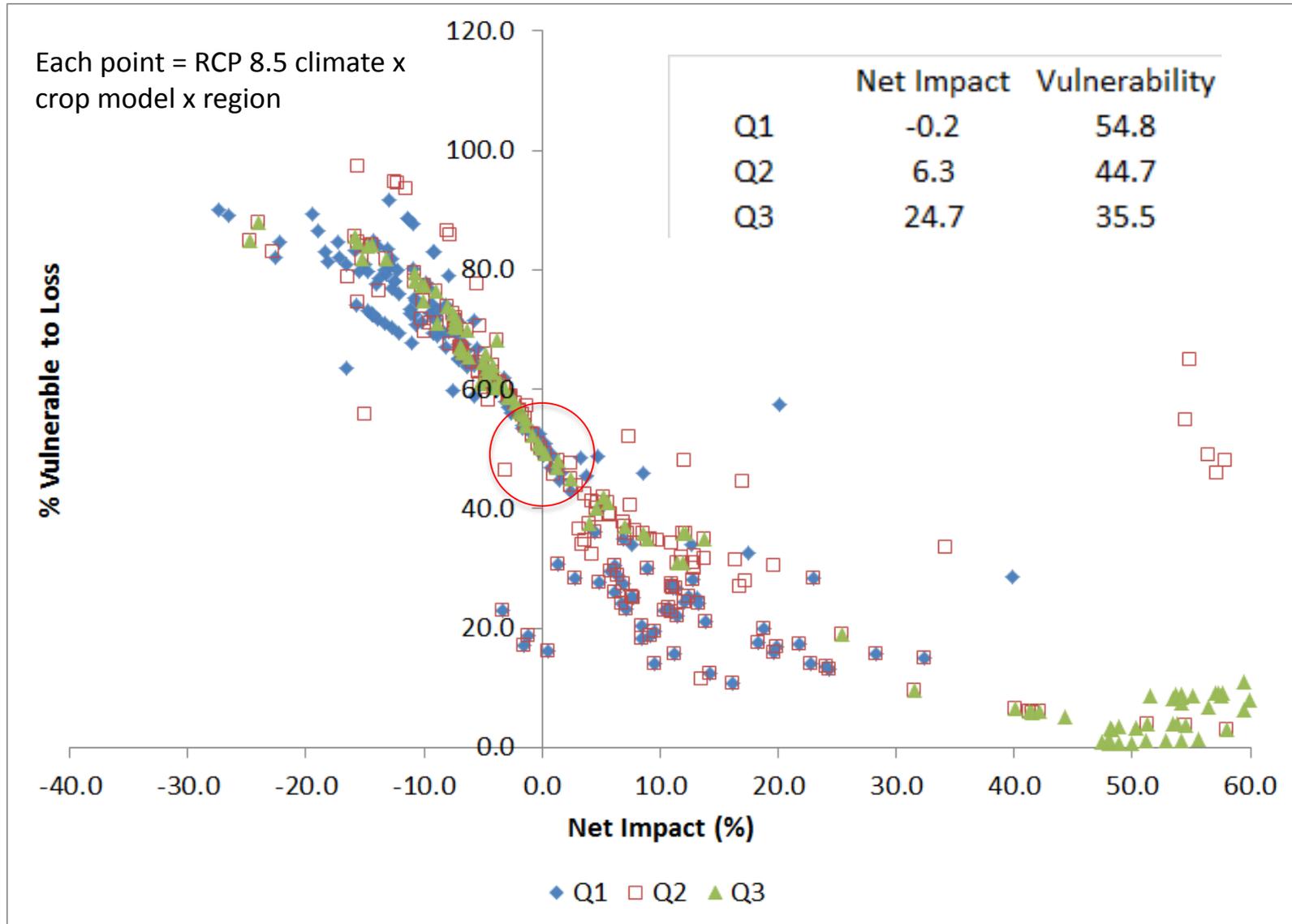
Example: Relative wheat yield distribution and gains and losses from CC

Heterogeneous region

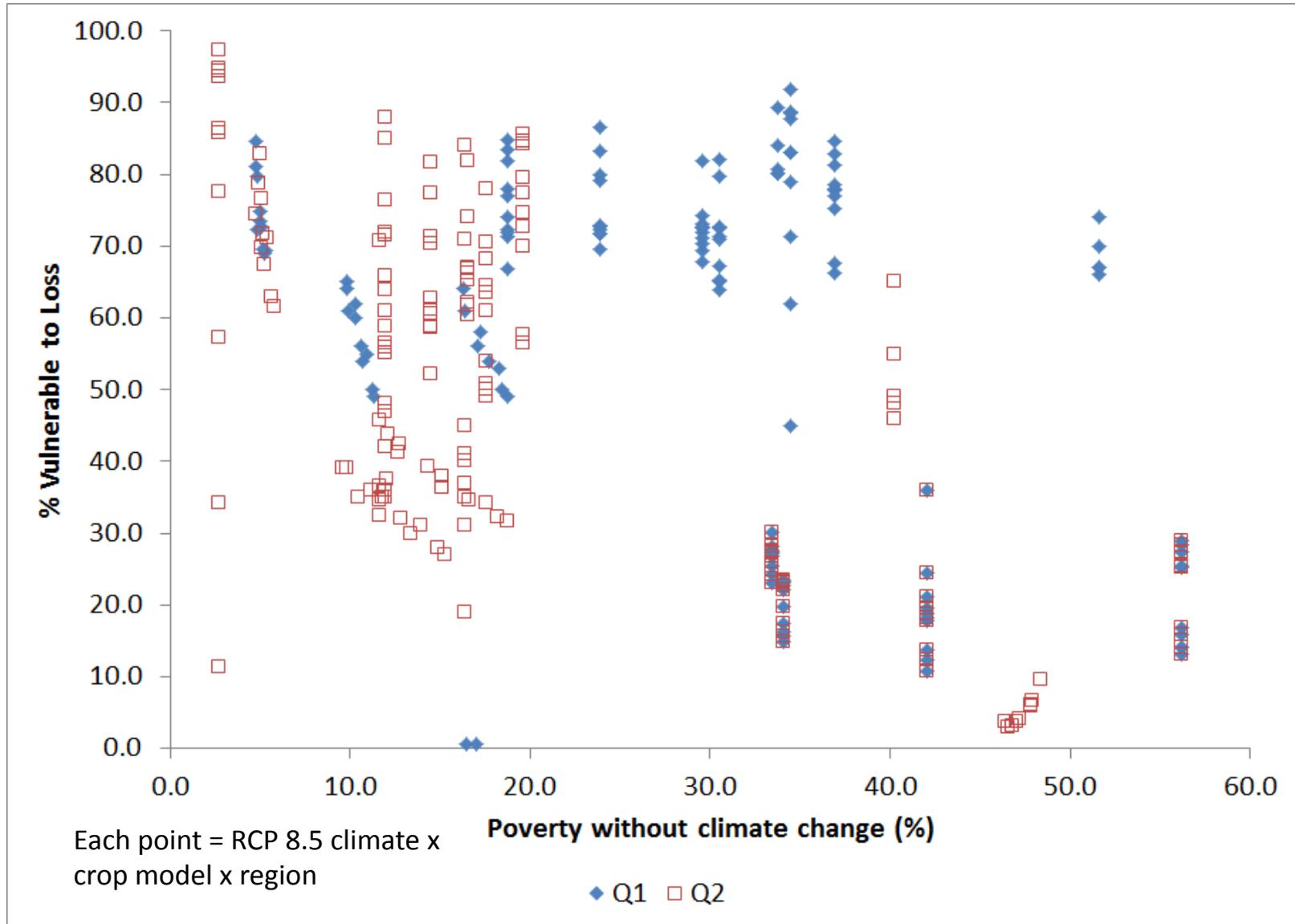


TOA-MD model simulated gains and losses

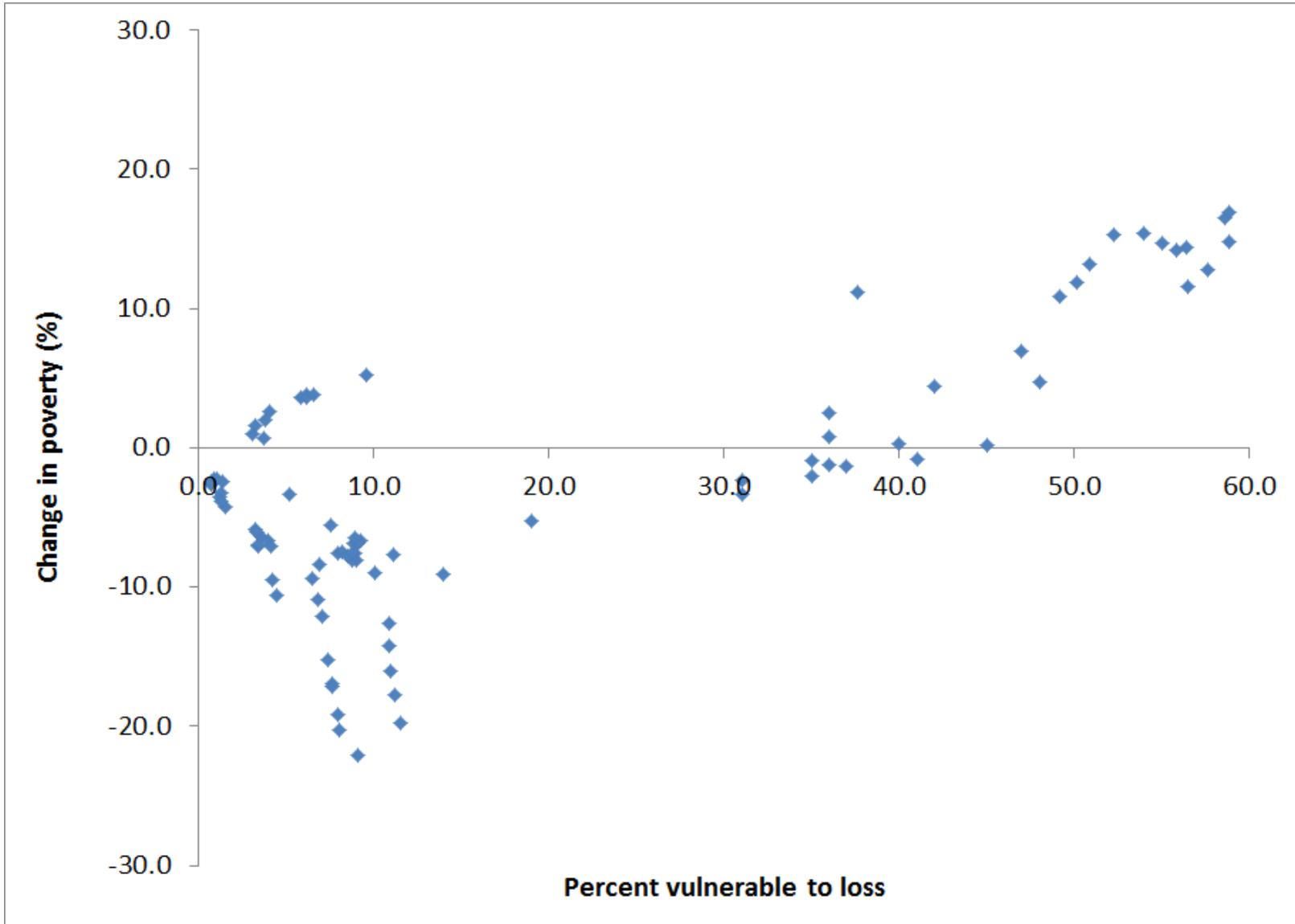
AgMIP Regional RIAs: Net Economic Impact vs Vulnerability



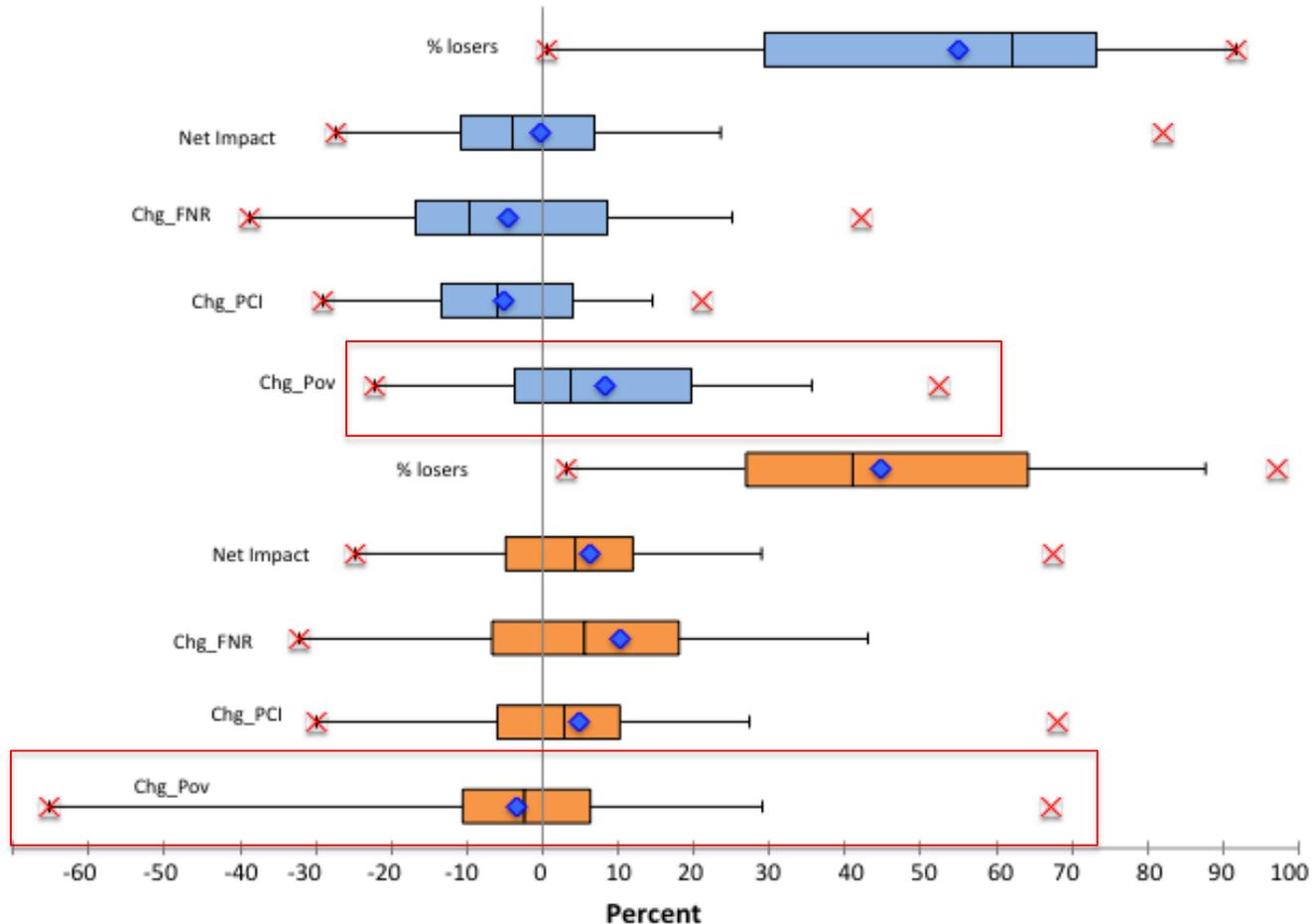
AgMIP Regional RIAs: Importance of Future Scenarios (RAPS)



AgMIP Regional RIAs: Effect of Some Specific Adaptations



AgMIP Regional RIAs: Impacts of Climate Change in Mid-Century



Q1 Q2

Variable

% losers

Net Impact

Chg_FNR

Chg_PCI

Chg_Pov

Description

Percent of losers from CC (%)

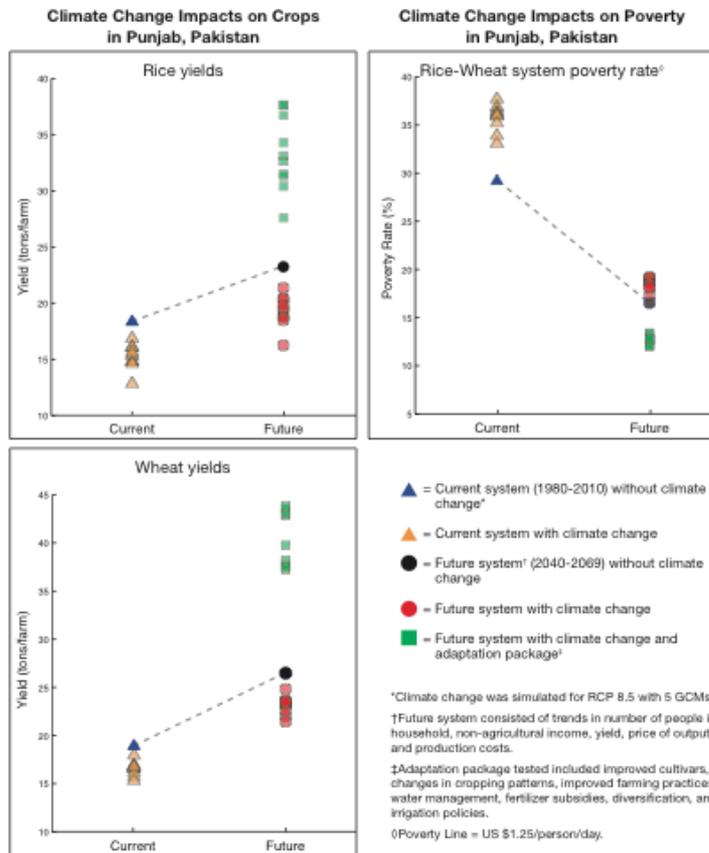
Net Impacts as a percent of farm net returns (%)

Change in farm net returns (%)

Change in per capita income (%)

Change in poverty rate (%)

=> Stakeholders: need narratives (interpretation) backed up by credible analysis & data



CLIMATE CHANGE IMPACTS on farms in Punjab, Pakistan

What is the sensitivity of **CURRENT** agricultural production systems to **CLIMATE CHANGE***?

74%

of farms will be negatively affected due to climate change[†]



What is the impact of **CLIMATE CHANGE** on **FUTURE**[‡] agricultural production systems?

66%

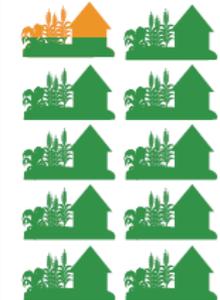
of farms will be negatively affected due to climate change[†]



What are the benefits of **FUTURE ADAPTATIONS**[‡] to **CLIMATE CHANGE**?

93%

of farms will benefit from adaptation to climate change[†]



Many Challenges

- Local-regional-global linkages across inter-related processes (complementary but questions about formal linkages)
- High spatial and temporal resolution of bio-physical and socio-economic processes (how do we get more comprehensive data – remote devices?)
- Climate (or weather?) variability and extremes (we can model impacts, but are climate data good enough?)
- Weeds, pests and diseases (new AgMIP activity...)
- Future socio-economic pathways: technology, demographics, institutions, policy ... (we need serious investment in this)
- Uncertainty: climate x bio-physical x economic – all large!