

Uncertainties and knowledge gap in predicting agricultural production and need for international collaboration



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RESEARCH PROGRAM ON
Climate Change,
Agriculture and
Food Security



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

Today's topics

- AgMIP approaches in brief
- Uncertainty in model assessment
- Gaps in implementing assessment at different scales
- Need for international collaboration (Coordinated Global and Regional Assessment, CGRA)



1st Global Oct 2010



2nd Global Oct 2011



4th Global Oct 2013



5th Global Feb 2015



Sub-Saharan Africa #3



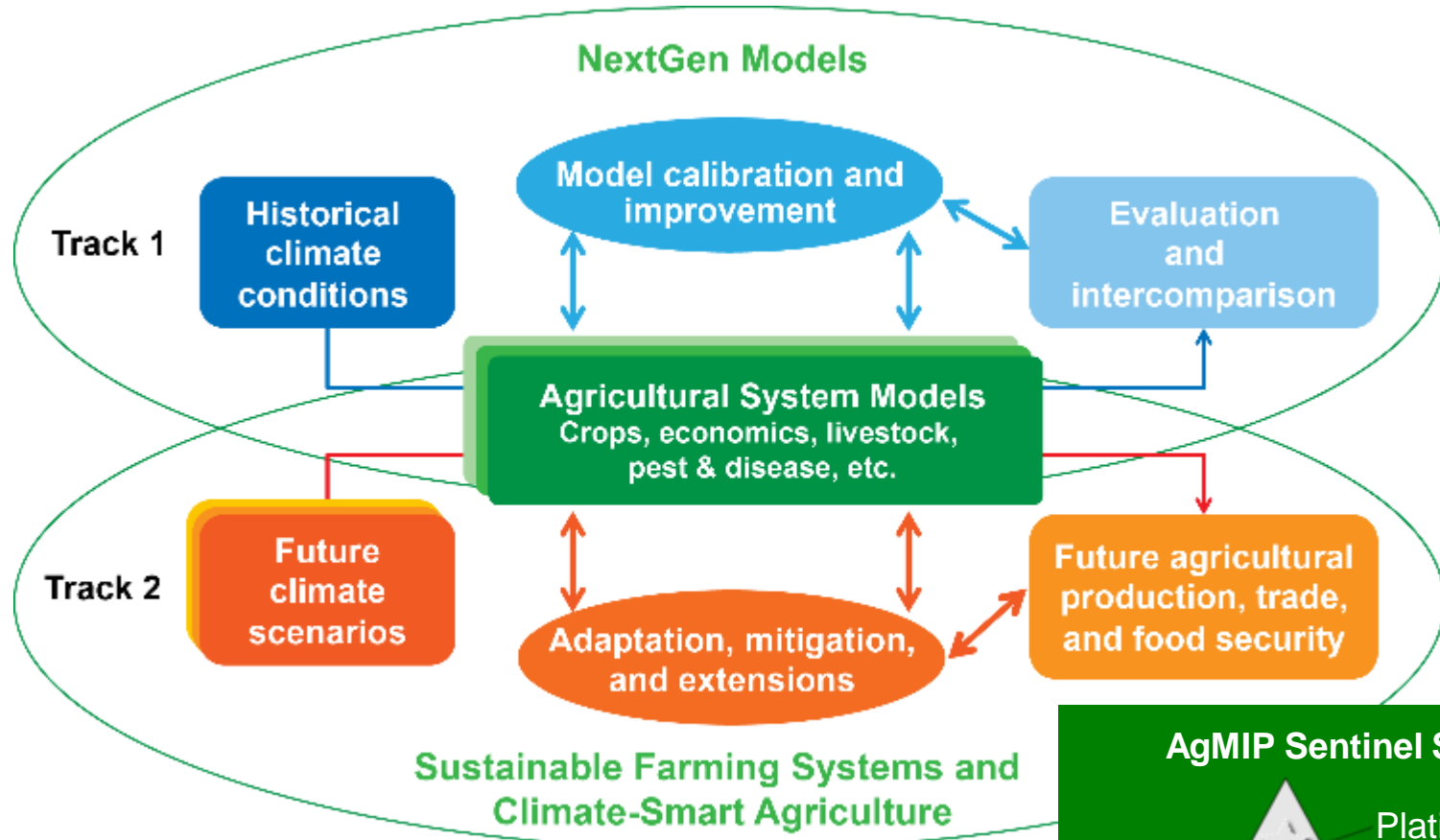
South Asia #3



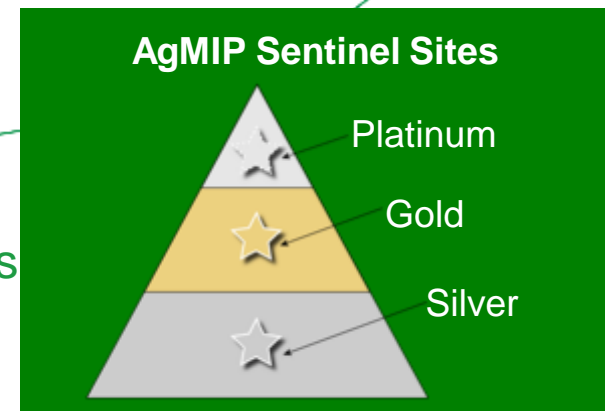
3rd Global Oct 2012



Some of the many partners and donor institutions involved in AgMIP

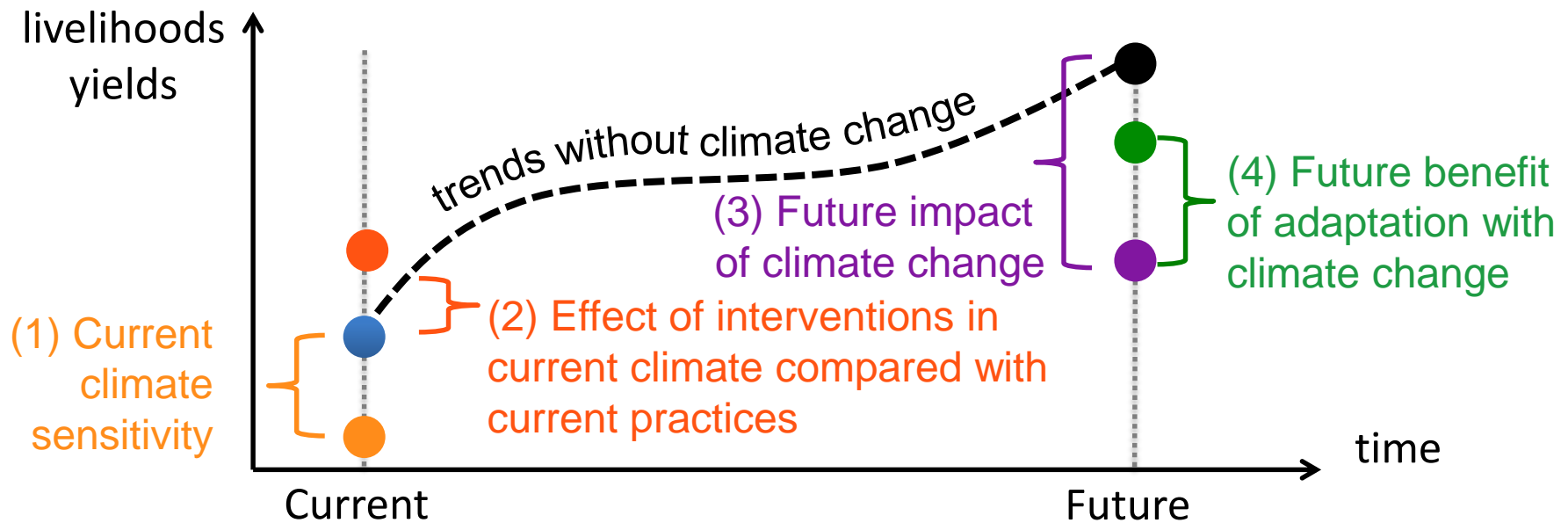


Track 1: Develop/Test NextGen Agricultural Systems Models
Track 2: Conduct Multi-Model Assessments for Sustainable Farming Systems and Climate-Smart Agriculture

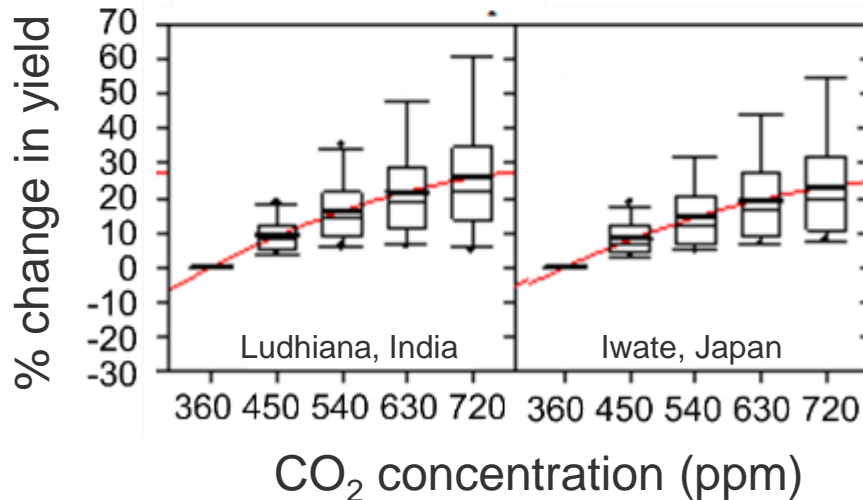
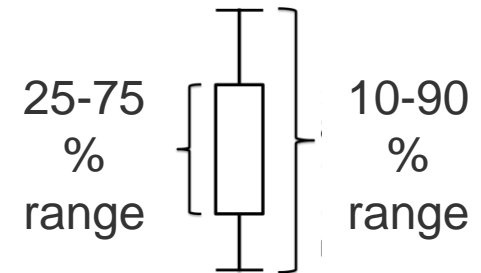
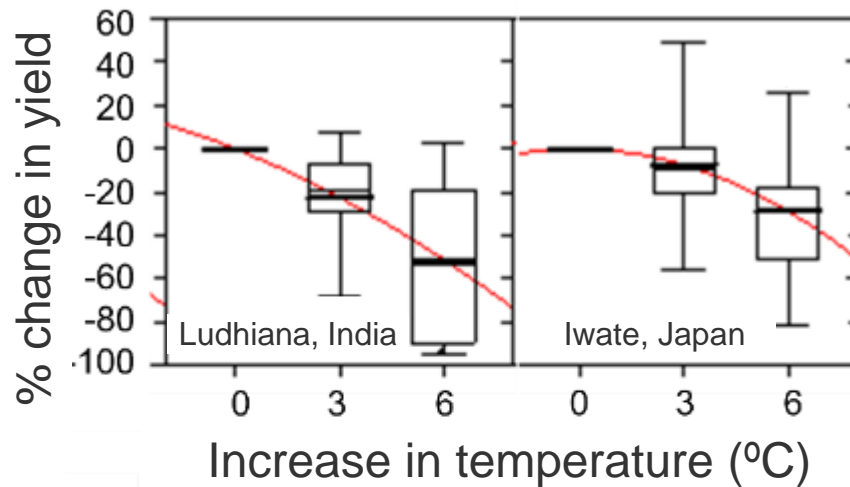


In Summary, the four core questions are:

- 1) What is the sensitivity of current agricultural production systems to climate change?
- 2) What is the effect of adaptations applied in the current climate?
- 3) What is the impact of climate change on future agricultural production systems?
- 4) What is the benefit of adaptation with climate change?



Crop modeling teams to intercompare existing crop models
 -An example from the rice team: Comparison of 13 rice models.



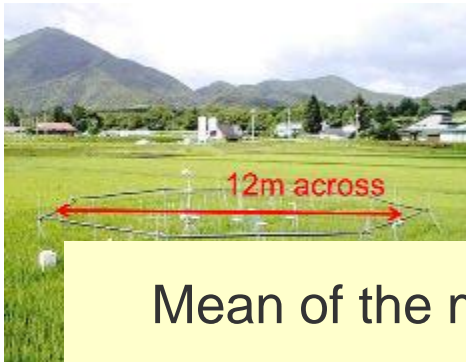
Li et al (2015) Global Change Biology

Rice free-air CO₂ enrichment (FACE) and chamber studies to test [CO₂] response of 16 rice models

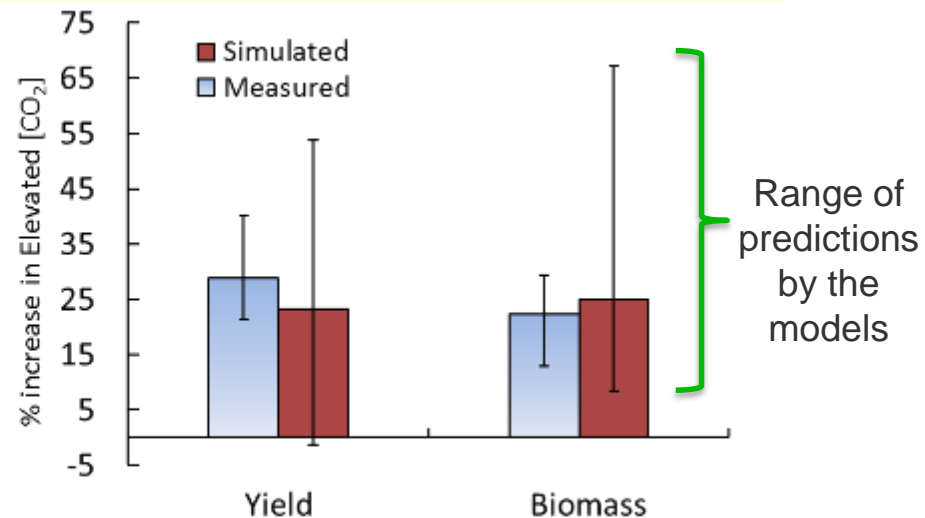
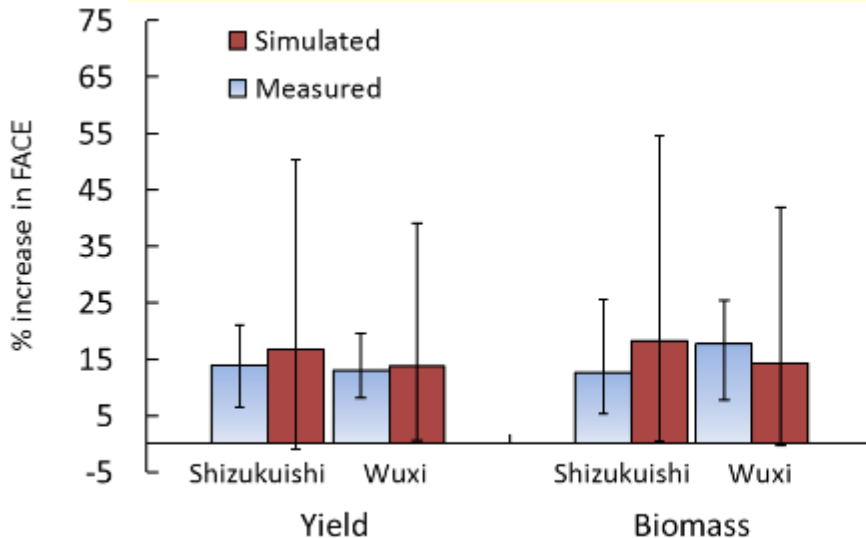
Shizukuishi, Japan
(39°38' N, 140°57' E)

Wuxi, China
(31°37' N, 120°28' E),

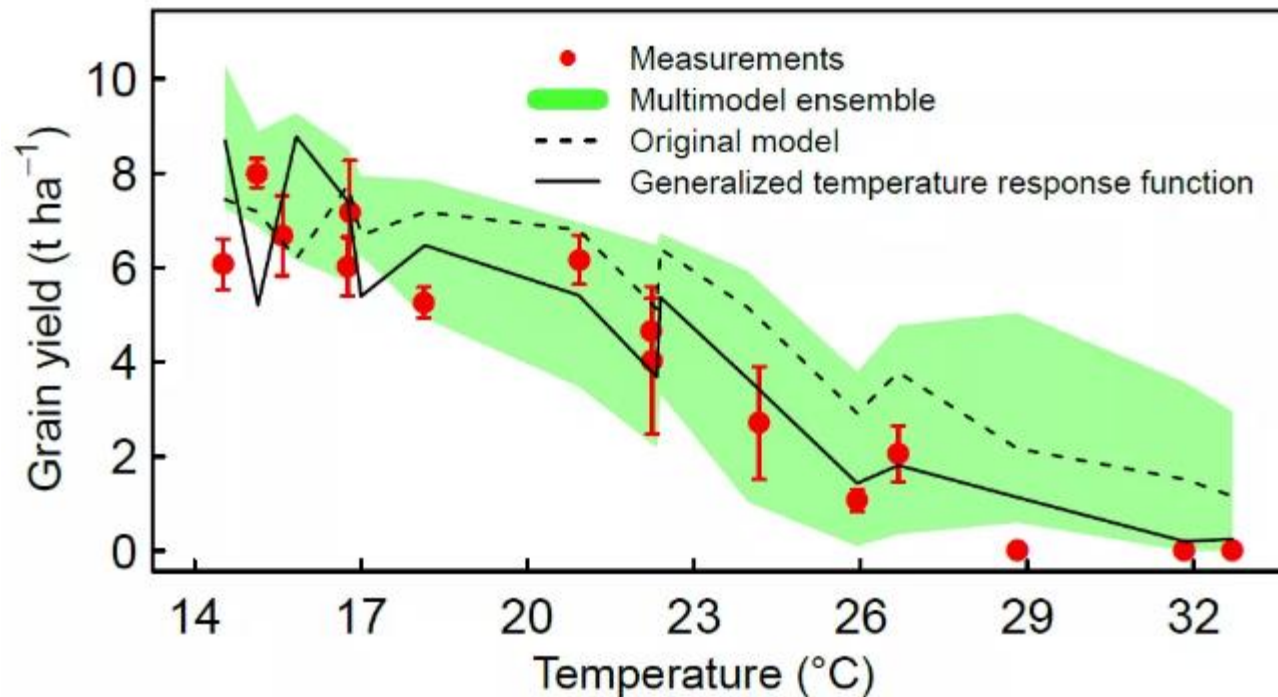
SPAR chamber in Florida, USA
(39°38' N, 140°57' E)



Mean of the models are right but individual models varied.



Responses to temperature of 29 wheat models tested against Hot Serial Cereal experiments



Original models generally overestimate the yield under high temperature. Uncertainty can be reduced by identifying the sources.

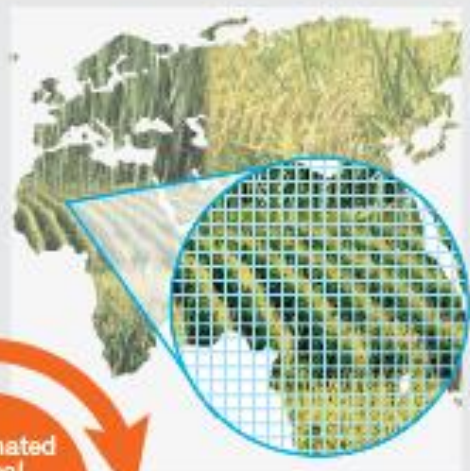
Regional

Global

Crops

Regional research

on farming systems using biophysical and socioeconomic models



High-resolution gridded crop modeling

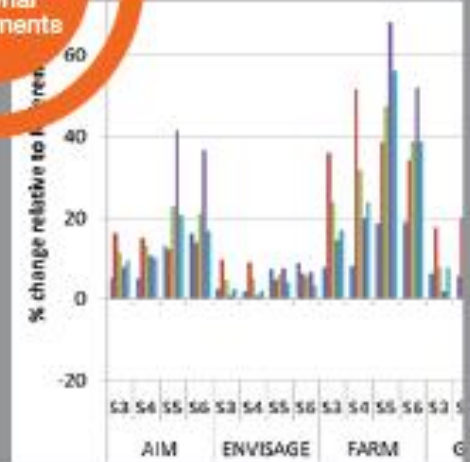
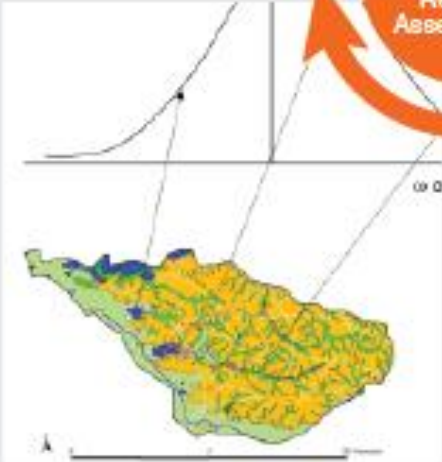
for gap-filling and aggregation in each region

Coordinated Global and Regional Assessments

Economics

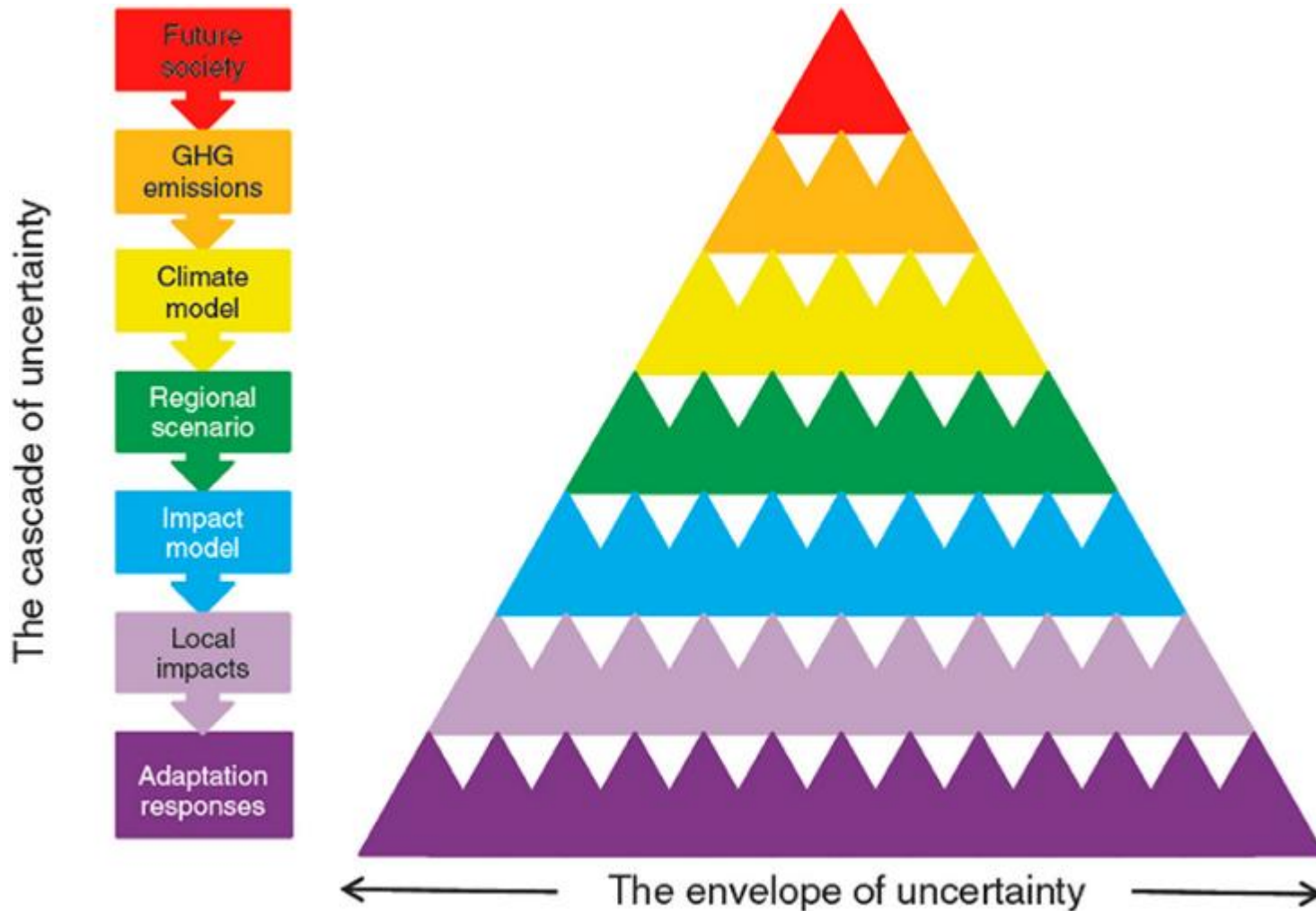
Production systems and regional economics

to respond to price changes



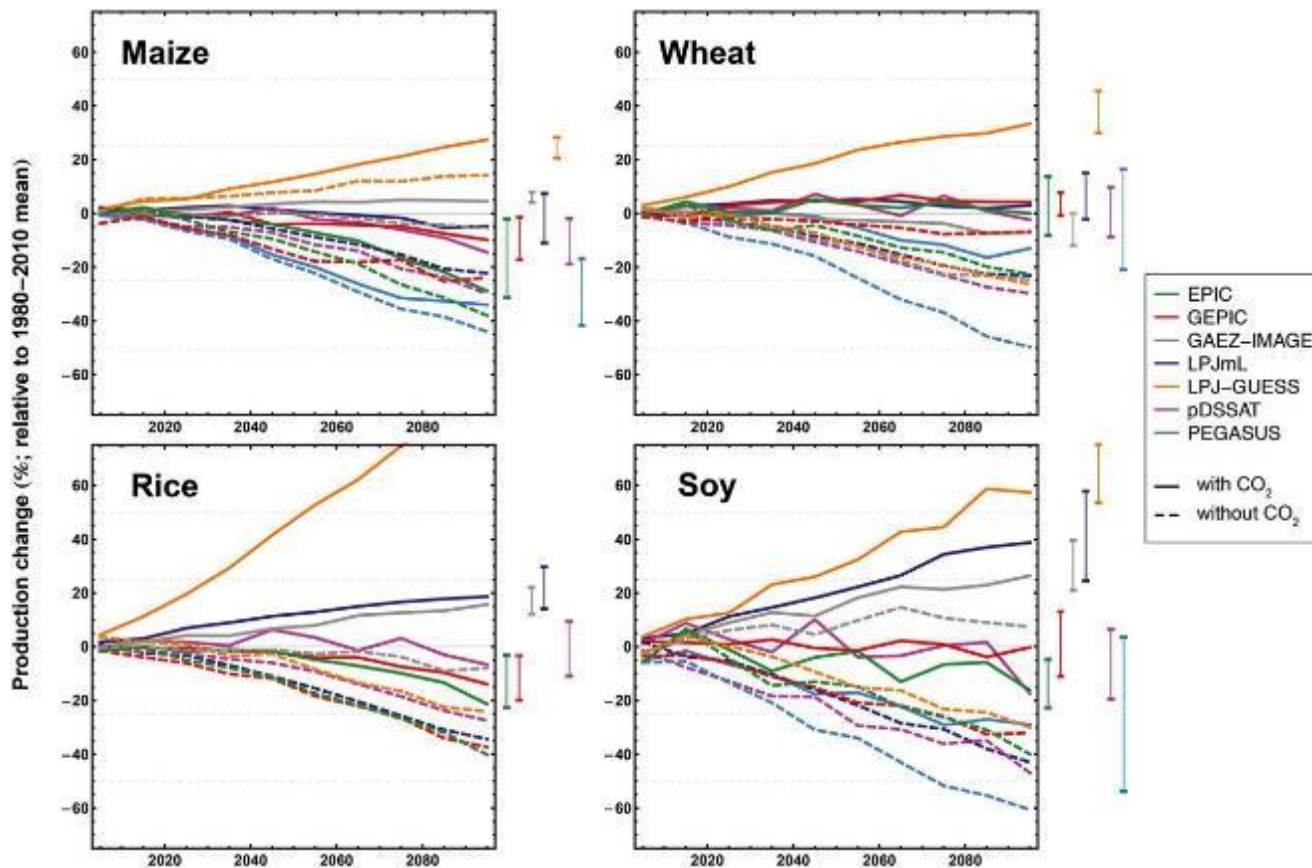
Global economics

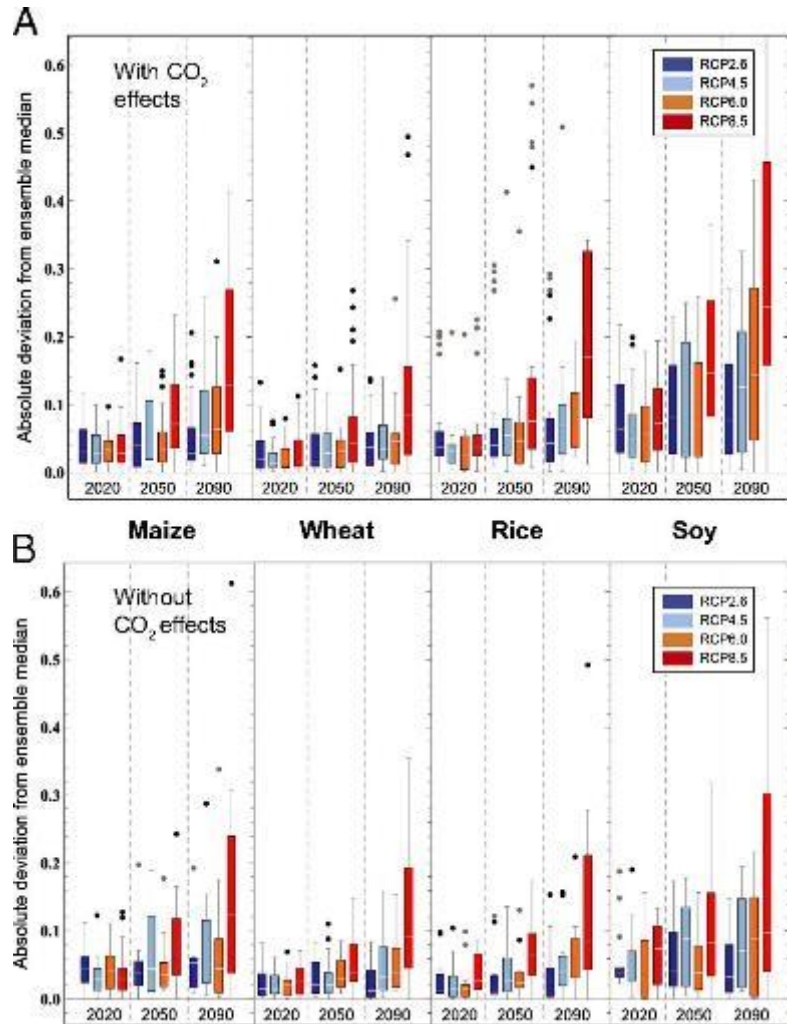
with analysis of world and regional prices



Falloon P, Challinor A, Dessai S, Hoang L, Johnson J, Koehler A-K (2014) Ensembles and uncertainty in climate change impacts. *Frontiers in Environmental Science*, 2, 1–7.

Relative change (%) in RCP8.5 decadal mean production for each GGCM (based on current agricultural lands and irrigation distribution) from ensemble median for all GCM combinations with (solid) and without (dashed) CO₂ effects for maize, wheat, rice, and soy...





Absolute deviation of decadal average production changes from ensemble median yield changes (as fraction of 1980–2010 reference period mean production) for all GCM × GGCM combinations in RCP2.6 (dark blue), RCP4.5 (light blue), RCP6.0 (orange), and RCP8.5 (...)

Cynthia Rosenzweig et al. PNAS 2014;111:3268-3273

Closing the gaps between **models** and **users** can also be practically important.

From a supply-driven (i.e., science-driven) approach toward a more demand-driven (i.e., end-user or stakeholder-driven) approach.

Antle JM, Jones JW, Rosenzweig C (2017) Next generation agricultural system models and knowledge products: Synthesis and strategy. *Agricultural Systems*, 155, 179–185.



Protocols for AgMIP
Regional
Integrated
Assessments

VERSION 6.1



<https://www.agmip.org/regional-integrated-assessments-handbook/>

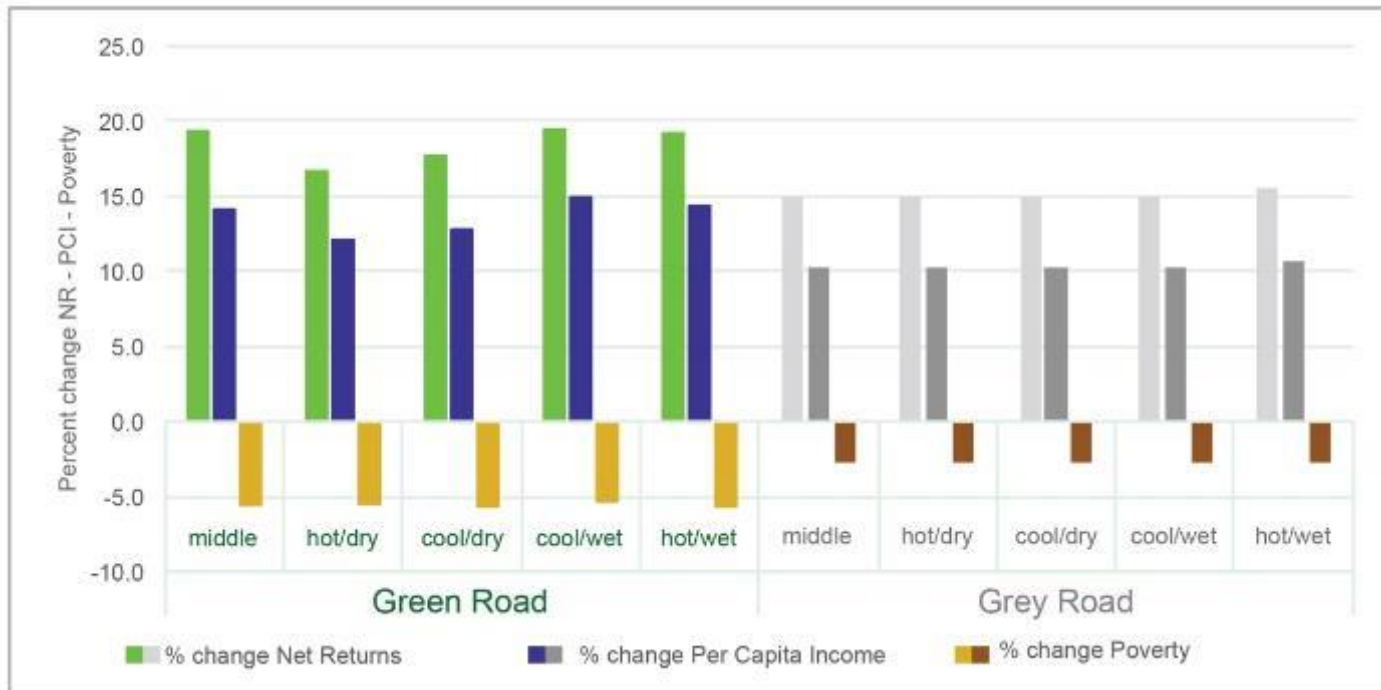
Sustainable Development Taking the Green Road

- **Inclusive approaches in public policies**, development of community initiatives and accountability of grassroots organizations
- **Good agro-ecological practices** are mainstreamed
- Fertilizer subsidies increase slightly - use of **organic fertilizer is encouraged**
- **Livestock productivity improves** - improved feeding and animal health programs.
- Agro-ecological practices and sustainable land management contribute **to improved soil fertility** with better integration of crop-livestock production systems.
- The use of **water storage technologies** and better management increase availability and access to water.
- Decentralization policies are fully implemented in a context **of improved human and social capital**

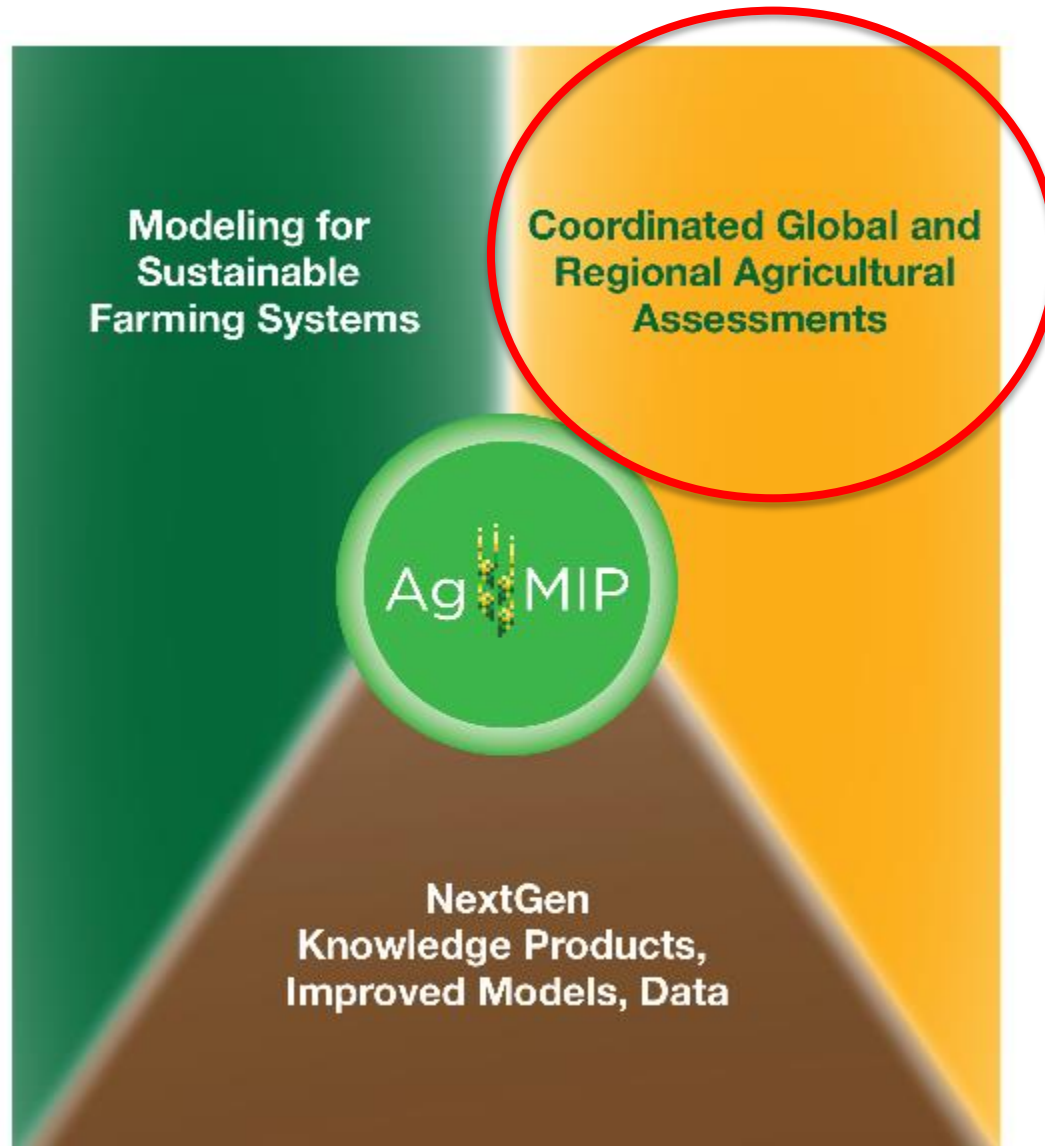
Fossil Fuel Development Taking the Grey Road

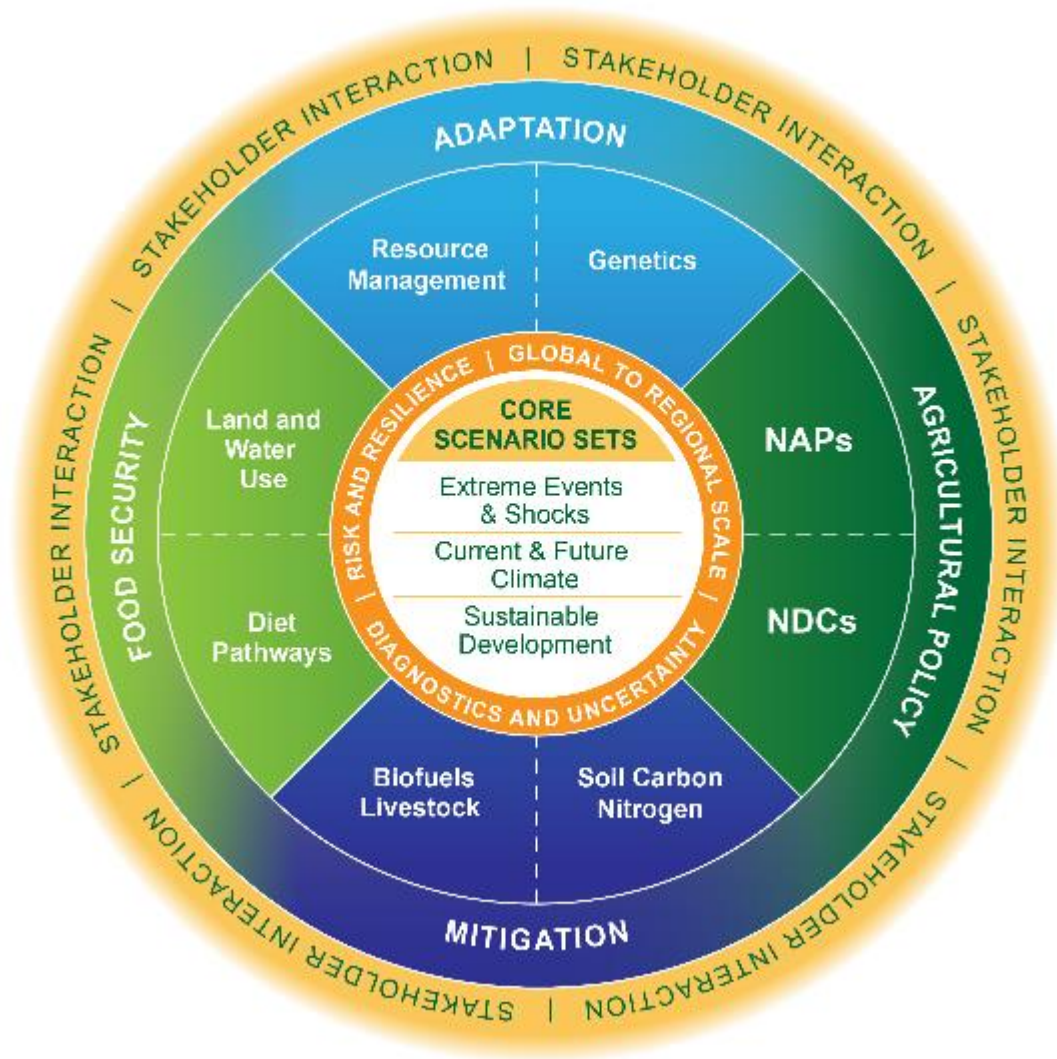
- **Population growth** - rapid urbanization lead to rapid rise in agricultural productivity
- The agricultural sector **responds quickly to increased demand**
- **Input subsidies**, development of road networks and the revitalization of the peanut basin
- Lack of good and environmentally friendly agricultural practices, **soil degradation and unsustainable use of water resources.**
- Herd size and **livestock productivity rise**
- The **development of the digital economy**, mechanization of agriculture, and a strong energy demand exert a powerful influence on rural activities.
- Household size and **fragmented farms decreases**
- Better road networks **increase employment opportunities outside agriculture.**

- One **adaptation package** was performed on each crop.
- Adaptation package involved **genetic improvements to cereals cultivars** and **narrower planting window** combined with future practices in RAPs (improved fertilization).
- Genetic improvement adaptation package was designed to create **heat-tolerant cultivars**, adapted to higher temperature.



Percent change in net returns, per capita income and poverty rate from the adaptation package (DSSAT)





Coordination between regional and global assessments through CGRA

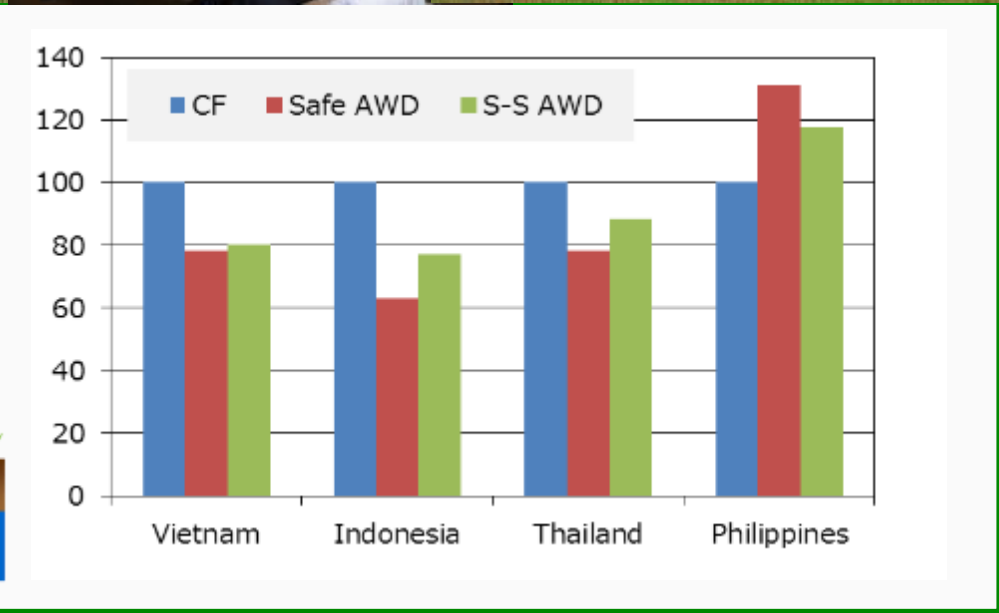
- Key to the integrated assessments under global changes

Collaborative Research Projects

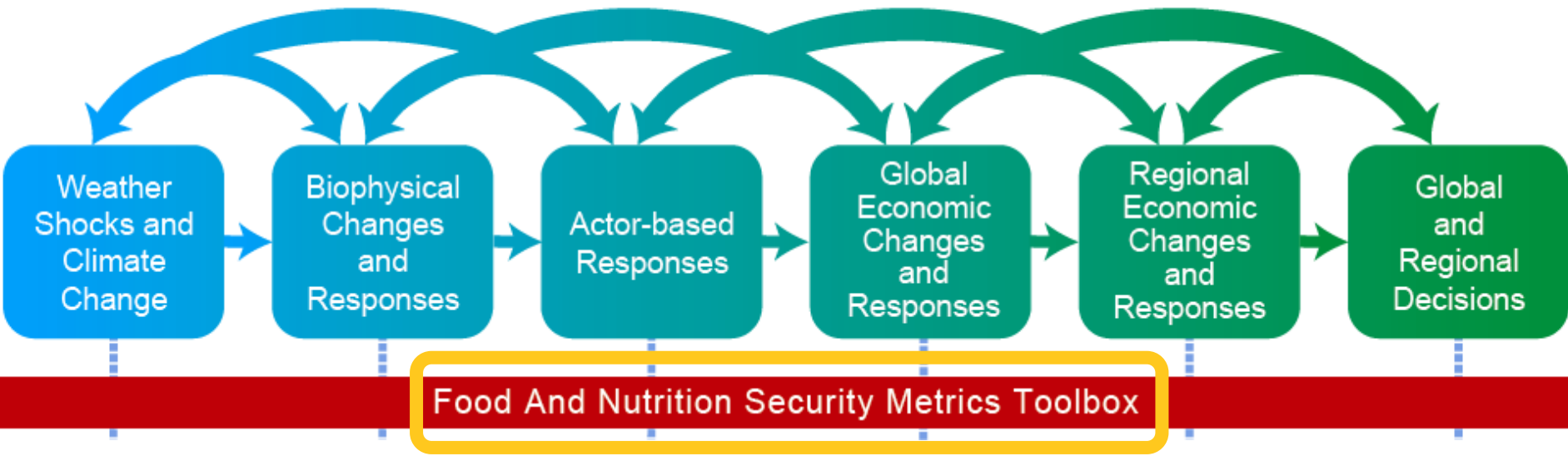
Paddy Rice Research Group

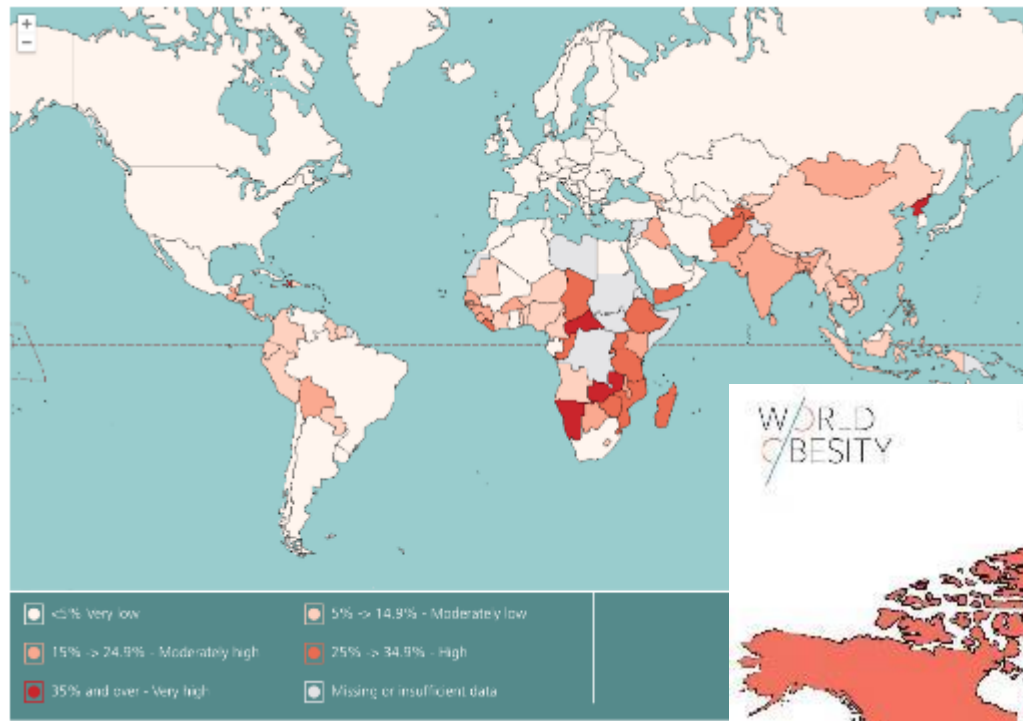
MIRSA Project

(Greenhouse Gas Mitigation in Irrigated Rice Paddies in Southeast Asia)

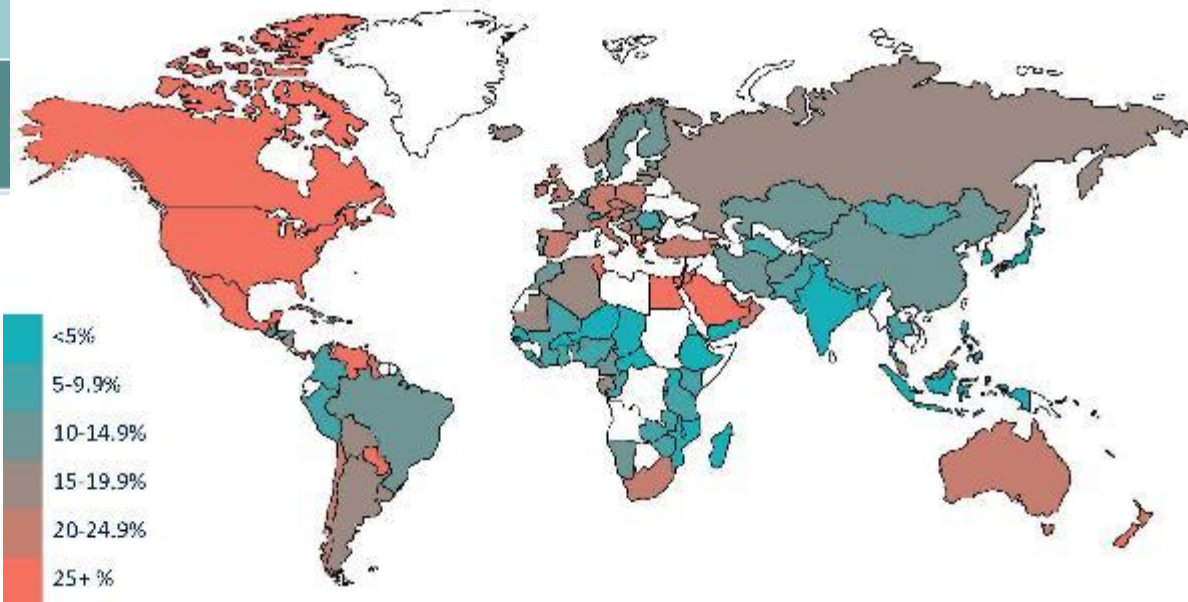


Representative Agricultural Pathways and Representative Dietary Pathways



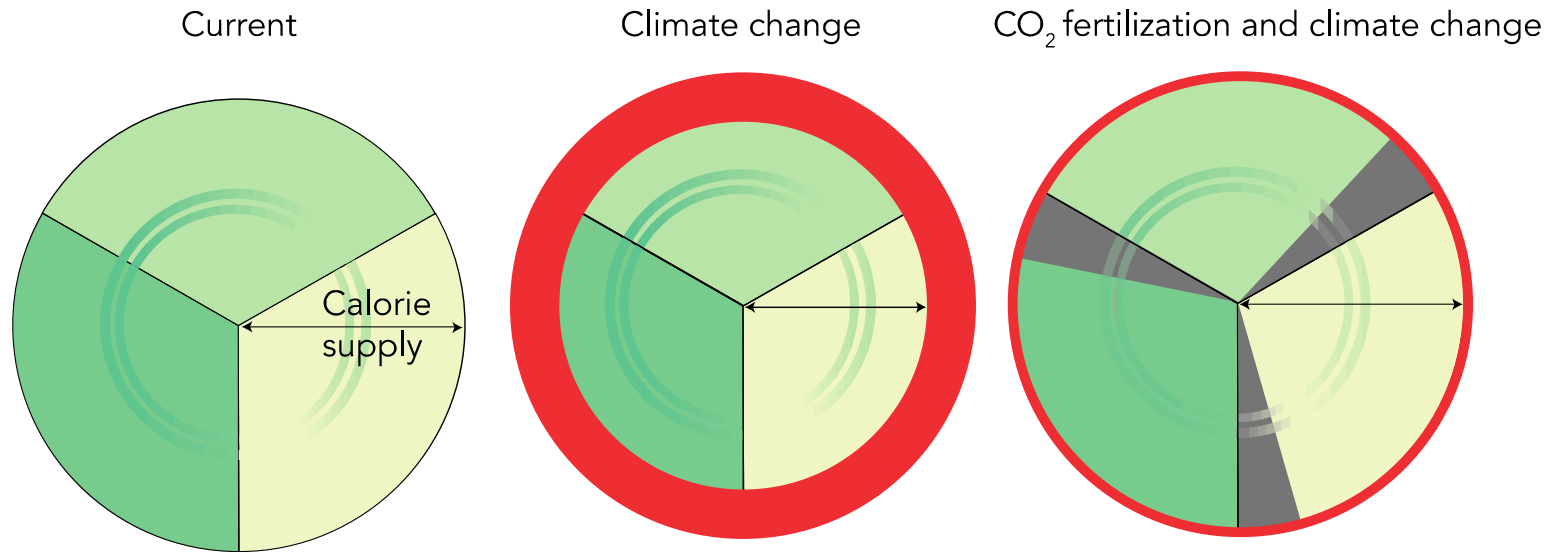


Hunger in the world is still prevalent, with 805 million people continuing to go hungry, according to FAO



FAO Hunger (Chronic Undernourishment) Map 2015

Obesity is now seen as one of the most important public health problems today; about 475 million adults are obese according to World Obesity



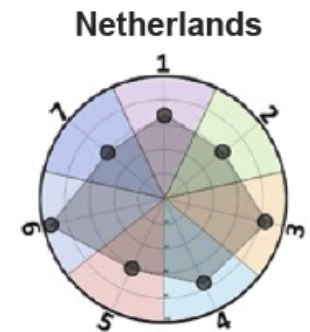
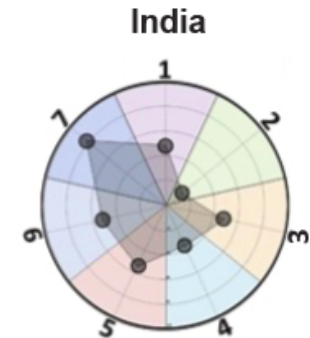
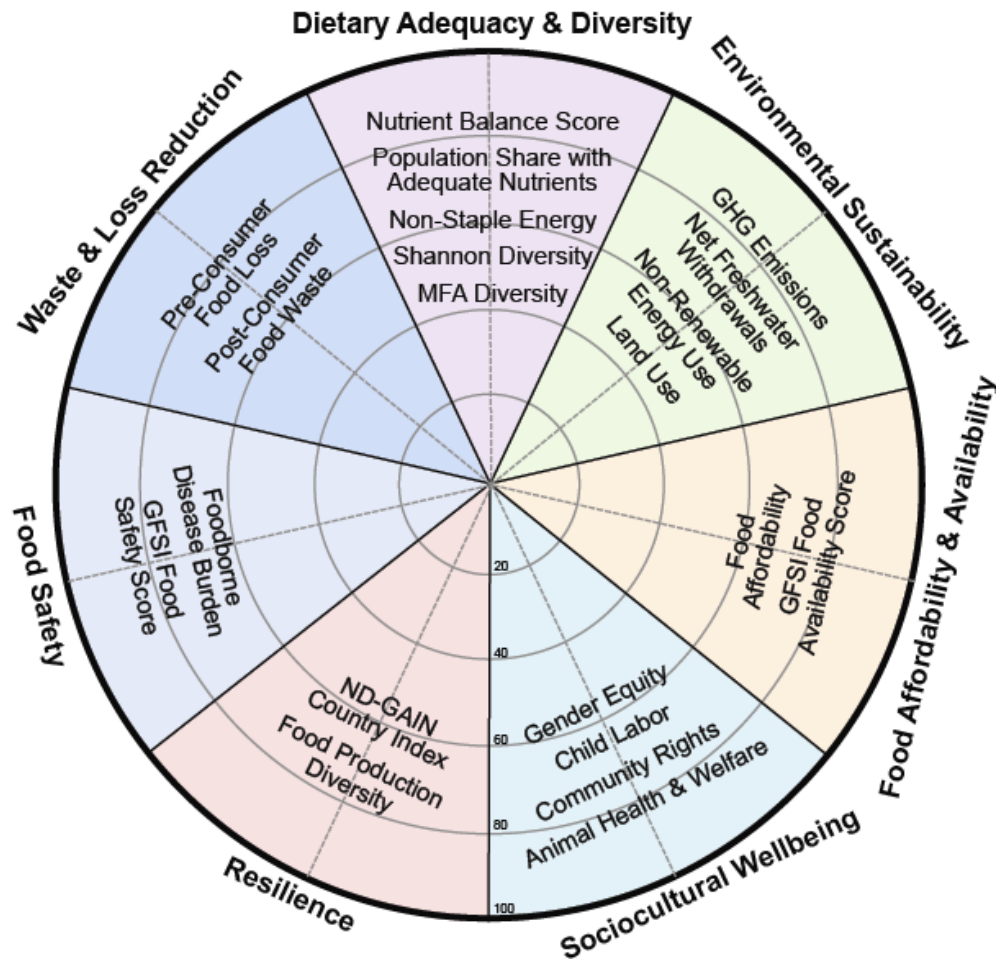
- Iron content
- Zinc content
- Protein content

Calorie Production Gap

World Rich in CO₂

Muller et al., Food Security: Fertilizing Hidden Hunger Nature Climate Change

Climate change alone decreases calories –
CO₂ effects restore calories but decrease nutritional content



1. Dietary Adequacy & Diversity
2. Environmental Sustainability
3. Food Affordability & Availability
4. Sociocultural Wellbeing
5. Resilience
6. Food safety
7. Waste & Loss Reduction

Source: Gustafson, D.; Gutman, A.; Leet, W.; Drewnowski, A.; Fanzo, J.; Ingram, J. Seven Food System Metrics of Sustainable Nutrition Security. Sustainability 2016, 8, 196.

AgMIP7

April 24-26, 2018

IICA, Costa Rica

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