Reducing risks to food security from climate change

CGIAR

RESEARCH PROGRAM ON
Climate Change, Agriculture and Food Security

CCAFS

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Outline

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- Moving to an action agenda: four challenges
- Conclusions

About CCAFS

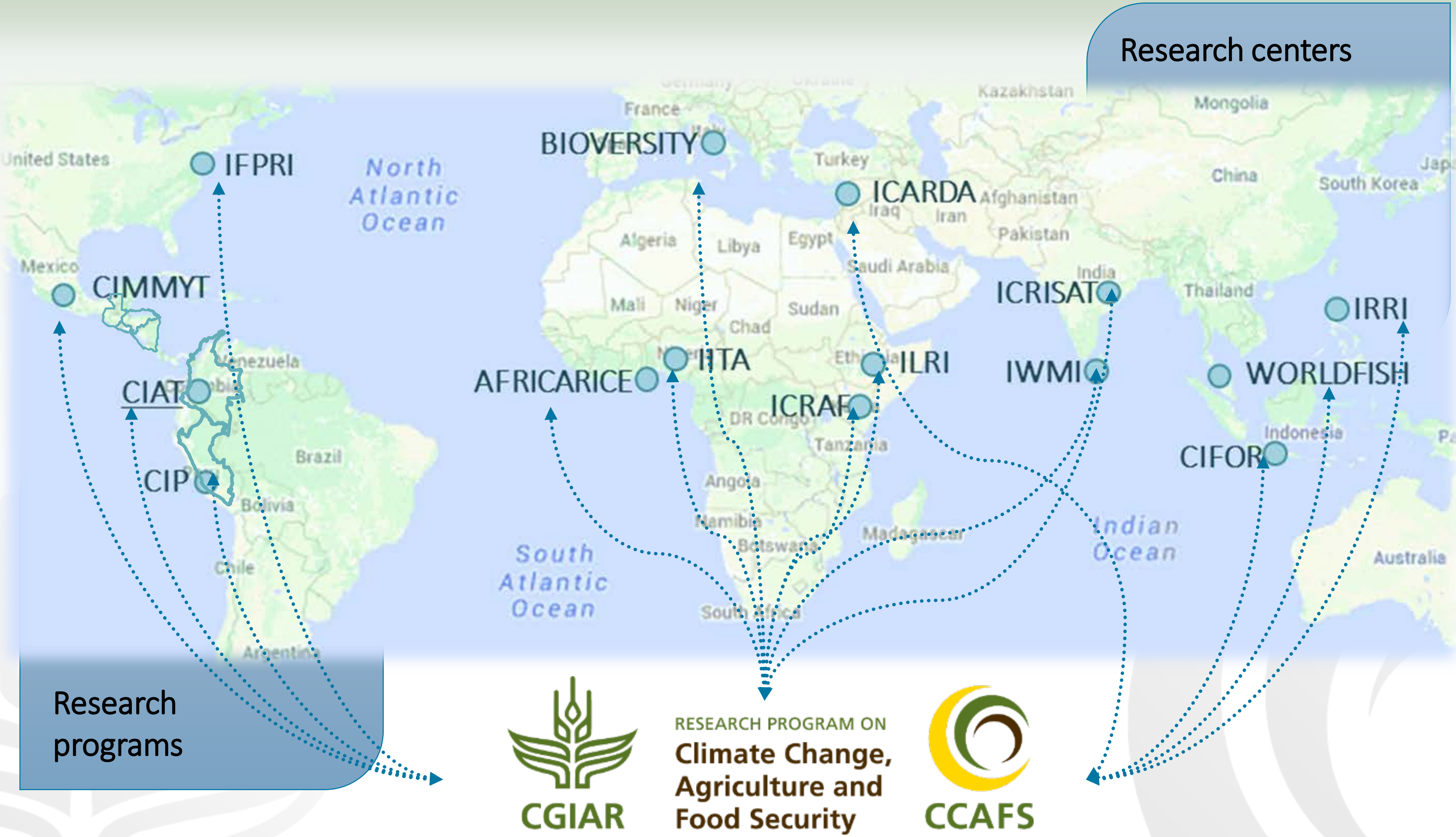
CGIAR RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security CCAFS

Quesungual Agroforestry System, Honduras

CCAFS' vision is to be, with its key partners, the foremost global source of collaborative research that leads to strategies that help farmers tackle food insecurity in the face of climate change.

A global research partnership

CCAFS works closely with the CGIAR System research centers to generate high-quality scientific products to support decision-making in rural communities to address the impacts of changing climate.



Introduction


1.4 billion living
in Poverty
Nearly 1 billion
going Hungry
1 billion more
People by 2030
14% more
Food needed per
decade
1.5
billion
people
depend on
Degraded
Land

Three challenges: adaptation, food security, and mitigation

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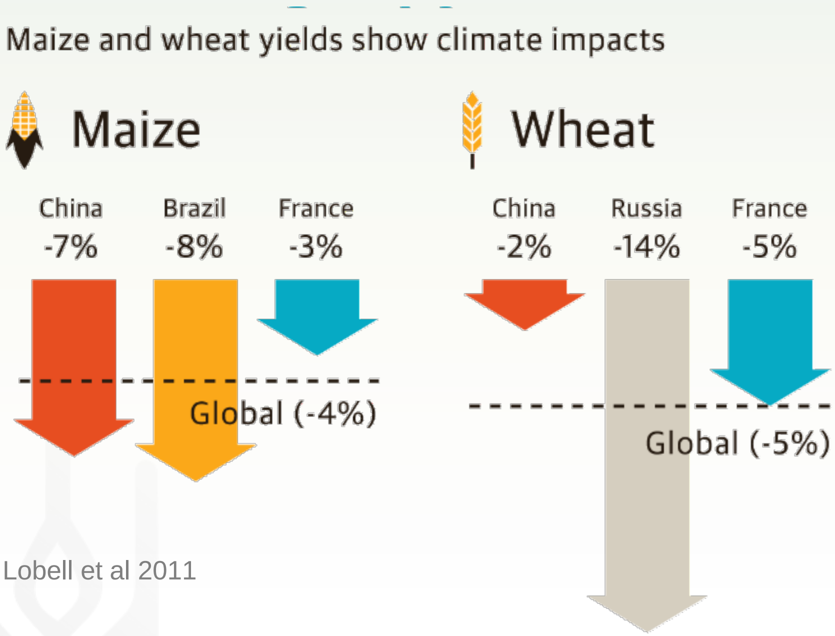
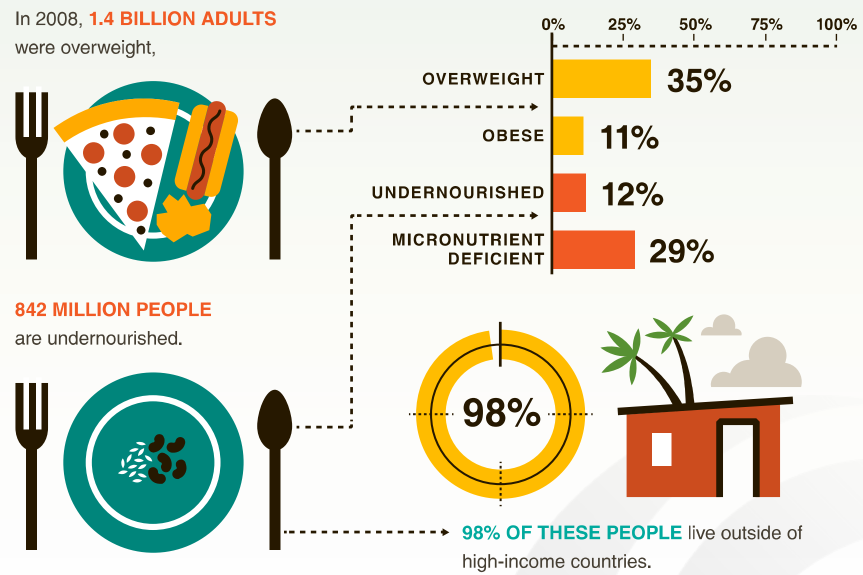
Adaptation: Evidence that yields losses occur already



Lobell et al 2011

Food security: Food and nutrition security issues



Source: FAO, 2013 ; WHO 2012

The third challenge: mitigation

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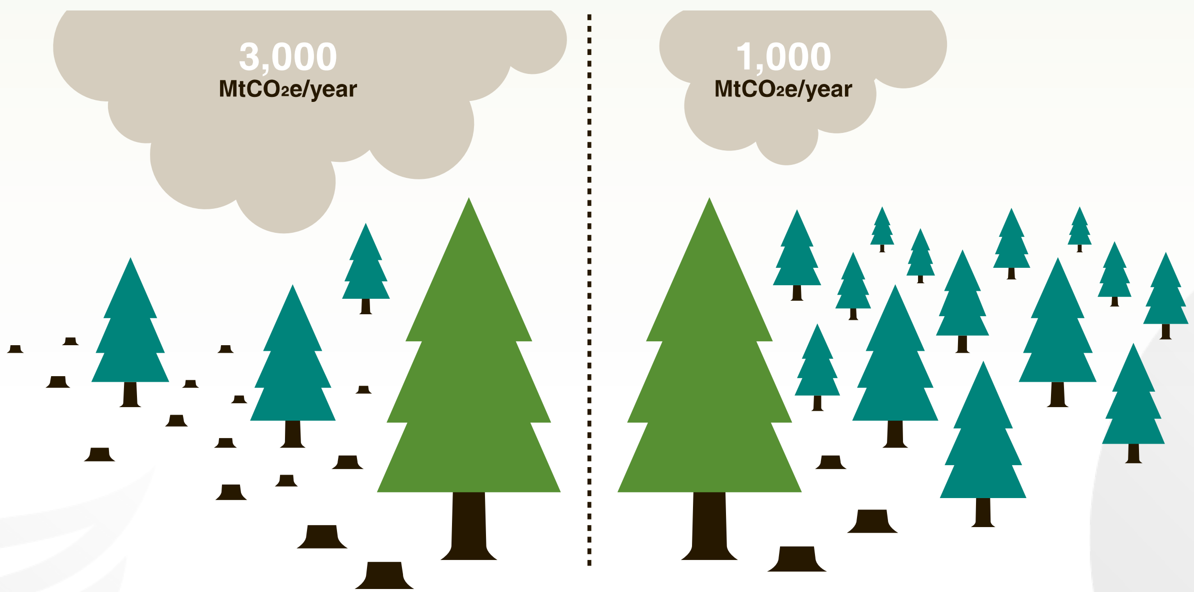
Agriculture is responsible for **75% OF GLOBAL DEFORESTATION.**

75%

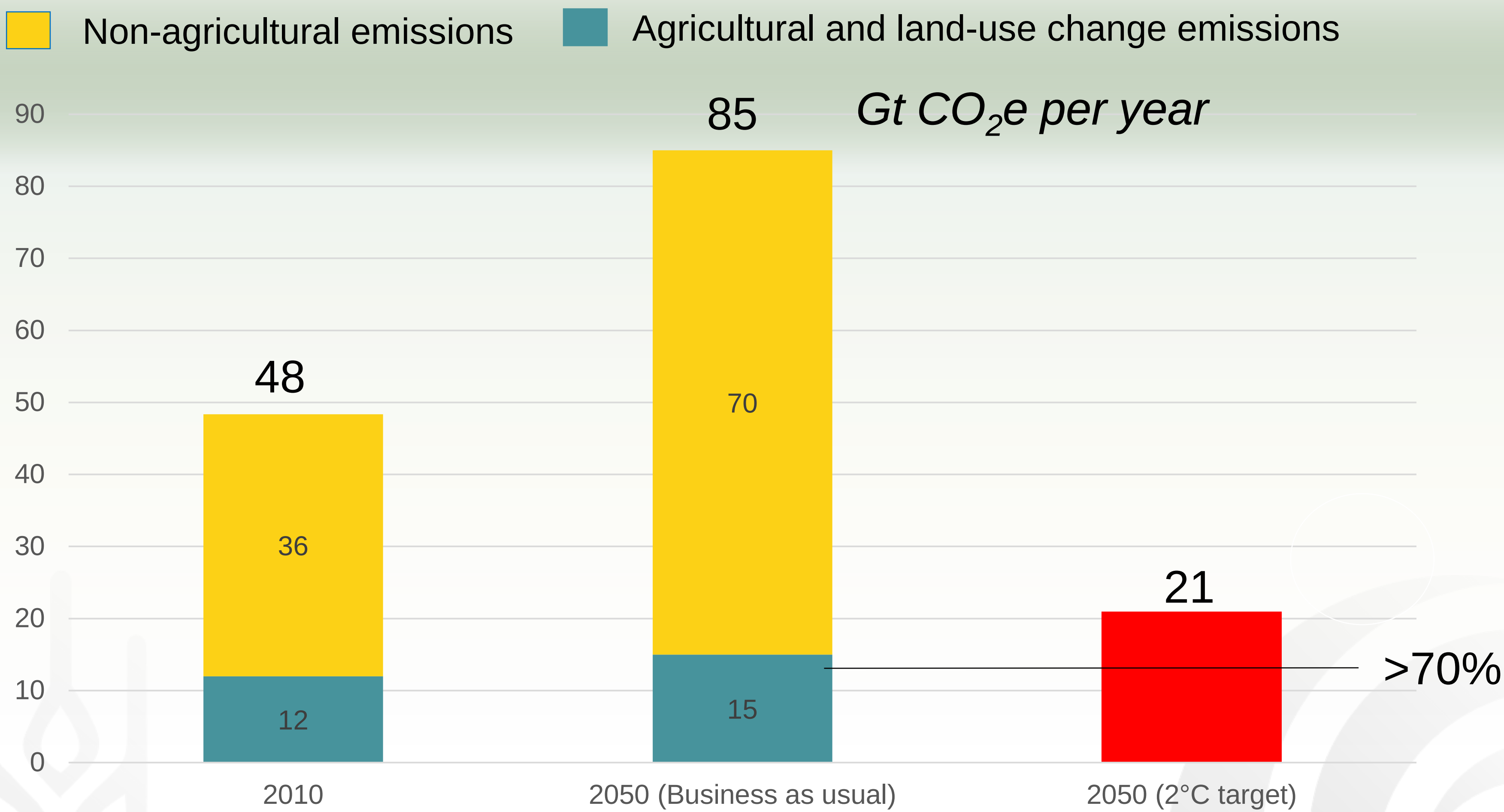
If trends continue, **ABOUT 10 MILLION km² OF LAND** will likely be cleared by 2050 to meet food demand.

Alternative pathways would only require **ABOUT 2 MILLION km² OF LAND** be cleared.



Source: Blaser and Robledo, 2007 || Tilman et al., 2011

Can Agriculture be excused from emission targets?



World Resources Institute (2014)

Ag must do its part

General challenges

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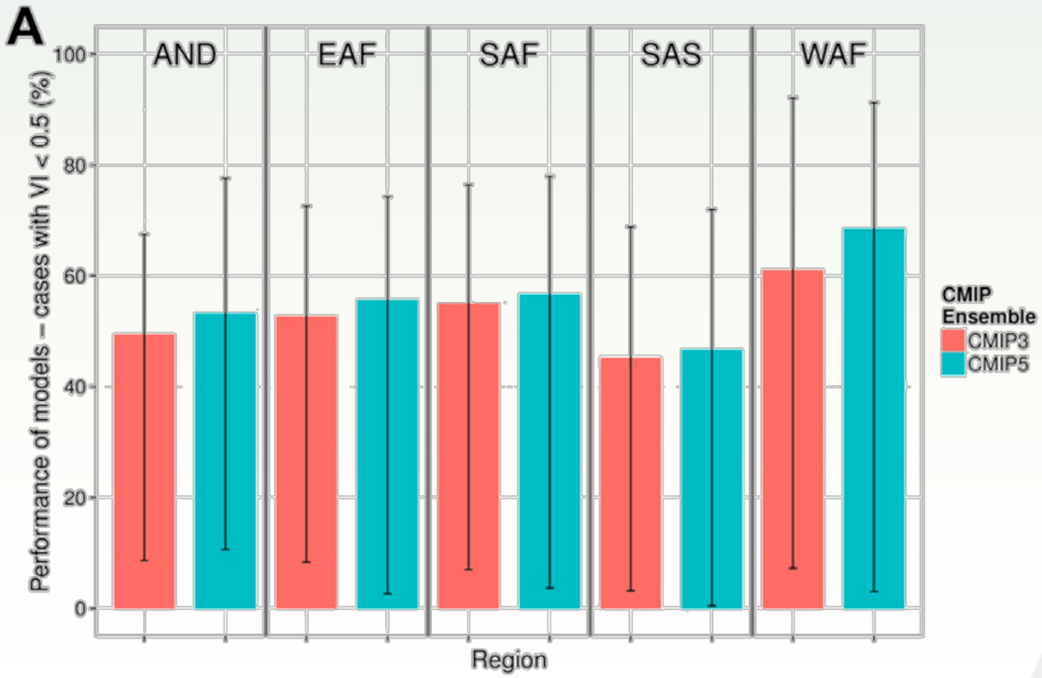
- Farmers already have to deal with changing weather patterns and rising frequency and intensity of extreme weather events, making farming even more risky (IPCC, 2012).
- There is a gap between research and implementation.
- With climate change there is the additional problem of deep uncertainties.
- We must seek tools and processes whereby uncertain knowledge can drive action.

Knowledge limitations about climate change risks to food security

Climate models limiting for food production impact studies

In climate modelling, improvements in parameterisation and increases in model complexity and spatial resolution have resulted in enhanced model performance (Delworth et al., 2012).

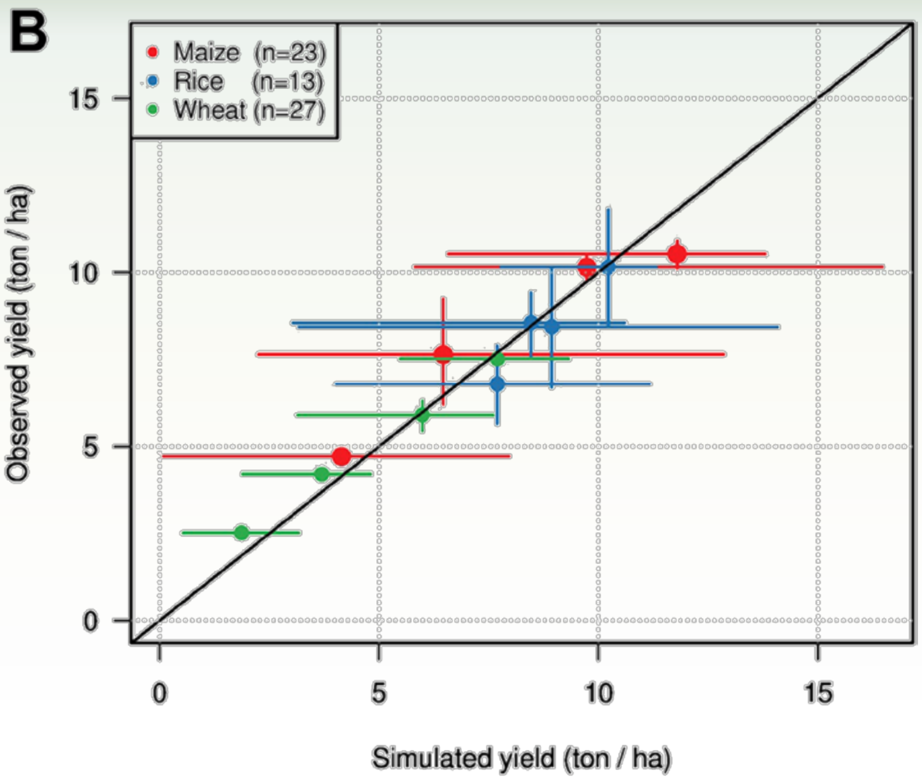


Improvement in CMIP climate model performance in representing interannual variability of temperature (from CMIP3 to CMIP5) across different regions (Ramirez-Villegas et al., 2013). Model performance is measured as the number of country* season combinations with a variability index (VI) below 0.5, that denotes good model performance. Bars show the average of all GCMs and error lines span the range of variation of individual GCM simulations of each ensemble.

CONVENTIONS: **AND:** Andes, **EAF:** East Africa, **SAF:** Southern Africa, **SAS:** South Asia, **WAF:** West Africa.

Crop models limiting for food production impact studies

The quality and quantity of information available to stakeholders varies depending on the crop system and areas (Challinor et al., 2014a).



Summary of multi-crop-model evaluations for maize (Bassu et al., 2014), rice (Li et al., 2015), and wheat (Asseng et al., 2013). Each point shows the average of observations and median of simulations for 23 (maize), 13 (rice) and 27 (wheat) crop simulation models for a given site where model evaluations were carried out (4 sites for each crop). Horizontal error bars show maximum and minimum simulated yield in the ensemble of models, and vertical error bars show observational error.

Crop-climate models limiting for food production impact studies

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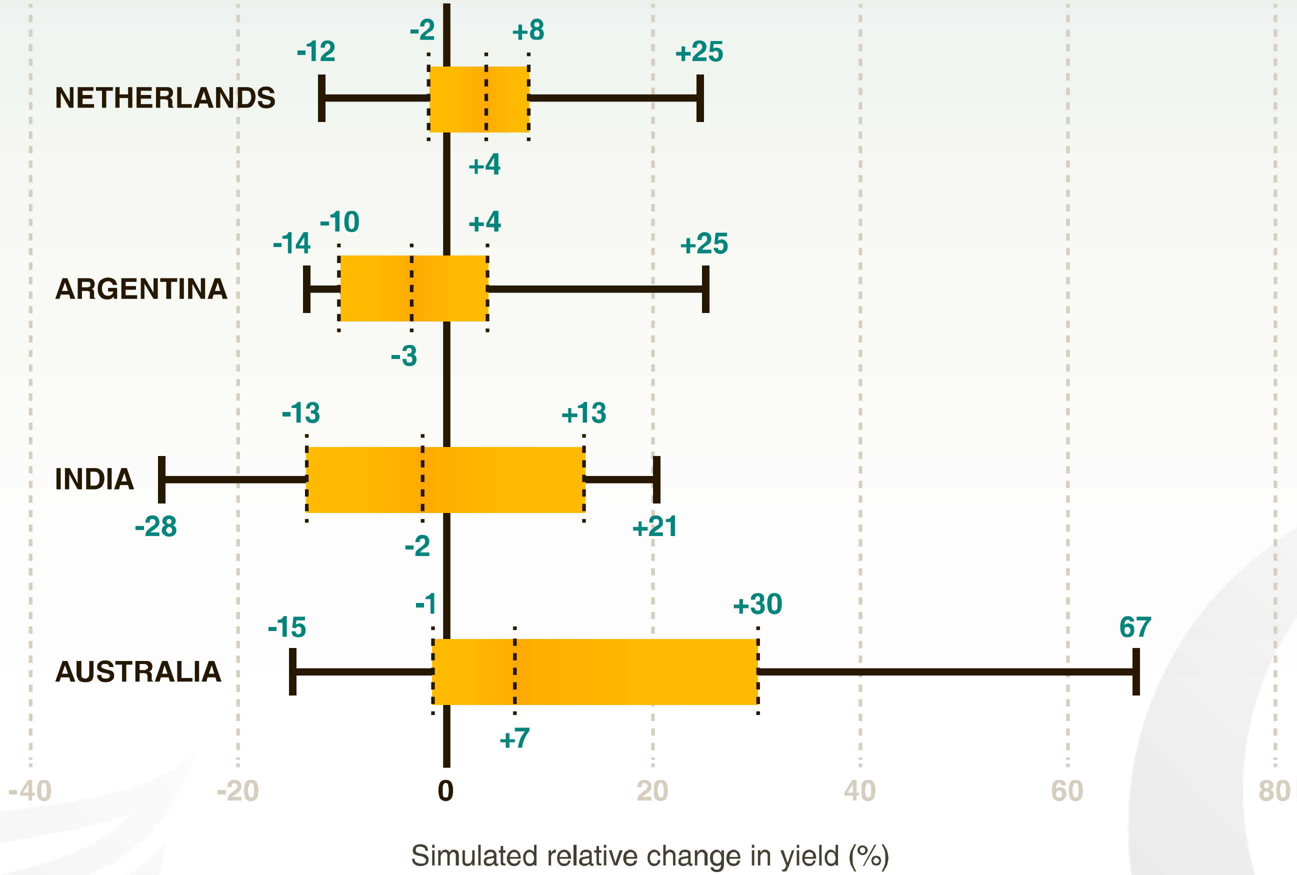
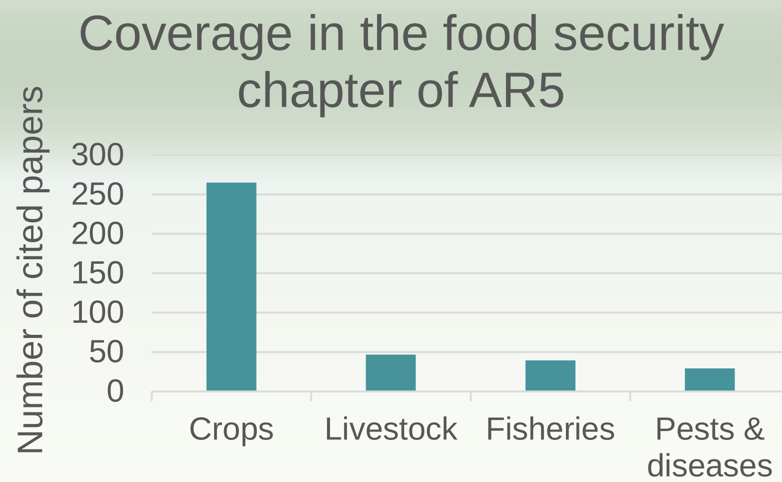
Simulations of wheat yields under a future climate change scenario with **+3°C** temperature change and a **CO_2 LEVEL OF 540 ppm** indicate yields changes across multiple regions.

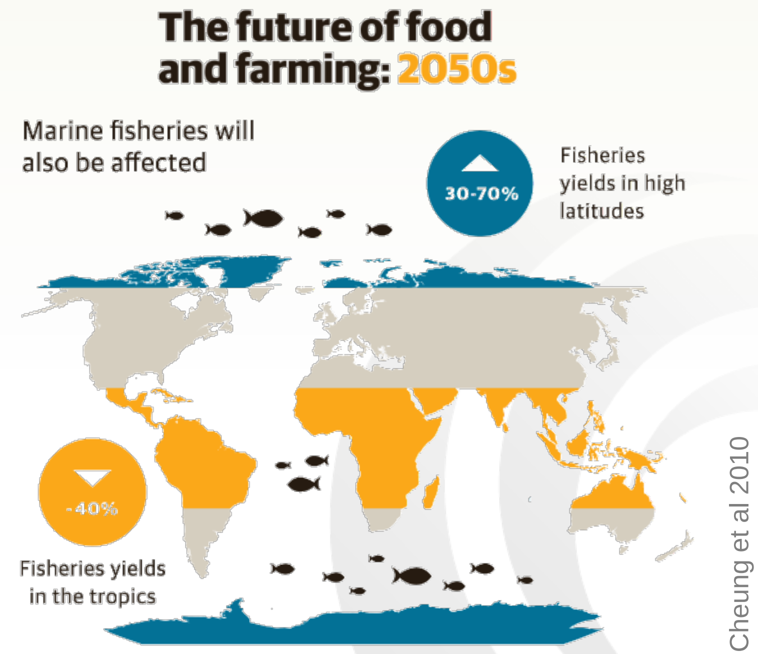


Asseng et al. (2013)

Lack of attention to livestock, fisheries, pests and diseases, and interactions

- Significant increases in meat and milk consumption: demand will increase 70–80% of current levels by 2050 (Herrero et al., 2015).
- More than 1 billion poor people obtain most of their animal protein from fish, and there has been a spectacular growth in aquaculture (Beveridge et al., 2013).
- Pests and diseases still reduce global harvest by 10–16%, and are particularly problematic in dev. countries (Chakraborty and Newton, 2011; Grace et al., 2015).
- Little attention to crops as components of farming systems, value chains or landscapes.

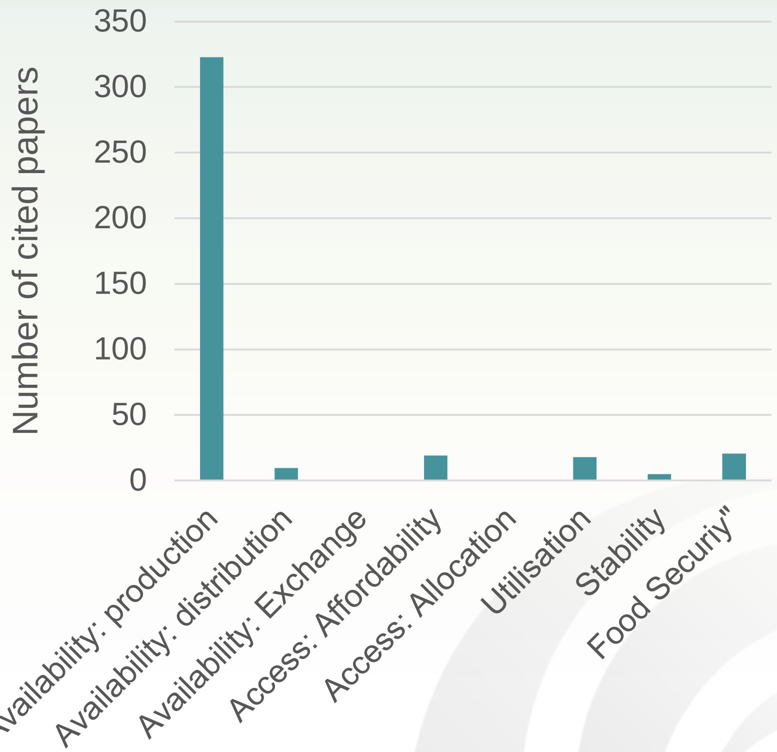




Lack of attention to broader food security determinants

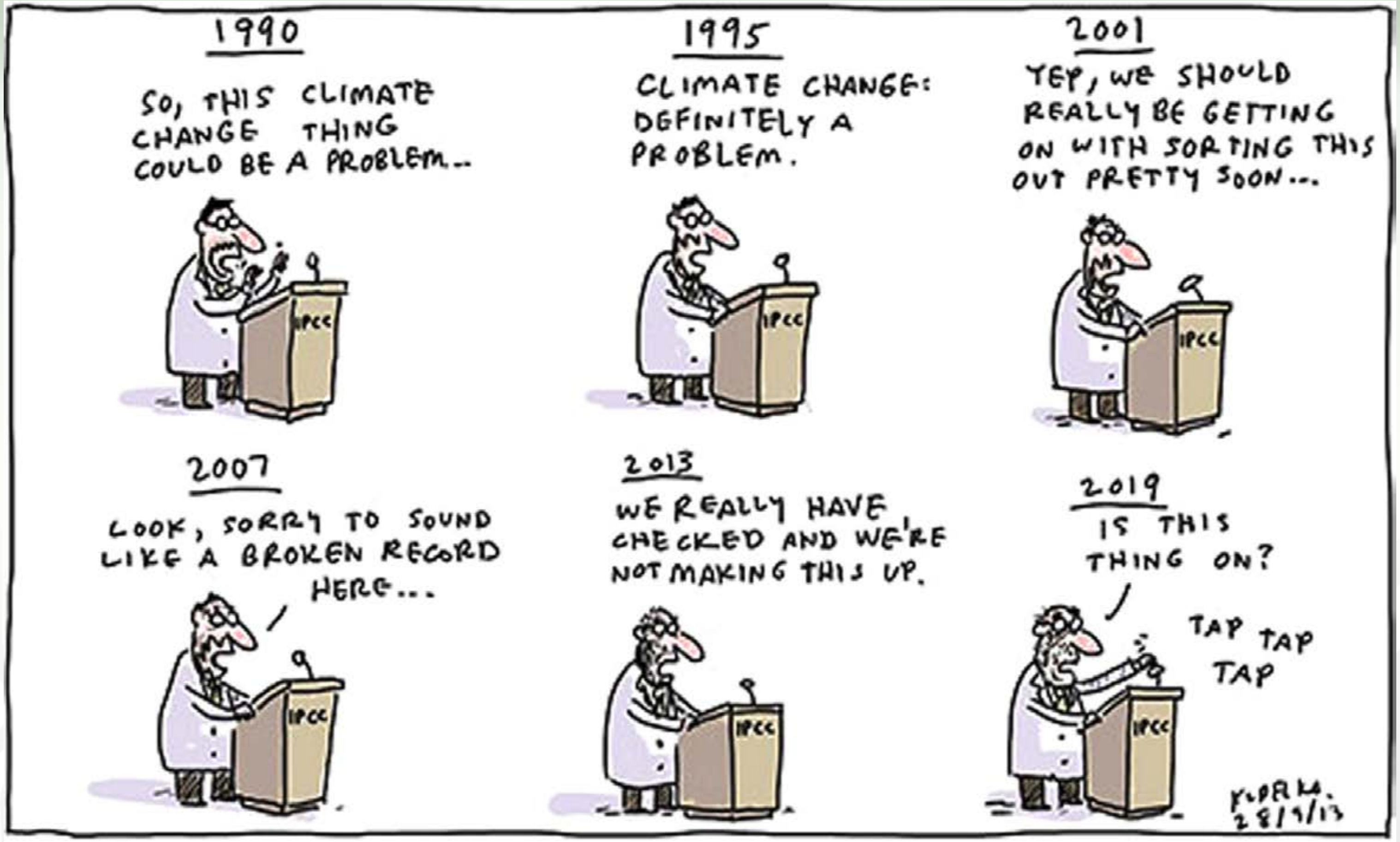
- Climate change will have impacts on all dimensions of food security, namely availability, access, utilisation and stability, and have impacts over the whole food system (Vermeulen et al., 2012).
- New food systems approach embraces demand-side solutions to achieving food security under climate change, particularly action on food waste and diets.
- Deliver good nutrition to individuals and households rather than merely securing sufficient available calories (Lang and Barling, 2013).

Coverage in the food security chapter of AR5 of food security determinants



“Food security” covers food security in general terms.

Much analysis, but action paralysis

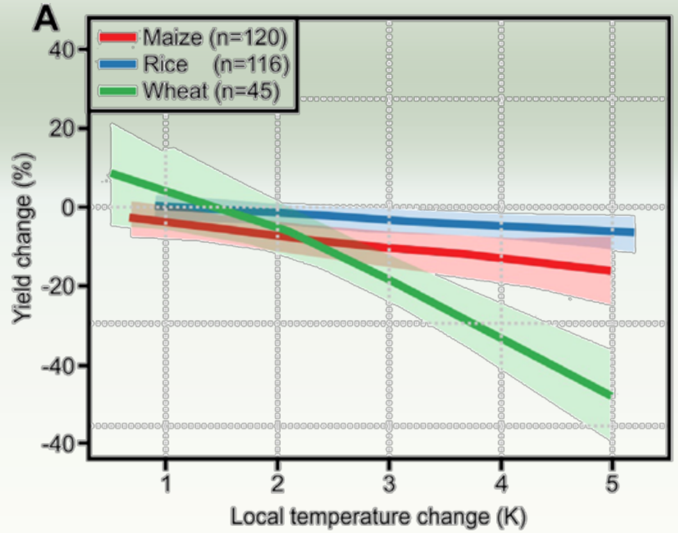


Cartoon illustrating our frustration with climate impact studies of agriculture, whereby there are marginal improvements in knowledge, but much less focus on solutions and their implementation. Copyright: Jon Kudelka.

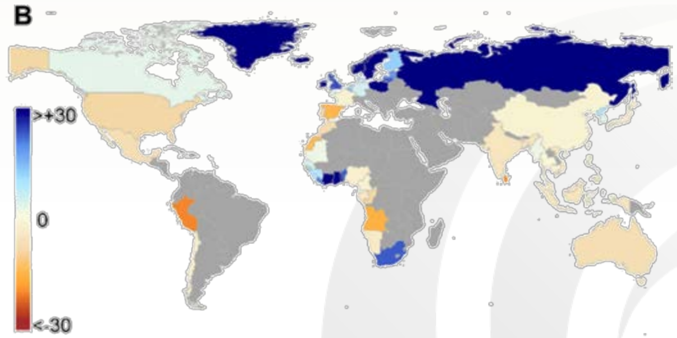
Impacts of climate change on food security

Crops, livestock and fisheries quantity and quality

- Despite uncertainties, on average, global mean crop yields of rice, maize and wheat are projected to decrease (Challinor et al., 2014b).
- Evidence suggests reduced quality due to decreases in leaf and grain N, protein and macro- and micronutrient concentrations associated with increased CO_2 concentrations and more variable and warmer climates (DaMatta et al., 2010).
- Impacts on livestock systems will be mediated through reduced feed quantity and quality, changes in pest and disease prevalence, and direct impairment of production.



Impacts of climate change on the productivity of tropical cereal crops. Adapted from Porter et al. (2014), who develop yield response curves from a meta-analysis of published crop simulations.



Impacts of climate change on the productivity of fisheries
Percentage change in fisheries production aggregated to the country level for select countries by 2050 (SRES-A1B) (Merino et al., 2012).

Access (affordability, functioning markets and policies)

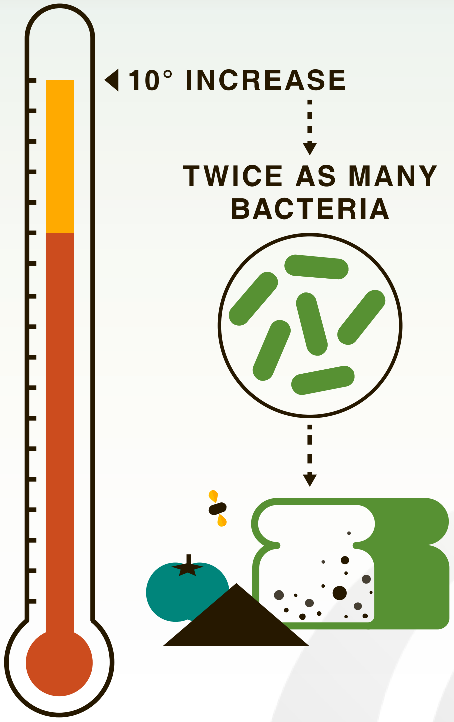
- Food prices are projected to increase across a wider range of scenarios, but there are considerable differences between the results of different macro-economic models (Nelson et al., 2014b).
- Affordability also depends on purchasing power of households (White et al., 2010), which may be affected by climate, especially among agricultural households.
- Climate change is also likely to affect the geography of production at large scales (Havlik et al., 2014) which could have substantial impacts on prices, trade flows and food access.
- Physical access to food may be affected by climate change via effects on transport systems and physical well-being (White et al., 2010).

Source: Ivanic & Martin, 2008

Food quality and diversity

- Climate change is likely to reduce food safety due to higher rates of microbial growth at increased temperatures (Hammond et al., 2015).
- Rising disease incidence will lead to overuse of pesticides and veterinary medicines, especially in fisheries (Tirado et al., 2010).
- Indirect effects of climate change on health, will disproportionately affect people who are already poor (Costello et al., 2009).
- Food security is linked directly and indirectly to ecosystems through provisioning, regulating and supporting services (Millennium Ecosystem Assessment, 2005).

Climate change will affect food security and human health in many ways, including via food safety.



Bacterial growth rates approx. double with every 10 °C rise in temperature above 10 °C.

Source: James and James 2010

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Moving to an action agenda: four challenges

Challenge 1: Changing the culture of research to focus on an action agenda

- Incentives in most research systems reward publication of papers over solving problems and achieving outcomes (Knight et al., 2008).
- By focussing on current climate variability, there is less excuse for inaction due to uncertainty.
- Vermeulen and Campbell (2015) suggest that one of the principles to drive action-oriented research is “Allocate resources in three thirds – needs, research, capacity” (Fullana i Palmer et al., 2011).
- Multi-stakeholder platforms can be key mechanisms for engagement, dialogue and co-learning (Shackleton et al., 2015).

CSV
Climate-Smart Village

Climate-Smart Village Approach

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A community approach towards sustainable agriculture development

A **scalable** approach to bring together **global and locally-relevant knowledge** on **CSA practices, technologies and services**; and **institutional and policy interventions** that synergistically **build the resilience of smallholder farming communities** to a variable and changing climate, and where **appropriate reduce GHG emissions**.

CSV

Climate-Smart Village

Context specific conditions (social, economic, cultural, environmental)

Territory dynamics

Climate-smart technologies

Climate information services

Financial incentives and market access

Local adaptation plans

Scaling up and out

- ✓ Policies
- ✓ Private sector
- ✓ Champion cases are used in big initiatives

- ✓ Continuous learning
- ✓ Stakeholder diversity
- ✓ Capacity building

Integrated management through a portfolio that responds to context-specific needs in the territory

Scenarios: An innovative way to ´future-proof´ public and private planning and investments related to climate change

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- Government officials, researchers and private sector representatives analyse challenges and opportunities presented within the different scenarios they envision.
- The Costa Rica case shows how scenarios focus on practical questions and outcomes:
- Using the scenarios approach, they created four scenarios, and tested reduction strategies to explore which of them would be effective under different future conditions, and what changes would be needed to implement the strategies.
- This resulted in a set of robust strategies for each sector within the INDC.


2016

Shifting the paradigm: Narratives of the future guide the development of Costa Rica's INDC

KEY MESSAGES

Publication available at
http://hdl.handle.net/10568/69238

Challenge 2: Deriving stakeholder-driven portfolios of options for farmers, communities and countries

- Resources are scarce and should be directed to those actions with greatest benefits. Action is needed in the short-term and must be driven by careful prioritization.
- A portfolio approach for planning and implementing actions is intended to improve integration between actions.
- Planners tend to focus on on-farm technical interventions, but portfolios should also include services and programs to support technologies and wider development.

Climate-Smart Agriculture Prioritization Framework (CSA-PF)

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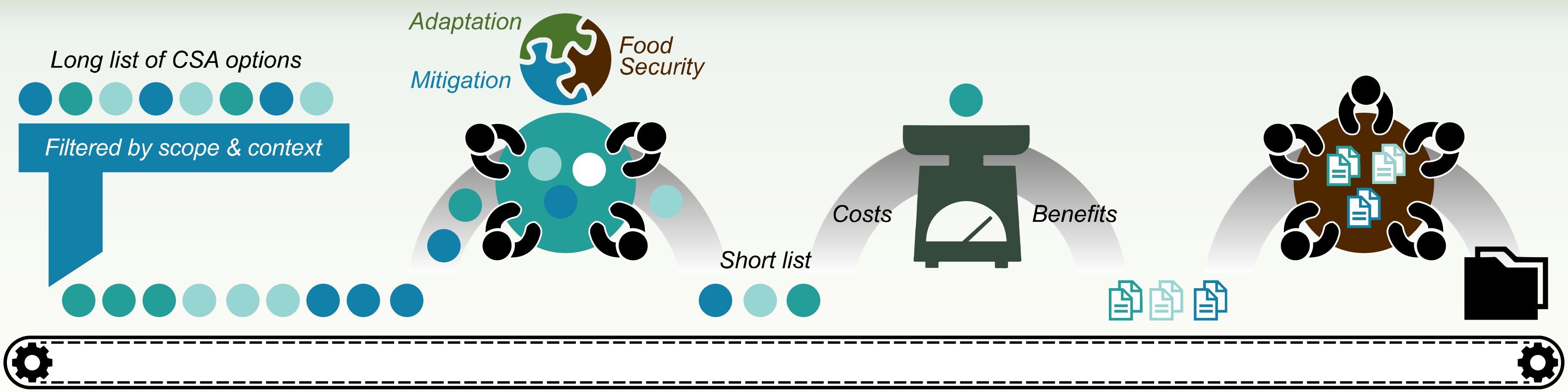
PHASE 1:
Initial assessment of CSA options

PHASE 2:
Workshop #1 Identification of top CSA options

PHASE 3:
Calculation of costs & benefits of top CSA options

PHASE 4:
Workshop #2 Portfolio development



Results
Long list of CSA options ranked by expected impact on food security, adaptation, and mitigation

Results
Stakeholder prioritized short list of high-interest CSA options

Results
Short list ranked by multiple cost-benefit analysis variables

Results
Stakeholder developed CSA Investment Portfolios of best-bet options; action plans for implementation

CSA-PF guides decision-makers through a process of narrowing down long lists of applicable CSA practices and services to investment portfolios

Challenge 3: Ensuring that adaptation actions are relevant to those most vulnerable to climate change

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- Adaptation actions must take into account differential vulnerability to climate change.
- Gender affects individuals' and families' exposure to risk, as well as their access to and control of resources, finance, land, technology and services (Quisumbing et al., 2015).
- New tools are emerging to understand social differentiation and enable more inclusive approaches to adaptation (Jost et al., 2014).
- For example, in Bolivia men prioritize interventions such as irrigation, while women prefer new crop varieties or diversified production (Ashwill et al., 2011).

Challenge 4: Combining adaptation and mitigation, while ensuring food security

- Closing the emissions intensity gap by both increasing production and decreasing emissions should be the goal for sustainable food systems that include climate goals.
- Many promising technical options for combining adaptation and mitigation, while ensuring food security are already available.
- Robust evidence is needed to demonstrate that mitigating agricultural GHG can be achieved while also increasing yields and not imposing other costs or constraints on farmers.

Reducing emissions in paddy rice: the case of alternate wetting and drying (AWD) in rice

- AWD was introduced as a water saving technology in rice production in the early 2000s but has been found to reduce methane emission in rice production by an average of 43% compared to continuously flooded irrigated rice systems (Sanders et al., 2015).
- In Vietnam, AWD is now promoted in development projects and included in a number of national policies, including the INDC.
- About 50,000 ha of rice lands are now under AWD, with another 245,000 ha having partial application.

Conclusions

- It is clear that climate impacts on food security will be serious, and thus we advocate for more research that directly informs the actions needed to tackle food security challenges.
- While food systems will need transformative options in the coming decades, we identify four immediate challenges.
- To meet these challenges, science must work hand in hand with practitioners and policy-makers, to devise sensible options that meet current needs and capacities, try out best bets, and learn from experience.

Changing the culture of research to focus on an action agenda

Deriving stakeholder-driven portfolios of options for farmers, communities and countries

Ensuring that adaptation actions are relevant to those most vulnerable to climate change

Combining adaptation and mitigation, while ensuring food security

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Reducing risks to food security from climate change

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ABSTRACT

Climate change will have far-reaching impacts on crop, livestock and fisheries production, and will change the prevalence of crop pests. Many of these impacts are already measurable. Climate impact studies are dominated by those on crop yields despite the limitations of climate-crop modelling, with very little attention paid to more systems components of cropping, let alone other dimensions of food security. Given the serious threats to food security, attention should shift to an action-oriented research agenda, where we see four key challenges: (a) changing the culture of research; (b) deriving stakeholder-driven portfolios of options for farmers, communities and countries; (c) ensuring that adaptation actions are relevant to those most vulnerable to climate change; (d) combining adaptation and mitigation.

1. Introduction

Reducing risks to food security from climate change is one of the major challenges of the 21st century. The impacts of climate change on crop yield can already be detected in observed data (Lobell et al., 2011). Climate impact studies on crops predominate, but impacts on fisheries and livestock production are no less serious (Creighton et al., 2015; Herrero et al., 2015). Whereas slow changes, such as rising temperatures and sea level, will only have major impacts in the coming decades, farmers already have to deal with changing weather patterns and rising frequency and intensity of extreme weather events, making farming even more risky (IPCC, 2012). Adaptation actions to reduce risks are urgent.

In many applied disciplines, there is a gap between research and implementation, variously termed the research-implementation, research-practice, knowing-doing or science-policy gap (Knight et al., 2008). With climate change there is the additional problem of deep uncertainties – not knowing the exact shape of future climates or even the next season, and these uncertainties are unlikely to go away in the next decade (Heal and Millner, 2014). But decision-making in the face of uncertainty is by no means unique to the climate change challenge (Beven and Alcock, 2012). We must seek tools and processes whereby uncertain knowledge can drive action.

We posit that, given the limitations of doing yet more impact studies (in particular crop-focused studies – Section 2) and given the seriousness of climate change (Section 3), the research emphasis should shift to supporting implementation of solutions for food insecurity (Section 4). As Heal and Millner (2014) note, we have more than enough information about climate change and variability to understand that it is a serious problem that requires immediate attention.

2. Knowledge limitations about climate change risks to food security

2.1. Crop-climate models limiting for food production impact studies

Crop-climate modelling is central to the development of future agricultural outlooks that can inform policy processes and/or field-

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Thank you

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