Milling Quality: The Achilles Heel of Cereal Foresight Studies?

Gideon Kruseman, Kai Sonder, Carlos Guzman, Diego Pequeno

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LACC4, Hotel Hilton Reforma, Mexico City, Mexico, March 11-13, 2018

Overview

- Foresight and agricultural R&D
- Foresight and food security, state of the art
- Trigger of this research
- Drivers of change and wheat quality
- Starting to incorporate wheat quality into foresight
- Next steps

Foresight and agricultural R&D

Context

It takes anywhere between 10 and 25 years to develop new agricultural technologies, so focusing on today's issues may imply finding solution's to yesterday's problems.

"We may be at a high tide now, but ebb tide could soon set in if we become complacent and relax our efforts" (N. E. Borlaug, 1970).

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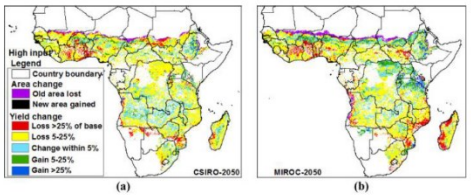
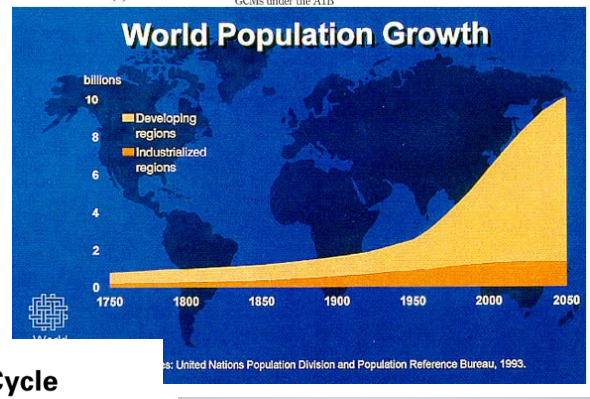
Foresight and agricultural R&D



Maize systems under climate change

Figure 2. Changes in yield and area of maize under high N level in SSA by 2050 (a and b) and 2080 (c and d) relative to the baseline (2000) using climate projection from CSISRO (cooler, drier) and MIROC (warmer, wetter) GCMs under the A1B

Source: Created by authors



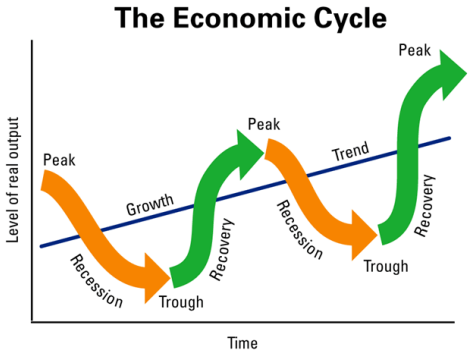
Drivers of change

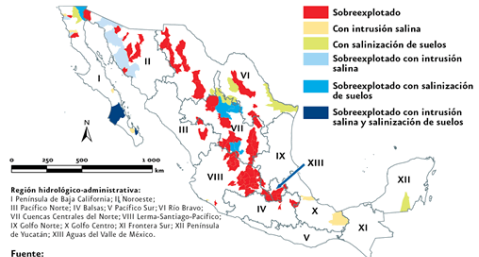
Primary

- Climate change
- Population growth
- Overall economic development

Secondary

- *Urbanization*
- *Dietary change*
- *Tech advances outside agriculture*
- *Resource scarcity*





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It’s not just gazing into…

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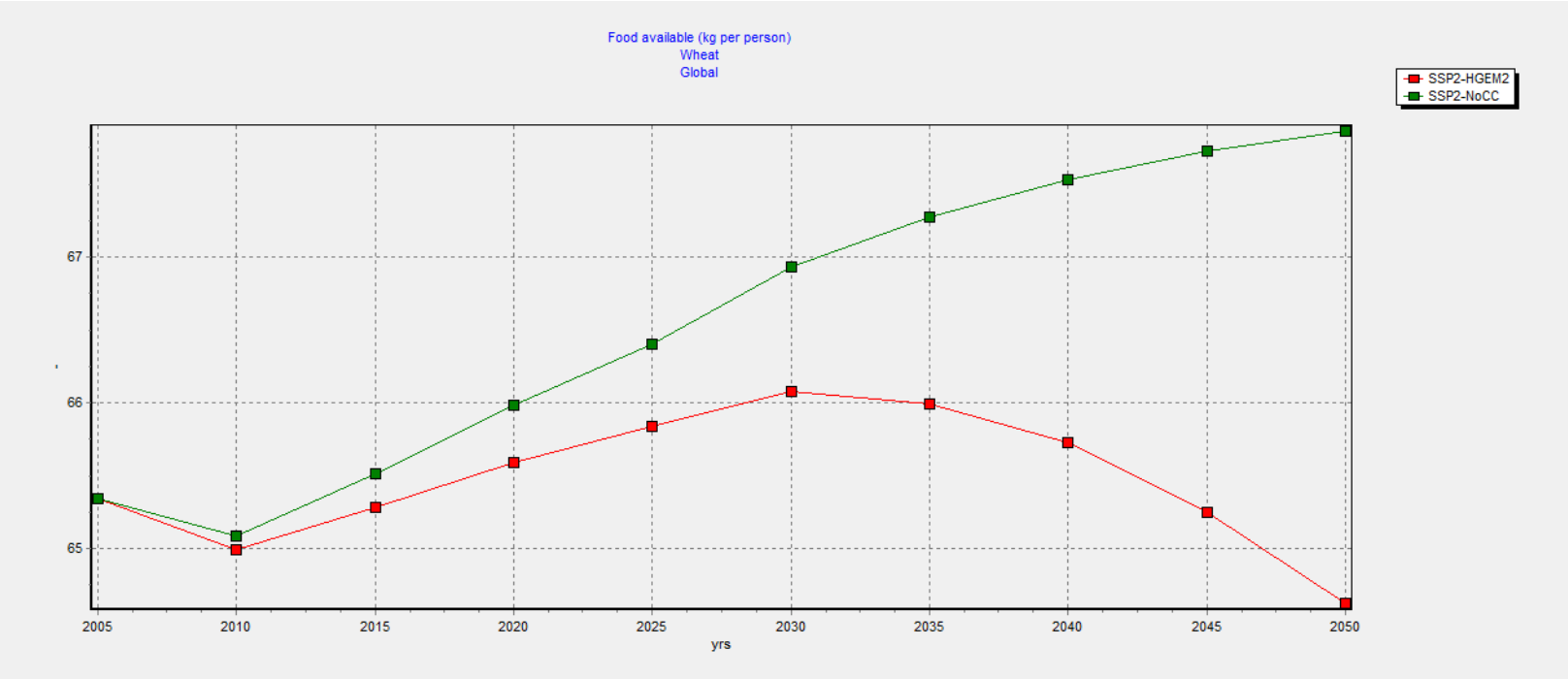
Foresight and food security, state of the art

Integrated assessment modeling

IMPACT model (Rosegrant, 2017)

- Food availability in kg/person under no climate change and expected BAU scenario (SSP2, RCP 4.5)

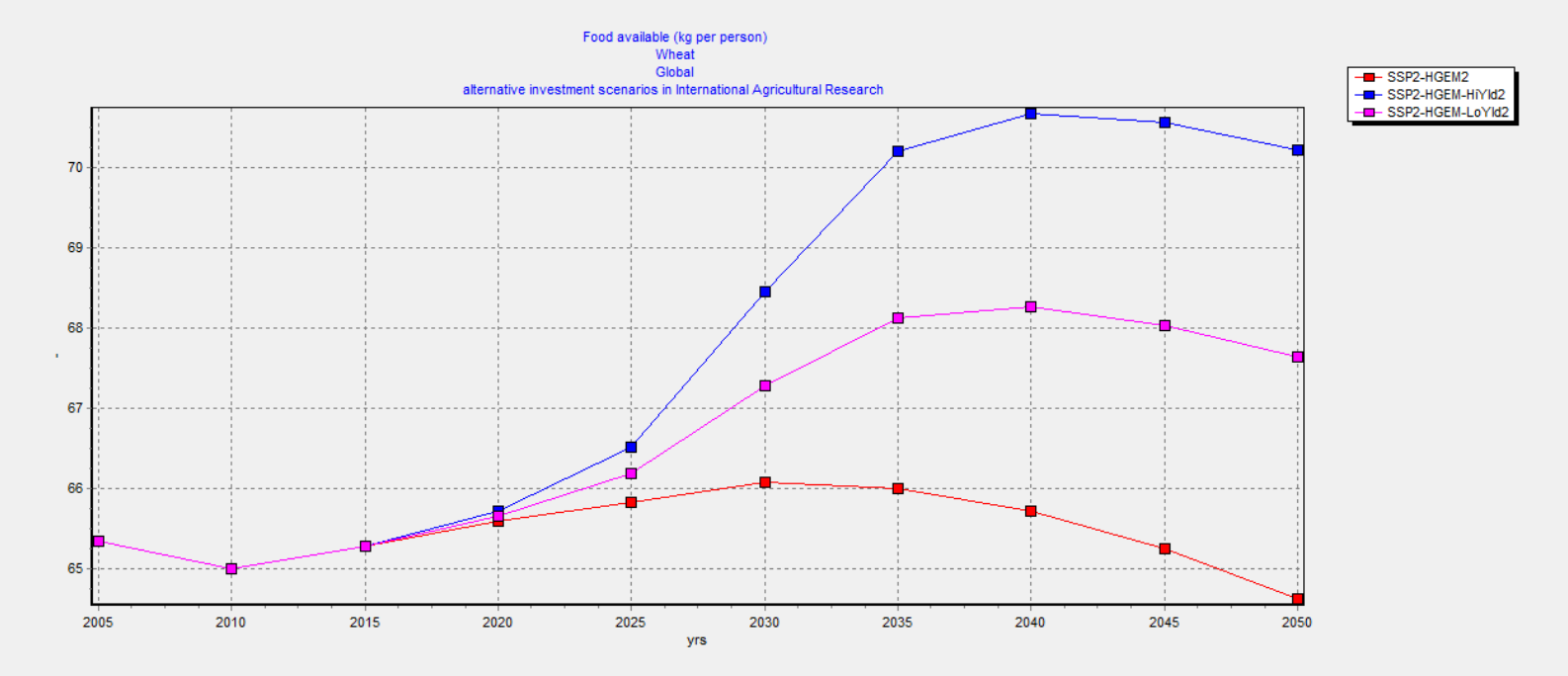


Foresight and food security, state of the art

Integrated assessment modeling

Alternative investment in international agricultural R&D scenarios

- Only considers yield not quality of the commodity
- Is this a problem?



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Trigger

U.S. WHEAT ASSOCIATES

THE WORLD'S MOST RELIABLE CHOICE.

ABOUT US | MARKET & CROP INFORMATION | BUYER INFORMATION | POLICY

Wheat Letter - August 25, 2016

Home > News & Meetings > Wheat Letter > Wheat Letter - August 25, 2016

U.S. Wheat Associates (USW) is the industry's market development organization working in more than 100 countries. I
international markets to enhance the profitability of U.S. wheat producers and their customers." USW activities are func

state wheat commissions and USDA Foreign Agricultural Service cost-share programs. For more information, visit ww

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In This Issue:

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2. **Welcome Progress on Trans-Pacific Partnership**
3. **USW Training Partners Help Customers Improve Their Products**
4. **Quality is Generally Better in the 2016 SRW Crop**
5. **USW Bringing Indonesian Milling Executives to Experience U.S. Wheat Supply System**
6. **Wheat Industry News**

Online Edition: Wheat Letter – August 25, 2016
PDF Version: *(See attached file: Wheat Letter - August 25, 2016.pdf)*

USW Harvest Report: www.uswheat.org/harvest

2016 wheat production

- August 2106, Weather conditions in Europe were leading to higher yields
- By early 2017, this was confirmed with actual production data
- Why did this go mostly unnoticed?

- Buffer stocks were still at record highs
- So what's the big deal?

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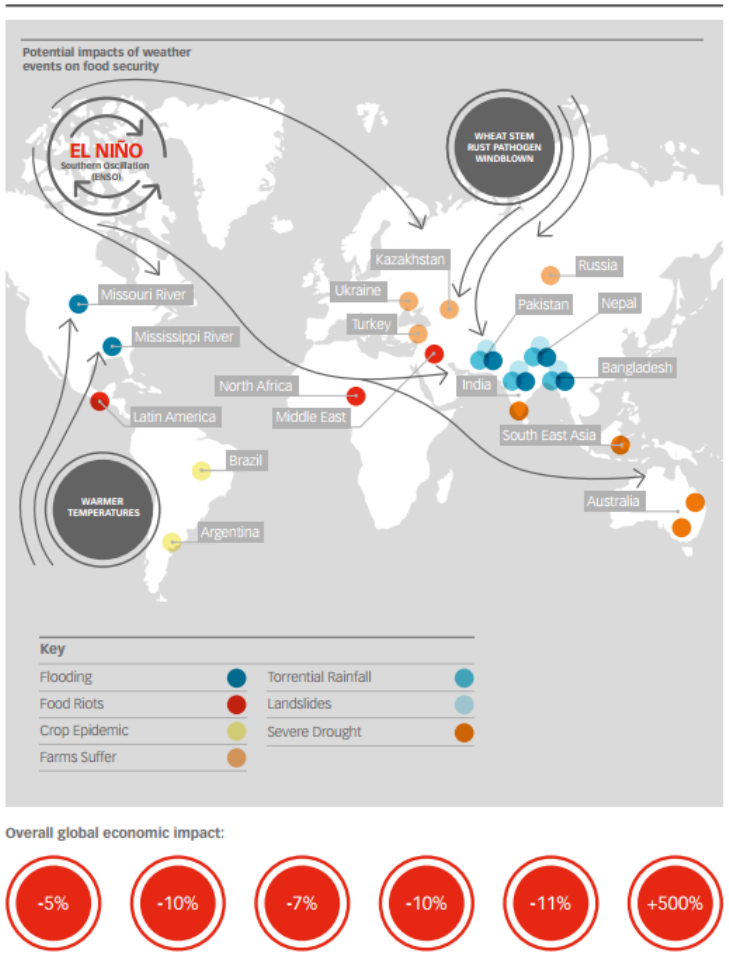
Foresight and food security, state of the art



Integrated assessment modeling

Lloyd's study of multiple bread basket failures (Lloyd's, 2015)

- The ability of the global food system to achieve food security is under significant pressure.
- There is a pressing need to reduce the uncertainty surrounding the impacts of an extreme shock to the food supply.
- The systemic production shock to the world's staple food crops potentially generates widespread economic, political and social impacts.

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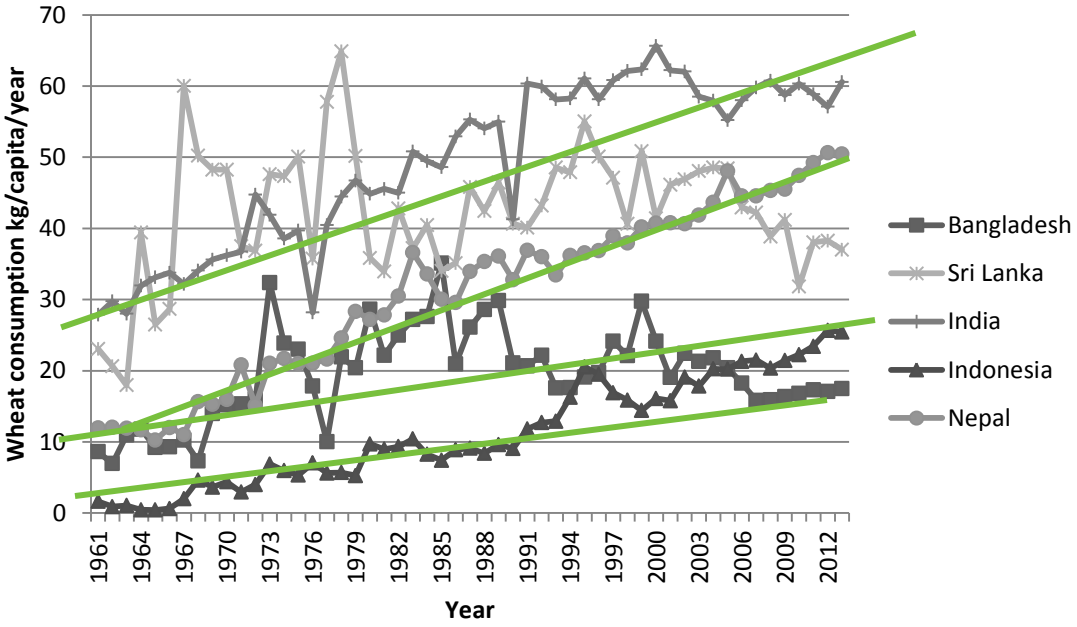
Drivers of change and wheat quality



Population growth and economic development

- Feeding 9 billion plus in 2050
- Urbanization and dietary change indicate an increase in wheat consumption in traditionally non-wheat staple areas
- Urbanization implies higher demand for processed foods in general, hence increased importance of wheat quality.

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Drivers of change and wheat quality

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Milling, processing and end-use quality traits of CIMMYT spring bread wheat germplasm under drought and heat stress

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Wheat breeding
Drought stress
Heat stress

ABSTRACT

The CIMMYT wheat breeding program aims to develop bread wheat (*Triticum aestivum* L.) genotypes that have superior grain yields, disease resistance and stress tolerance, along with appropriate quality to satisfy all stakeholders of the wheat value chain. Grain quality for wheat consists of a combination of many defined parameters including grain morphological characteristics, dough and final products properties, all of which are defined by the genotype, the environment and their interactions. Our current approach for improving grain quality is to study grain samples obtained under high yield potential environments with optimum management. To assess the effect of this strategy on quality under stressed environments, 54 genotypes were evaluated for two years under six environmental conditions, including drought and heat stress. Grain morphology (grain density and size), protein content and flour yield were severely affected by the environment, as drought and heat stress had a strong negative effect on all of these characteristics except protein content. Gluten quality (strength and extensibility) was defined more by the genotype, although the environmental effects and the interactions were also important, particularly for gluten extensibility. The current selection strategy for quality trials carried out under optimum conditions was found to be suitable to ensure high quality characteristics across several environments for most of the parameters with an overall positive outcome.

1. Introduction

Wheat (*Triticum* spp.) was one of the first domesticated food crops, and for eight thousand years, it has been the basic food staple of the major civilizations of Europe, West Asia and North Africa. Currently, wheat exhibits large genetic diversity with over 25,000 types or cultivars, which are adapted to a wide range of temperate environments (Feldman, 2001). FAO estimated that the world wheat production for 2015/2016 was approximately 735 million tons. Wheat grain can be processed into flour, semolina and other products that form the basic ingredients of many foods worldwide (e.g. bread, cookies, pastries, pasta, noodles, couscous, etc.). These foods provide about 20% of the calories and protein source for a large portion of the world's population (FAOSTAT). In densely populated countries, such as India or Pakistan, wheat is an important source of calories and proteins, and its consumption will probably increase in other countries such as Bangladesh due to the adoption of a "western lifestyle" (Shewry and Hey, 2015). Therefore, global wheat production needs to increase in the upcoming decades to cover the rising demand for this grain.

The spring bread wheat (*T. aestivum* L.) breeding program of the International Maize and Wheat Improvement Center (CIMMYT) breeds high yielding, disease resistant and stress tolerant wheat germplasm and annually distributes it worldwide to national partners mainly in four target areas (mega-environments): 1) Irrigated areas (Northwestern India, Pakistan, Iran, Egypt, China, Mexico, etc.); 2) High rainfall areas (West of Asia, Eastern Africa, highlands of Mexico, etc.); 3) Semi-arid areas (North Africa, West Asia, South America, etc.); and 4) Warmer areas (Nepal, Bangladesh, Eastern Gangetic Plains of India, Southern Pakistan, Sudan, etc.) (Rajaram et al., 1993). One key objective of the CIMMYT breeding program is to improve end-use quality in conjunction with other relevant traits to satisfy all stakeholders of the wheat value chain: farmers (bold and plump grain), millers (high test weight and high flour yield), food manufacturers (processing quality) and consumers (end-use and nutritional quality) (Guzmán et al., 2016a).

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Climate change

- More erratic weather patterns
- Higher CO2
- Heat and drought.

- Negatively affect wheat quality

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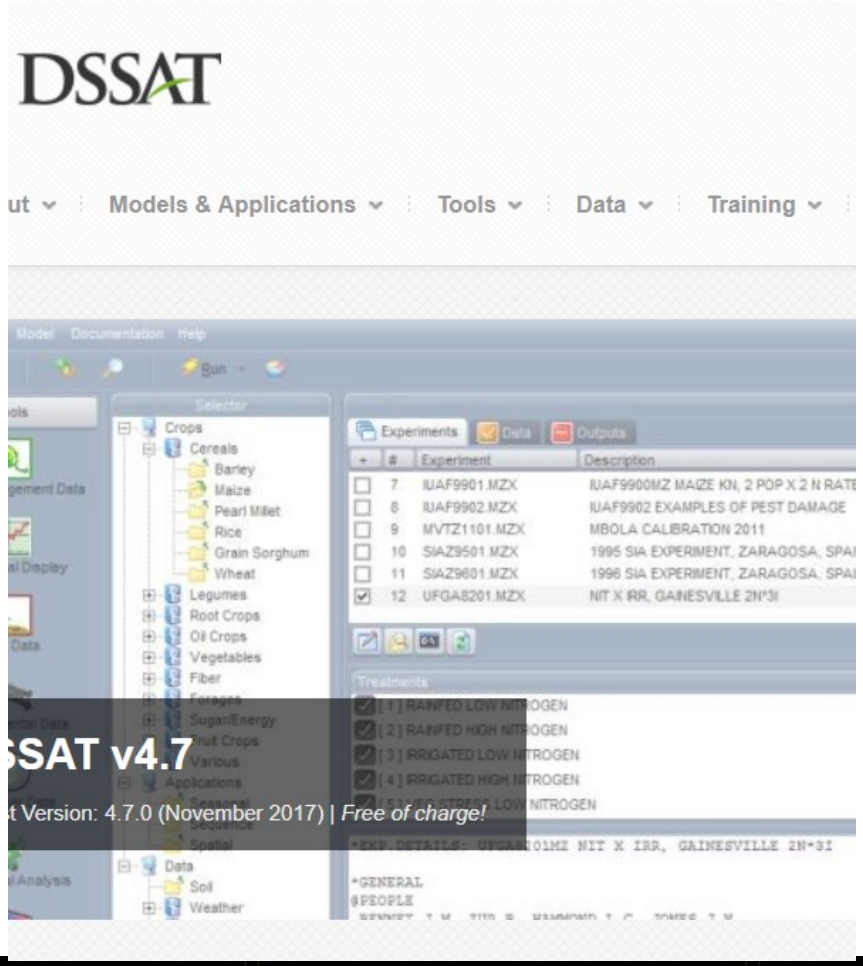
Starting to incorporate wheat quality into foresight



Crop modeling

- Climate change impact on grain yield and grain protein
- Mexico as case study
- Irrigated and rain-fed conditions
- Baseline and RCP 4.5 and 8.5
- Current production areas and potential production areas

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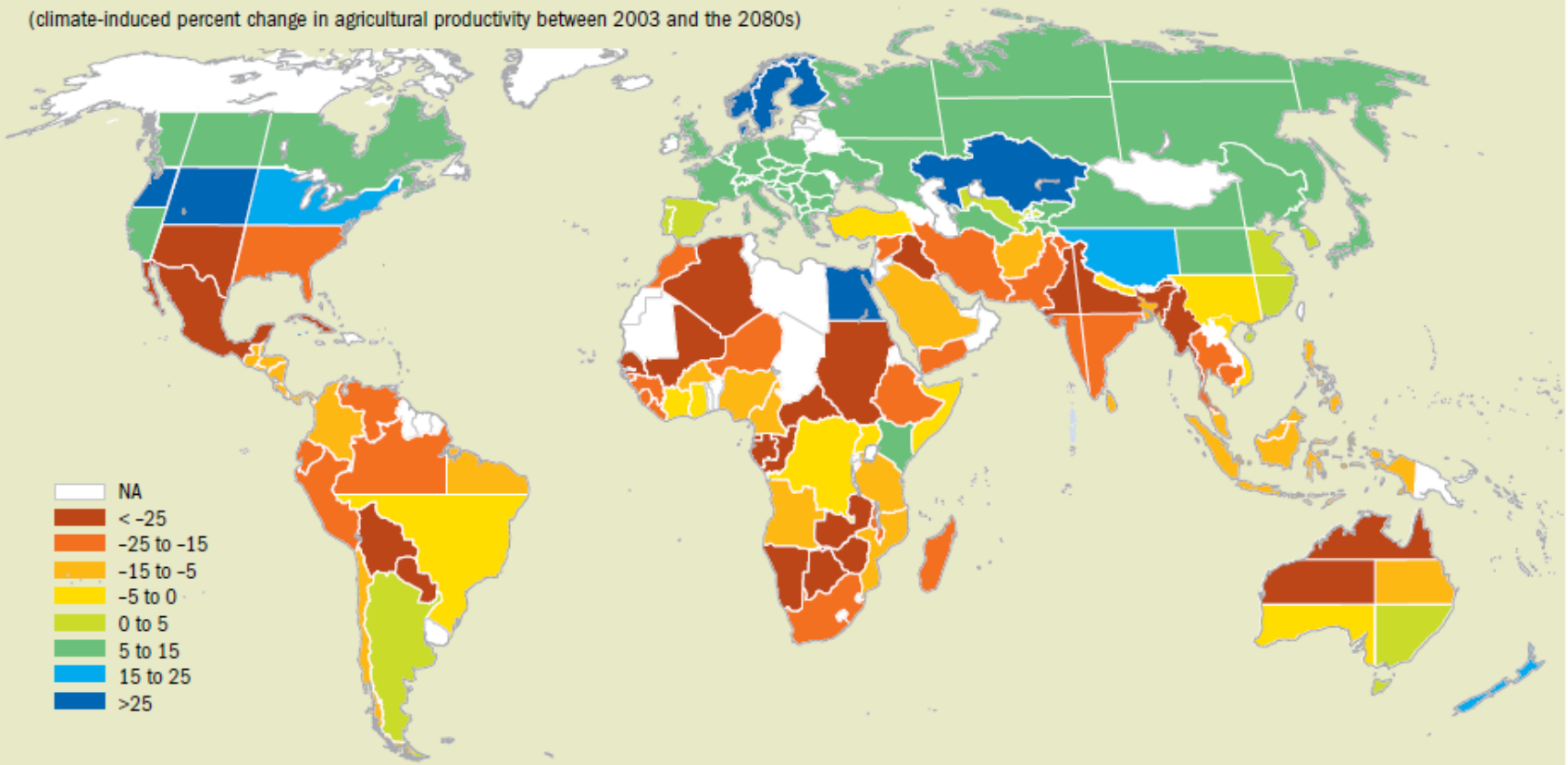
CO2 has positive and negative effects on yield

If some crops benefit from increased carbon dioxide, the global impact is less dire and those areas farther from the equator may see some increases in agricultural productivity.

(climate-induced percent change in agricultural productivity between 2003 and the 2080s)



Source: Cline (2007)

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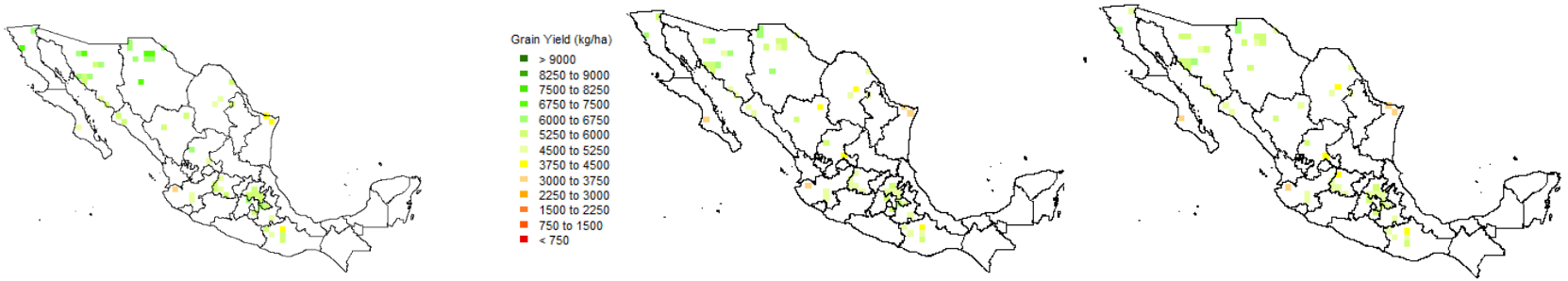
Starting to incorporate wheat quality into foresight



Baseline RCP 4.5 RCP 8.5

Wheat grain yield (kg ha^{-1}) gridded simulations using the DSSAT software linked to the MINK system (Robertson, 2017) in Mexico for **irrigated** systems using a period of 30-year of the baseline period (1980 to 2010) and for the simulated future yields using 5 GCMs. **Actual** production areas.

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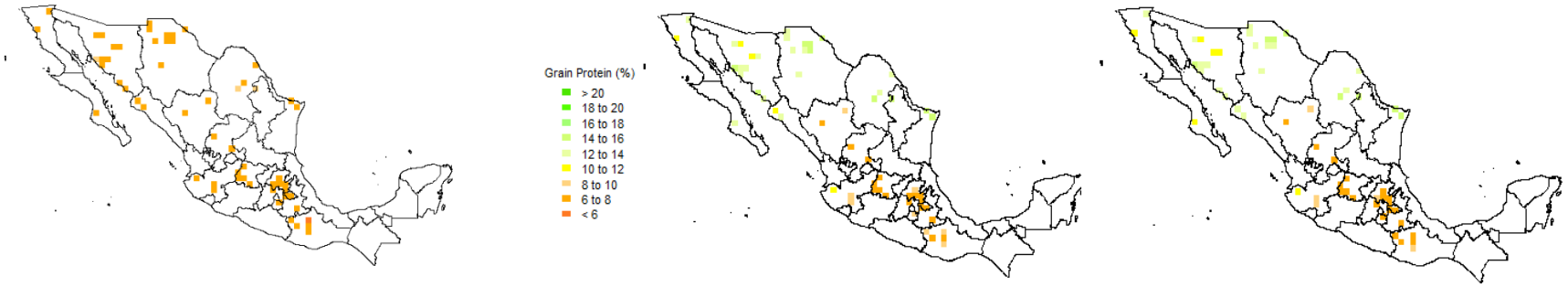

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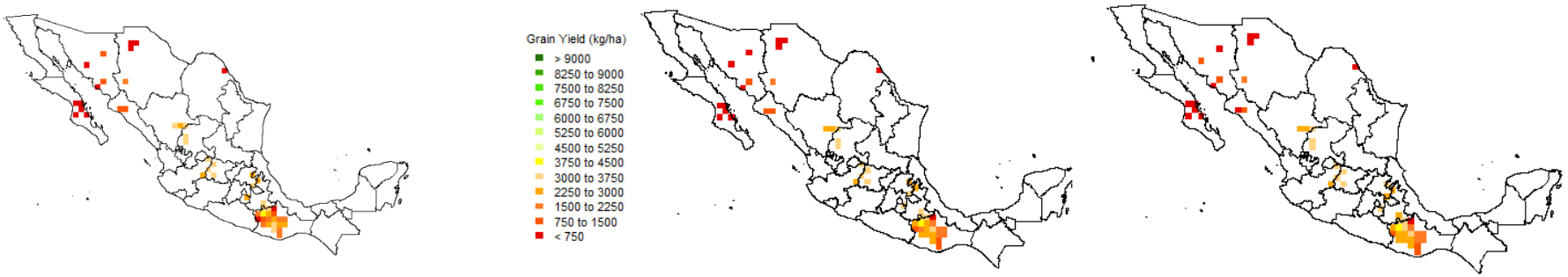

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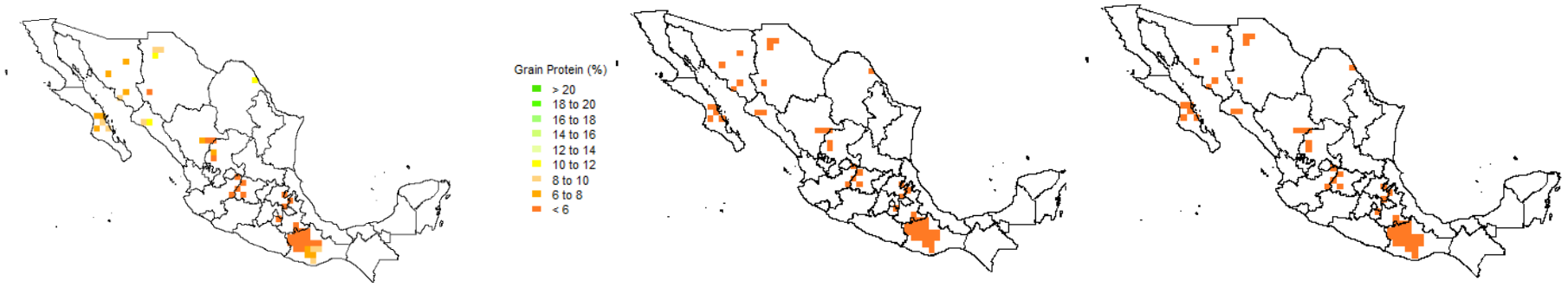

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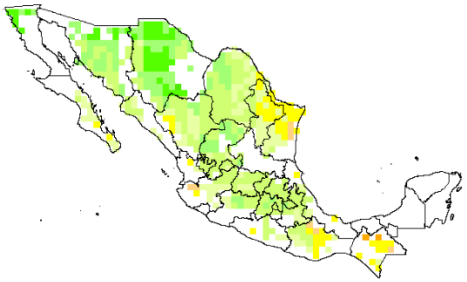

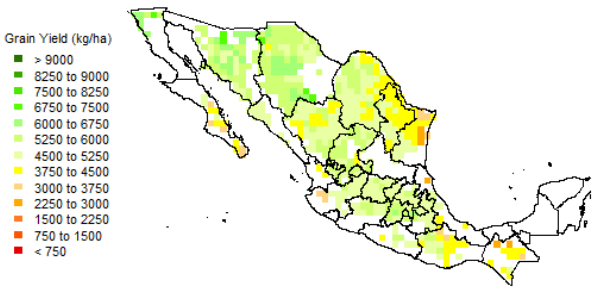

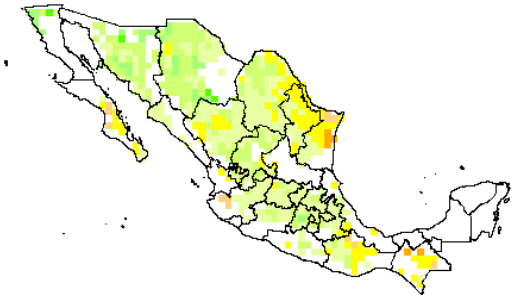

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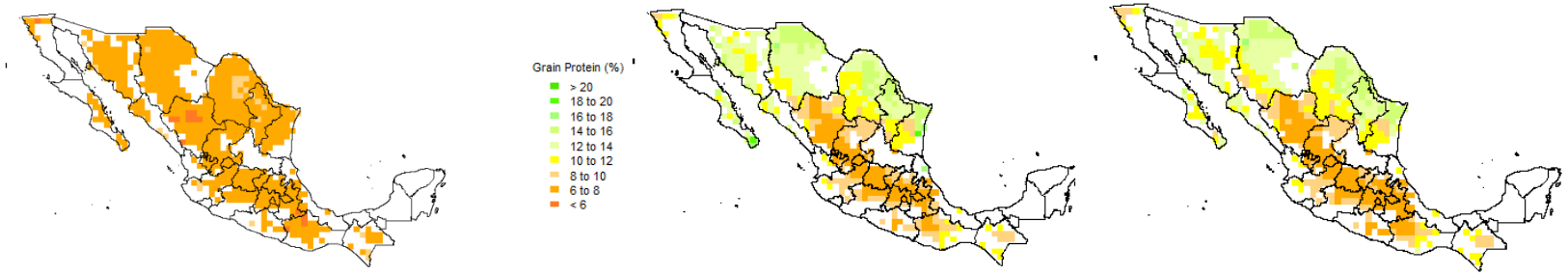

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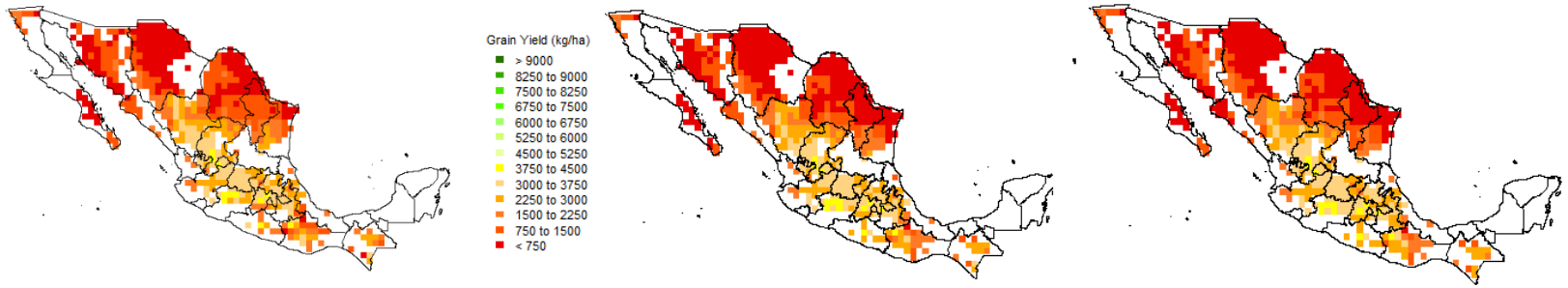

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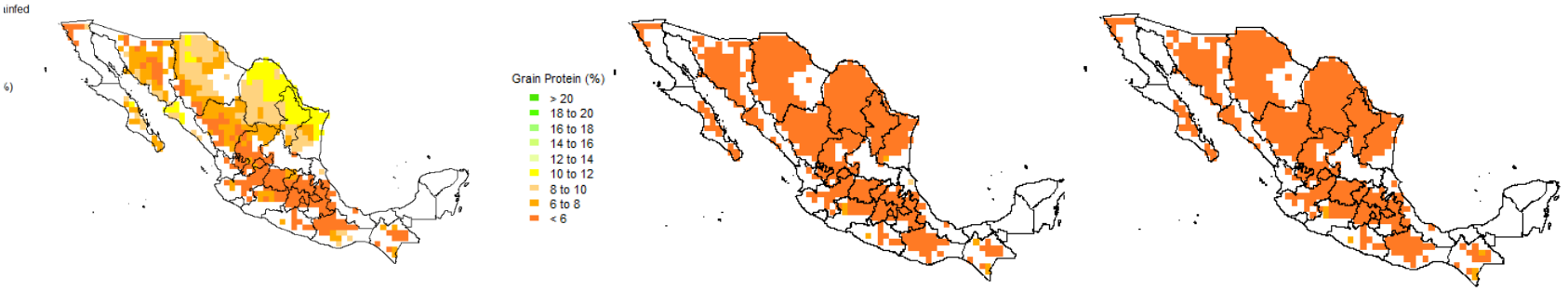

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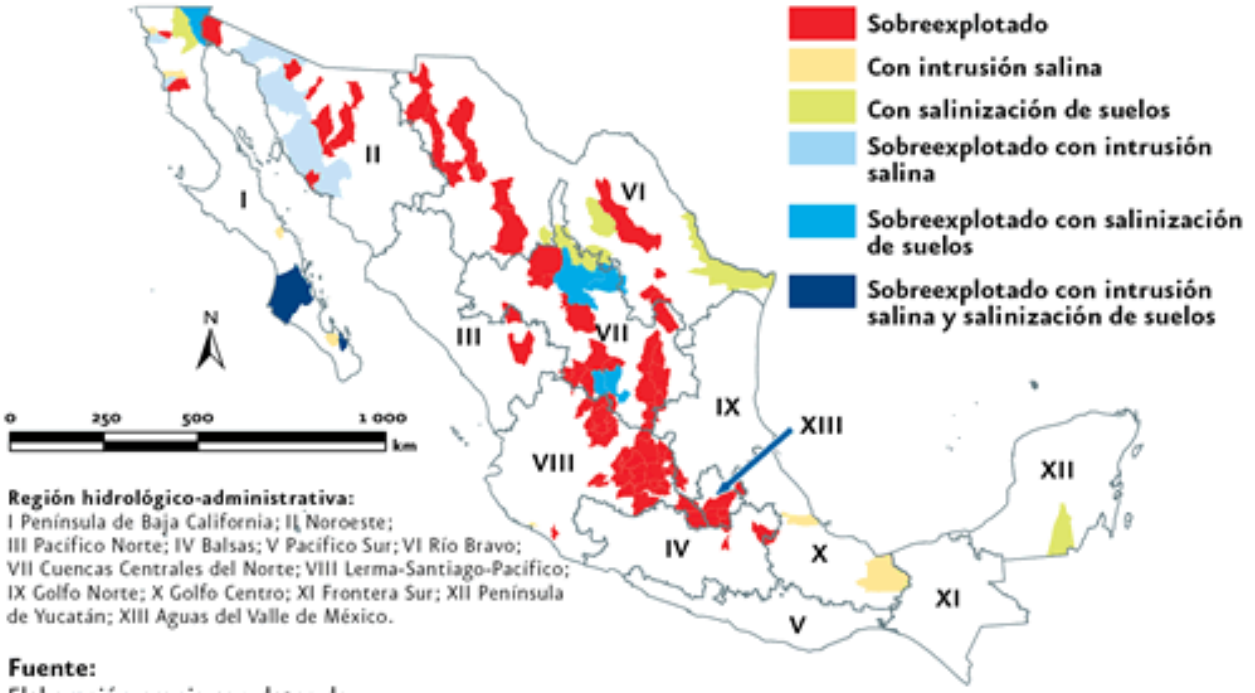
Is irrigation an option?

Mapa 6.6 Situación de los acuíferos por región hidrológico-administrativa, 2007



Región hidrológico-administrativa:
I Península de Baja California; II Noroeste; III Pacífico Norte; IV Balsas; V Pacífico Sur; VI Río Bravo; VII Cuencas Centrales del Norte; VIII Lerma-Santiago-Pacífico; IX Golfo Norte; X Golfo Centro; XI Frontera Sur; XII Península de Yucatán; XIII Aguas del Valle de México.

Fuente:
Elaboración propia con datos de:
Conagua. *Estadísticas del Agua en México*, 2008. México. 2008.

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Conclusions

- High levels of CO_2 can negatively influence protein quality and hence milling quality
- CO_2 increases can improve yields but reduces micro-nutrient content N, Fe, S, Zn, y Mg
- Danger of qualitative malnutrition!

- Under rain-fed conditions both yield and protein content is negatively affected by climate change
- Expanding irrigation is not a viable option

Next steps

The many moving parts in foresight

- Further refinement of crop model outcomes for climate change scenarios
- Especially for quality characteristics
- Understanding better the future demand for wheat quality
- Refinement of demand in economic foresight models to take into consideration wheat quality

There are a lot of moving pieces on the board to take into consideration

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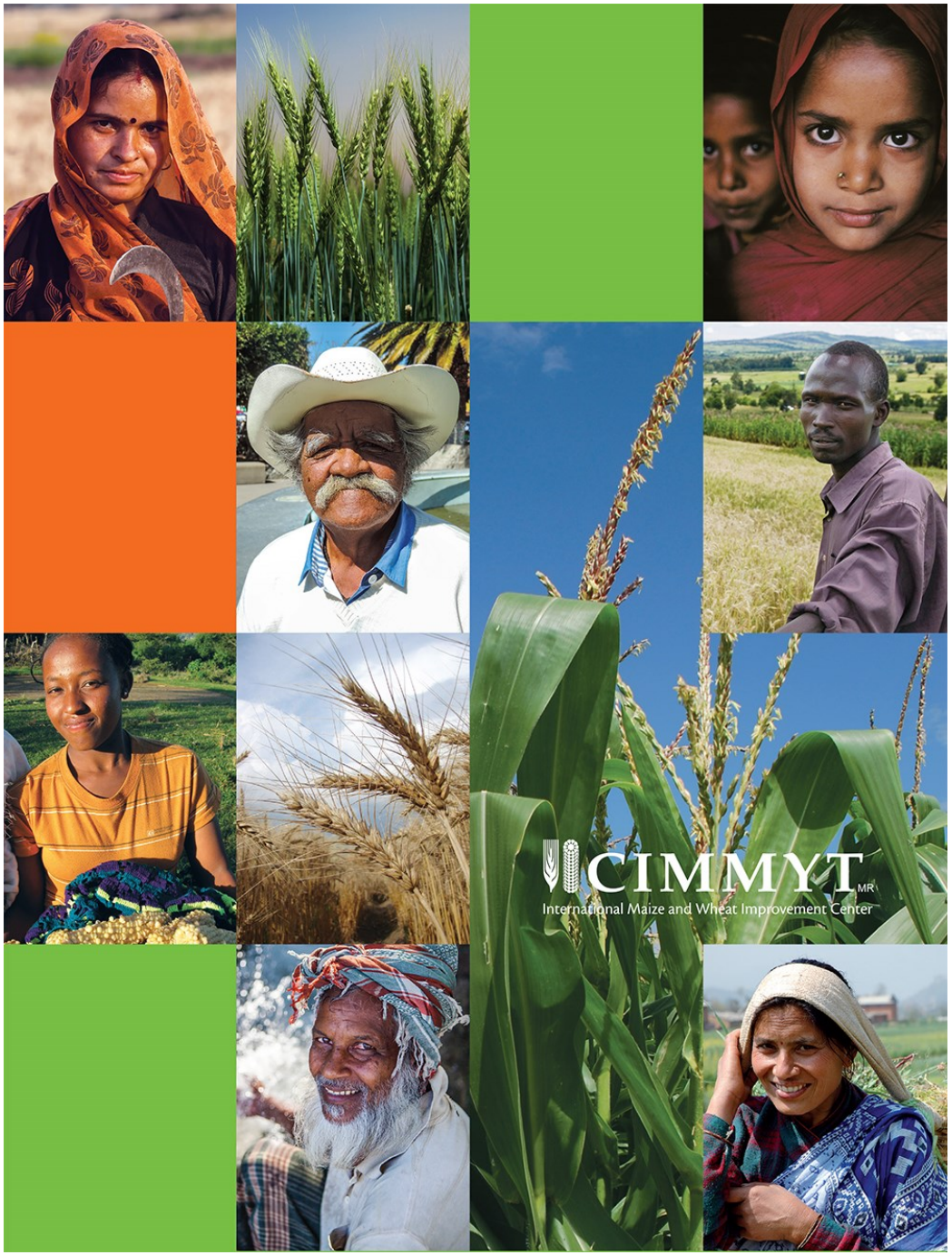

Thank you for your interest!