Evaluating the Site-Specific Potential for Spring Wheat Production in Mexico under the Uncertainty of Future Climate

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BACKGROUND & OBJECTIVES

WHEAT is one of the most important food crops in the world and very relevant to food security and incomes both in developed and developing countries. However, the climate change and variability and extreme weather events like heat waves as experienced recently in Russia as well as severe droughts have caused crop production instability, increasing wheat prices and are threatening the global food security and have led to food riots in many countries. Many research efforts on crop modeling have been carried out using various climate change scenarios. This study was carried using two climate change models for scenario A1B for evaluation of wheat suitability and spatial variations of future spring wheat production areas in Mexico.

METHODOLOGY

***Study Area*:** Obregon (38m) is located in Sonora in northern Mexico and Toluca (2,640m) is in the central highlands of Mexico in the State of Mexico (Fig. 1).

***Agro-Climatic characteristic*:** Temperate temperature in Mega environment 1 that is defined by CIMMYT (Fig. 3(A)).

***Cultivar*:** PBW343 is a benchmark cultivar of CIMMYT (*http://wheatatlas.cimmyt.org/articles/me.aspx*).

***Crop Model*:** CERES-Wheat (DSSAT 4.5 package) and is run on a HPC (High Performance Computing) cluster.

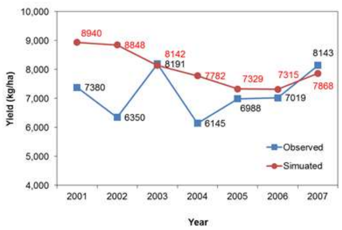

Fig. 1. Model parameters' calibration with 7 years observed data of Obregon.

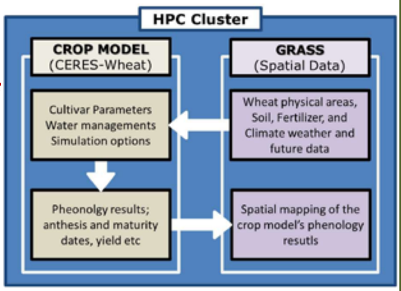

Fig. 2. Overview of HPC cluster in this study.

Processed Input Spatial data:
- Spatial resolution: 5 arc minutes (10 km at the equator).
- Climate data: base climate is from 1950 to 2000, and two future climates of 2050s (A1B: CSIRO2, Australia; MIROC 3.2, Japan).
- Crop management and others: all treatments are assumed to be controlled well. Wheat mega environment (A), wheat SPAM (B), soil profile number (C), air temperature (D), rainfall (E), and solar radiation (F).

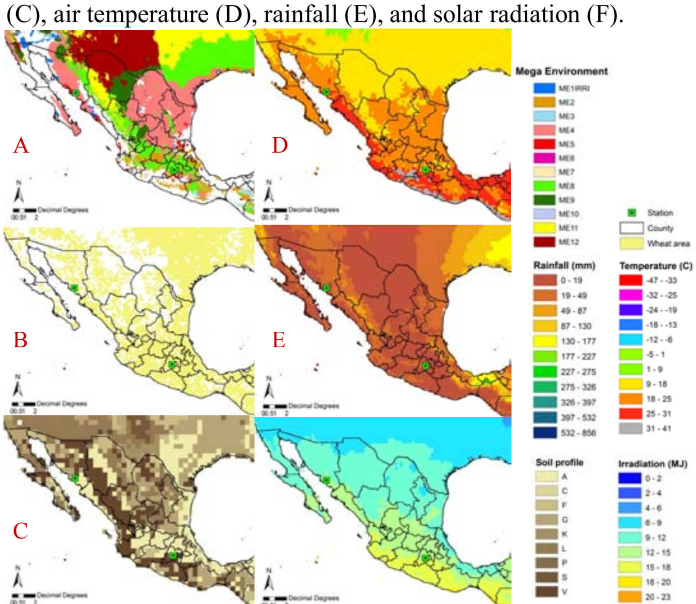

Fig. 3. Input spatial data of HPC cluster in this study.

RESULTS

***Yield and area changes*:** we classified the results in three different classes according to the climate data (Base, MIROC 3.2 and CSIRO2), respectively (Fig. 4 and Table 1 and 2). These results are base on the irrigated system. First class was defined as less 1,000 kg and the second was between 1,000 and 3,000 kg, and the last was > 3,000 kg.

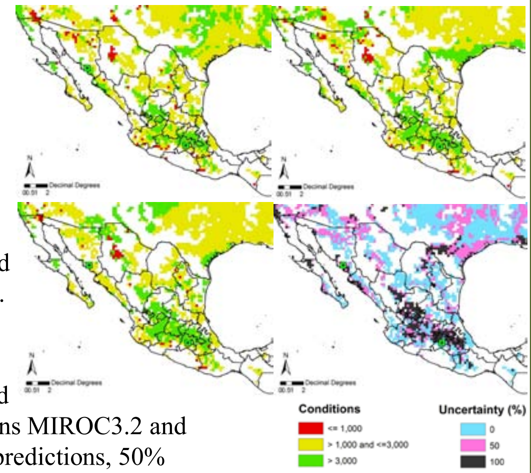

Fig. 4. Yield and area changes according to future climate (base: (I), MIROC3.2 (G) and CSIRO2 (H) and model agreements (J).

***Uncertainty*:** we defined the uncertainty 0% means MIROC3.2 and CISRO2 agree in their predictions, 50% means one of them agrees, 100% means there is no model agreements of the two future climate models.

Tables 1. Spatial average yield changes according to the applied climate data at two points

Yield average on irrigated(kg/ha)	CLIMATE			DIFFERENCE		RATIO (%)	
	Base2000	MIR2050	CSI2050	DF_MIR	DF_CSI	MIR	CSI
Obregon	2,088	3,611	-	1523	-	73	-
Toluca	4,075	3,258	4,107	-817	32	-20	1

; Yield on irrigated system at Obregon (low altitude) could be increased if the temperature is increased by 75%, but Toluca's (high altitude) yield change showed decreased with temperature increasing climate.

Tables 2. Yield/area changes according to the applied climate data each condition classified

CONDITIONS Yield (kg/ha)	CLIMATE			DIFFERENCE		RATIO (%)	
	Base2000	MIR2050	CSI2050	DF_MIR	DF_CSI	MIR	CSI
1,000 >=	283,514	362,897	357,227	79,384	73,714	28	26
1,000 < and <= 3,000	3,731,039	4,349,098	3,872,795	618,060	141,757	17	4
> 3,000	2,489,249	1,780,465	2,273,779	-708,784	-215,470	-28	-9

CONCLUSIONS & FUTURE WORKS

The results show that some areas may be negatively impacted for wheat production, while some will benefit. We need to expand future works as stated below;

- **improve wheat phenological parameters for varieties and soil data for better precision, add more climate scenarios to improve wheat suitability and uncertainty maps (eg., ensemble approach)**

References

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