Assessing Impact of Climate Change and Variability and on Crop Production in Ogallala Region Using Regional Climate Data

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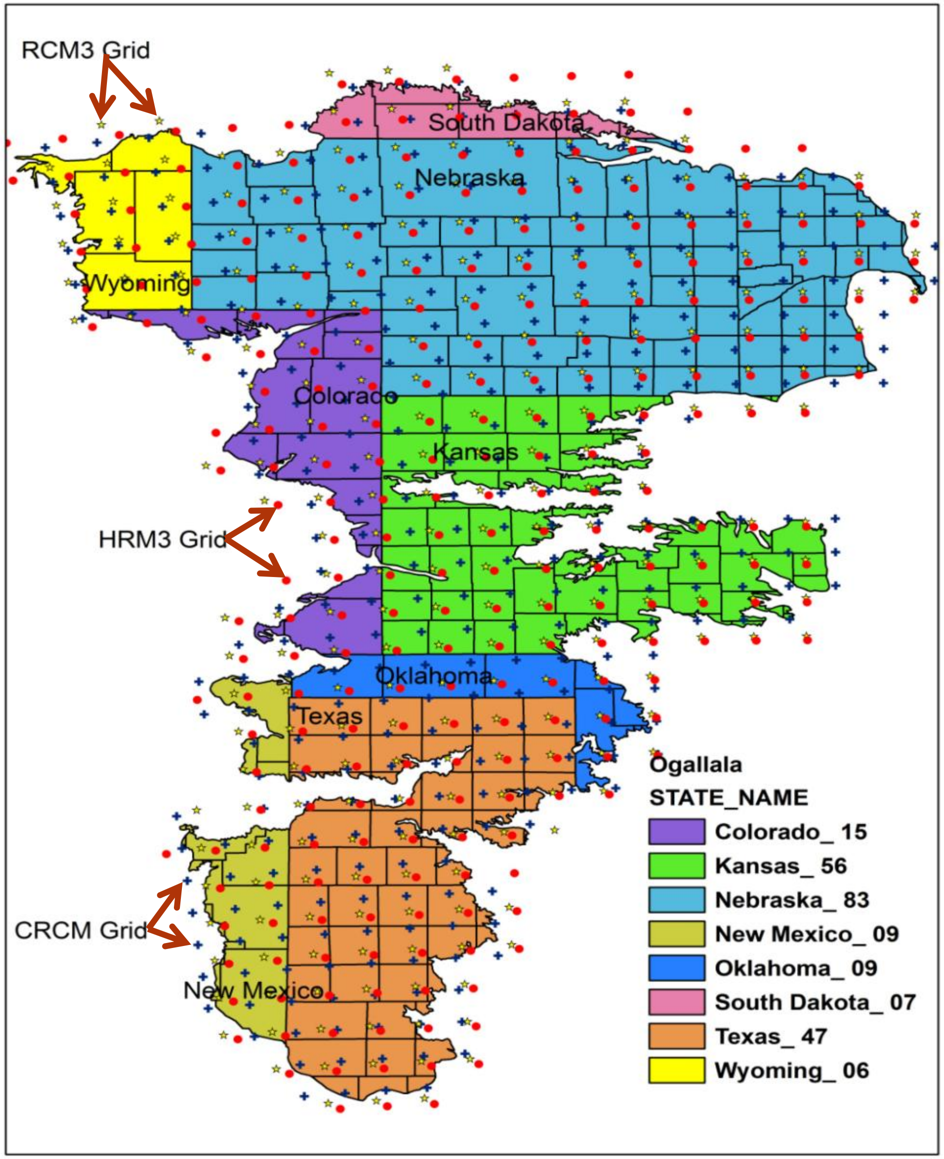
Introduction



The Ogallala Aquifer Region consisting of 232 counties spread over 8 states of Conterminous United States is facing declining water levels and deteriorating water quality. Coupled with, is the climate change, largely affecting the productivity of crop and water availability.

Objectives

1. To analyze the climate variability and change across the Ogallala region

2. To quantify the impact of climate change on the agricultural production in the Ogallala region

3. Analyze influence of various Crop Management Decision and Genetic Traits as adaptation / mitigation options for coping with climate variability and change.

Work flow and Significant features of the study

- The three regional climate models (RCM) used in this study were Canadian RCM, Italian RCM and the Hadley RCM (UK)
- The A2 climate scenario data for historic period (1971-2000) and future (2041-2070) were acquired from North American Regional Climate Change Assessment Program (NARCCAP).
- Observed baseline climate data (1971-2000) were used for validation.

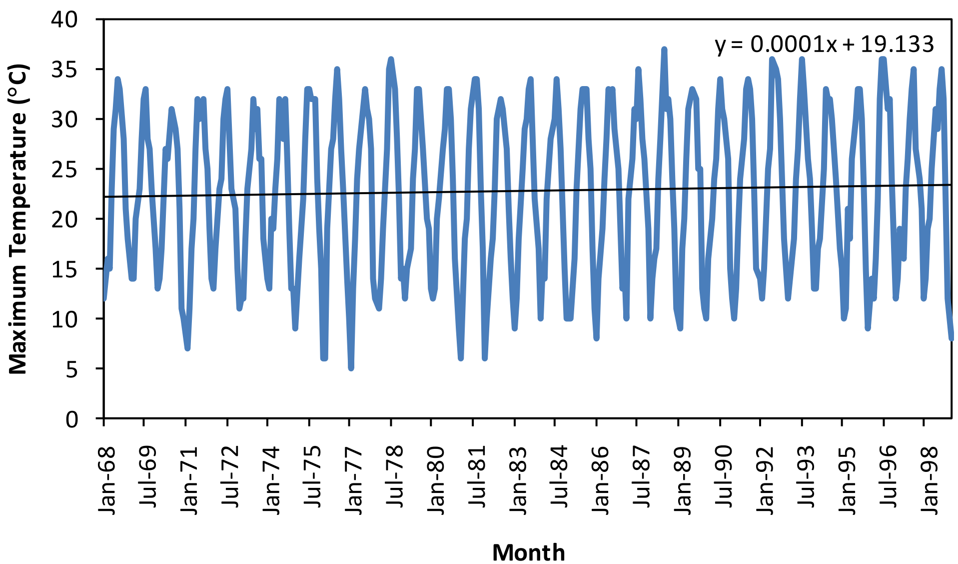
Work flow and Significant features of the study

- **Spatial crop modeling was performed in AEGIS/WIN, a GIS interface available in DSSAT (Decision Support System for Agrotechnology Transfer) software suite.**

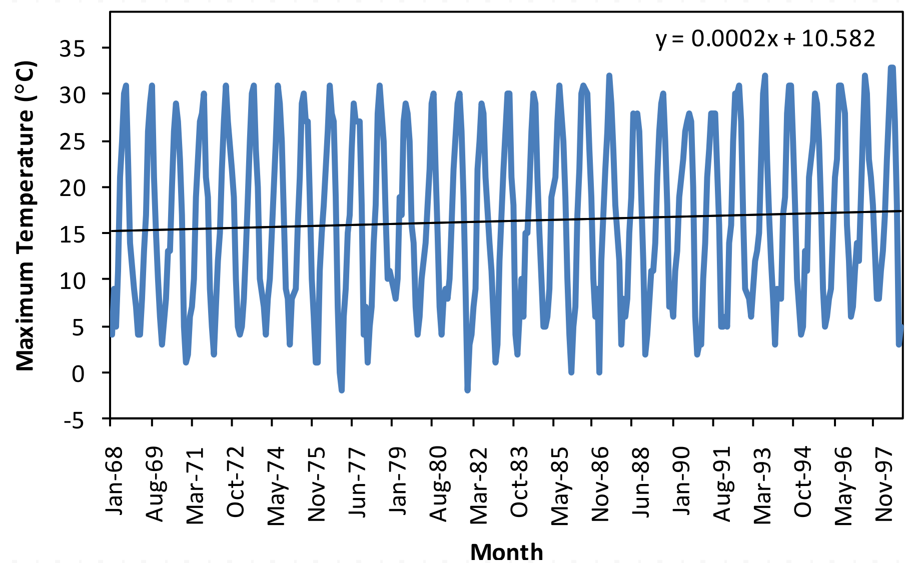
- **CERES-Sorghum and CERES-Wheat were used to simulate phenology, growth and grain yield.**

- **Management, genetic advancements (changes) and effects of elevated CO_2 were incorporated as part of future model runs and crop simulations were conducted under irrigated and rainfed conditions.**

Climate Change: Increased temperatures over the past 30 years

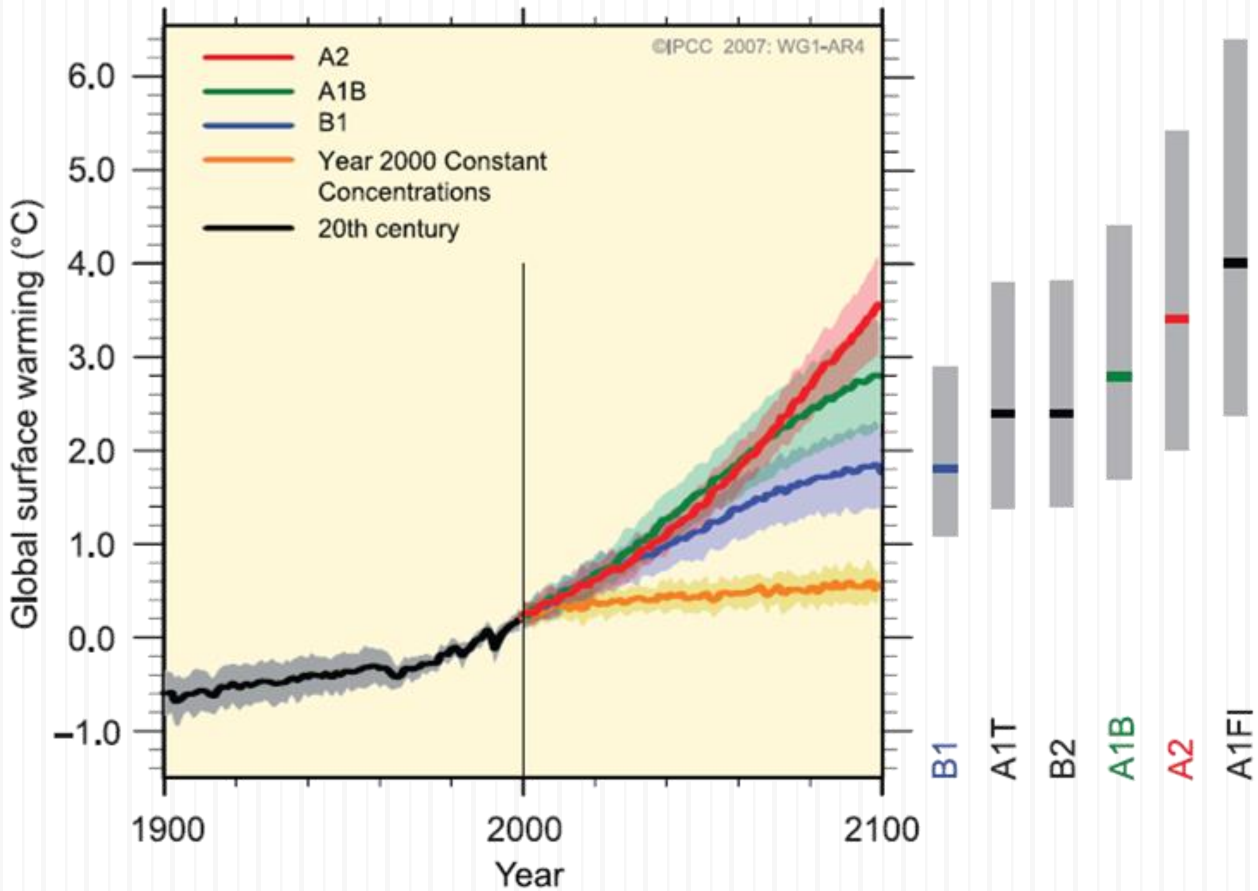


Lubbock, Texas

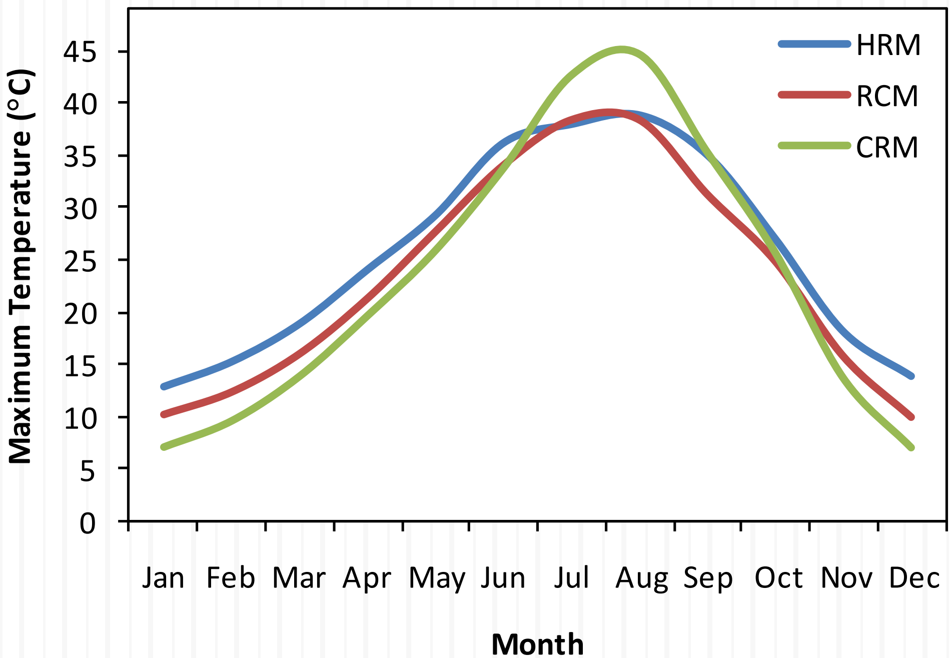


Goshen , Wyoming

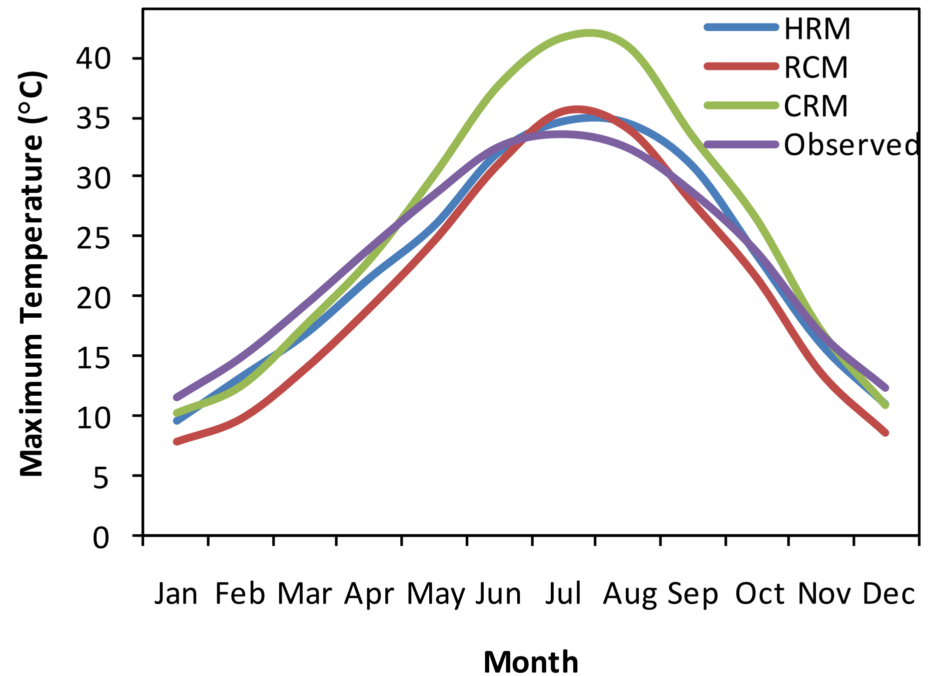
The A2 climate scenario



Climate Change: Model uncertainties and temporal variability: Lubbock, Texas

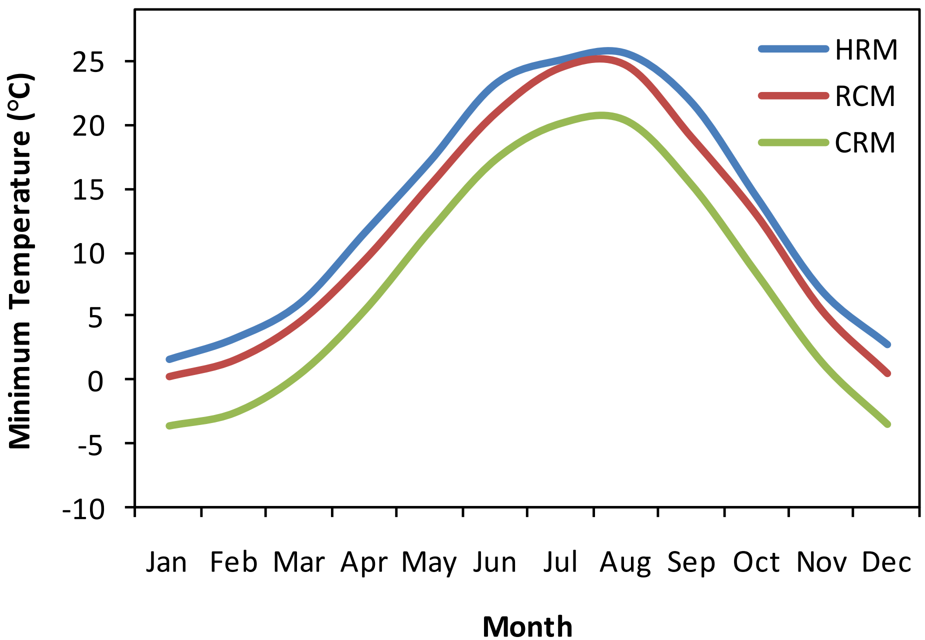


Future Predicted Climate

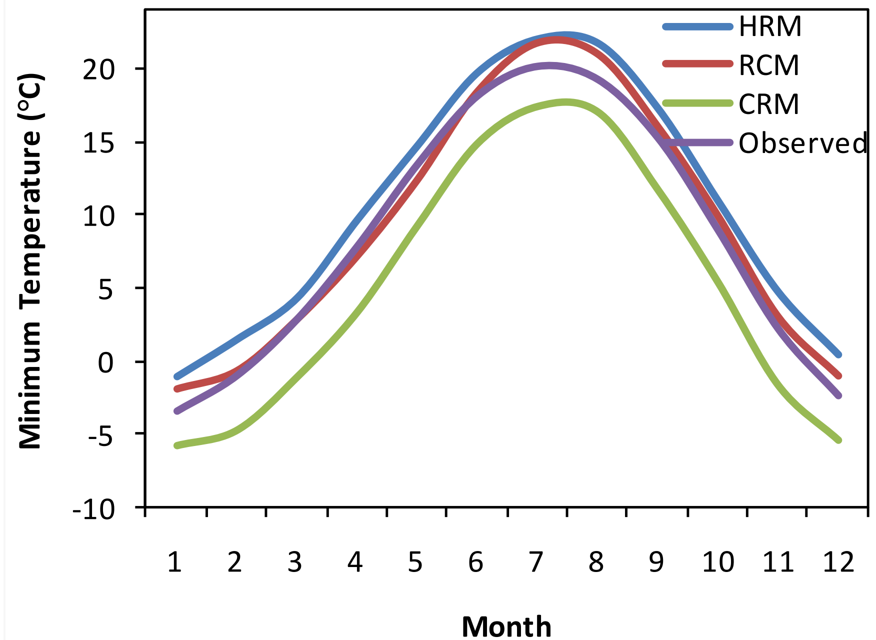


Past Predicted and Observed Climate

Climate Change: Model uncertainties and temporal variability : Lubbock, Texas

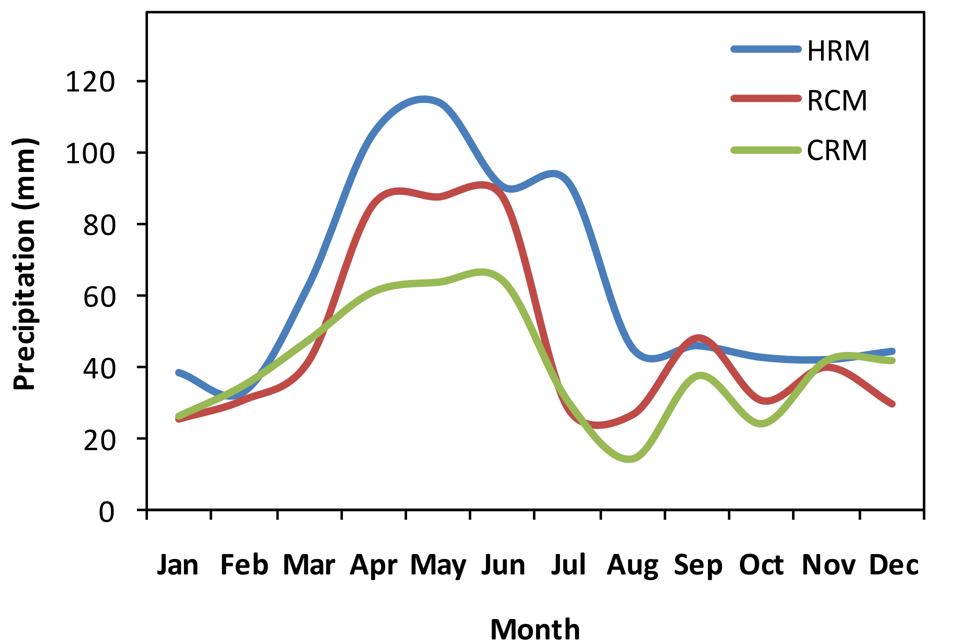


Future Predicted Climate

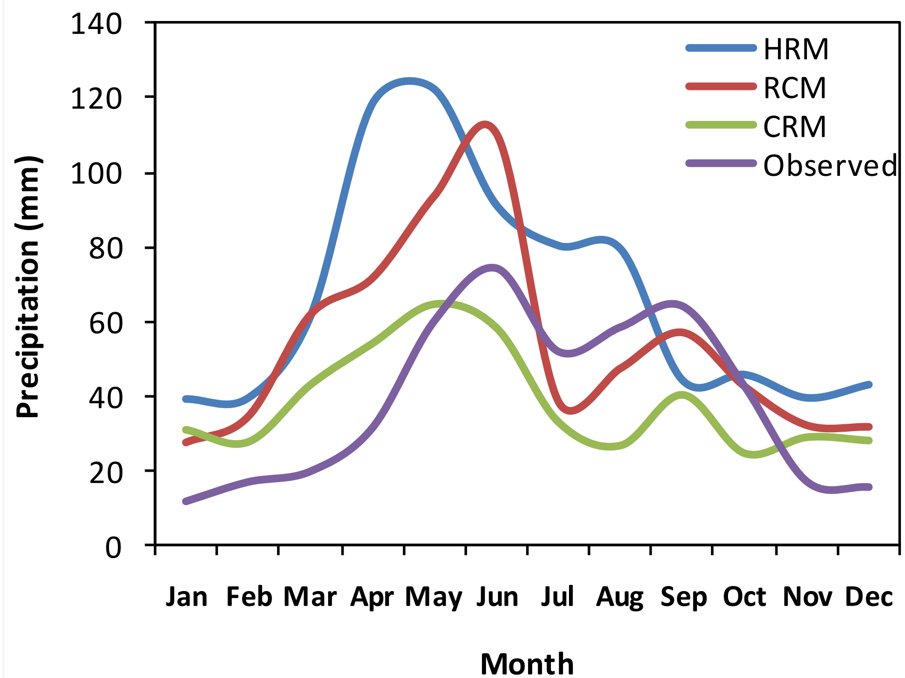


Past Predicted and Observed Climate

Climate Change: Model uncertainties and temporal variability : Lubbock, Texas

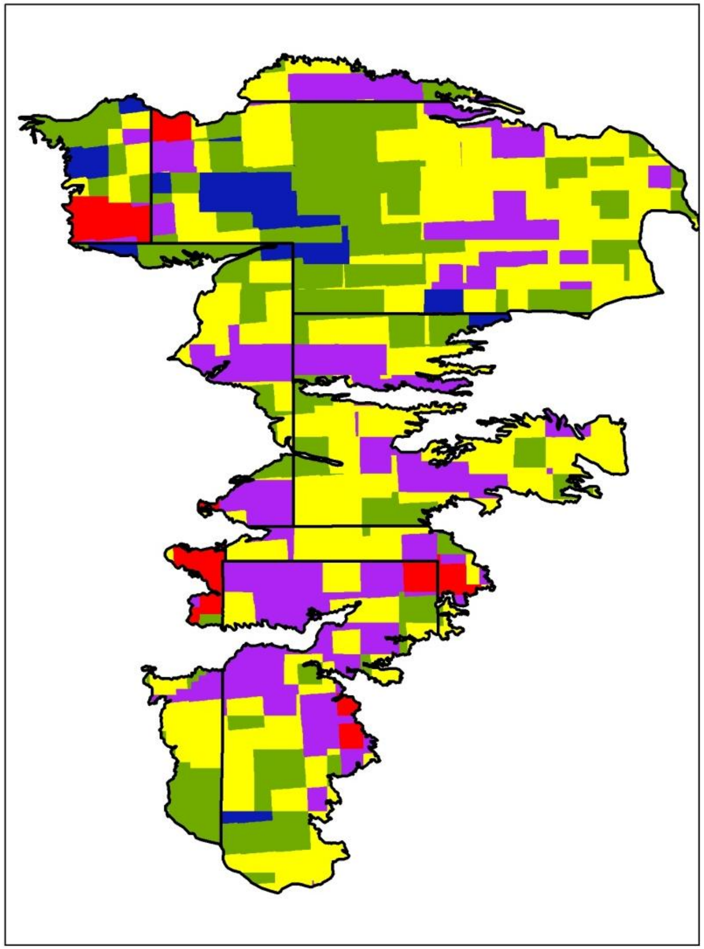


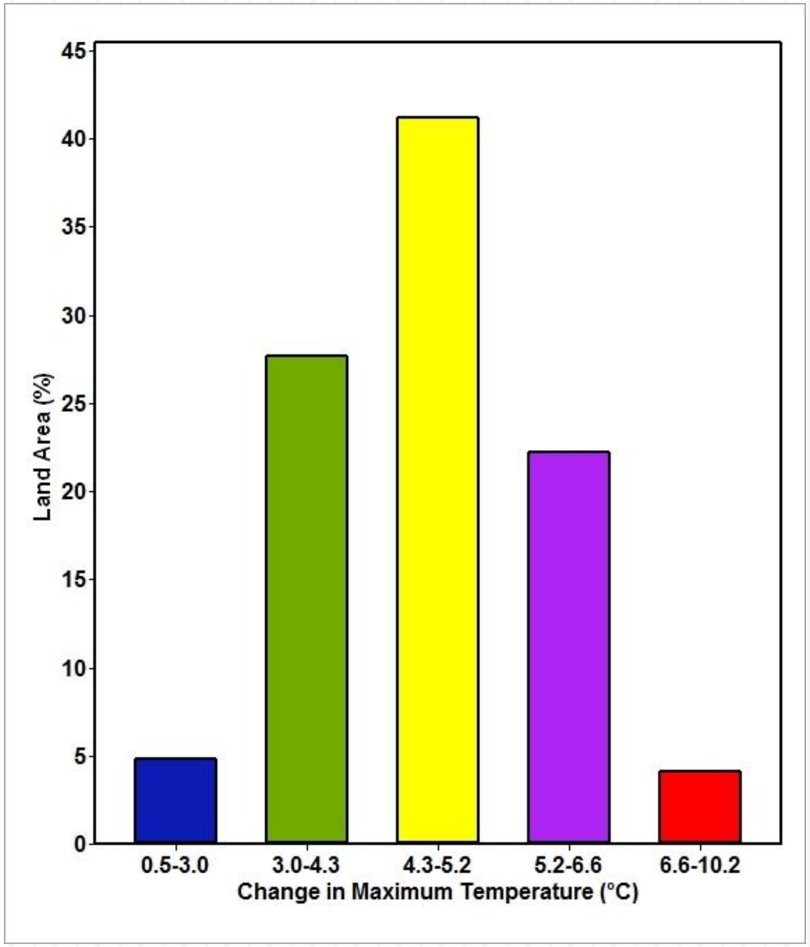
Future Predicted Climate



Past Predicted and Observed Climate

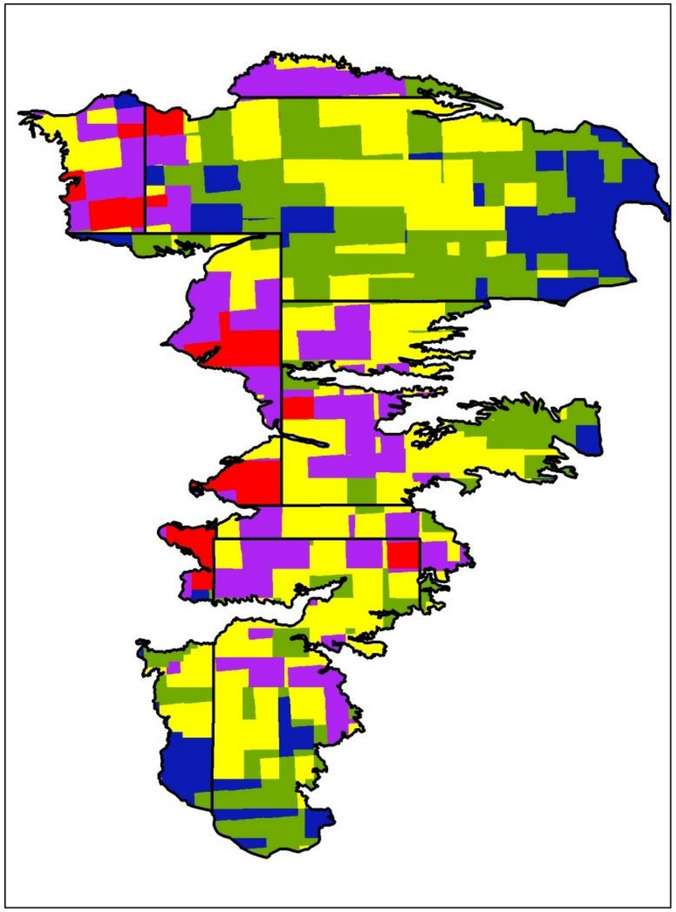
Climate Change: Spatial Variability: Max Temp

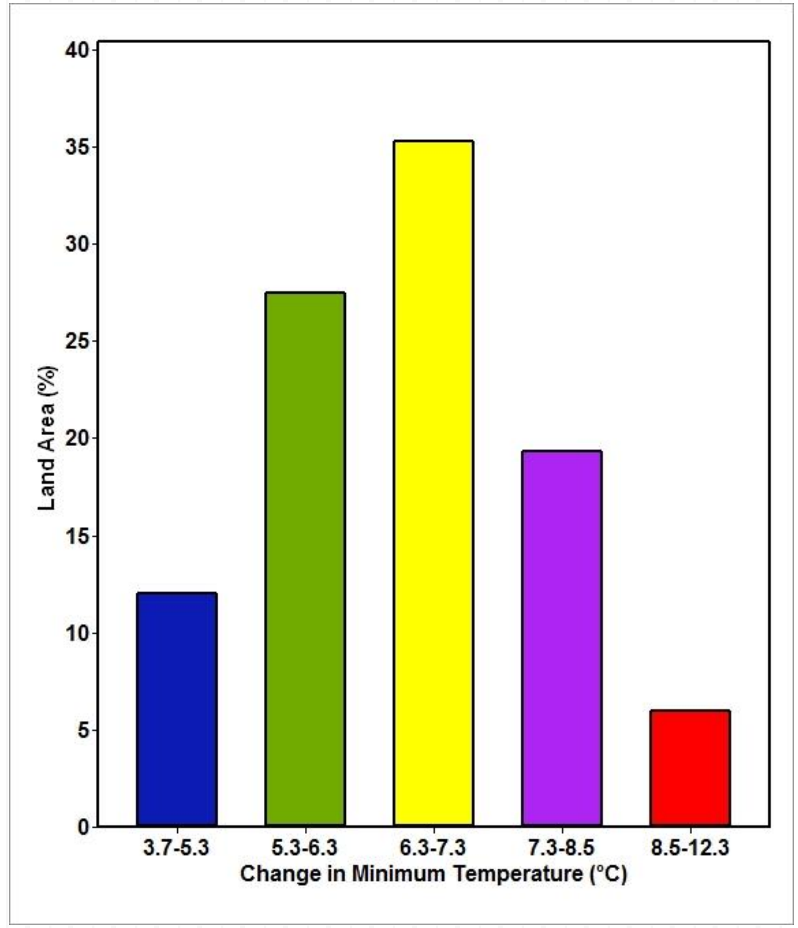




Change in Maximum Temperature (°C) from Baseline Climate for the month of <u>July</u> as predicted by HRM

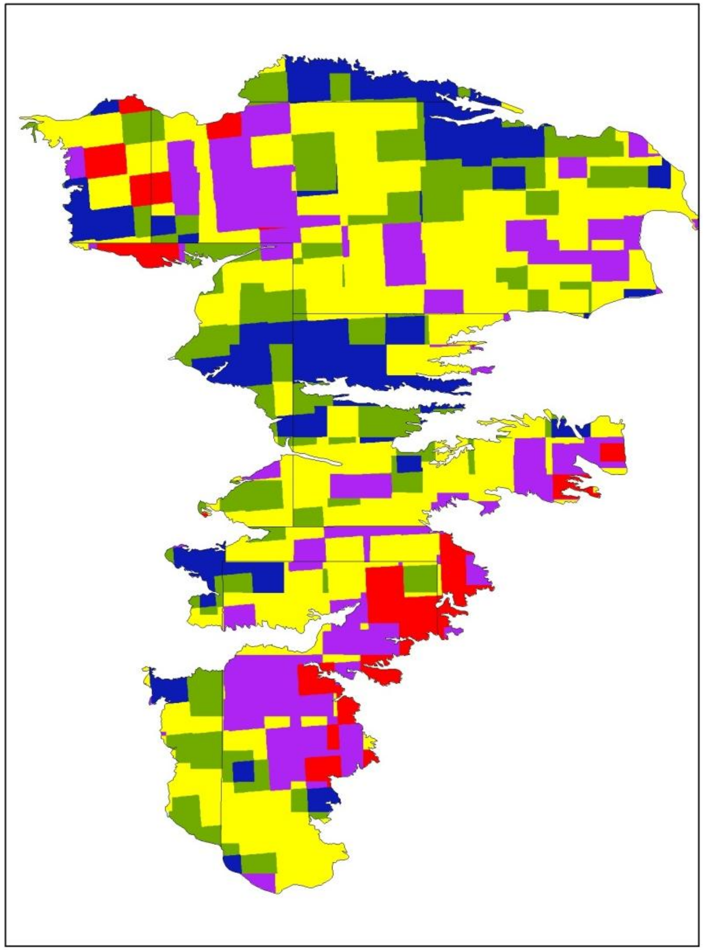
Climate Change: Spatial Variability: Min Temp

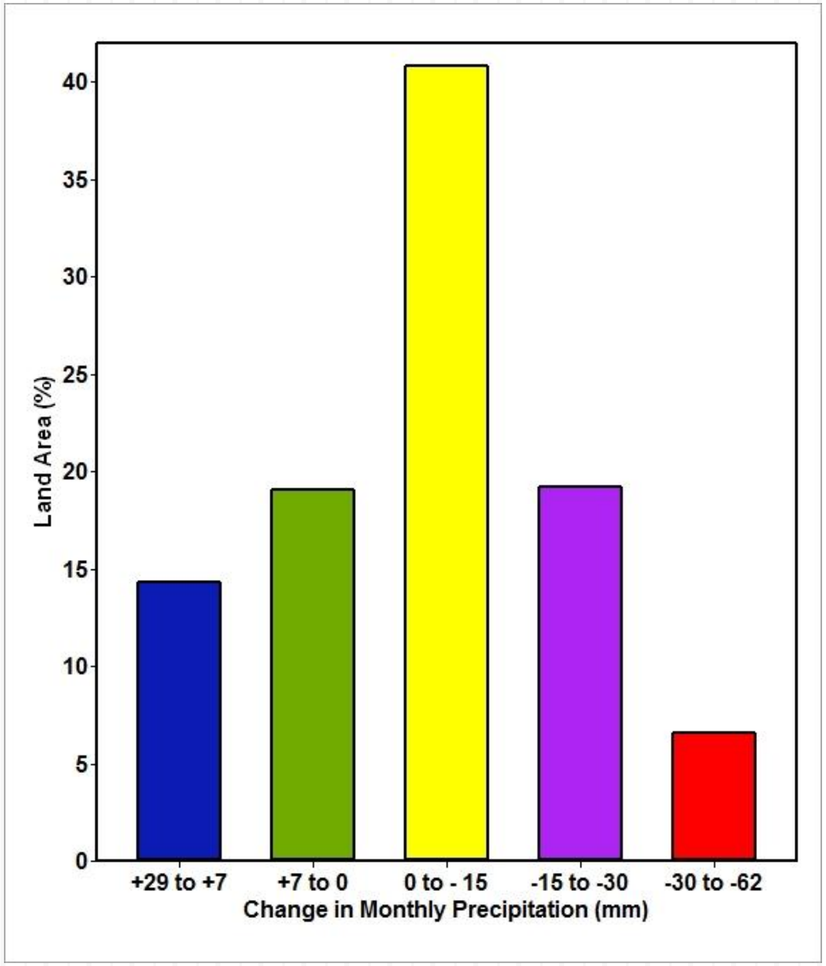




Change in Minimum Temperature from Baseline Climate for the month of July as predicted by HRM

Climate Change: Spatial Variability: Precipitation





Change in Precipitation from Baseline Climate for the month of July as predicted by HRM

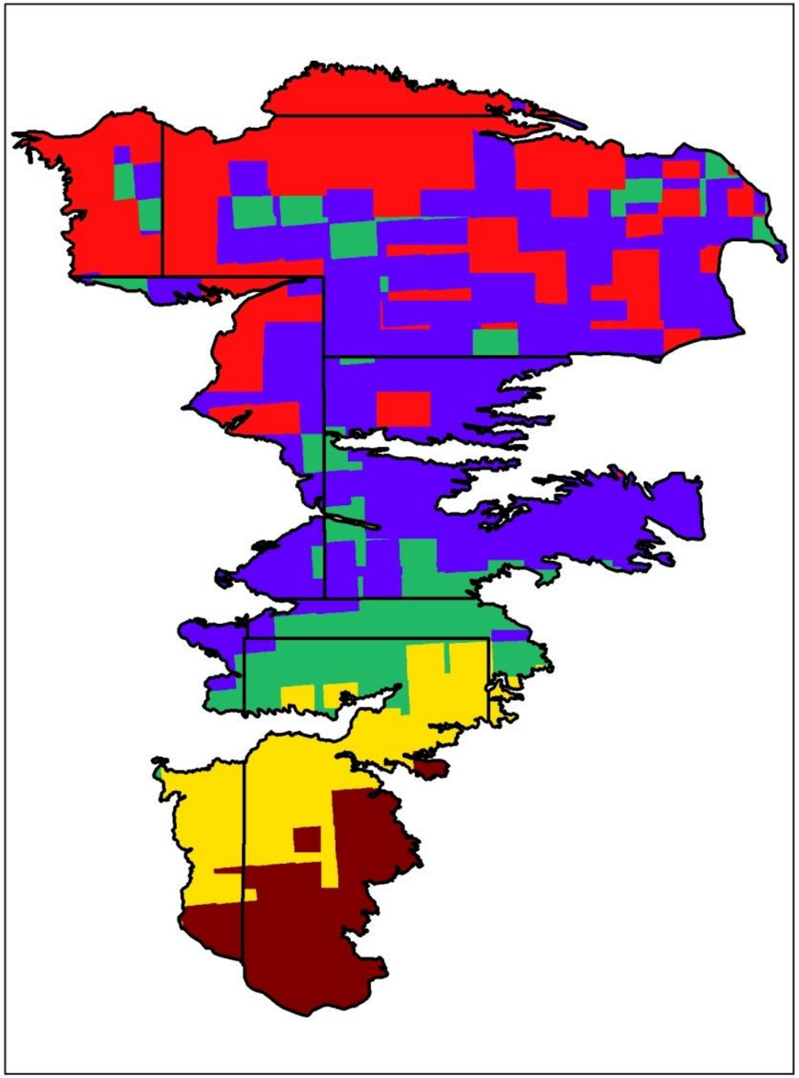
Crop model Inputs

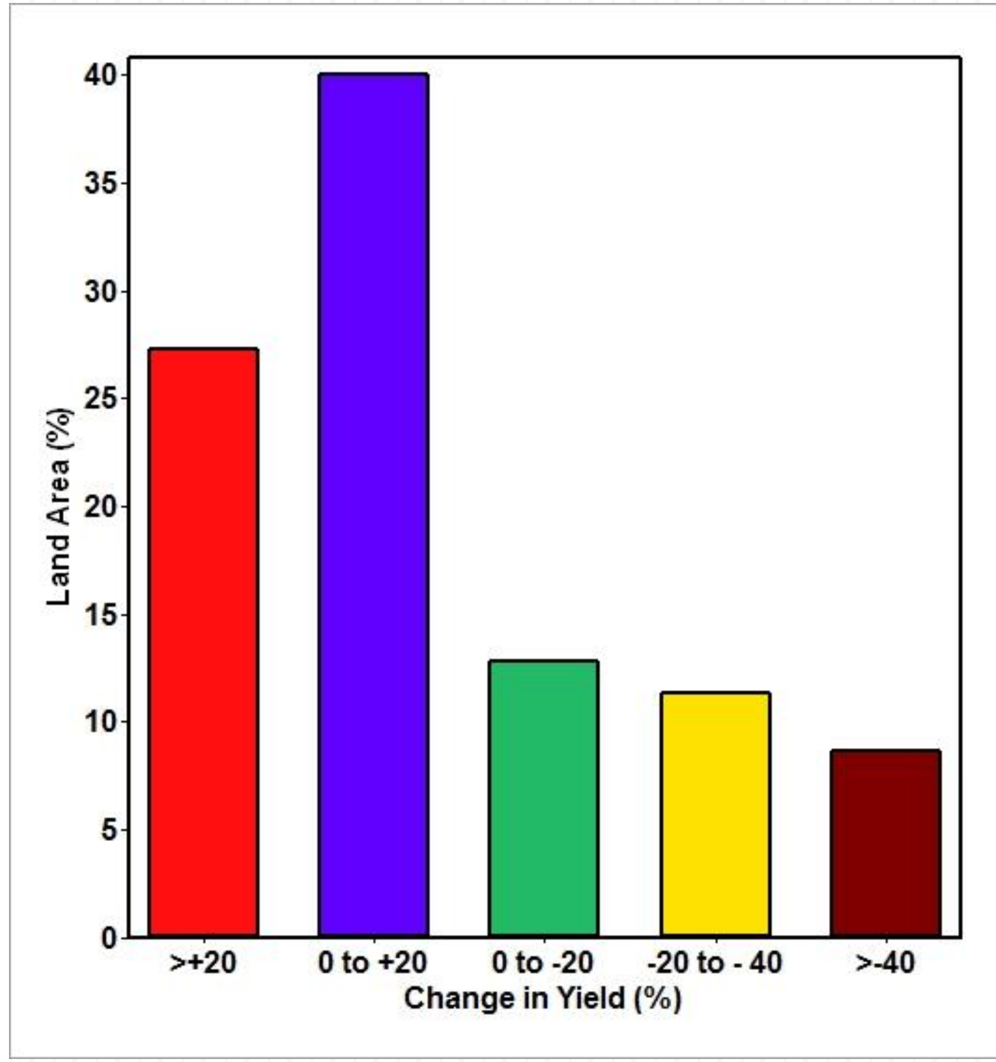
DSSAT – CERES – Wheat Model

Winter Wheat

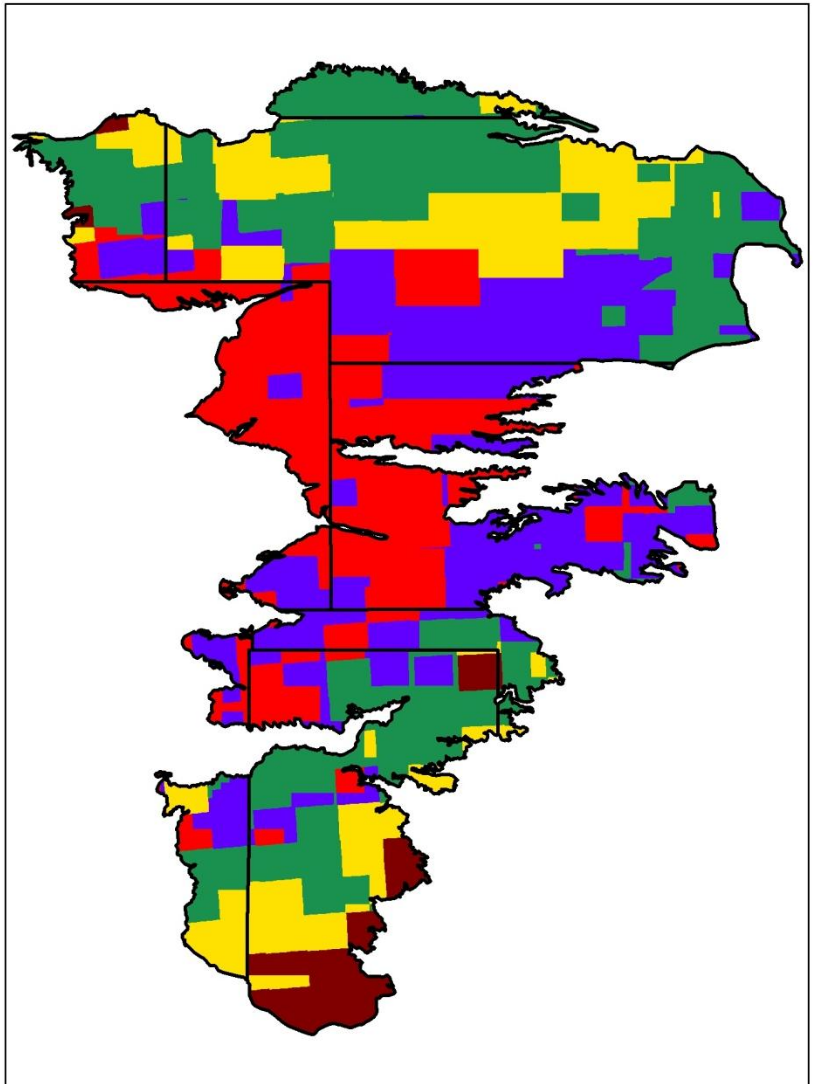
Soil – Ulysses silt loam
Cultivar – Newton
Plant Population – 1,779,535 plants/ha
Planting Date – October 1

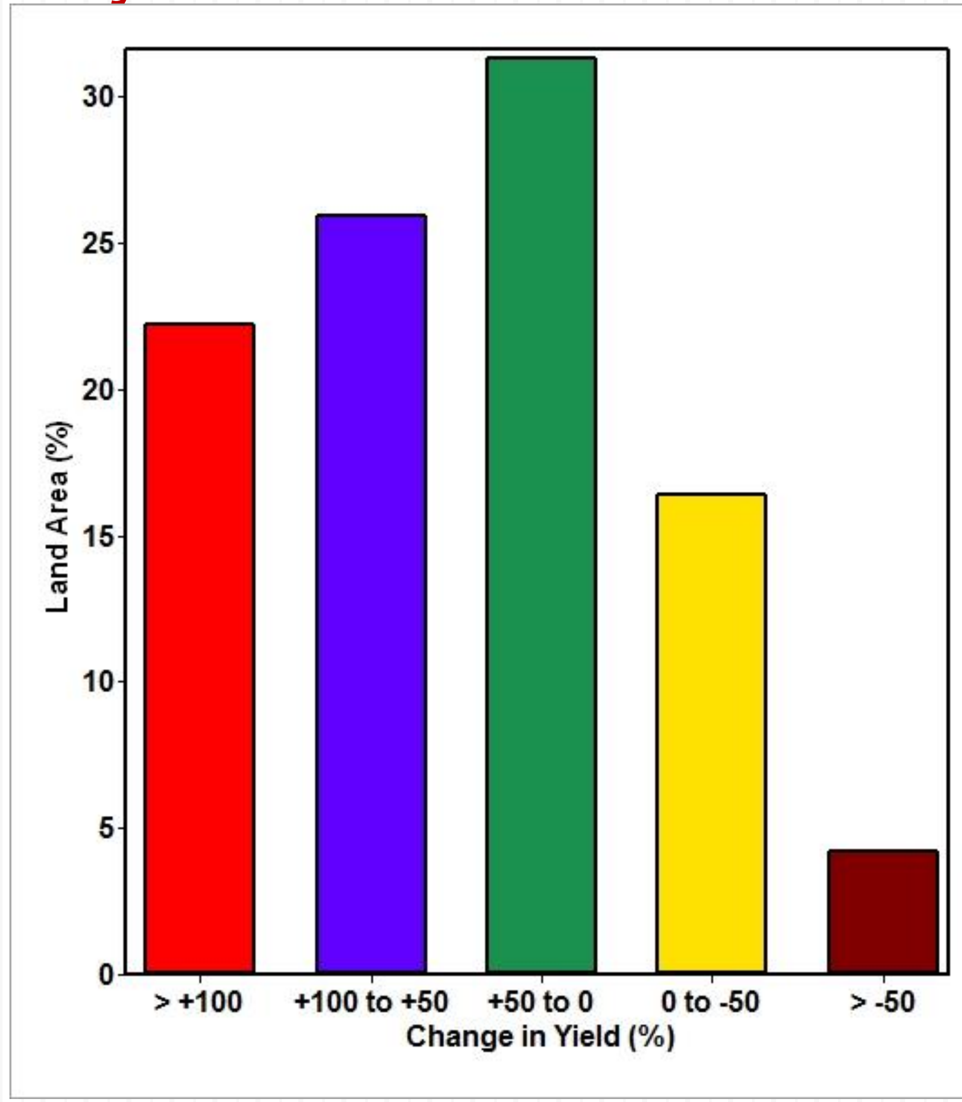
Wheat Irrigated





Wheat Dryland





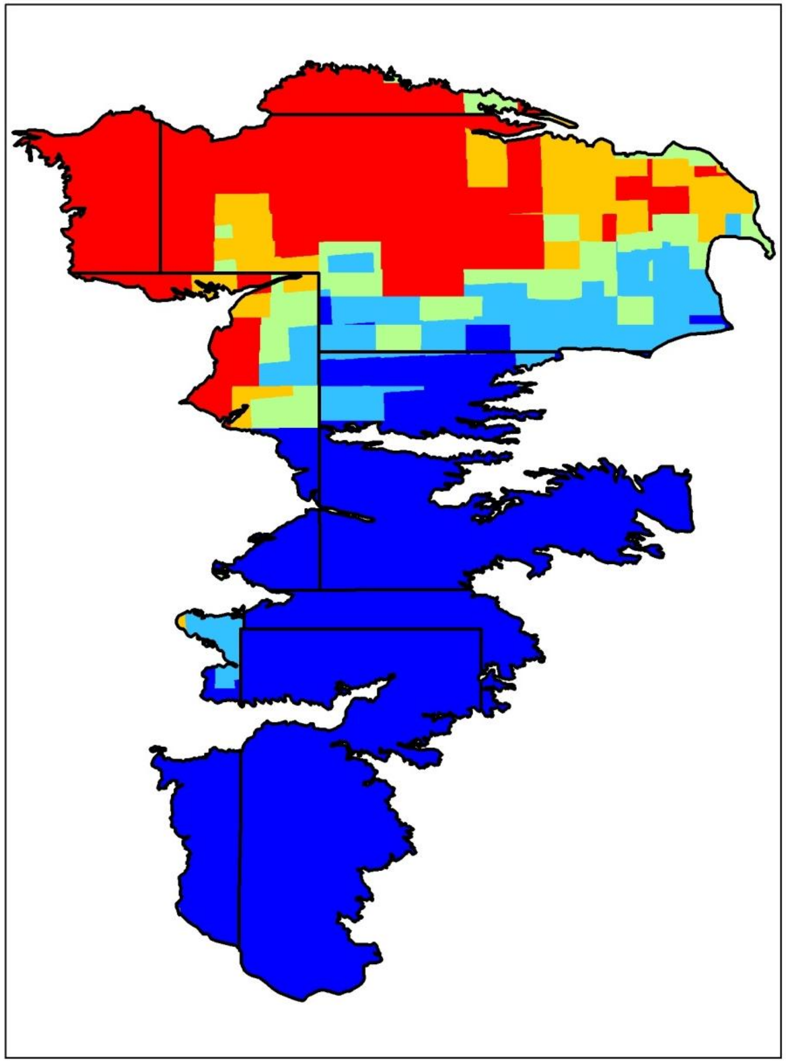
Crop Model Inputs

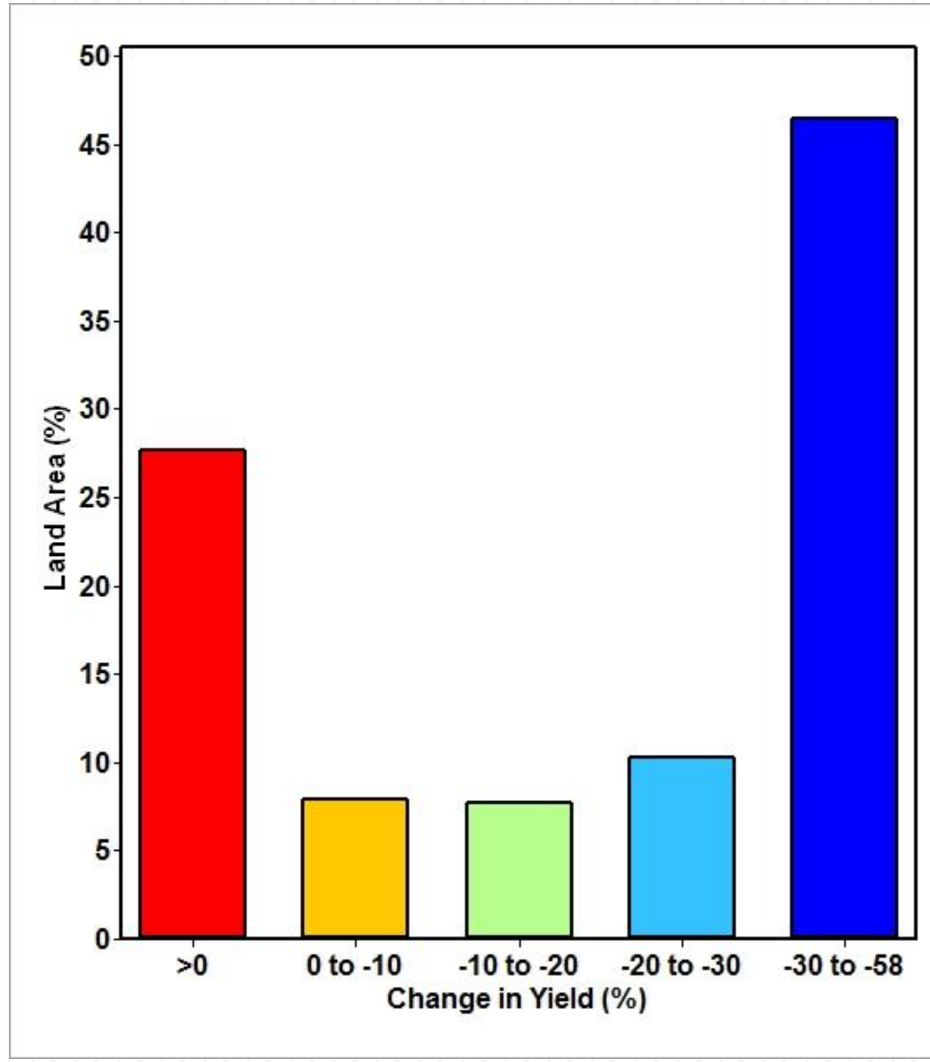
DSSAT – CERES - Sorghum

Grain Sorghum

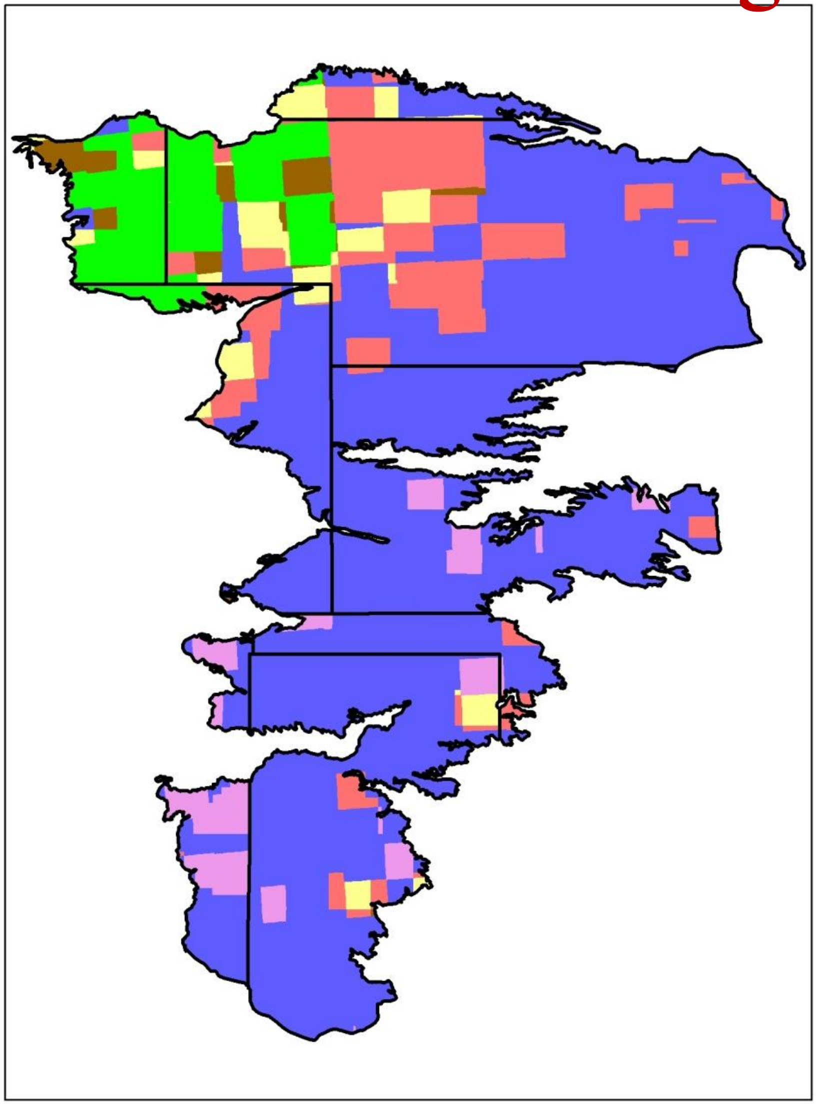
Soil – Ulysses silt loam
Cultivar – Pioneer 8333
Plant Population – 160,000 plants/ha
Planting Date – June 1

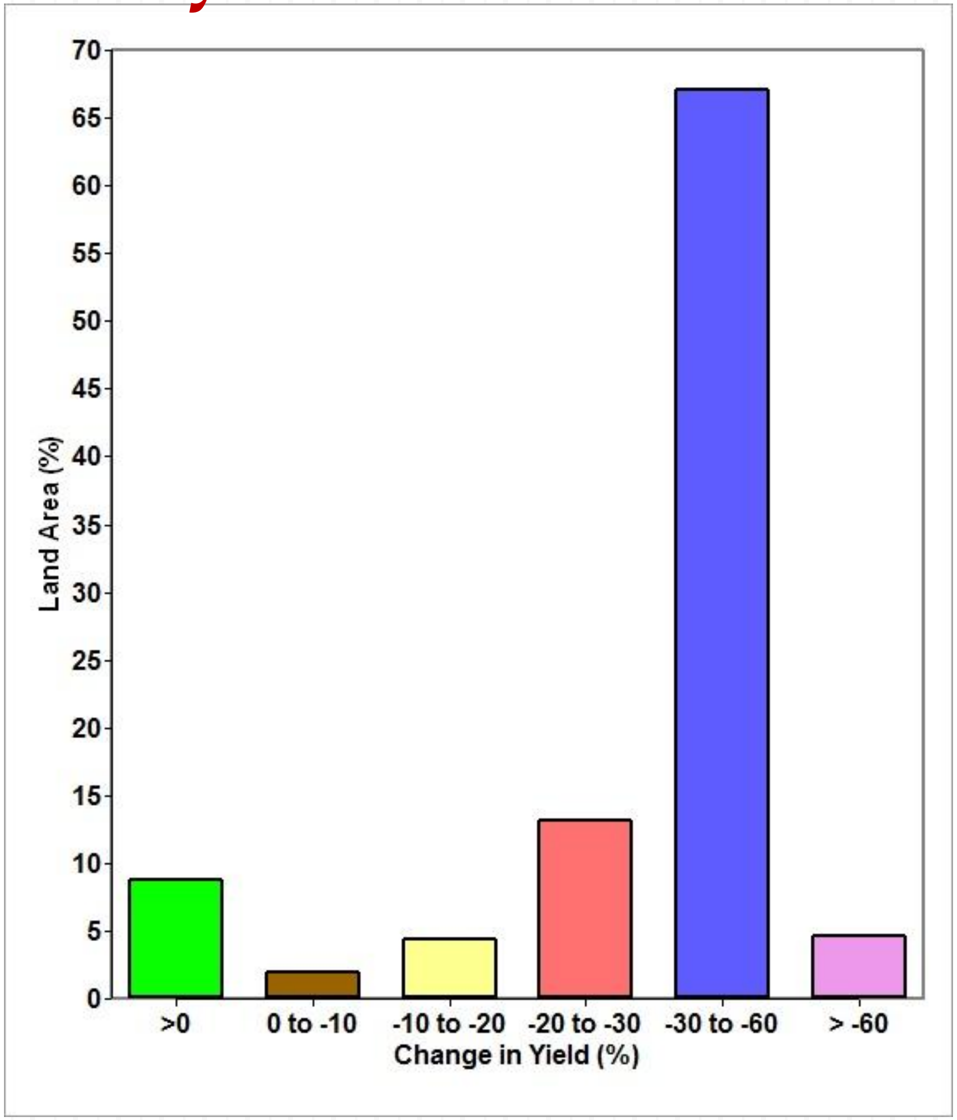
Sorghum Irrigated



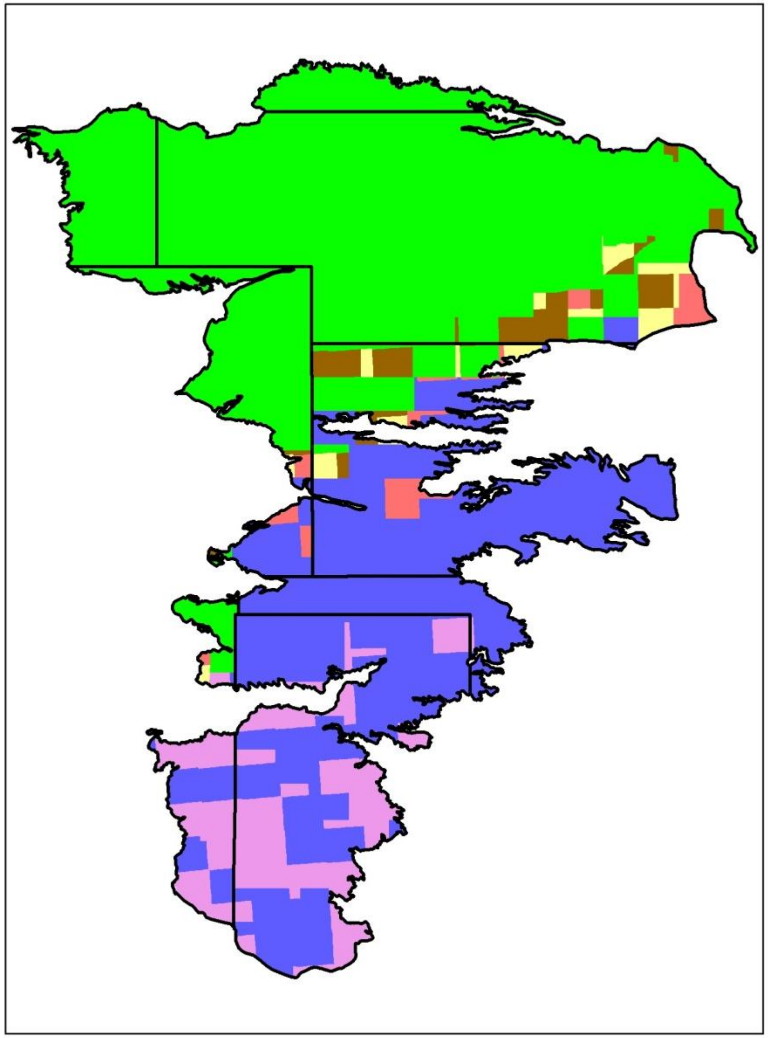


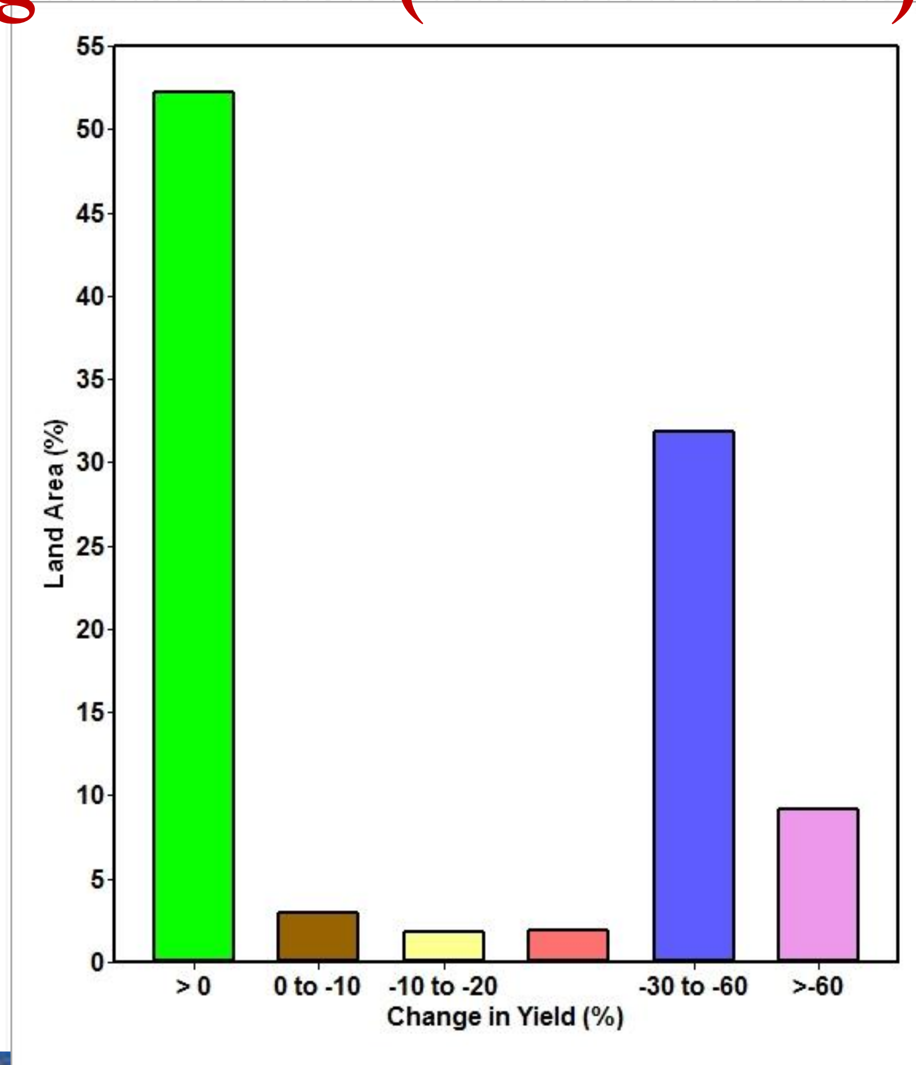
Sorghum Dryland



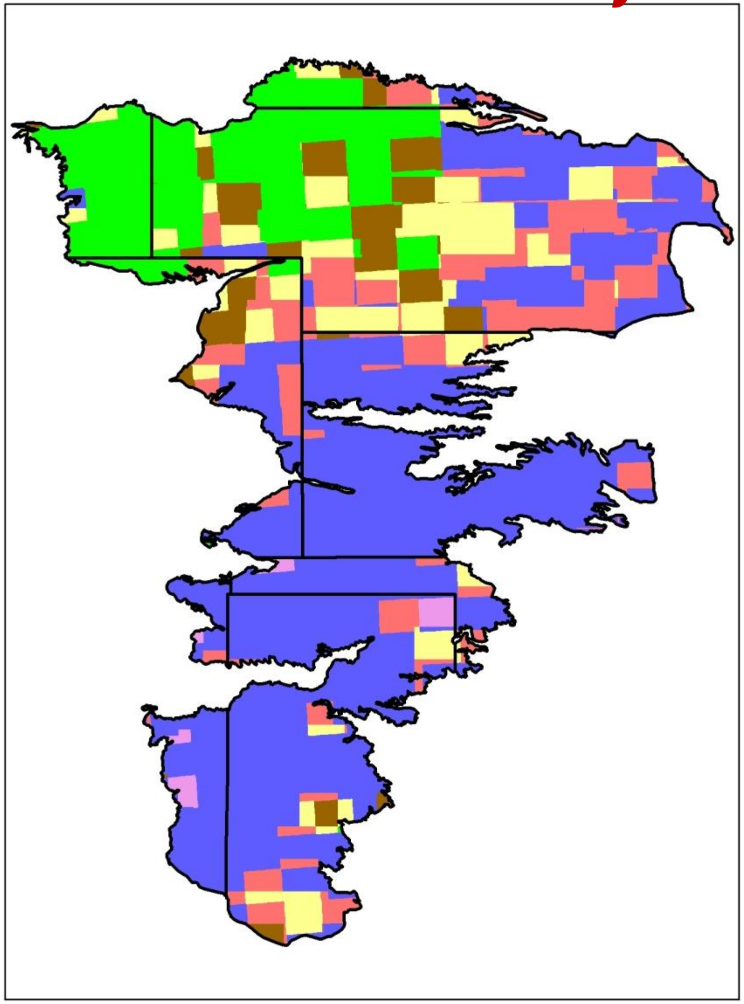


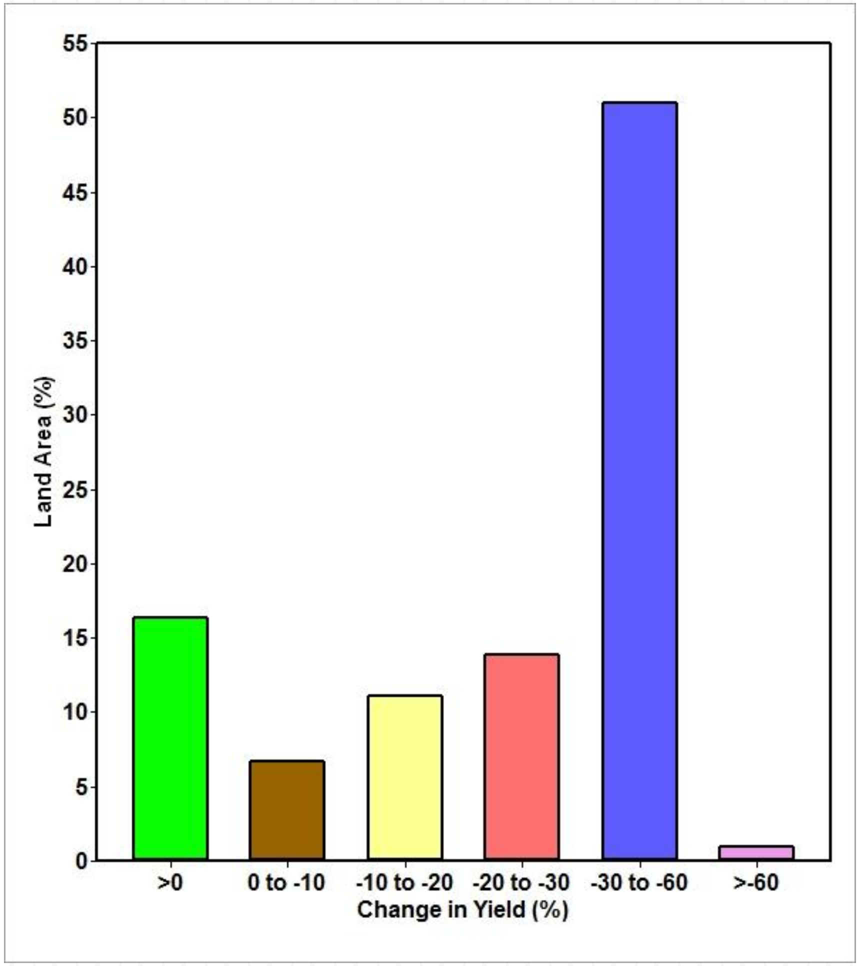
Sorghum Dryland, Cultivar change
Short duration to Long duration (30 d increase)





Sorghum Dryland, Planting Date Change
Early Planting (30 d)





Comprehensive Change – Genetics, Management and Climate (Grain Sorghum) – 30 years simulations

Genetic Traits	Ranges	Initial Value	Final Value	Yield change range (%)	Avg. yield change (%)
Thermal time grain filling to maturity (P5)	450-600	540	600	7-10	+8
Partitioning to panicle (G2)	4.5-6.5	6	6.5	4-7	+6
Phylochron interval (PHINT)	40-49	49	40	3-7	+5.5
Relative leaf size (G1)	3-22	11	13	1-2	+1
Management					
Cultivar duration	90-150	100	130	0-100	+10
Planting date	May - July	June	May	0-100	+10
Carbon dioxide	380 - 660	330	475 - 600	10 - 20	+14
					+54
Climate Change (Temp)	4-6	base line	4-6	10-60	-30 to -40

Conclusions

1. Climate models (A2 scenario) suggest increases in temperature and highly variable rainfall distribution

2. Distinct variations in the three climate models suggest inherent uncertainty in predictions

3. Changes in climate will influence crop productivity

4. Genetics and crop management decisions can help manage/mitigate yield losses

5. Agricultural production in the Ogallala region would be highly susceptible to the future climates and therefore requires appropriate mitigation/adaptation strategies

Acknowledgements

- *Colleagues at Crop Physiology Lab, Kansas State University*
- *North American Regional Climate Change Assessment Program (NARCCAP) for providing the data*
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Thank You

QUESTIONS

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