



Cereal production systems in North America: Challenges for effective adaptation

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**Transitioning Cereal Systems
to Adapt to Climate Change**

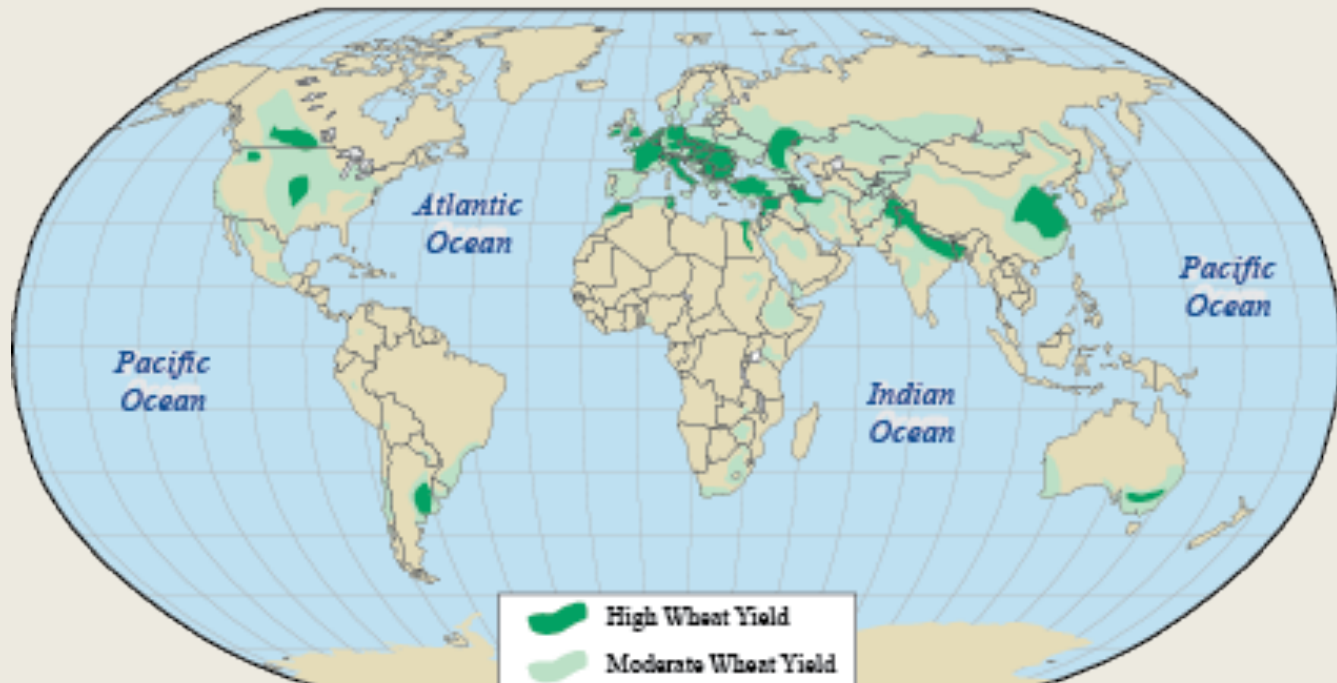
November 13-14, 2015

Cereal Crops and Climate Change

Ensuring Future Supplies

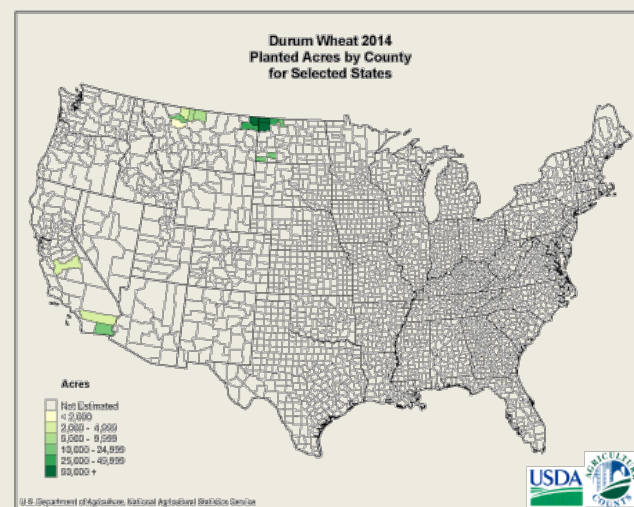
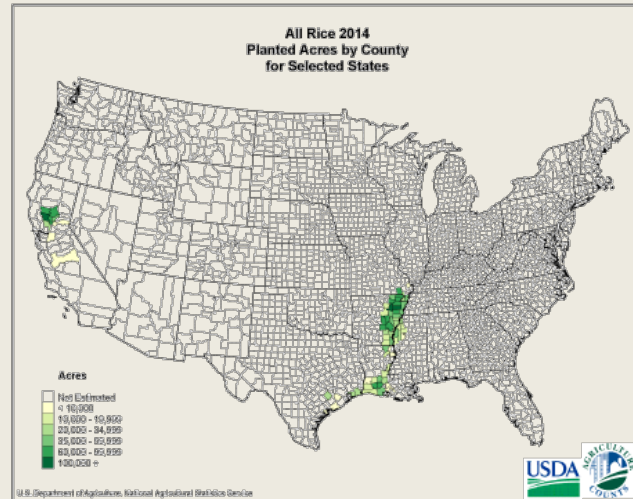
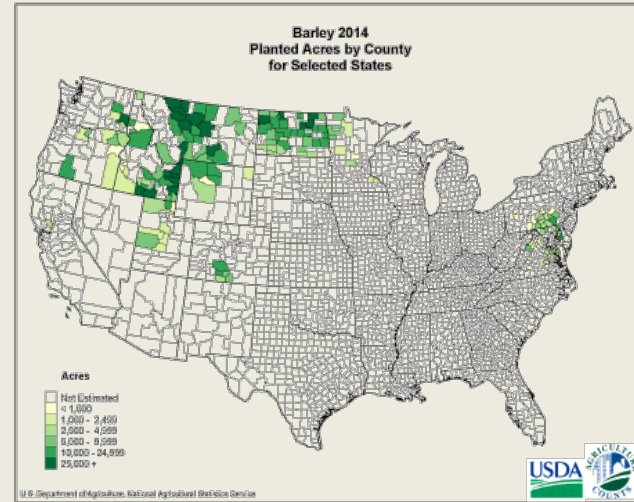
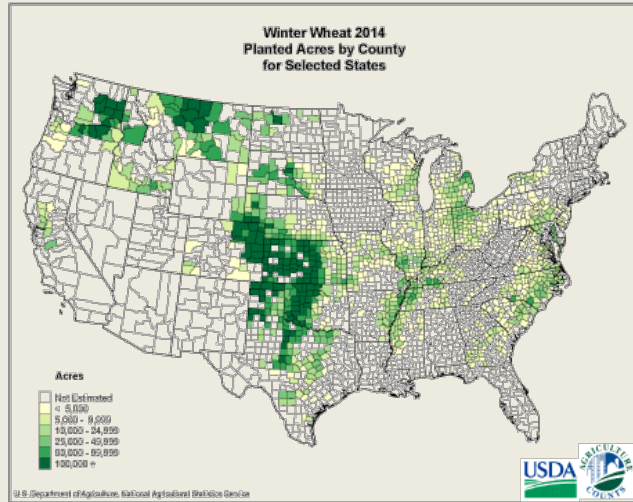
World Distribution of Cereals

Where is the Wheat?

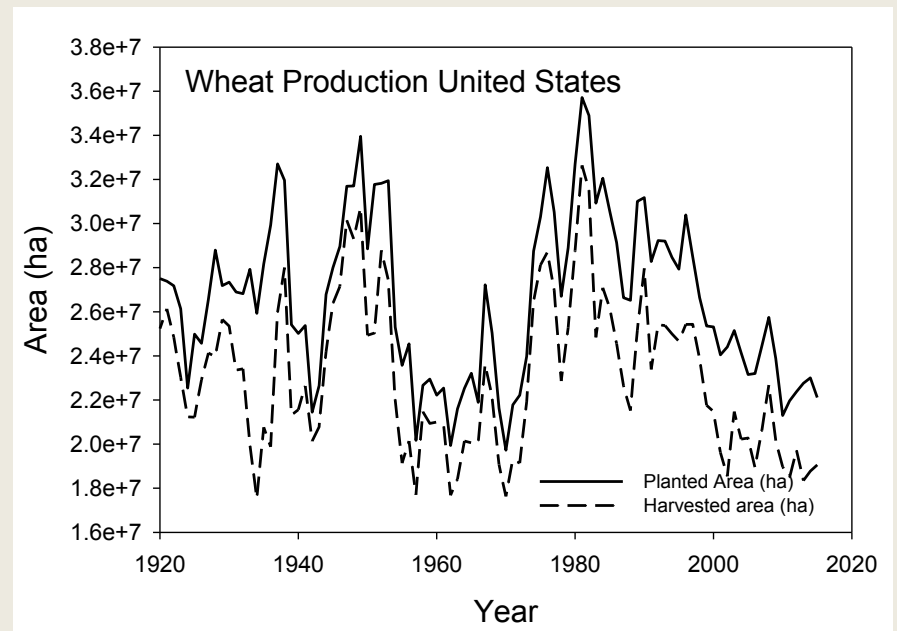
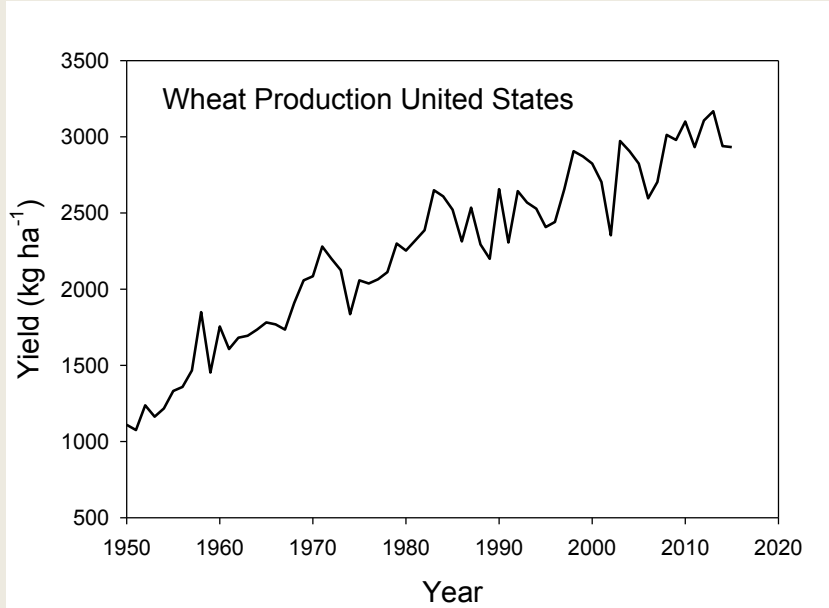


Geography in the News 9/9/11 Source: Goode's World Atlas, 20th ed. M. Shears

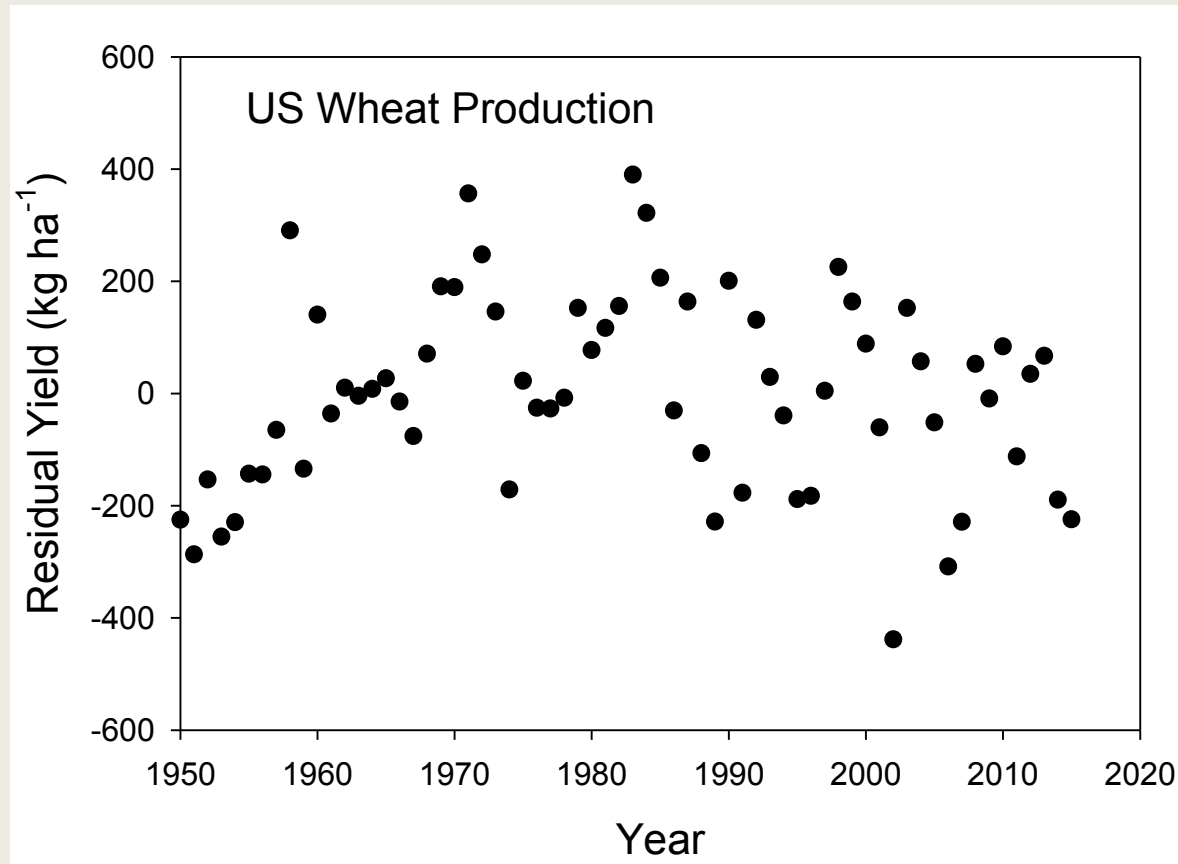
United States Production



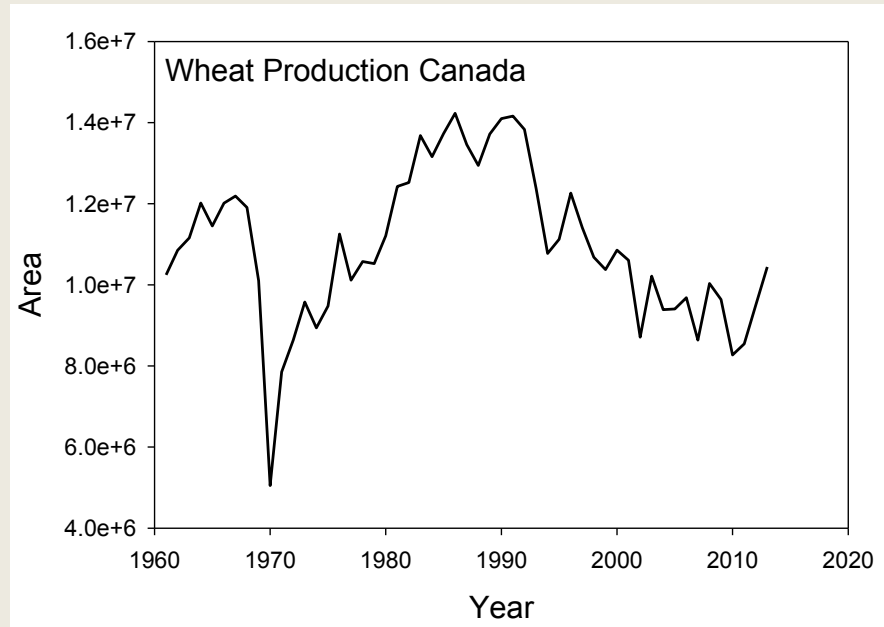
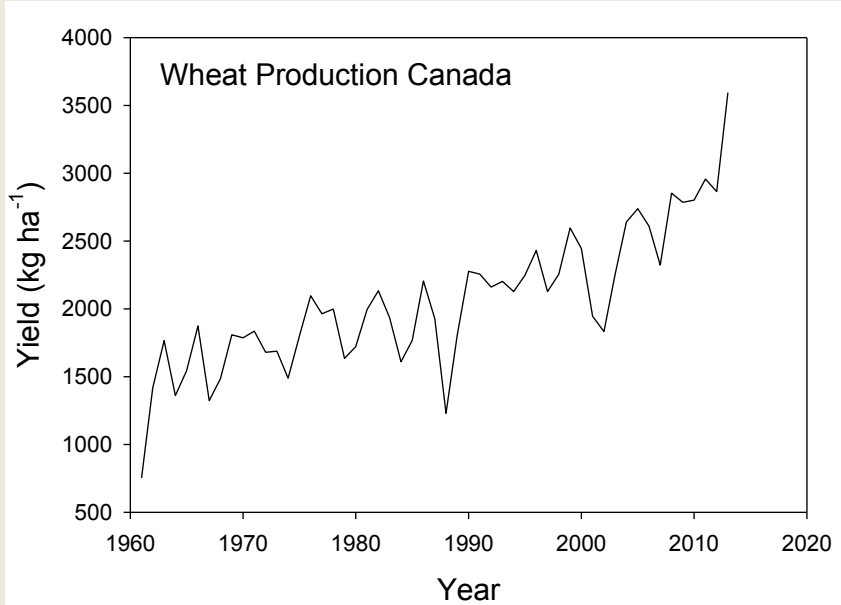
Wheat Production United States



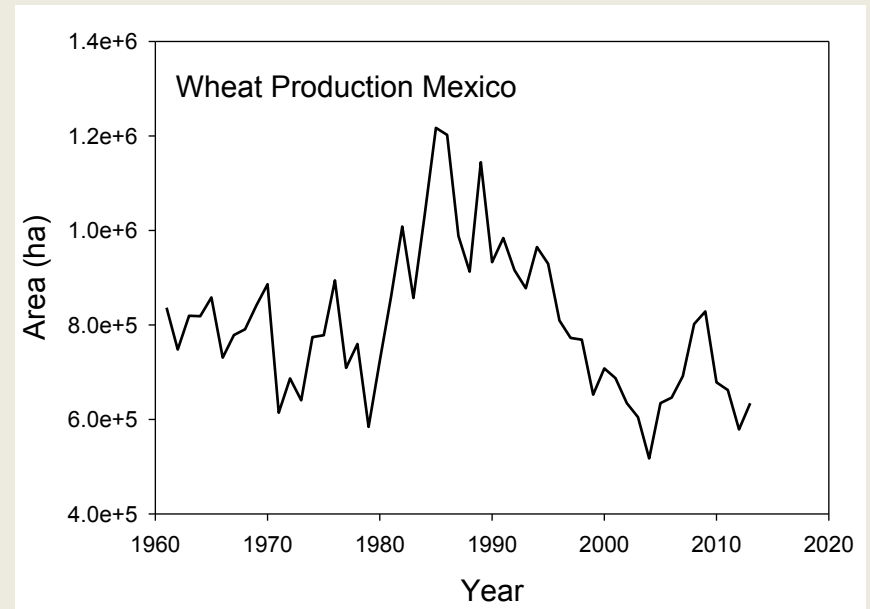
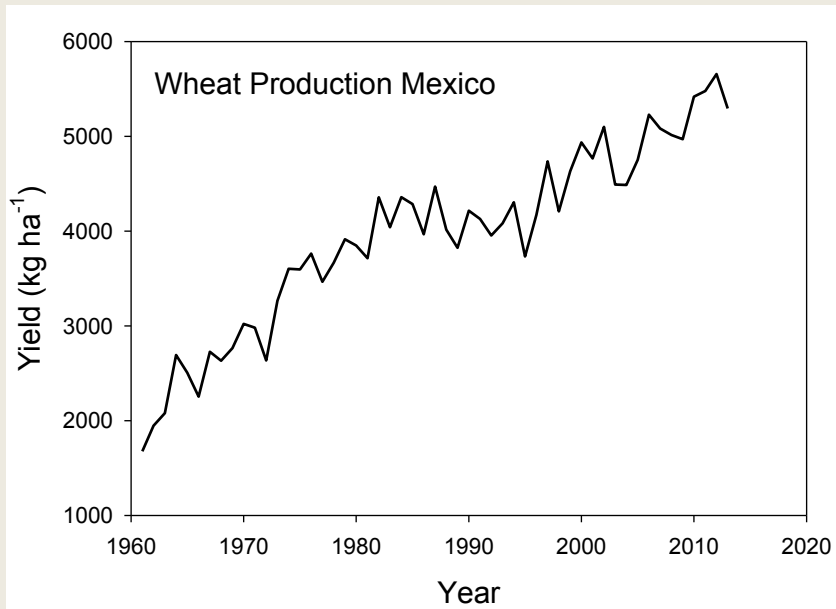
Residual Yields



Canada Wheat Production



Wheat Production Mexico



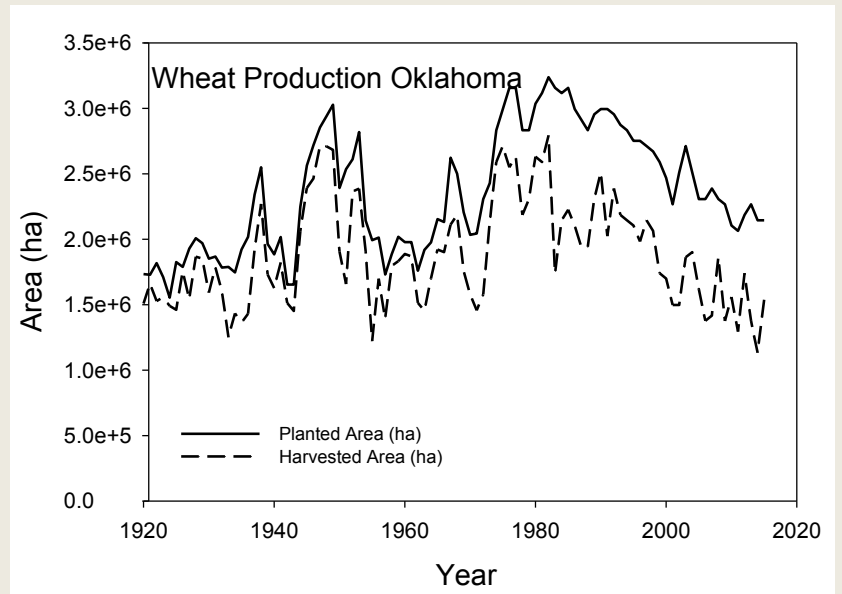
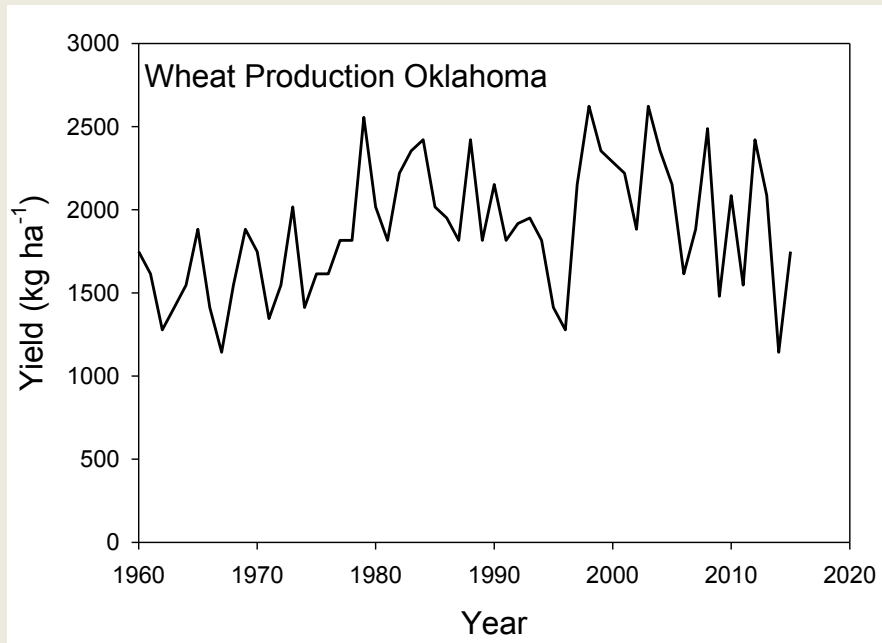
Wheat Yield Increases

- Mexico – 59.30 kg ha⁻¹ yr⁻¹
- Canada – 27.87 kg ha⁻¹ yr⁻¹
- United States – 28.03 kg ha⁻¹ yr⁻¹

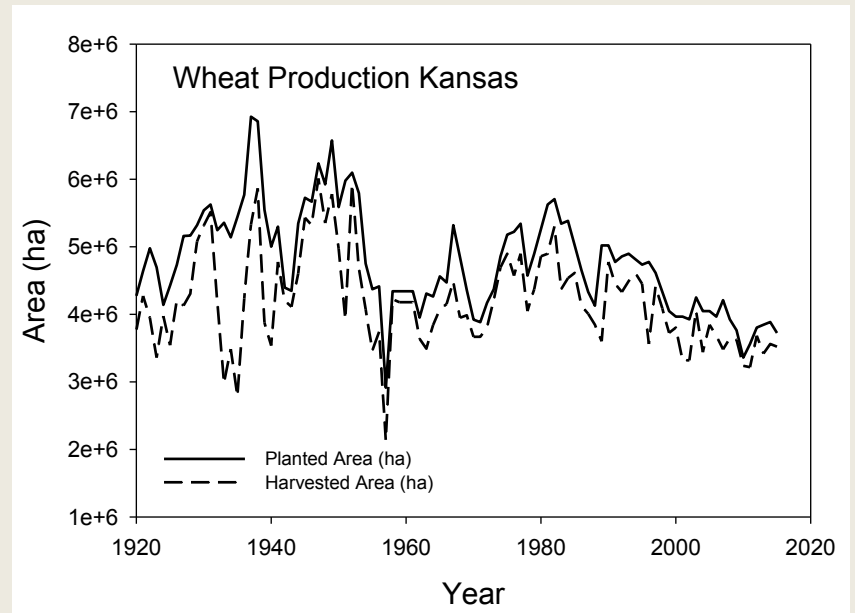
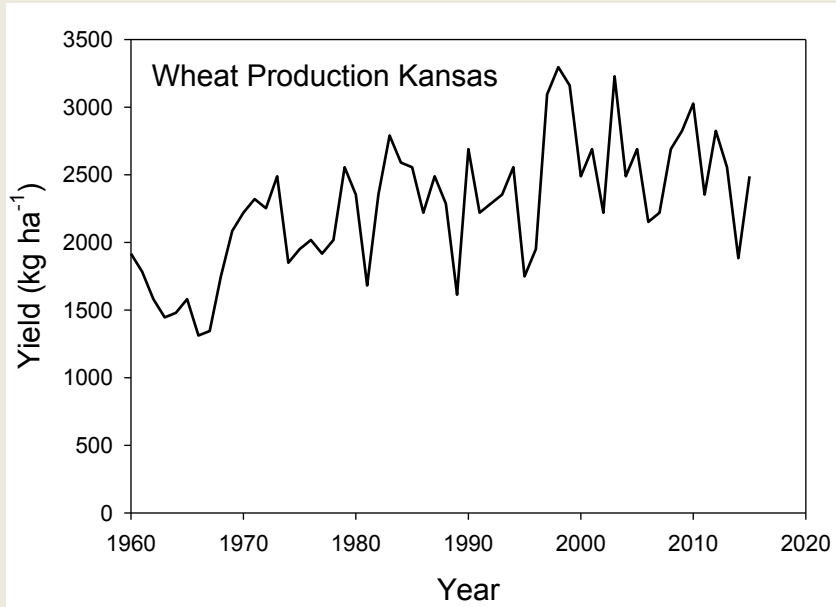
Climate Impacts

- Temperature
 - Heat
 - Frost
- Precipitation
 - Spring vs Fall

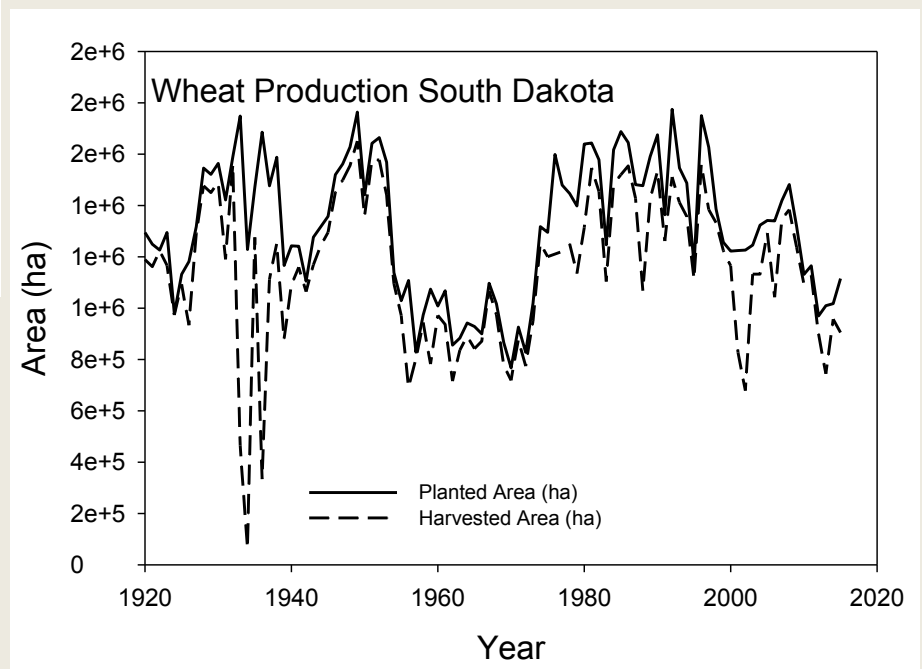
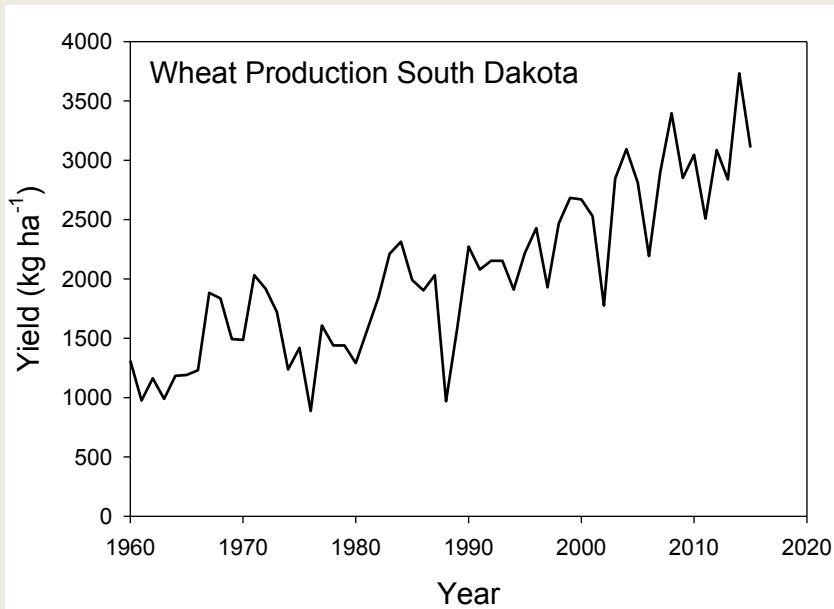
Oklahoma



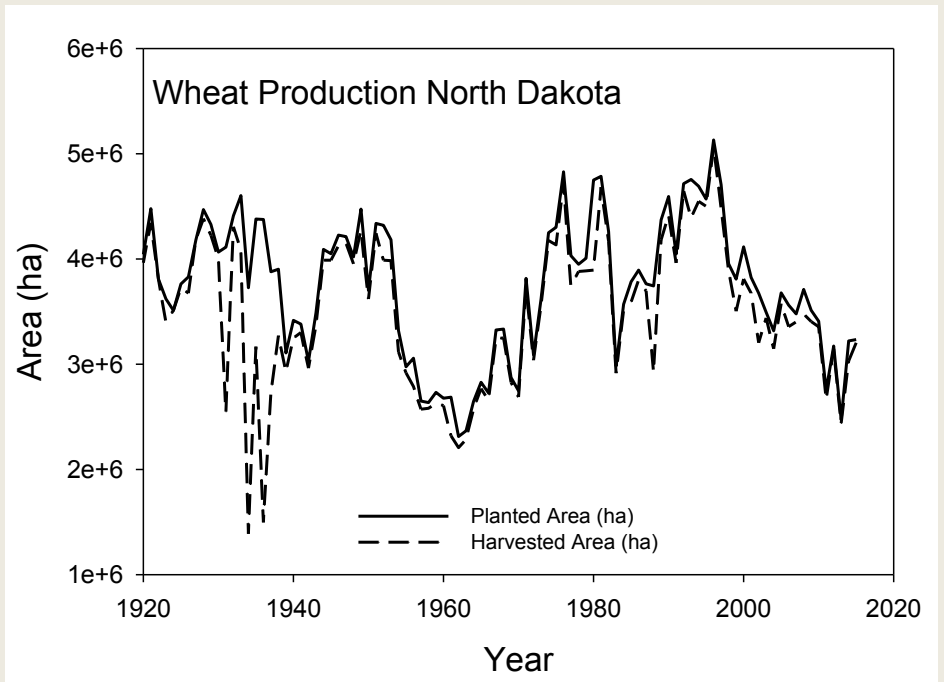
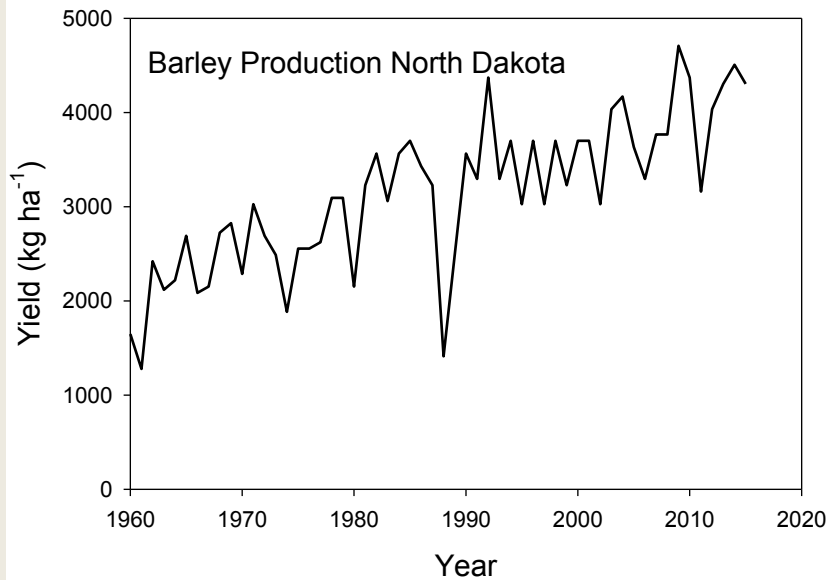
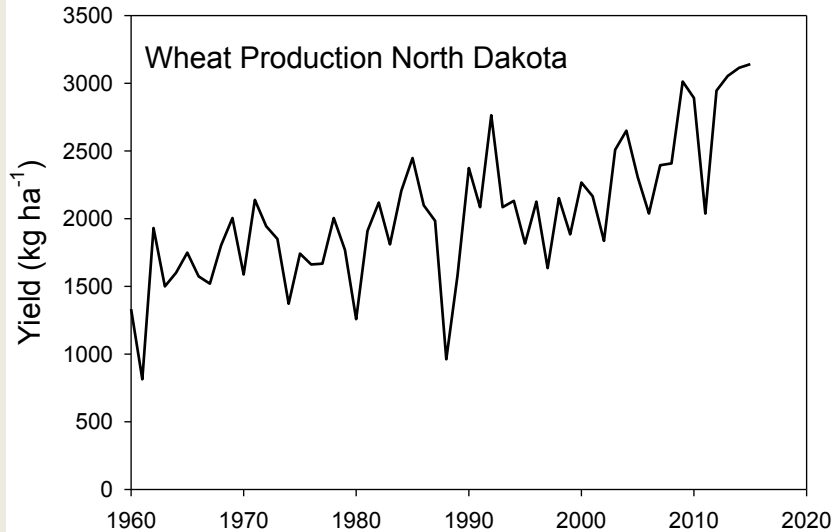
Kansas



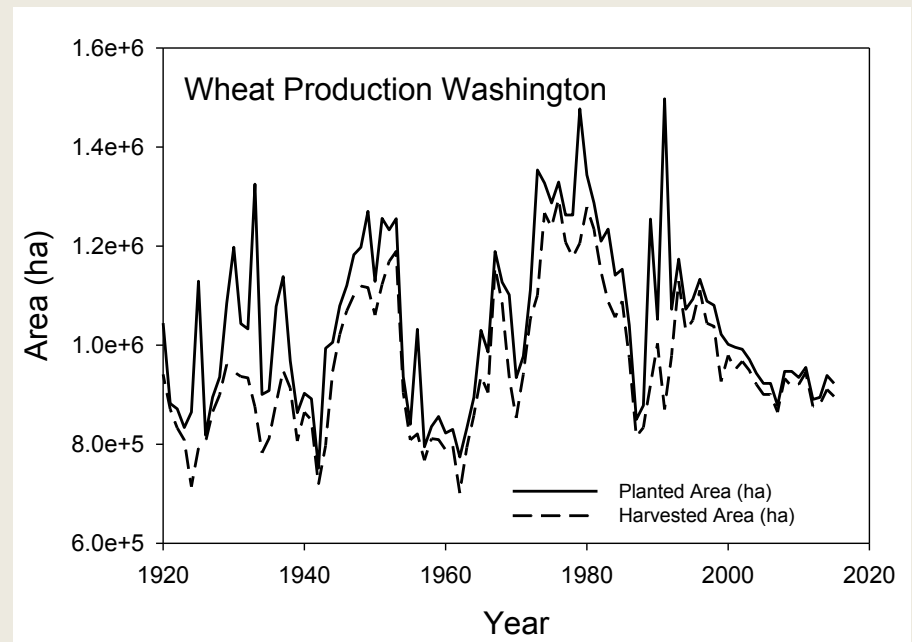
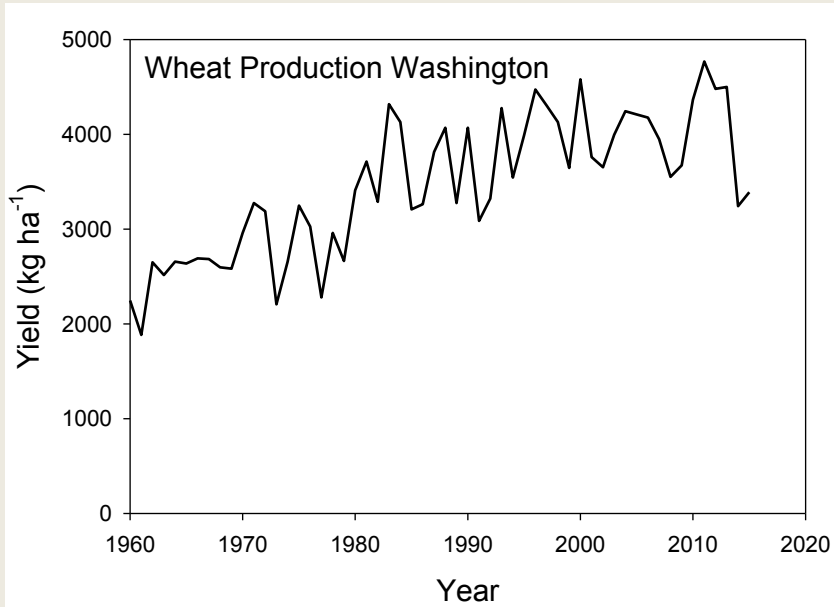
South Dakota



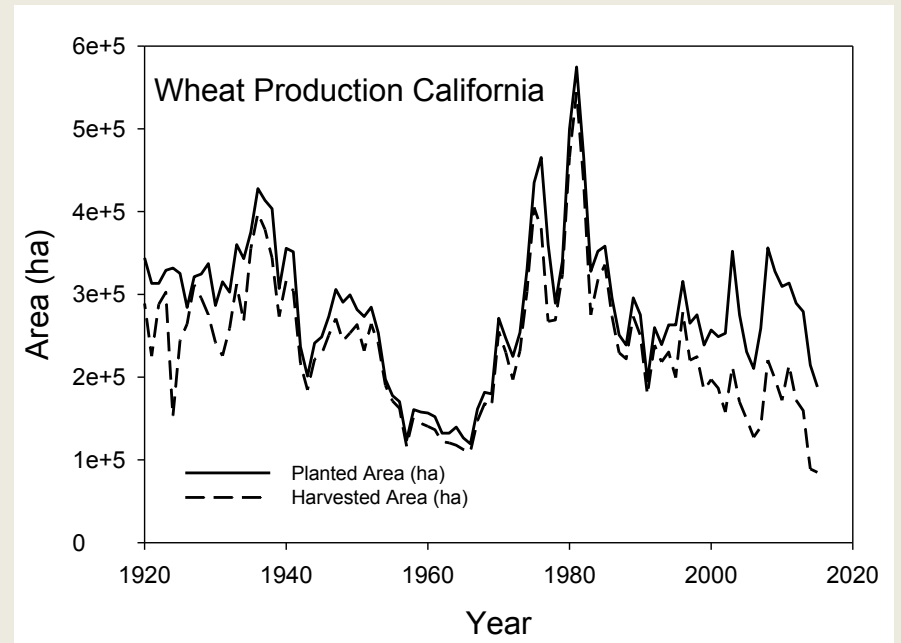
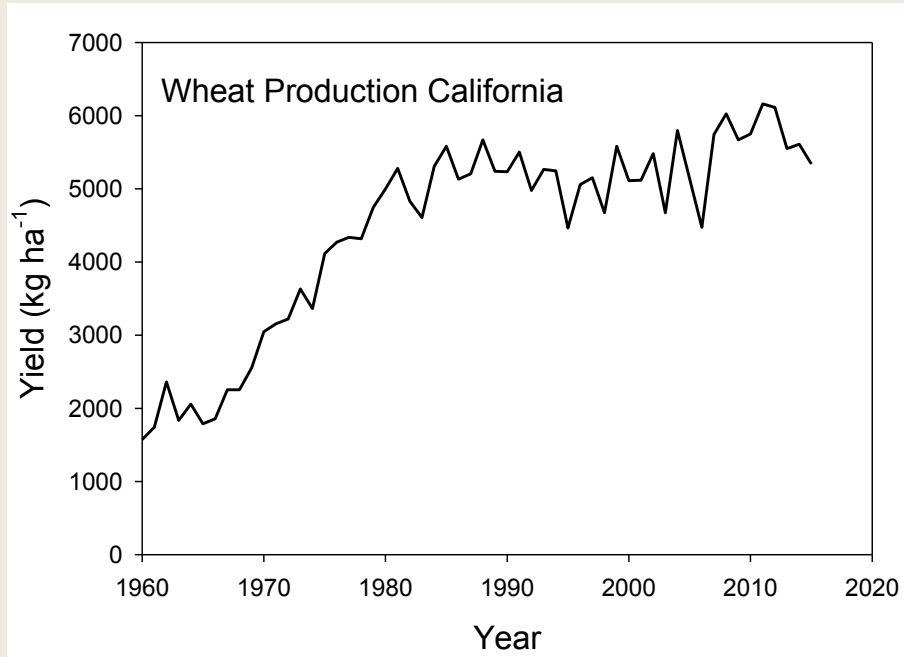
North Dakota



Washington



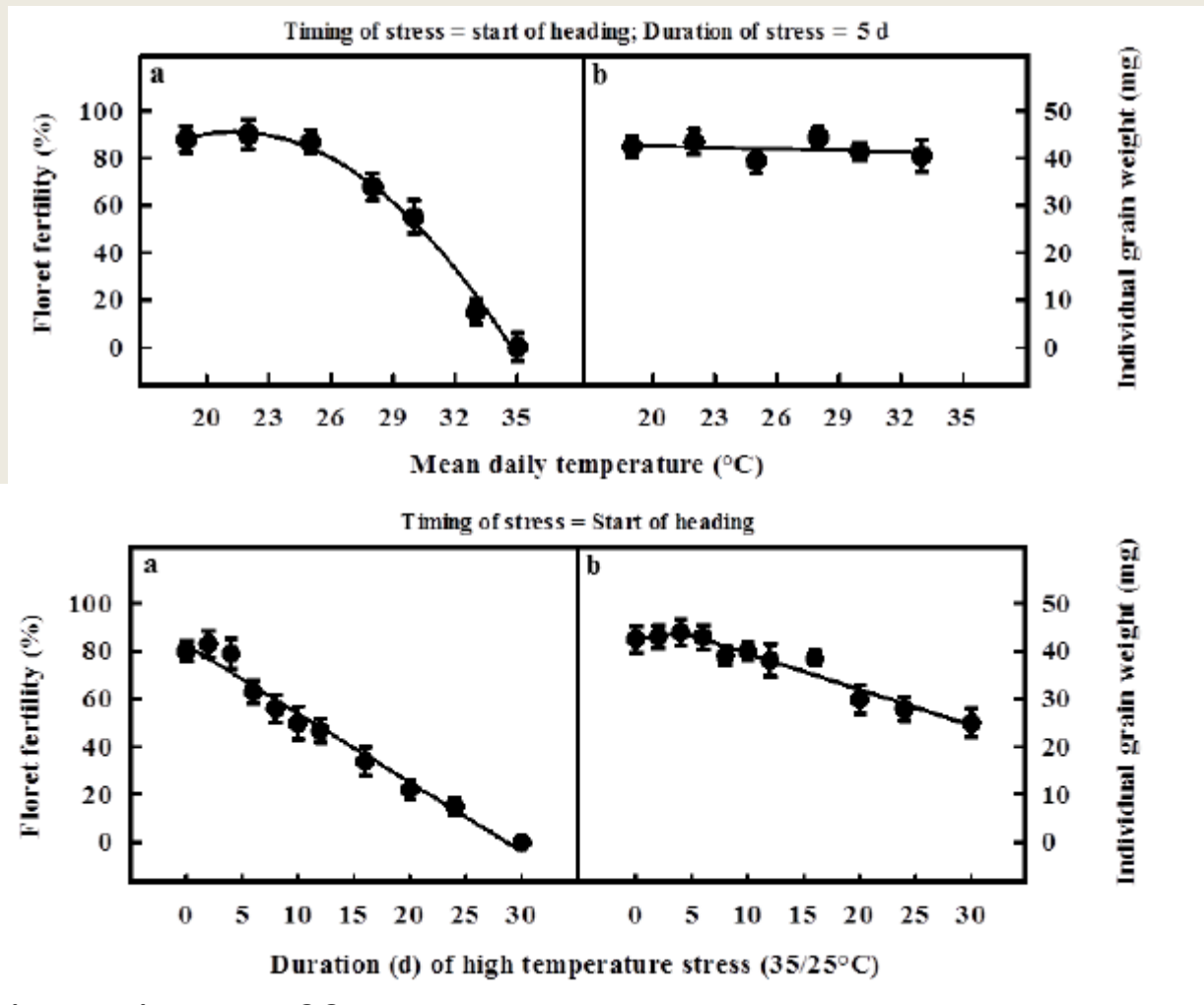
California



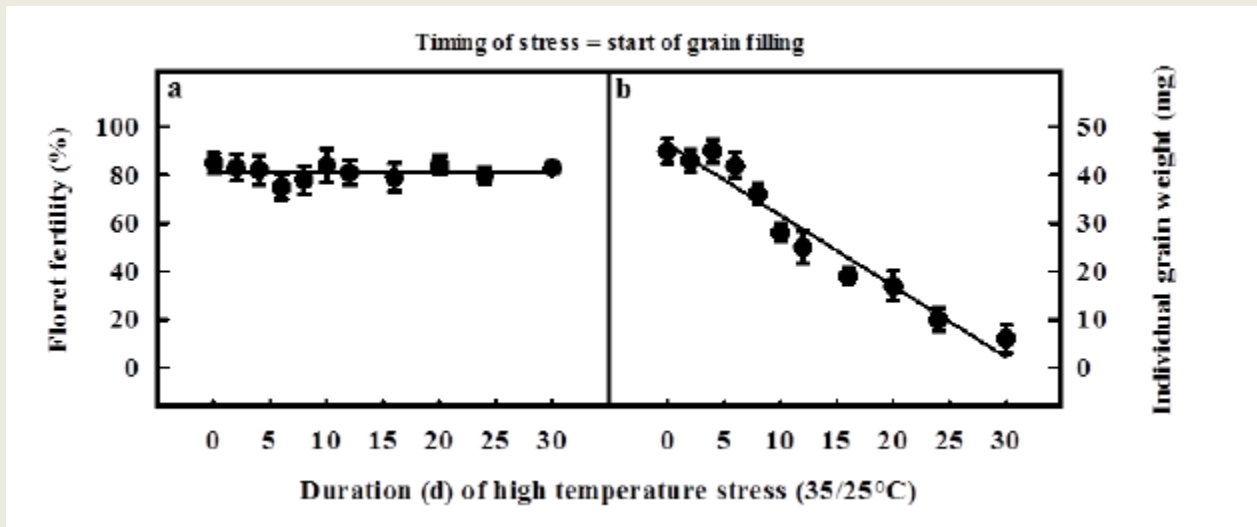
Observations

- Southern portion of the wheat belt is showing yield declines since 1990
- Yield increases are occurring in more northern latitudes of the wheat belt
- Combination of factors primarily related to temperature

Temperature Impacts

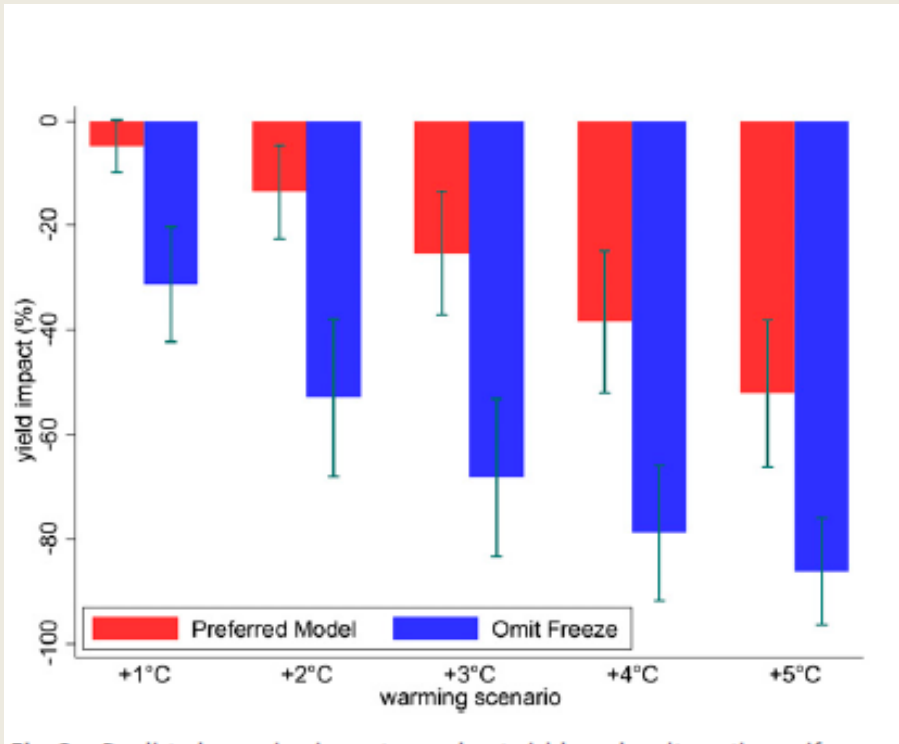


Temperature Impacts

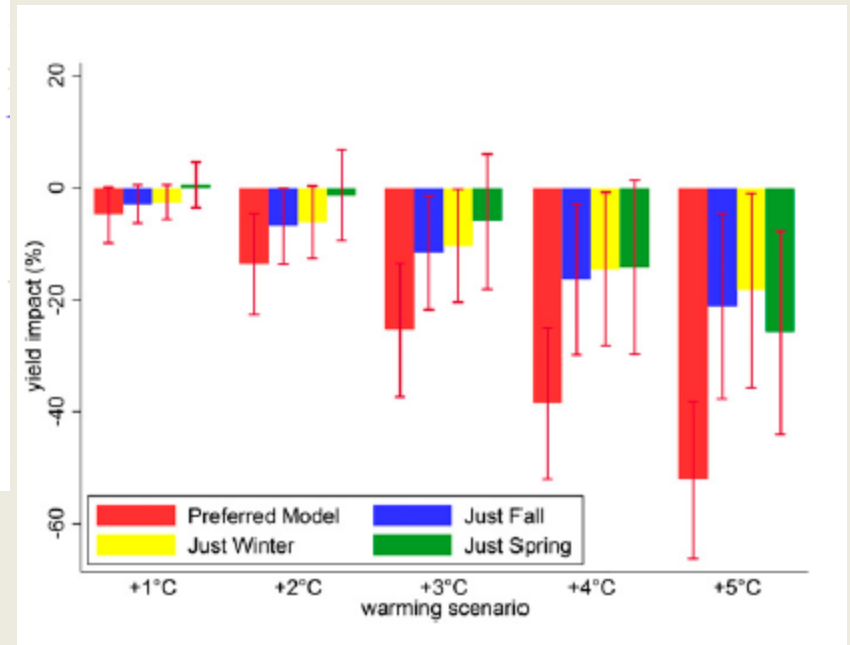


Prasad and Djanaguiraman, 2014

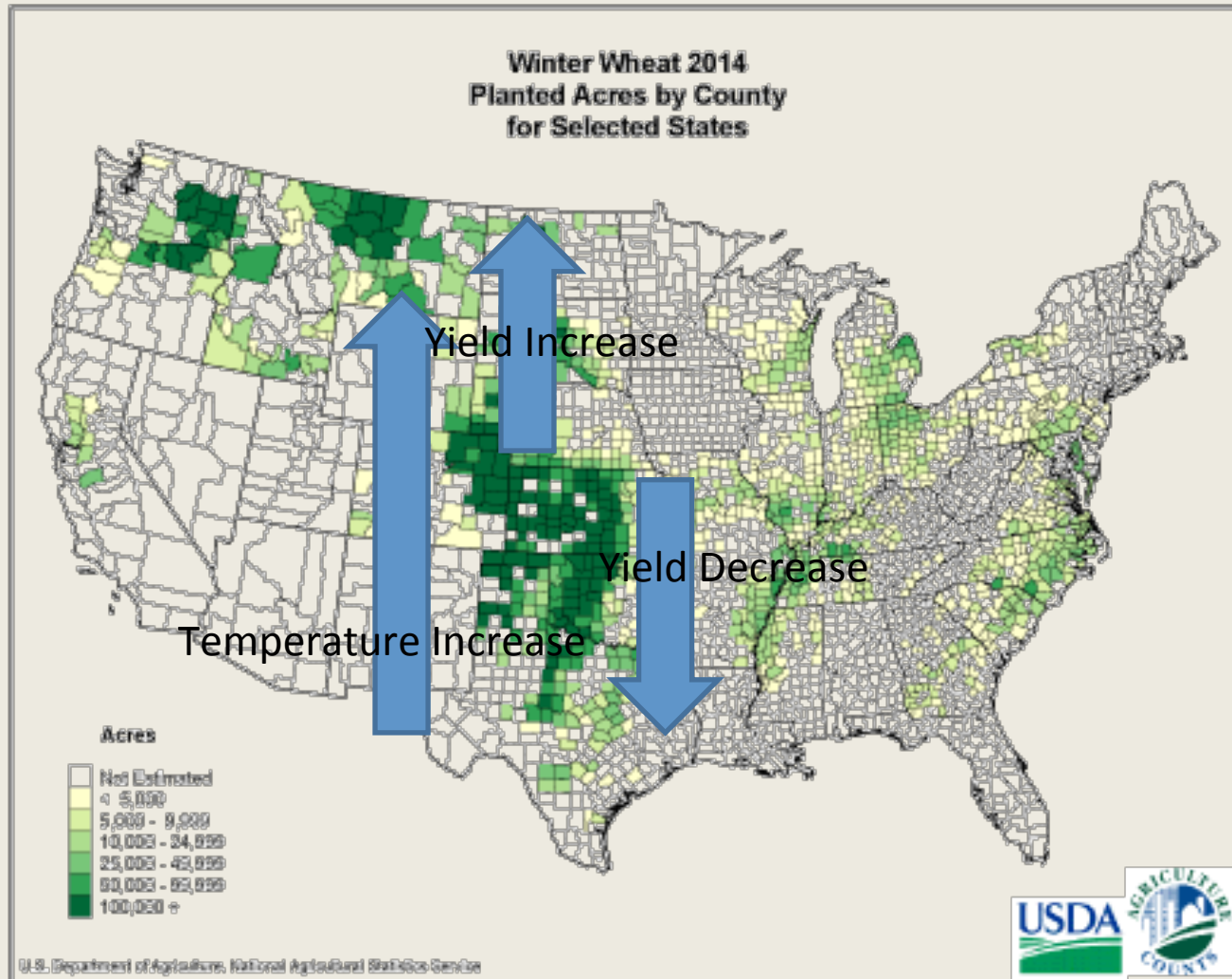
Kansas Wheat Yield Analysis



Tack et al. 2015 PNAS



Changing Climate



Implications

- Increasing temperature in the flowering and grain-filling period in the southern wheat belt will continue to decrease yields
- Temperature extremes (frost) and high temperatures (pollination) will affect yield
- Temperature increases bring northern wheat belt into more favorable regime
- Soil water more of a factor in western wheat production areas (CA, OR, WA)



Thank you!

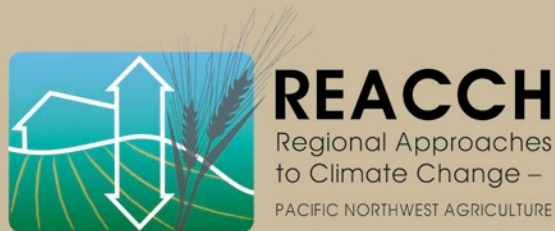
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Monsanto