

Climate and Agriculture



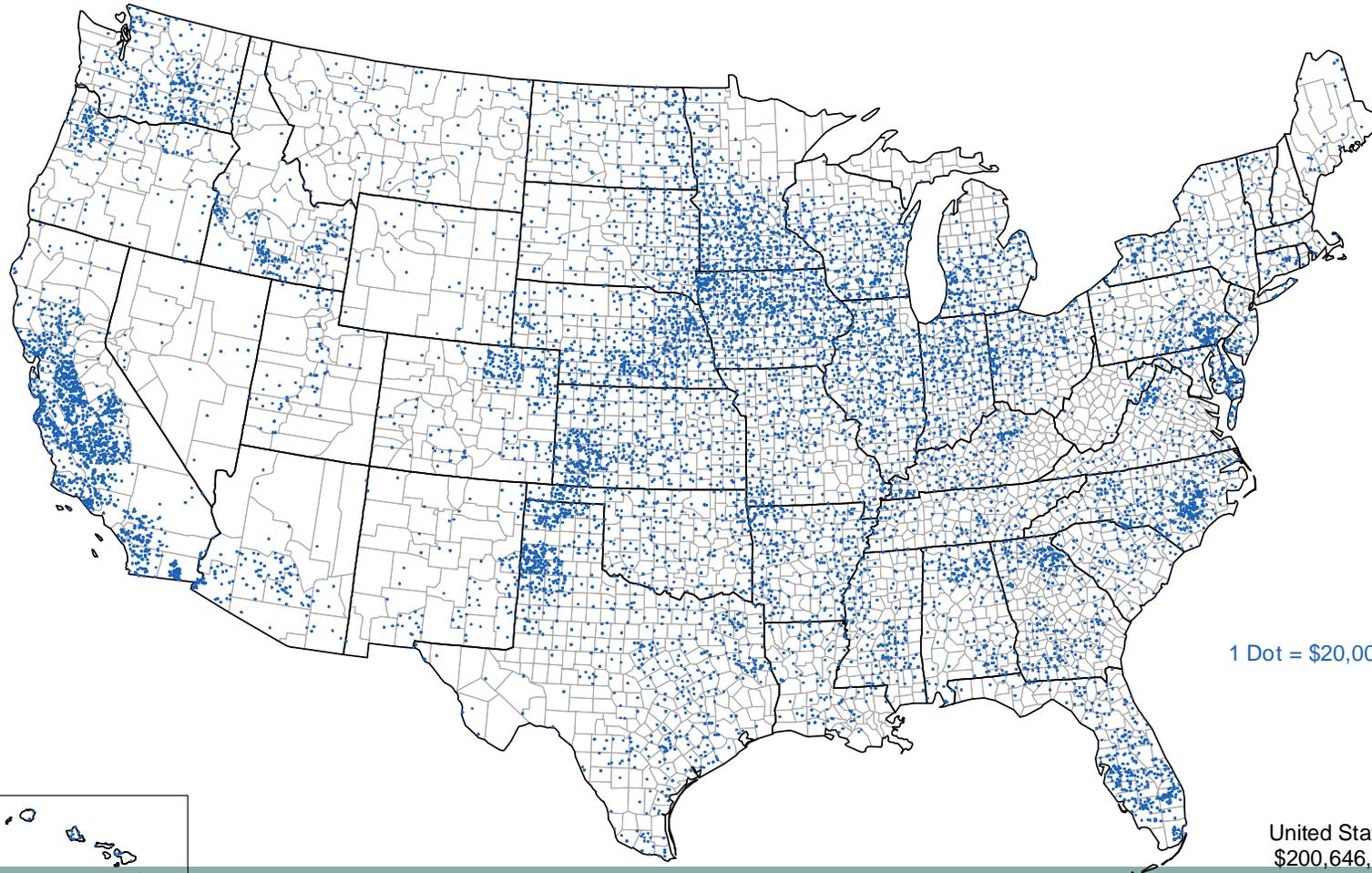
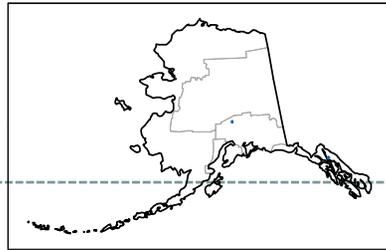
CHALLENGES FOR EFFICIENT PRODUCTION

Diversity of Agriculture



- **Annual Crops**
- **Perennial Crops**
- **Pasture and Rangeland**
- **Animals**
 - Range
 - Confined

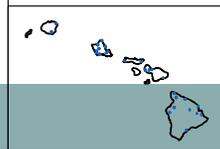
Market Value of Agricultural Products Sold: 2002



1 Dot = \$20,000,000

United States Total
\$200,646,355,000

2002 Census of Agriculture



Climate Impacts Agriculture



- **Temperature**
- **Carbon dioxide**
- **Precipitation**
- **Solar radiation**

Climate and Agriculture



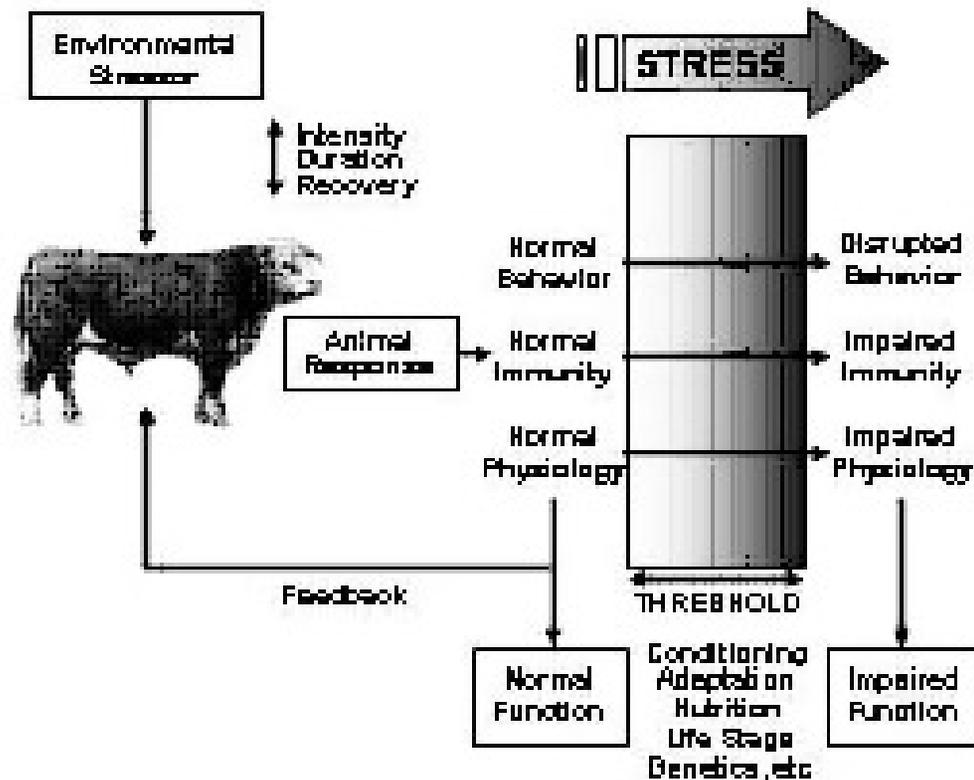
- **Stress from environmental factors affects productivity and efficiency**
- **Both climate and weather affect agricultural production systems**

Animals

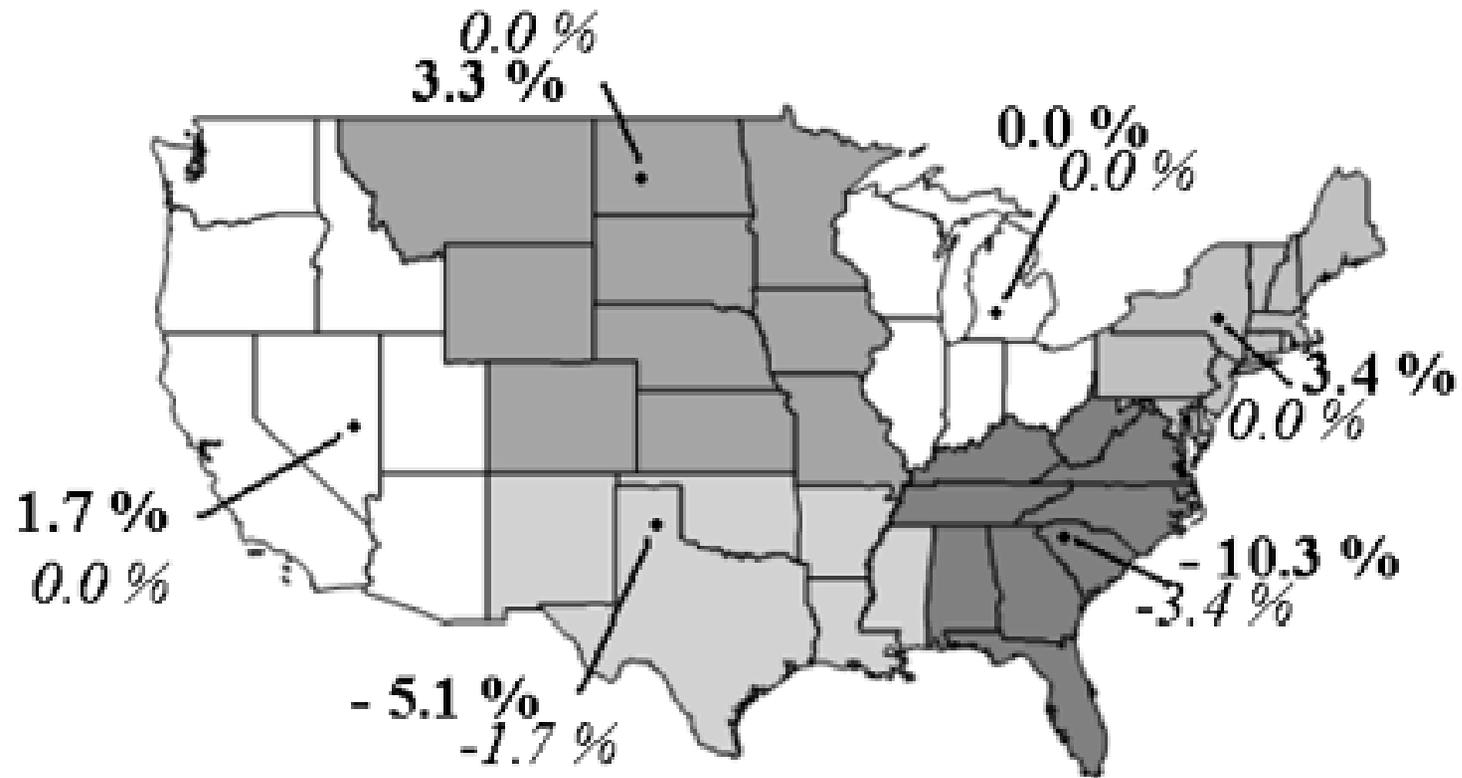


- Optimum temperature is a very narrow range (thermoneutral zone) in which an animal does not need to alter behavior or physiological function to maintain core temperature
- Responses include panting, shivering, reduced feed intake, increased (cold) or decreased (warm) metabolic rates
- Any of these responses will impact productivity (meat, milk, or reproduction)

Temperature Response

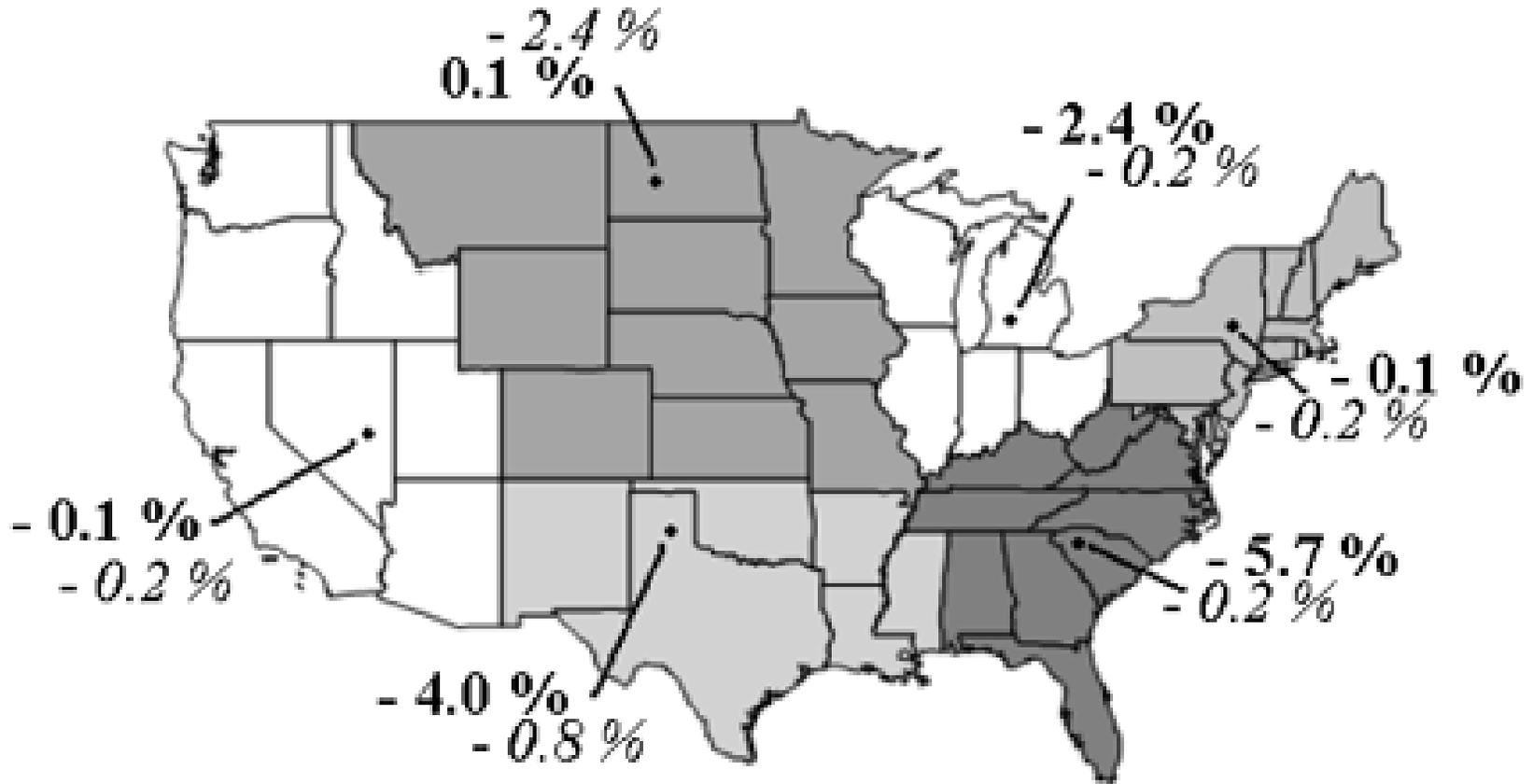


Impacts on Swine Production



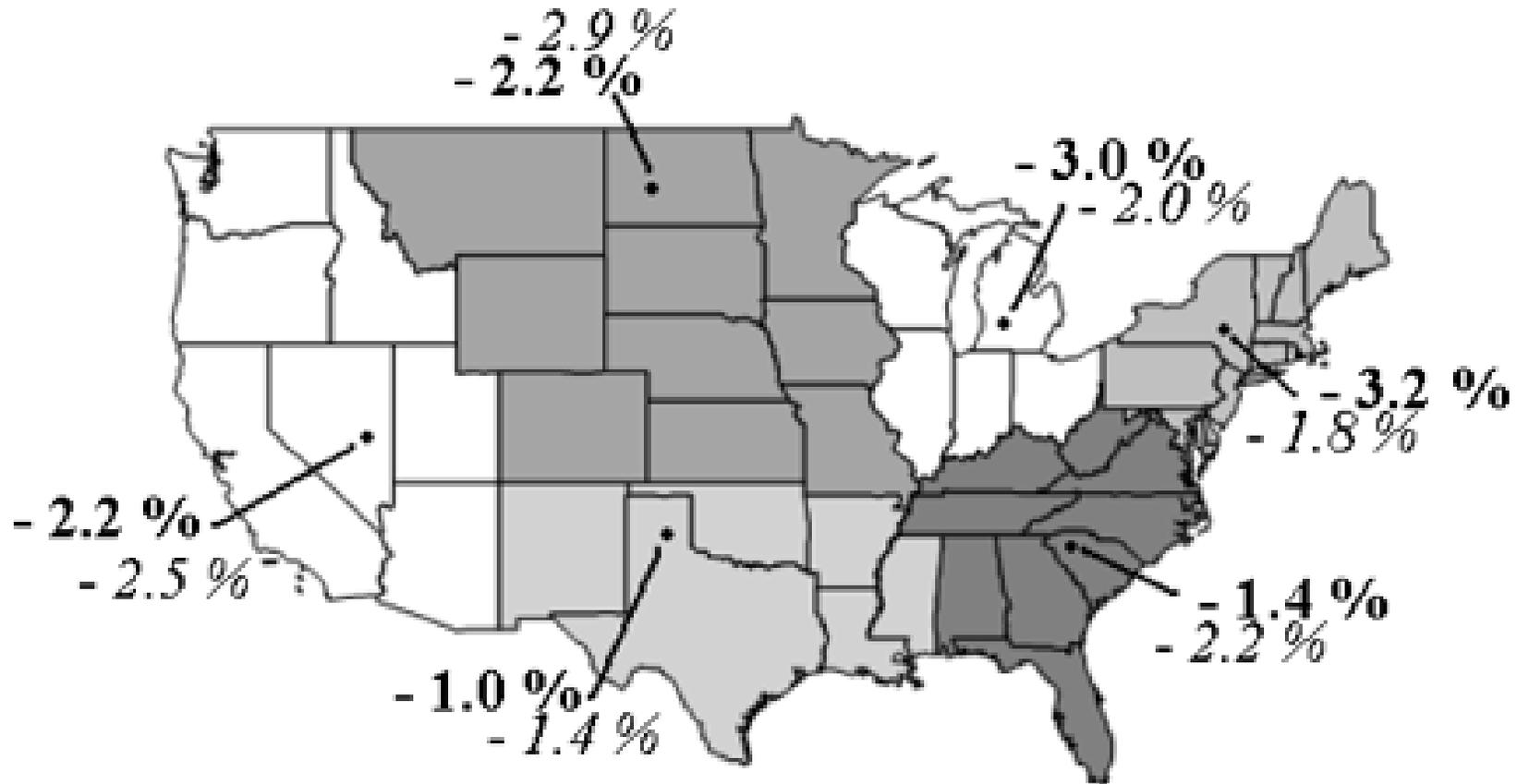
Days for swine to grow from 50 to 110 kg

Impacts on Beef Production



Changes in days to reach market weight

Impacts on Milk Production



Effects on milk production due to temperature increases

Temperature Effects on Reproduction



- Dairy cows reduced conception rate of 4.6% for Thermal/Humidity Index values above 70
- Beef cows reduced conception rate of 3.2% for Thermal/Humidity Index values above 70
- Beef cows 3.5% reduction in conception rate for each degree of temperature increase above 23.4C

Episodic Temperature Events



- High temperature episodes causes stress in animals which affects rate of gain, milk production
- Cold temperature episodes affect feed consumption and survival of young animals
- Temperature extremes lead to economic loss on order of Millions of dollars

Challenges



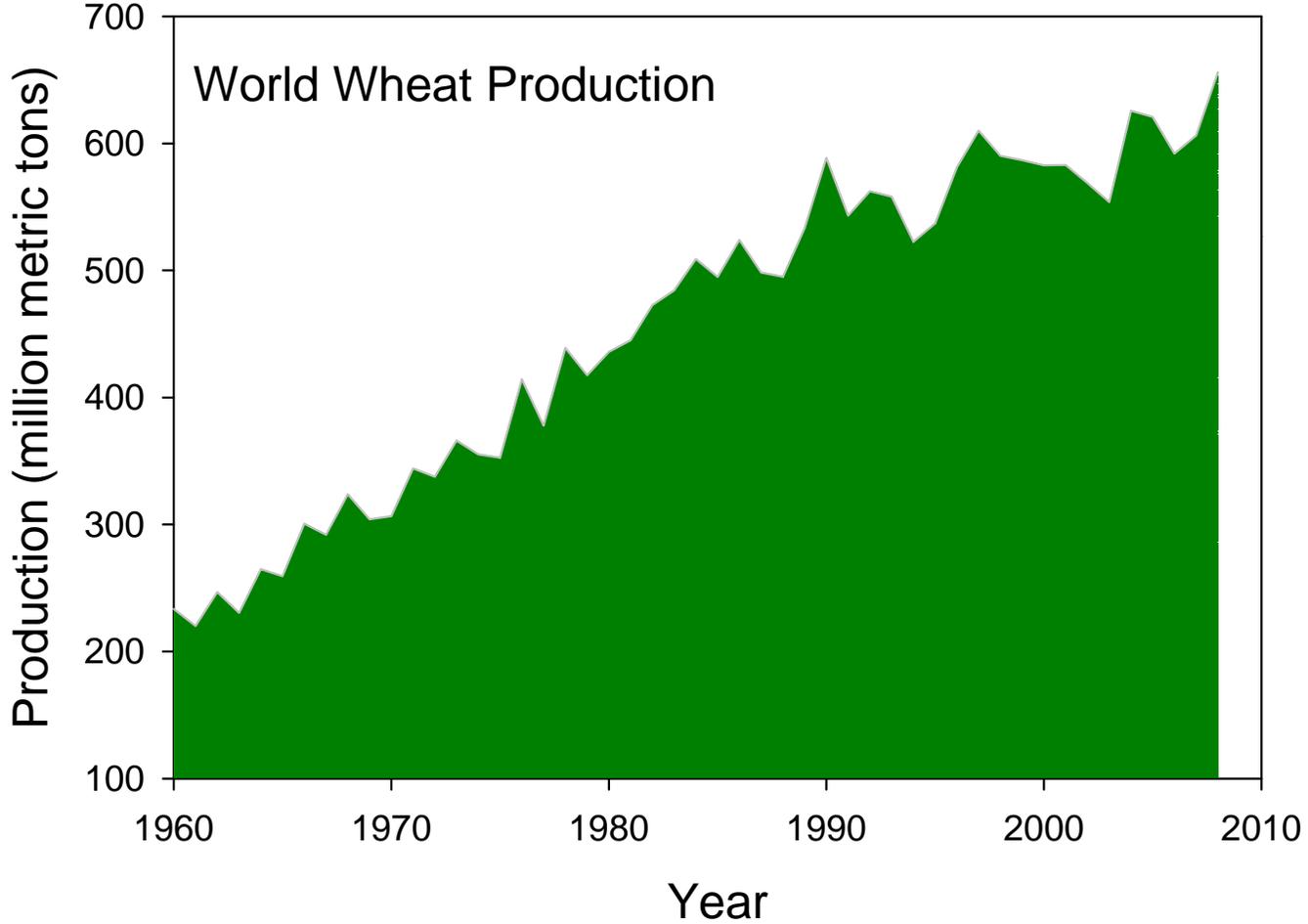
- **Manage animal production systems to decrease exposure to extreme temperature events**
- **Capital investment in facilities to reduce potential thermal stress**
- **Increased investment in ensuring adequate water for range animals**

Crop Production

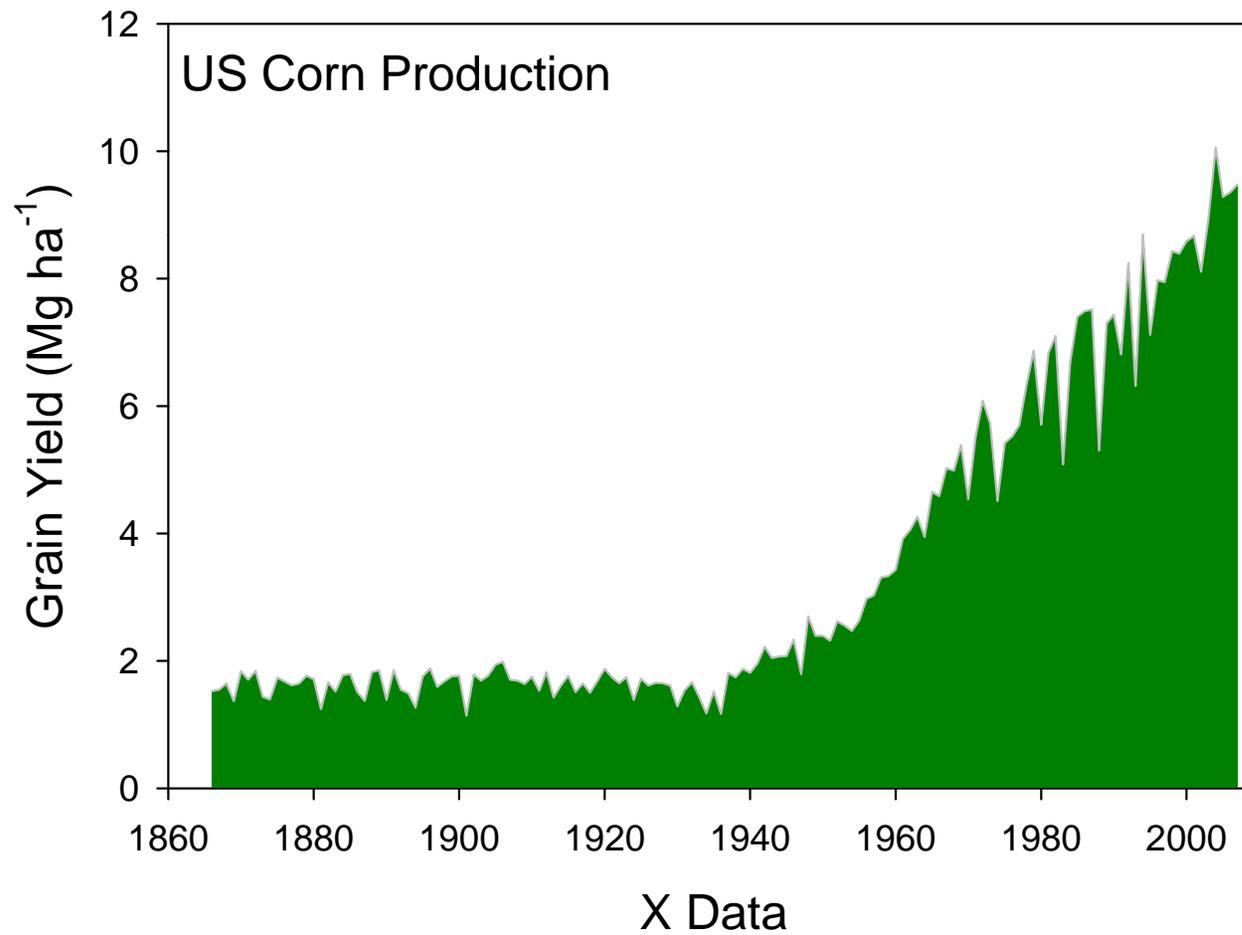


- **Variation among years due to within season weather impacts**
- **Long-term yield trends reveal the impacts of climate on crop production**

World Wheat Yields



Corn Yields

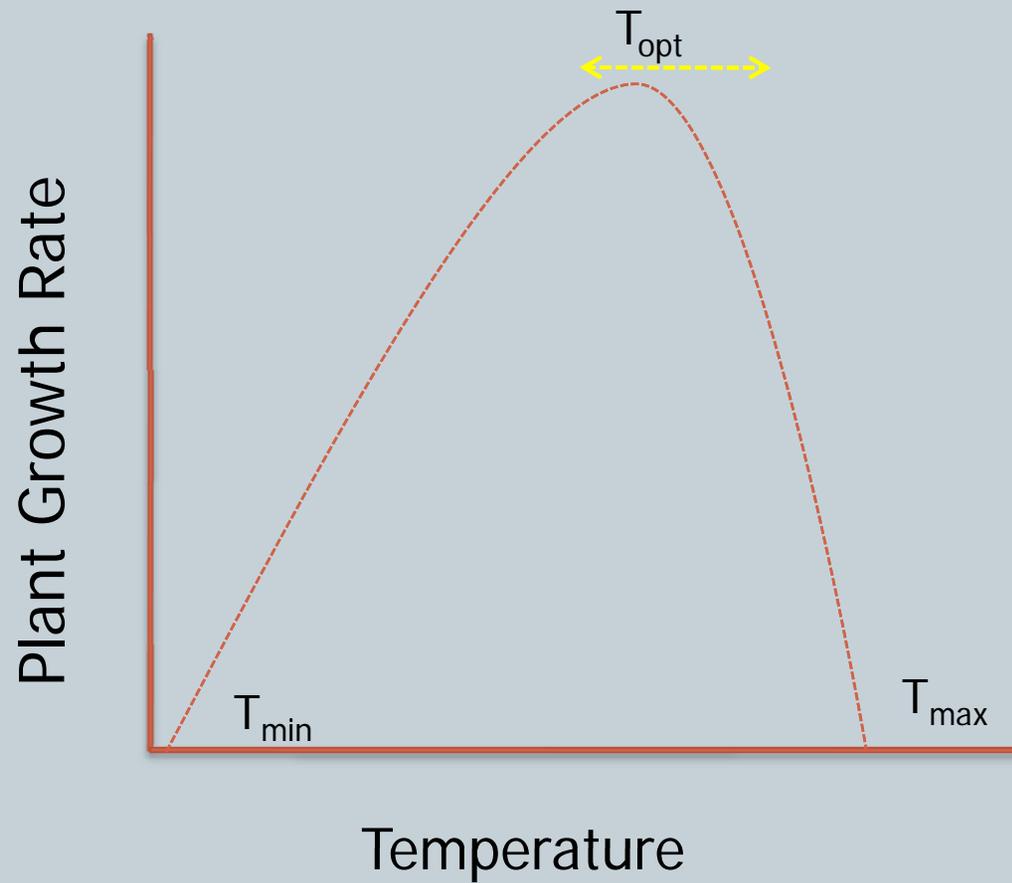


Plant Temperature Responses

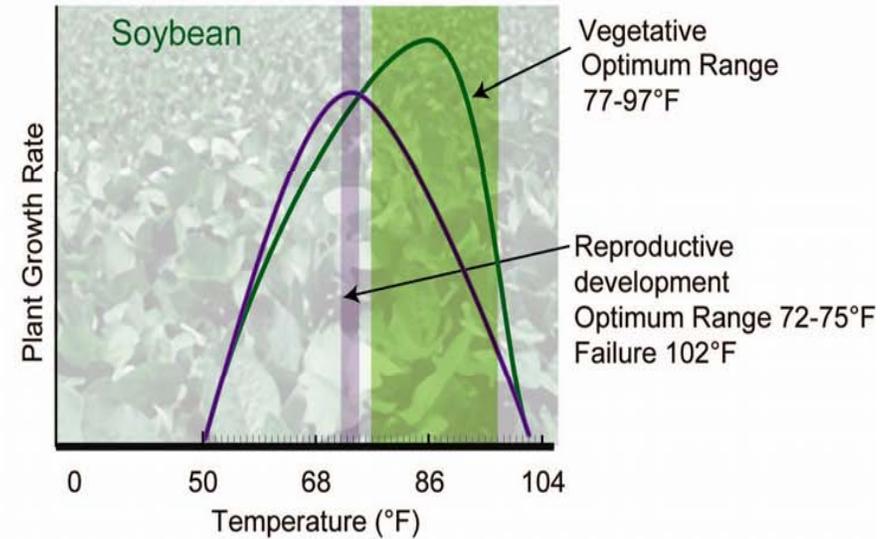
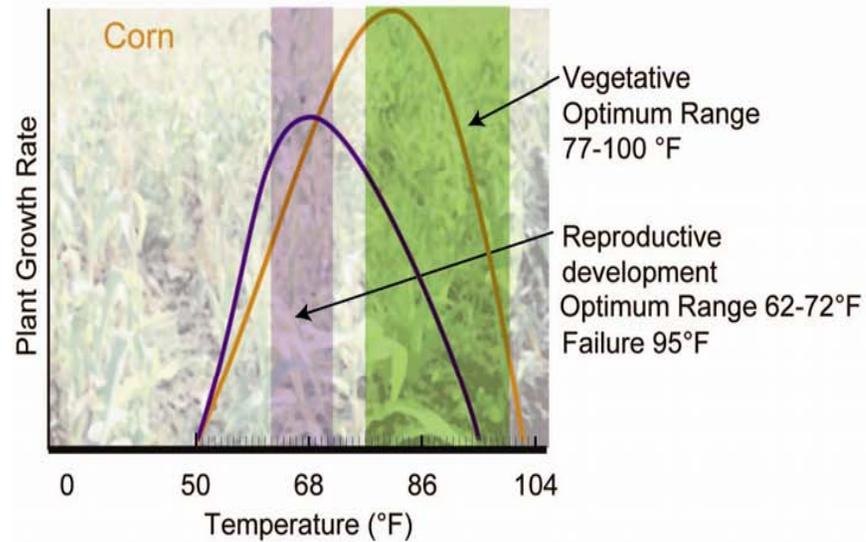


- Variation among plants
- Variation among plant phenological stages
 - Germination
 - Vegetative Growth
 - Reproductive Growth
- Difference between air temperature and plant temperatures

Temperature Responses of Plants



Temperature Responses

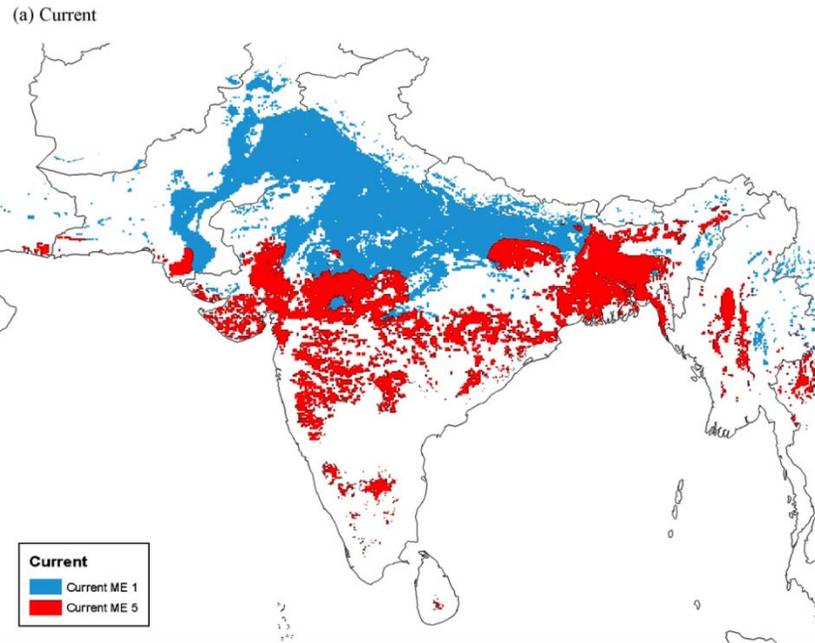


Temperature Impacts

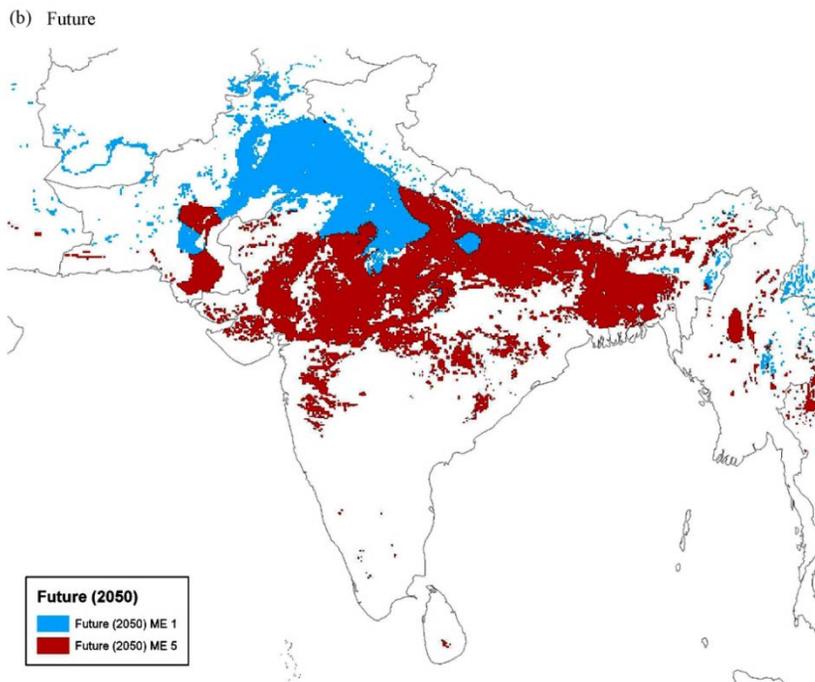


- **Warming temperatures causes faster plant development (vegetative and reproductive)**
- **Faster development doesn't equate to increased grain yield**
- **Warmer nighttime temperatures increase the respiration rate and reduce growth or yield**

Current Mega-climate regimes



Future (2050) mega-climate regimes



Move from a favorable to unfavorable climate for wheat

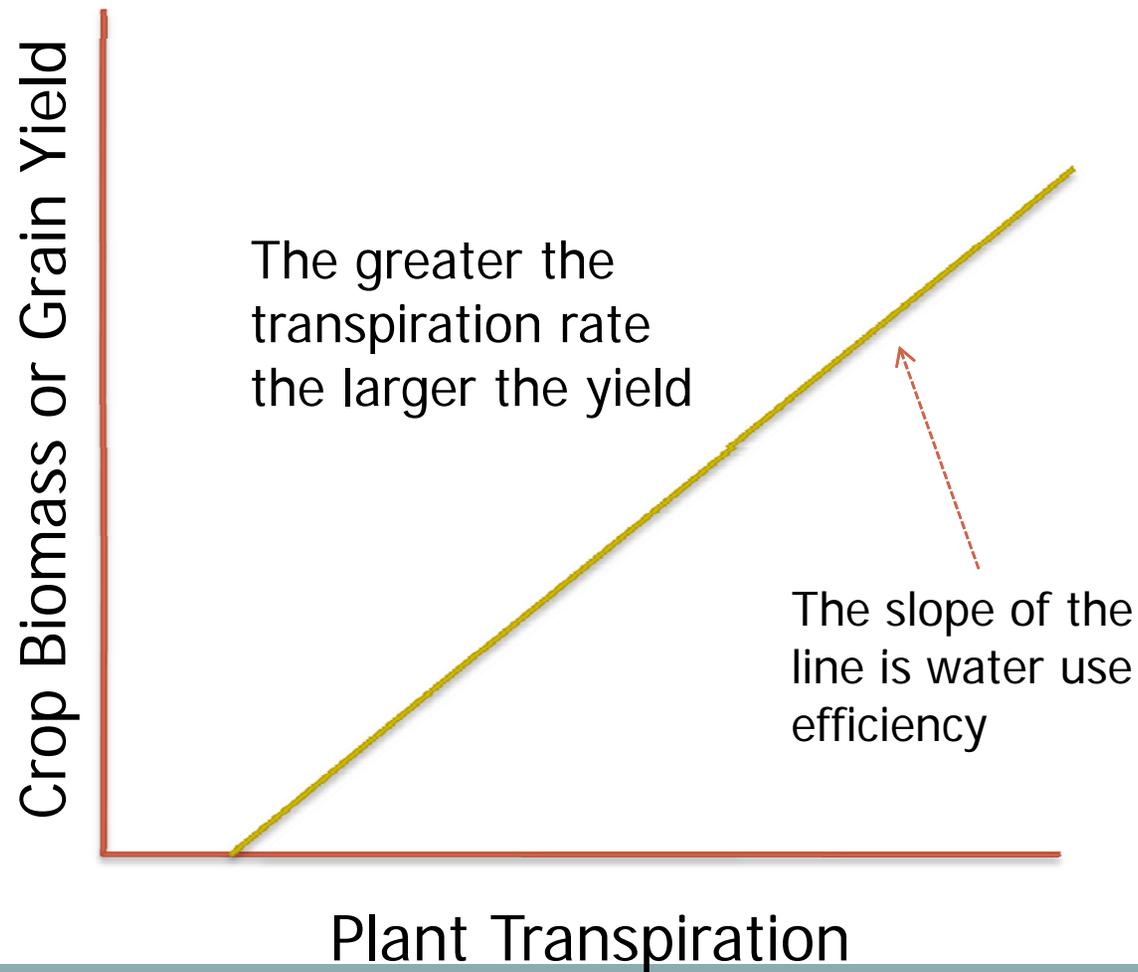
Ortiz et al. *Agric Ecosys & Environ.* 2008. 126:46-58

Water and Crops

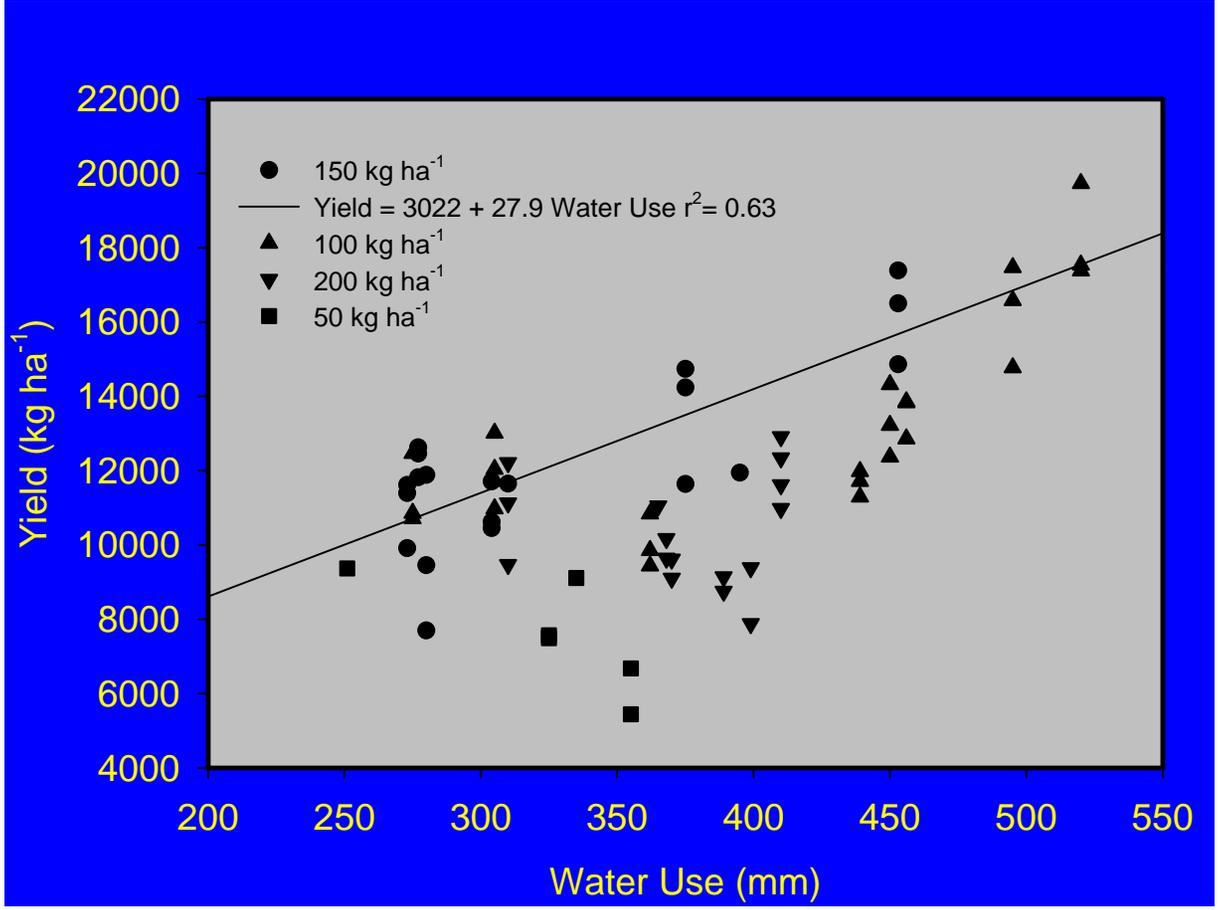


- Majority of crops are produced in rainfed environments and amount of water available to a plant depends upon frequency of precipitation and water holding capacity of the soil.
- Increased variability in precipitation will further increase the risks to crop production

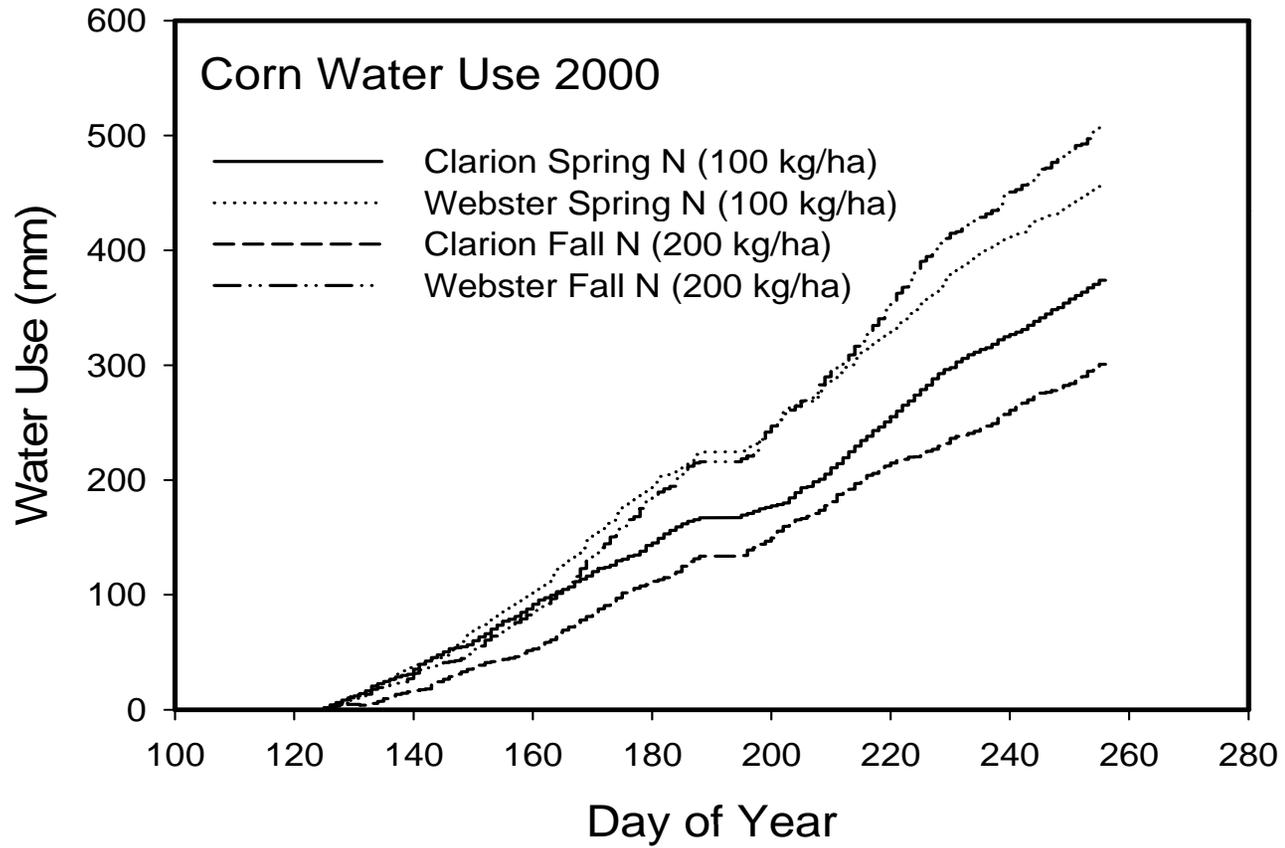
Water Impacts



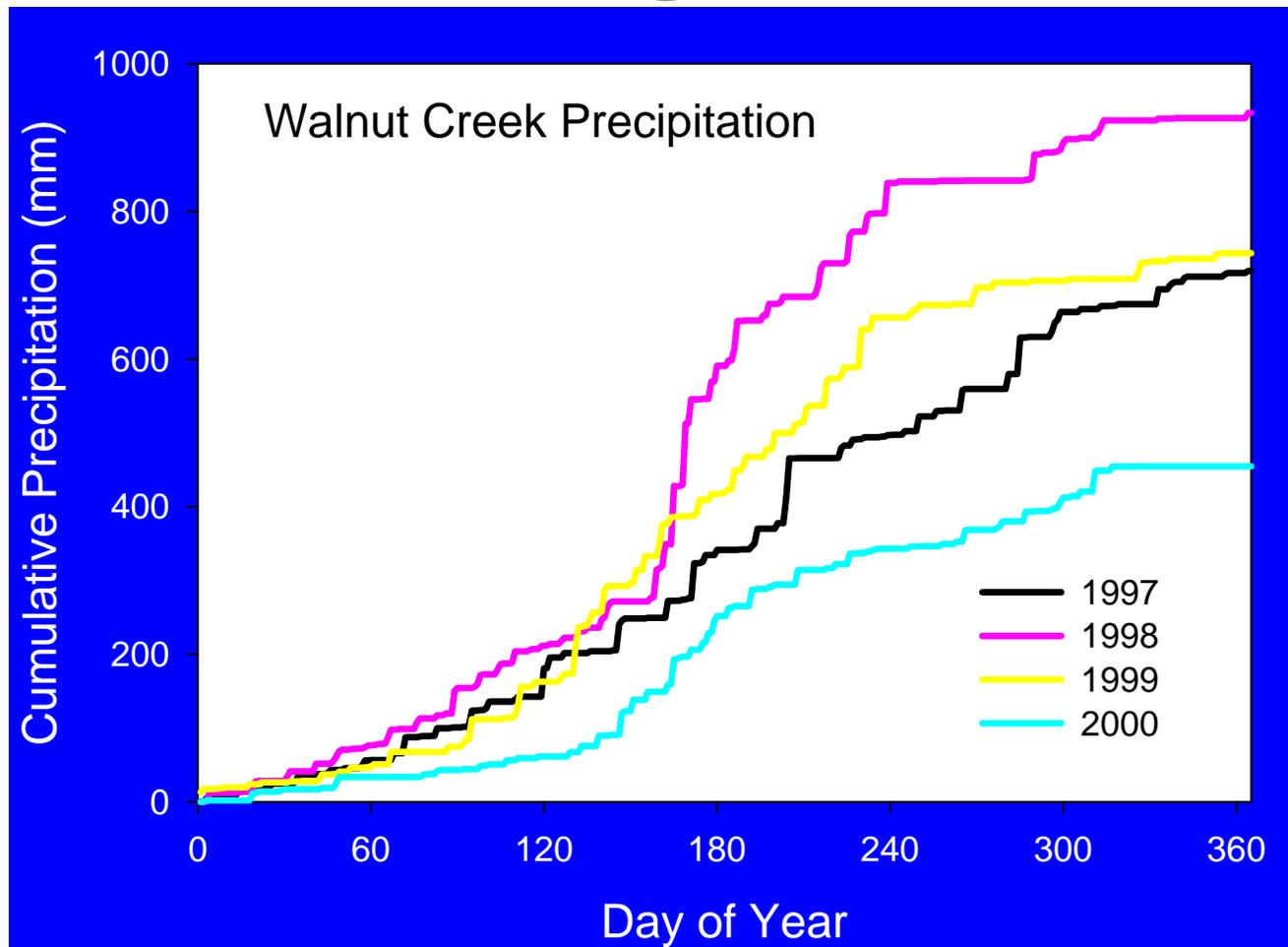
Water Use Efficiency



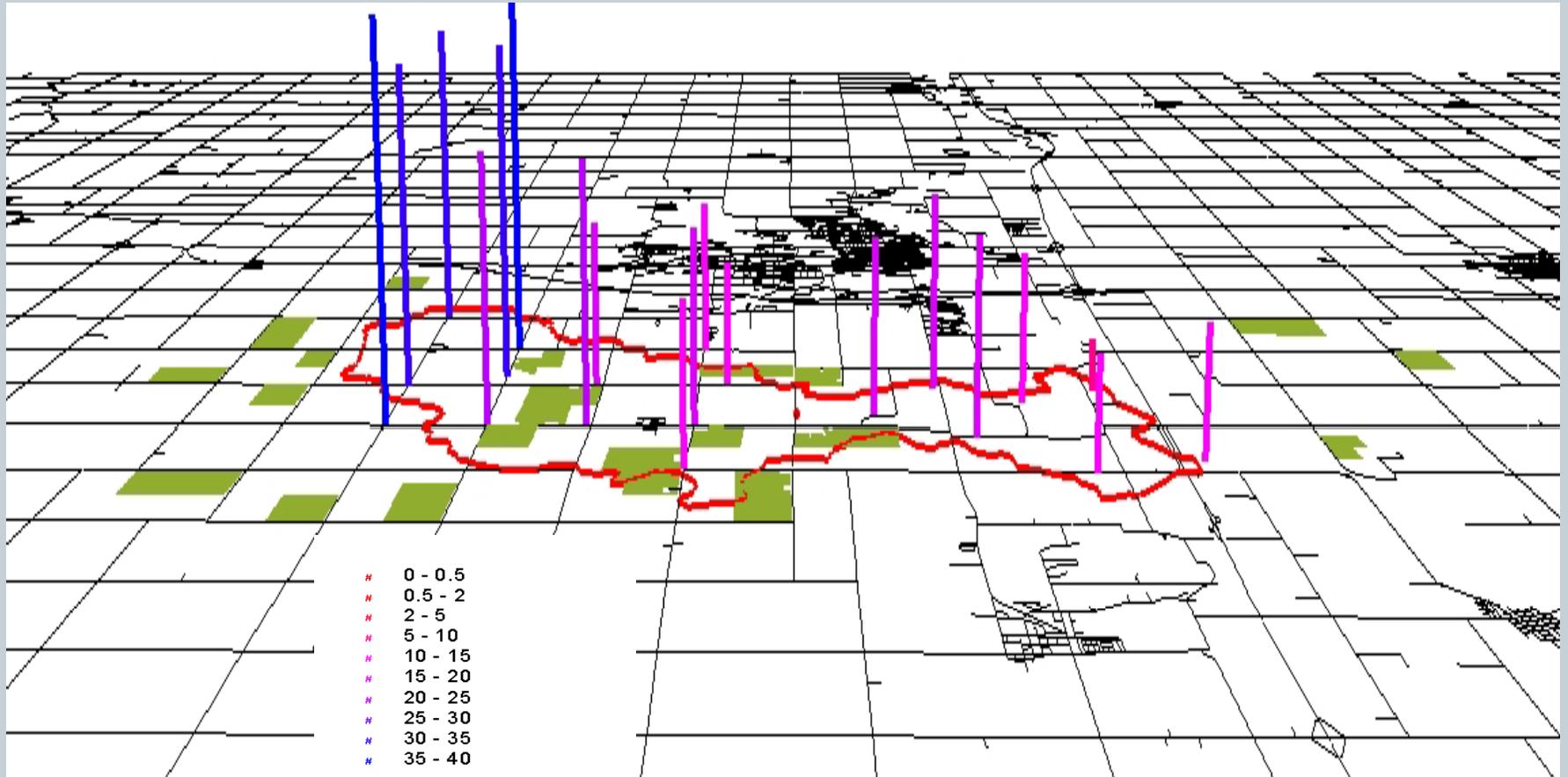
Water Use Between Soils



Annual Precipitation



Variation in Precipitation

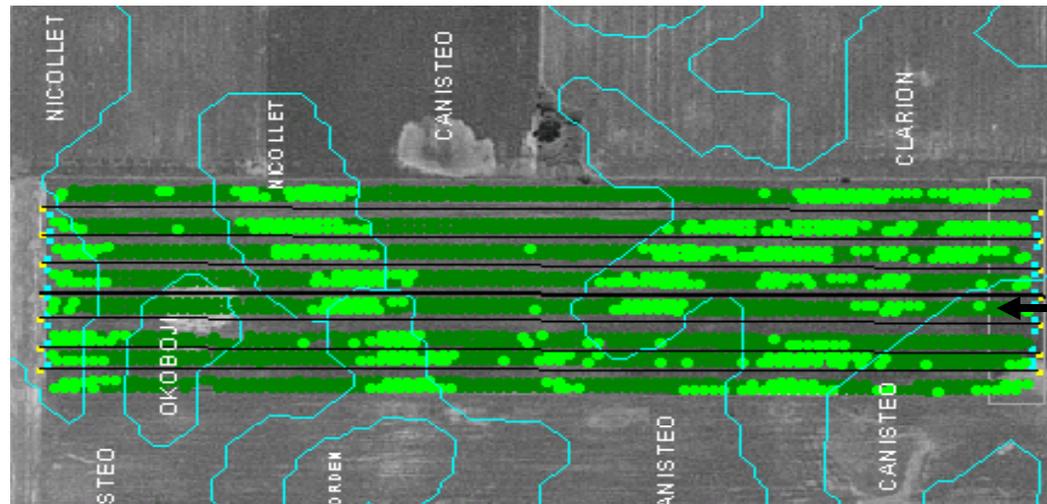


Total Rainfall (6/1/02-8/19/02) (cm)

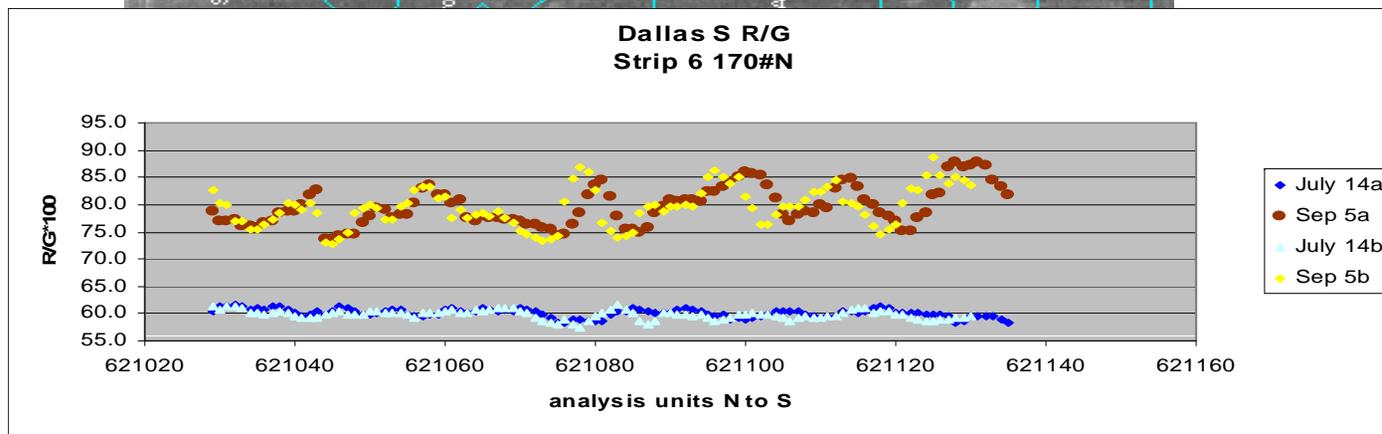
Dallas South Yields



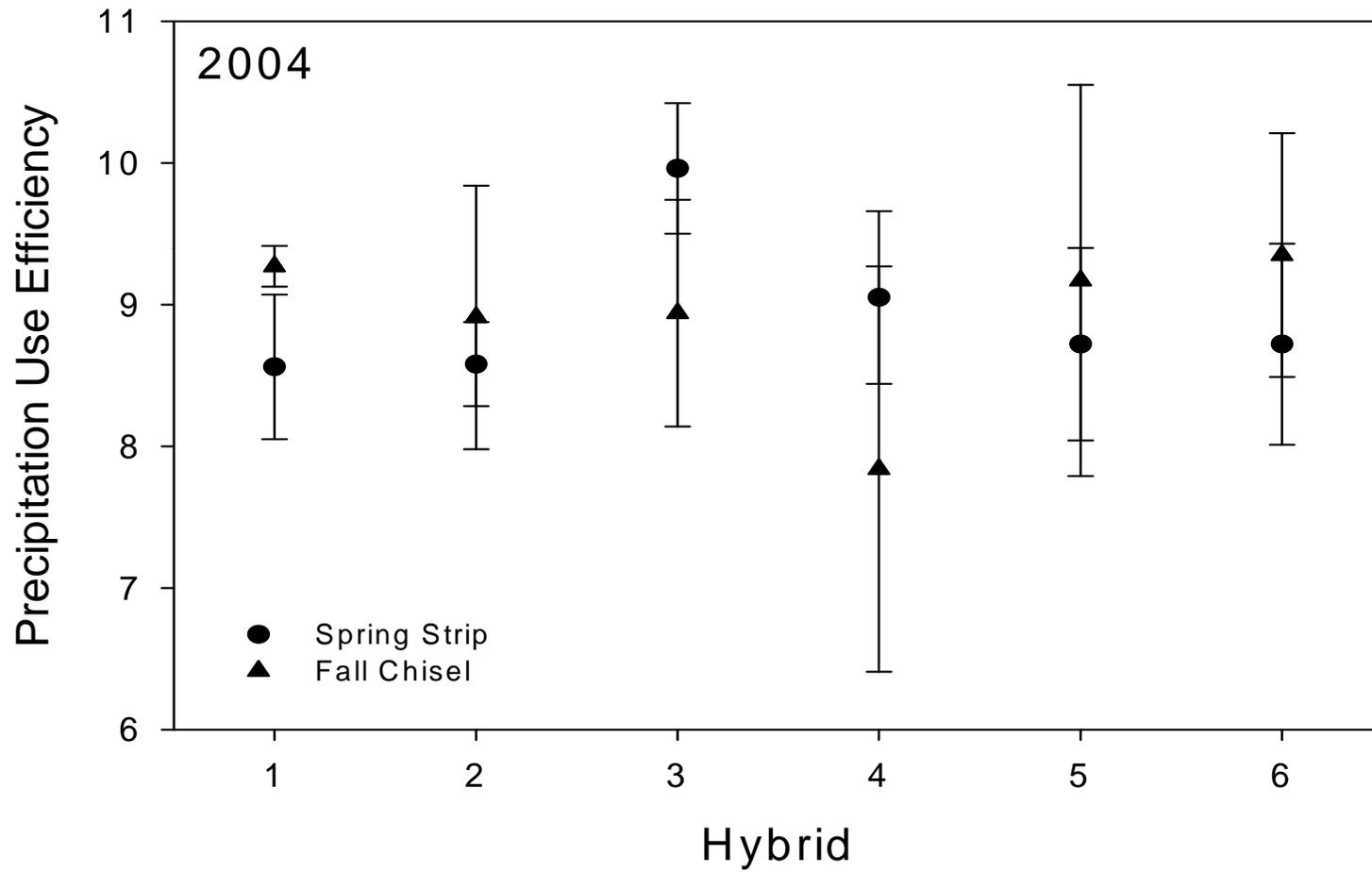
North



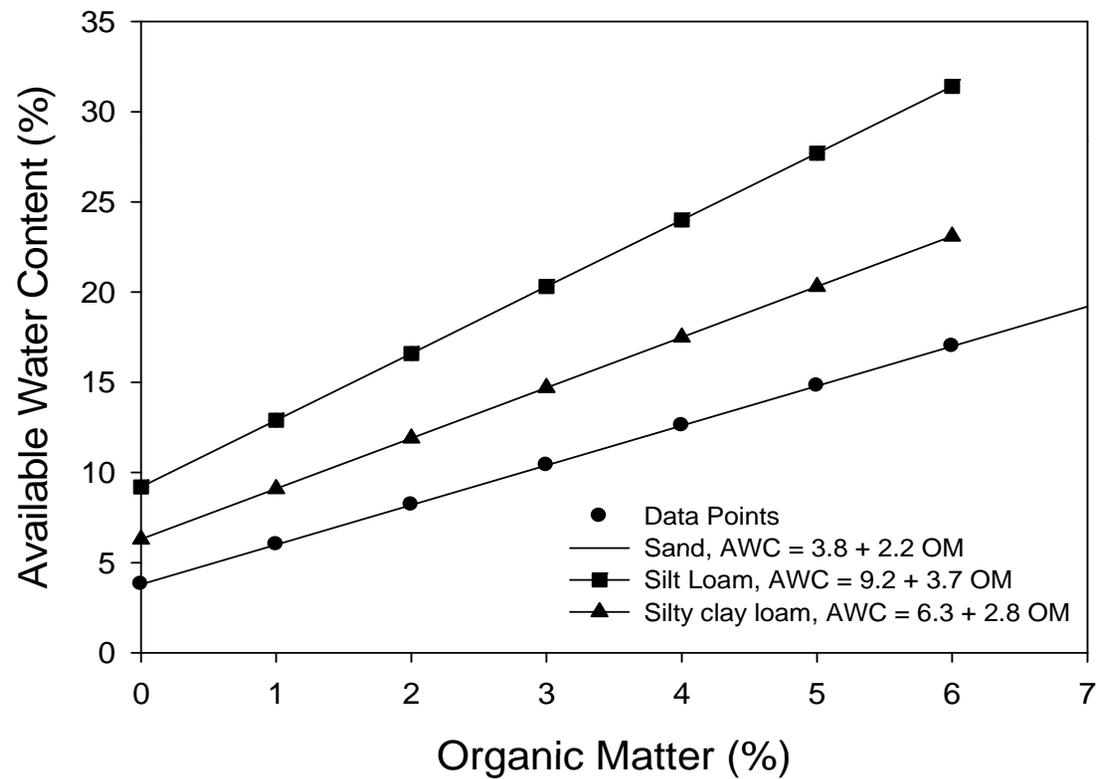
Data comparisons from last two strips



Water Use Efficiency



Soil Water Availability



Managing Soil Water



- **Increasing water supply to the crop throughout the growing season will be critical to long-term efficient production**
- **Improve the ability to soil to retain precipitation and supply to growing crop will be the difference in crop yields**

Carbon Dioxide Responses



- Increasing CO_2 will increase plant growth
- Difference between C3 and C4 plants
- Increasing CO_2 will increase water use efficiency because of increased growth per unit of water transpired

CO₂ Effects on Weeds



Ambient CO₂

Future CO₂ (+300 ppm)



Increasing CO₂ reduces herbicide efficacy.

e.g. Ziska et al. *Weed Science* 2004

Crop Production



- Increasing temperature will require a change in planting dates or tolerant varieties to avoid exposure to high temperatures
- Need to increase the soil water holding capacity to increase available water to the developing crop either by improving organic matter or reducing evaporation from soil
- Changes in weed response under increasing CO₂ will present additional challenges

Impacts on Rangeland and Pastureland



- Variability of precipitation will impact growth of pastures and rangeland
- Increasing CO₂ will impact forage quality and species composition in rangelands
- Interactions of grazing management, climate change, and species composition will impact the long-term use and sustainability

Implications for Agricultural Production



- Increased impact of climate that will tax our abilities to efficiently produce crops
- Develop systems level research to understand the impact on farming systems and the interactions among genetics, environment, and production systems.