What is the impact from climate change?

AGRICULTURE IMPACTS AND IMPACTS ON INTERNATIONAL FOOD SUPPLIES AND PRICES

Projections

"Assuming no change in population growth, food consumption patterns and food waste management, the following production increases must take place by 2050:

cereals production must increase by 940 million tonnes to reach 3 billion tonnes;

meat production must increase by 196 million tonnes to reach 455 million tonnes;

and oilcrops by must increase by 133 million tonnes to reach 282 million tonnes (Alexabdratos and Bruinsma, 2012).

It is also estimated that global demand for crop calories will increase by 100 percent ±11 percent and global demand for crop protein will increase by 110 percent ±7 percent from 2005 to 2050 (Tilman et al. 2011). "

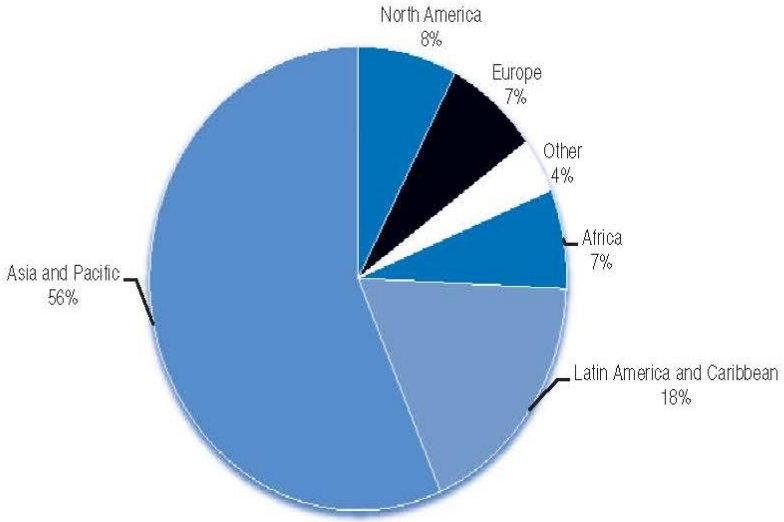
Alexandratos N, Bruinsma J. 2012. World agriculture towards 2030/2050, the 2012 revision. *ESA Working Paper No. 12-03, June 2012*. Rome: Food and Agriculture Organization of the United Nations (FAO). (Available from http://www.fao.org/docrep/016/ap106e/ap106e.pdf)

Tilman D, Balzer C, Hill J, Befort BL. 2011. Global food demand and the sustainable intensification of agriculture. *PNAS* 108(50):20260–20264. Washington DC: Proceedings of the National Academy of Sciences of the United States of America. (Available from http://www.pnas.org/content/108/50/20260)

Demand by region

Figure 7.3. **Increase in meat demand, by region between 2020 and the base period (c.w.e. or r.t.c.)**

Consumption growth of 60 Mt is projected by 2020; predominantly in Asia

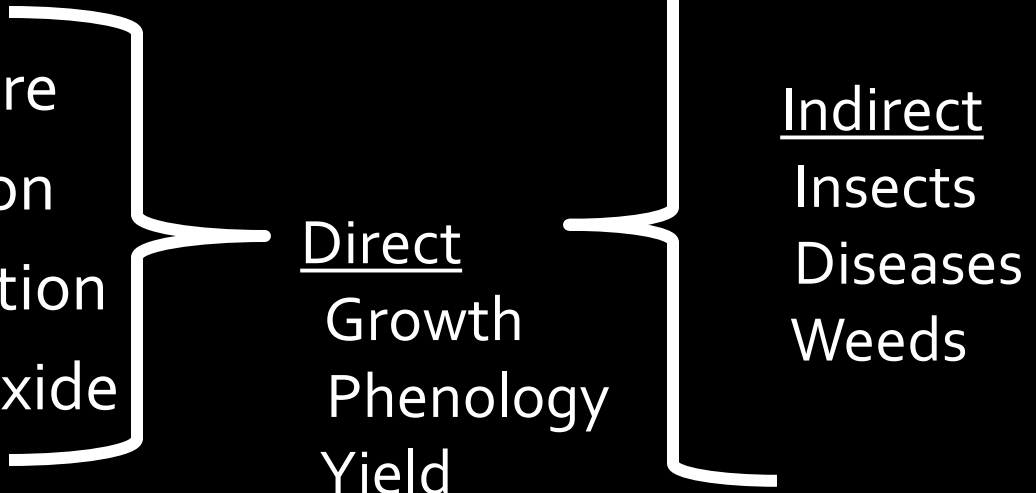


Source: OECD and FAO Secretariats.

StatLink http://dx.doi.org/10.1787/888932427094

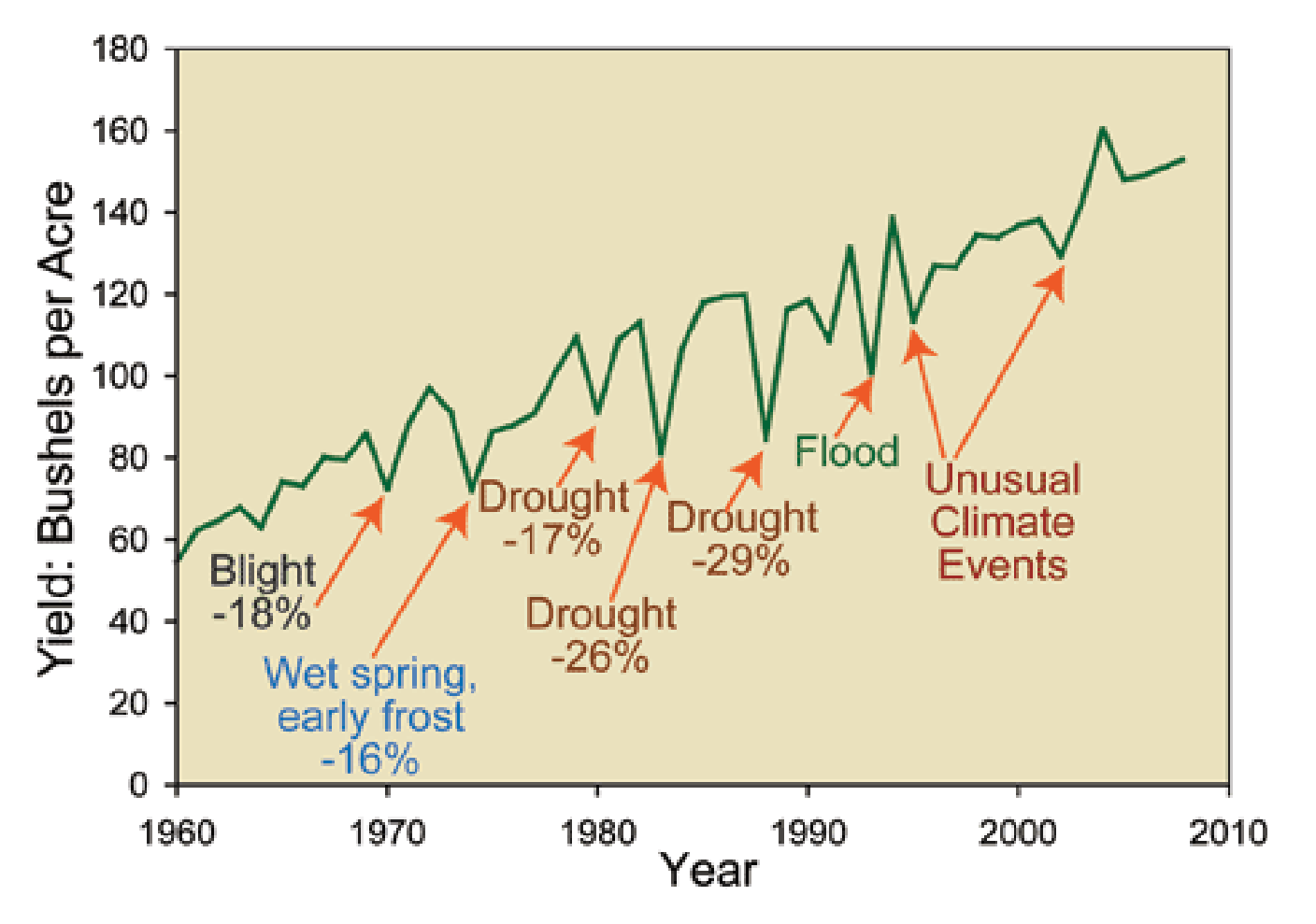
Climate Factors

- Inputs
  - Temperature
  - Precipitation
  - Solar radiation
  - Carbon dioxide

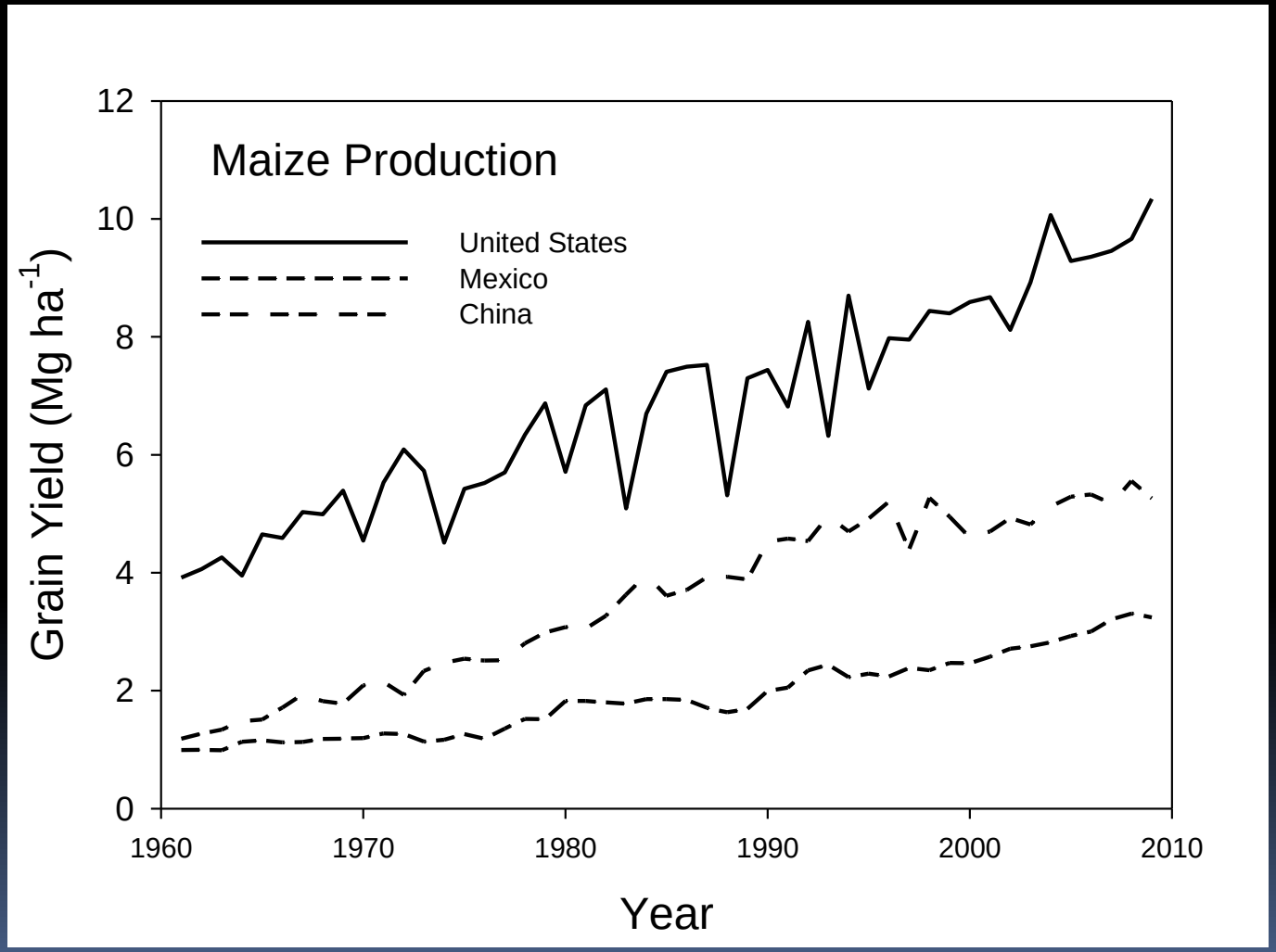


Soil is the underlying factor as a resource for nutrients and water

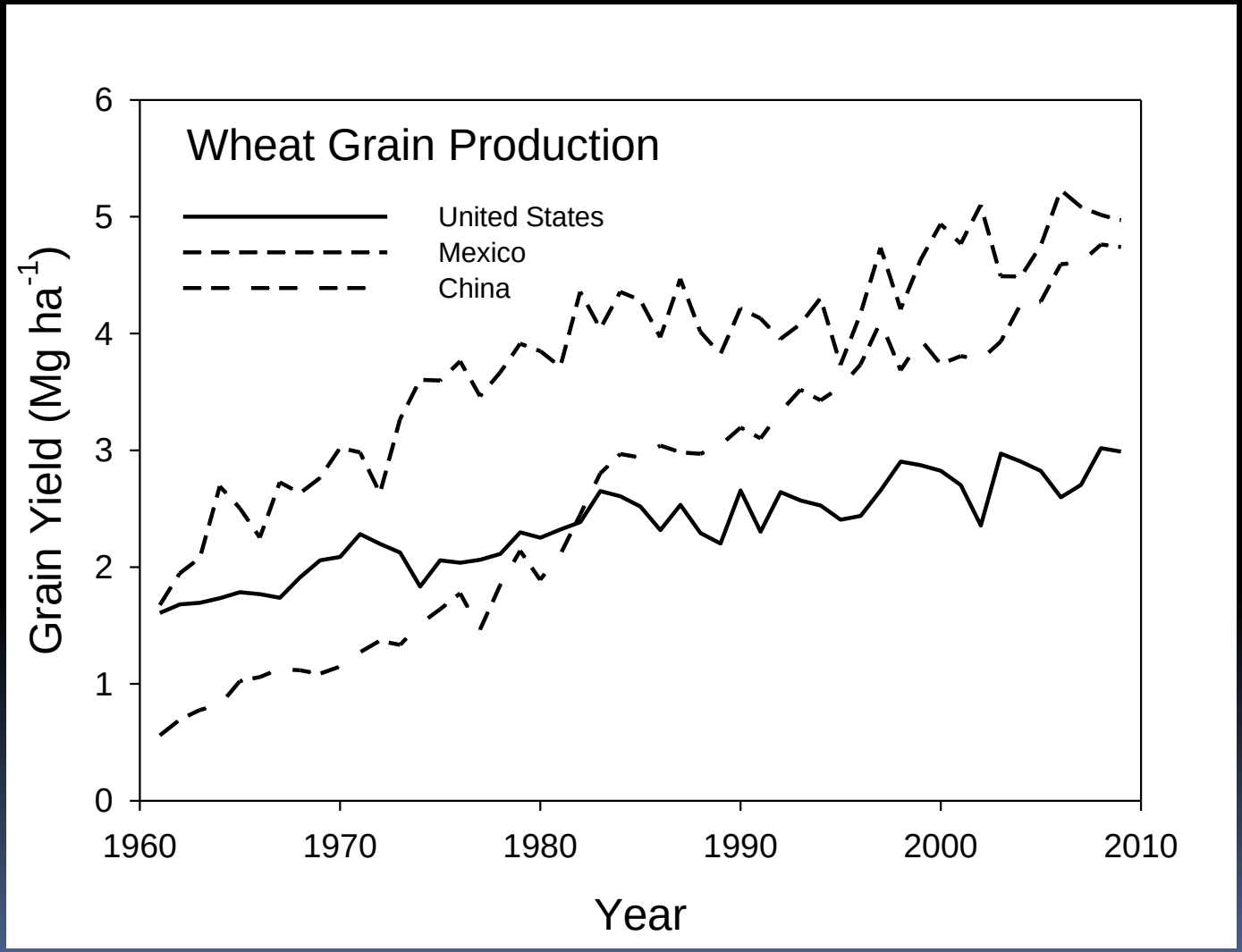
Climate Impacts on US Corn Yields



Maize Yields



Wheat Yields

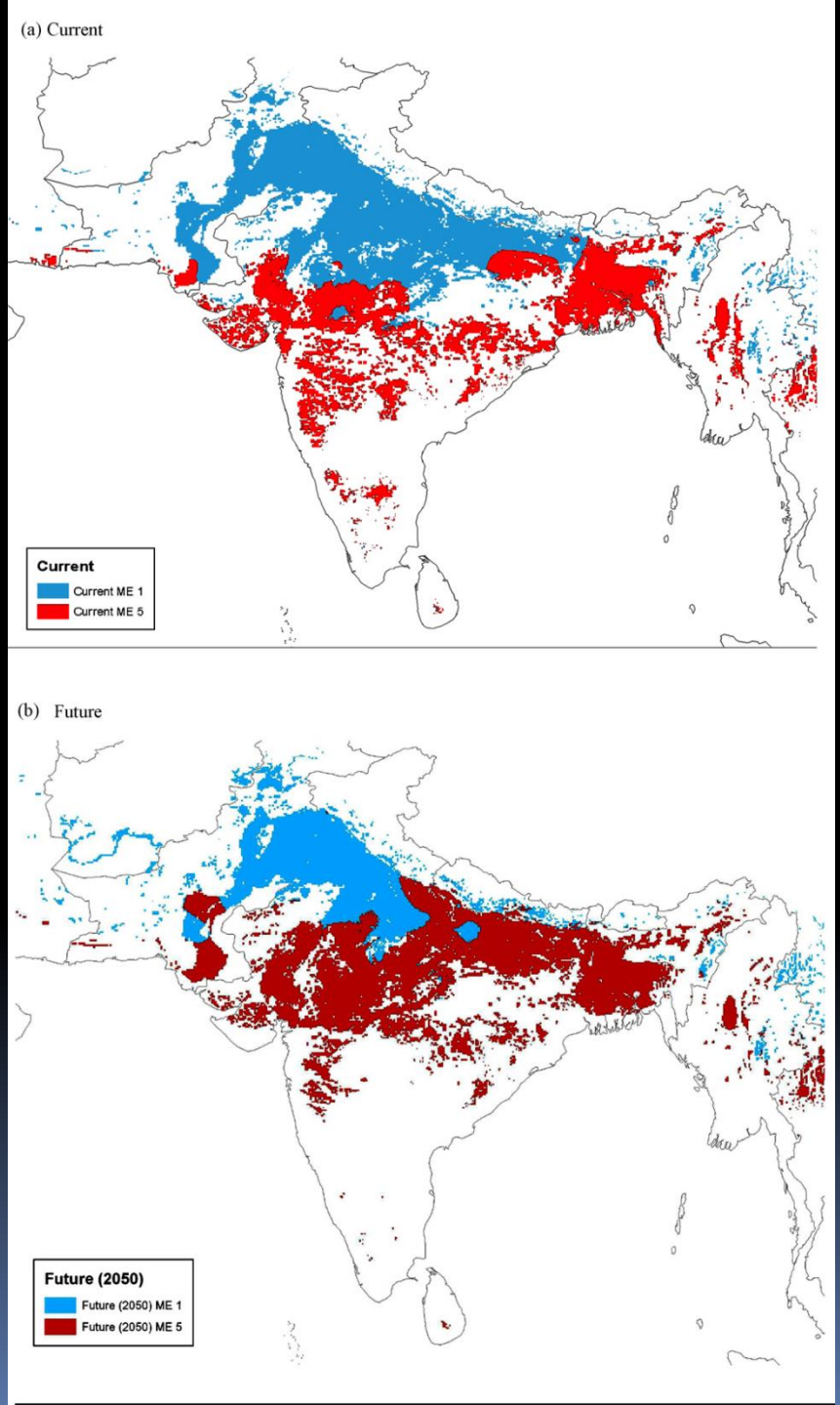


Current Mega-climate regimes

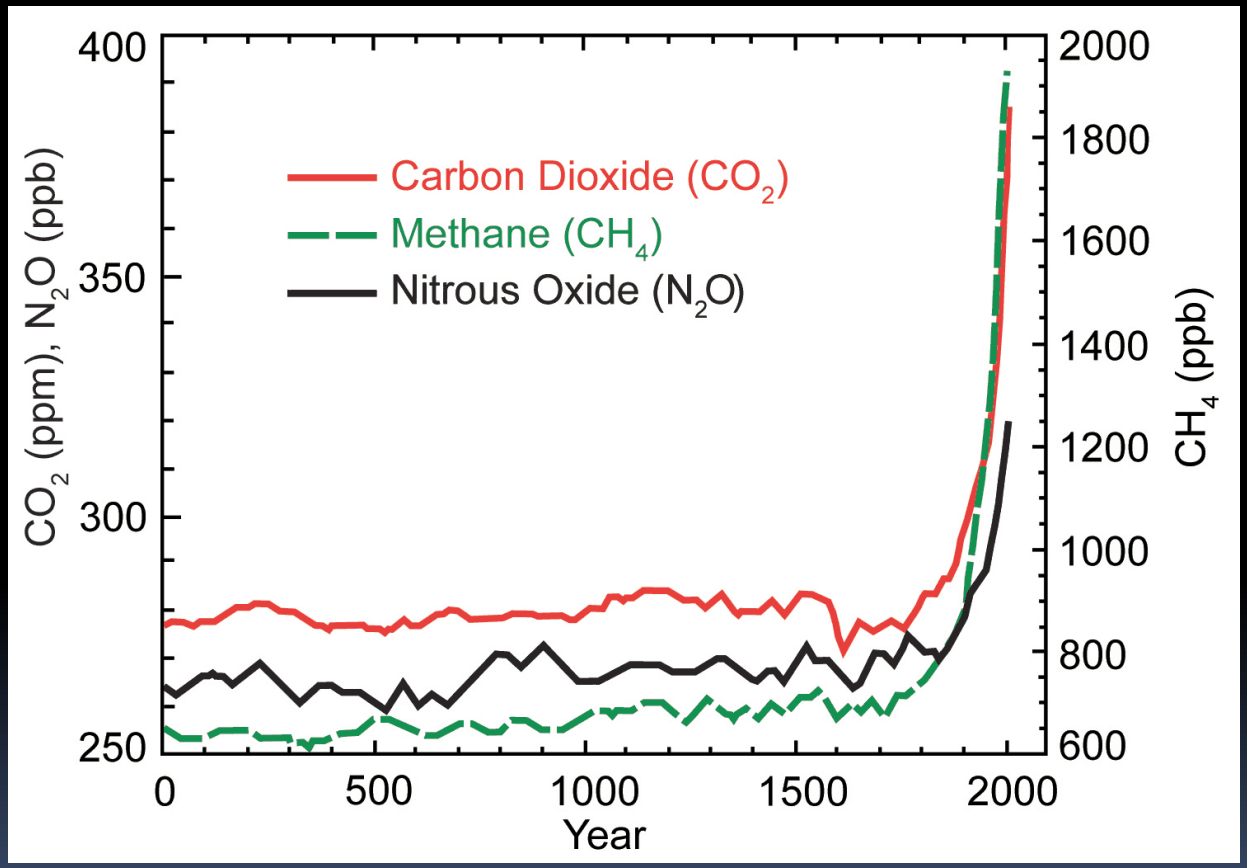
Future (2050) mega-climate regimes

Move from a favorable to unfavorable climate for wheat

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



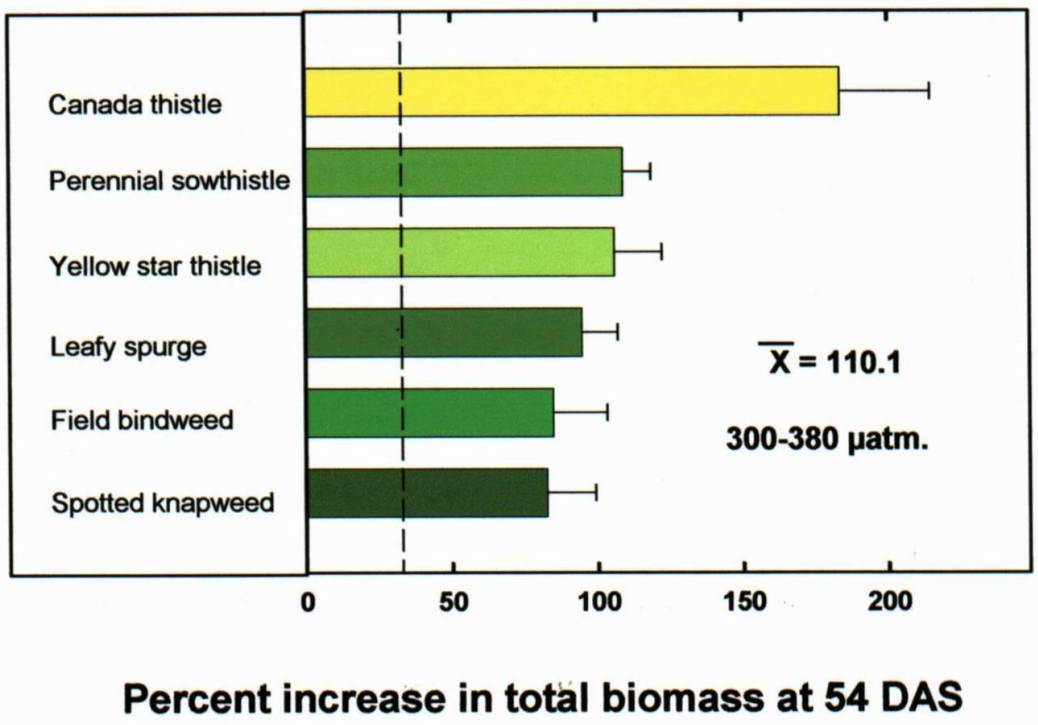
Carbon Dioxide Increases



Carbon Dioxide Responses

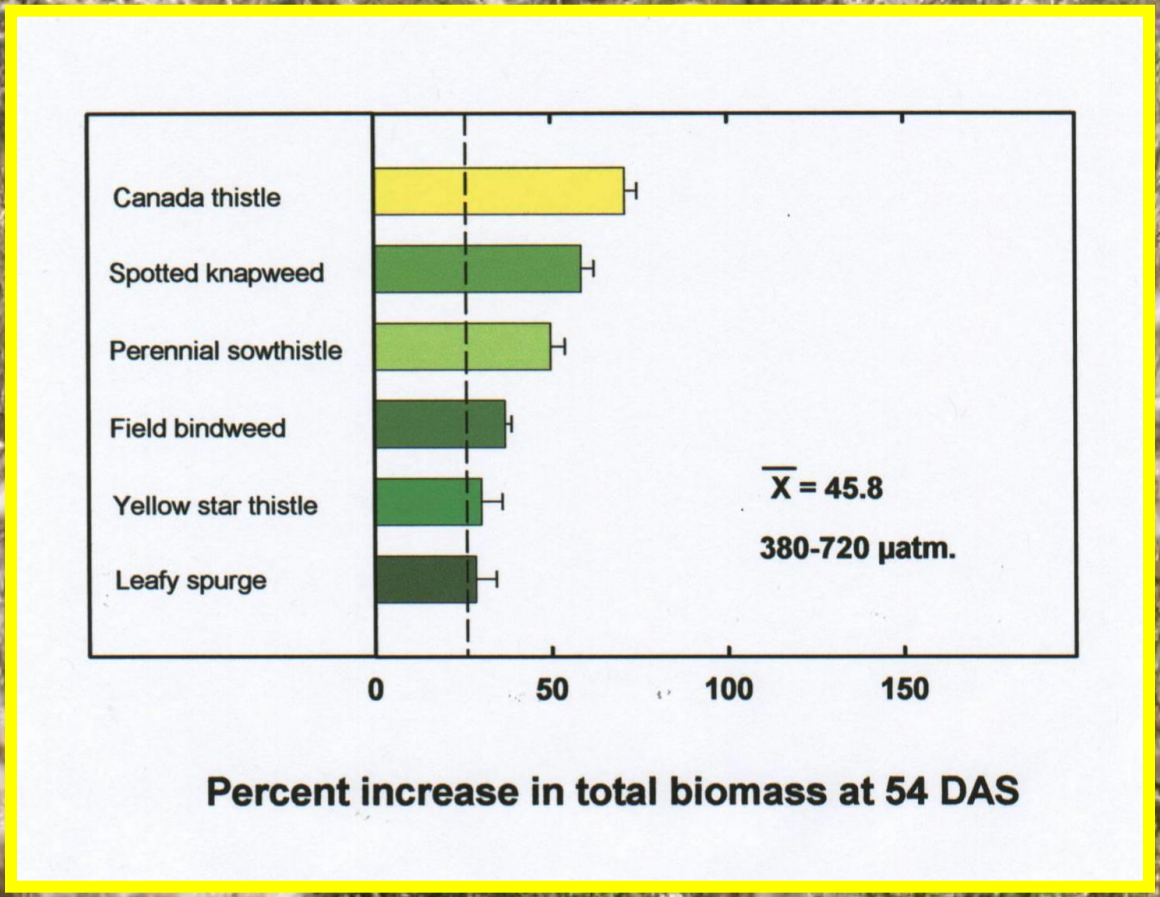
- Increasing CO_2 will increase plant growth
- Difference between C3 and C4 plants
- Increasing CO_2 will increase water use efficiency because of increased growth per unit of water transpired

Present vs. Past



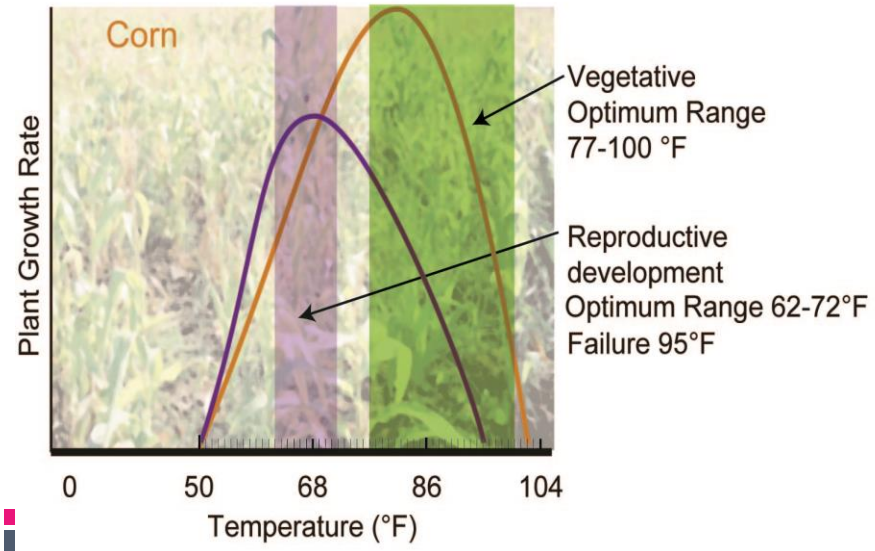
L. Ziska, USDA-ARS

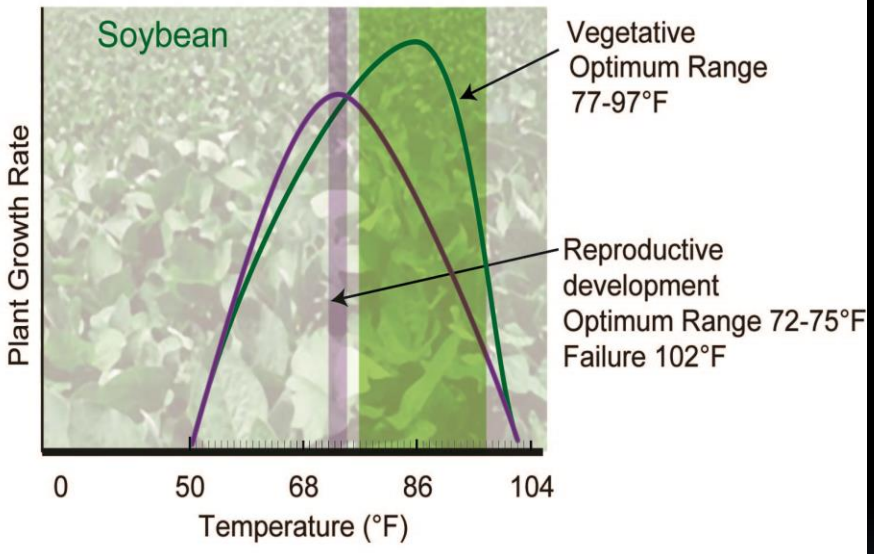
Present vs. Future



L. Ziska, USDA-ARS

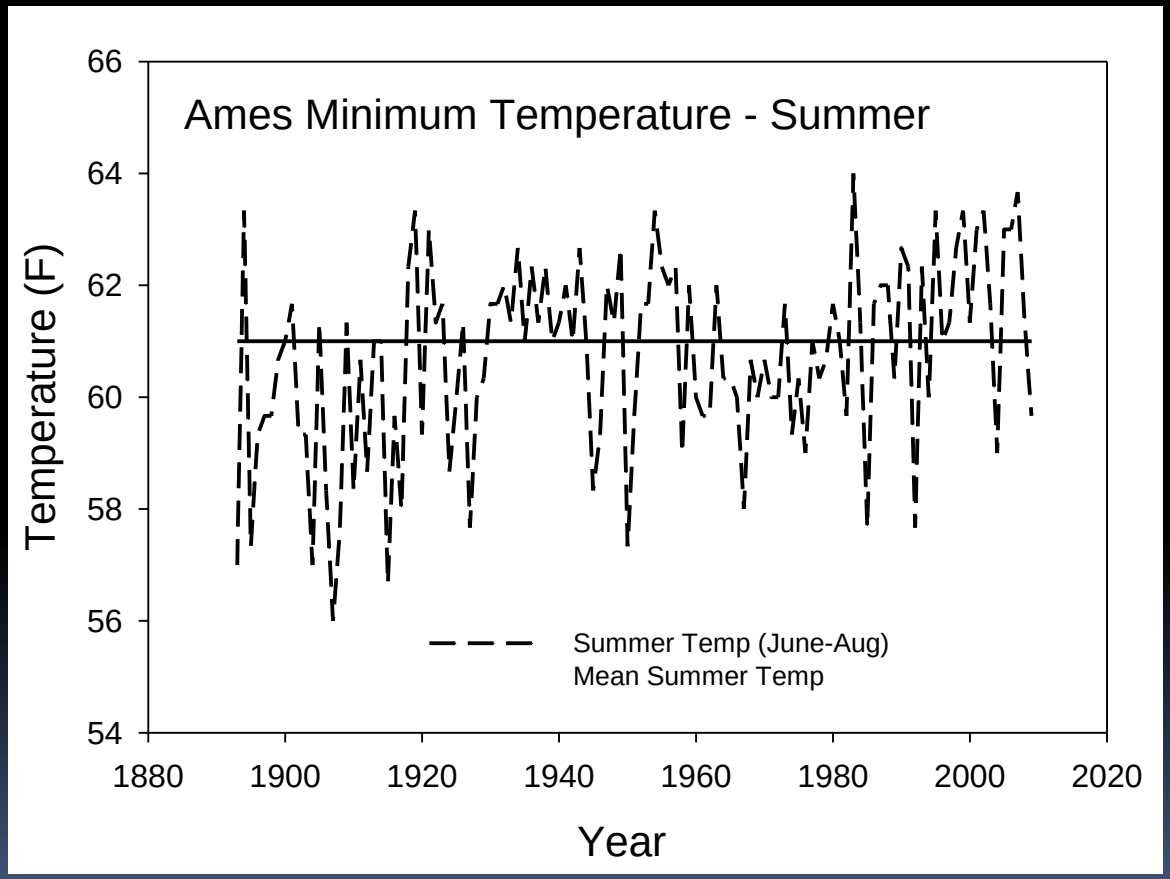
Temperature Responses



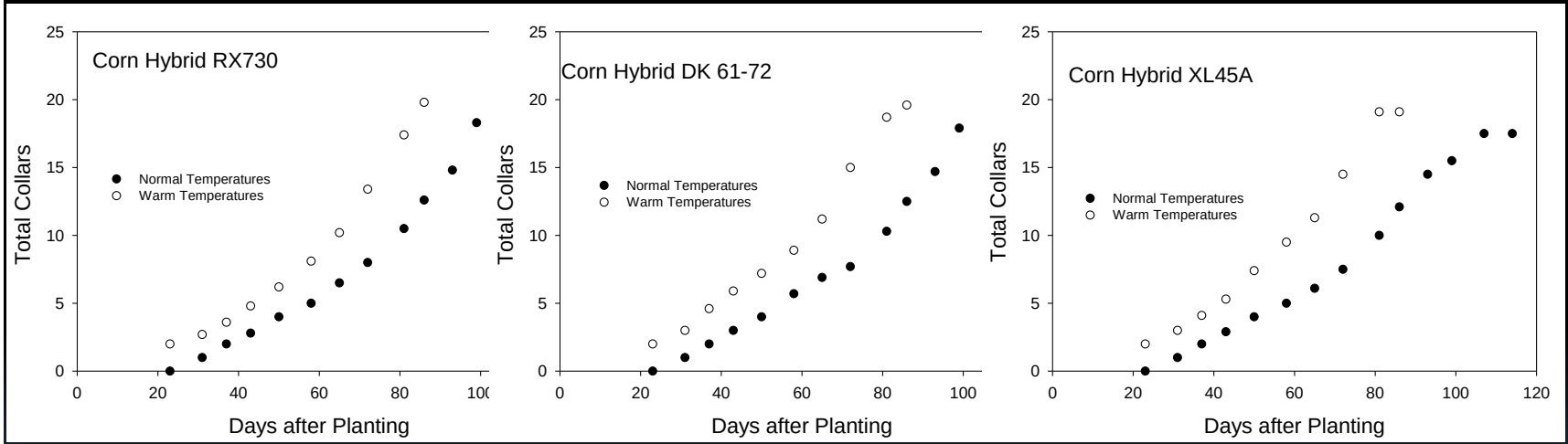


Difference in temperature response between the vegetative and reproductive stage of development for crops. The higher the temperature the faster the rate of development

Nighttime Temperatures (Ames)



Temperature effects on Corn Phenology



Rhizotron study with warm chamber 4C warmer than normal chamber with simulation of Ames IA temperature patterns.

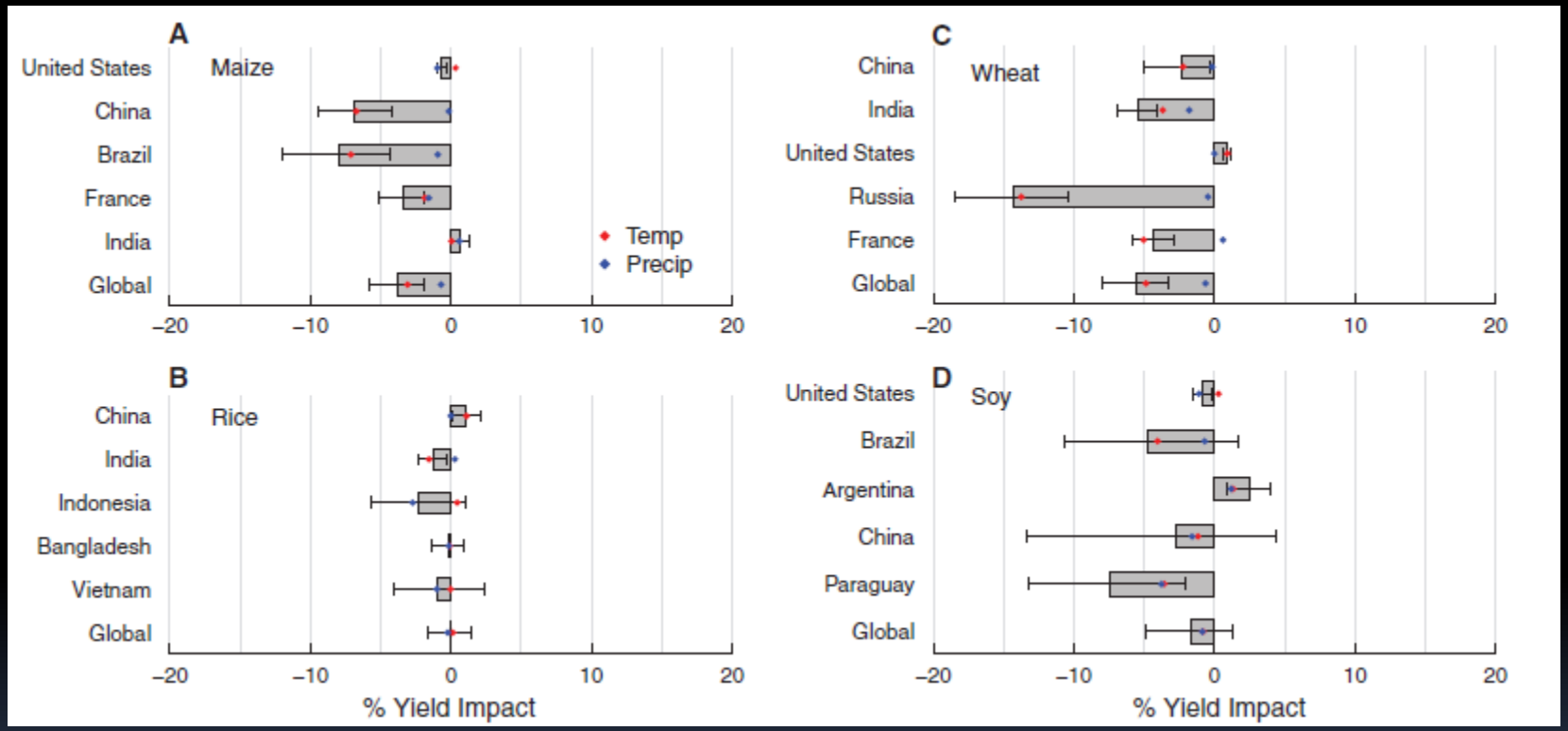
Increasing Temperature

- Increases the crop water demand because ET is a function of vapor pressure deficit
- Crops will undergo water stress more quickly in soils with limited water holding capacity

Climate Impacts

Crop	Yield Change
Maize	-4.0%
Soybean-Midwest	+2.5%
Soybean-South	-3.5%
Wheat	-6.7%
Rice	-12.0%
Sorghum	-9.4%
Cotton	-5.7%
Peanut	-5.4%
Bean	-8.6%

Current Reductions in Yields

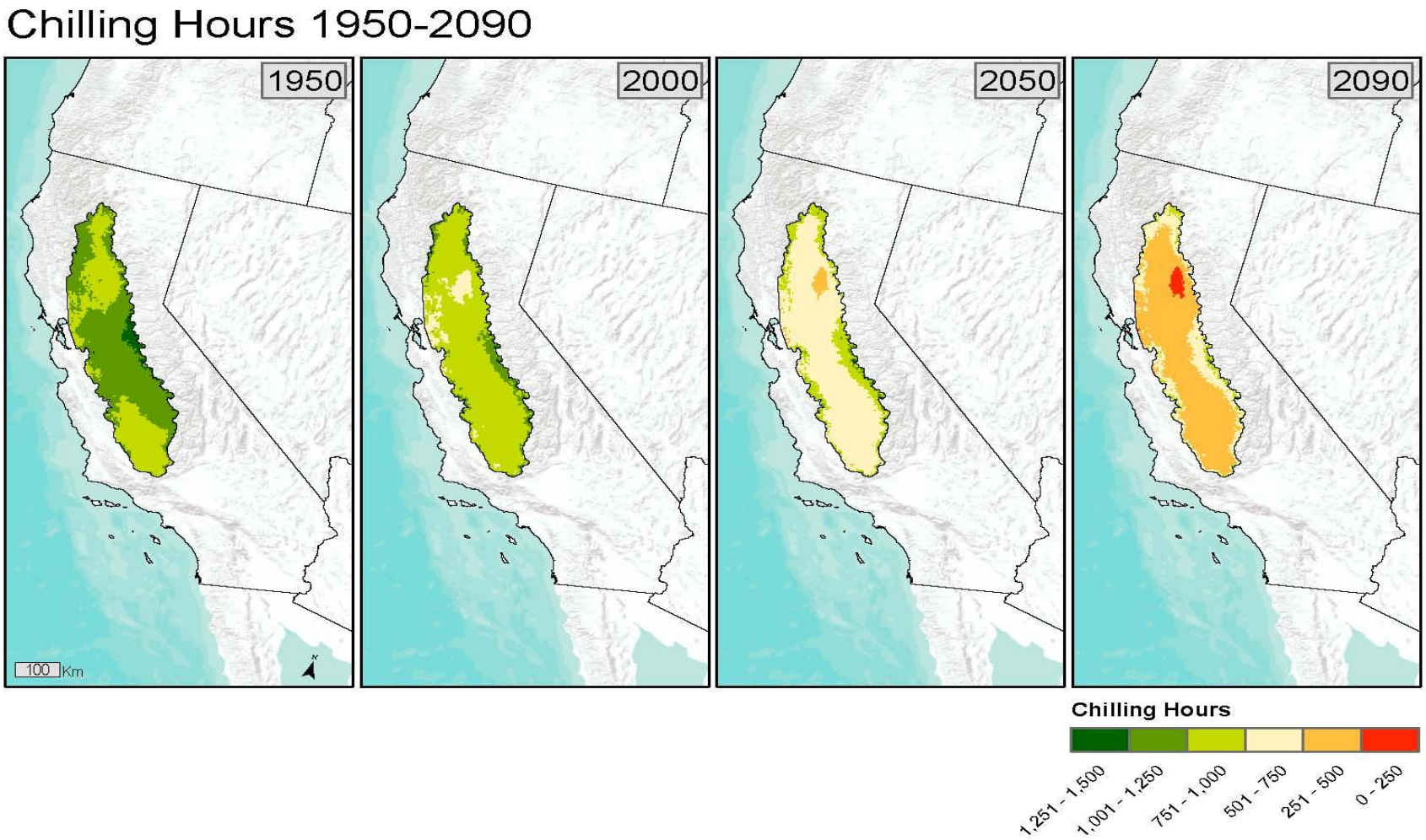


Lobell et al. 2011 Science 333:616-620

Perennial Crops

- Require chilling over winter to induce flowering and fruit initiation in sensitive species
- Subjected to late season frost when late winter, early spring is warmer than normal
- High temperatures during the growing season affects fruit quality

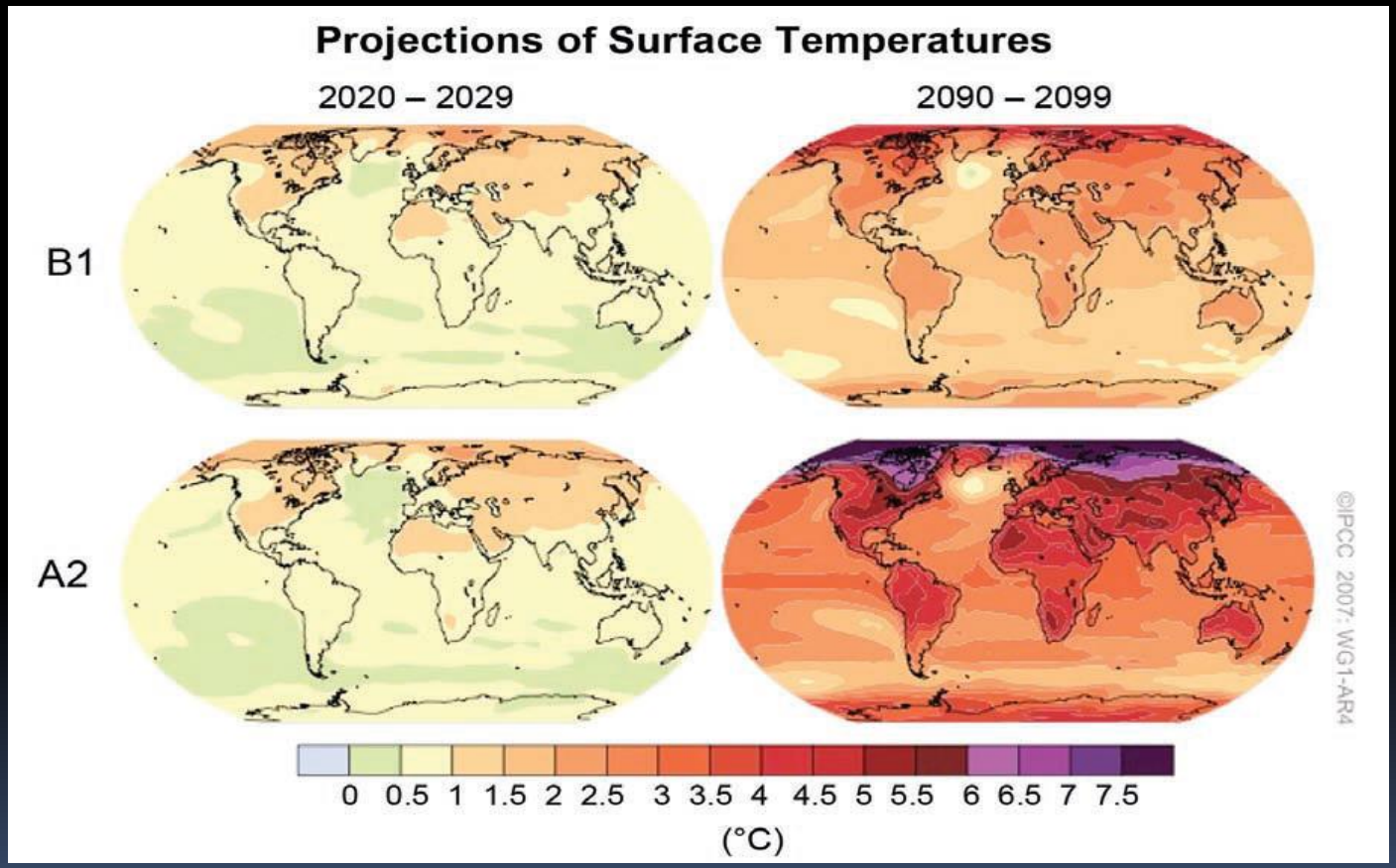
Chilling Hours



Extreme Temperature Events

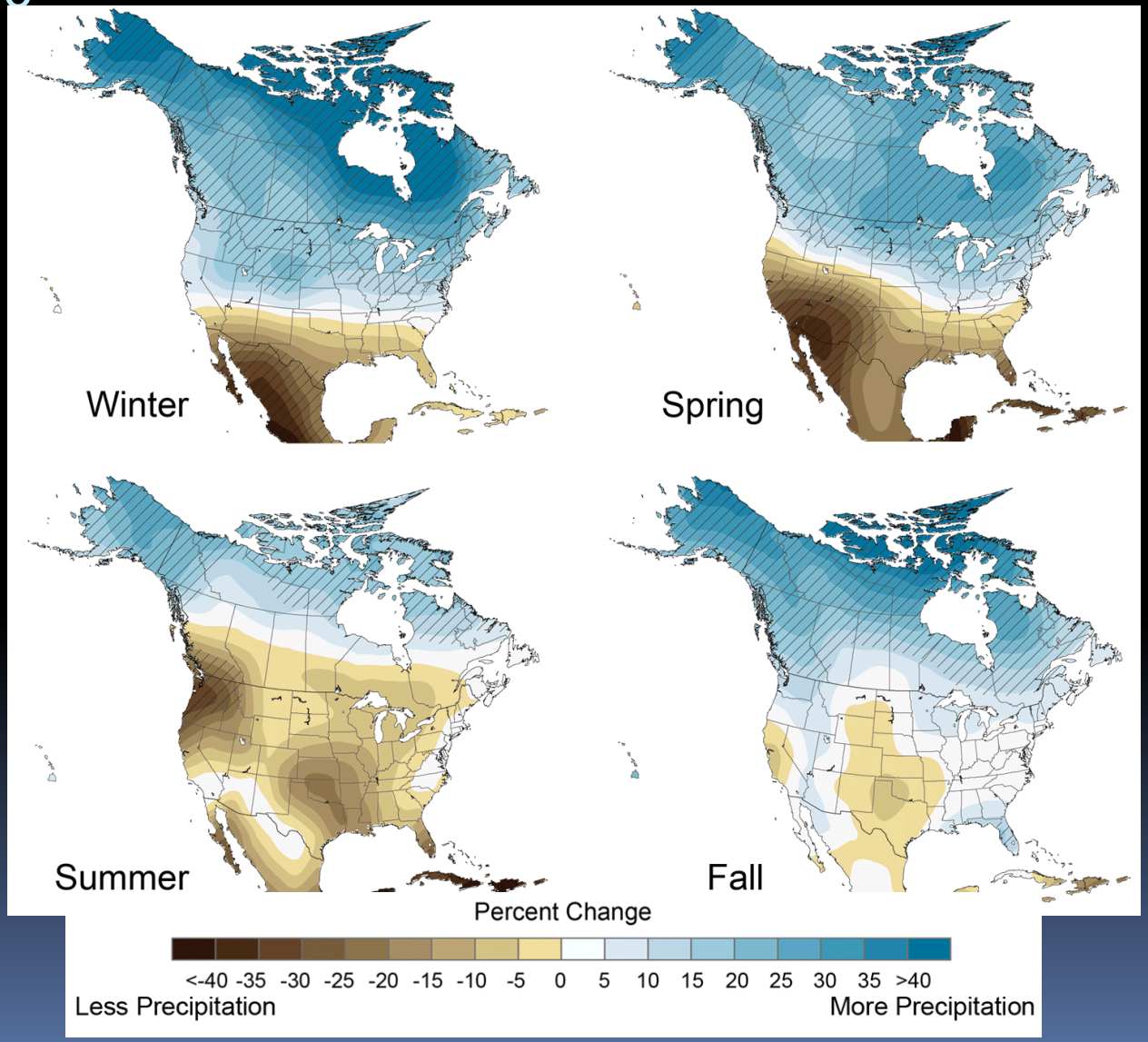
- Depends upon the phenological stage of the plant
- Couple water stress with high temperature stress on metabolic activity
- Animal reaction is related to metabolic activity and reproductive stage

Changing Temperature

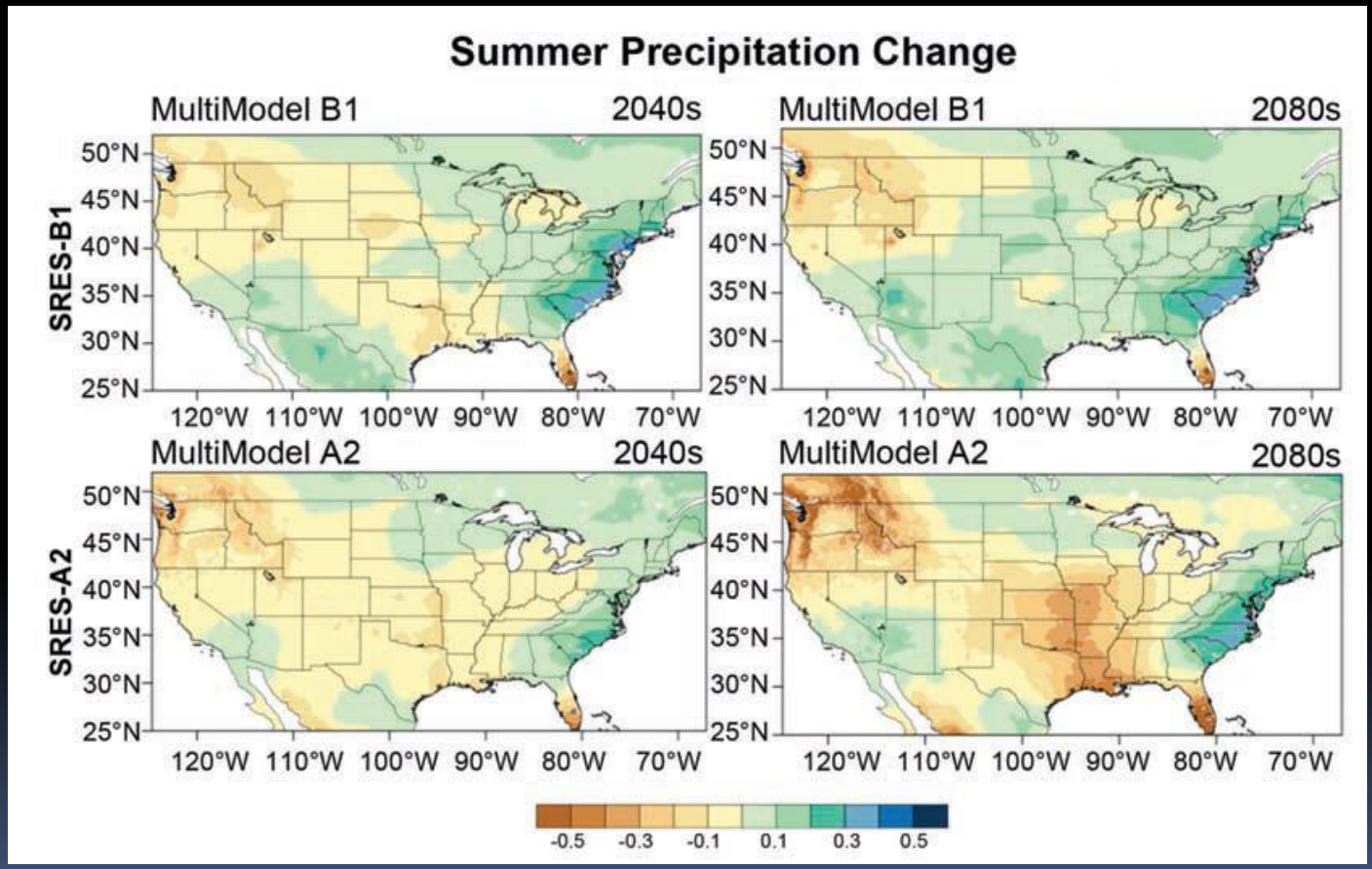


Projected Change in N. American Precipitation

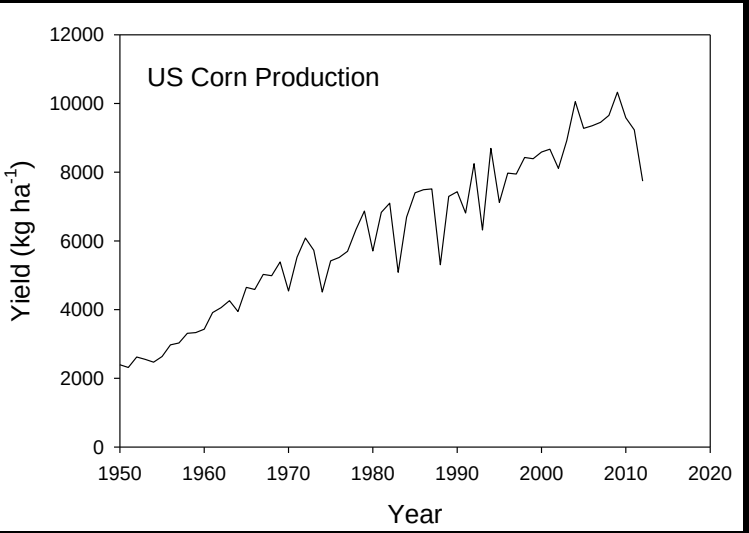
by 2080-2090

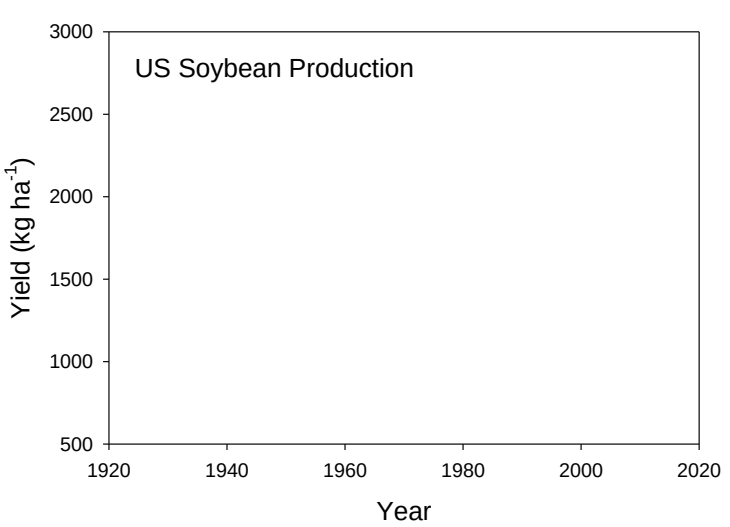


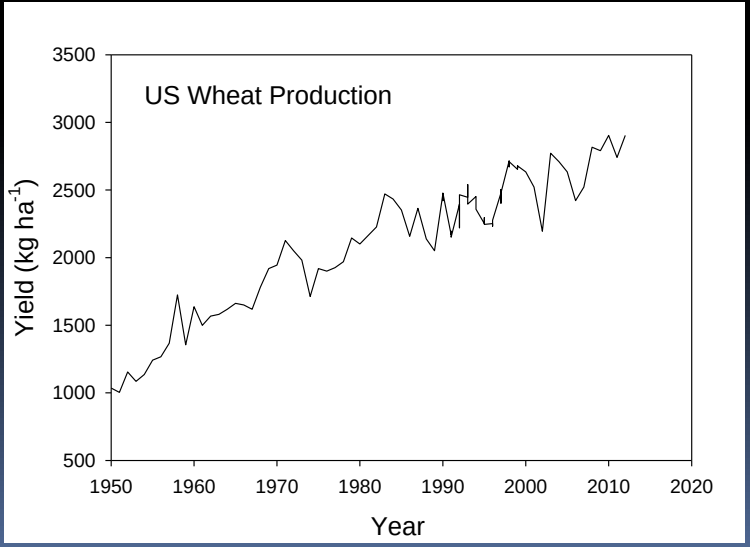
Summer Precipitation



US Grain Production

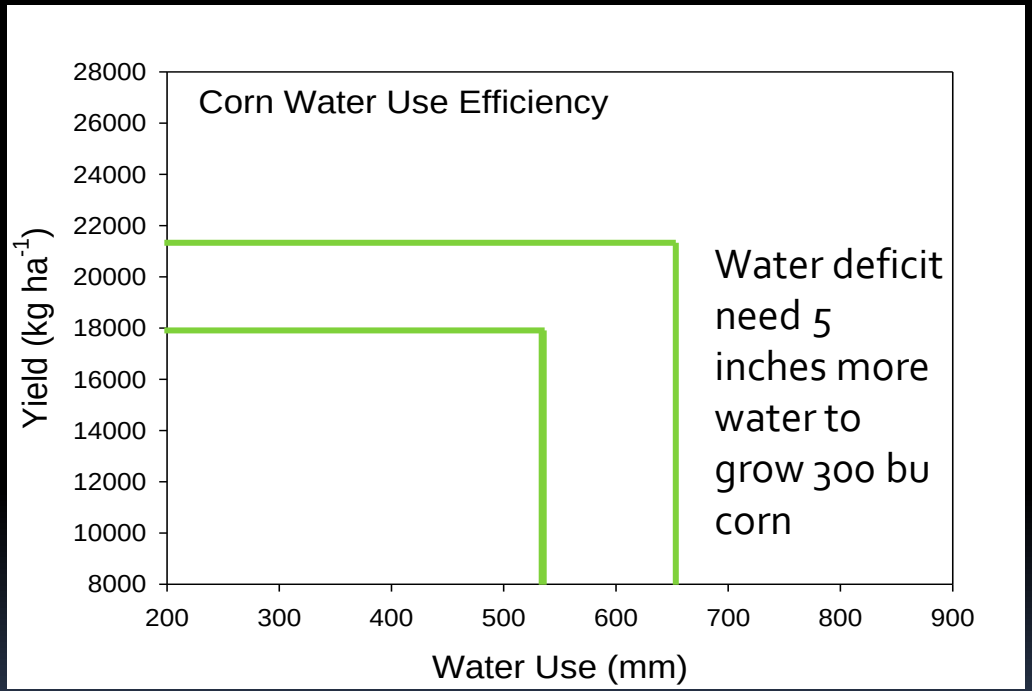






Precipitation Impacts

- Variability in precipitation will create more variation in crop yield and grass production for grazing animals
- Shifts in seasonality of precipitation will change water availability to the crop and require changes in cropping systems
- Yield is a direct function of the amount of water transpired by the crop



Expectations

- More variable weather and climate trends will increase the variability in production
- Demand will increase placing more pressure for food and feed production leading to increased prices
- Changing climate will also affect the ability to store grains through disease or insect pressure
- Animal production (meat, eggs, and milk) will be affected