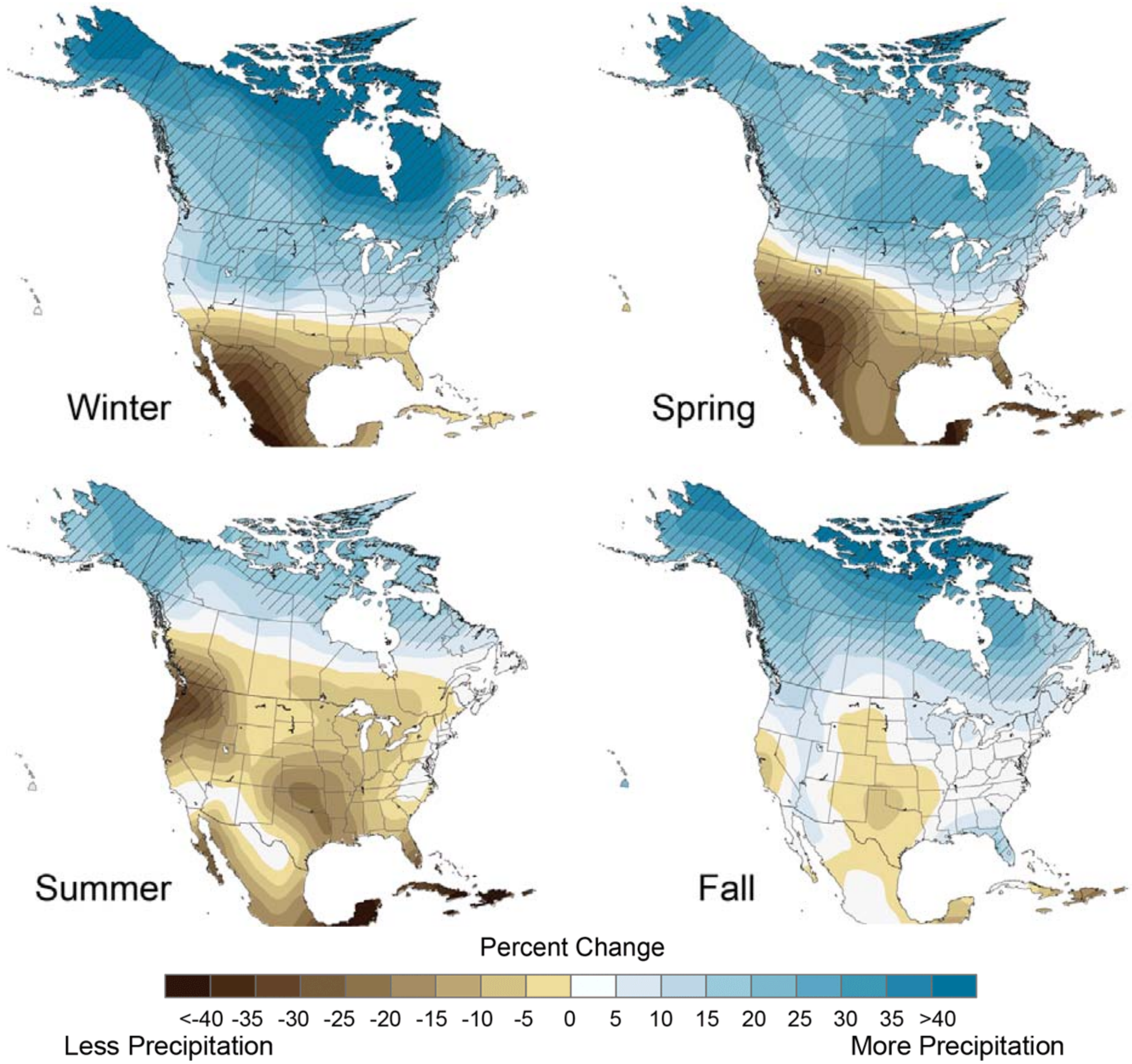
Future challenges

Soil Health and Climate Resilience

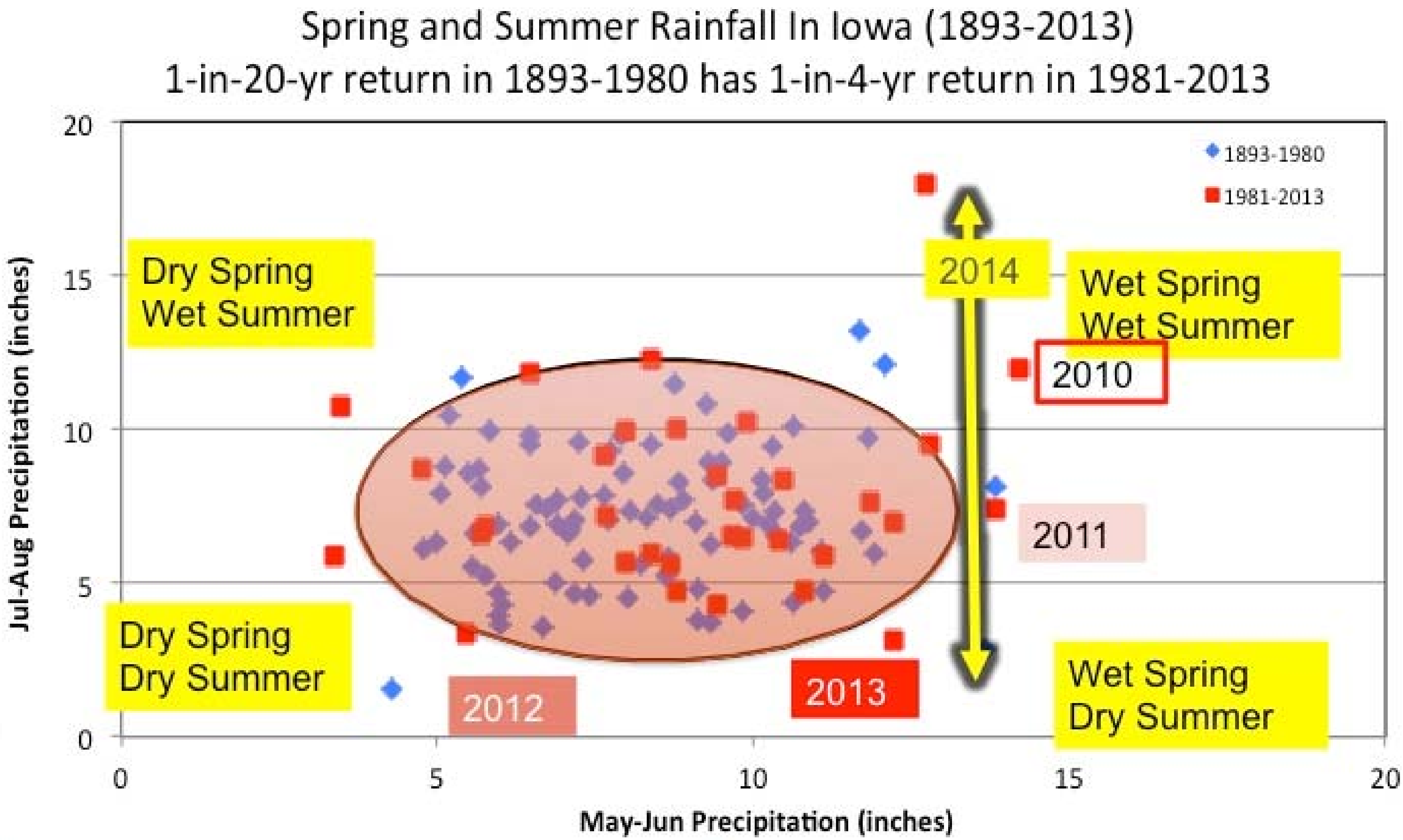
What does the future hold?

- More variable weather within and among seasons
- Warmer temperatures
- Shifting seasonality of precipitation
- More demand for food, feed, and fiber

Projected Change in N. American Precipitation
by 2080-2090

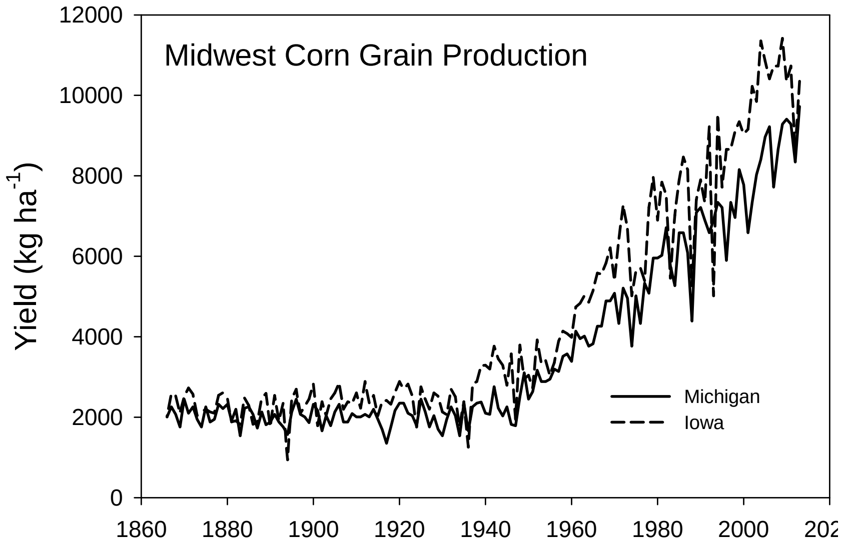


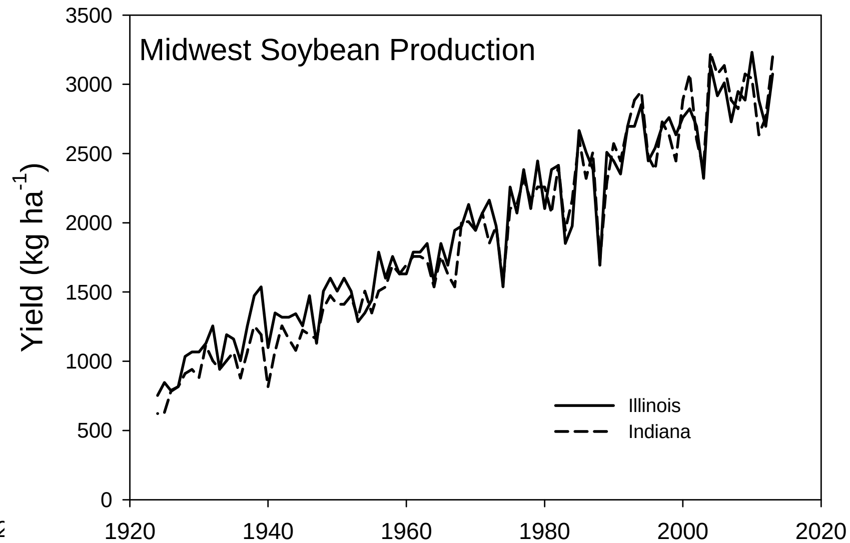
Weather Trend: Unusual combinations of spring and summer rainfall are occurring more often

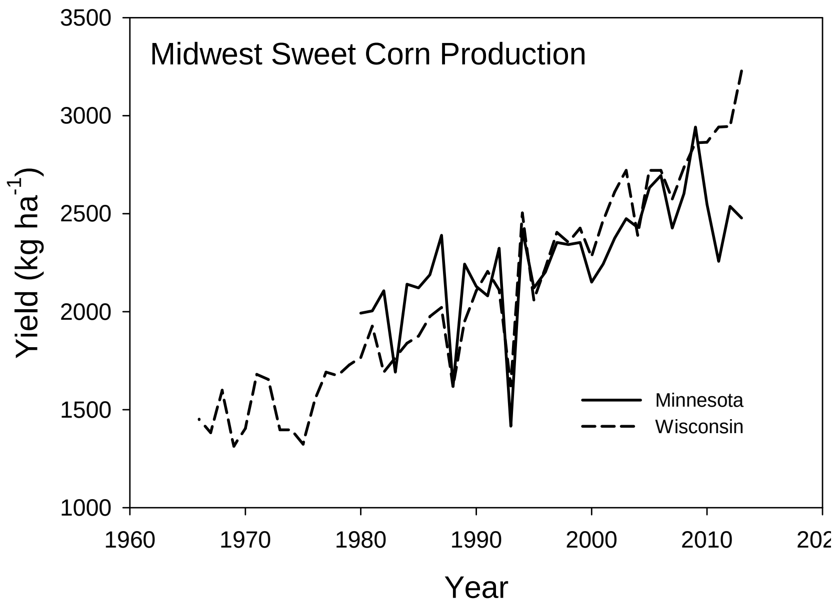


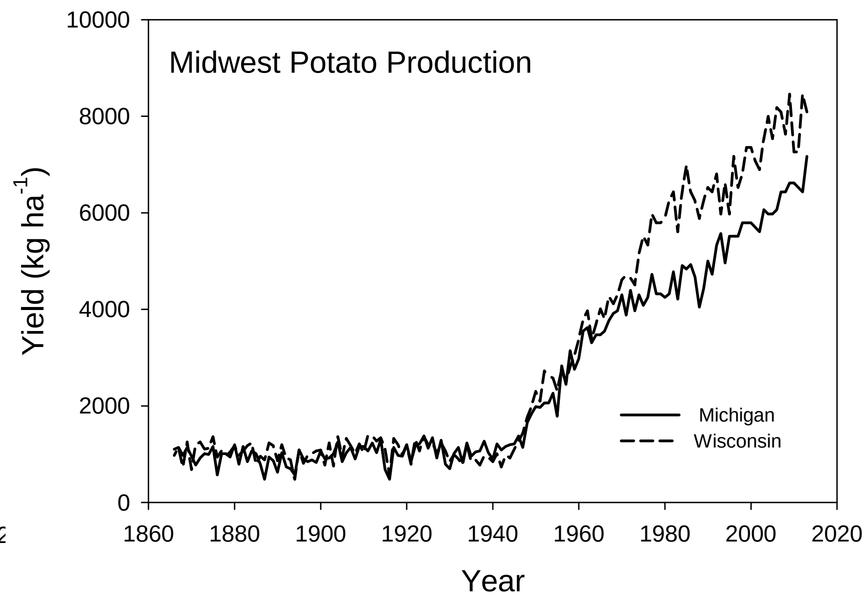
Data Source: State of Iowa Climatologist

Current Agriculture in the Midwest

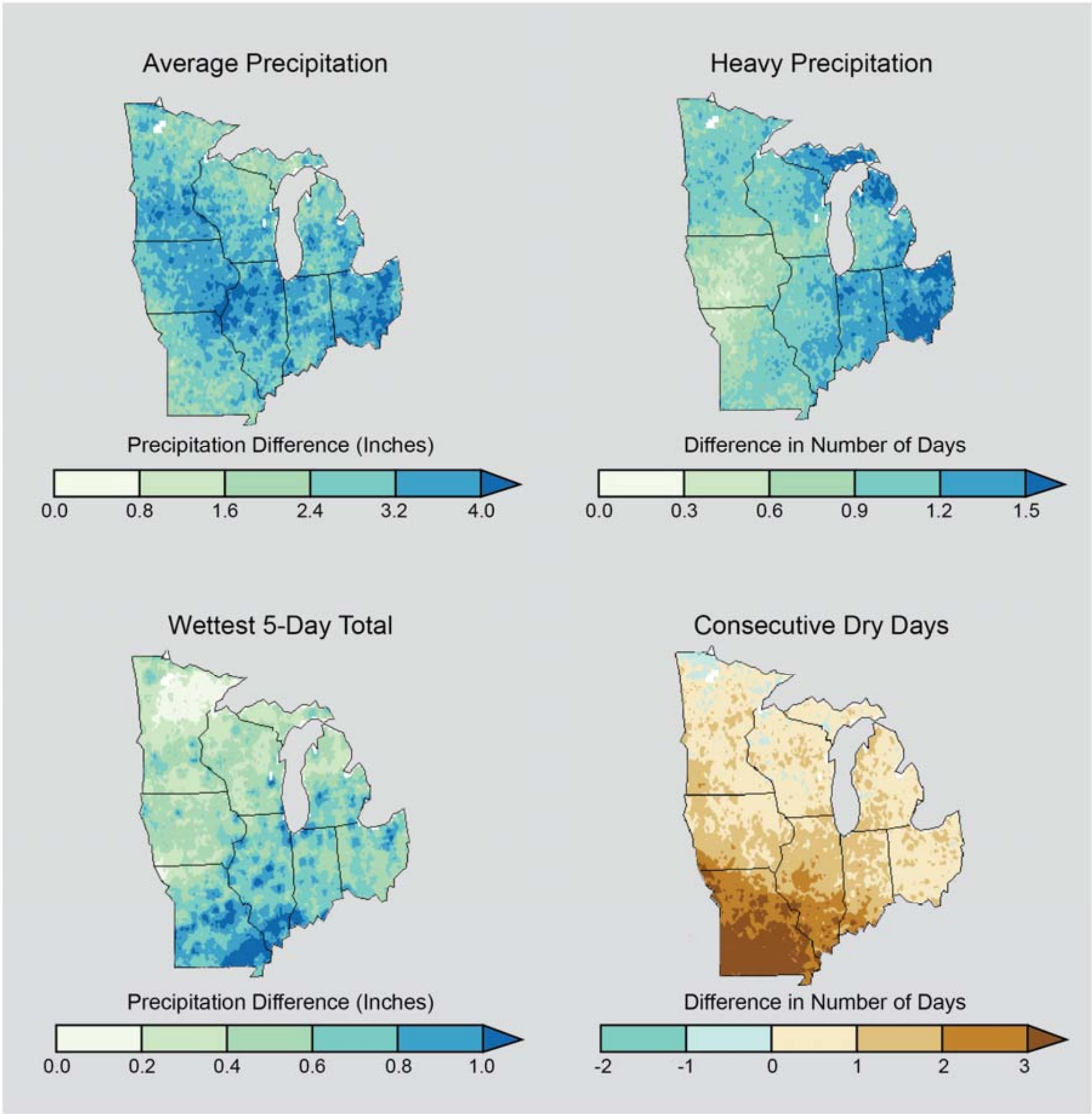




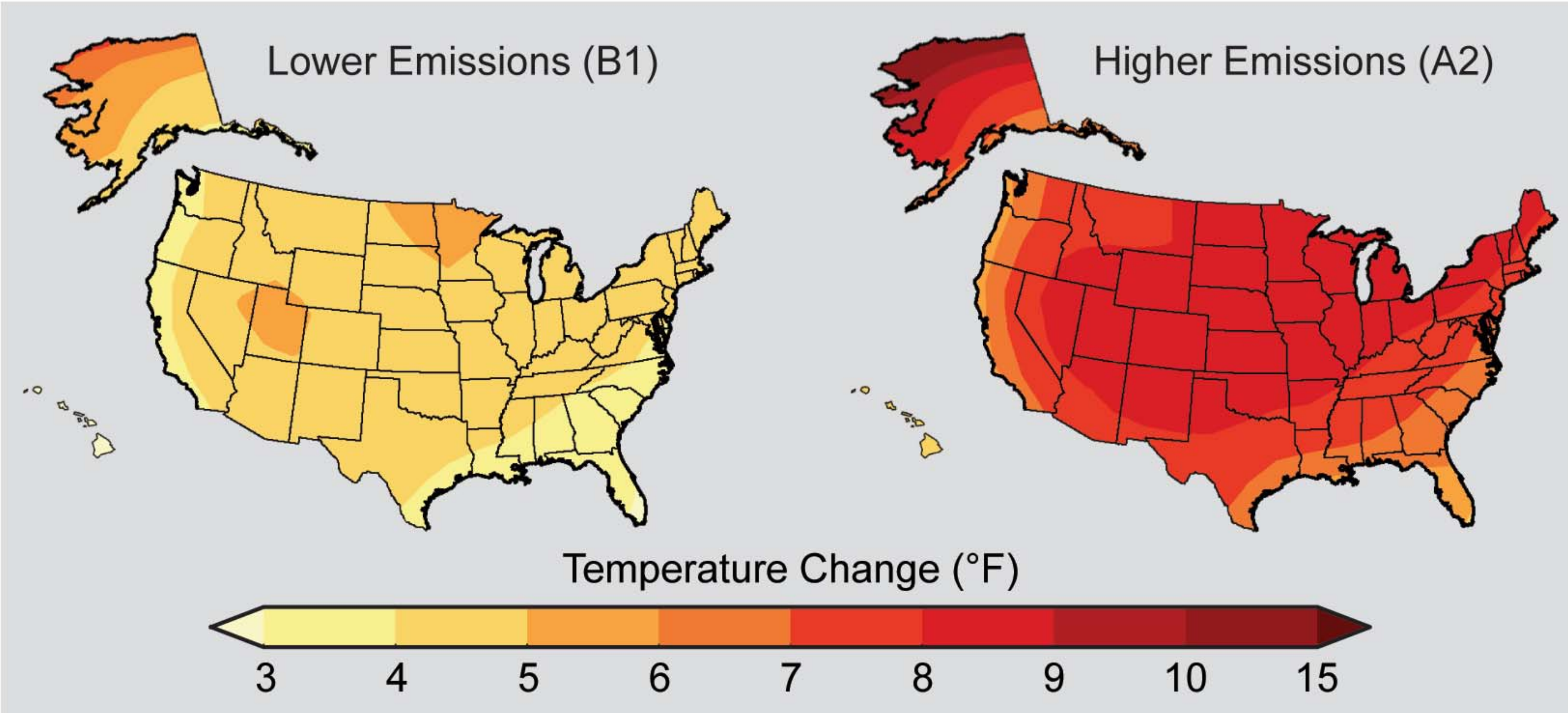




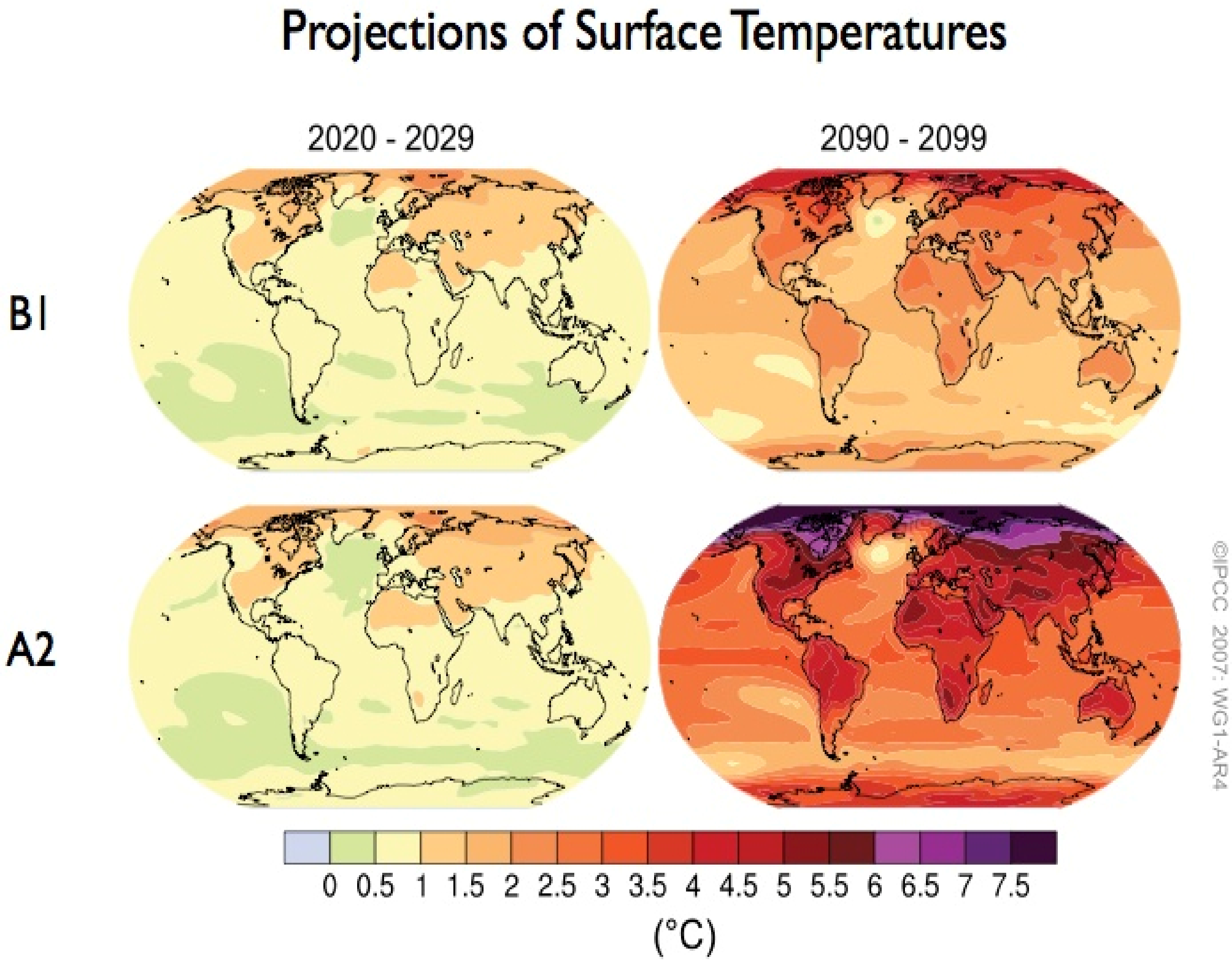
When it Rains, it Pours



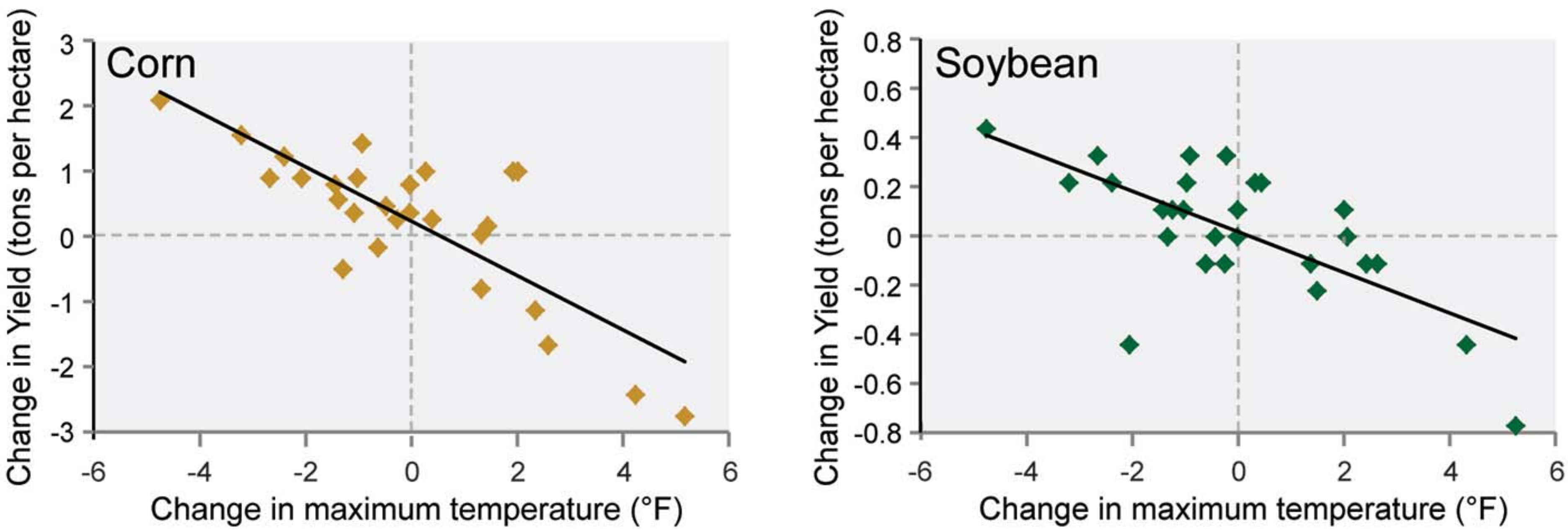
Projected Temperature Change



Temperature Changes



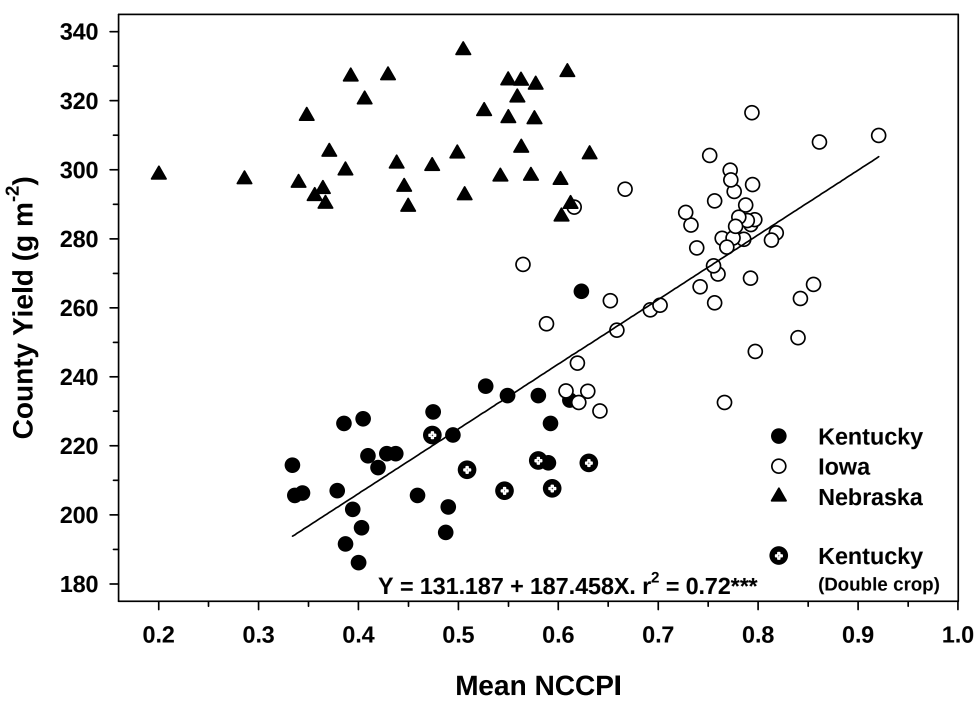
Crop Yields Decline under Higher Temperatures



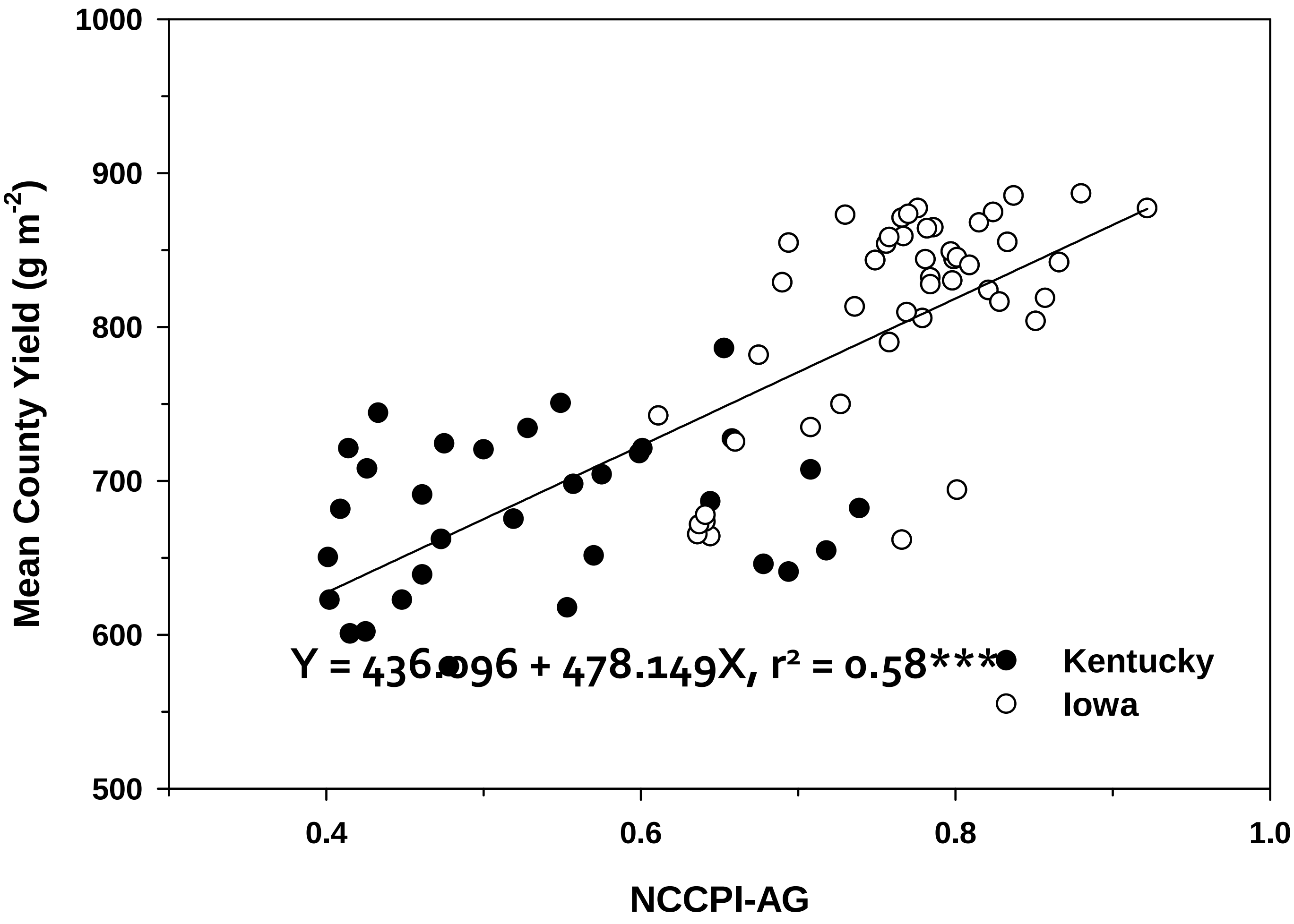
Mishra and Cherkauer, 2010

Good Soils = Good Yields

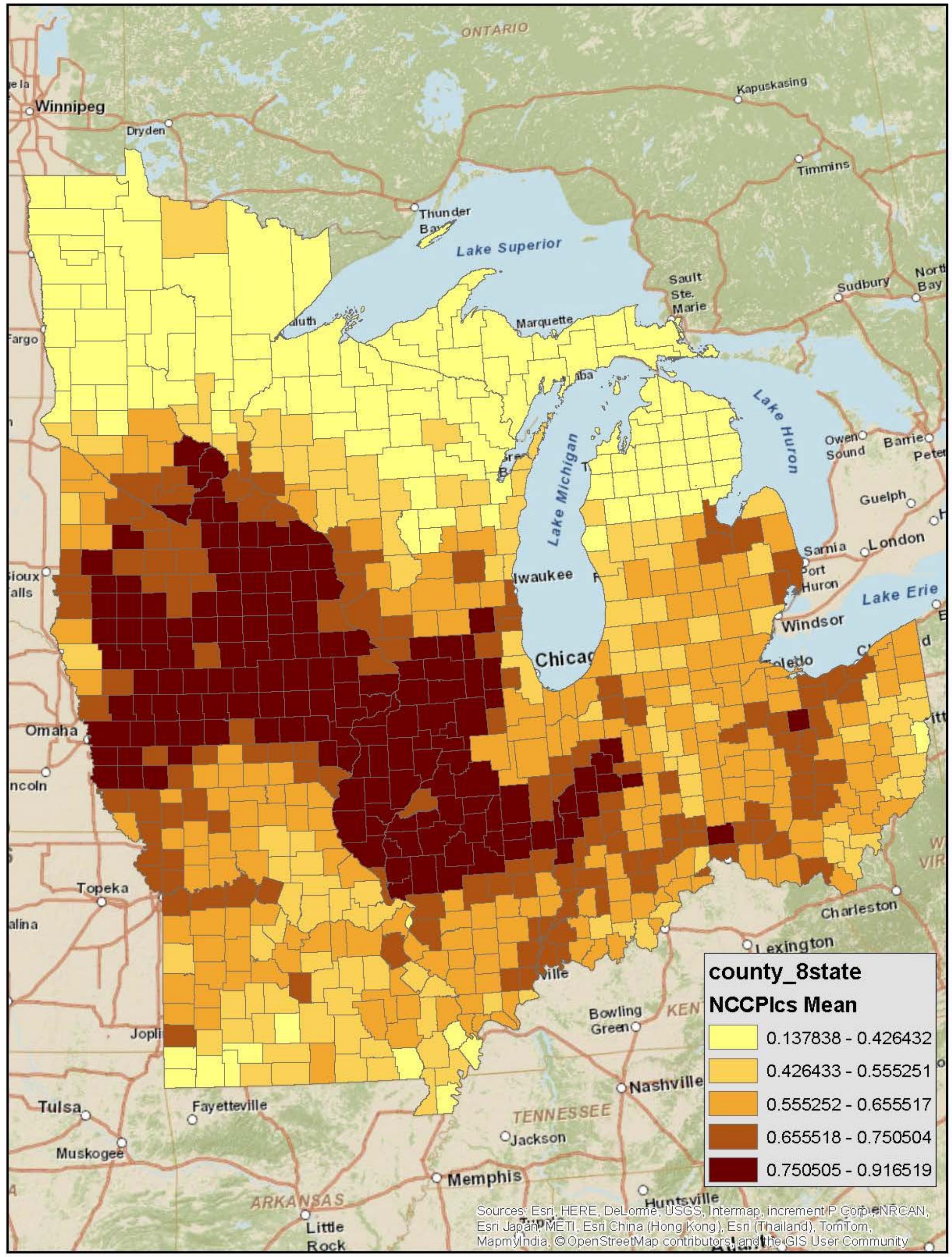
Soybean yields across Iowa, Kentucky, and Nebraska



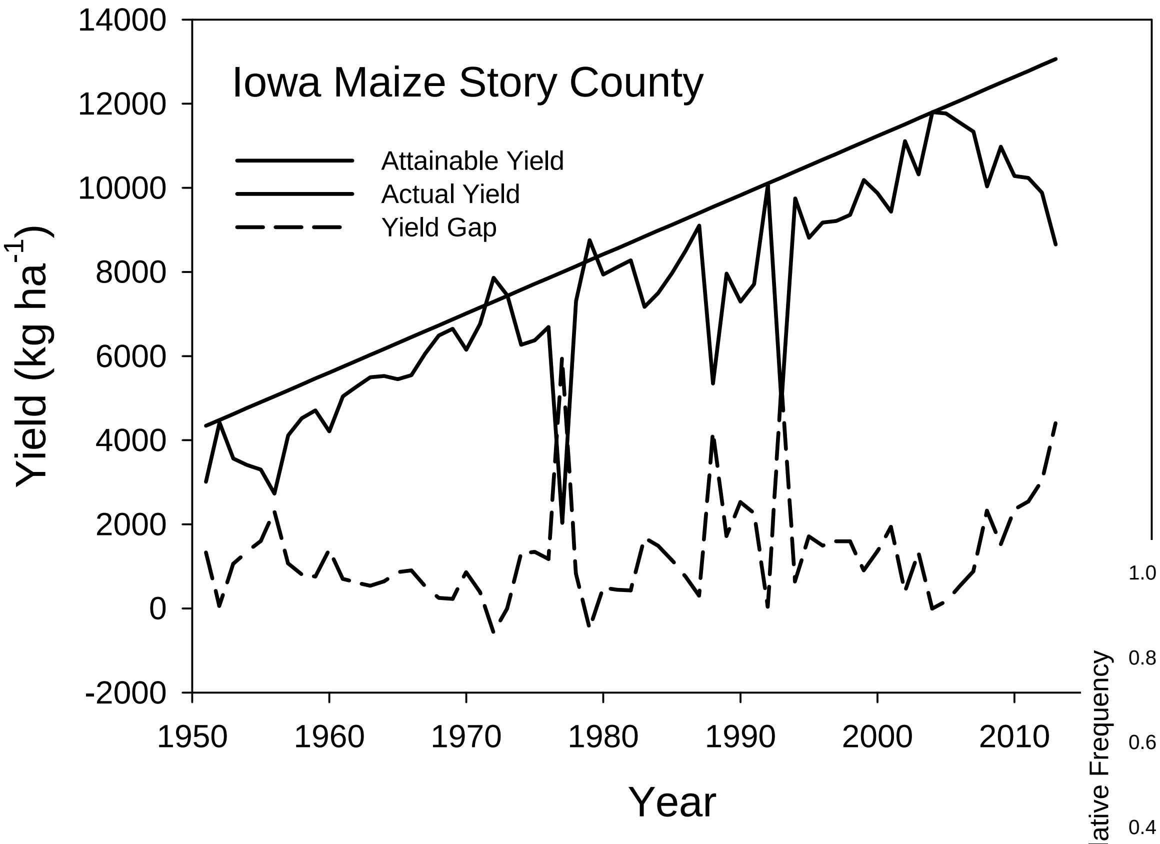
Maize County Yields



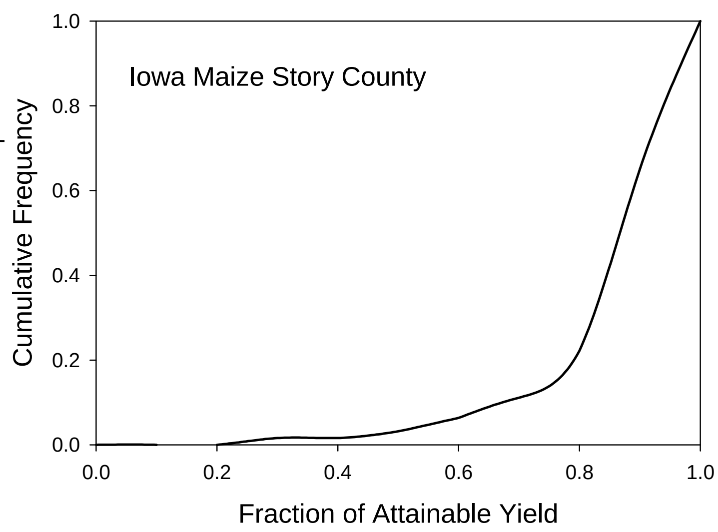
NCCPI Across the Midwest



Yield Gaps

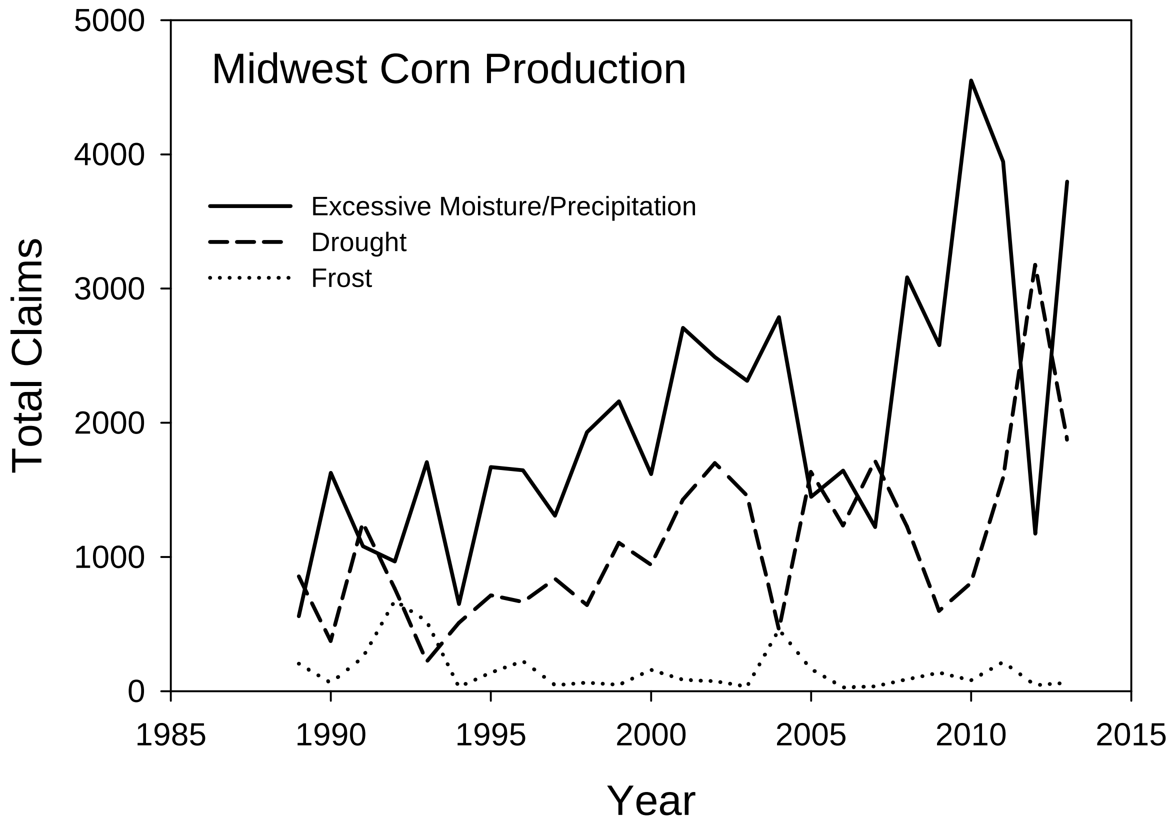


Iowa Maize Story County
Attainable Yield
Actual Yield
Yield Gap
Yield (kg ha-1)
14000
12000
10000
8000
6000
4000
2000
0
-2000
1950
1960
1970
1980
1990
2000
2010
Year

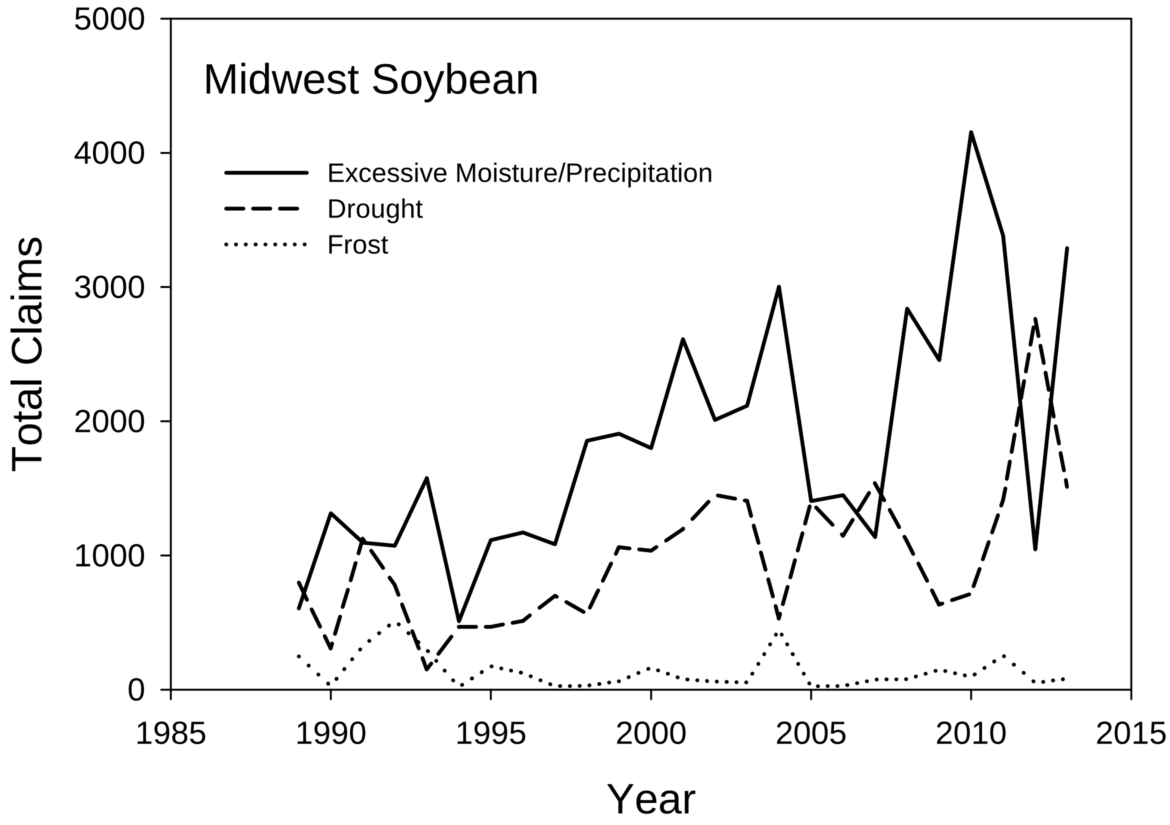


Iowa Maize Story County
Cumulative Frequency
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Fraction of Attainable Yield

Corn: Specific Claims



Soybean: Specific Claims



Soil Degradation Spiral

Poor Land Management

Aggregation Degradation

Compaction
& crusting

Water & Wind Erosion

Plant Growth

Soil Biology

Yield

Reduced Soil
Productivity

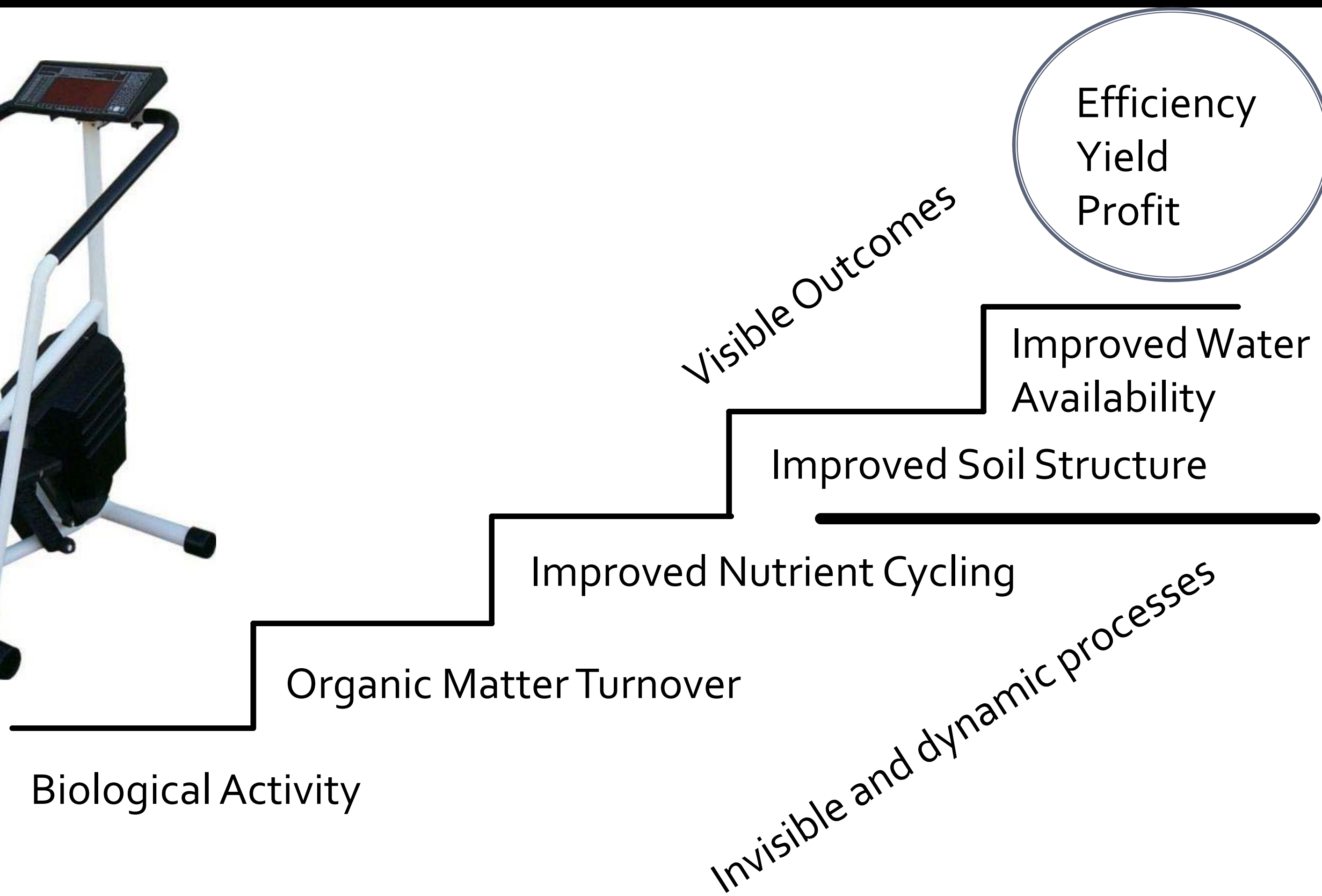
Erosion: How much is tolerable

NLAE
National Laboratory for Agriculture and the Environment

The wind blows too

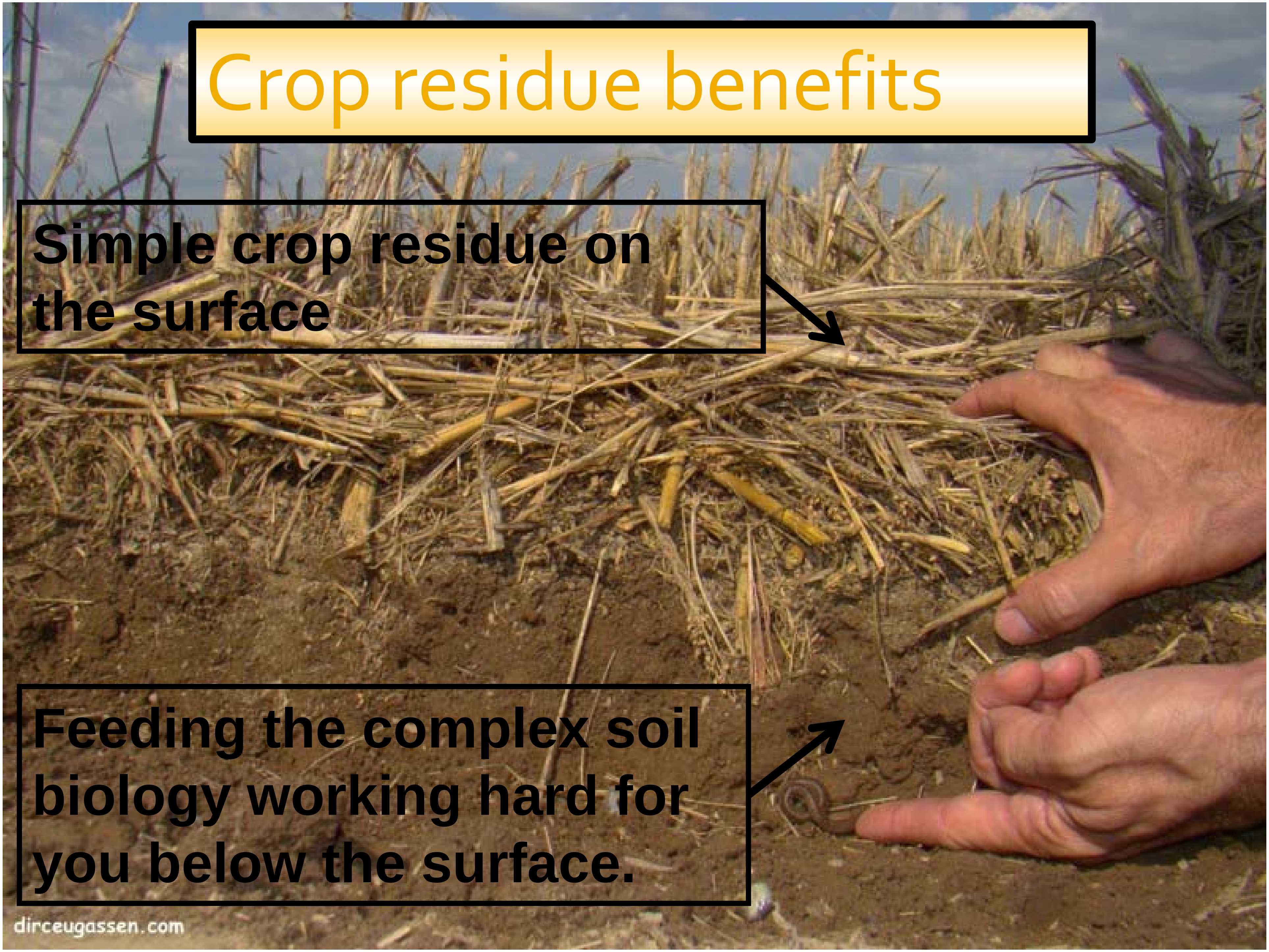
NLAE National Laboratory for Agriculture and the Environment

Soil Aggradation Climb



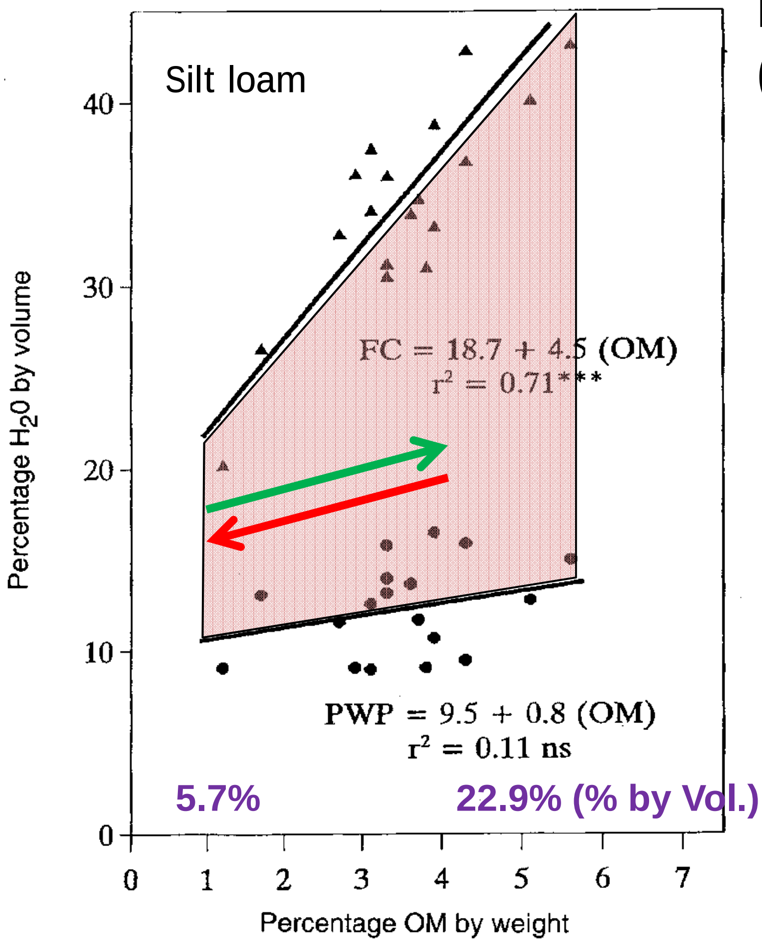
We build soil through biological activity not by physical or chemical manipulation

Crop residue benefits



Organic Matter Effects on Available Water Capacity

[redacted]



- Sands: FL (n = 20)
- Silt loams: IA, WI, MN, KS (n = 18)
- Silty clay loams: IA, WI, MN, KS (n = 21)

Sands AWC = 3.8 + 2.2 (OM)
$r^2 = 0.79$

Silt loams AWC = 9.2 + 3.7(OM)
$r^2 = 0.58$

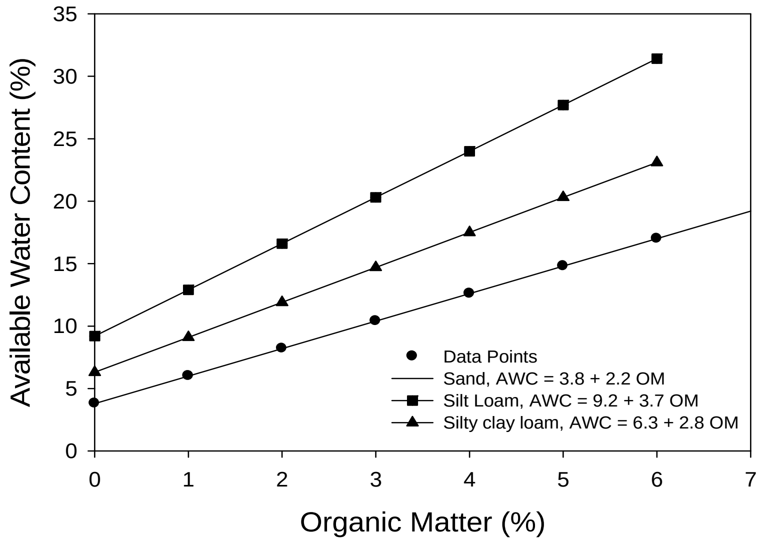
Silty clay loams AWC = 6.3 + 2.8 (OM)
$r^2 = 0.76$

OM increase from 1% to 4.5%
AWC doubles!

Hudson, B. D. 1994. Soil organic matter and available water capacity. J. Soil Water Conserv. 49(2):189-194.

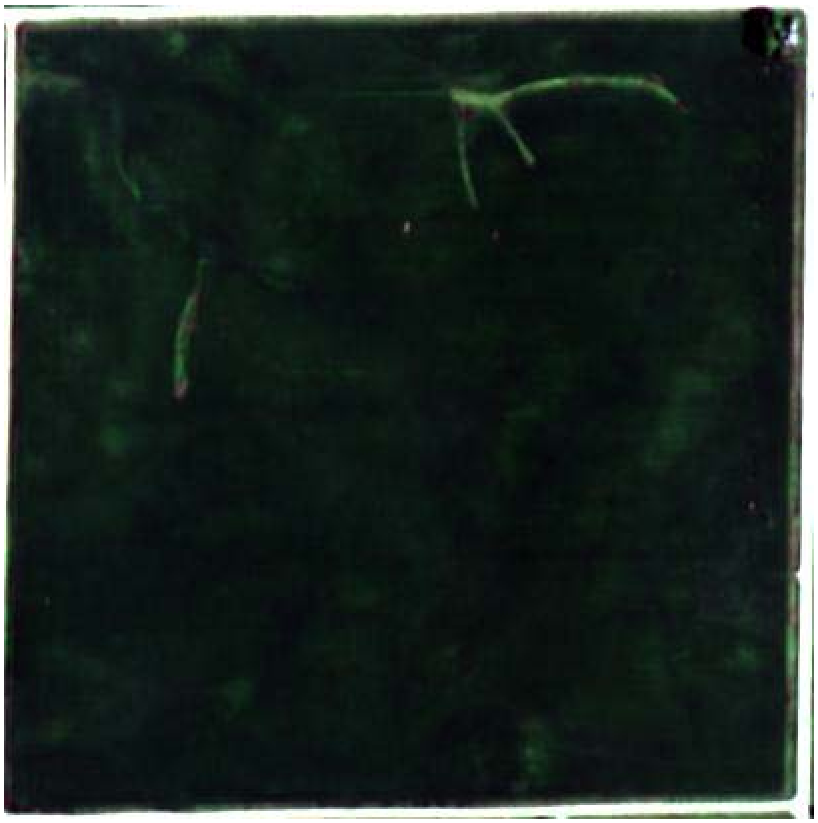
Improving the soil

- Will not change the precipitation availability
- Will be able to change the soil water availability if we reduce E of ET, residue can reduce the soil water evaporation by 50 to 100%
- Increase the soil biology will increase the organic matter content



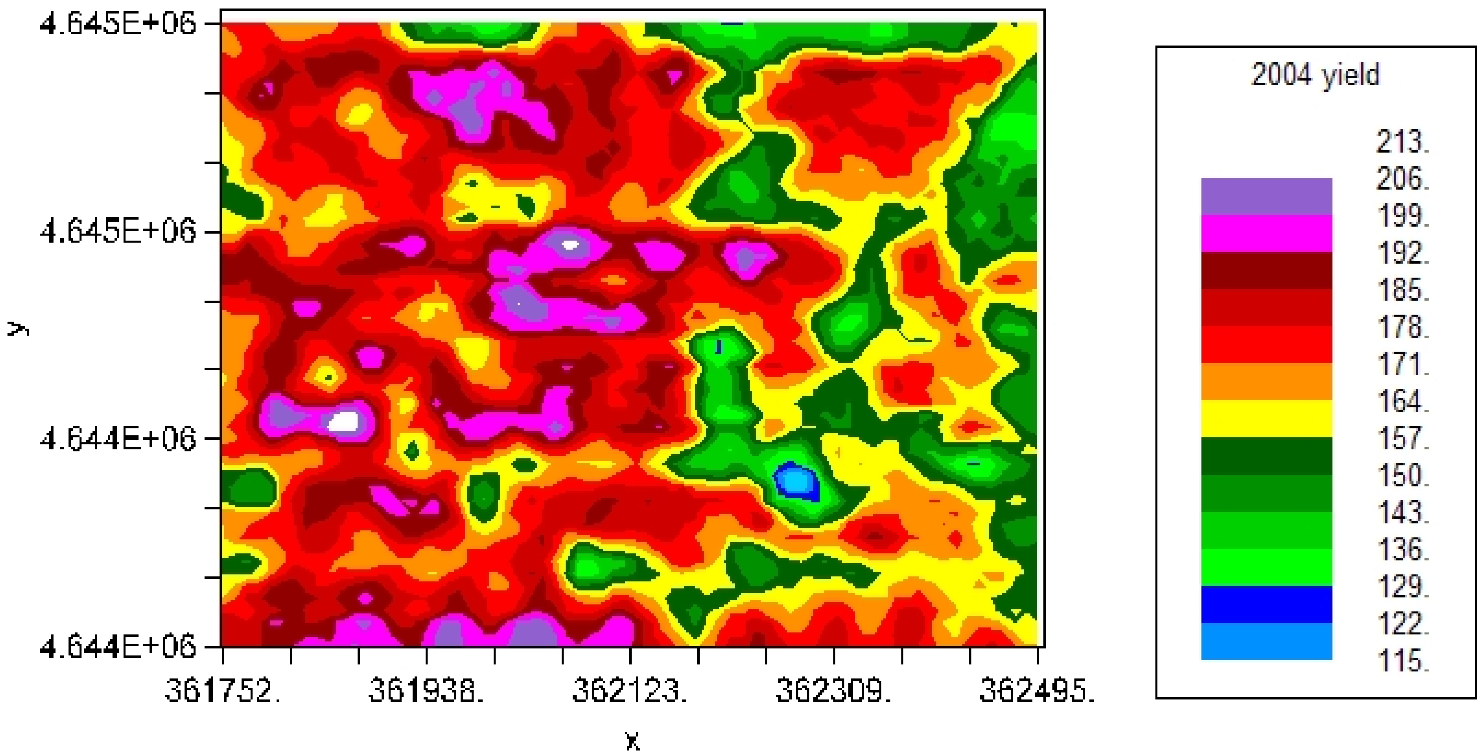
Soybean Production Field

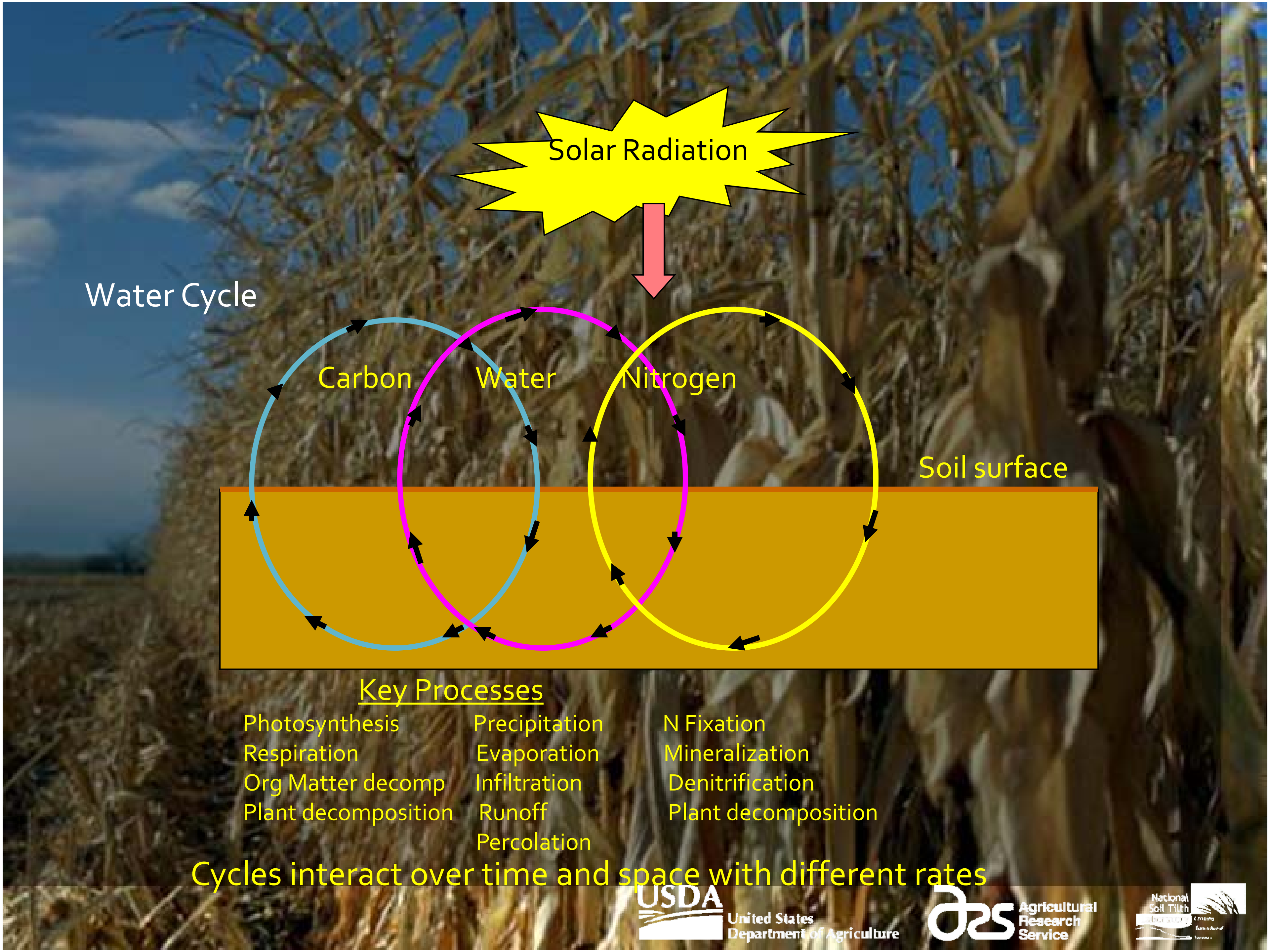
Early August



Late August

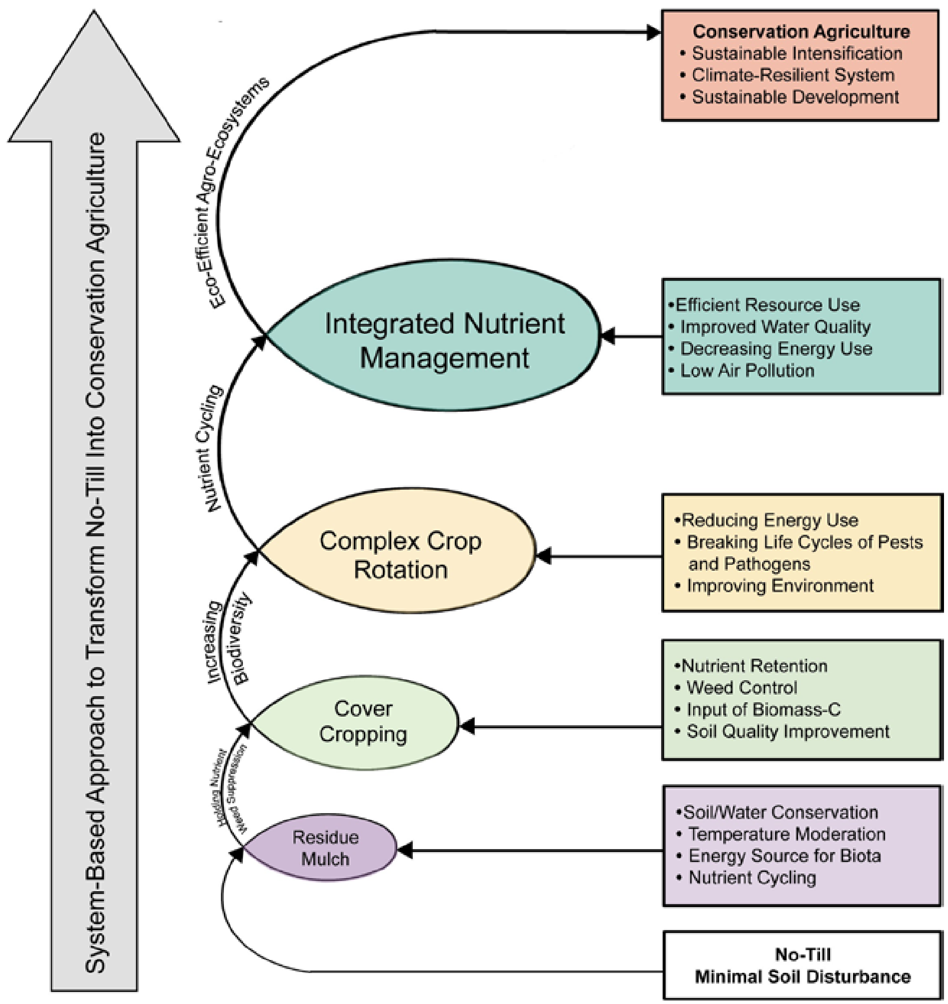
Crop Yield Variation





Water Cycle
Solar Radiation
Carbon
Water
Nitrogen
Soil surface
Key Processes
Photosynthesis
Respiration
Org Matter decomp
Plant decomposition
Precipitation
Evaporation
Infiltration
Runoff
Percolation
N Fixation
Mineralization
Denitrification
Plant decomposition
Cycles interact over time and space with different rates
USDA
United States Department of Agriculture
Agricultural Research Service
National Soil Tilth

A Systems Approach



Lal, 2015, JSWC
70:82A-88A

Climate Resilience

- Requires a soil to supply water and nutrients throughout the life cycle of the plant
- Cropping system that can withstand the stresses imposed by variable weather
- Requires an integration of genetics and management to offset the environmental impacts (G x E x M)
- Enhancing the soil will increase the capacity of the agroecosystem to be resilient