Understanding Risk in Agriculture

WHAT IS CAUSING RISK?

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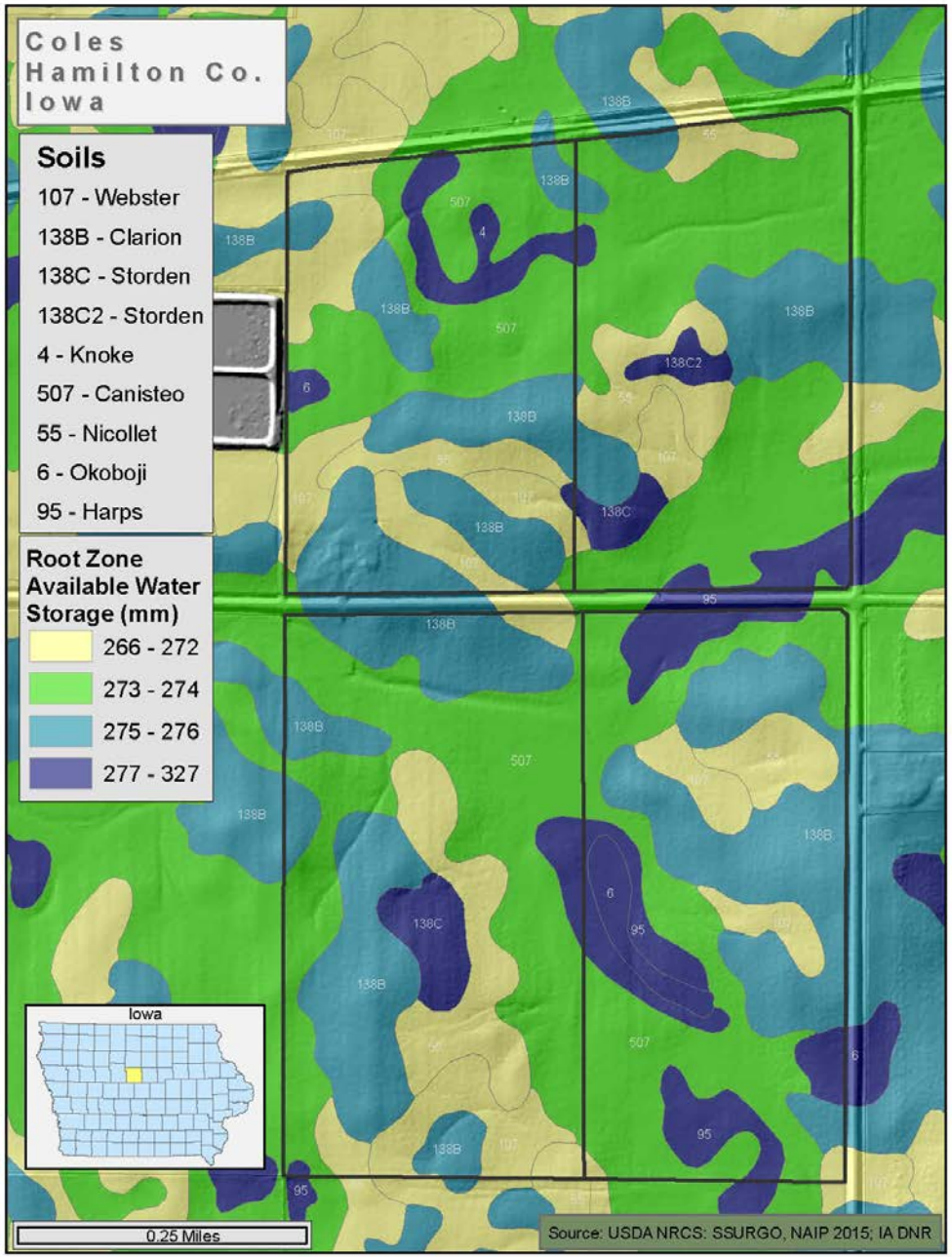
Crop Insurance Claims

Top 2 insurance claims since 1989

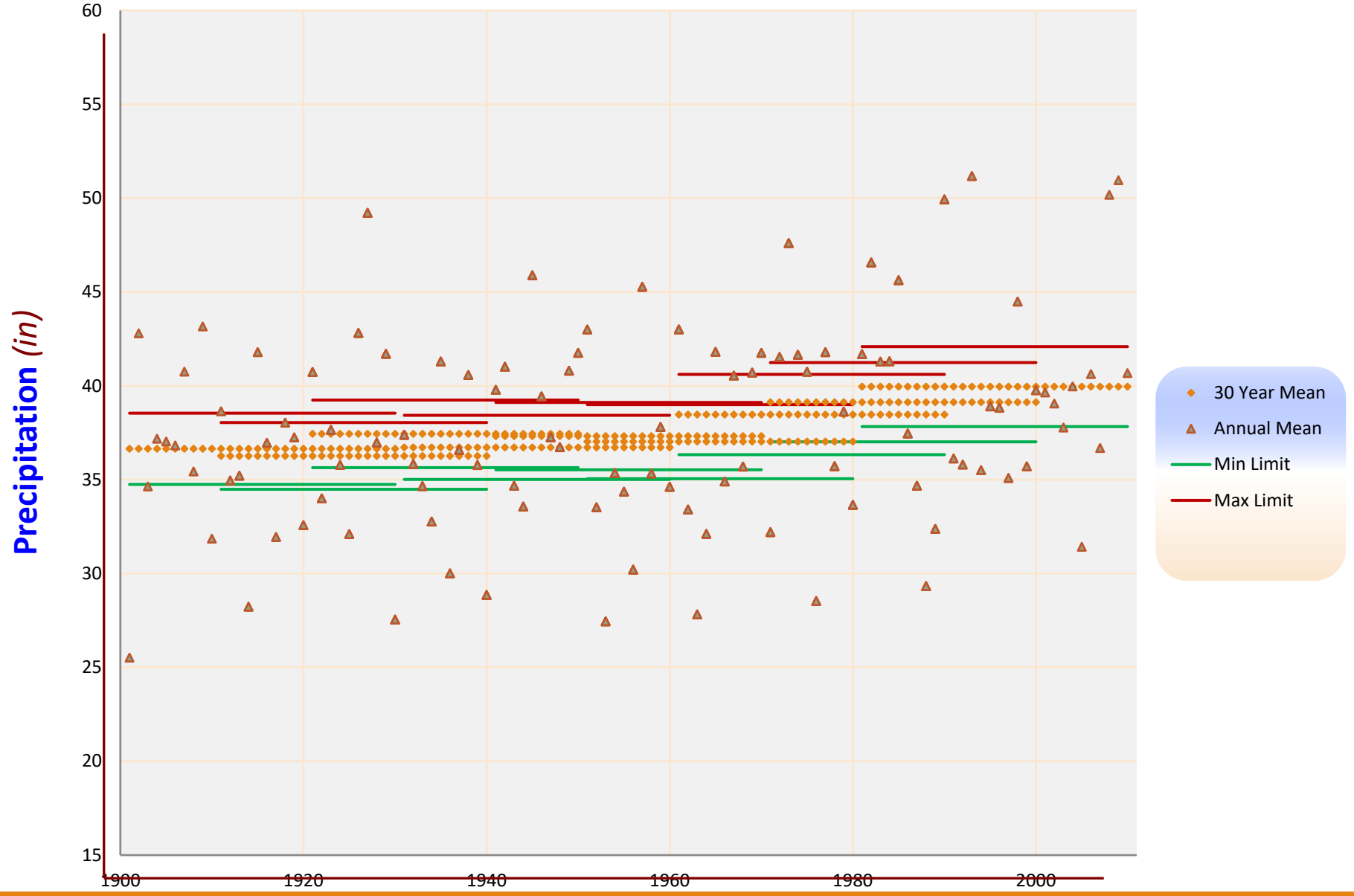
- Excessive moisture
- Drought

Is it soil or climate?

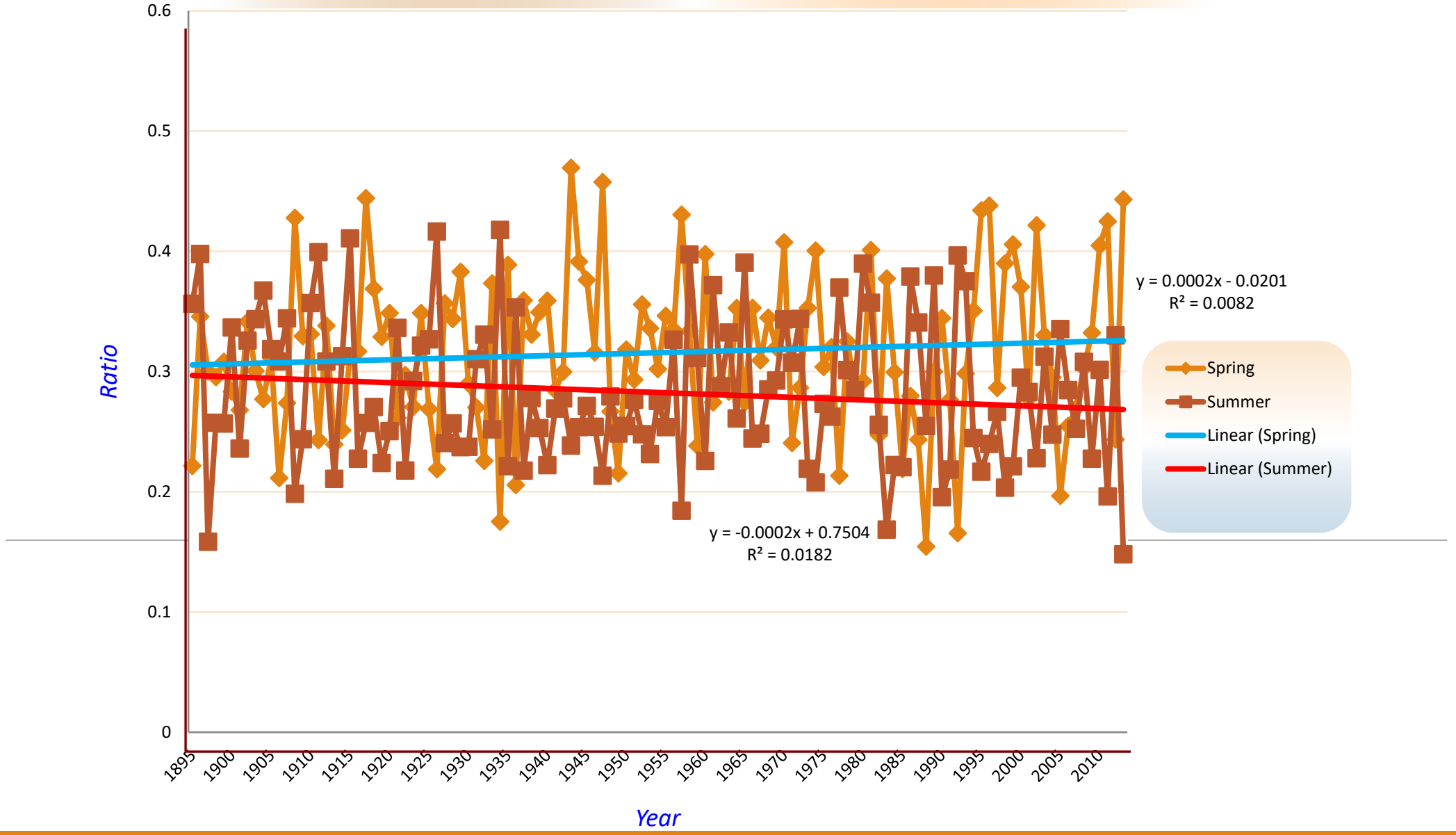


Our Changing Climate

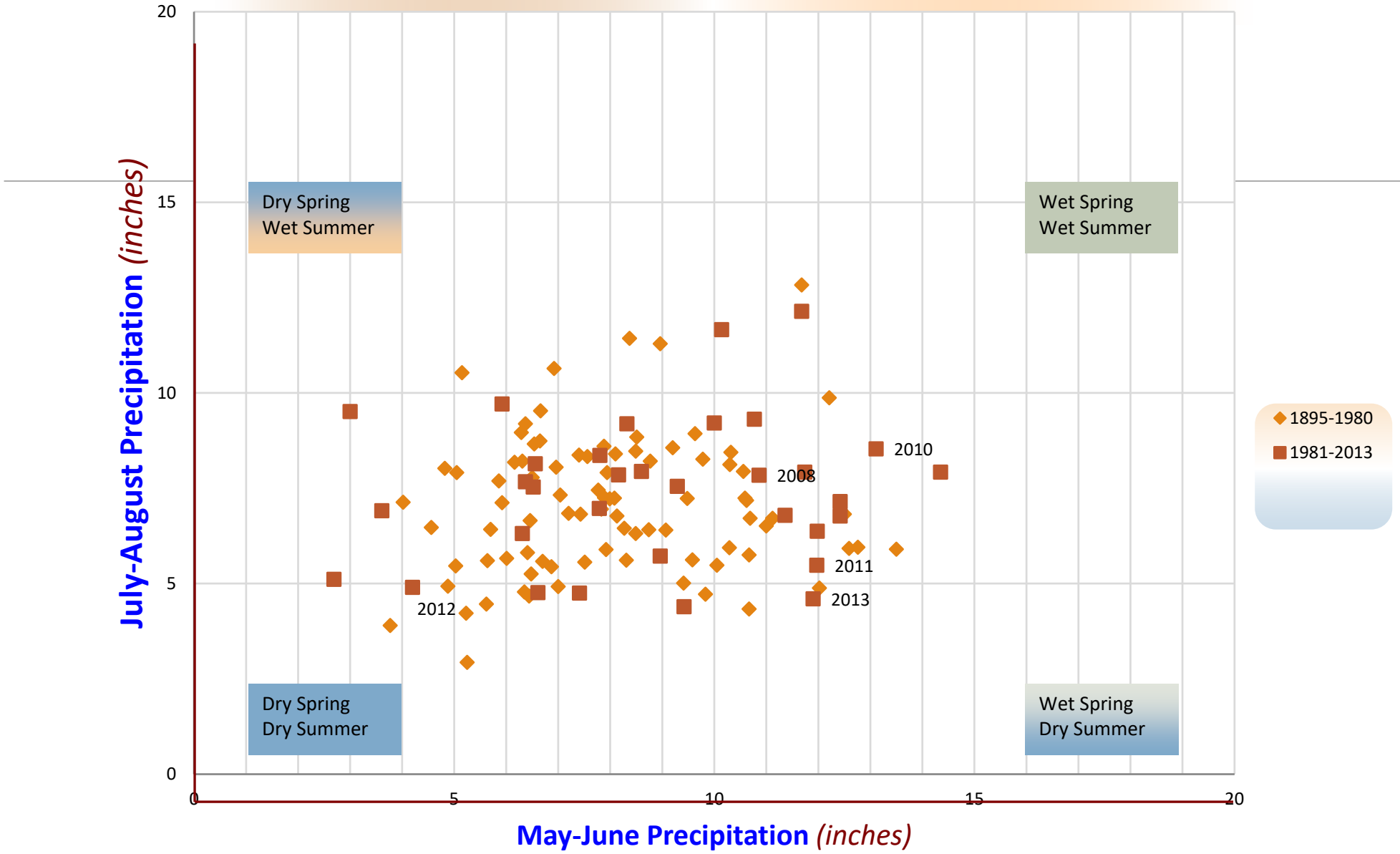
Illinois Precipitation: 1901-2010



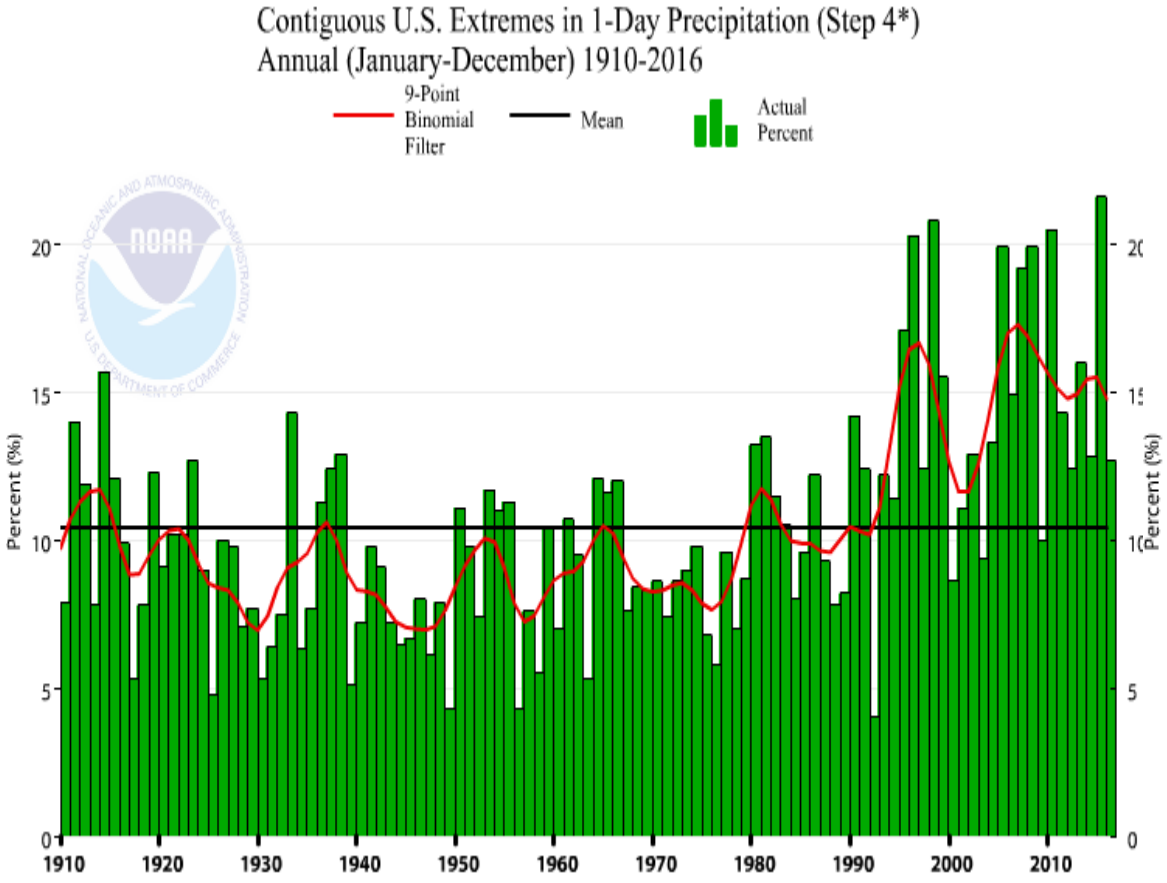
Seasonal Annual: Total Annual Precipitation- Illinois

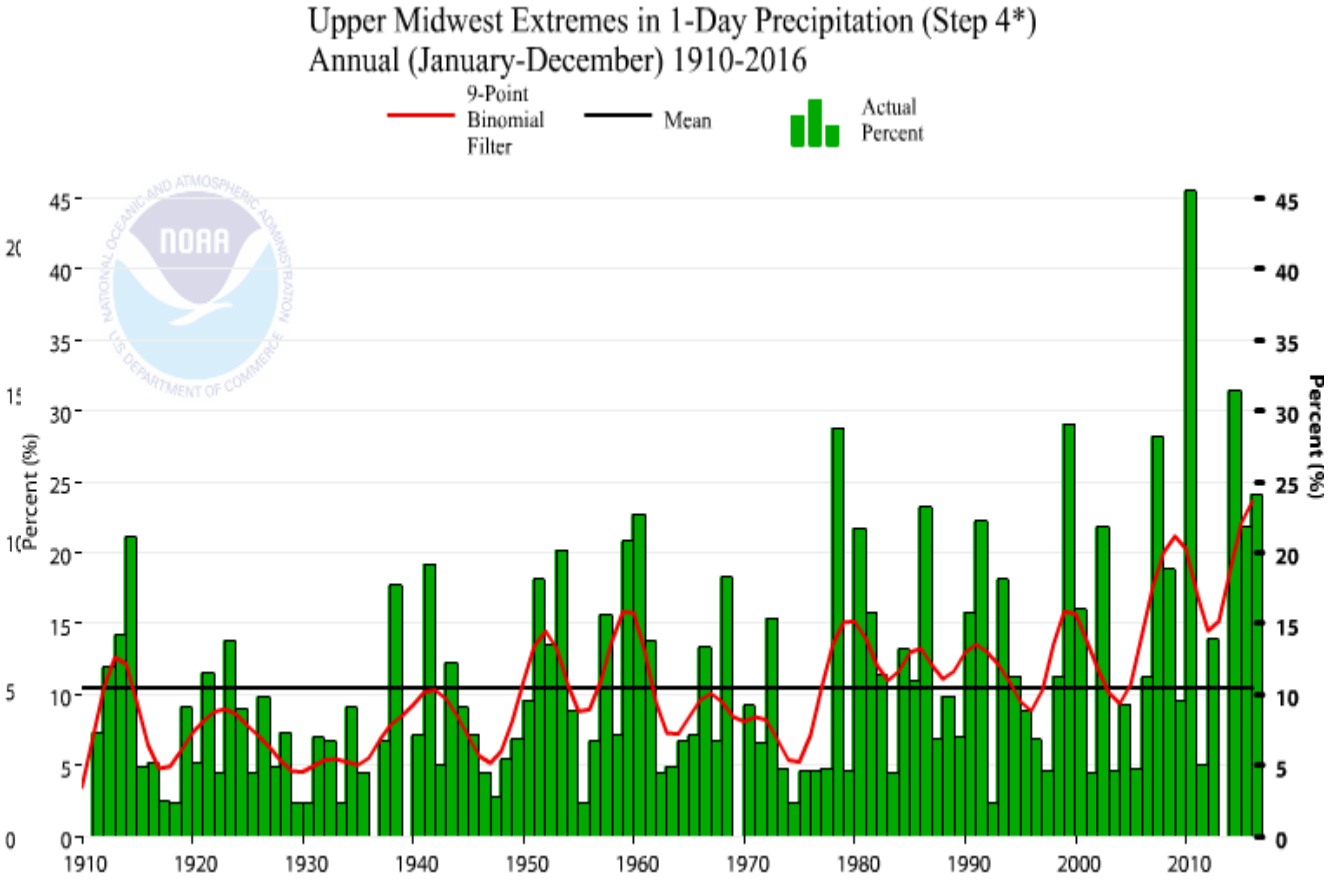


Spring and Summer Rainfall- *Illinois*



Extreme Precipitation





Climate trends

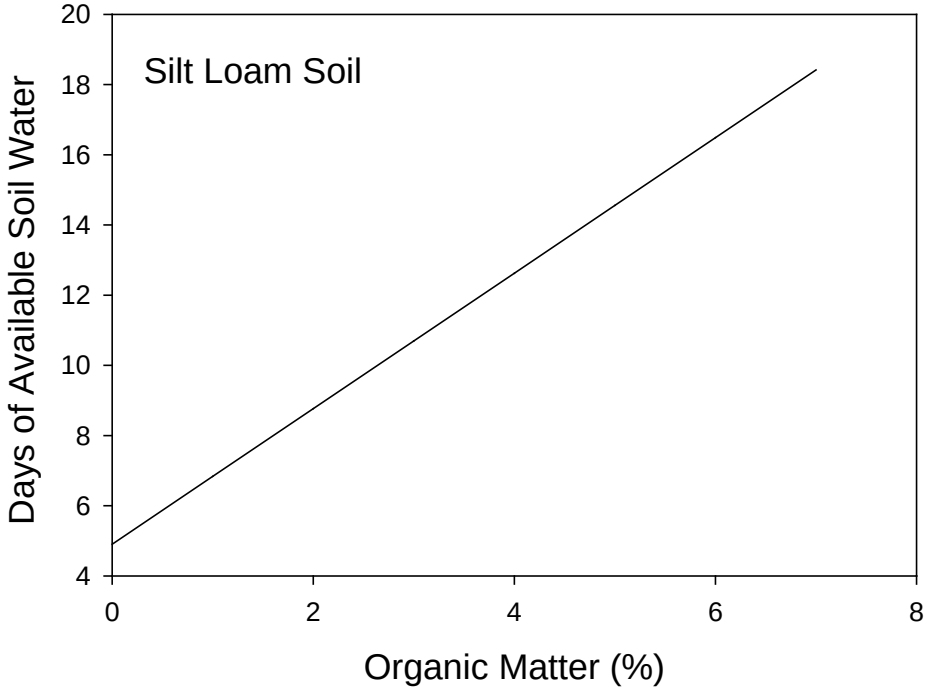
Increasing precipitation

Shift in seasonality with more spring and more variable summer precipitation

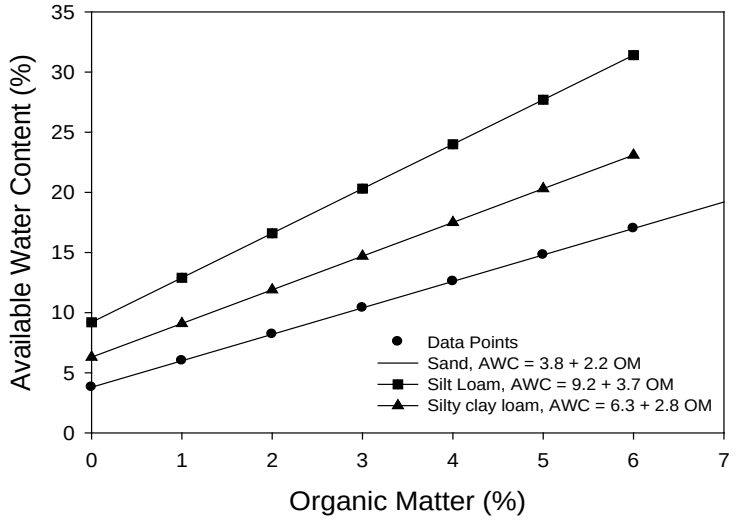
Minimum temperatures are increasing more than maximum

Temperatures are increasing more in the winter than the summer

Rain into the soil



Assuming an average rate of crop water use during the grain-filling period for corn



Hudson, 1994

What are we doing to our soil?

Soil Degradation Spiral

Poor Land Management

Aggregation Degradation

Compaction & crusting

Water & Wind Erosion

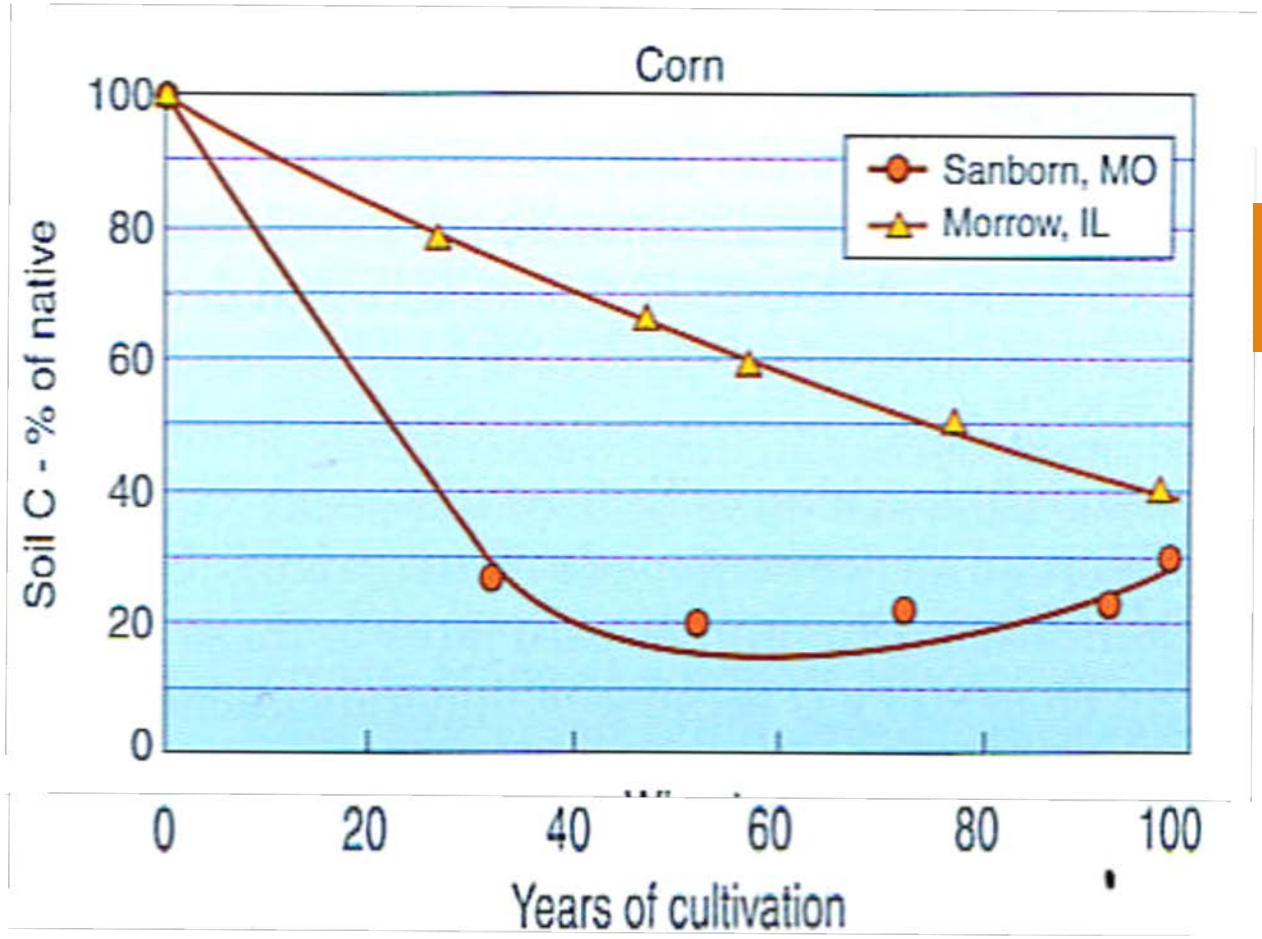
Plant Growth

Soil Biology

Yield

Reduced Soil Productivity

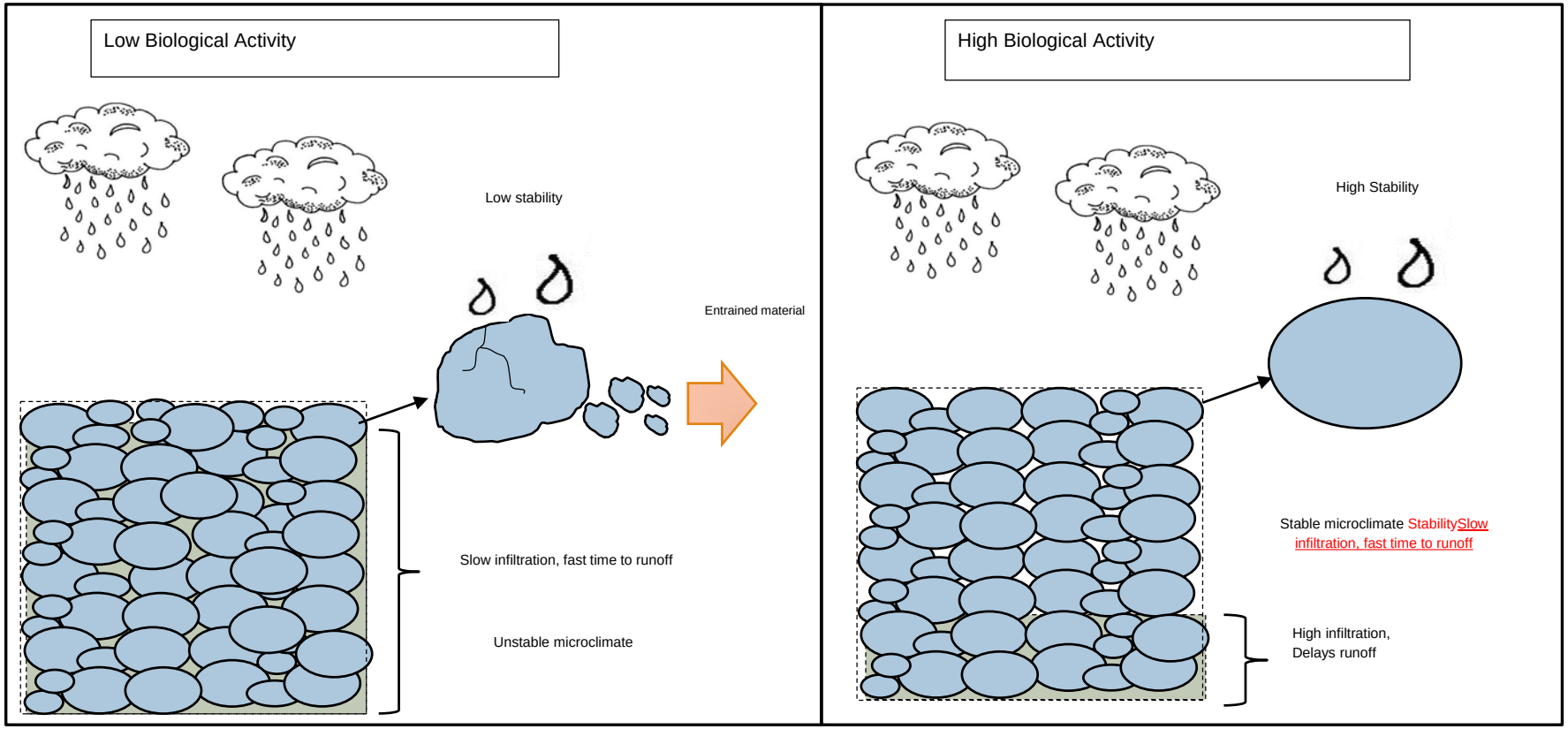
Soil Organic Matter Changes



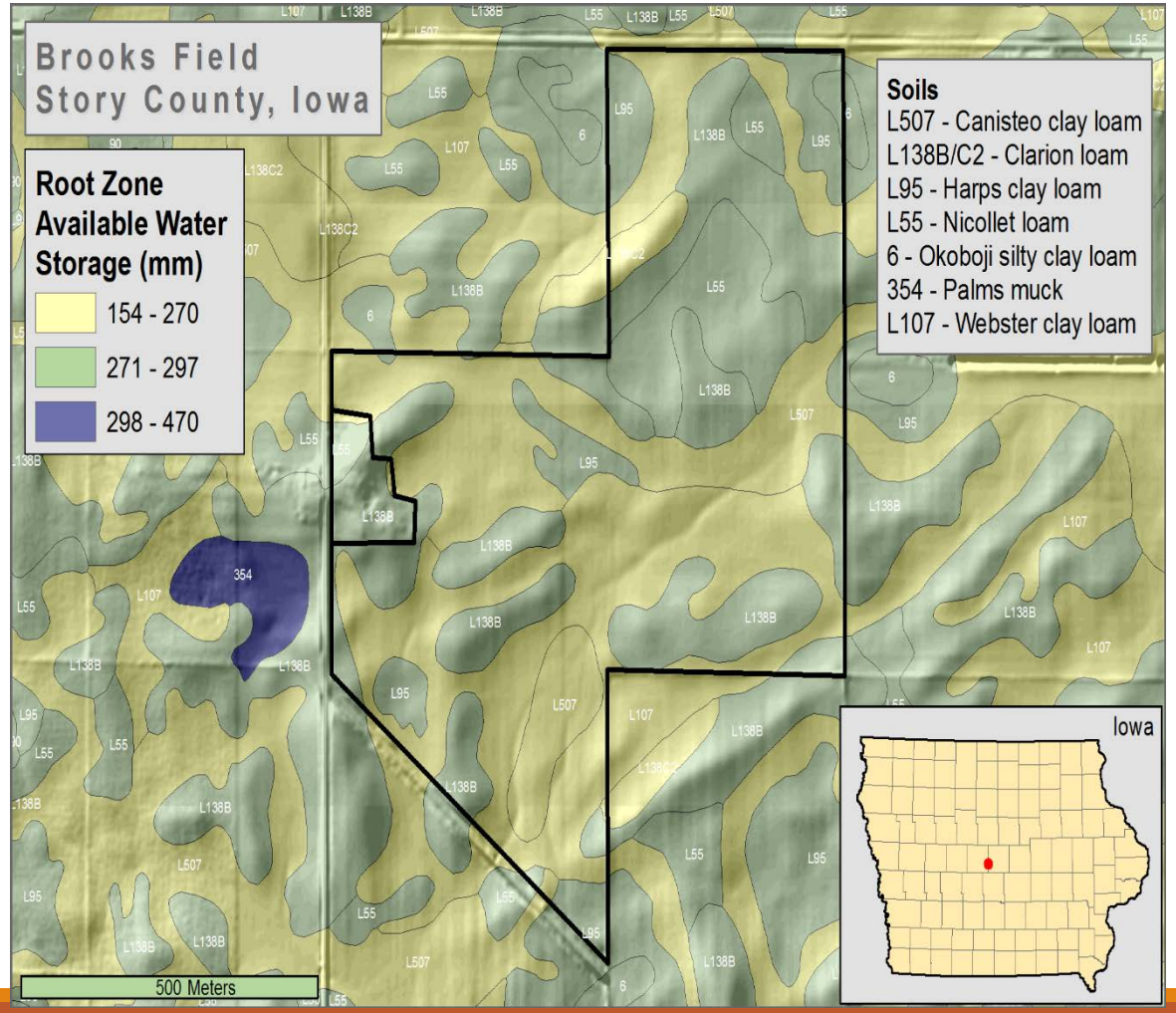
Decrease in OM *quantity*
& changes in OM *quality*

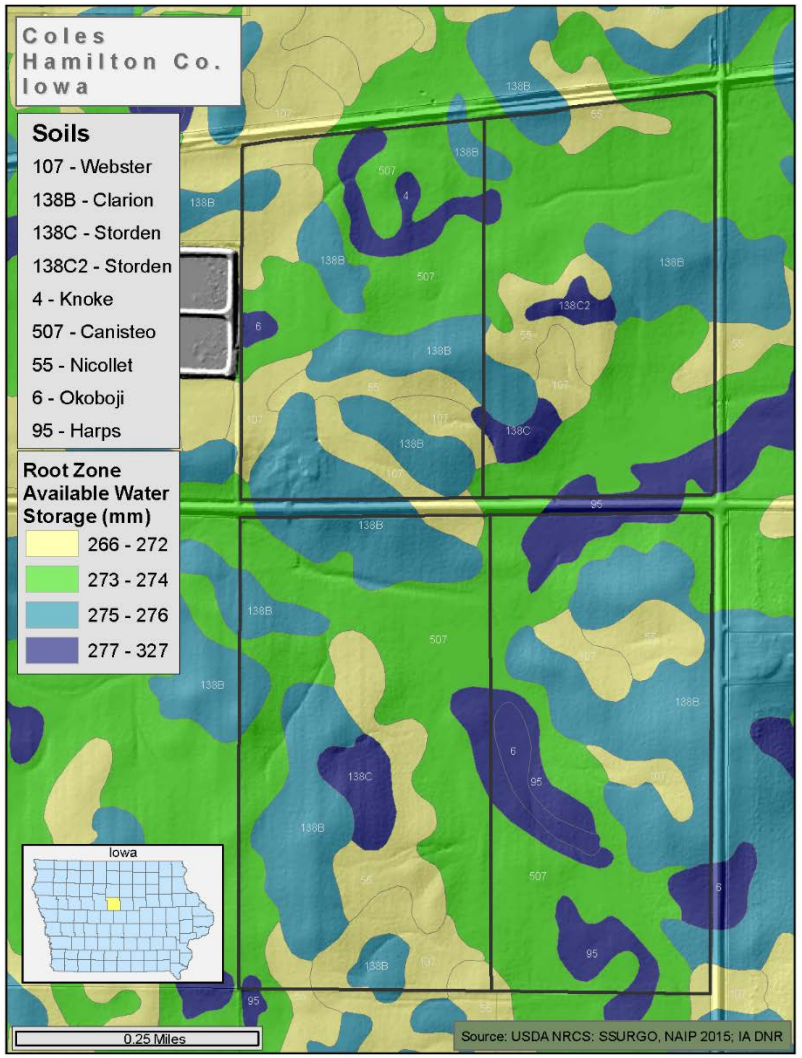
Paustian et al., 1997

Stable Soil Systems



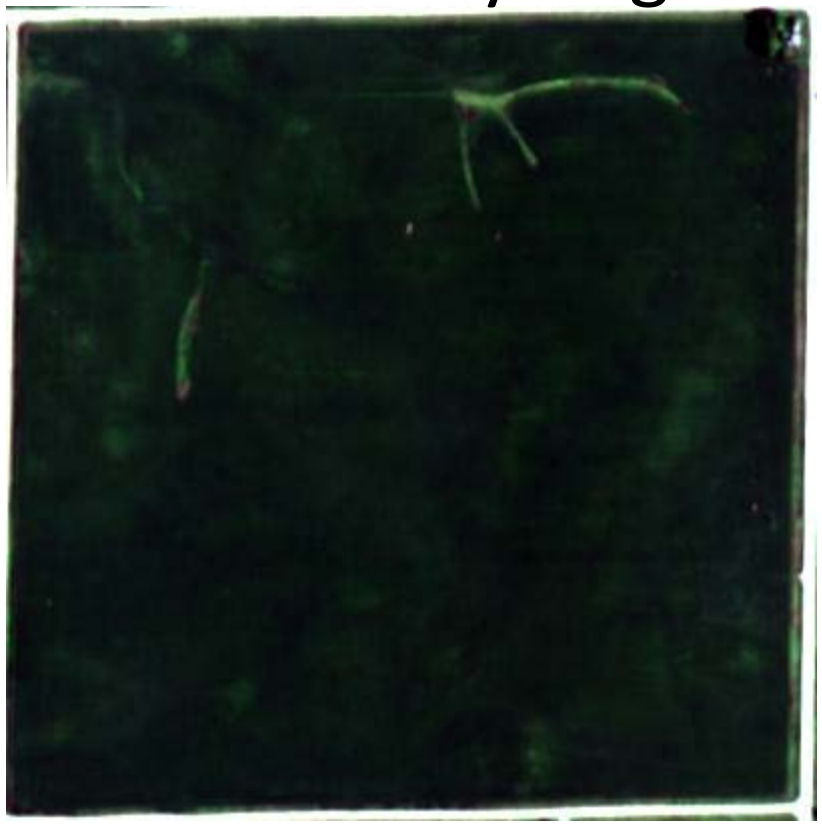
Variation of Water Holding Capacity within production fields



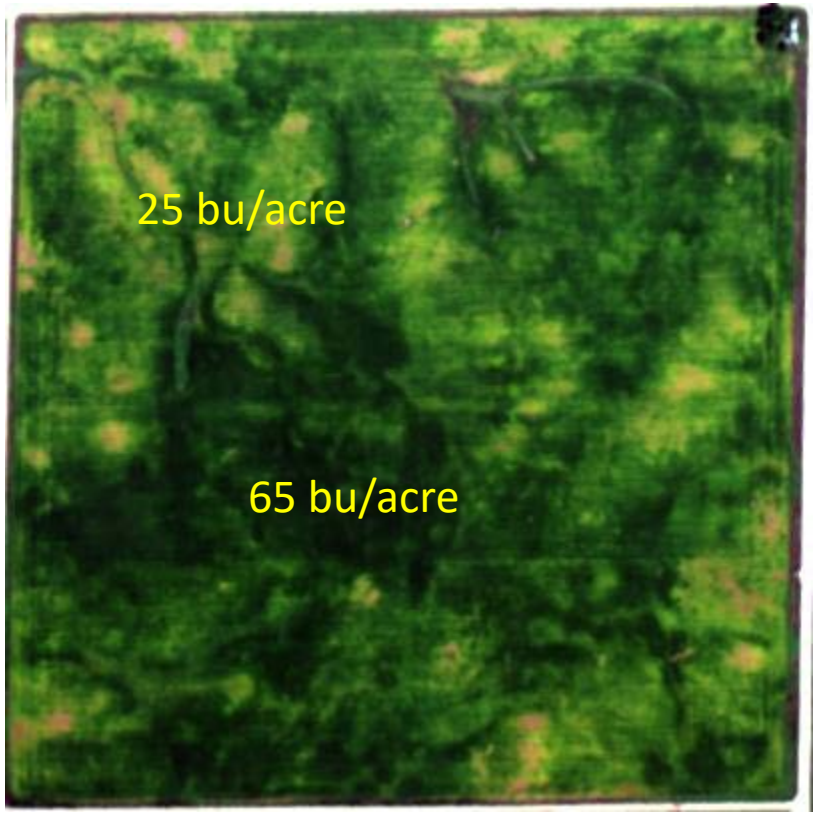


Soybean Production Field

Early August

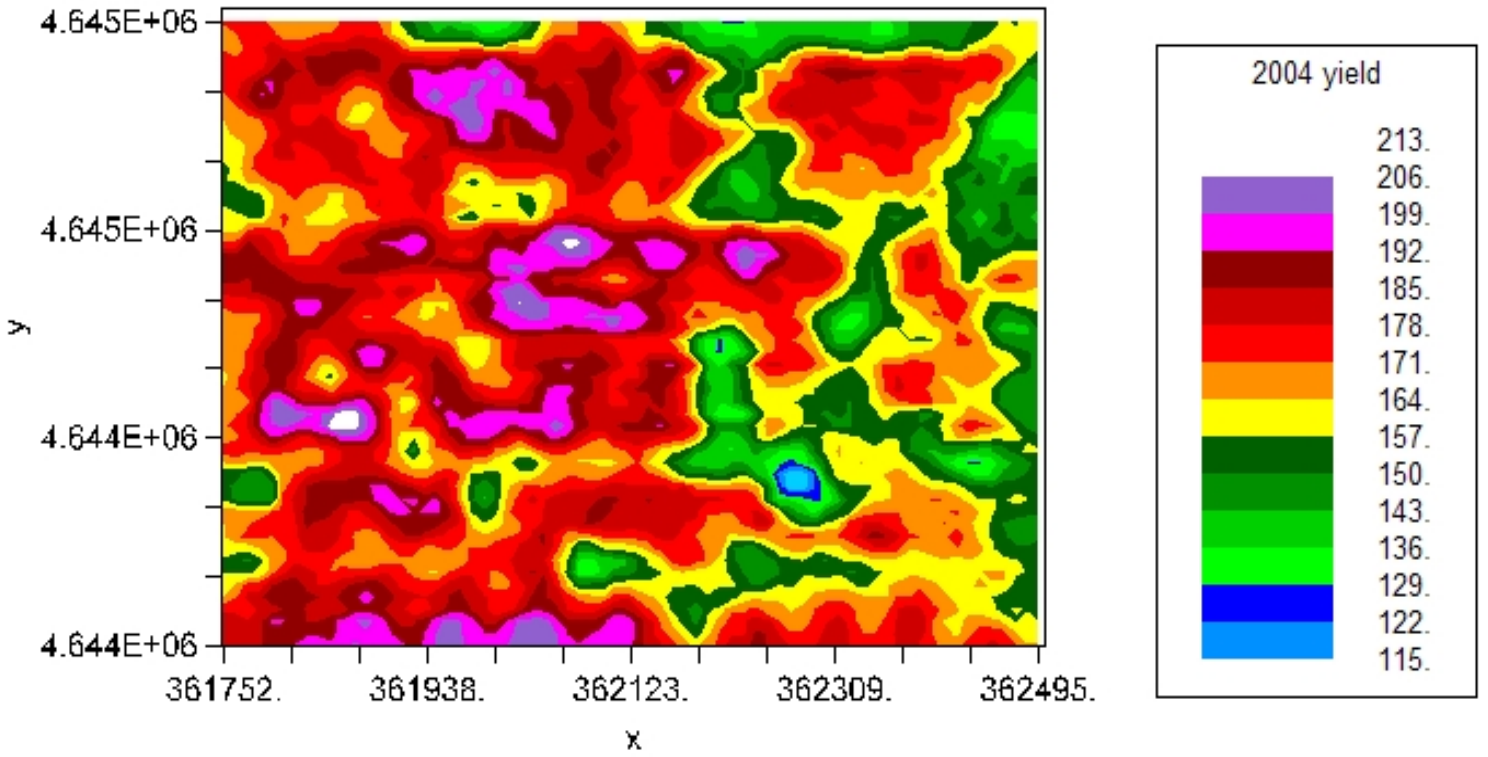


Late August



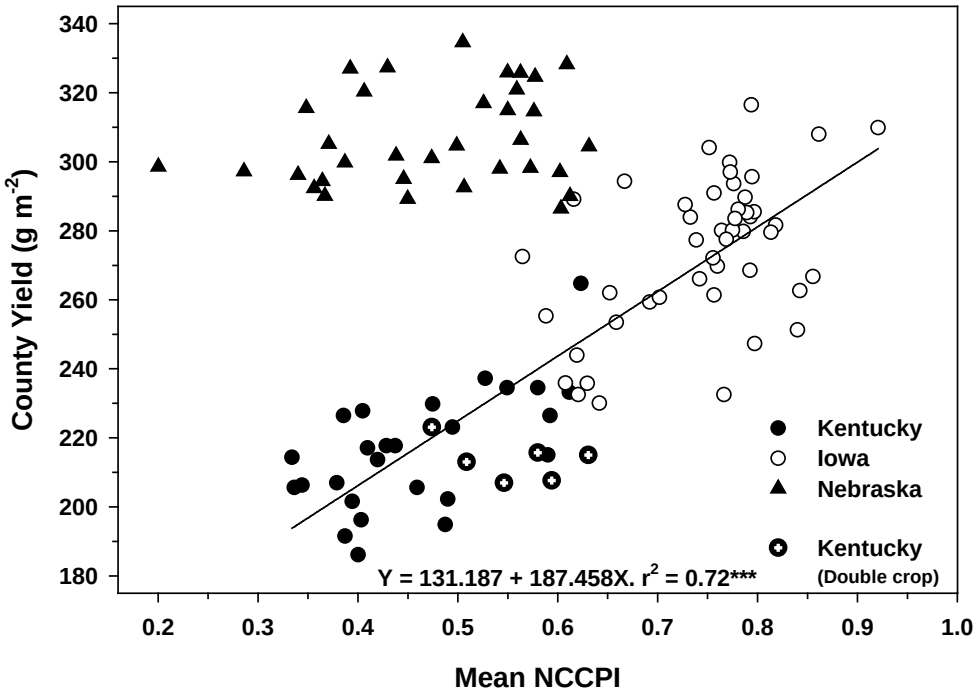
Yield variability in a field comes from soils inability to supply water during grain-filling

Crop Yield Variation



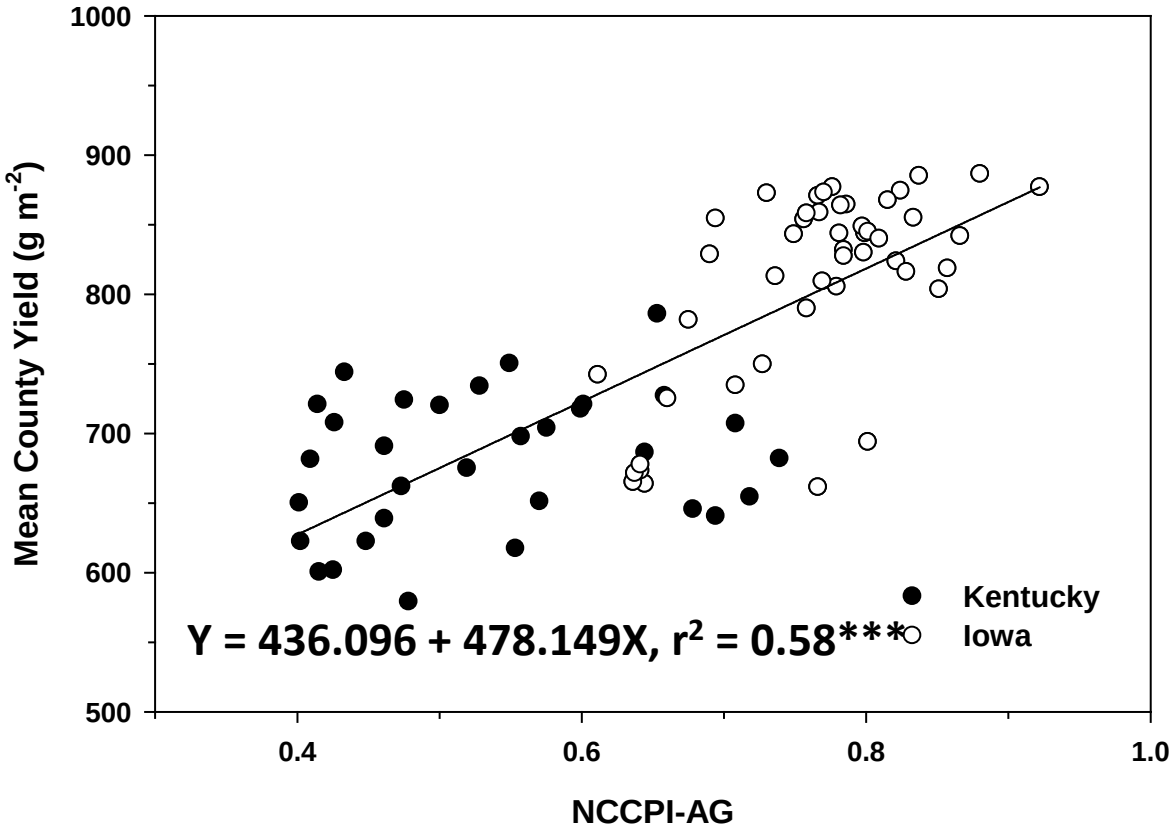
Good Soils = Good Yields

Soybean yields across Iowa, Kentucky, and Nebraska

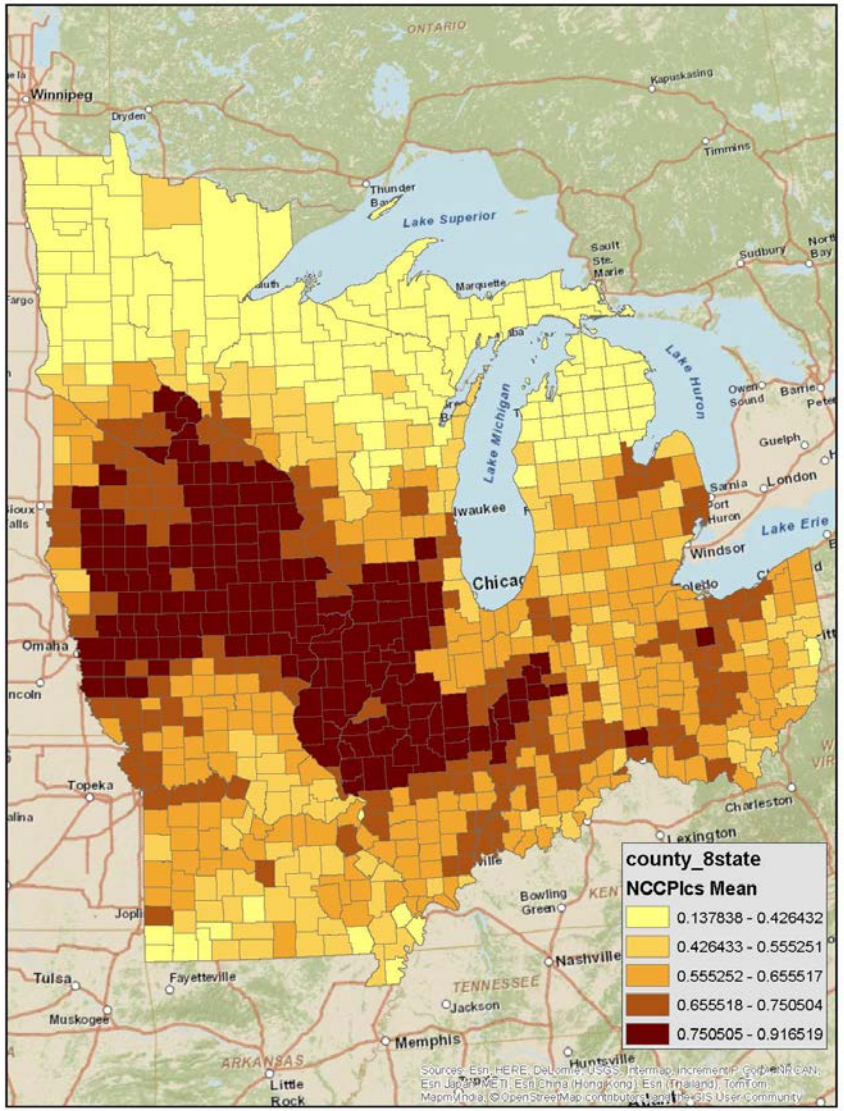


Climate resilience is derived from good soils in rainfed agricultural systems

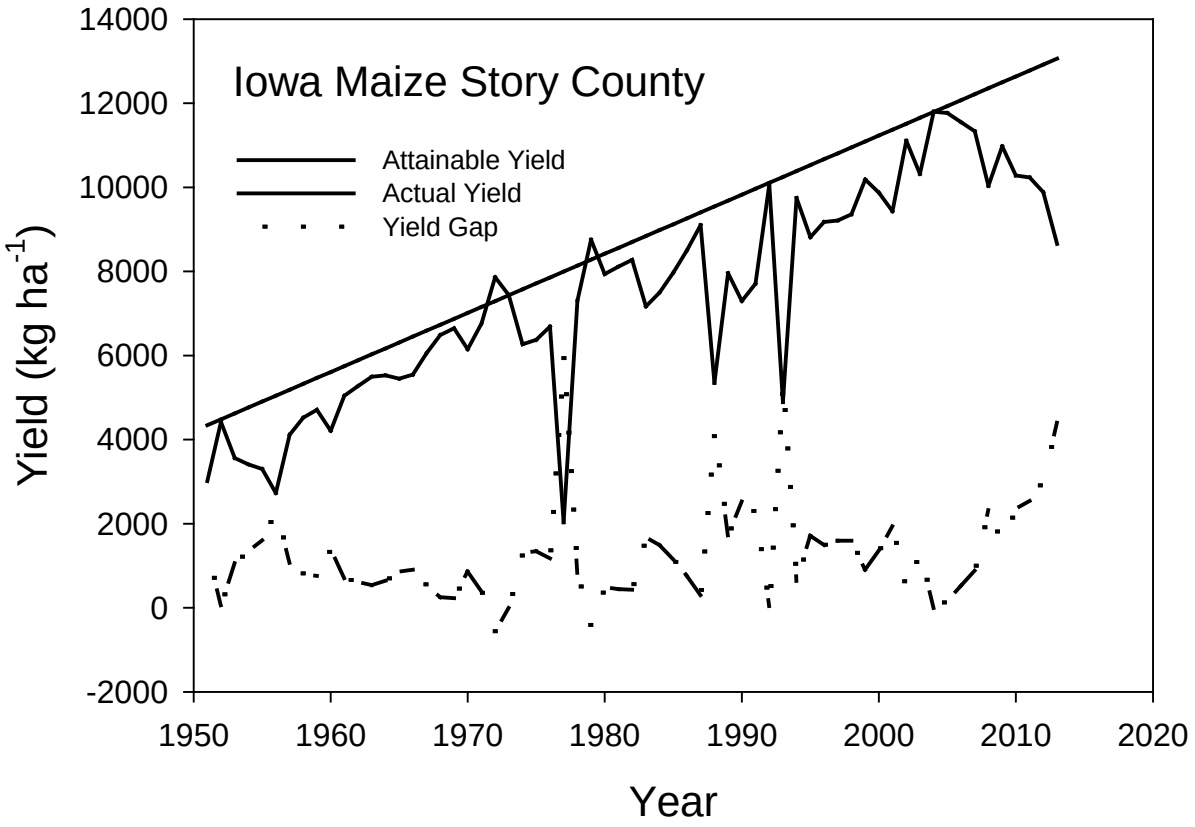
Maize County Yields



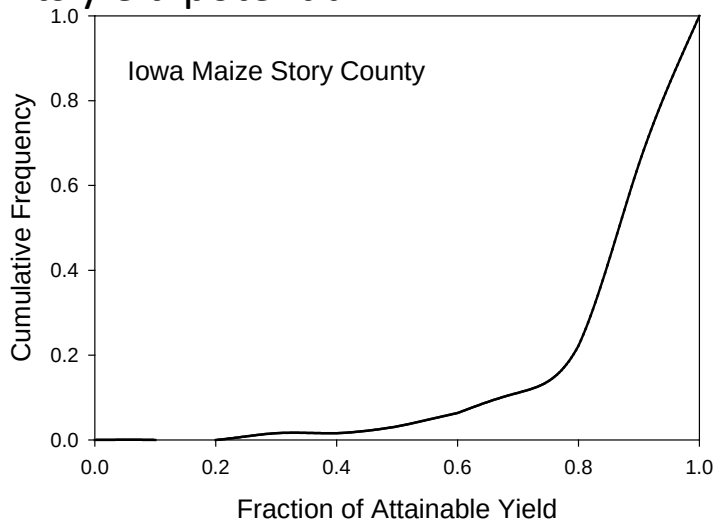
Variation in NCCPI across the Midwest



Yield Gaps



We have found that 20% of the yield loss occur 80% of the time due to short term stresses, e.g., we needed an 2 inches but only received 1 inch of rainfall for the week so the plant is under a moderate stress and not fulling its yield potential



Role of residue on the soil surface

Stable Microclimate

85-90 F

120-130 F

Temperature profiles in the soil

Extremes in temperature limit the biological activity in the soil, induced by a dry soil

Benefits of Using Cover Crops

Reduced erosion

Reduced nitrate leaching

Reduced phosphorus losses

Increased soil organic matter

Improved weed control

Support and maintain soil organisms

Improve soil structure – especially no-till

Grazing and forage potential

Recycling manure nutrients

The “living soil”, a biological system.

Mammals - gophers, moles, mice, groundhogs

Earthworms - night crawlers, garden worms

Insects and mollusks - ants, beetles, centipedes, snails, slugs

Microfauna - nematodes, protozoa, rotifers≈

Microflora - fungi, yeast, molds, mychorhiza

Actinomycetes - smaller than fungi, act like bacteria

Bacteria - autotrophs, heterotrophs, rhizobia, nitrobacter

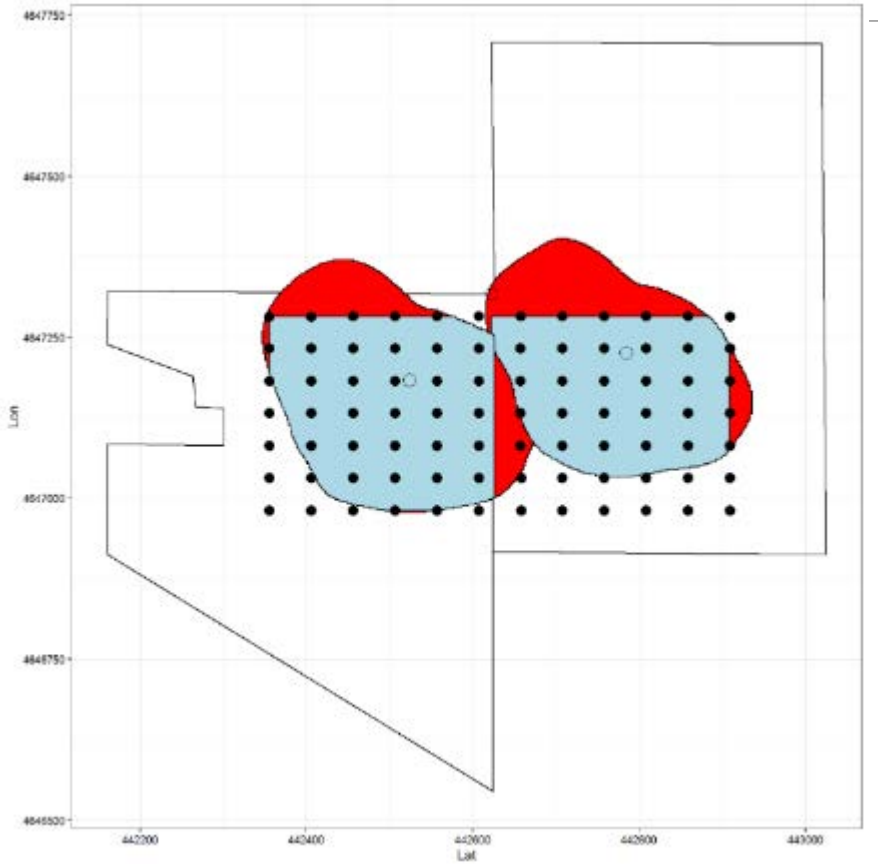
Algae - green, blue-green

≈

Earthworms, insects and rodents are “nature’s plow” and the most visible components of the “living soil” team. They work in tandem with other soil fauna, soil microorganisms and fungi to contribute to aeration and nutrient cycling as part of a “soil factory” team effort.

Carbon Balance in Corn-Soybean Fields 2000-2016

Rates (Mg C ha^{-1} yr^{-1})	Field	Footprint
ΔTC	-1.52 ± 0.78	-1.54 ± 0.76
C budget	-1.70 ± 0.01	-1.72 ± 0.02



Current state of our soils

Continually lose carbon

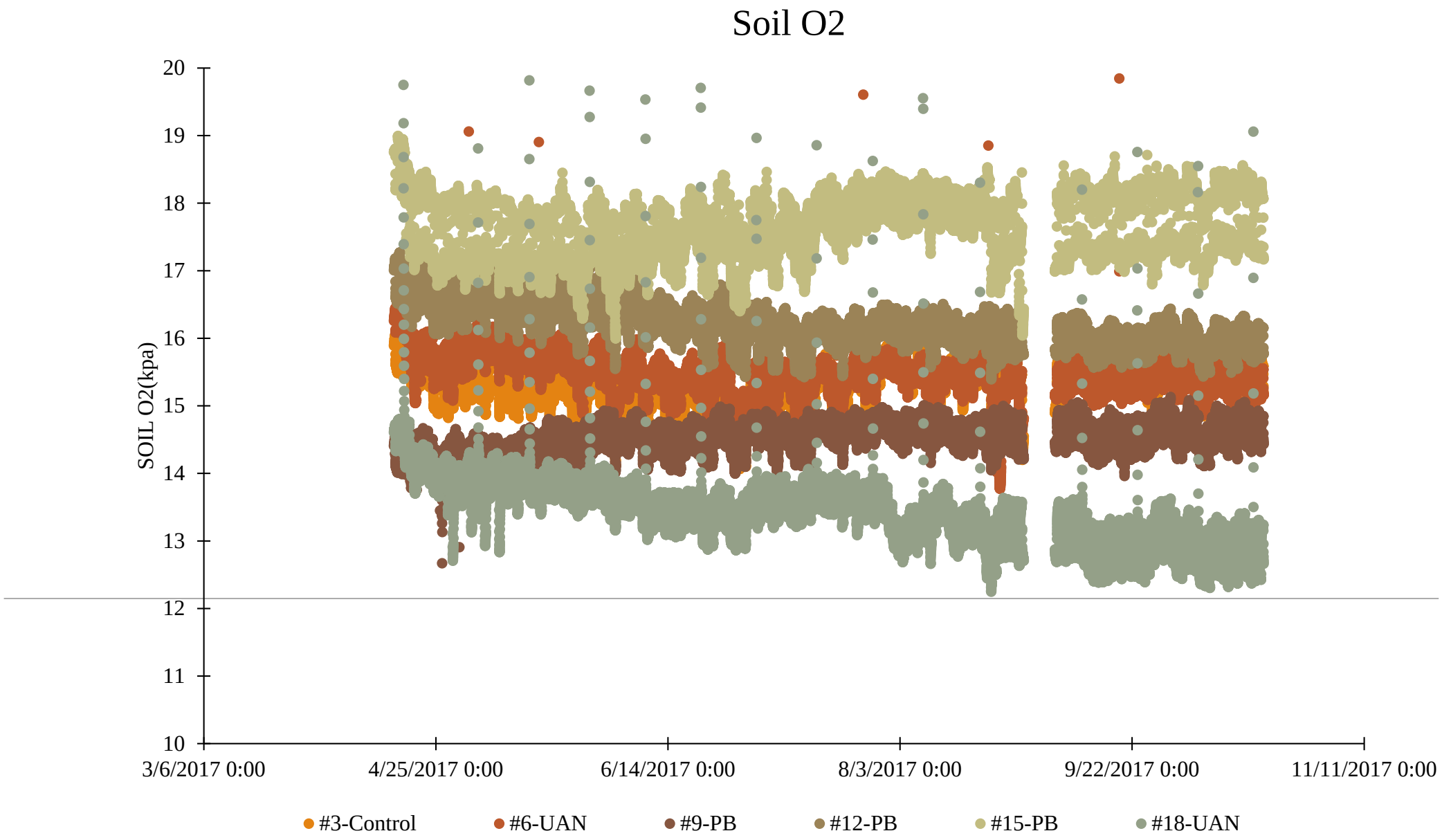
Decrease the soil quality and infiltration rate

Increasing the potential for yield variation within fields

Increasing the risk of weather impacts on production

Soil Experiment – Laboratory

Evaluation of cover crop mixtures on changes in soil properties and gas exchange (CO_2 and O_2)


Soil O2
SOIL O2(kpa)
20
19
18
17
16
15
14
13
12
11
10
3/6/2017 0:00
4/25/2017 0:00
6/14/2017 0:00
8/3/2017 0:00
9/22/2017 0:00
11/11/2017 0:00
#3-Control
#6-UAN
#9-PB
#12-PB
#15-PB
#18-UAN

Risk

We can reduce the risk due to weather and climate changes by increasing the capacity of or soils to cycle water and nutrients.

What do we know

Our weather is becoming more variable

Efficient crop production is dependent upon good weather and a good soil

We can manage the soil to increase climate resilience by increasing water availability and nutrient cycling

Enhancement is soil is only possible by enhancing and maintaining the soil biological system

Overcoming Variability for Maximum Yield

G x E x M

Genetics x Environment x Management
(optimize) (overcome) (oversee)