Turning soils into sponges

Opportunities for agriculture to reduce flood and drought risks

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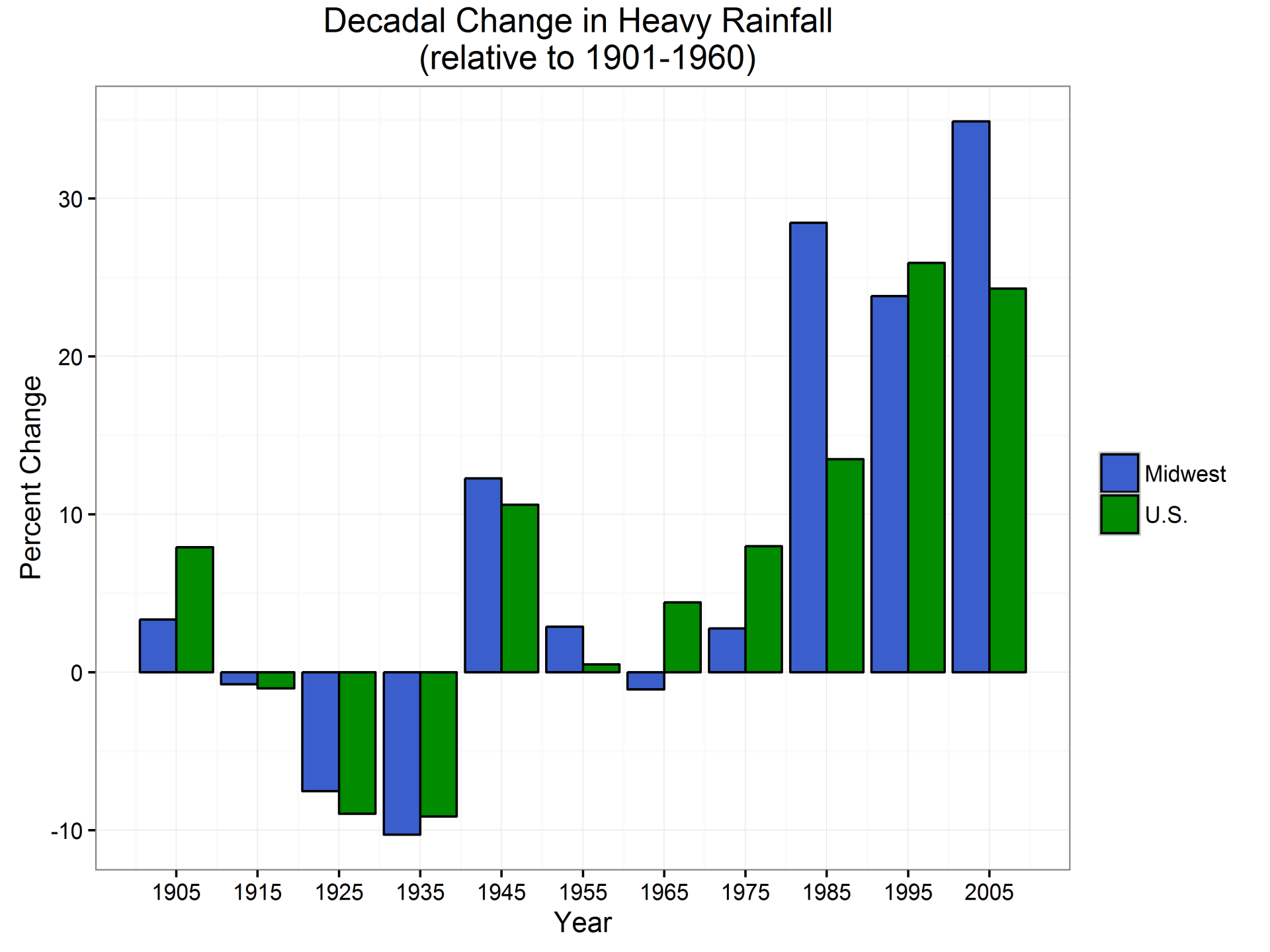
2019 Soils Caucus Briefing Series

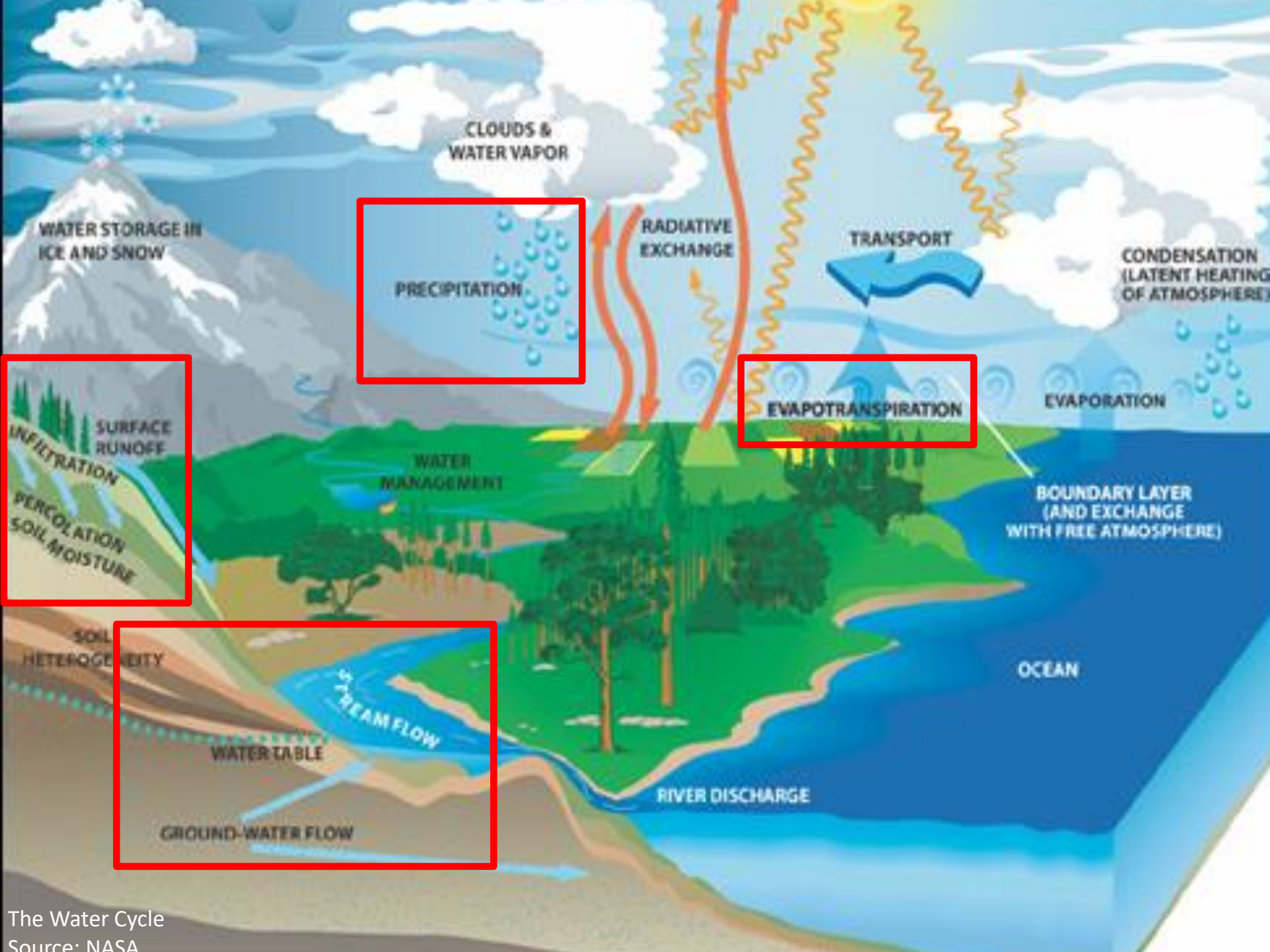

Decadal Change in Heavy Rainfall
(relative to 1901-1960)
Percent Change
30
20
10
0
-10
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
Year
Midwest
U.S.

2019 flooding in Nebraska

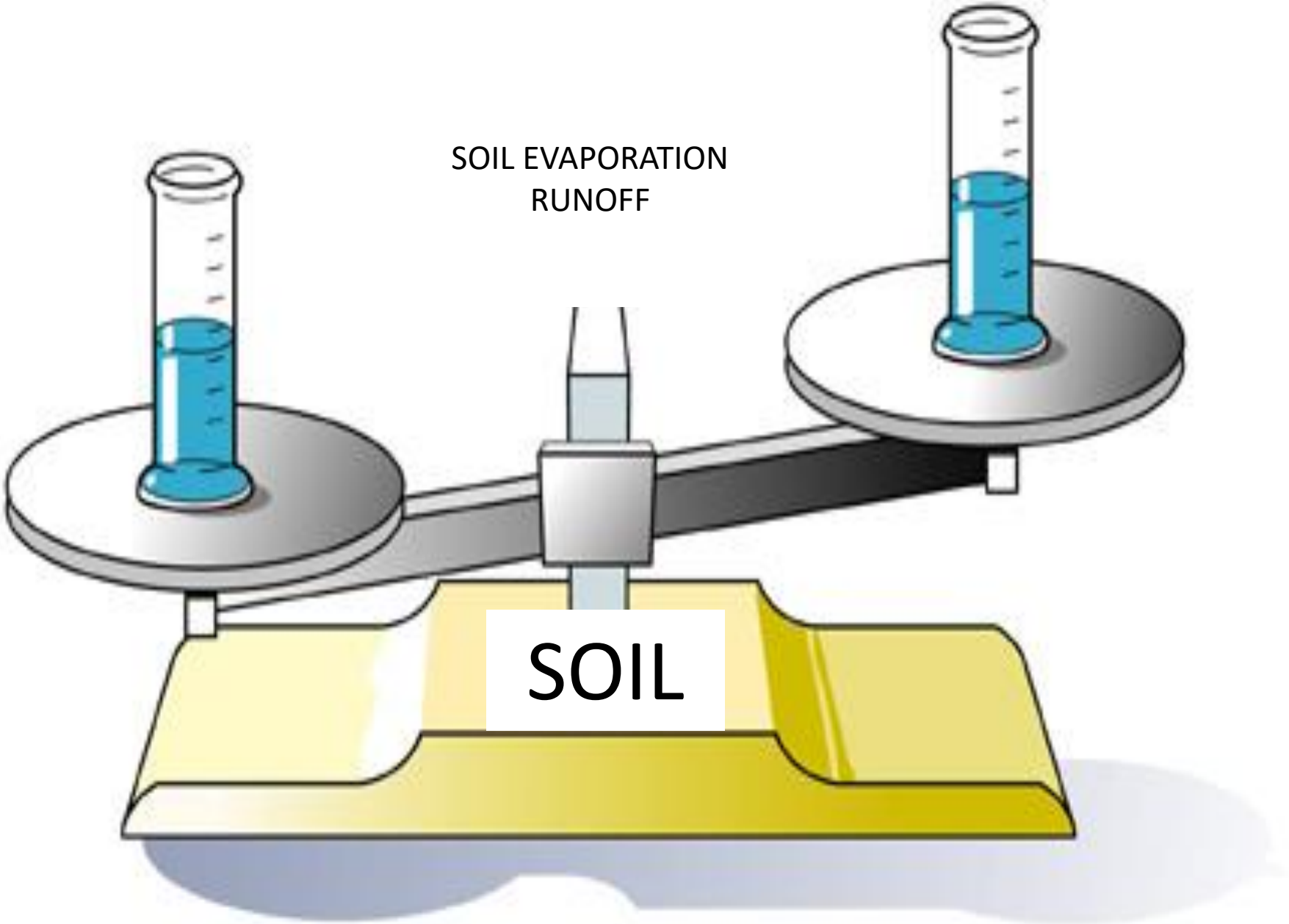
Punchochar Family Century Farm

Middle Loup River, St. Paul NE

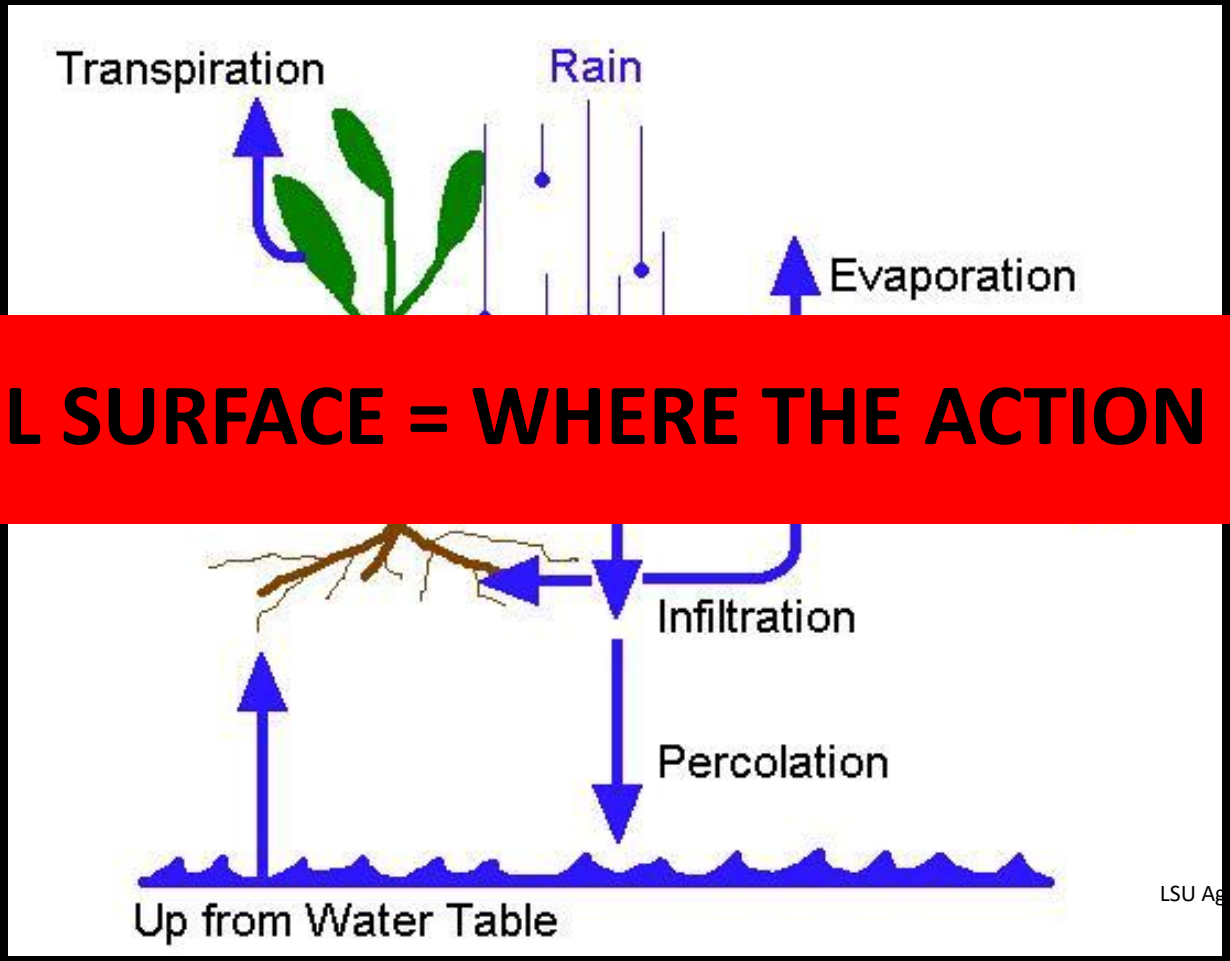
Photo: Rebecca Punchochar



The Water Cycle
Source: NASA


SOIL EVAPORATION
RUNOFF
SOIL

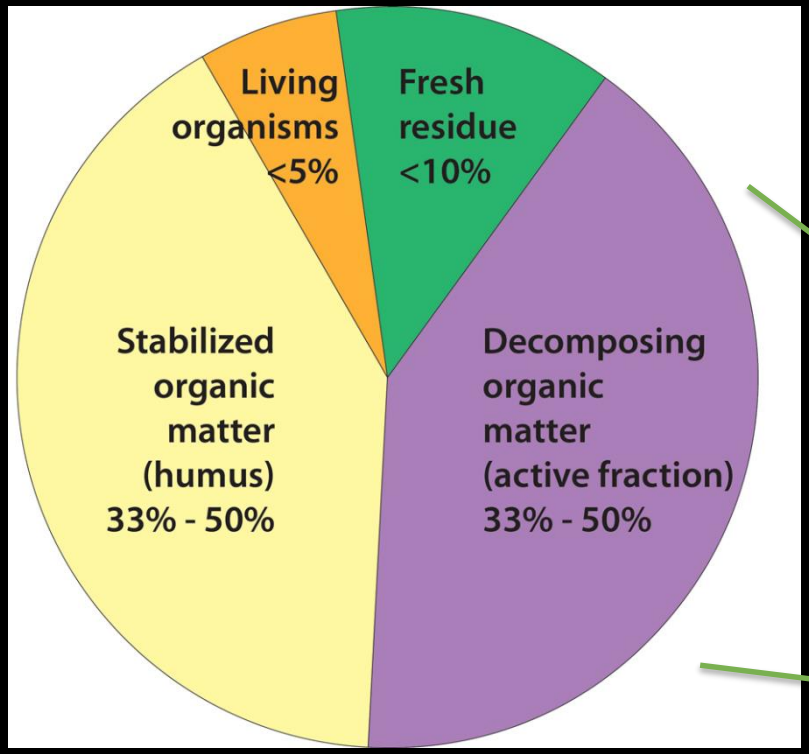
All components of the water balance converge at the soil surface

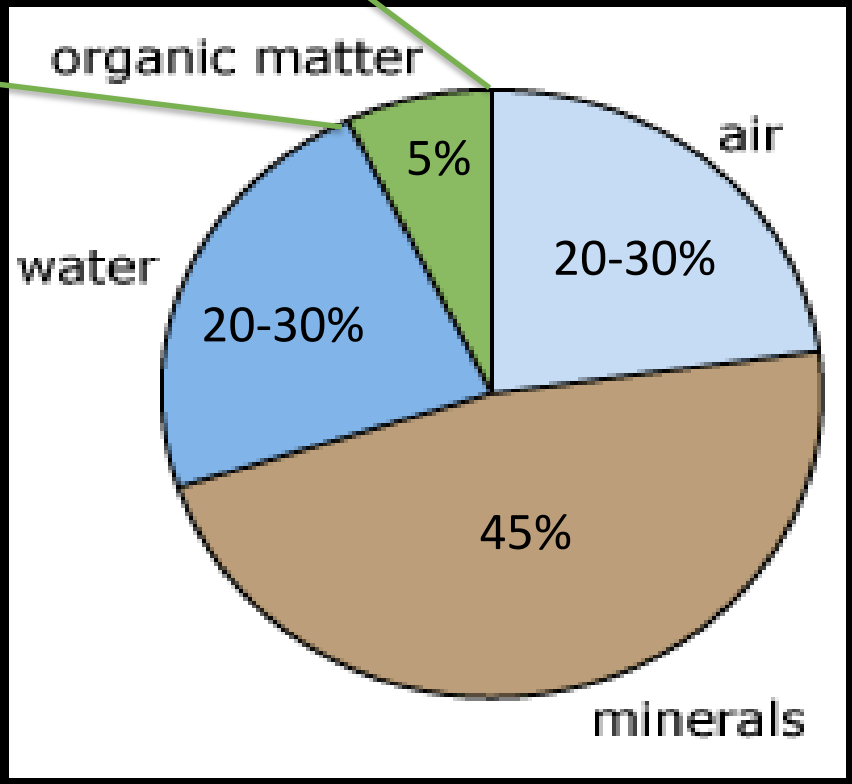


SOIL SURFACE = WHERE THE ACTION IS!!

LSU Ag

Soils are a “matrix” of living and non-living materials that require proper pore spaces and organic matter for water movement

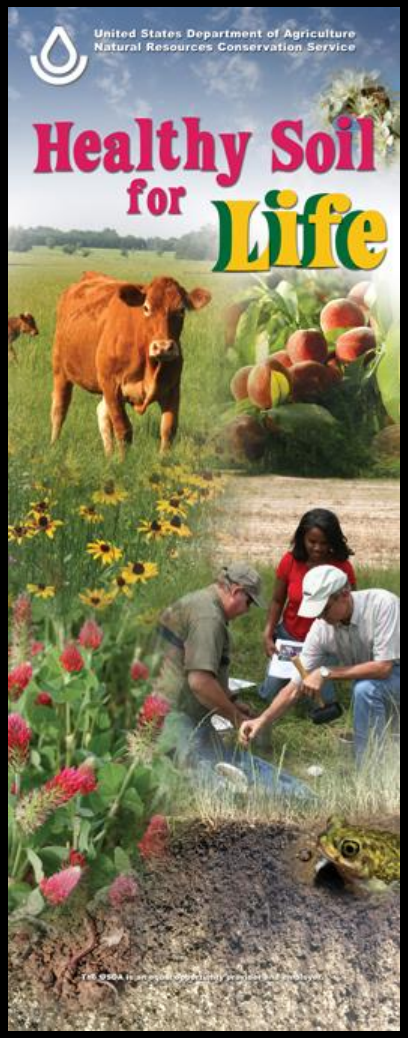




Source: USDA NRCS

-Organic matter = living material in soil that impacts many other properties and functions
-Infiltration rate = rate of water absorbed the soil
-Runoff = water not absorbed by the soil

Soils can have sponge-like characteristics



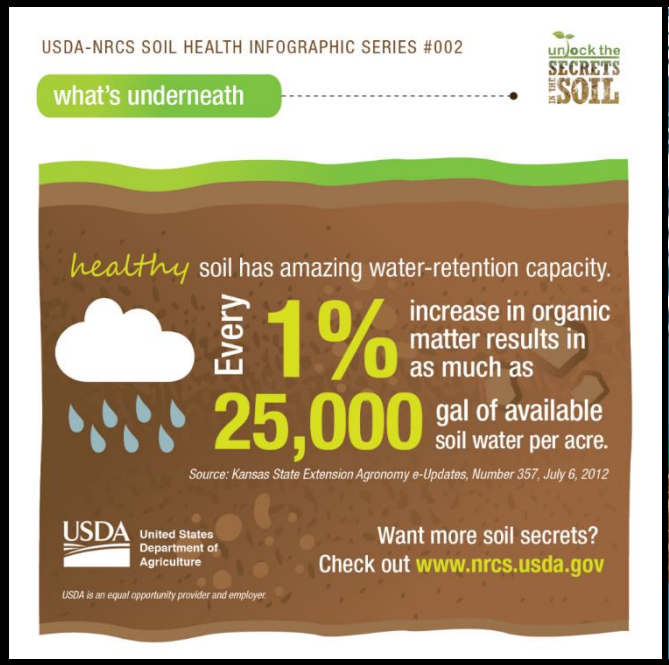
Soil health

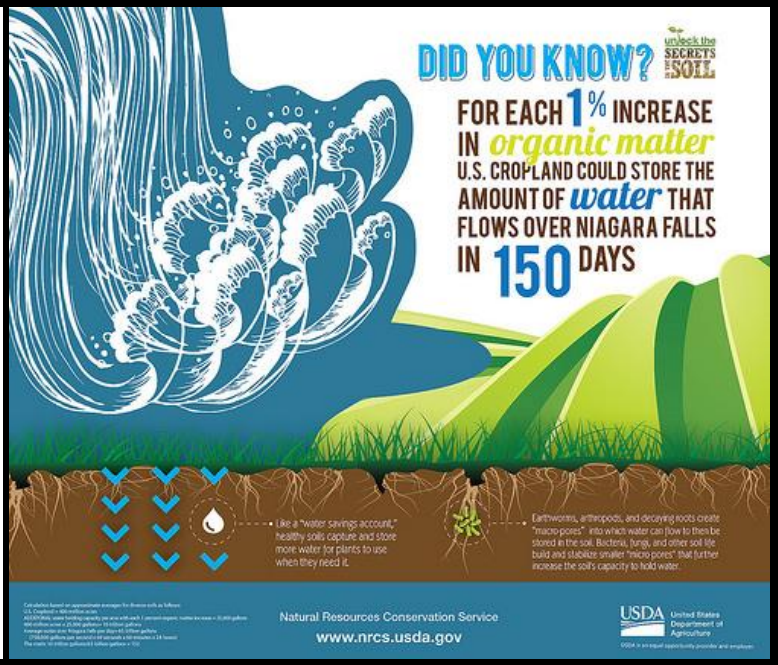
- Continued capacity of soil to function as a vital living ecosystem that sustains plants, animals and humans
- Managing soils for future generations
- Functioning of biological, chemical and physical aspects of the soil

Principles of soil health

- Minimize disturbance
- Maximize crop/plant diversity
- Integrate livestock
- Maintain continuous residue and root cover

Healthier soils can improve water management





Healthy soils could lead to better water outcomes, yet questions remain

- What do soil improvements actually mean for water impacts on a field scale?
  - And, what practices or management systems are most effective?
- How do practices or management systems change water outcomes on a landscape scale?

Do agricultural practices make soil spongier on individual fields?

How do these practices change infiltration rates, the rate that water enters the soil?

DeLonge and Basche, 2018

Basche and DeLonge, 2019

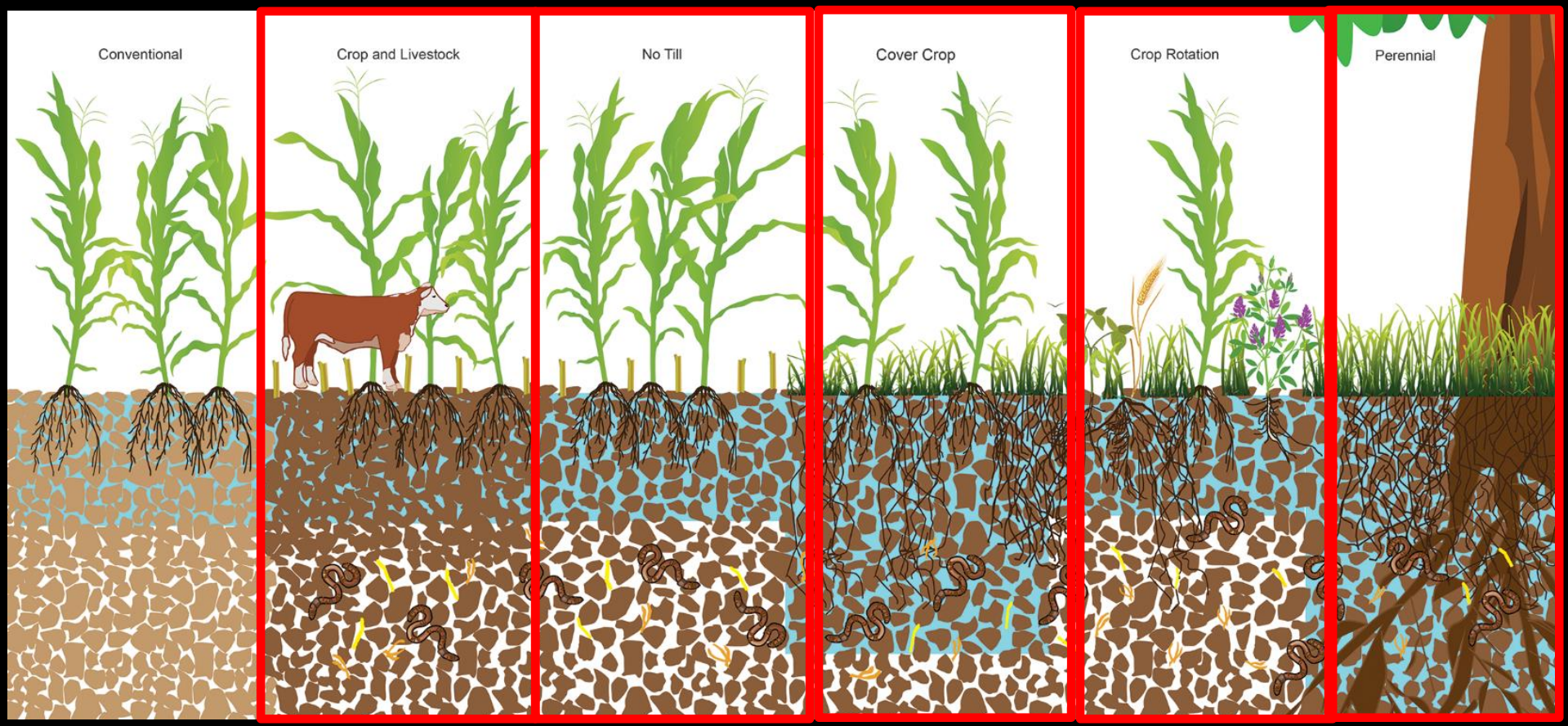
Turning soils into sponges: How farmers can help fight floods and droughts. 2017. Union of Concerned Scientists Report. ucsusa.org/soilsintosponges

Continuous roots in the soil

Integrating livestock on croplands

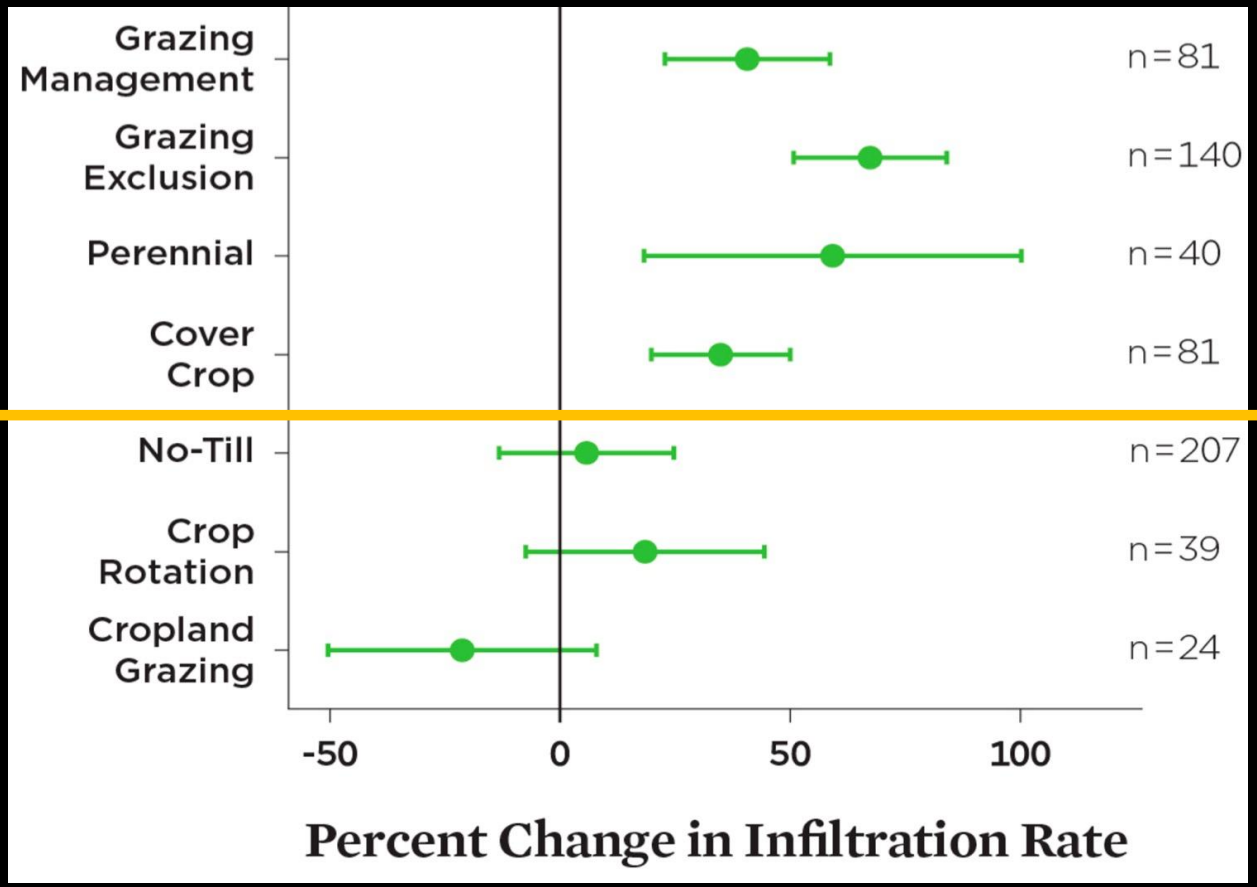
Minimizing soil disturbance

Maximizing crop diversity



Artwork by Lana Koepke Johnson
Basche and DeLonge, 2019

Conservation practices improve infiltration rates, especially “continuous living cover”



DeLonge & Basche, 2018

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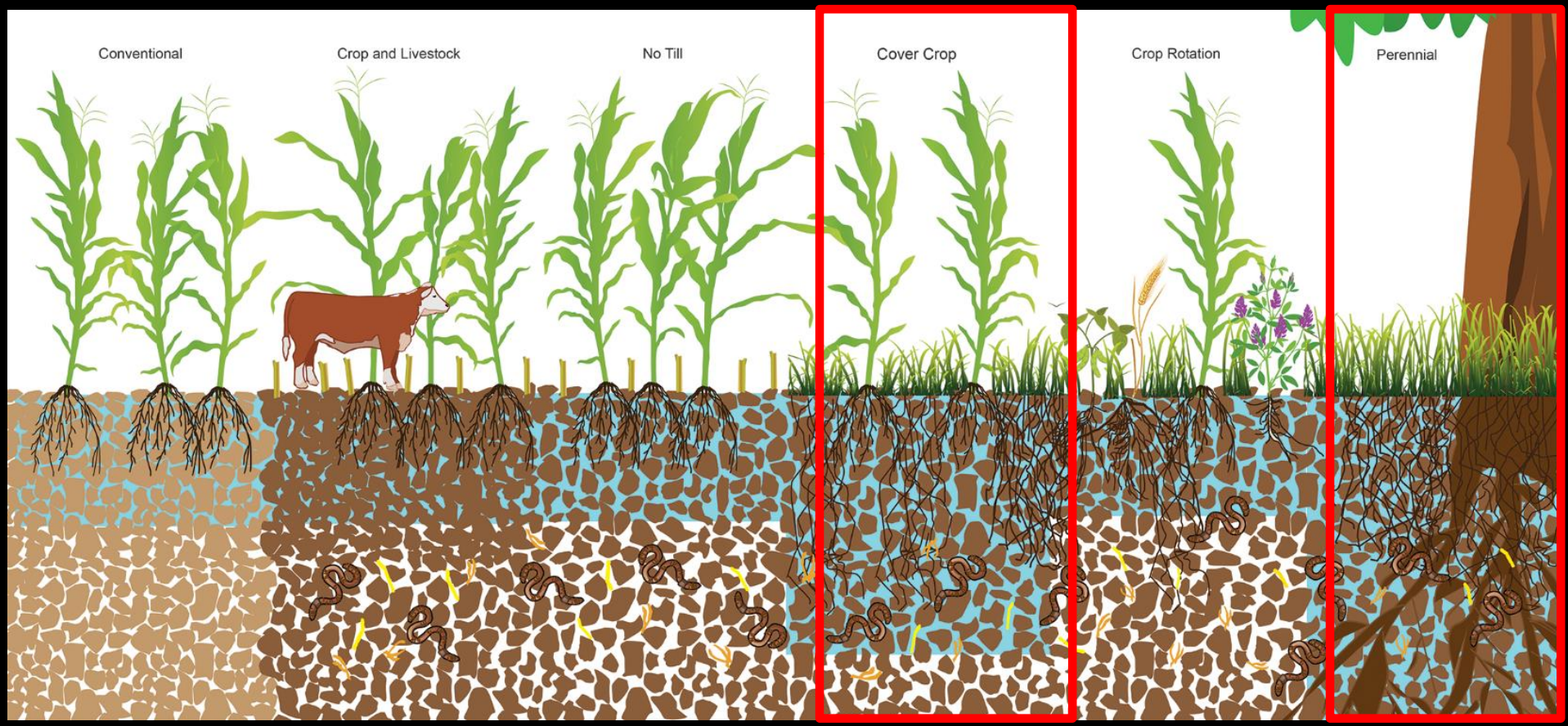
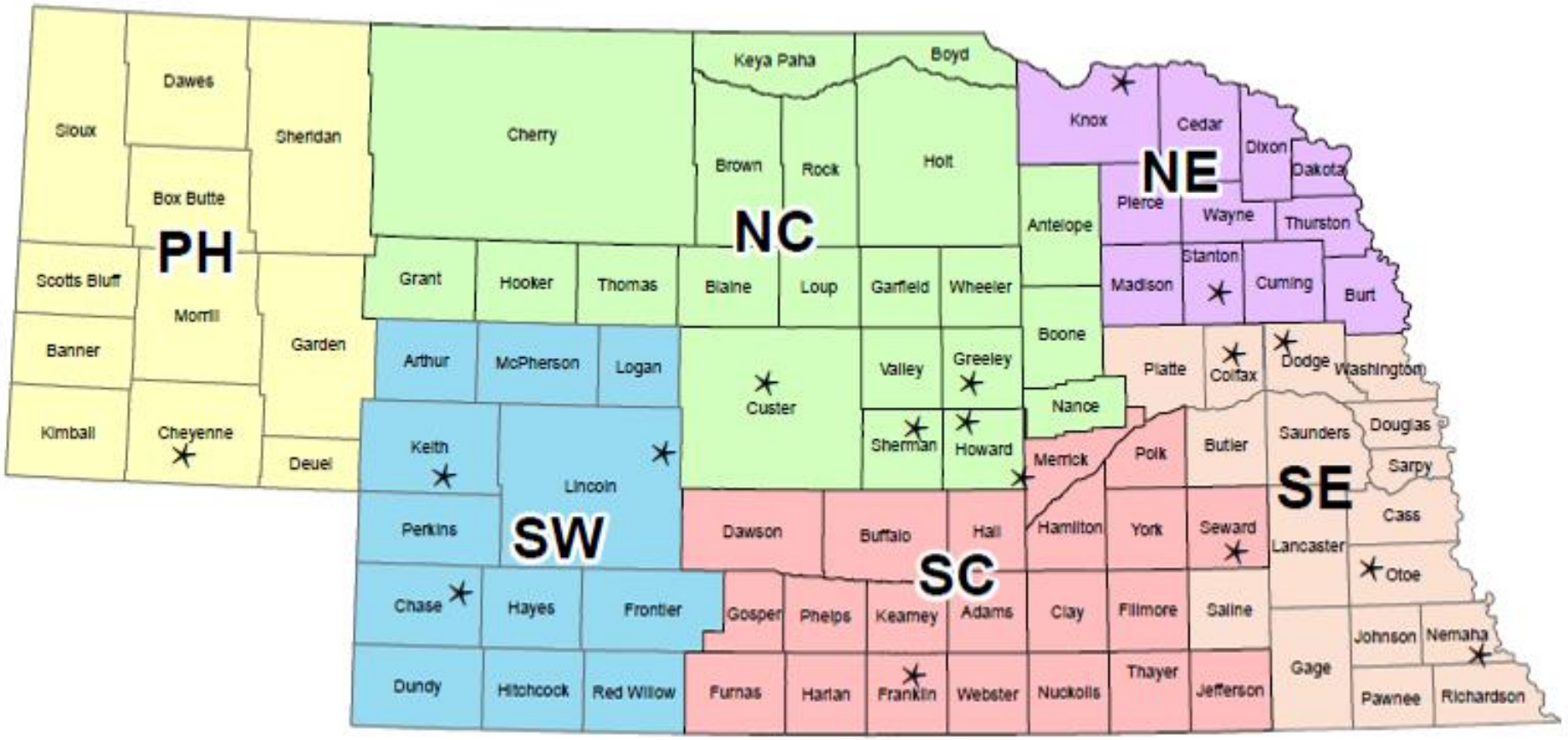
Continuous roots in the soil found to be best way to increase water entering the soil



Artwork by Lana Koepke Johnson
Basche and DeLonge, 2019

How does this work in real life on a farm??

Soil Health Demonstration Fields



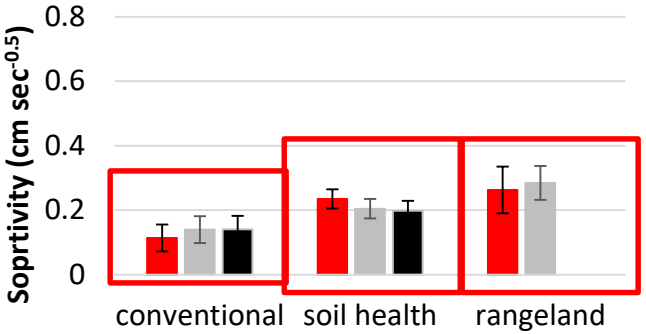
★ 17 - Demonstration Fields

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

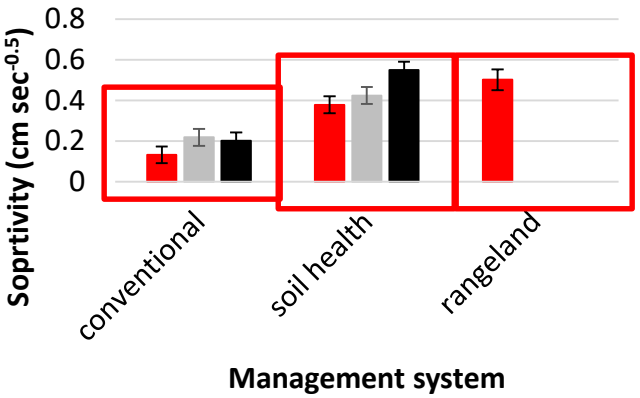
Data collected in July 2019

Averaged across different soil type and sites, cover cropping increased initial soil water infiltration by 59% compared to conventional farming systems (no cover cropping).

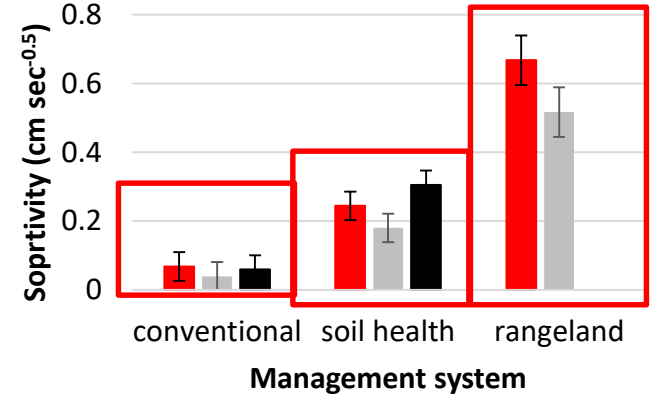
The trend of increasing infiltration from conventional to soil health to rangeland (perennial, less disturbance) was found across multiple sites and soil types.



- Kenesaw silt loam, 1-6% slopes
- Valentine and Thurman soils, 0-17% slopes
- Thurman loamy fine sand, 0-2% slopes



- Moody silty clay loam, terrace, 0-2% slopes
- Moody silty clay loam, 2-6% slopes
- Moody silty clay loam, 6-11% slopes



- Hersh-Gates complex, 17-30% slopes
- Valentine loamy fine sand, 3-9% slopes
- Gates silt loam, 3-6% slopes, eroded

USDA

United States Department of Agriculture

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News Release

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Aaron Hird, NRCS Soil Health Specialist

"The 'Bomb Cyclone' went through here and it just rained and rained and rained. Our ground was so frozen, it could not take barely anything in at all. The creek came out of its banks and out of 75 farmable acres, 70 of them were underwater. It probably took about five days before the water was off the bottom end of the field. The rye survived, and the field came out of it. I cannot imagine what that field would have looked like if the rye had not been there."

"First, I want to preface that we had flooding, but we did not have near the flooding other areas had," said Noah Seim. "We have nothing to complain about here."

"What we did have was an 80 that dad planted to soybeans last year, three miles west of the home place," Seim explained. "We drilled a cover crop of predominantly cereal rye in the mix right behind the combine into that field. That farm sits right along Prairie Creek at the top lateral of the field."

It turns out that cover crop ended up serving as sort of an "ark" for Noah's bean field following the severe weather Nebraska had this past March.

"The storm went through here and it just rained and rained and rained. Our ground was frozen, it could not take barely anything in at all. The creek came out of its banks and out of 75 farmable acres, 70 of them were underwater. It probably took about five days before the water was off the

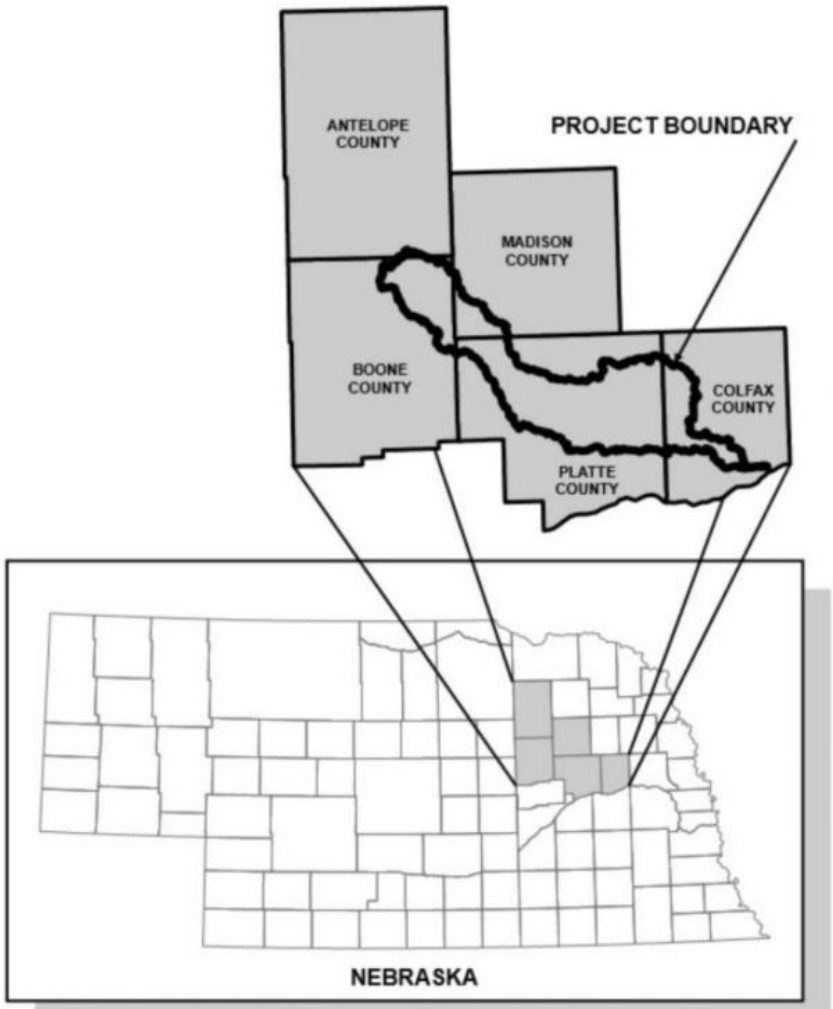
How does this work in real life for a community on a larger scale??

Shell Creek Watershed Improvement Group

Shell Creek Watershed Improvement Group (SCWIG) History

The Shell Creek covers almost 110 miles, running through five different counties in Nebraska, and drains approximately 304,873 acres of surrounding farmland. Over the last 20 years, erosion has drastically affected the Shell Creek Watershed. Concerns about poor water quality and the erosion's effect on agriculture production led to the formation of a local group to identify and promote essential conservation practices.

- Group formed in Northeast Nebraska to address flooding and water quality concerns in 1999
- Estimates of conservation practices in 2005 & 2015 in this ~300k acre watershed



Shell Creek Watershed Environmental Enhancement Plan

Nebraska

Figure 1-1: Vicinity Map

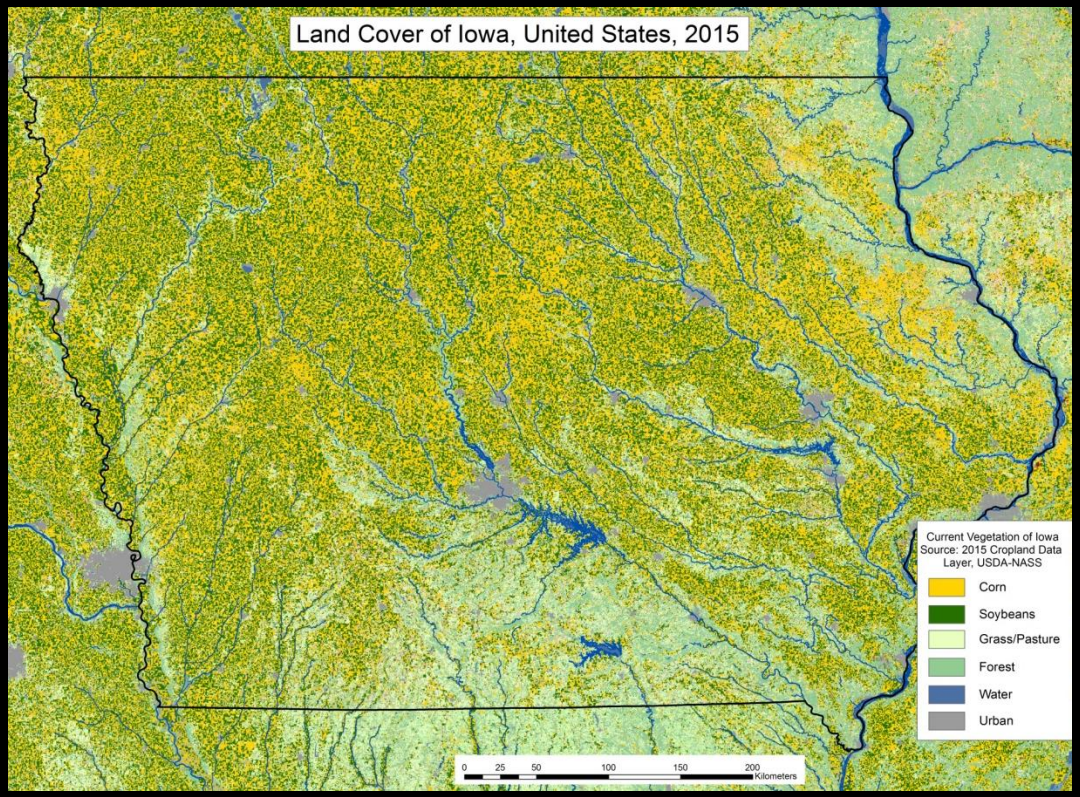
EA Engineering, Science, and Technology, Inc., PBC

Data Source: GIS data was obtained from the Lower Platte North NRD
Aerial Source: ESRI 2014
Date: 5/28/2015

Results of Shell Creek Watershed Improvement Group

- Estimated that reduced tillage increased significantly between 2005 and 2015 – from ~14% to ~87%
- Investments from EQIP, EPA/Water Quality, and state agencies totaled over $3 million during this time
- Streams in the watershed were declassified as impaired for atrazine in 2018

How can spongier soil impact water on a landscape scale?



This is a hard question to answer. But we tried with a model.

Livestock on perennial grasses

Perennial crops (i.e. alfalfa)

Diverse cover crops

Basin Characterization Model

SNOW PROCESSES

Sublimation

Snow accumulation

Snowmelt

CLIMATE INPUTS

Precipitation

Air temperature

Watershed

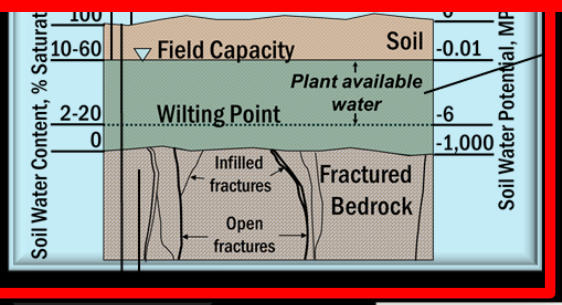
ENERGY BALANCE

Solar radiation

Potential evapotranspiration

piration

SOIL SURFACE = WHERE THE ACTION IS!!



Climatic water deficit (PET-AET)

Local recharge

Local runoff

Basin discharge

Basin groundwater recharge

WATER SUPPLY

Livestock on perennial grasses

Perennial crops (i.e. alfalfa)

Diverse cover crops

Shifting more erodible or less profitable croplands led to…

- Less runoff overall
- More water available for crops in severe droughts (1988, 2012)
- Reduced flood frequency (# of months reaching flood stage)
- Similar magnitude benefits with future climate
- The more land with diverse crops and spongier soils, the greater the impact

Livestock on perennial grasses

Perennial crops (i.e. alfalfa)

Diverse cover crops

Summary

- Conservation practices have clear benefits to making soil more “sponge-like” on a field scale
  - And this provides benefits to producers in real life
- We found the largest benefits to come from practices that promote “continuous living cover” of the soil
- Landscape scale benefits are challenging to measure but modeling work and evidence from a watershed group illustrate promising results
- Federal investments in long-term research, LGUs and conservation programs make this work possible

Floods impact communities and livelihoods.

Punchochar Family Century Farm
Middle Loup River, St. Paul NE

Photo: Rebecca Punchochar

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