Welcome to *The Current*, the North Central Region Water Network's Speed Networking Webinar Series

Nutrient Management Practices and their Co-Benefits: 2PM CT

1. Submit your questions for presenters via the chat box. The chat box is accessible via the purple collaborate panel in the lower right corner of the webinar screen.
2. There will be a dedicated Q & A session following the last presentation.
3. A phone-in option can be accessed by opening the Session menu in the upper left area of the webinar screen and selecting "Use your phone for audio".

This session will be recorded and available at northcentralwater.org and learn.extension.org.

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northcentralwater.org

Today's Presenters:

- **Chris Hay**, Senior Research Scientist, Iowa Soybean Association
- **Laura Paine**, Outreach Coordinator, Grassland 2.0
- **John Tyndall**, Associate Professor, Iowa State University

Follow @northcentralh2o and #TheCurrent on Twitter for live tweets!

NORTH CENTRAL REGION WATER NETWORK

Chris Hay

Chris Hay is a Senior Research Scientist at the Iowa Soybean Association, where he is responsible for leading scientific research efforts, providing technical assistance to field services operations, and outreach programs on conservation drainage. Chris has more than 25 years of experience in agricultural water management and water quality in industry, academia, consulting, and government. He holds BS and MS degrees in Agricultural and Bioresource Engineering from Colorado State University and a PhD in Agricultural and Biological Systems Engineering from the University of Nebraska-Lincoln. He is a licensed Professional Agricultural Engineer in the State of Nebraska.

IOWA SOYBEAN Association

Recycling Drainage Water for Multiple Benefits

Chris Hay
Sr. Research Scientist

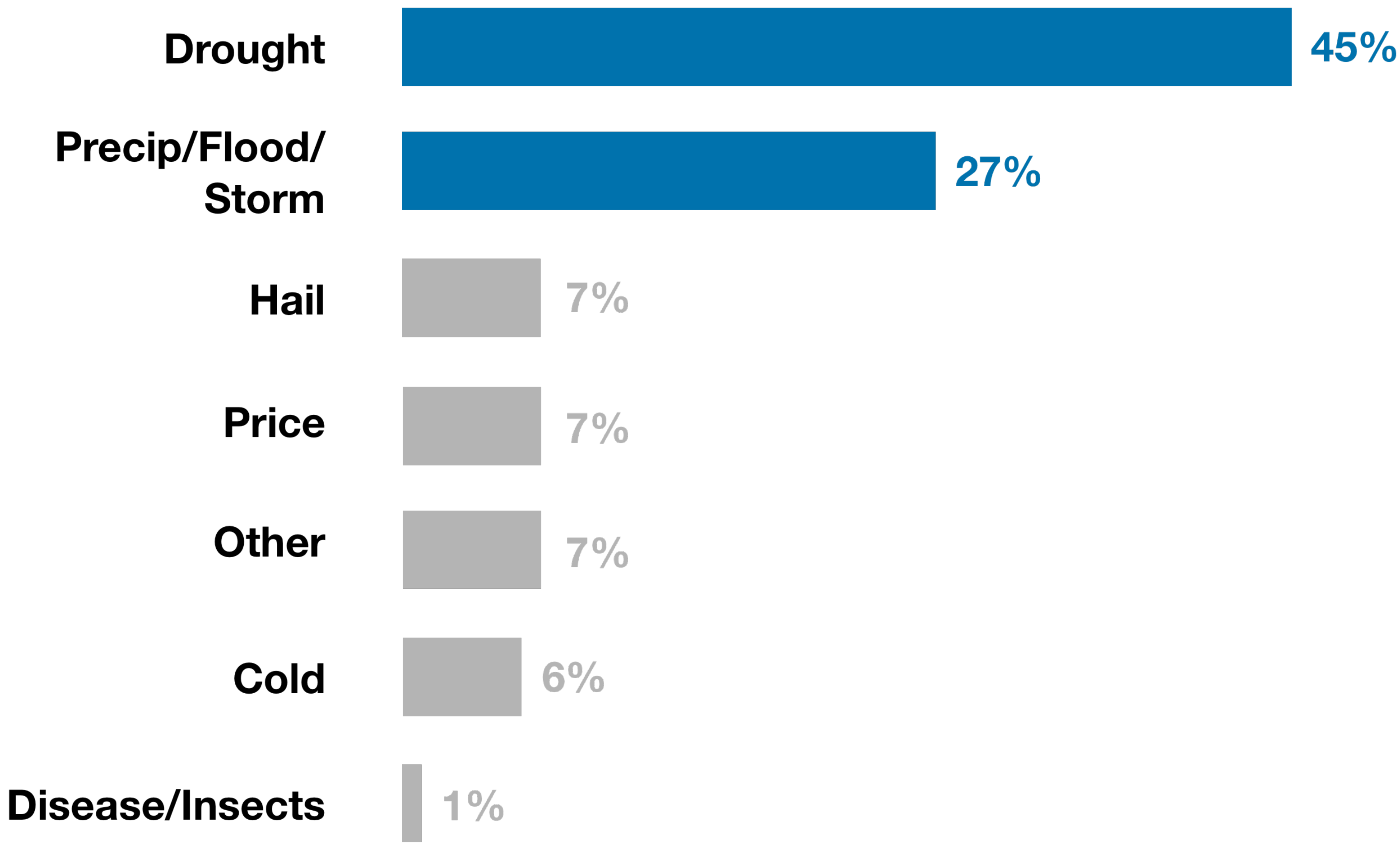
Crops need water

Photo: United Soybean Board

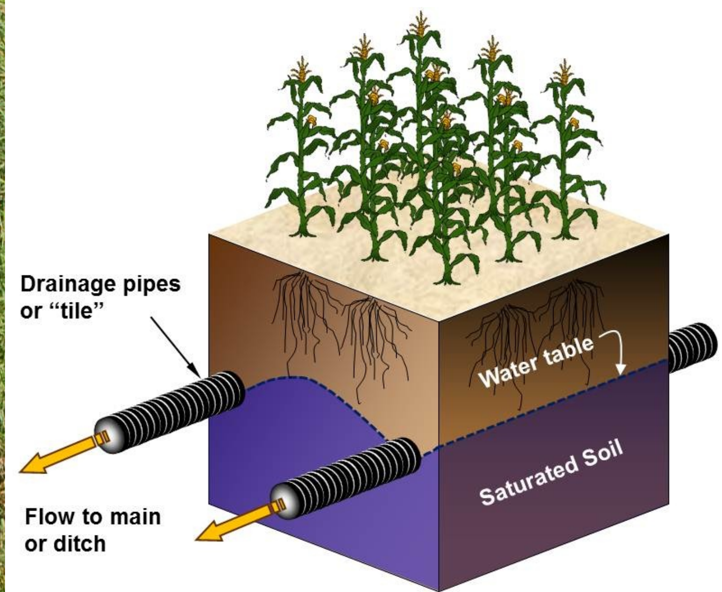

Too much
Photo: United Soybean Board


Too little
Photo: Jane Shotaku

72% of crop loss is related to water



Source: USDA RMA 2001–2015 Insured Perils — Share of Indemnity



Graphic: Gary Sands, University of Minnesota

Nitrogen
Phosphorus
Photo: Iowa Soybean Association

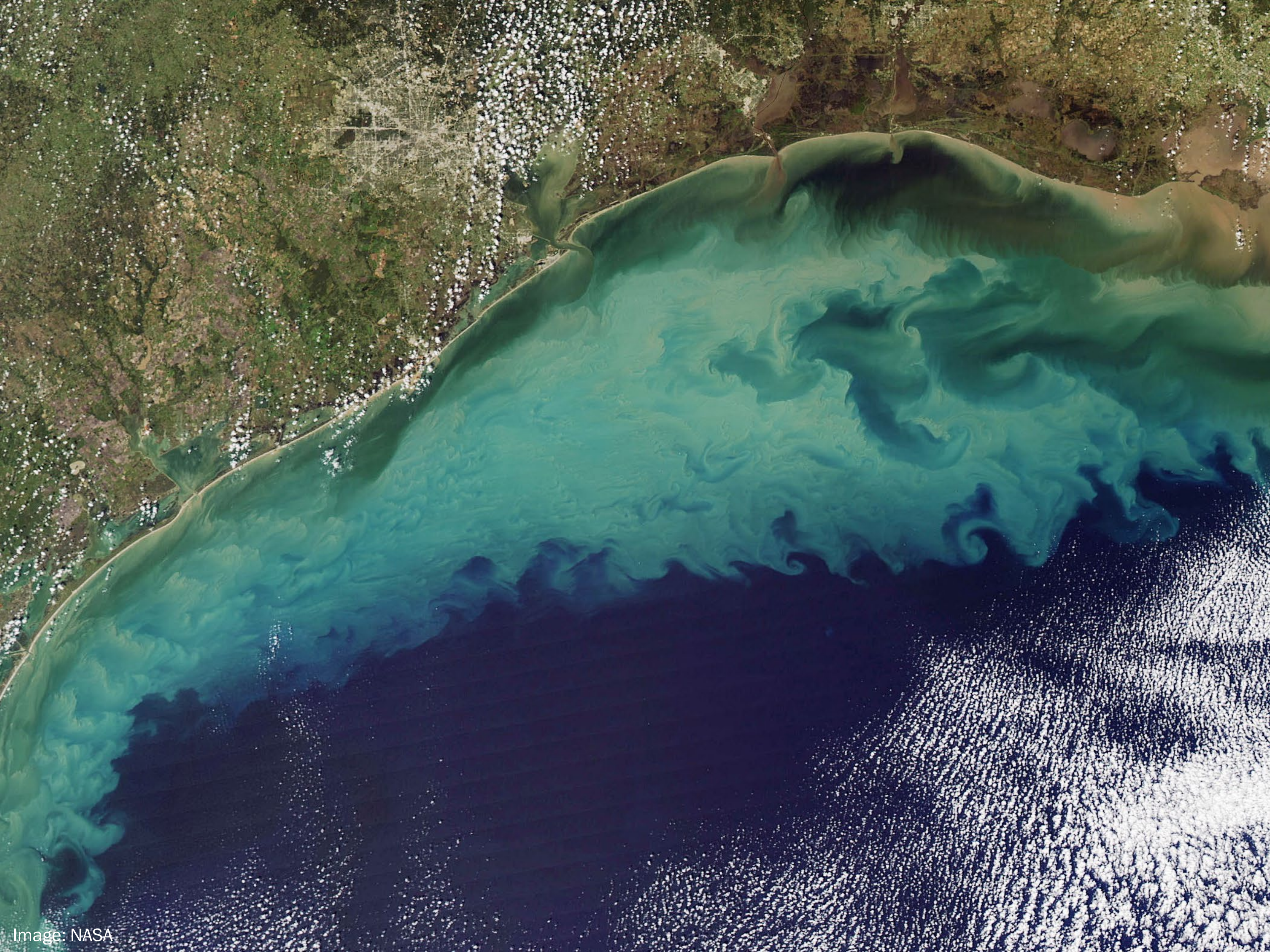
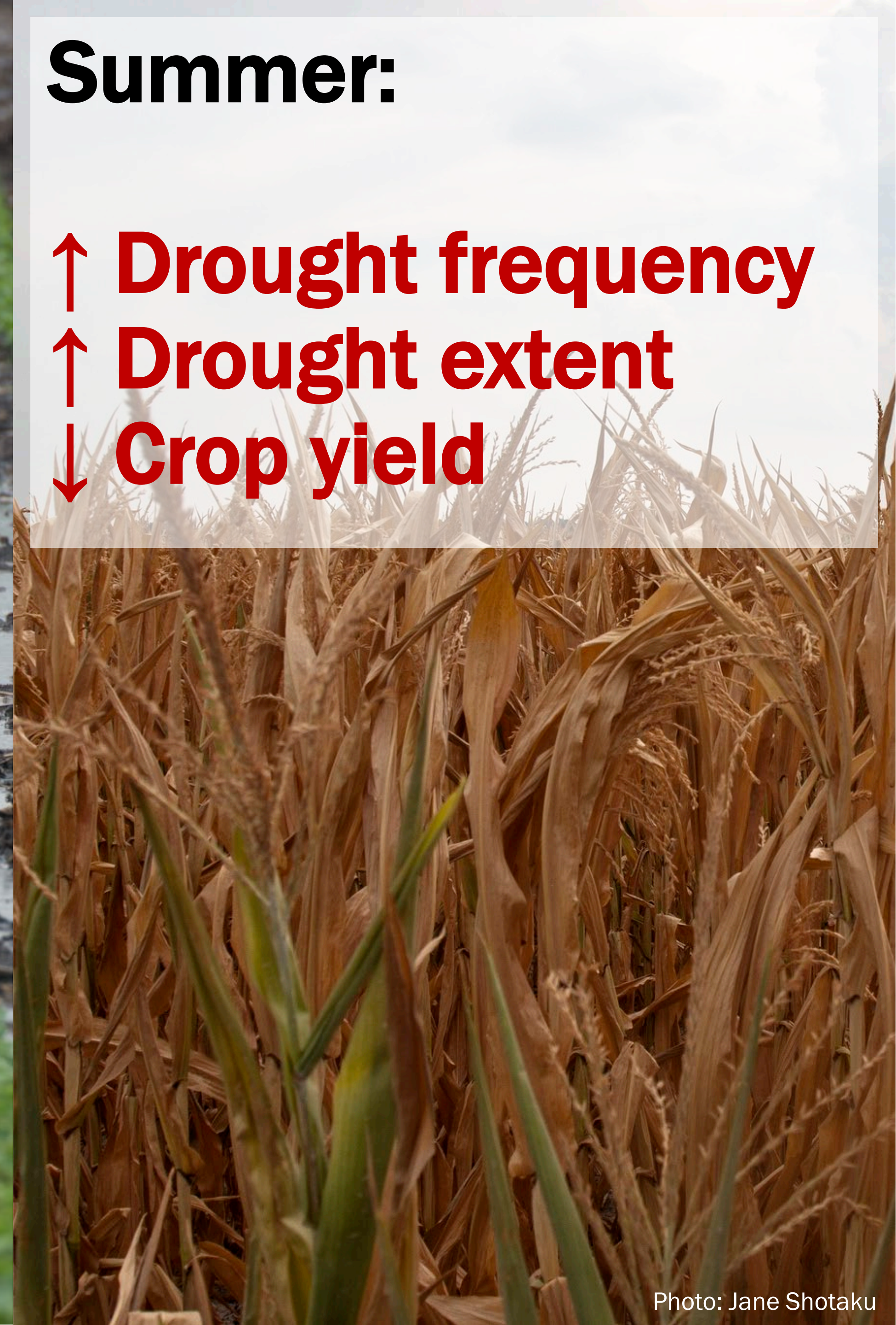


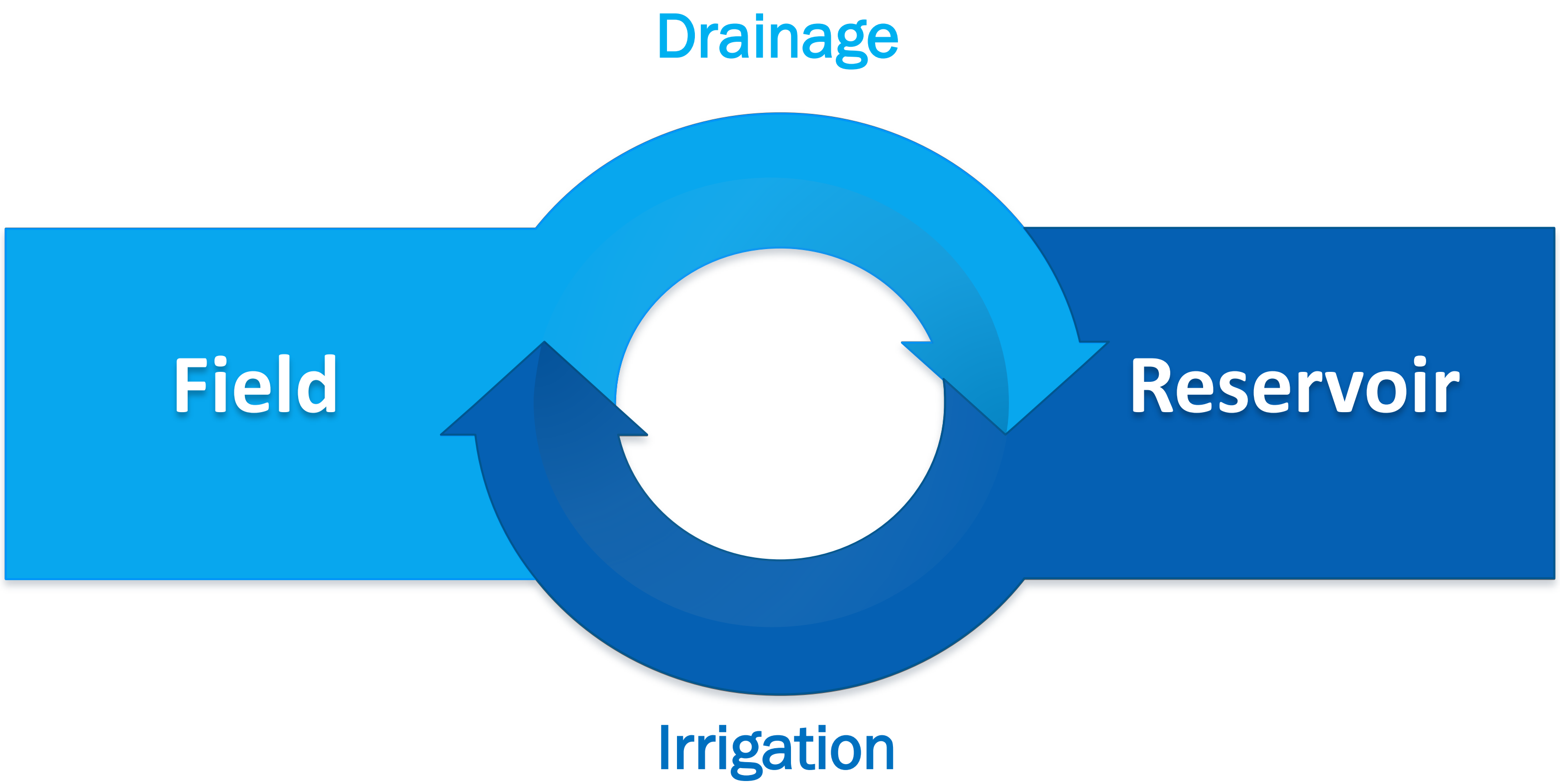
Image: NASA

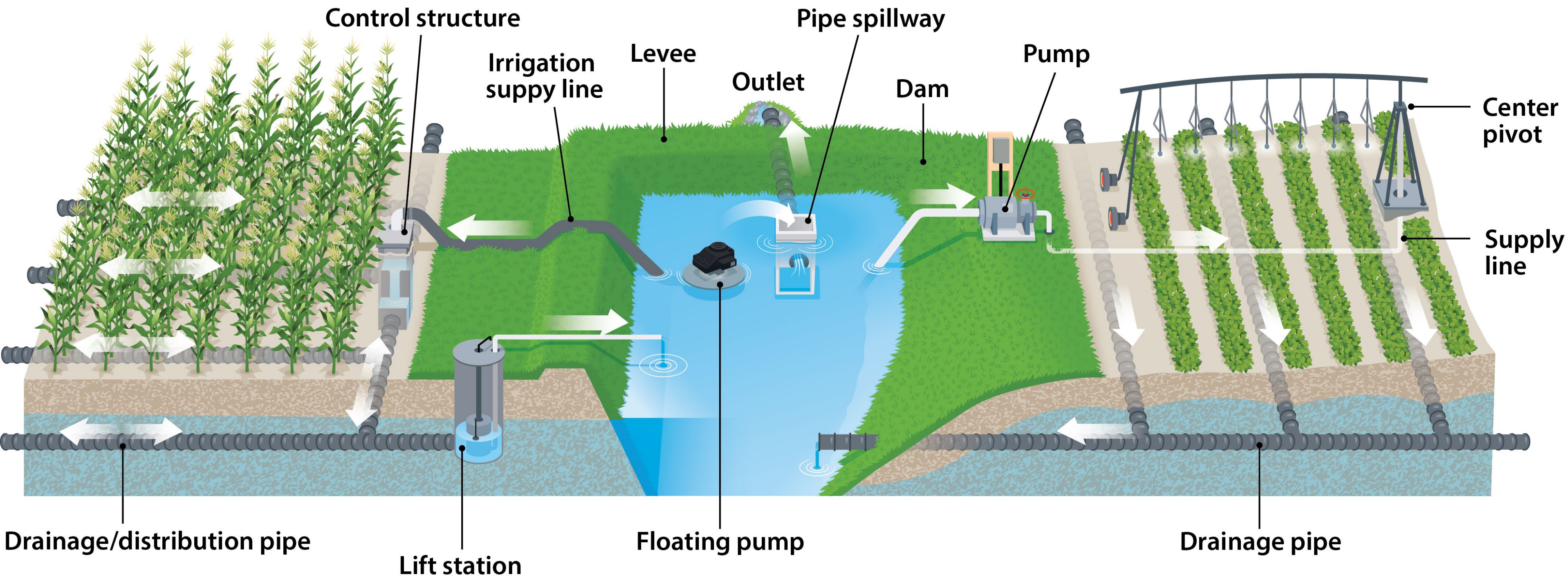
Photo: United Soybean Board


Spring:
↑ Precipitation
↑ Runoff
↑ Nutrient loss
Photo: United Soybean Board


Summer:
↑ Drought frequency
↑ Drought extent
↓ Crop yield
Photo: Jane Shotaku

Drainage water recycling





TRANSFORMING DRAINAGE.ORG
Managing Water for Tomorrow's Agriculture

USDA
United States Department of Agriculture
National Institute of Food and Agriculture

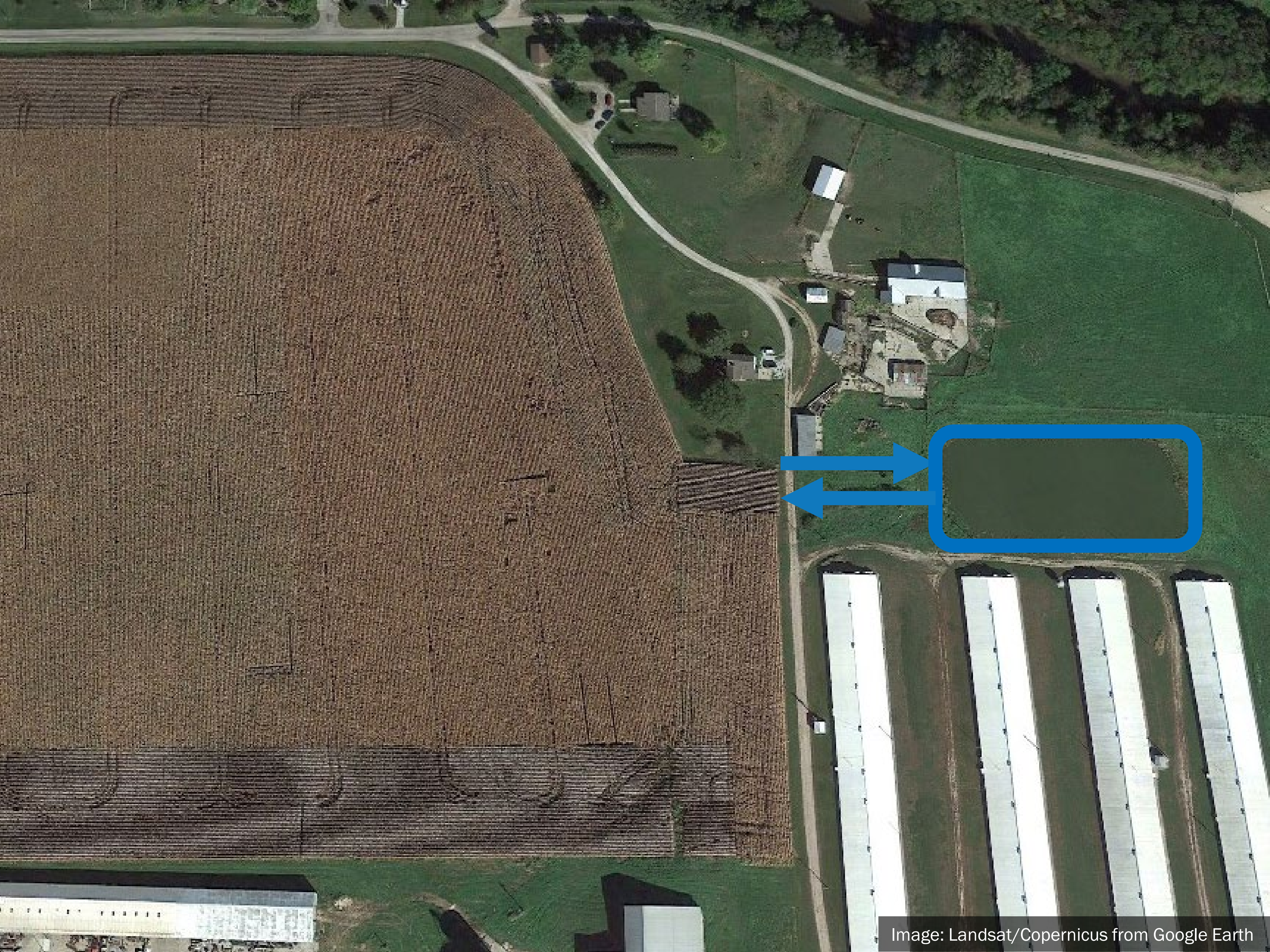


Image: Landsat/Copernicus from Google Earth


Comar Lake
Center Pivot Point
Google Earth

Image by inspirexpressmiami from Pixabay

Photo: ISA

Photo: United Soybean Board

7

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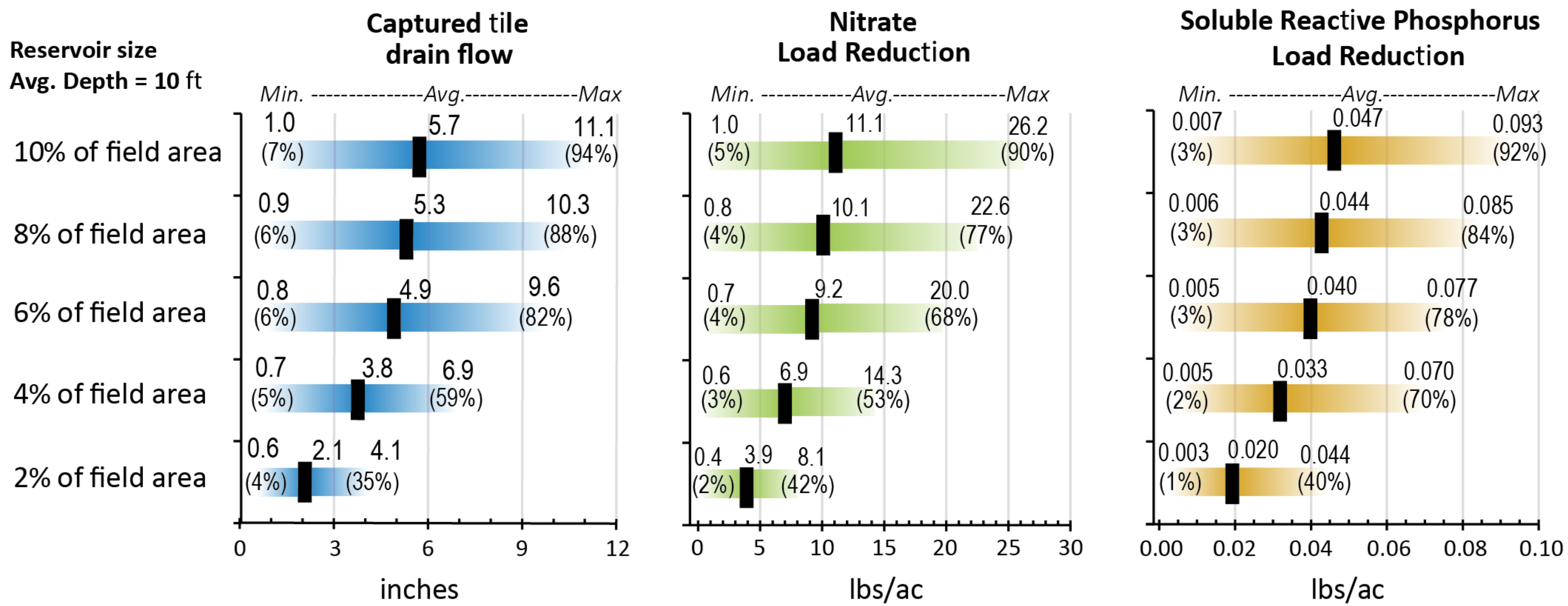
Photo: United Soybean Board

Photo: Jane Shotaku

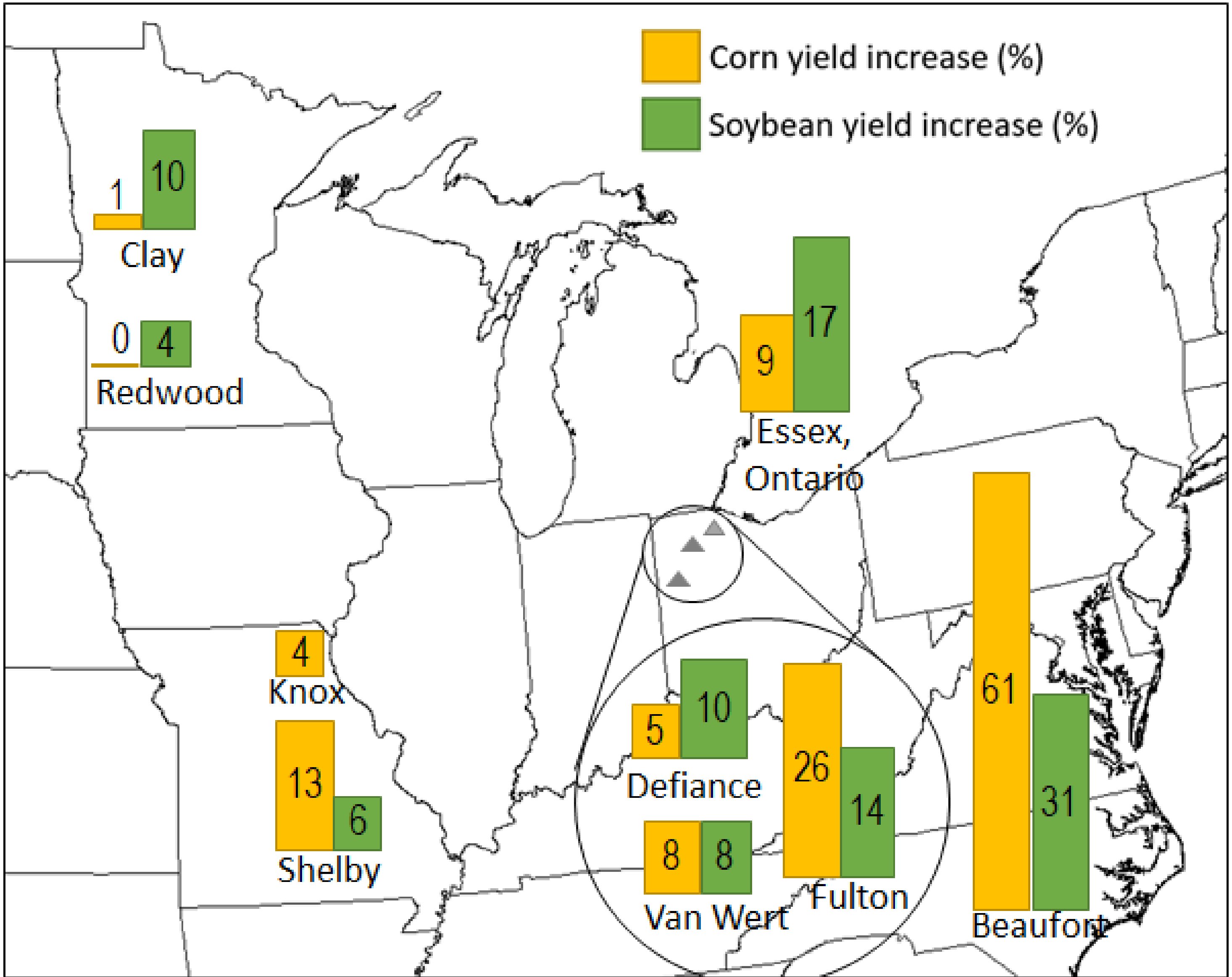
Photo: USGS

Photo: ISA

Captured Flow and Nutrients (Indiana site)



Reinhart et al. (2019). *Agricultural Water Management*. 223.



Hay et al. (in review)


Photo: YvesSch


Photo: Jim Kennedy


Photo: Theo Gunther

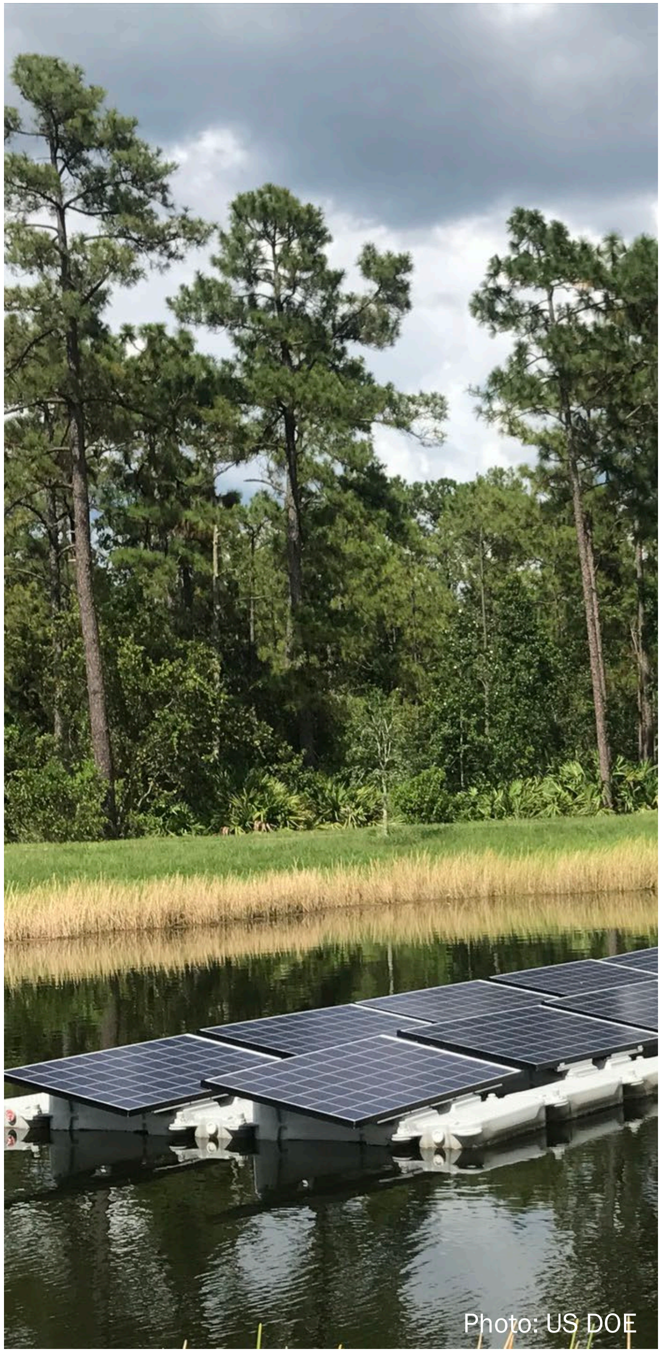
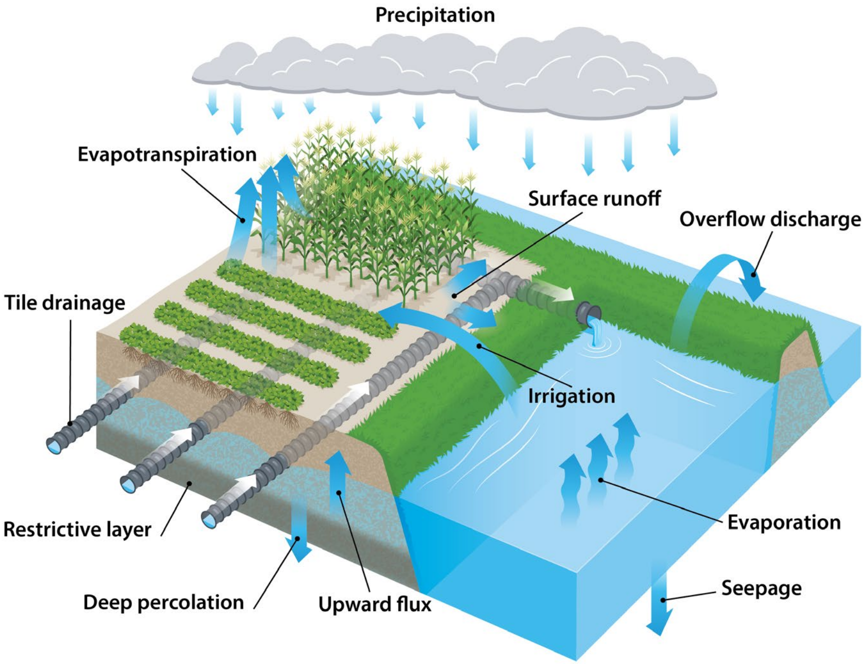


Photo: US DOE

DWR research needs



- More monitored field sites
- How much water can we capture and reuse as irrigation?
- How do we manage systems to maximize productivity/profitability?
- What are the water quality impacts?
- How can design and management provide other benefits and avoid unintended consequences?

Graphic: TransformingDrainage.org

TRANSFORMING DRAINAGE.ORG

Managing Water for Tomorrow's Agriculture

EXPERT REVIEWED

ABE-156-W

Questions and Answers About Drainage Water Recycling for the Midwest

Jane Frankenberger, Ben Reinhart, Kelly Nelson, Laura Bowling, Chris Hay, Mohamed Youssef, Jeff Strock, Xinhua Jia, Matt Helmers, Barry Allred

WHAT IS DRAINAGE WATER RECYCLING?

Drainage water recycling is the practice of capturing excess water drained from fields, storing the drained water in a pond, a reservoir, or a drainage ditch, and using the stored water to irrigate crops when there is a water deficit. Relative to conventional drainage, drainage water recycling has two major benefits: (1) increased crop yield and (2) improved downstream water quality.

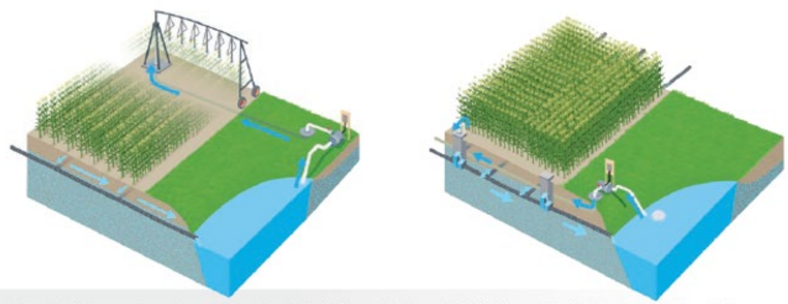


Figure 1: A drainage water recycling system consists of storing drainage water in a pond, which is then used for field irrigation. Irrigation methods vary with site conditions and may include overhead irrigation (left) or subirrigation (right).

Although precipitation in the Midwest is generally plentiful, the timing and amount do not always coincide with crop water needs. Drainage occurs mostly in the spring due to excess precipitation, while crop water use in mid- to late summer may result in periods when available water is insufficient. Storing drainage water can provide value to crops during periods when crop water needs exceed available soil water. The practice can also provide an opportunity for irrigation where certain limitations exist, such as inadequate water supplies or poor water quality.

Water quality also benefits from this system, because drained water, which typically contains nitrogen, phosphorus, and potentially other contaminants that can harm downstream water, is diverted into the water storage pond instead. Storing and recycling drainage water for beneficial use on crops prevents it from causing water quality problems, such as algae blooms in Lake Erie or hypoxia in the Gulf of Mexico.

Drainage water recycling can be a closed loop system where the drained water from a field is recirculated onto the same field, or water drained from one field can be used to irrigate a different field. Irrigation may be through subirrigation that raises the soil water table by adding water to the subsurface drain tiles, sprinkler irrigation systems, drip irrigation, or other technologies.

In summary:

- DWR can provide multiple benefits for crop production, water quality, and other complementary benefits

- Research to date shows potential for the practice in the Midwest

- More research is needed to quantify benefits to support financing and adoption

Laura Paine

Laura Paine is outreach coordinator for Grassland 2.0. She has been involved in regenerative agriculture education and research in the upper Midwest for nearly 30 years. Her work experience includes research, education and market development work for grass-fed and organic farmers with the University of Wisconsin-Madison, UW Extension, and the Wisconsin Department of Agriculture, Trade and Consumer Protection. Most recently, she served as program director for Dairy Grazing Apprenticeship (DGA). Laura is an NRCS Technical Service Provider and a Certified Crop Advisor. Laura and her husband recently retired from raising grass-fed beef on their 82-acre farm near Columbus, Wisconsin.

Carbon Sequestration Potential of Working Grasslands

Laura Paine
Outreach Specialist
Department of Agronomy
University of Wisconsin-Madison

The Current, December 9, 2020

grassLAND 2.0

Premise: By restoring much of the structure and function of the former prairie to our dominant agricultural systems, we can help support diversified, profitable family farms with integrated livestock operations that also promote healthy individuals, communities, and ecosystems.

Problem: Massive barriers to this transformation exist in the social, economic, political, and agronomic realms.

Goal: provide a blueprint for farmers, policymakers, and citizens to transform livestock production from grain-based to grass-based agriculture in the North Central US.

An agroecological transformation plan for perennial grassland agriculture

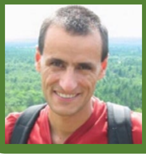
grassLAND 2.0 people

Meta-stakeholders

Obj. 1
Agroecological transformation plan
(Randy Jackson)

Obj. 2
Supply chains
(Nick Jordan)

Obj. 3
Economics & finance
(Brad Barham)



Obj. 4
Modeling & data
(Claudio Gratton)

Obj. 5
Policy
(Adena Rissman)

Obj. 7
Education
(Michael Bell)

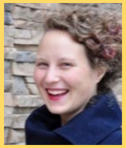
Obj. 6
Learning Hubs
(Rebecca Power)

Outreach coordination
(Laura Paine)

Project management
(Carl Wepking)

Communications
(Anne Nardi)

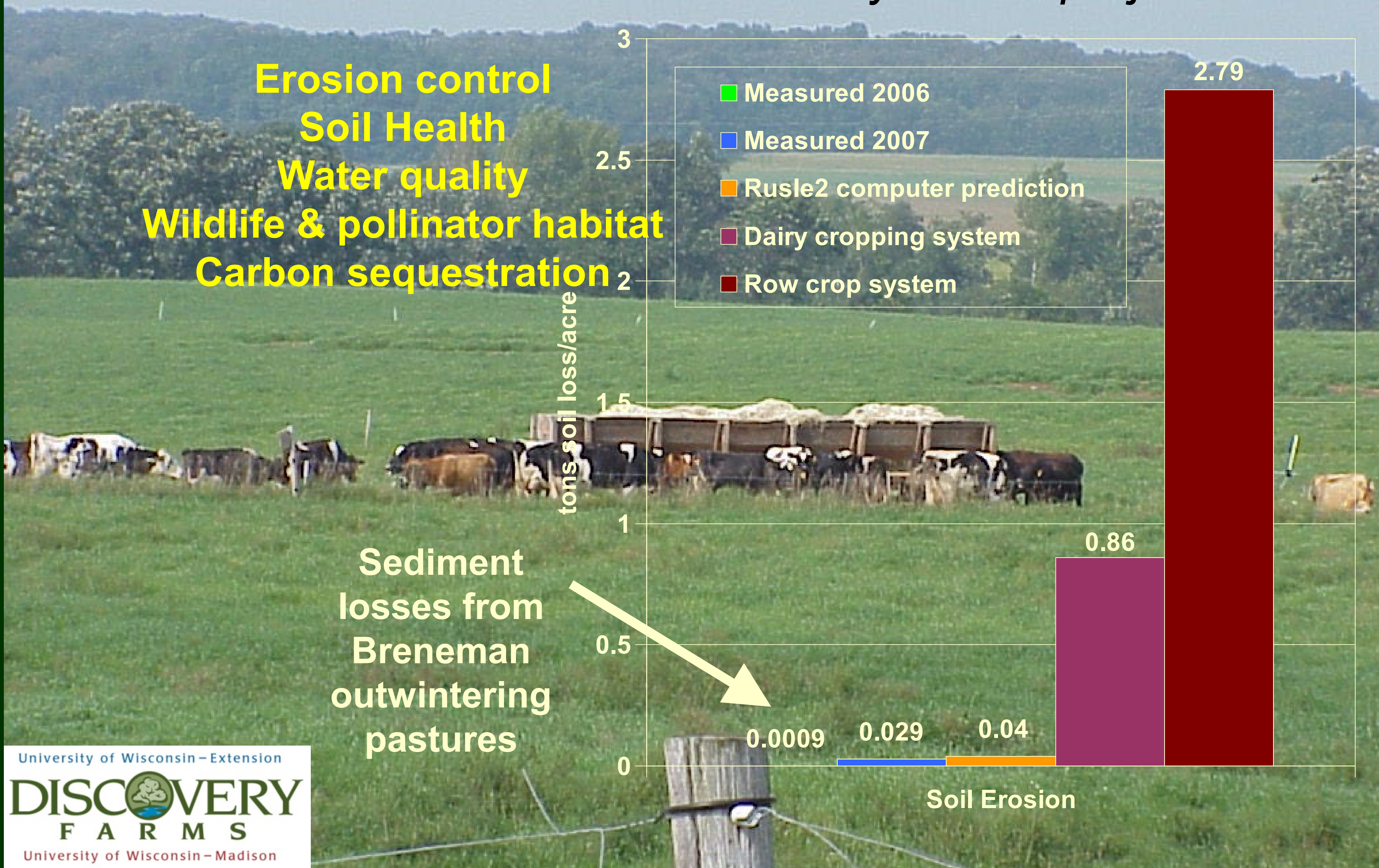
Developmental evaluation
(Courtney Bolinson)



Program evaluation
(Greta Landis)

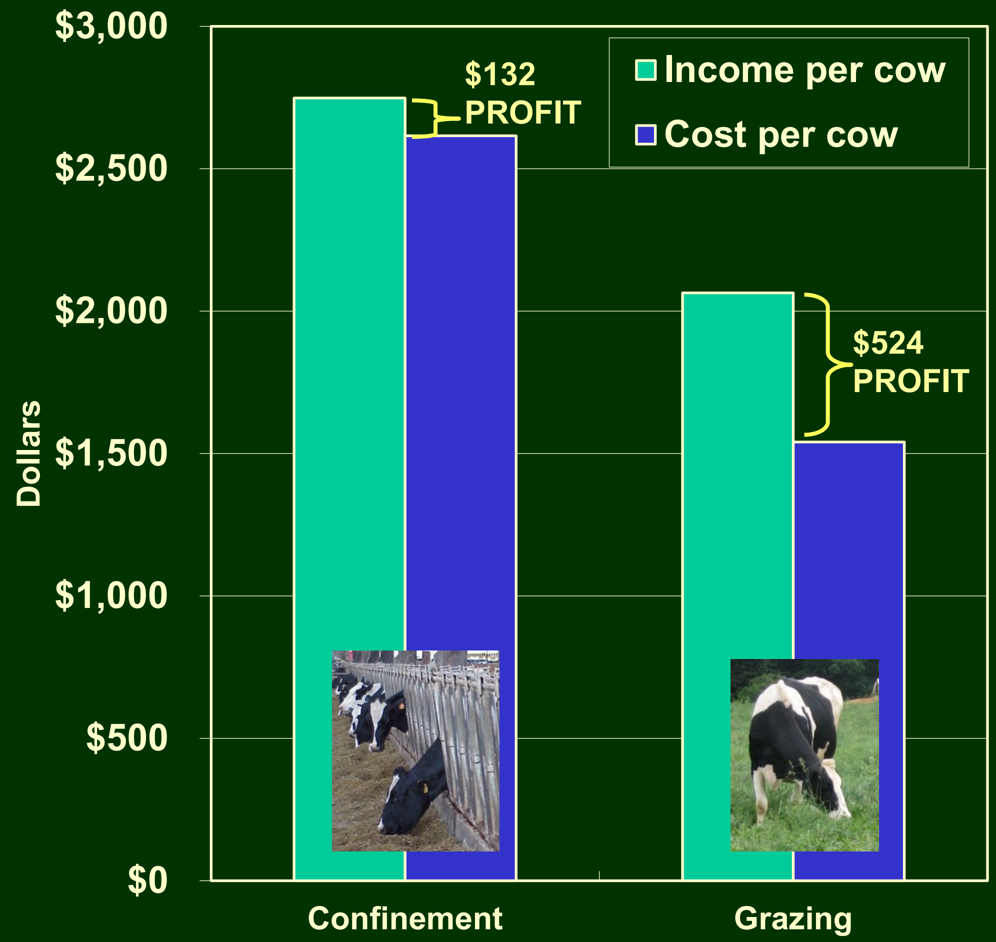
Environmental benefits of perennial cover

data from Breneman Discovery Farms project



Managed Grazing reduces costs, increases net profit

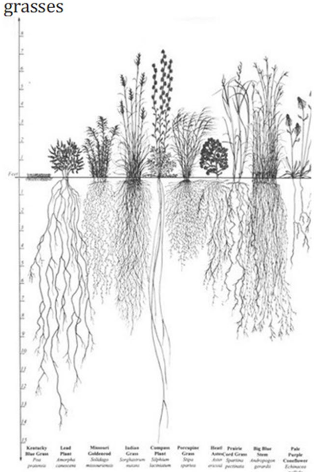
Production is usually lower
Cost per cow is significantly lower
Net income is higher
One grazing cow can generate as much income as four confinement cows



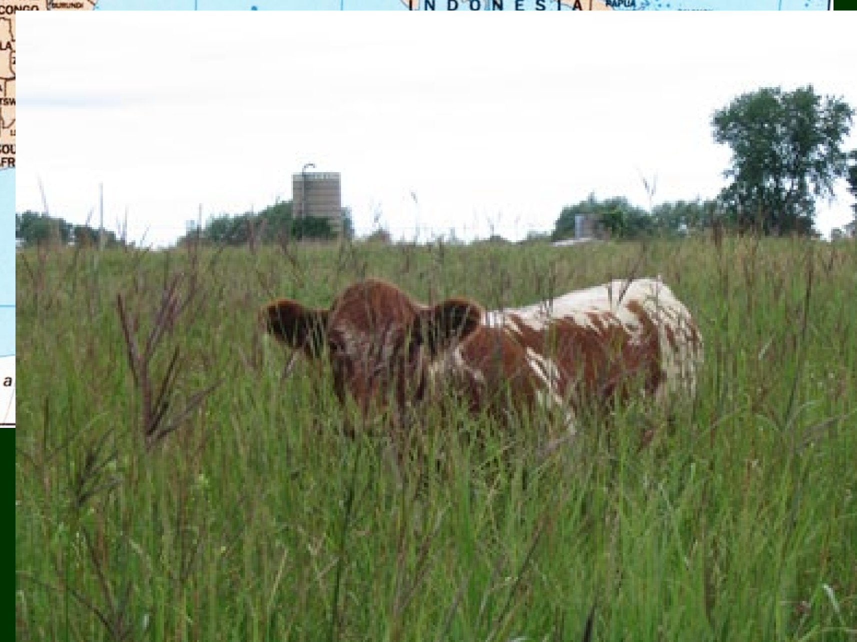
Multi-year data summarized in 2011, from Kriegl (https://cdp.wisc.edu/Great%20Lakes.htm)

High-OM Mollisols are grassland soils

Figure 5. Example: Illustration of native grasses



Root Systems of Prairie Plants



GreenLands BlueWaters

grassLAND 2.0

Understanding soil carbon dynamics in pasture systems

September 2020

Grasslands are King

-- when it comes to soil carbon sequestration. The fibrous roots of perennial grasses turn over rapidly in the soil, feeding soil microbes that help organic matter accumulate (1). The highly productive soils of the North American Midwest formed over tens of thousands of years under tallgrass prairie ecosystems populated by millions of grazing animals that moved frequently in dense herds. The deep rooted, diverse prairie plant community (Fig. 1) was especially well-suited to building soil carbon, but cool-season grasses and legumes in pastures can be managed for this purpose as well. What do we know about carbon storage in grasslands and how can we manage our pastures to encourage carbon sequestration?

Figure 1. Source: Laura Paine

What is carbon sequestration?

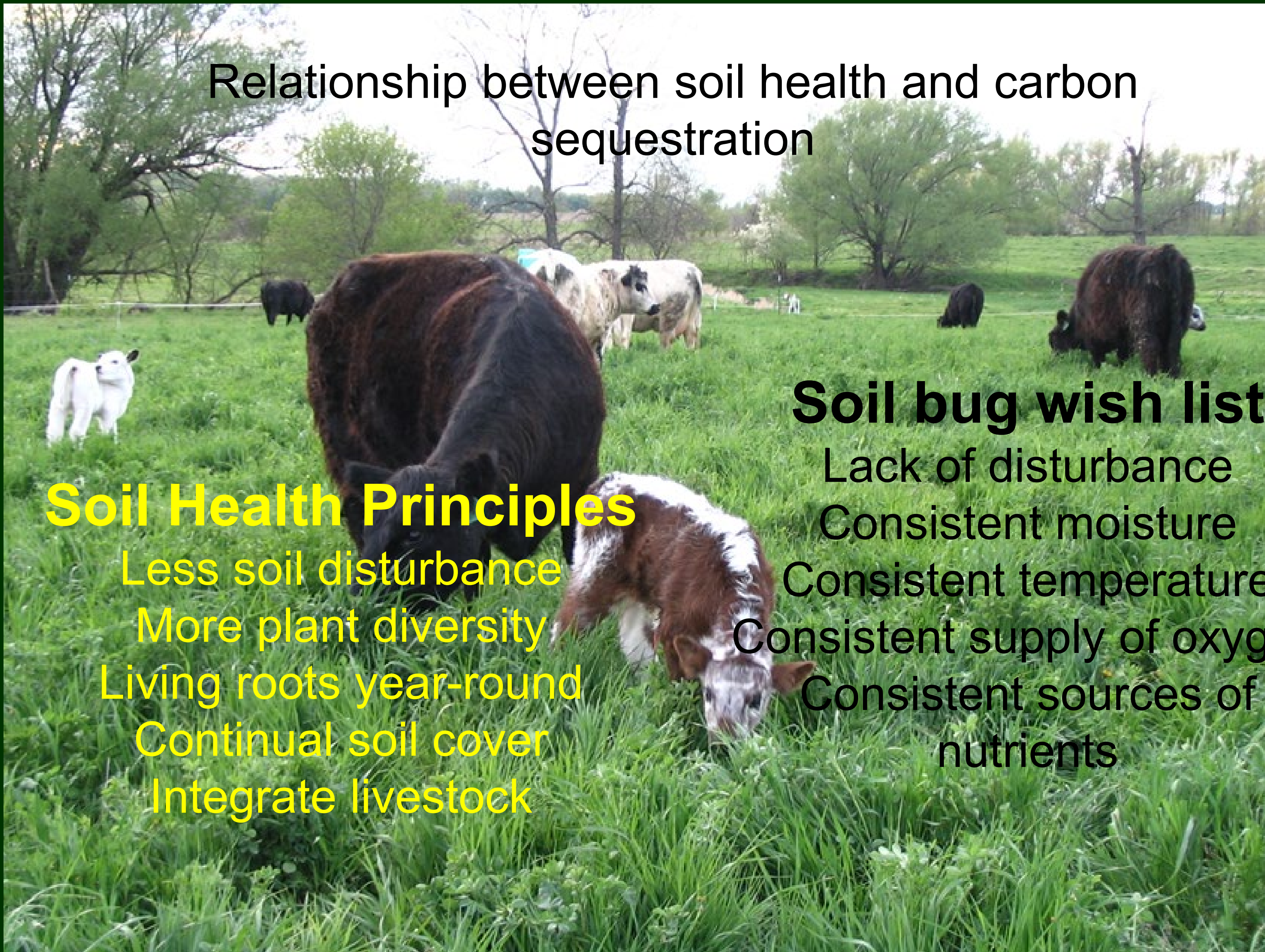
Through photosynthesis, plants capture the sun's energy and store it in chemical bonds when they combine carbon dioxide and water to form carbohydrates. In our pastures, grasses and legumes use this fuel for maintenance, reproduction, and growth. If we manage well, there is enough growth to feed our grazing livestock and leave some residual to feed soil microbes - largely fungi and bacteria - that break down plant tissue and recycle nutrients. It is this last pool of carbohydrates that may be converted to more stable forms of soil organic matter. For carbon to be sequestered, it must be in a form that won't be readily consumed and respired back to the atmosphere as carbon dioxide.

Knowledge of the plant-soil-microbial ecosystem is growing fast – yet there remain many questions to be answered. The picture that is emerging is that within the rhizosphere (the zone where plant roots and microbes interact), a complex web of mutually beneficial interactions occur and the health of that ecosystem leads to healthier outcomes for our pastures, livestock, and the nutritional value of their meat and milk.

Variables

Soil type/texture
Climate
Prior cropping history
Pasture species composition
Pasture management practices
Relatively young science—a lot of unknowns!

[Link: Understanding soil carbon dynamics in pasture systems]



Relationship between soil health and carbon sequestration

Soil Health Principles

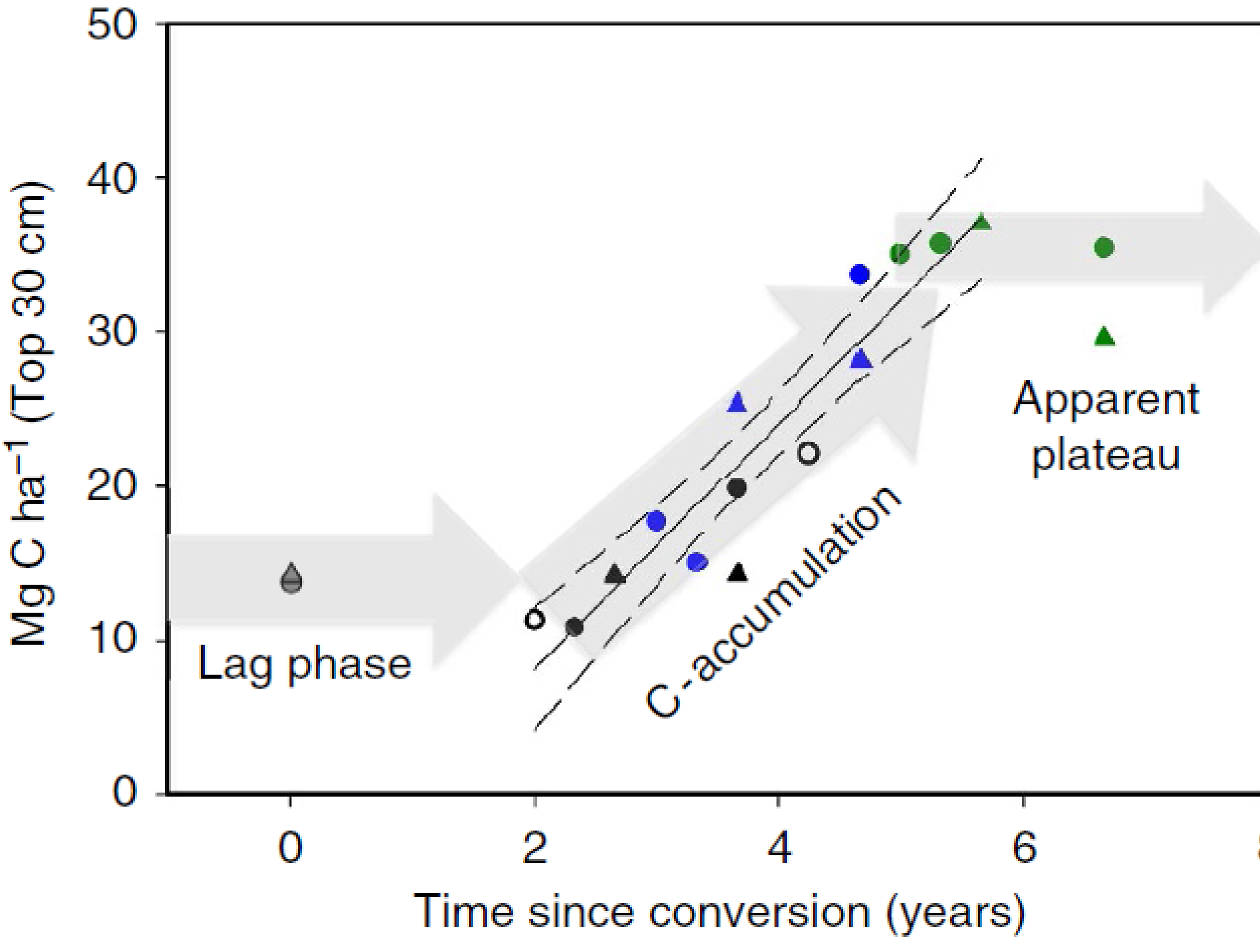
Less soil disturbance
More plant diversity
Living roots year-round
Continual soil cover
Integrate livestock

Soil bug wish list

Lack of disturbance
Consistent moisture
Consistent temperature
Consistent supply of oxygen
Consistent sources of nutrients

Conversion from annual cropping to perennial working grassland

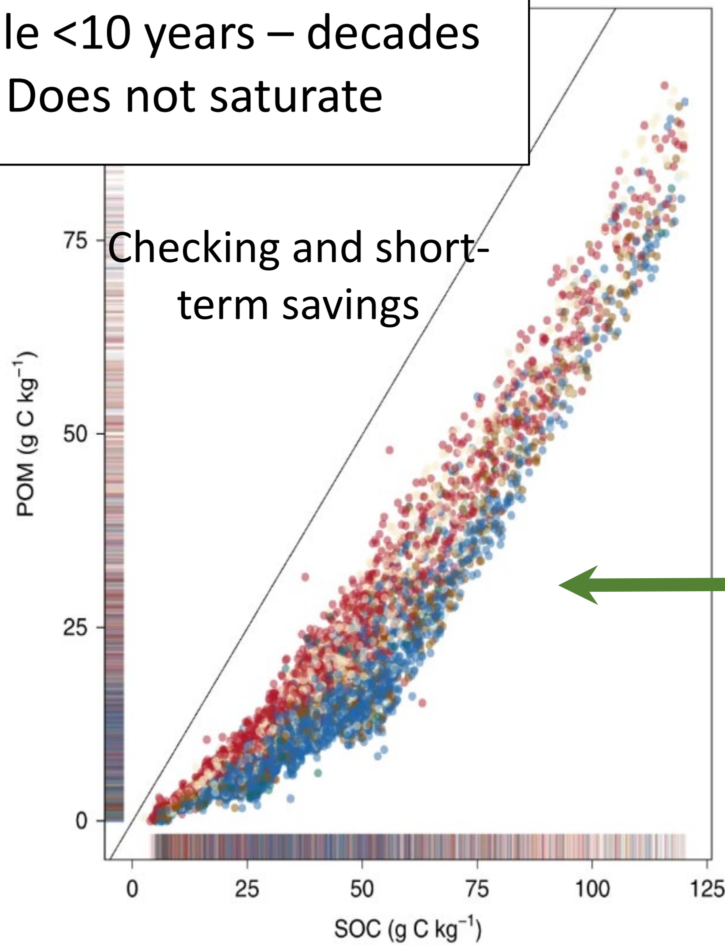
- Meta-analysis of 42 studies showed an average increase in soil organic carbon of 39% (Conant et al, 2016)



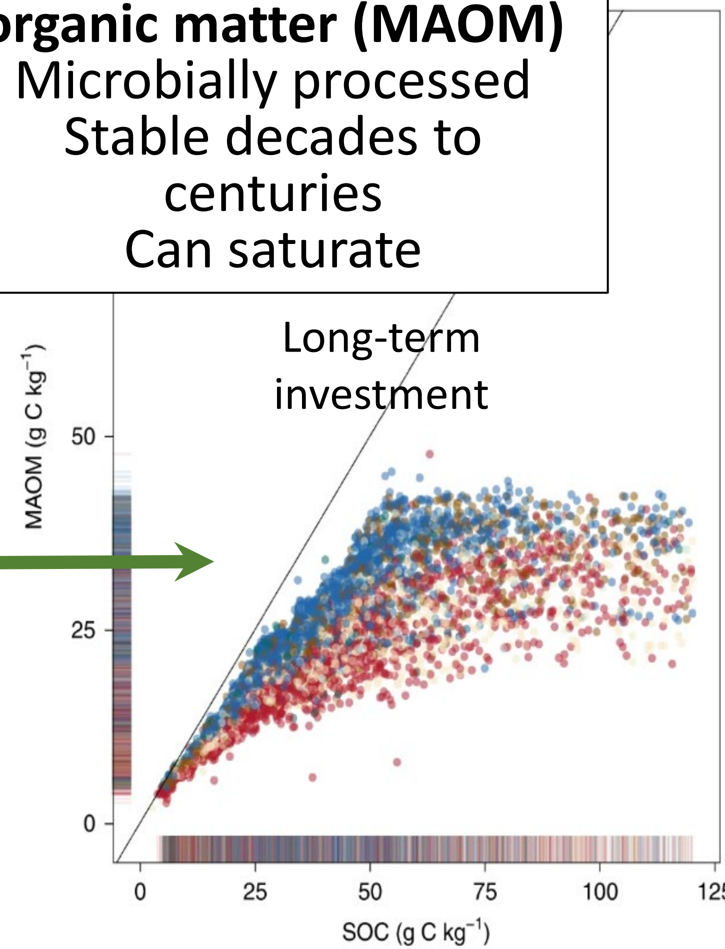
Machmuller et al. 2015. Emerging land use practices rapidly increase soil organic matter.

Soil Carbon Pools: POM and MAOM

Particulate organic matter (POM)
Decomposing plant material
Stable <10 years – decades
Does not saturate

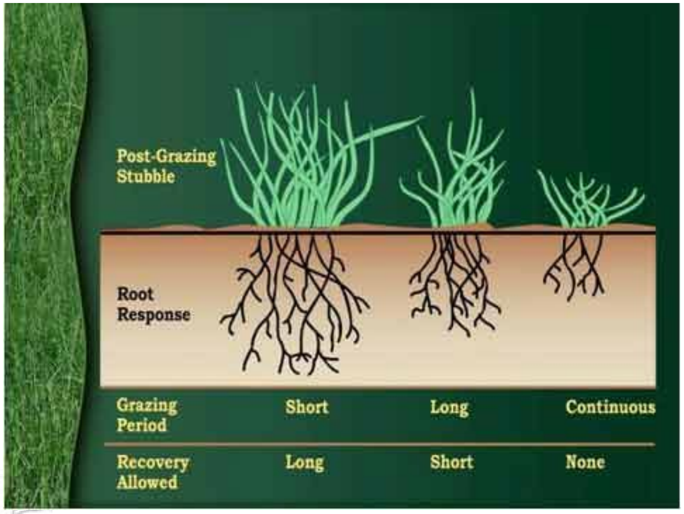


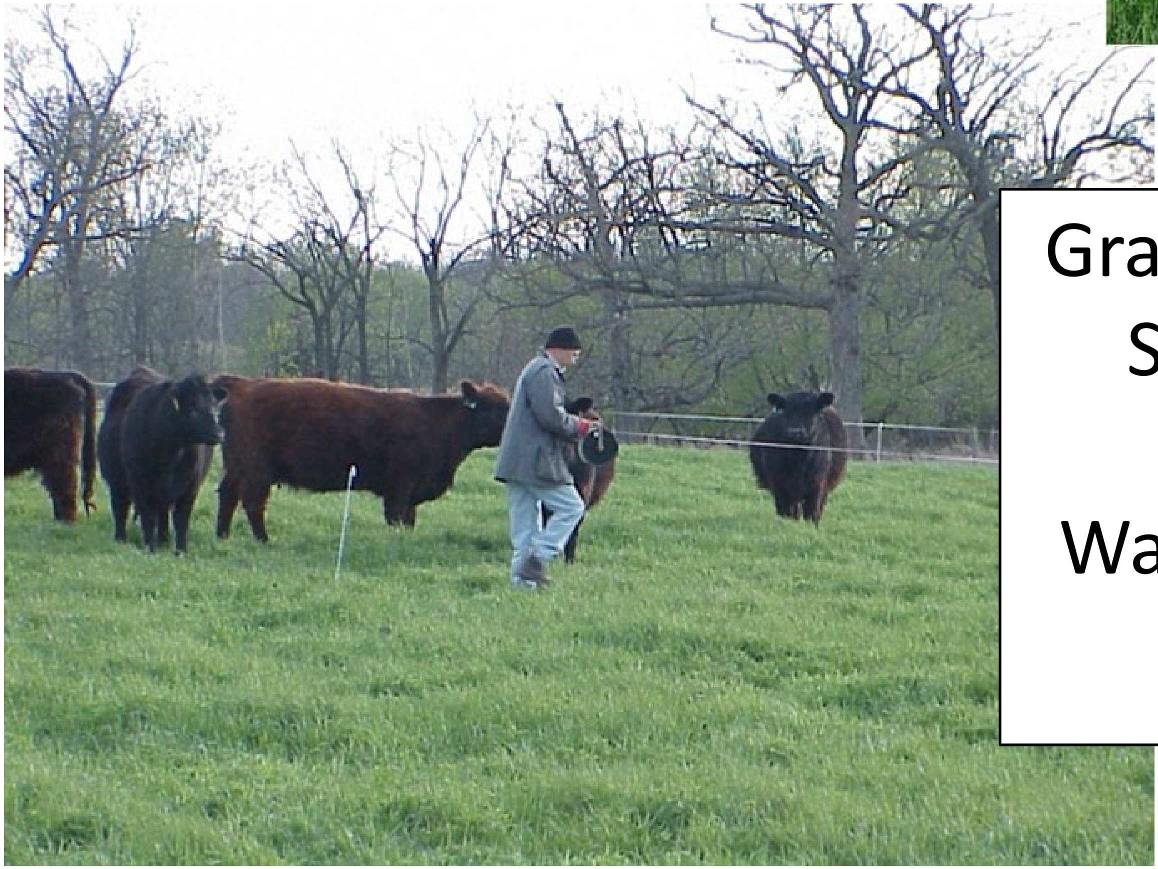
Mineral-associated organic matter (MAOM)
Microbially processed
Stable decades to centuries
Can saturate



(Cotrufo et al., 2019, Lavallee, Soong & Cotrufo, 2019)

Managing grazing to increase carbon storage





Grazing management
Species diversity
Rooting depth
Warm season versus cool season

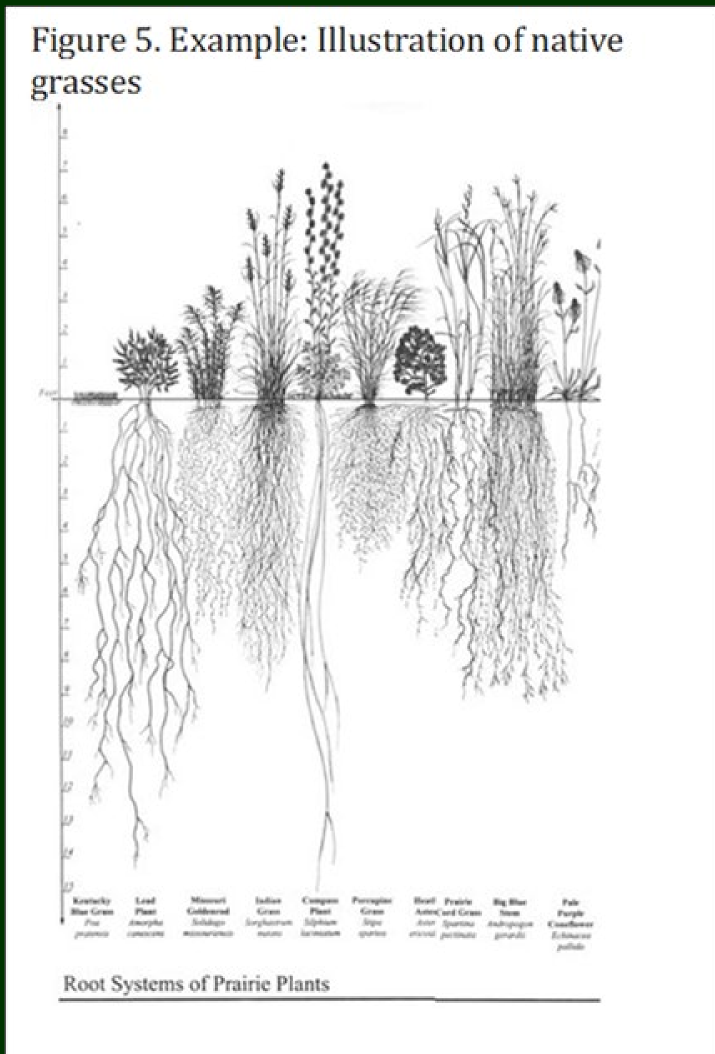
Intensive management increases rooting depth, nutrient cycling and microbiome health

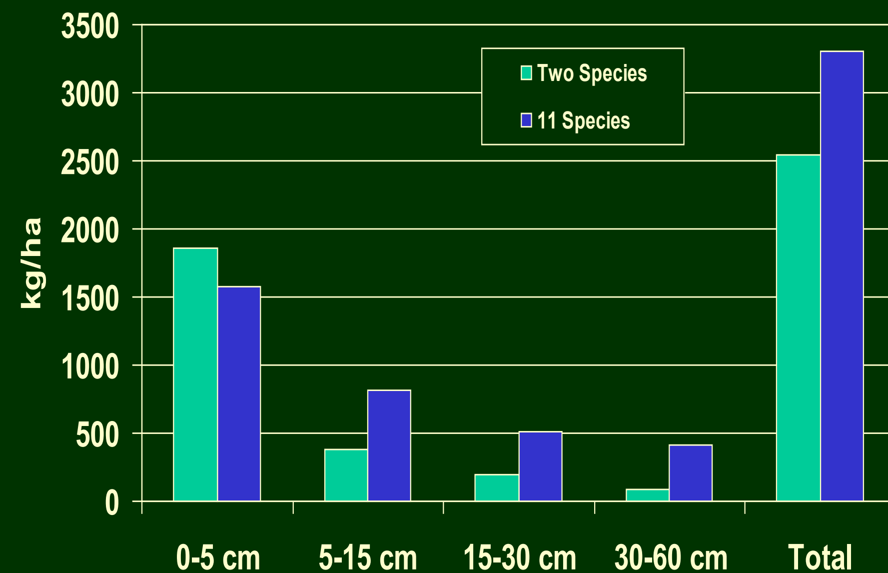
30 days
1 paddock

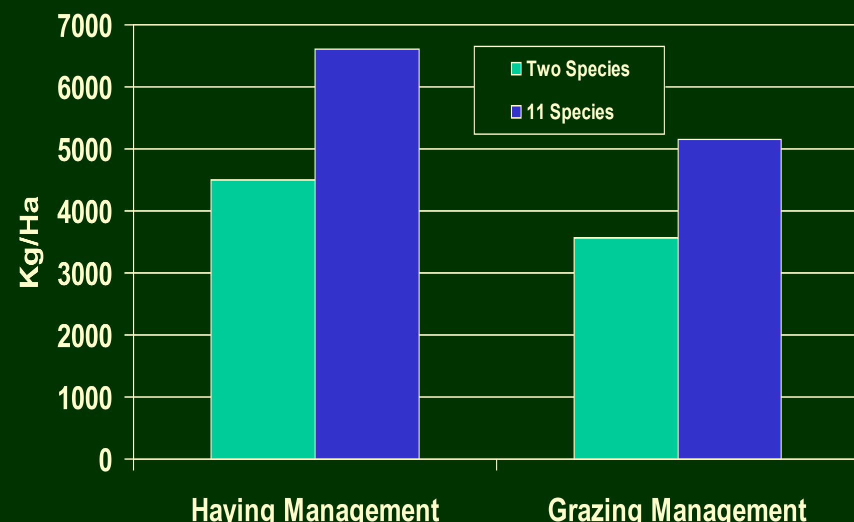
30 days
30 paddocks

Rest-Rotation Continuum

Species diversity and rooting depth

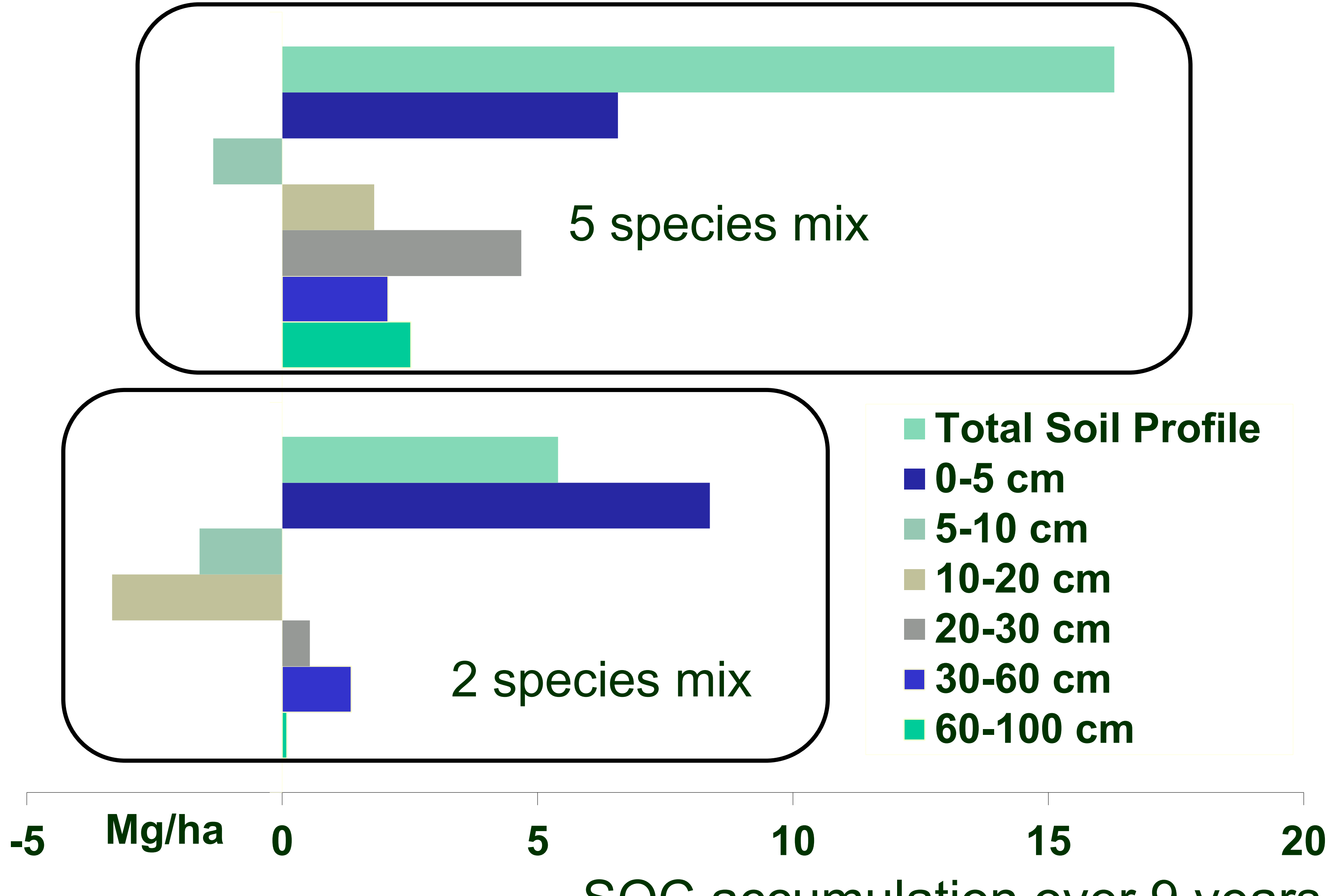




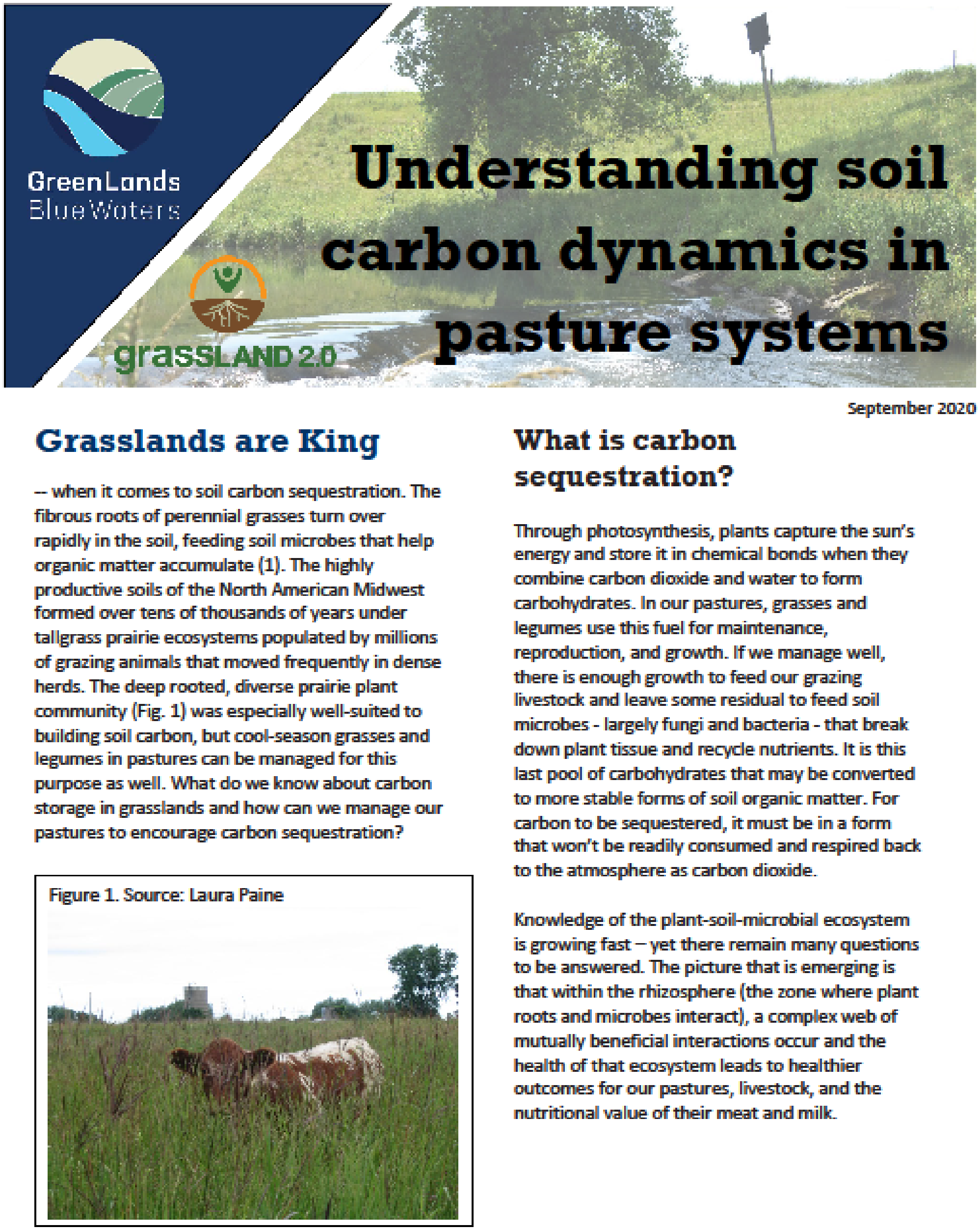


Skinner et al. 2006 Agronomy J.

Species Diversity and Rooting Depth



Data from Skinner & Dell 2016



Understanding soil carbon dynamics in pasture systems

GreenLands BlueWaters

grassLAND 2.0

September 2020

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Figure 1. Source: Laura Paine

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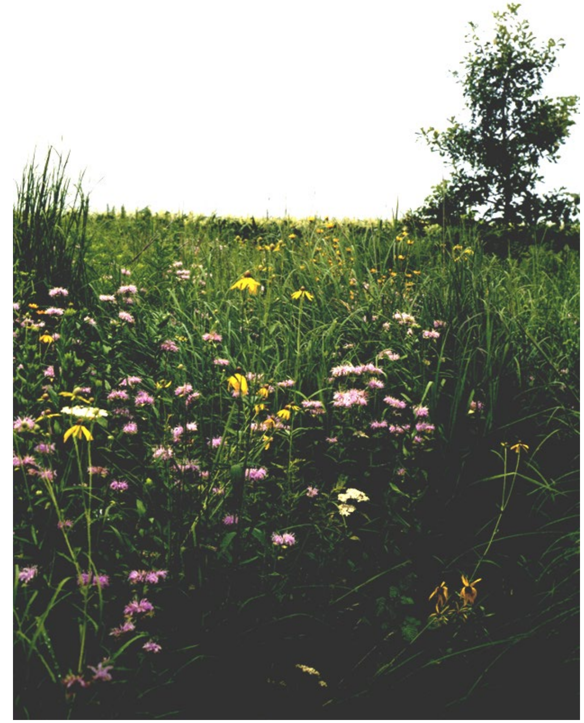


References

Download this fact sheet for a list of references:
Understanding soil carbon dynamics in pasture systems

John Tyndall

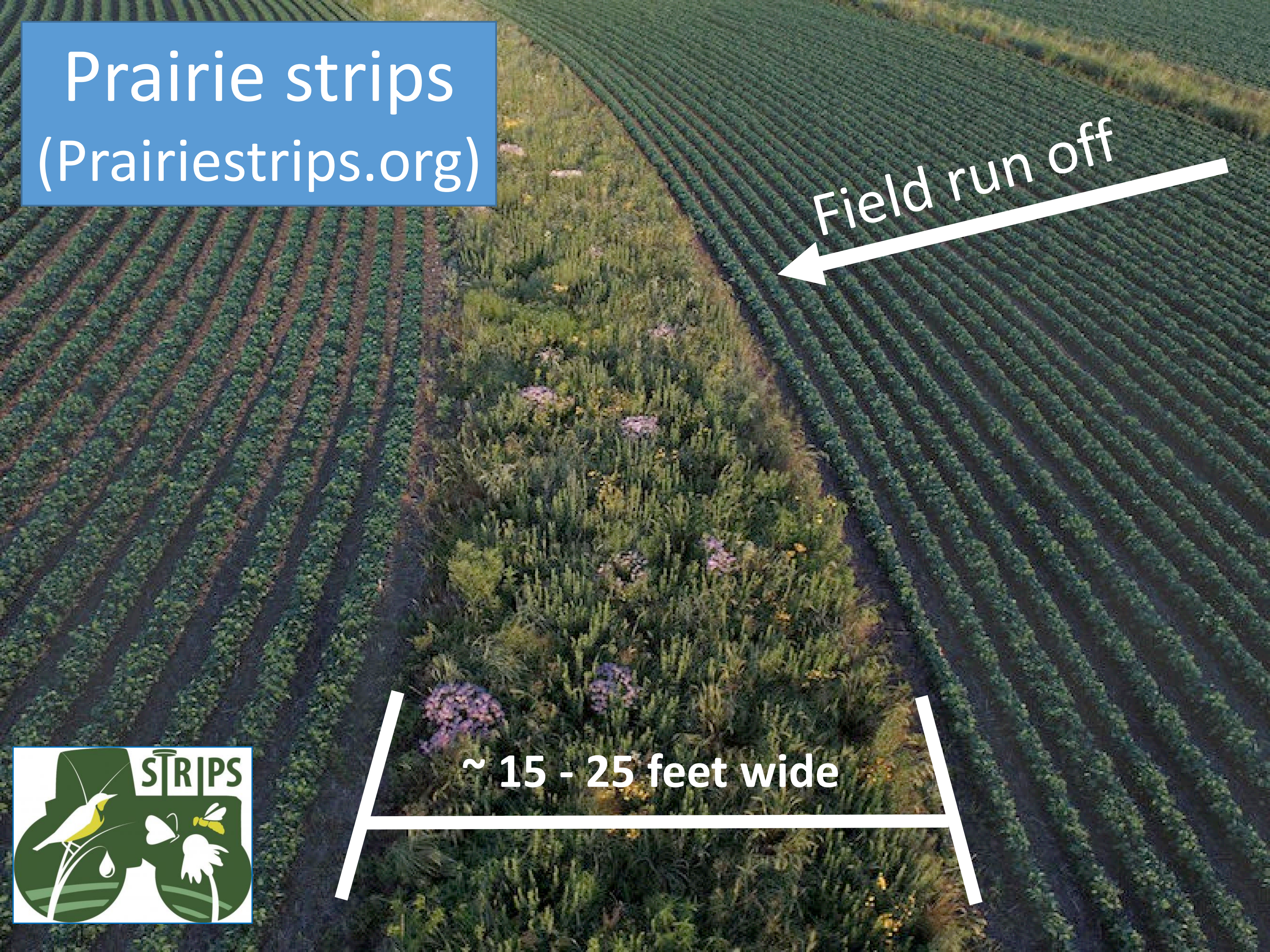
Dr. John Tyndall is a natural resource economist and Associate Professor at Iowa State University. He has a broad interest in environmental and natural resource economics, policy and sociology within forestry and agriculture. He specializes in financial and economic explorations of environmental quality management in highly managed agricultural, forest, and urban landscapes.

Prairie and Tree Planting Tool - PT^2 (1.0):
A conservation decision support tool for Iowa

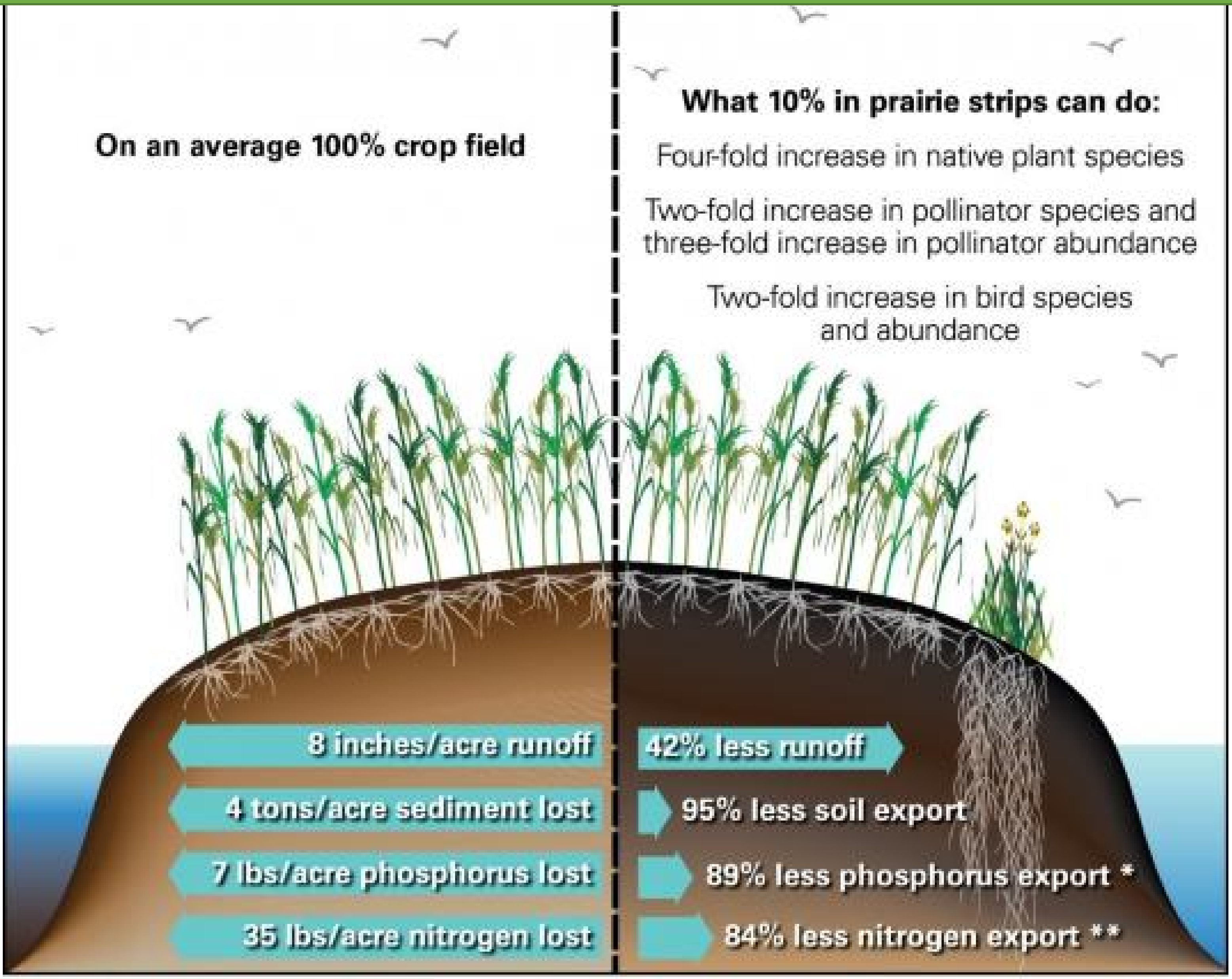
John Tyndall, Iowa State University

STRIPS

FFAR
Foundation for Food
and Agriculture Research


Prairie strips
(Prairiestrips.org)
Field run off
~ 15 - 25 feet wide
STRIPS

Prairie Strips promoted by NRCS & eligible for CRP and EQIP funding



Summarized in Schulte et al. 2017 PNAS

Source: STRIPS Research Team and Leopold Center for Sustainable Agriculture

PT² (1.0) Online Interface

Data layers:

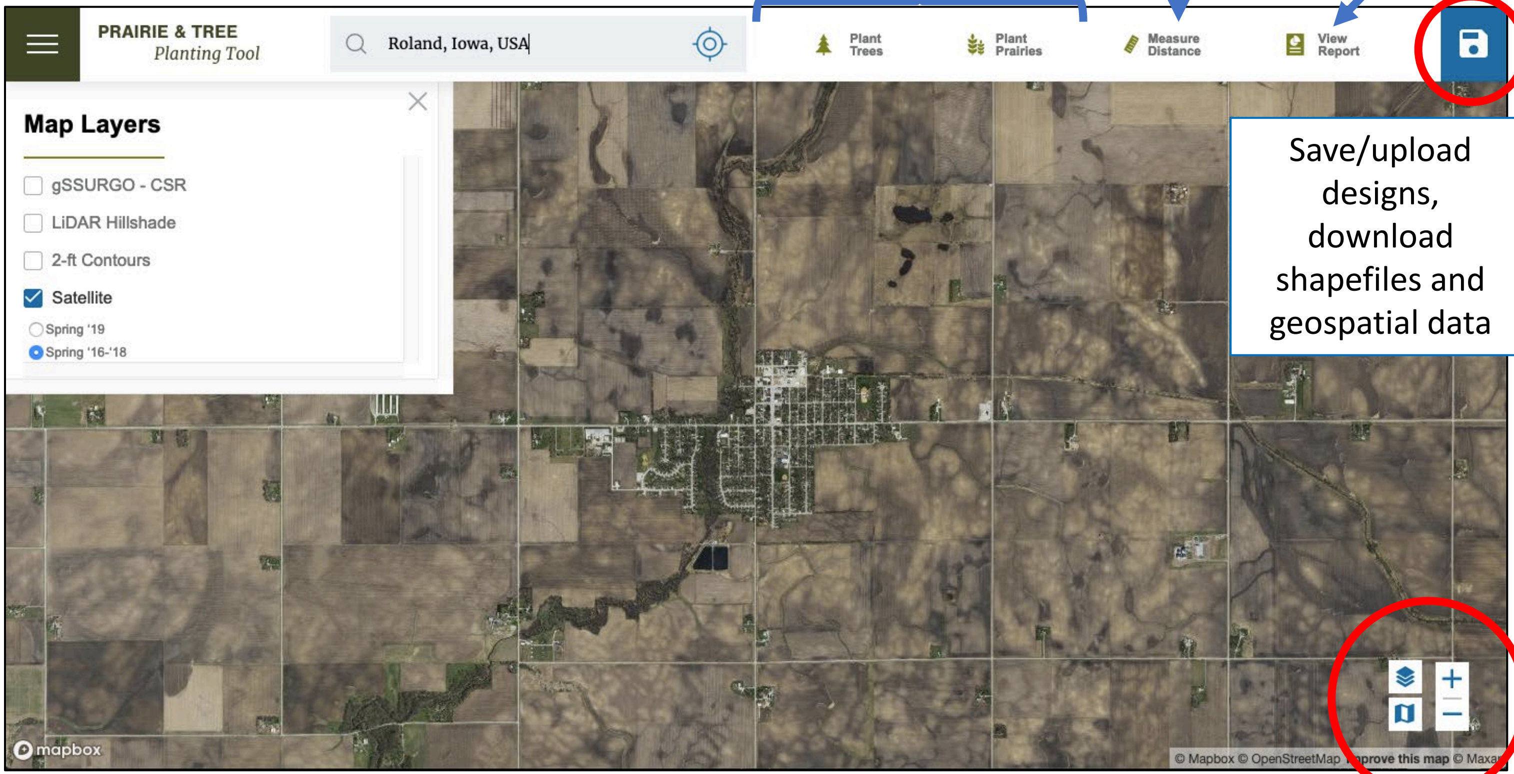
- Soil map with corn suitability rating & rent;
- Lidar;
- 2-ft contour topography;
- two different orthophoto options

Plant trees and/or prairie

Exploring distance and area

Financial report

Address search



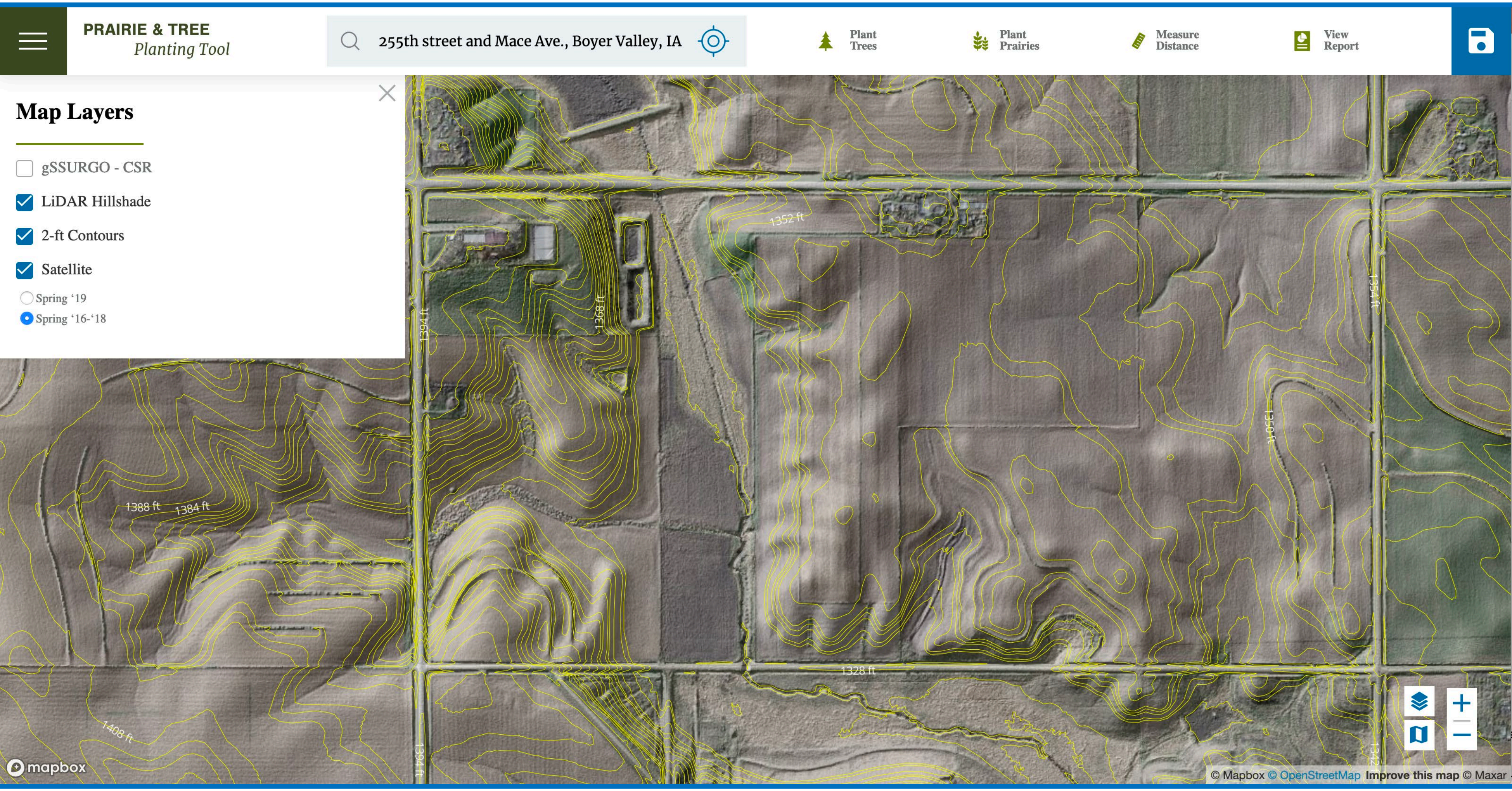
Save/upload designs, download shapefiles and geospatial data

Data layers, legend soils, zoom

Beta version located at:

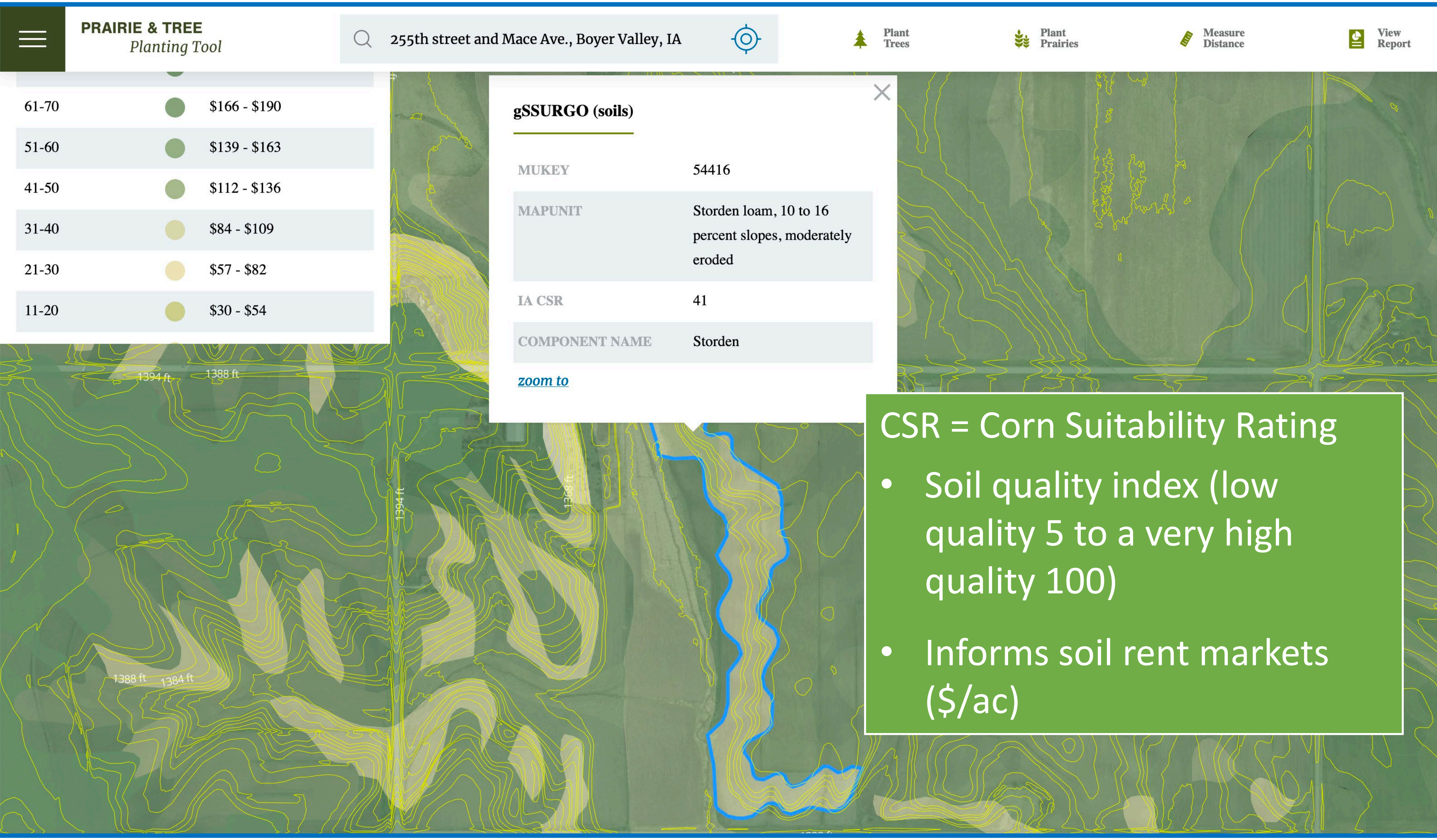
https://pt2.nrem.iastate.edu/

Explore high resolution topography, landscape positions, aspect



Data: Iowa 2016-2018 Spring Orthophotos; Two-foot elevation contour data; Iowa LiDAR Hillshade from 2007-2010 state-wide collection

Explore soils, planting conditions, opportunity cost

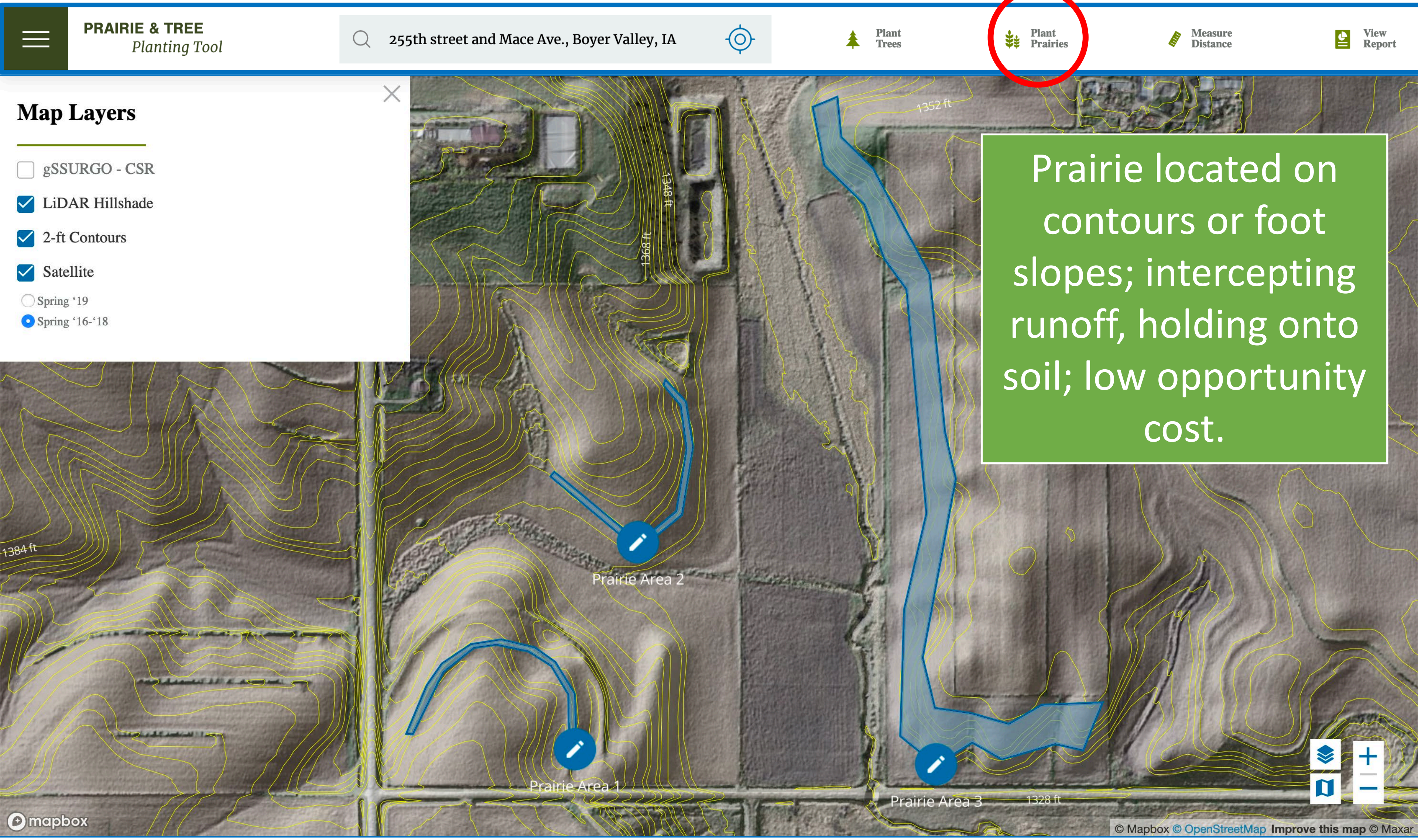


CSR = Corn Suitability Rating

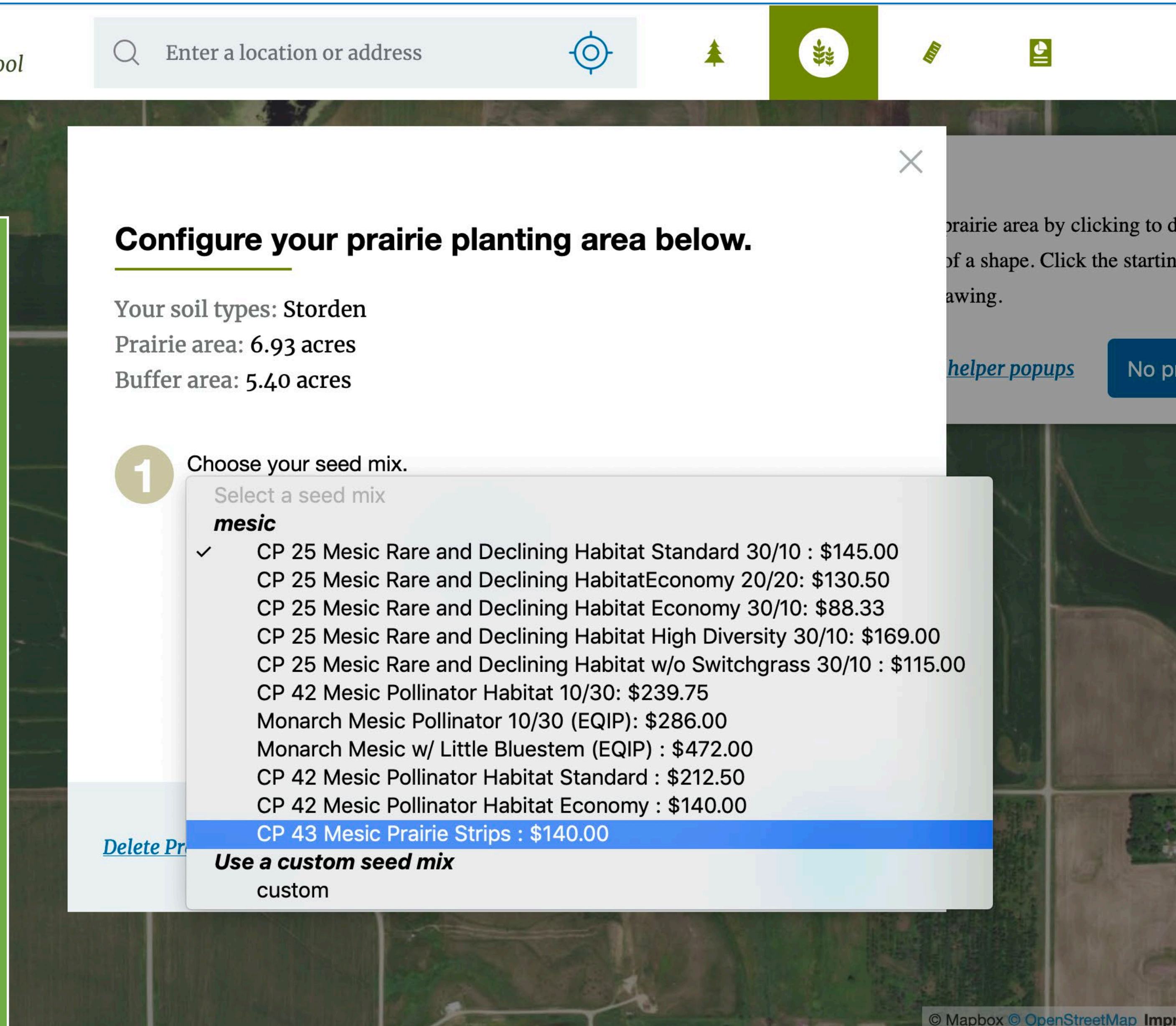
- Soil quality index (low quality 5 to a very high quality 100)
- Informs soil rent markets ($/ac)

Data: NRCS gSSURGO Soil Survey data (soil mapping & CSR2 data layer)

Example prairie strip & linear patch design accounting for runoff & erosion vulnerable locations



Allows for some custom design flexibility…



Soils categorized based on moisture conditions:

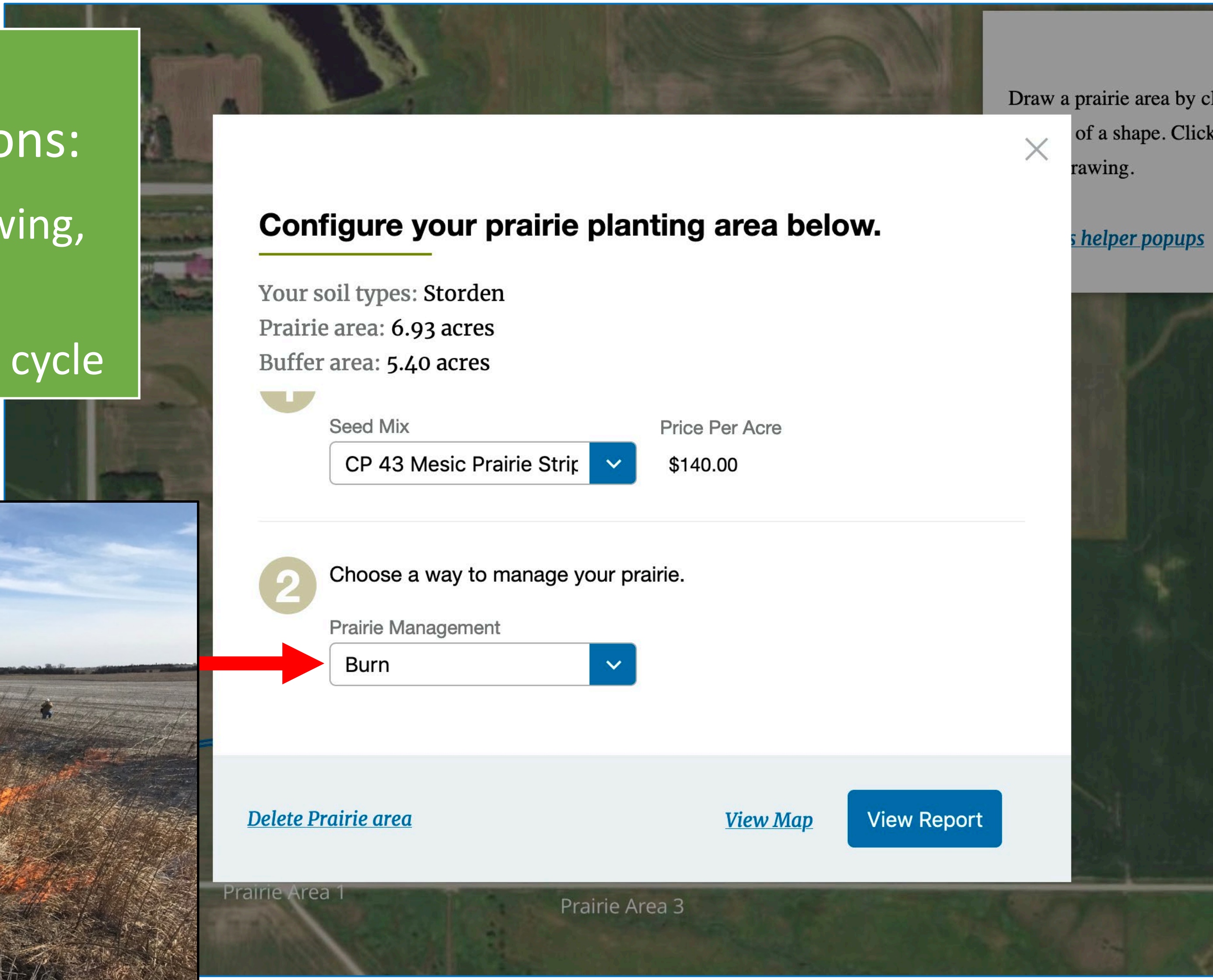
- Hydric
- Wet-mesic
- Mesic
- Dry-mesic
- Xeric

Prairie seed mix prices per moisture regimes. 2019/2020 prices based on survey of regional seed dealers (n=5).

Current long term management options:

1) mowing, raking, rowing, bailing; or

2) burning on a 3-year cycle



Financial Reporting

Prairie Area 3

View Report Area: Prairie Area 3

Site Preparation | Establishment | Management | Opportunity Cost | Conservation Programs | Net Totals

Establishment Costs	Unit Costs	Units	Qty	Annualized Total Costs
Seed	$140.00	$/acre	6.93	$75.55
Seed Drilling	$18.70	$/acre	6.93	$10.09
Culitpacking	$20.00	$/acre	6.93	$10.79
Total Establishment Costs				**$96.43**

Prairie Area 3

View Report Area: Prairie Area 3

Site Preparation | Establishment | Management | Opportunity Cost | Conservation Programs | Net Totals

Opportunity Costs	Unit Costs	Units	Qty	Annualized Total Costs
Land Rent (year 1-15)	$119.31	$/acre	6.93	$827.26
General Operation Costs (year 1-15)	$10.00	$/acre	6.93	$69.34
Total Opportunity Costs				**$896.60**

Prairie Area 3

View Report Area: Prairie Area 3

Site Preparation | Establishment | Management | Opportunity Cost | Conservation Programs | Net Totals

Category	Annualized Total Costs
Site Preparation	$32.31
Establishment	$96.43
Management	$271.71
Opportunity Cost	$896.60
Subtotal Costs	$1,297.05
Conservation Programs	- $833.05
Net Annualized Total Cost	**$464.00**

Financial data based on current comprehensive enterprise budgets, discounted cash flow analysis (real discount rate of 2%; 15 yr planning horizon), annualized.

Broader Implications…

Removing 7 acres of low yielding crop land (that generally = net $ loss) increased average whole field yield by 3 bu/ acre and lowered total farm costs.

(The following <u>NOT</u> calculated by PT^2 1.0)

Net revenue in 2020 for 277 acres (no prairie) = $32,506

Net Revenue in 2020 for 270 acres (with prairie) = $32,911

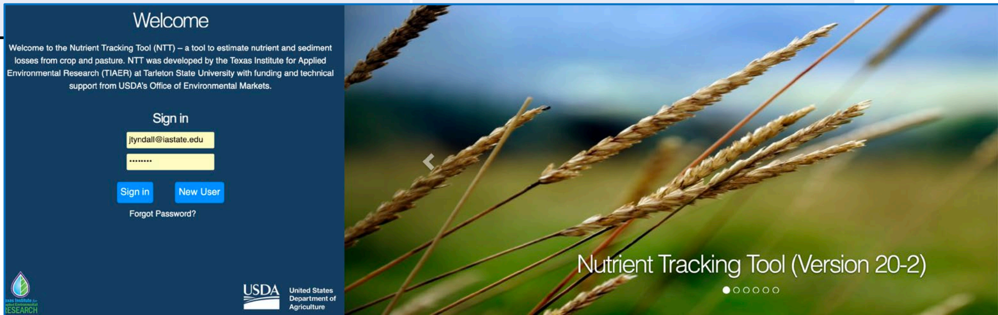
Net crop revenue with conservation = + $405

Sub-field profitability analysis: From 2013- 2020, a prairie system as shown would have provided an average total absolute benefit of $1,539/ year (or $220/acre/yr of prairie). With CRP, prairie costs ~$66/acre/ year

Estimated Water, Nutrient, & Sediment Management Outcomes

Sac County, Iowa Farm	No conservation	With prairie buffers
Description	Losses	(%) Change
Total N (lbs/ac)	40.4	-64.1
Total P (lbs/ac)	1.3	-45.2
Total Sediment (t/ac)	0.4	-43
Tile Drain P (lbs/ac)	0.15	-91.75
Tile Drain Flow (in)	13.5	-34.9
Surface Flow (in)	3.26	-24.47
Tile Drain Flow (in)	9.2	-91.74
Deep Percolation (in)	0.71	432.7

Data: Nutrient Tracking Tool:
https://www.oem.usda.gov/nutrient-tracking-tool-ntt;
Analysis by J. Tyndall, 2020




"This is the kind of agriculture I love, to talk about the soil, about sustainability, about production…will I be able to say that I left the land better than I found it?
That's what matters to me."
Image: Page Co., Tatum Watkin

Question and Answer Session

We will draw initial questions and comments from those submitted via the chat box during the presentations.

Today's Speakers

Chris Hay – chay@iasoybeans.com
Laura Paine – lkpaine@gmail.com
John Tyndall – jtyndall@iastate.edu

Thank you for participating in today's *The Current*!

Visit our website, northcentralwater.org, to access the recording and our webinar archive!

Our climate and soil health teams have two webinars next week!

Drought Decision Calendars for Specialty Crops
Monday, December 14th at 1pm CT
https://northcentralclimate.org/

Just-in-Time Soil Health
Wednesday, December 16th at 2pm CT
https://soilhealthnexus.org/

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