USDA Midwest Climate Hub
U.S. DEPARTMENT OF AGRICULTURE

Re-Carbonizing Row Crop Ag Lands:

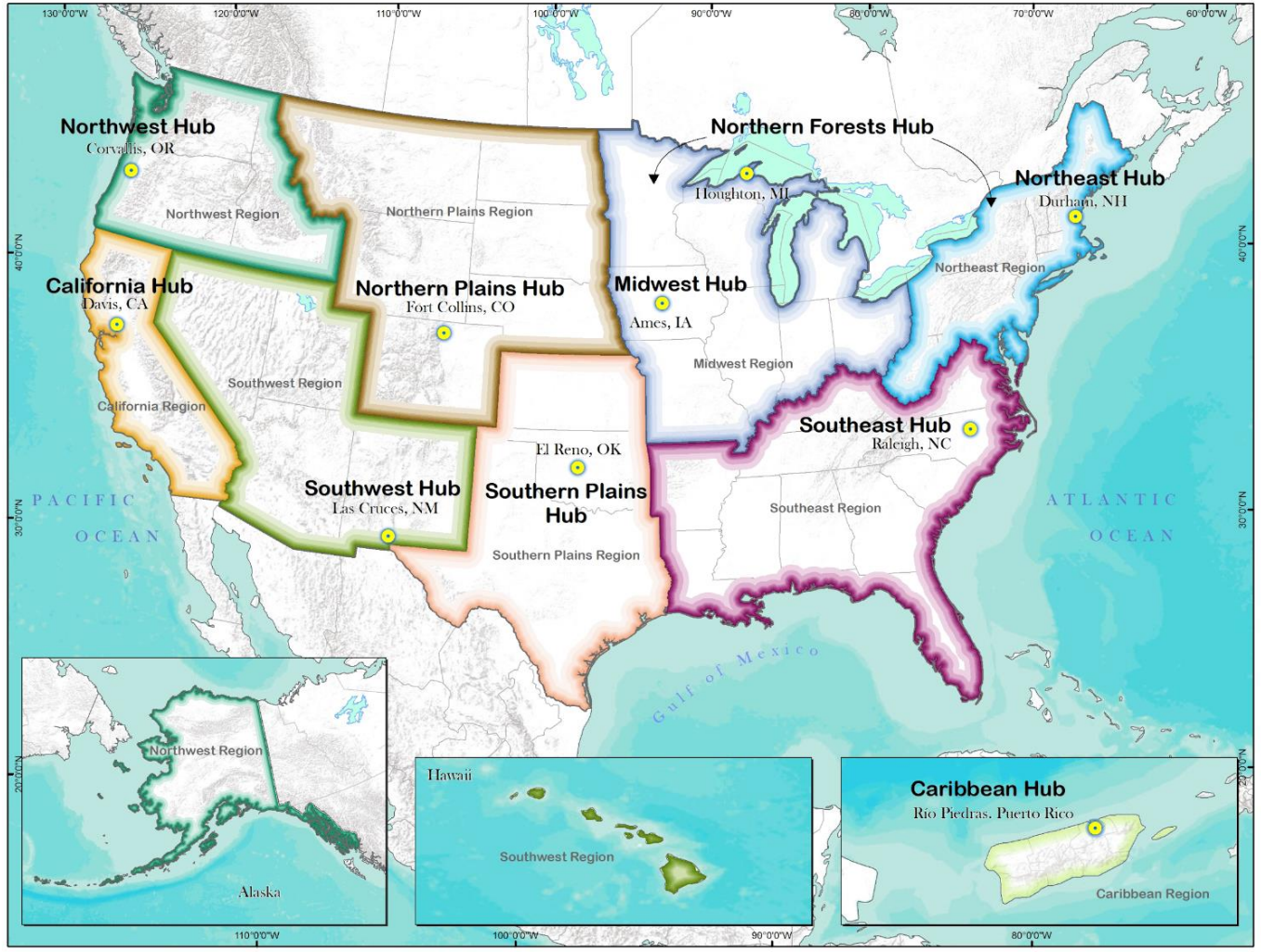
Evidence-based management strategies to increase soil carbon and promote financial resilience for farmers.

2019 NRCS Midwest Climate Hub Liaison: *Justin Mount*

Concepts and Considerations:

- Point out USDA Climate hub locations, functions and services
- View observed and predicted rainfall variability
- Establish attributes and functions of productive soils
- Explain Soil Condition Index (SCI)
- View Integrated Erosion Tool (IET) crop system editor interface
- Discuss short and long term strategies to promote adoption
- Discuss IET outputs and intended use

USDA Climate Hubs



Assessments and Syntheses
delivering relevant information

Outreach and Education
enabling climate-informed decisions

Technical Support
facilitating engagement, discovery and exchange

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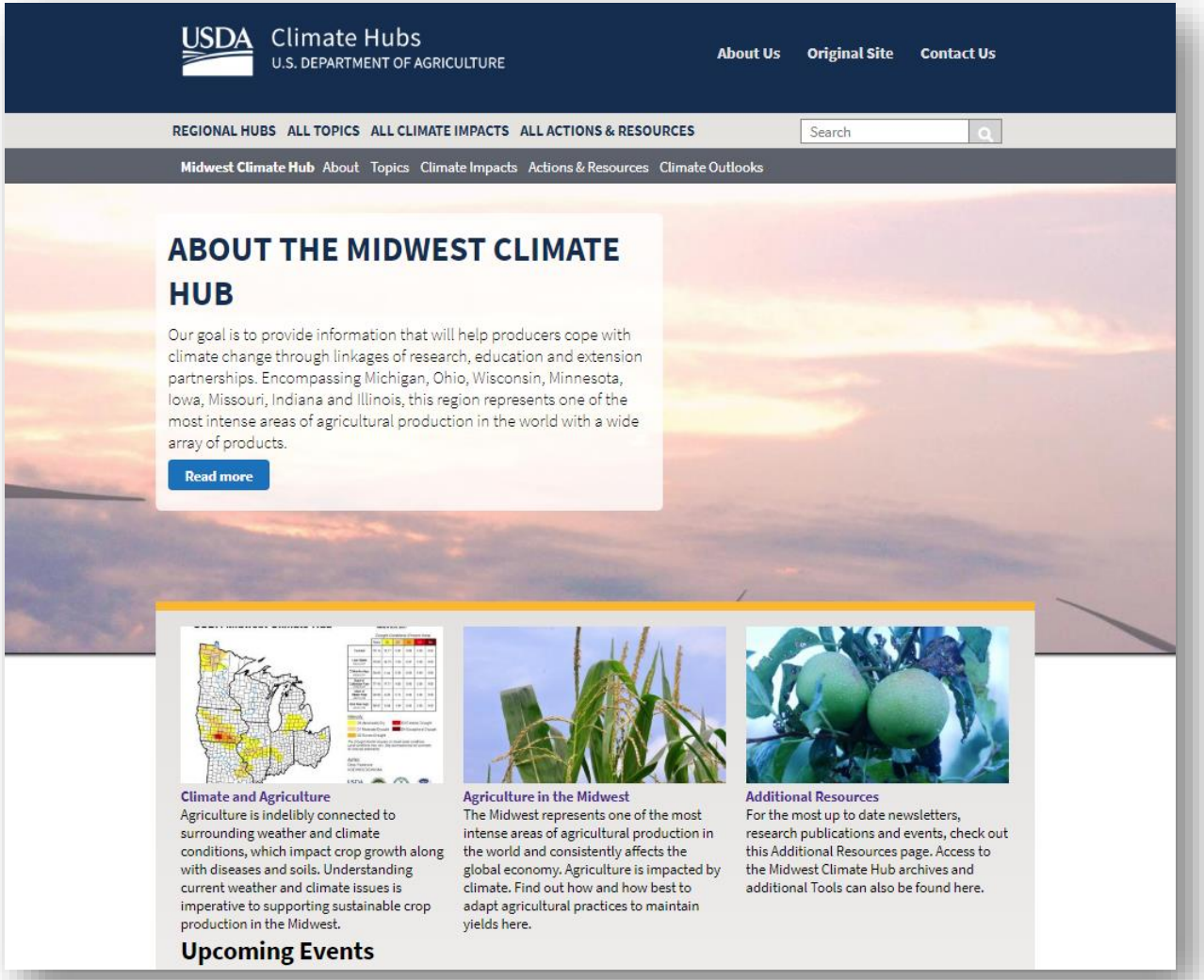
Learn more about the Midwest Climate Hub (MCH)



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Midwest Climate Hub

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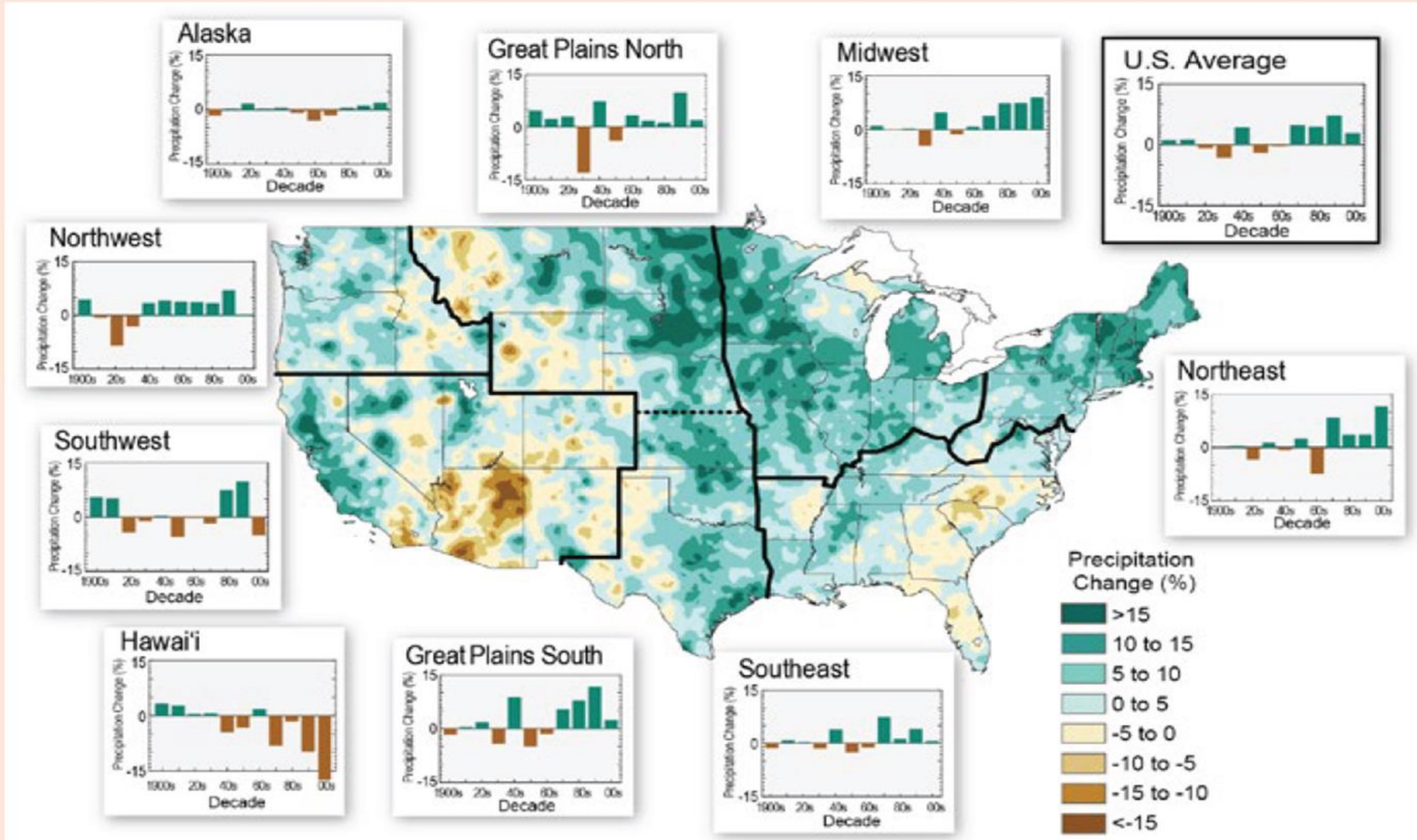
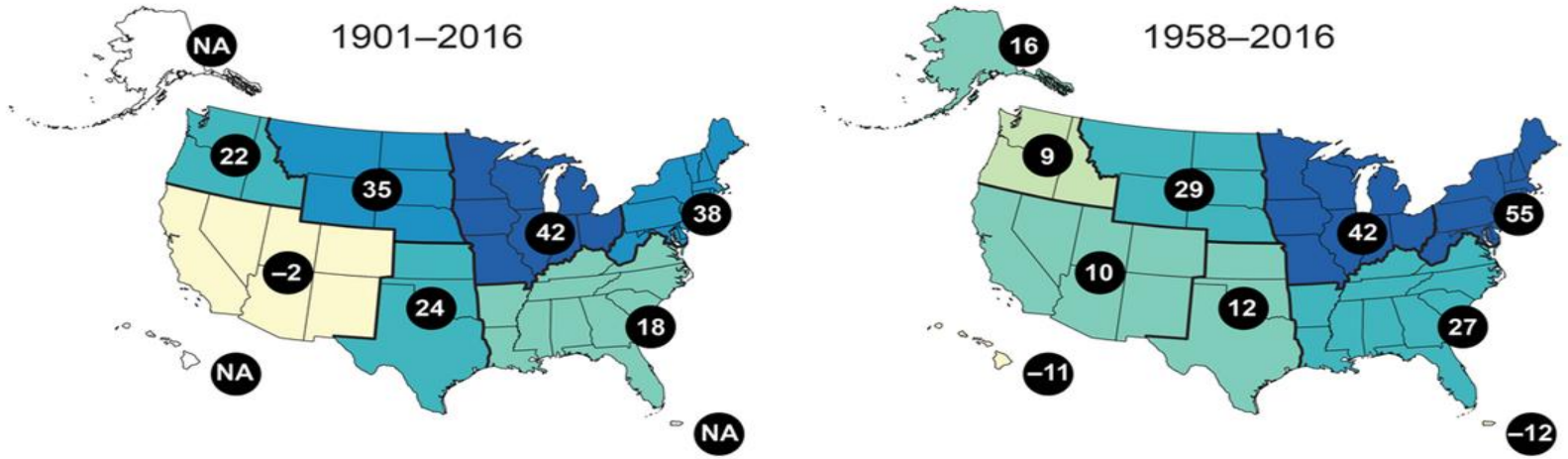
https://www.climatehubs.oce.usda.gov/hubs/midwest

Observed U.S. Precipitation Change

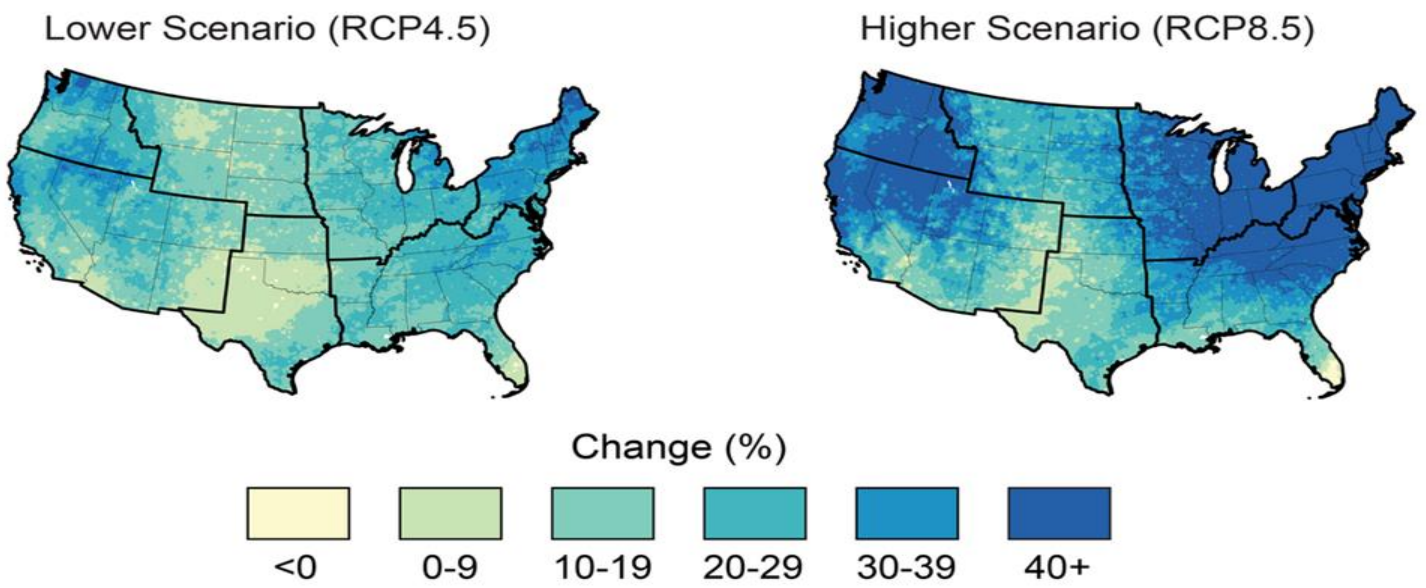


https://nca2018.globalchange.gov/

Observed Change in Total Annual Precipitation Falling in the Heaviest 1% of Events

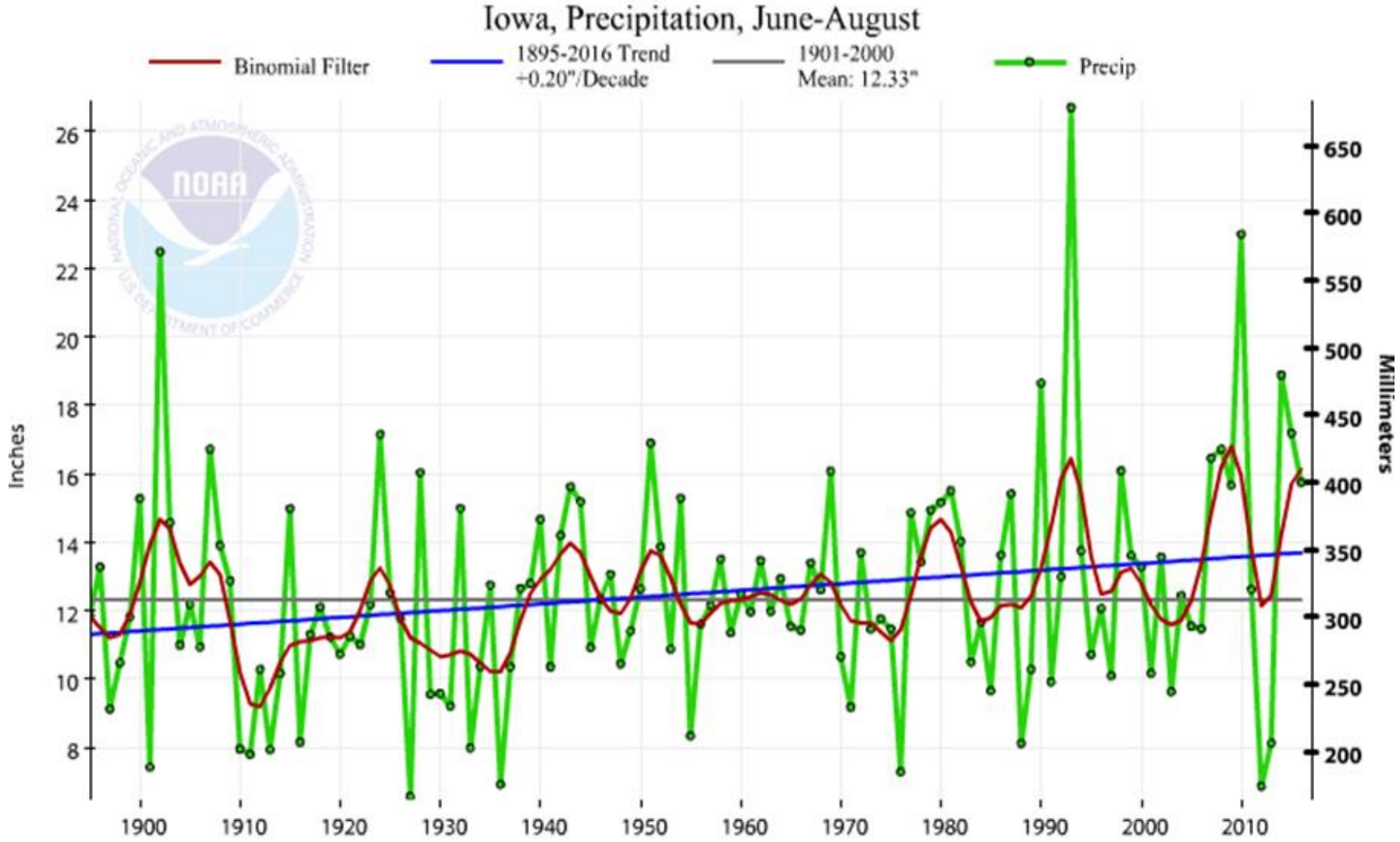


Projected Change in Total Annual Precipitation Falling in the Heaviest 1% of Events by Late 21st Century



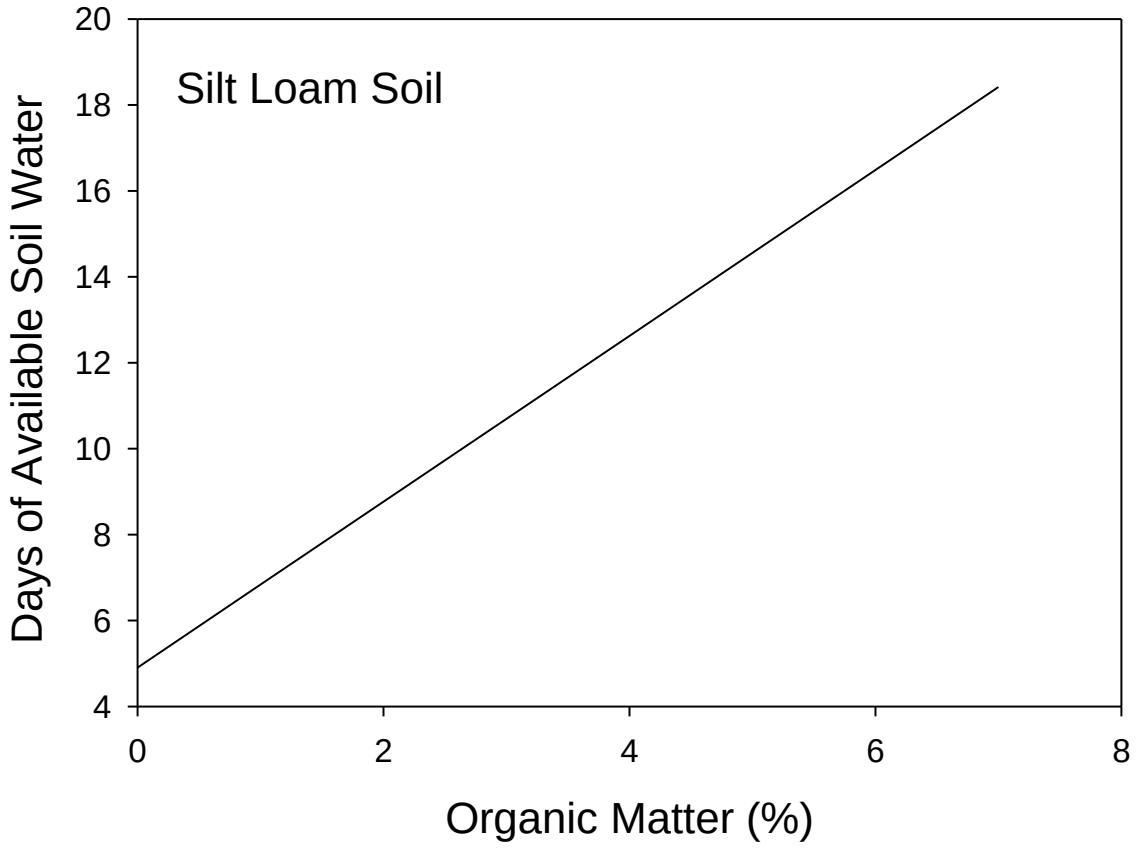
https://nca2018.globalchange.gov/

Summer Precip. data - Iowa

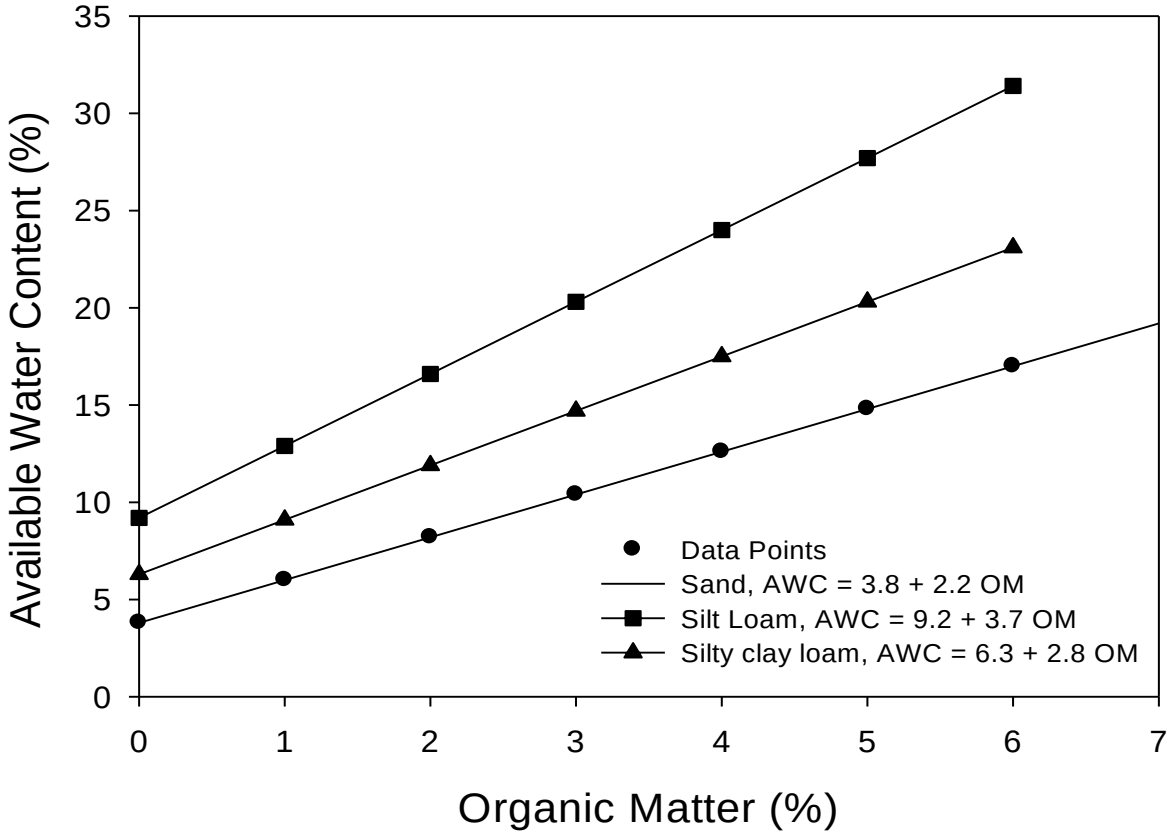


https://www.ncdc.noaa.gov/cag

Soil Water Reserves for Crops



Assuming an average rate of crop water use during the grain-filling period for corn Hudson, 1994

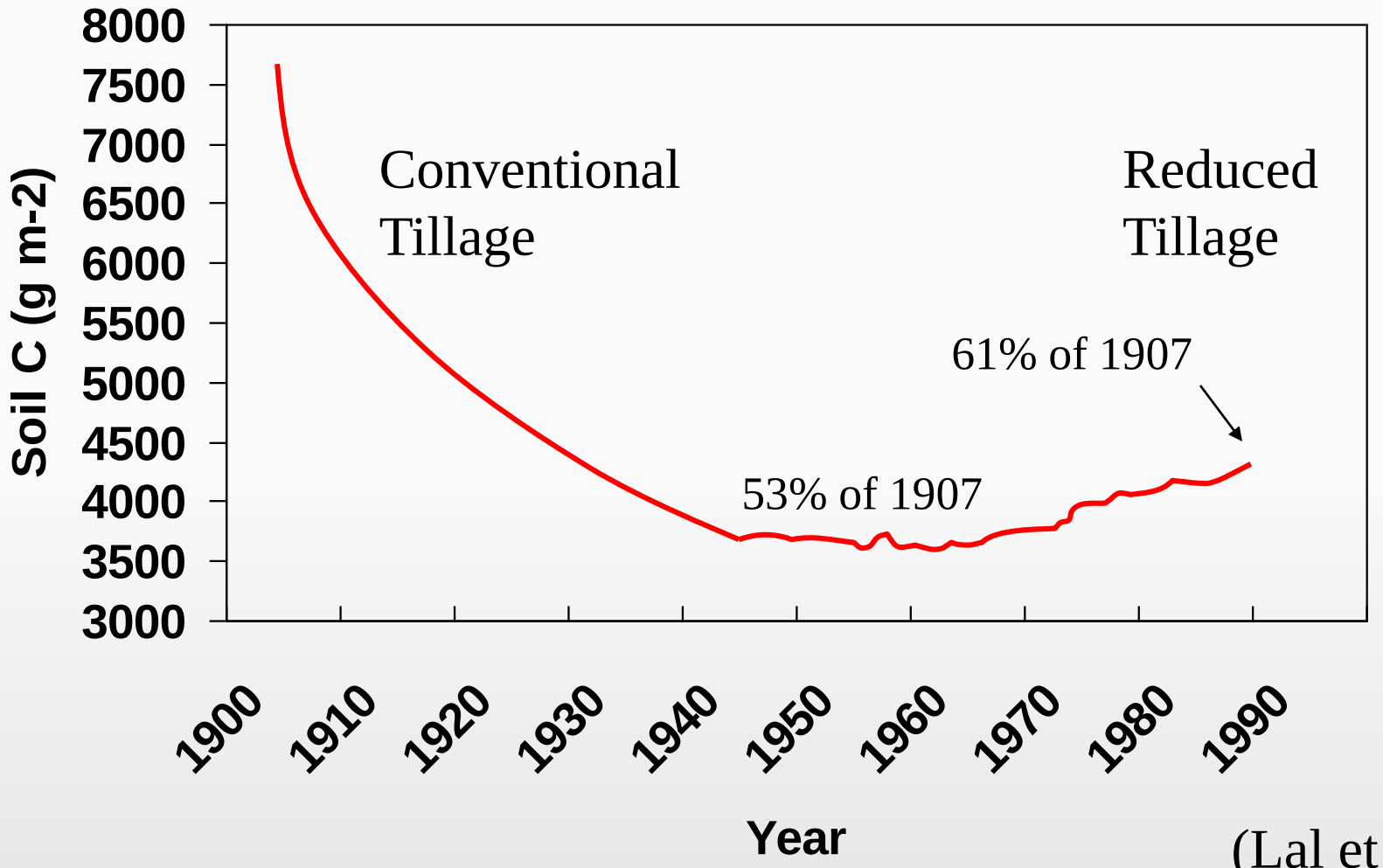


Crop System considerations resulting from intensified and varied precipitation events

- Precipitation variability:
  - ✓ Spatially (locality)
  - ✓ Temporally > precip intensity outside of growing season
  - ✓ More weather events resulting in excessive soil loss
- Increased nutrient loss likelihood
  - ✓ Leaching
  - ✓ Runoff
  - ✓ Surface Manure applications moving offsite
  - ✓ Atmospheric releases (denitrification)

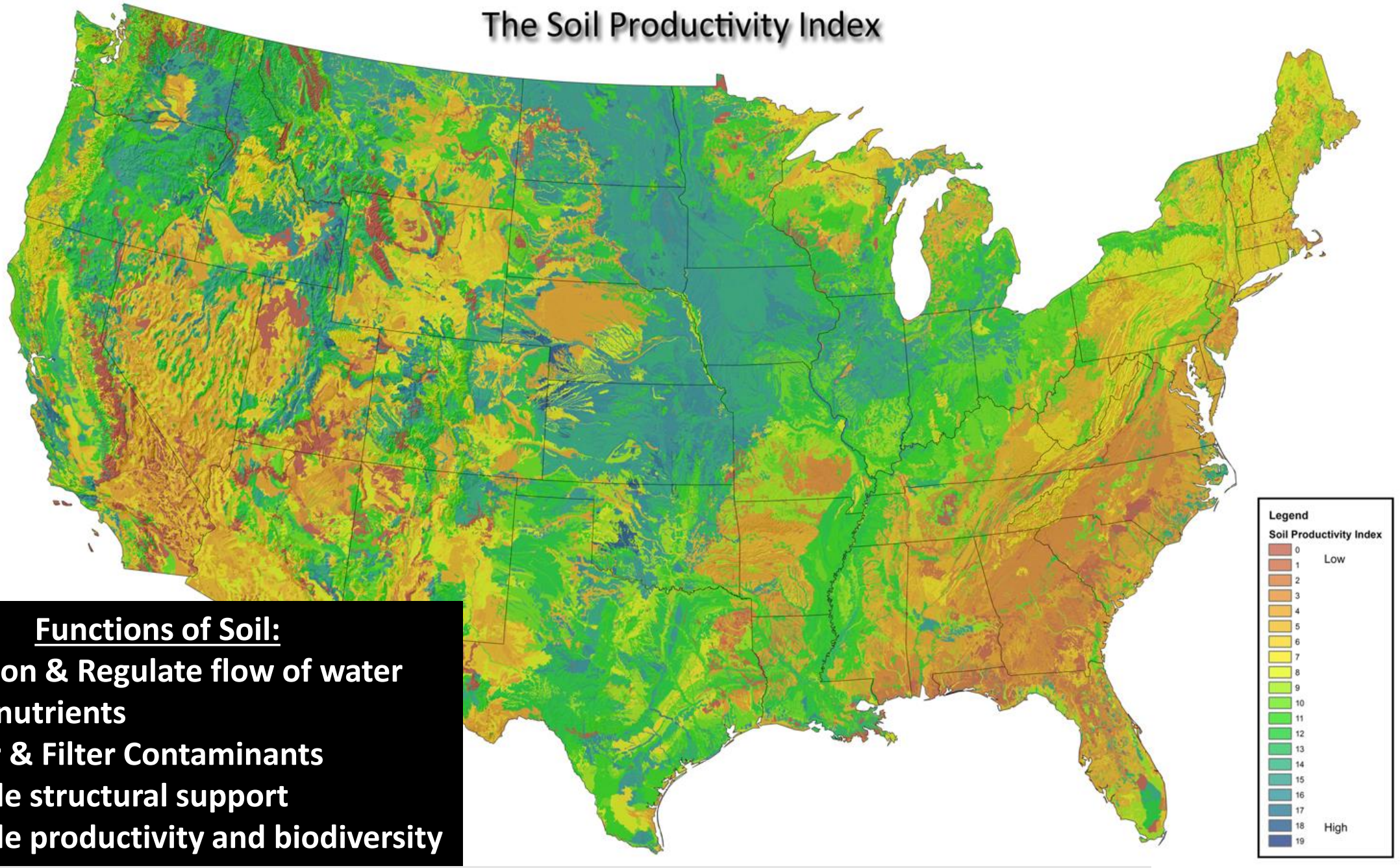
- Crop protection chemicals:
  - ✓ Efficacy adjustments
  - ✓ Movement of agrochemicals
  - ✓ Offsite impacts
- Increased need for drainage (surface and subsurface)
- Field days reduced:
  - ✓ Field pre-plant preparations
  - ✓ Planting
  - ✓ Crop nutrient applications
  - ✓ Crop protection chemical applications
  - ✓ Harvest
  - ✓ Cover crop planting

Average Loss of Soil Carbon in Corn Belt (mollisol)



(Lal et al., 1998)

The Soil Productivity Index

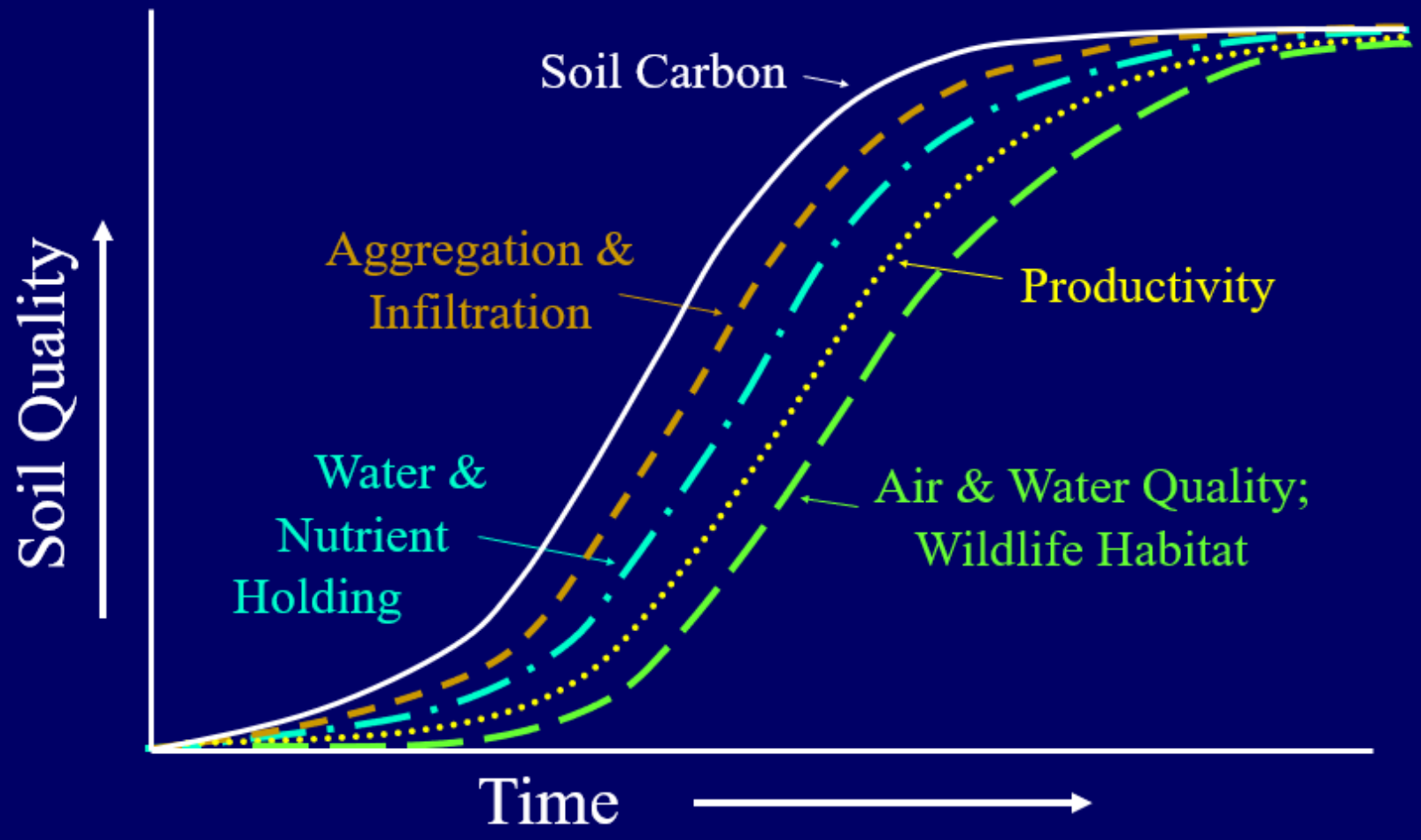


Functions of Soil:

- ✓ Partition & Regulate flow of water
- ✓ Cycle nutrients
- ✓ Buffer & Filter Contaminants
- ✓ Provide structural support
- ✓ Provide productivity and biodiversity

Map by Bradley Miller (bamiller@msu.edu),
Michigan State University, Department of Geography, 2011.

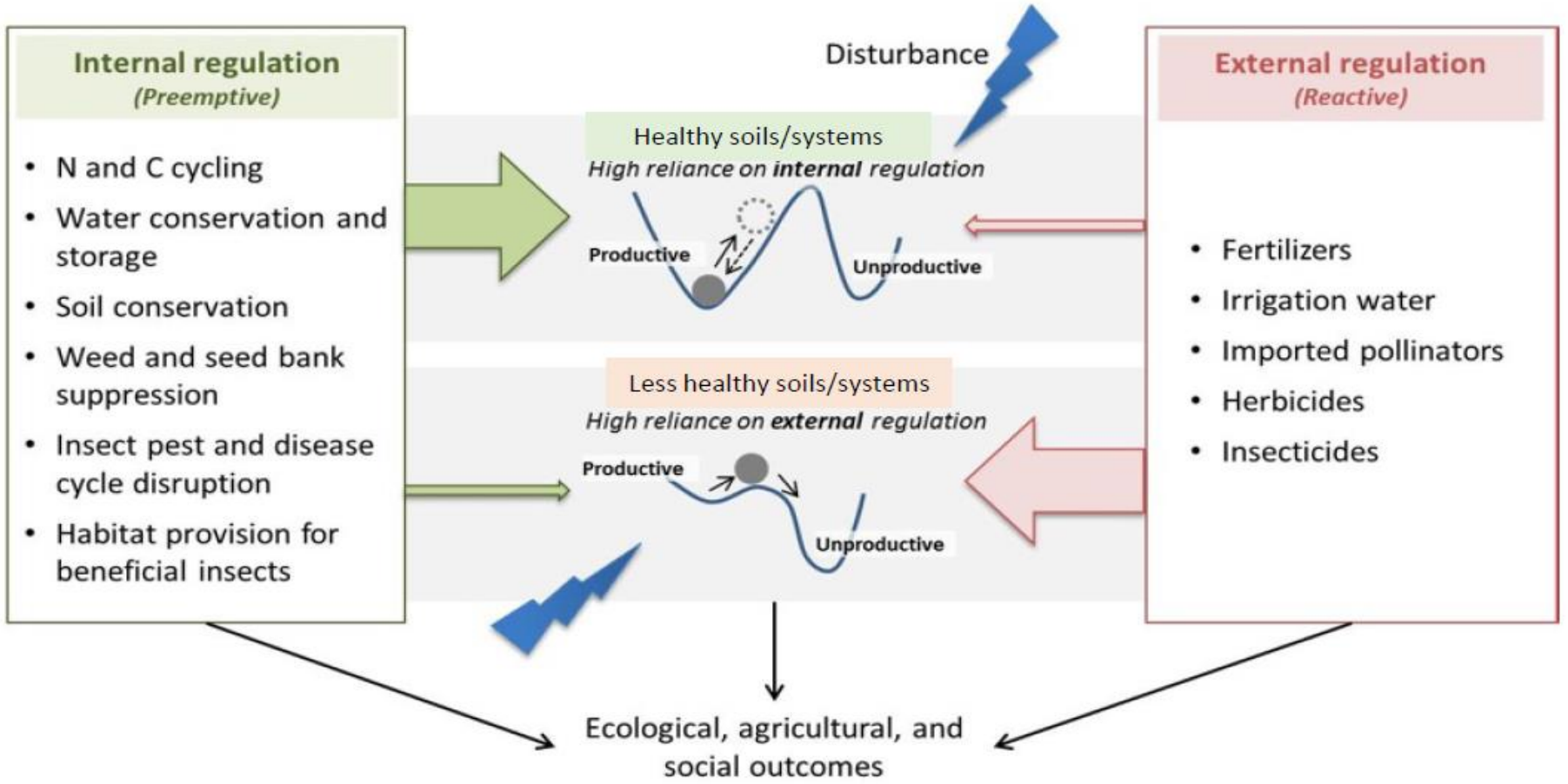
Benefits of Soil Carbon



Healthy soils have a major role to play

helping boost the internal regulatory mechanisms of a system

Why should farmers and conservationists be concerned with re-carbonizing annual row crop lands?



Peterson et al_2019_Agricultural systems

Soil Conditioning Index (SCI) formula is:

(OM x 0.4) + (FO x 0.4) + (ER x 0.2) =SCI

- **OM accounts for organic material returned to and grown by the soil**
- **FO represents field operation effects**
- **ER is the sorting and removal of surface soil material by sheet, rill and/or wind erosion**

Rotation Soil Conditioning Index (SCI):	1.1
SCI Organic Matter (OM) Factor:	1.7
SCI Field Operation (FO) Factor:	0.9
SCI Erosion (ER) Factor:	0.7

Soil Conditioning Index (SCI)

Organic Matter:

Biomass and residue additions:

- ✓ Plant roots
- ✓ Crop residue
- ✓ Manure
- ✓ Mulch

Biomass and residue removals:

- ✓ Grain removal
- ✓ Silage production
- ✓ Baling
- ✓ Grazing
- ✓ Burning

Field Operations:

- ✓ Ground / Arial
- ✓ Inversion tillage
- ✓ Horizontal tillage
- ✓ Vertical tillage
- ✓ Planting operations
- ✓ Nutrient applications
- ✓ Row cultivations
- ✓ Land leveling
- ✓ Etc…

Water-induced erosion:

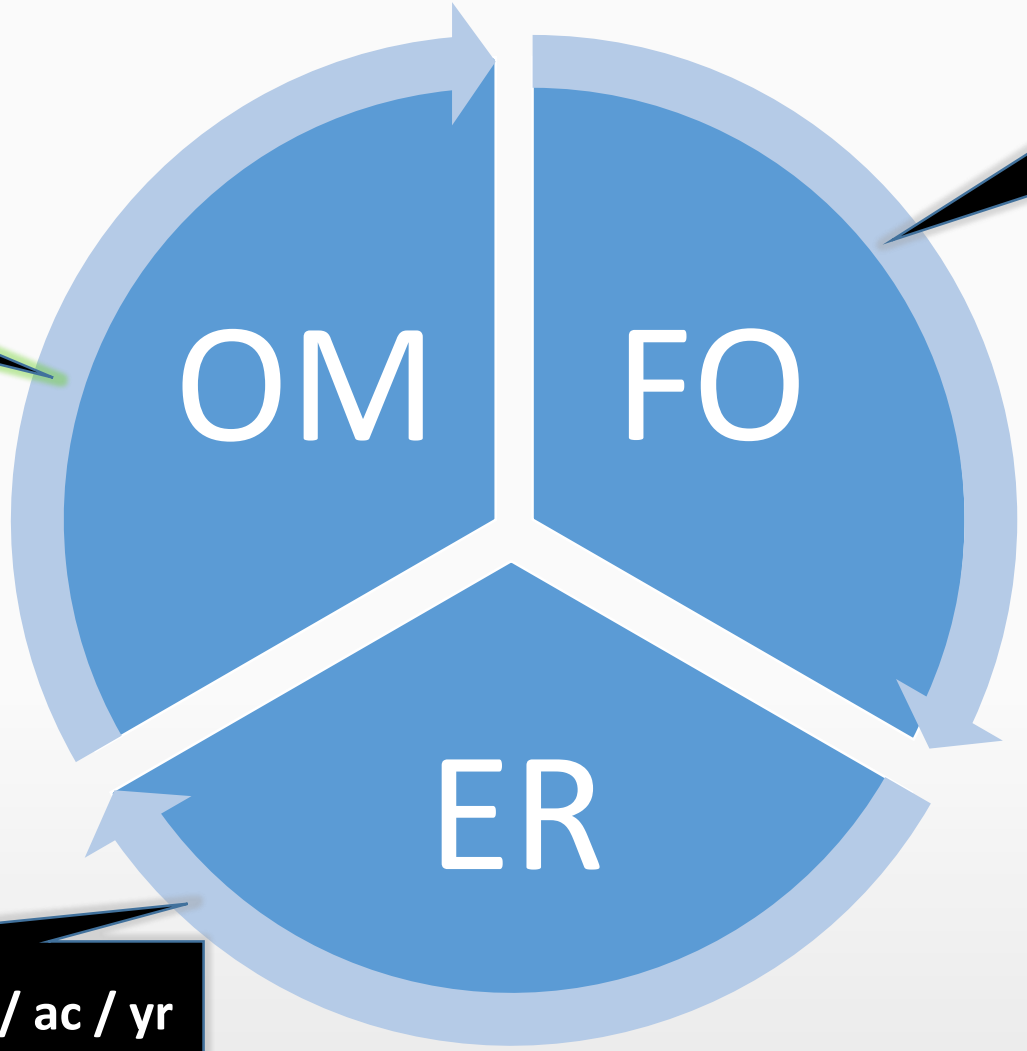
- ✓ Sheet erosion
- ✓ Rill erosion

Wind-induced erosion:

- ✓ Saltation
- ✓ Creep
- ✓ Suspension

* Monitor fields for Ephemeral and Gully Erosion.

Soil Conditioning Index (SCI) – crop management goals



Continuous Living Root

- **Nutrient placement**
- **Emergency tillage**

Total combined erosion ≤ 1 ton / ac / yr

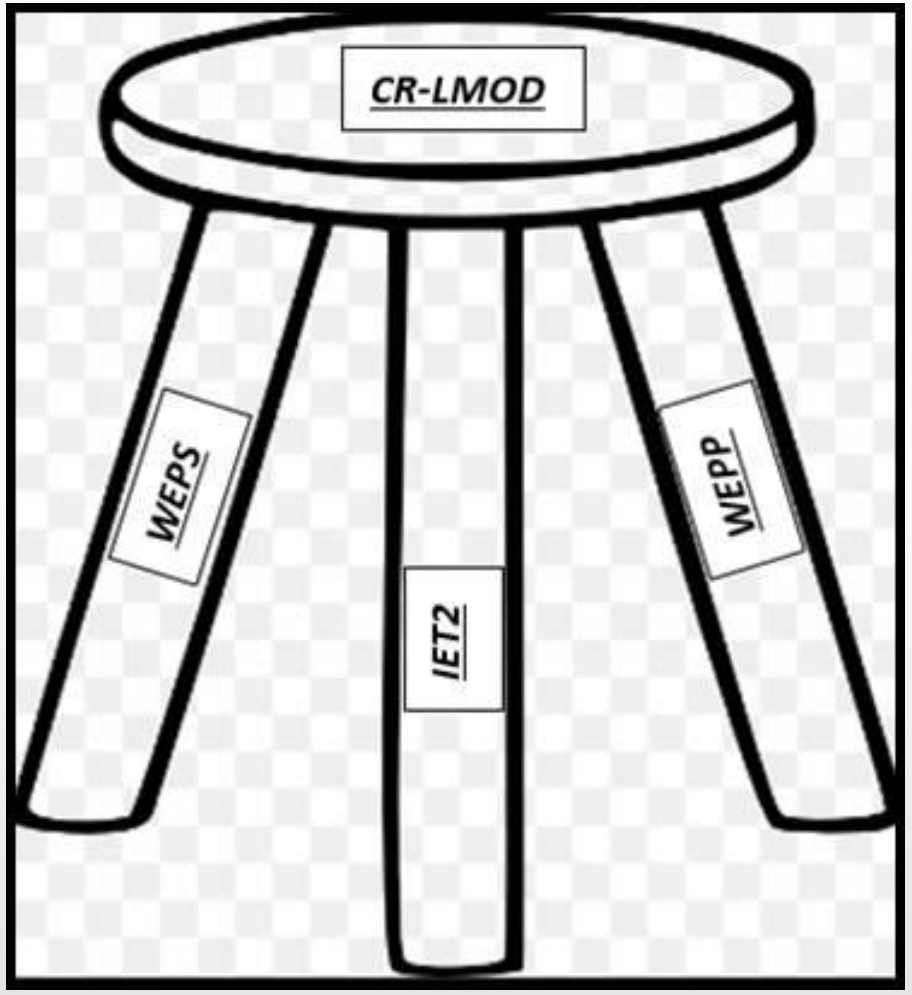
Integrated Erosion Tool (IET)

IET is a digital map-based interface designed to supply site specific and crop management data to current NRCS crop system models.

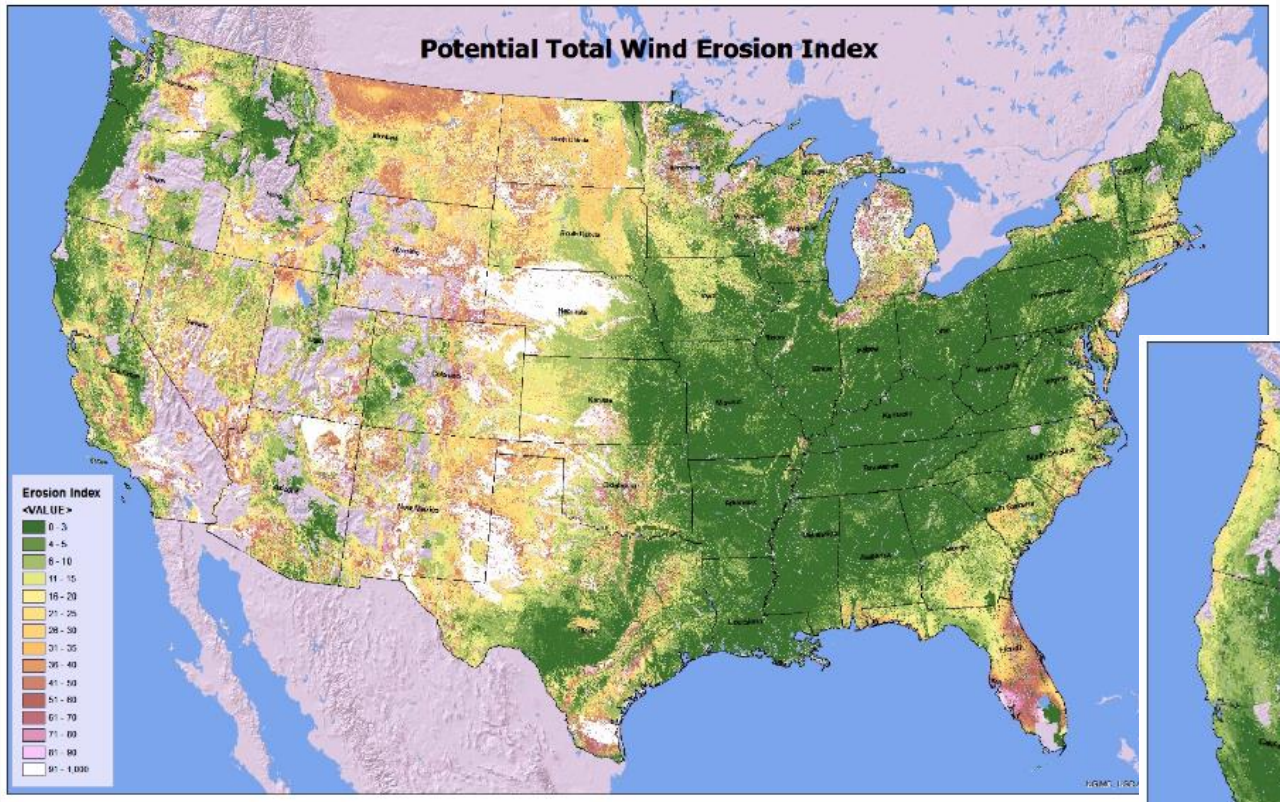
WEPP = **W**ater **E**rosion **P**rediction **P**roject

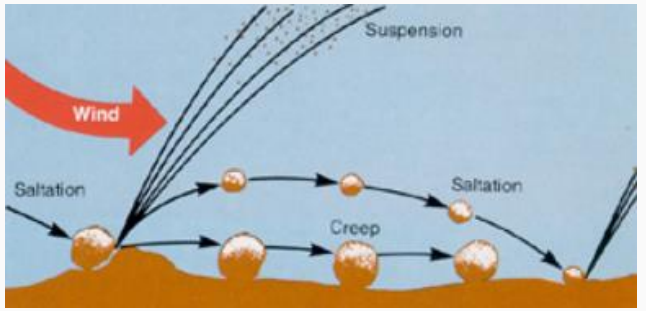
WEPS = **W**ind **E**rosion **P**rediction **S**ystem

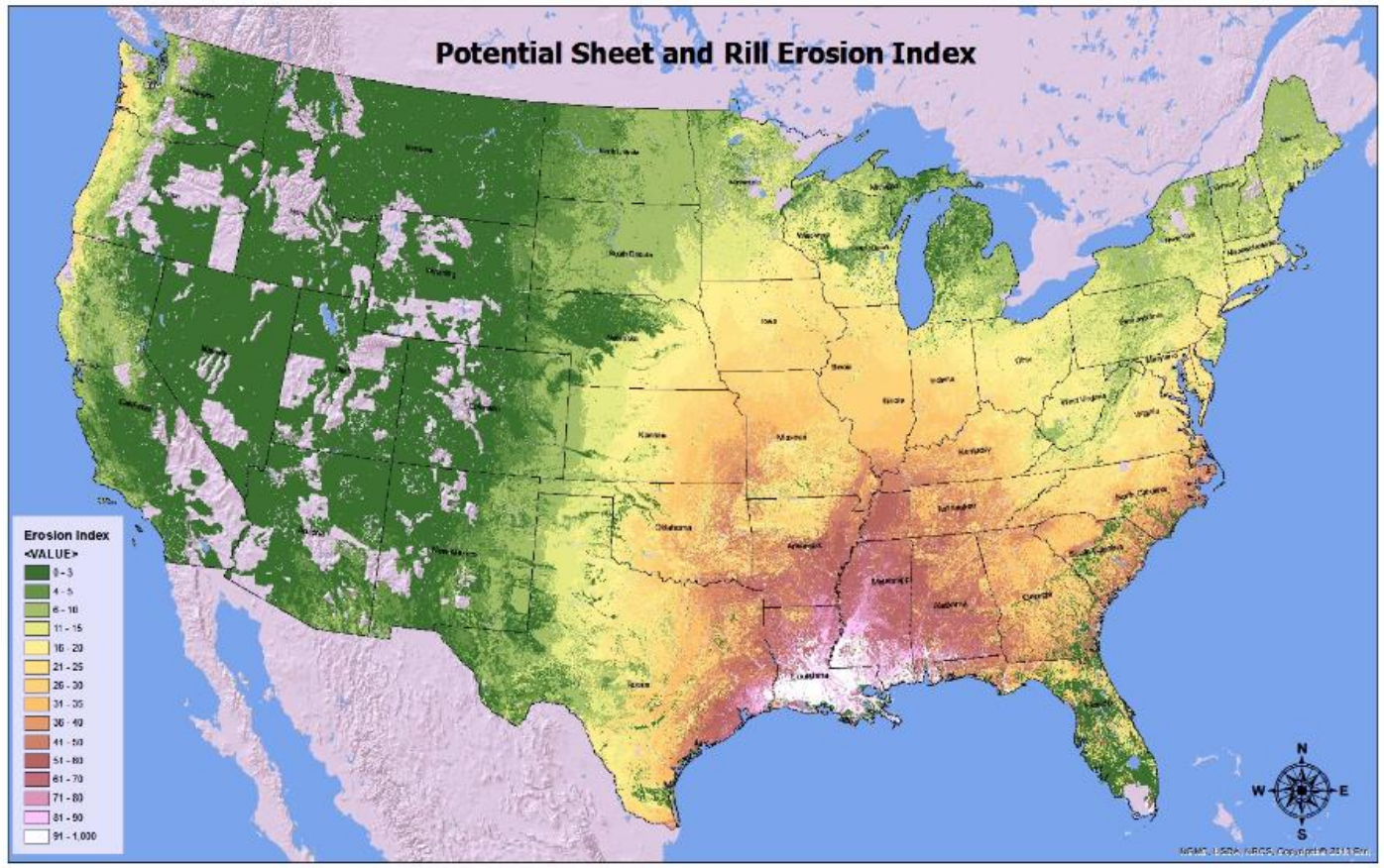
CR LMOD = **C**onservation **R**esources **L**and **M**anagement **O**perations **D**atabase

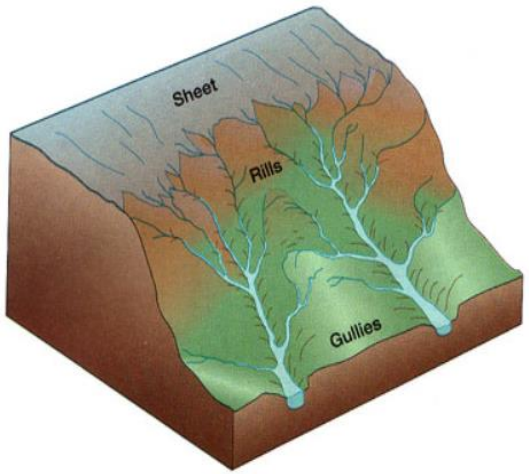


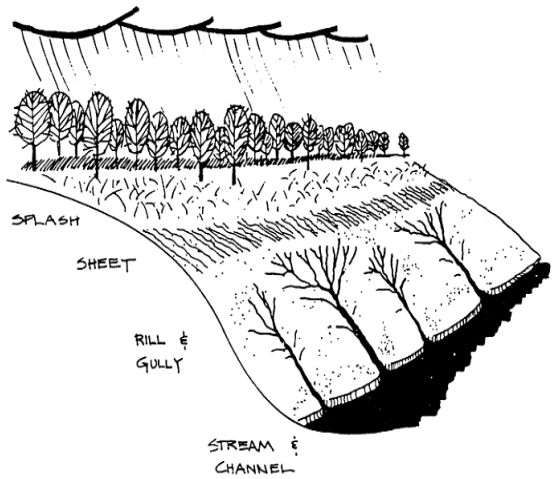
IET models both **Wind** and **Water** induced erosion











1:12,000,000

IET directly assesses seven NRCS resource concerns:

- ✓ Water-induced Erosion – *sheet & rill*
- ✓ Wind-induced Erosion – *saltation, suspension and creep*
- ✓ Soil Quality – *organic matter depletion*
- ✓ Water Quality & Quantity – *sediment delivery, runoff, evaporation, transpiration*
- ✓ Energy – *field operations*
- ✓ Air Quality – *particulate matter, objectionable odors, greenhouse gas precursors*
- ✓ Wildlife - Habitat – *surface residue, stem height, living root mass*

Integrated Erosion Tool (IET)

◯ **Anyone is able to engage IET.**

- Important to understand applied Agronomy and properties of the natural resource base supporting the farmer.

◯ **Numerous USDA Partners have deployed software using NRCS soils, crops, field operations and climate data to model cropping systems.**

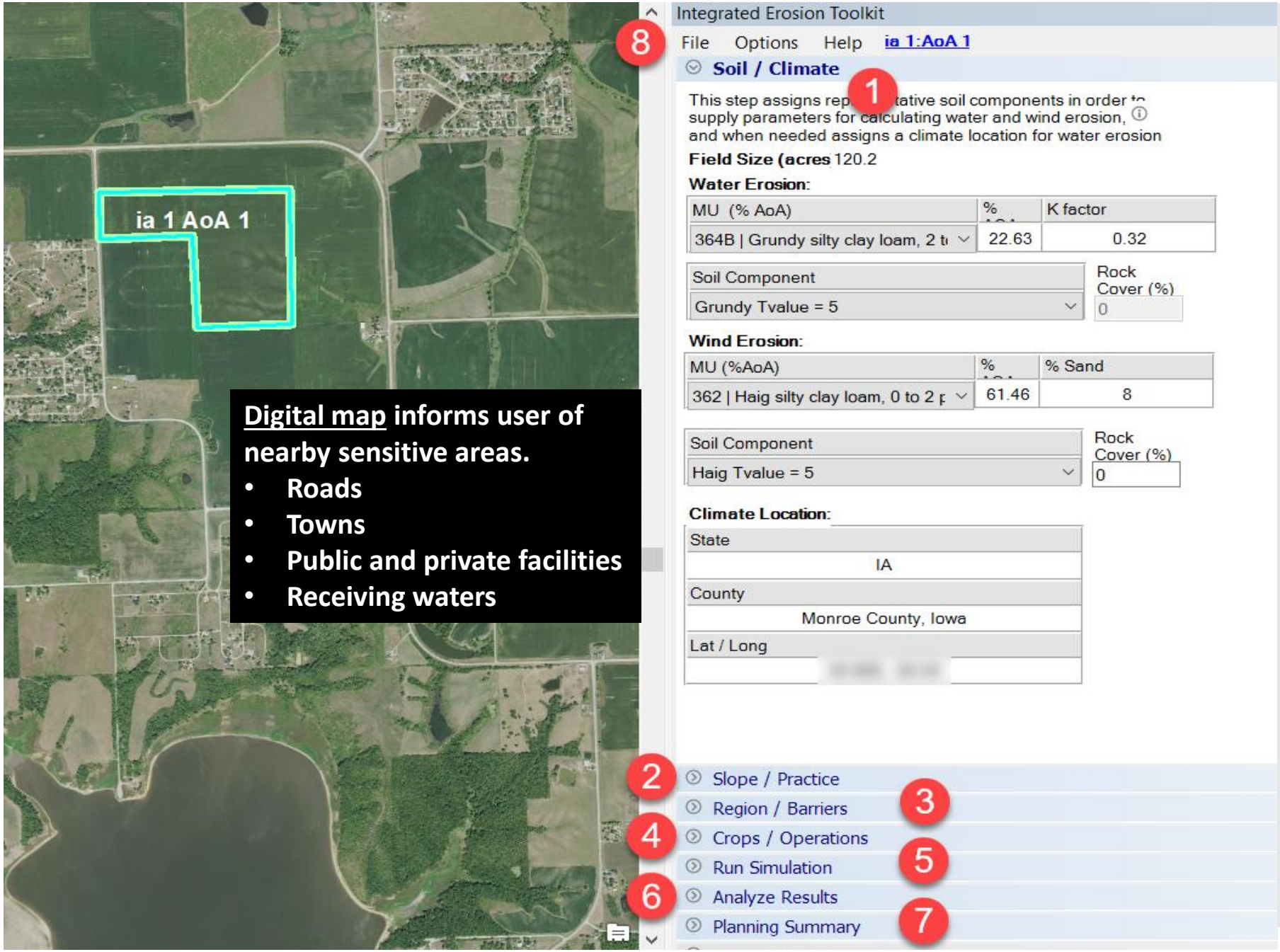
Purposes of IET:

Identify site factors:

- Soil
- Slope steepness
- Slope length
- Aspect
- Field shape and orientation (wind erosion)
- Barriers (wind erosion)

Document crop system management:

- Sequence and timing of field operations
- Residue additions
- Yield of crops grown
- Alternative System formulation and evaluation in order to infuse economic and operational considerations for the farmer.
- Planned system identified for famer



IET Workflow:

Area of Analysis has been identified on digital map.

Name the IET project then,

1. Identify soil
2. Set slope length and slope steepness.
3. Select field shape and set orientation.
4. Define timing of field operations and set crop yields.
5. Run model simulations.
6. Analyze graphs,
7. Generate planning summary
8. Create IET Report.

Crop System Conversation

Engage Farmer with IET outputs to demonstrate crop system and soil benefits of strongly positive SCI values.

Date	Interval End	Operation	Crop	Residue	Residue (lb/ac)	Yield	Yield Unit	Row / Ridge Dir
05-10-20	☐	Sprayer, pre-emergence		weed residue; 0-3 mo	50			0
05-12-20	☐	Drill or air seeder, double disk	Soybean, grain			70	bu/ac	0
06-07-20	☐	Sprayer, post emergence		weed residue; 0-3 mo	50			0
08-01-20	☐	Sprayer, post emerge, insecticide						0
10-15-20	☐	Harvest, killing crop 20pct standir						0
10-16-20	☐	Fert applic. surface broadcast						0
10-17-20	☑	Drill or air seeder, double disk	Cover crop, mix, cool season, wint				lbs/ac	0
05-01-21	☐	Sprayer, pre-emergence						0
05-01-21	☐	Planter, double disk opnr w fluted	Corn, grain, seed					
06-02-21	☐	Fert. applic. anhyd knife 30 inch s						0
06-07-21	☐	Sprayer, post emergence		weed residue; 0-3 mo				0
10-10-21	☐	Harvest, killing crop 20pct standir						
10-11-21	☐	Fert applic. surface broadcast						
10-12-21	☑	Drill or air seeder, double disk	Cover crop, mix, cool season, wint					
05-01-22	☐	Sprayer, post emergence, fertilize						
05-05-22	☐	Planter, double disk opnr w fluted	Corn, grain, seed					
06-02-22	☐	Fert applic. side-dress, liquid						
06-07-22	☐	Sprayer, post emergence						
10-10-22	☐	Harvest, killing crop 20pct standir						0
10-11-22	☐	Fert applic. surface broadcast						0
10-12-22	☑	Drill or air seeder, double disk	Cover crop, mix, cool season, wint			3890	lbs/ac	0

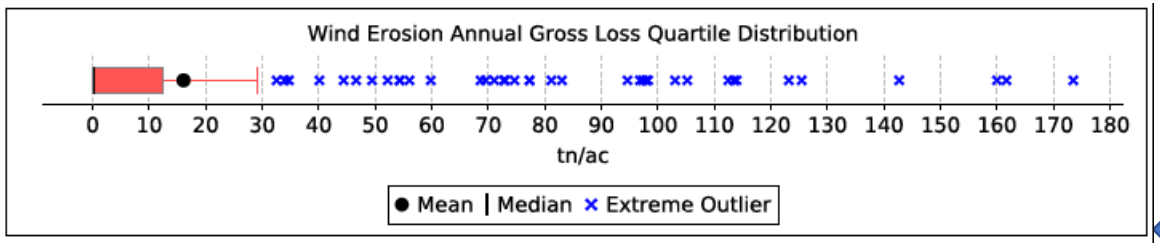
Crop System Management Editor.
Ability to model over 100 crops.

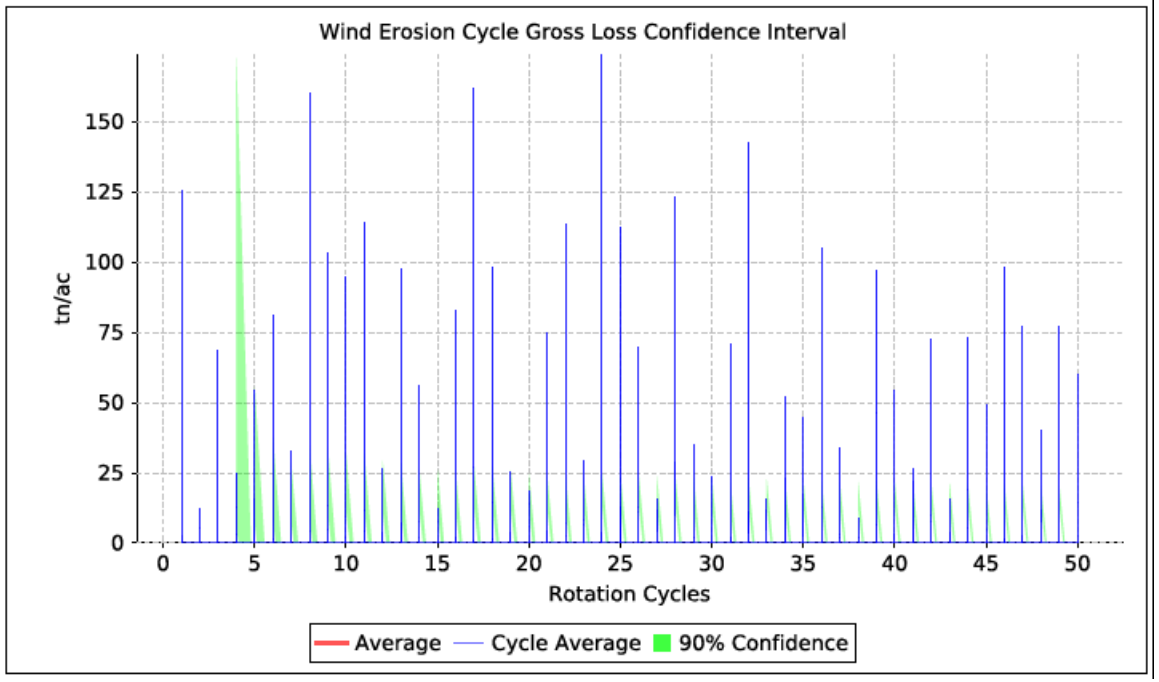
Crop Year STIR Information

Number	Crop Name	STIR	Start Date	End Date
1	Corn, grain, seed	128	5/26/2018	10/20/2020
2	Soybean, grain	7	10/21/2020	10/10/2021
3	Wheat, winter, grain	46	10/11/2021	7/1/2022
4	Alfalfa, hay	117	7/2/2022	5/25/2023

Annual Segment Statistics for 100 years

Segment	Model Output	Mean	Median	Standard Deviation	Coef. Of Variation	Min	Max
Hillslope	Precipitation	41	41	6.4	0.2	27	63
Hillslope	Soil Loss	9.5	8.3	6.8	0.7	0.05	42
Hillslope	Sediment delivery	1.4	1.2	1	0.7	0.007	6.3
1	Irrigation	0	0	0	0	0	0
1	Runoff	7.5	7.1	3.4	0.5	1.2	20
1	Plant Transpiration	17	17	3.7	0.2	11	23
1	Soil Evaporation	13	13	2	0.1	8.3	18

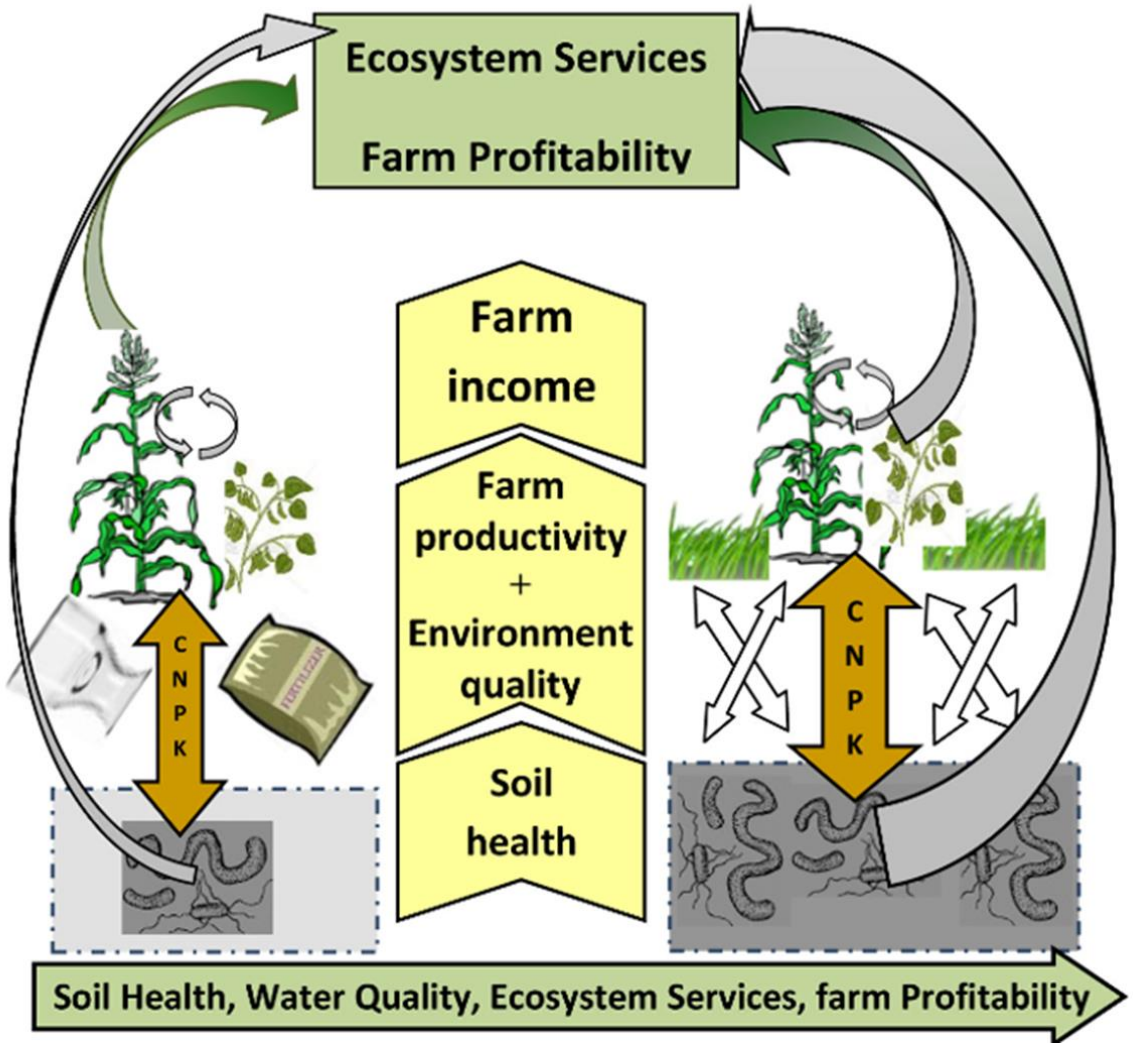




IET Outputs

Rotation Soil Conditioning Index (SCI):	1.1
SCI Organic Matter (OM) Factor:	1.7
SCI Field Operation (FO) Factor:	0.9
SCI Erosion (ER) Factor:	0.7

Annual Soil Tillage Intensity Rating (STIR):	11	
Air Particulates (PM10):	0	ton / ac / yr
Average Annual Fuel Use:	4	gal / ac / yr



Primary takeaways for IET and SCI:

✓ Digitally document row crop systems for a defined location(s).

✓ SCI is a foundational soil health metric:

- Lower STIR = > SCI = more soil carbon > farm profit potential.
- Lower total erosion > SCI = better field conditions more often.
- More OM additions results in an improving SCI trend.
- Providing living roots throughout the entire year undoubtedly results in a strongly positive trend for soil carbon

✓ IET model results are field specific and affected by interrelationships between multiple variables.

✓ At this time, IET is <u>unable</u> to account for ephemeral and gully erosion – inspect fields to understand land condition.

Economic incentives and financial resiliency benefits will encourage annual row crop farmers to prioritize and manage for increasing soil carbon.

Short term

Financial assistance provided by 2018 FarmBill programs such as:

- EQIP = Environmental Quality Incentives Program
- CSP = Conservation Stewardship Program
- RCPP = Regional Conservation Partnership Program

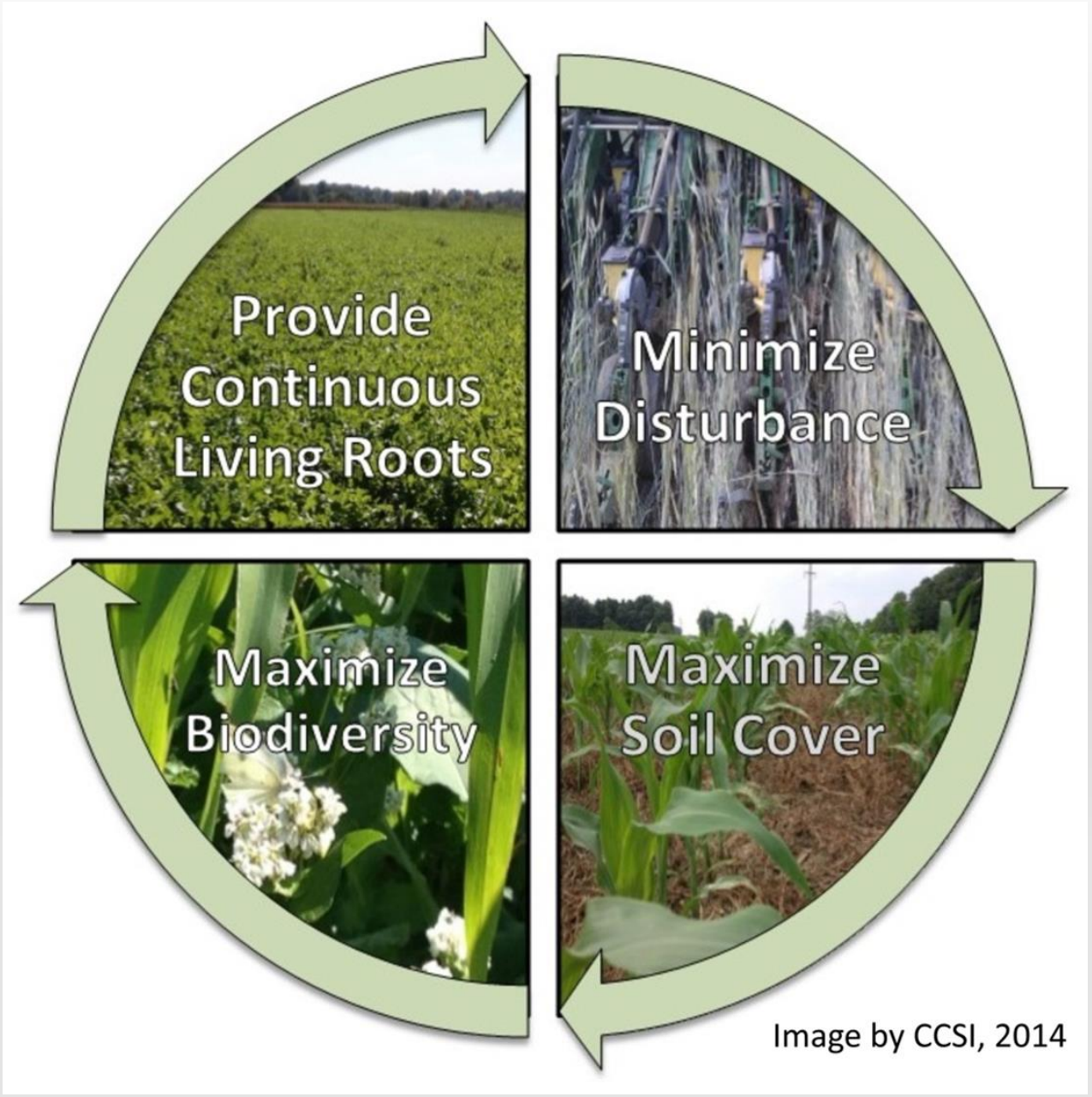
Long term

- ✓ Reduced crop yield variability
- ✓ Increases in plant available water
- ✓ Soil rewetting ability is magnified to capture more water during intense rainfall events
- ✓ Cleaner and fewer runoff events – healthy soil absorbs and cleans water
- ✓ Improved cycling of primary, secondary and micro nutrients
- ✓ More days open for ground engaging field activities
- ✓ Greater financial resiliency and profit stability
- ✓ Local Ag Retailer integrated into business model of increasing soil carbon at the farm field level
- ✓ Carbon Market(s), existing and emerging, participation more lucrative

Examples of NRCS Conservation Practices which can be densigned and implemented to increase soil carbon:

- ❑ 328 Conservation Corp Rotation
- ❑ 329 No Till / Strip Till / Direct Seed
  - requires < 20 annual **S**oil **T**illage **I**ntensity **R**ating {STIR}
  - Strip Till –area disturbed must be 1/3 or less of the planted crop row width
  - Full-width tillage prohibited
- ❑ 340 Cover Crop
- ❑ 345 Mulch / Reduced Till
  - ❑ allows full width tillage which leaves ample surface cover
  - ❑ excludes most heavy primary and some secondary tillage operations
  - ❑ inversion tillage operations are prohibited
- ❑ Nutrient Management (590), Pest Management (595) and Irrigation Water Management (449)

- ❑ Comments
- ❑ Observations
- ❑ Questions
- ❑ Suggestions



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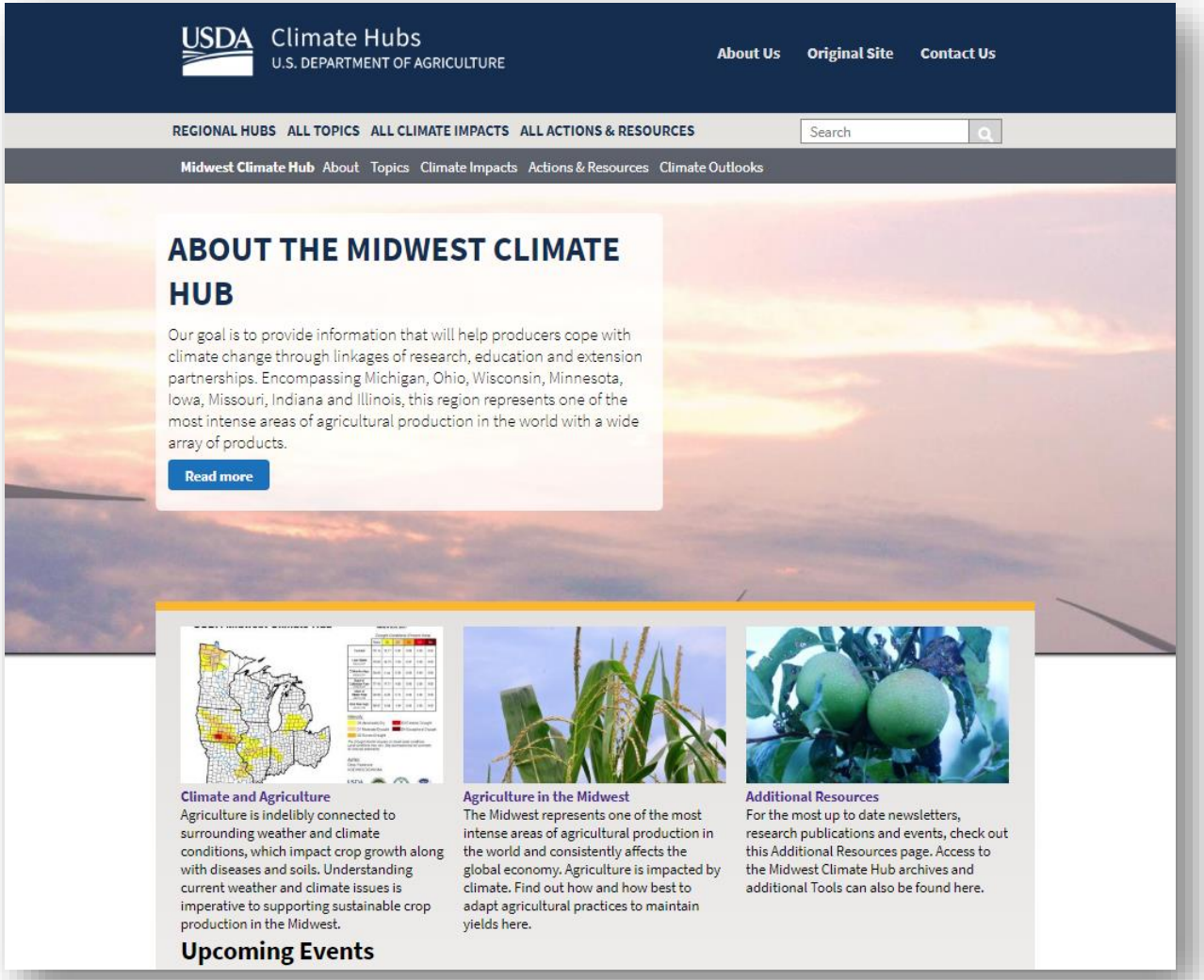

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