



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)

The screenshot shows the USDA Climate Hubs website. The header includes the USDA logo and 'Climate Hubs U.S. DEPARTMENT OF AGRICULTURE'. Navigation links include 'About Us', 'Original Site', and 'Contact Us'. A secondary navigation bar lists 'REGIONAL HUBS', 'ALL TOPICS', 'ALL CLIMATE IMPACTS', and 'ALL ACTIONS & RESOURCES', along with a search bar. Below this, a specific navigation bar for the 'Midwest Climate Hub' includes links for 'About', 'Topics', 'Climate Impacts', 'Actions & Resources', and 'Climate Outlooks'. The main content area features a large background image of a sunset over a field. A white box on the left contains the heading 'ABOUT THE MIDWEST CLIMATE HUB' and a paragraph of text: 'Our goal is to provide information that will help producers cope with climate change through linkages of research, education and extension partnerships. Encompassing Michigan, Ohio, Wisconsin, Minnesota, Iowa, Missouri, Indiana and Illinois, this region represents one of the most intense areas of agricultural production in the world with a wide array of products.' Below the text is a blue 'Read more' button. At the bottom, there are three columns of content: 'Climate and Agriculture' with a map of the Midwest, 'Agriculture in the Midwest' with a photo of corn, and 'Additional Resources' with a photo of green tomatoes.

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Midwest Climate Hub

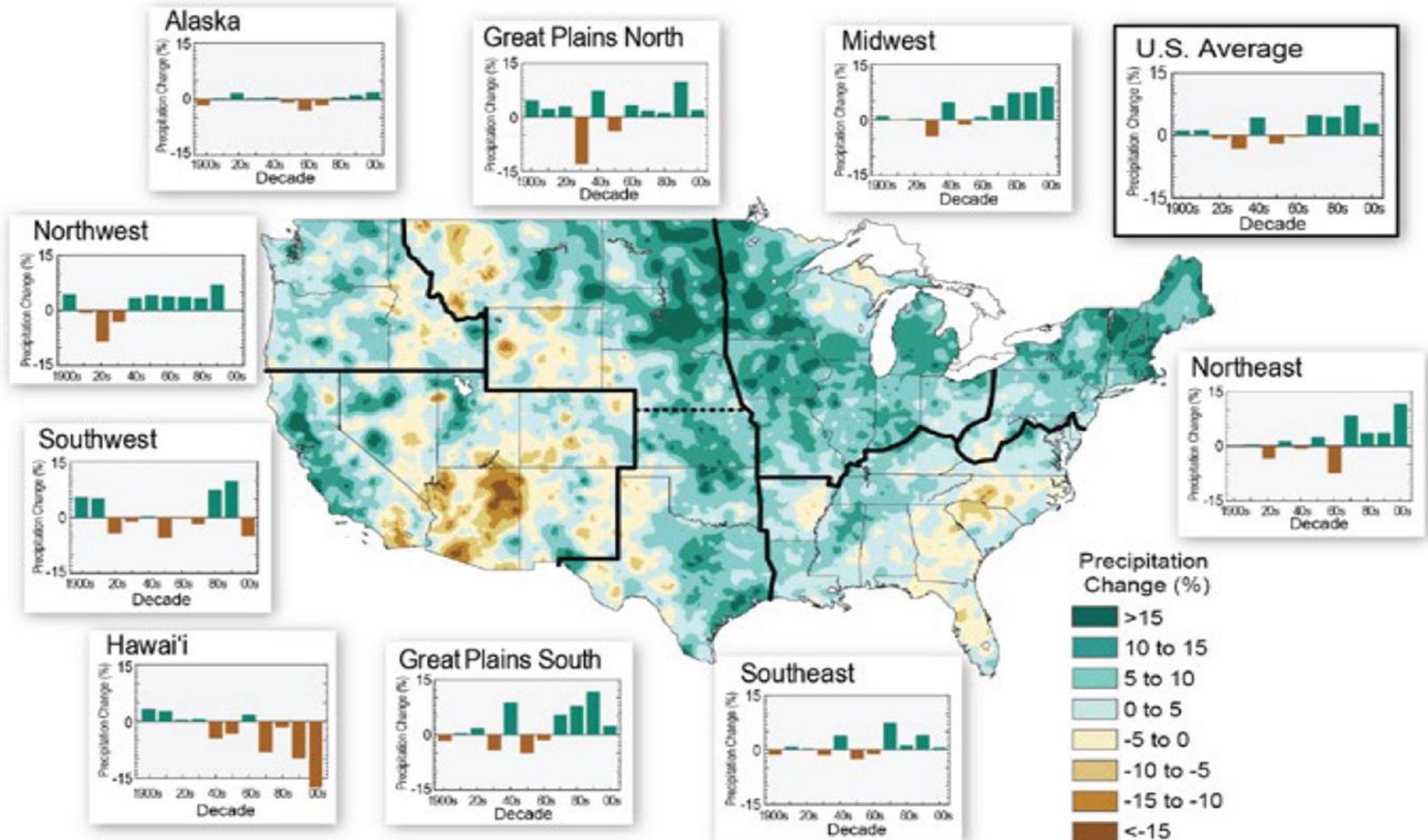


@USDAClimateHubs
@dennistodey

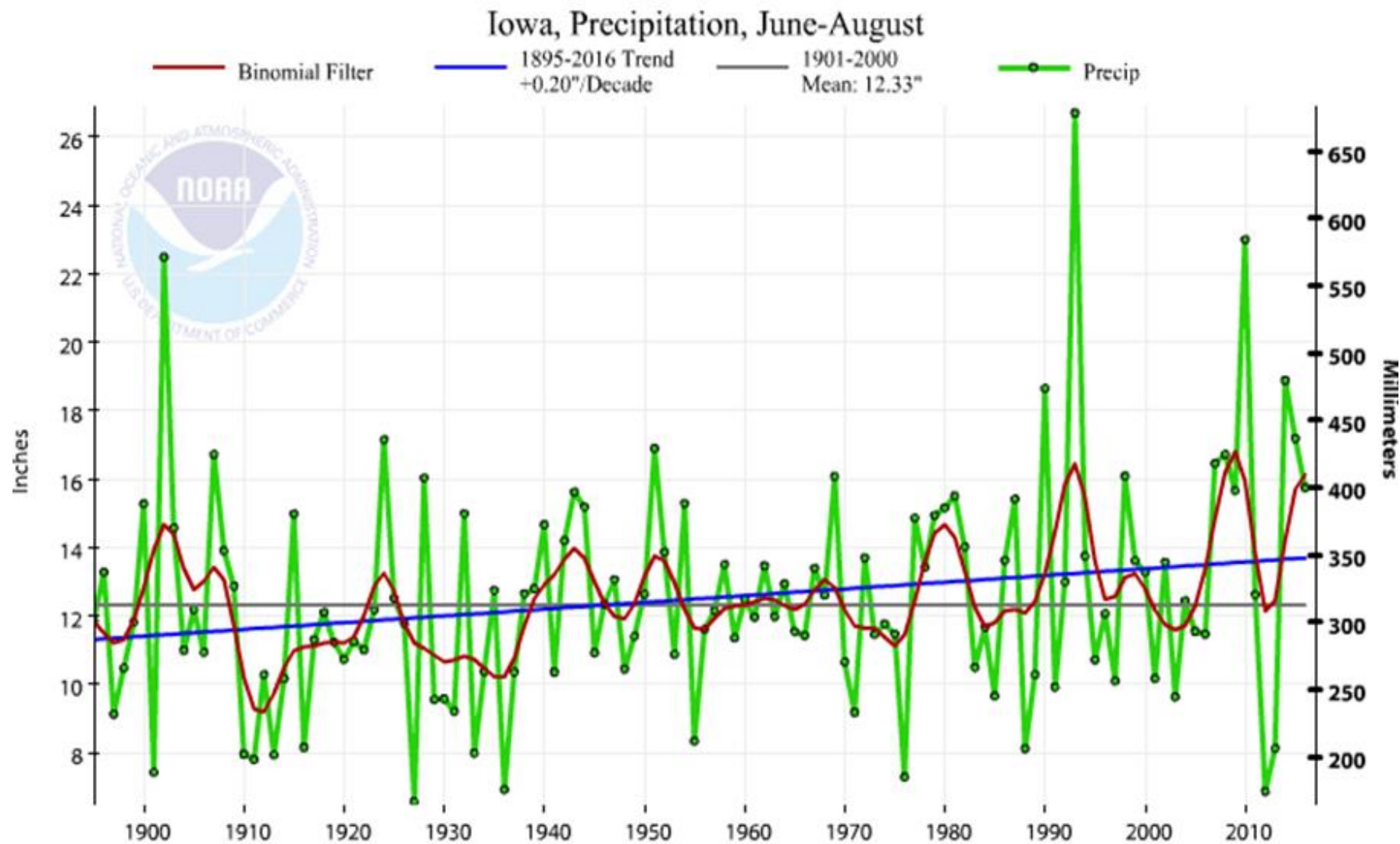


<https://www.climatehubs.ars.usda.gov/hubs/midwest>

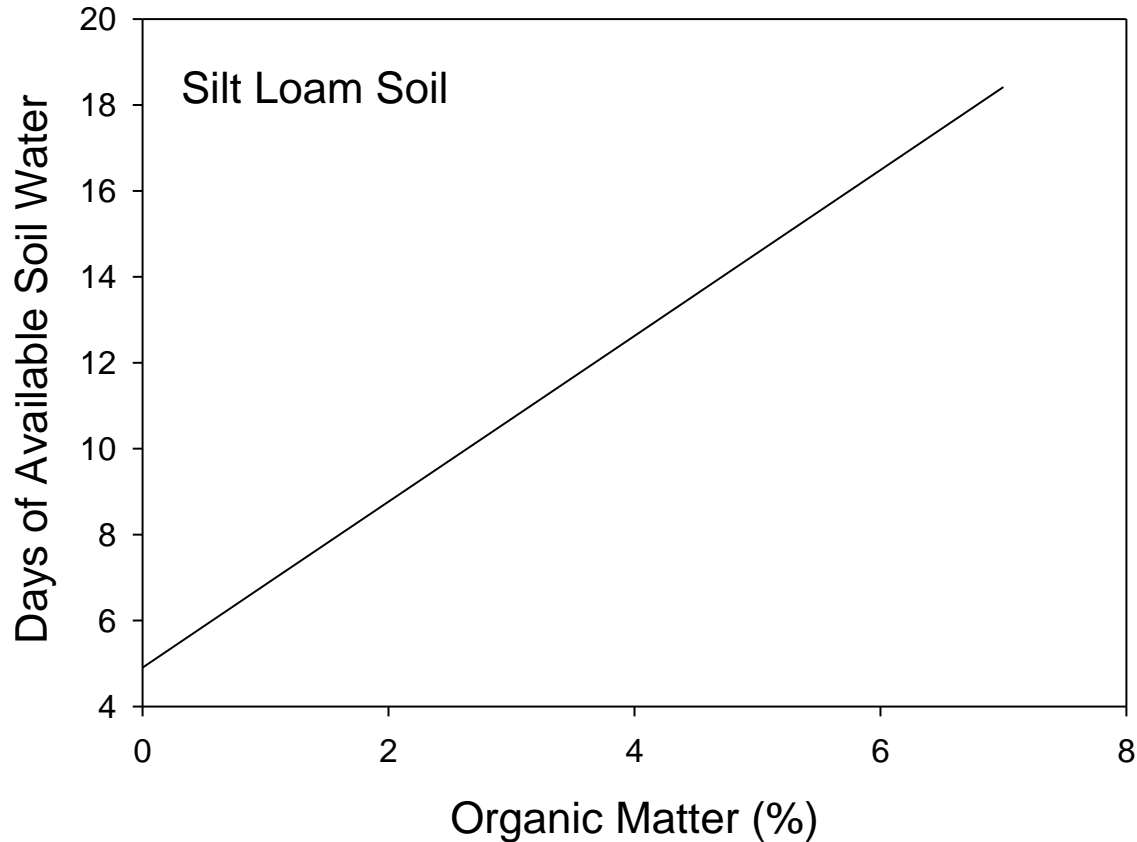
Observed U.S. Precipitation Change



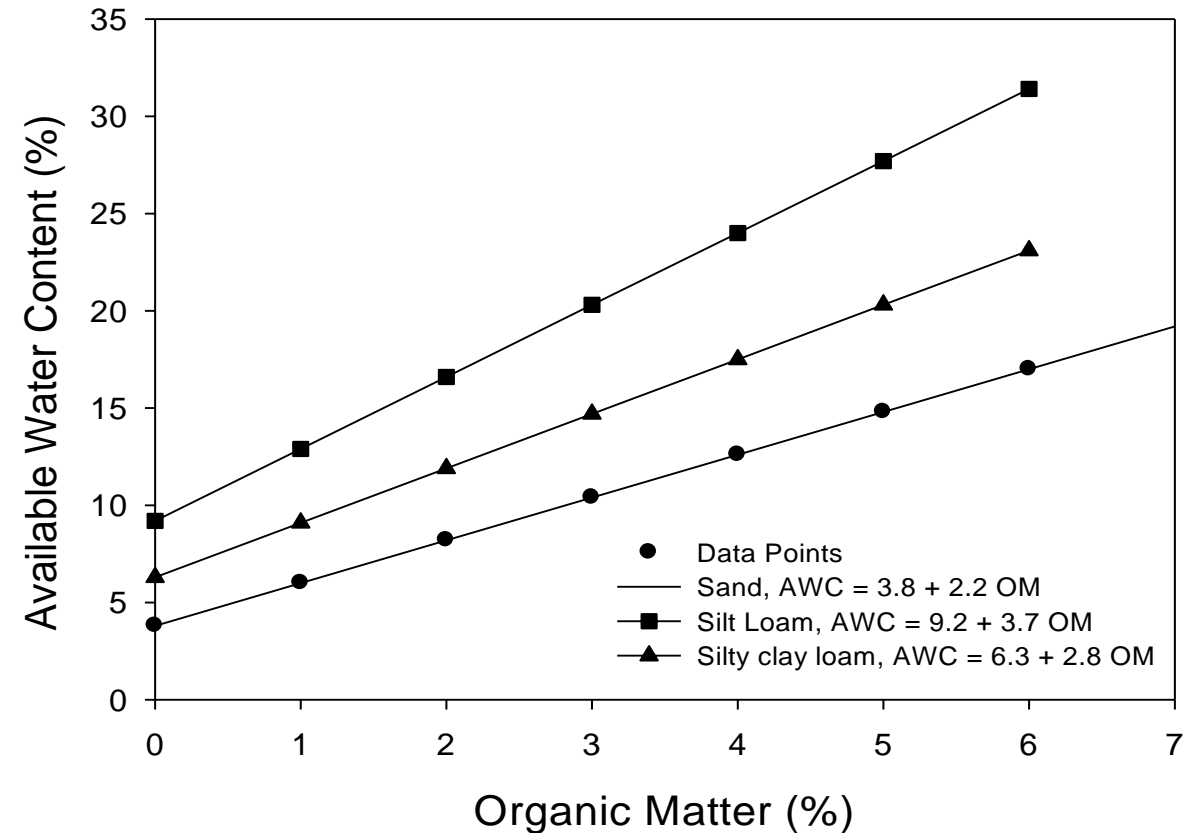
Summer
Precip. data -
Iowa



Soil Water Reserves for Crops



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

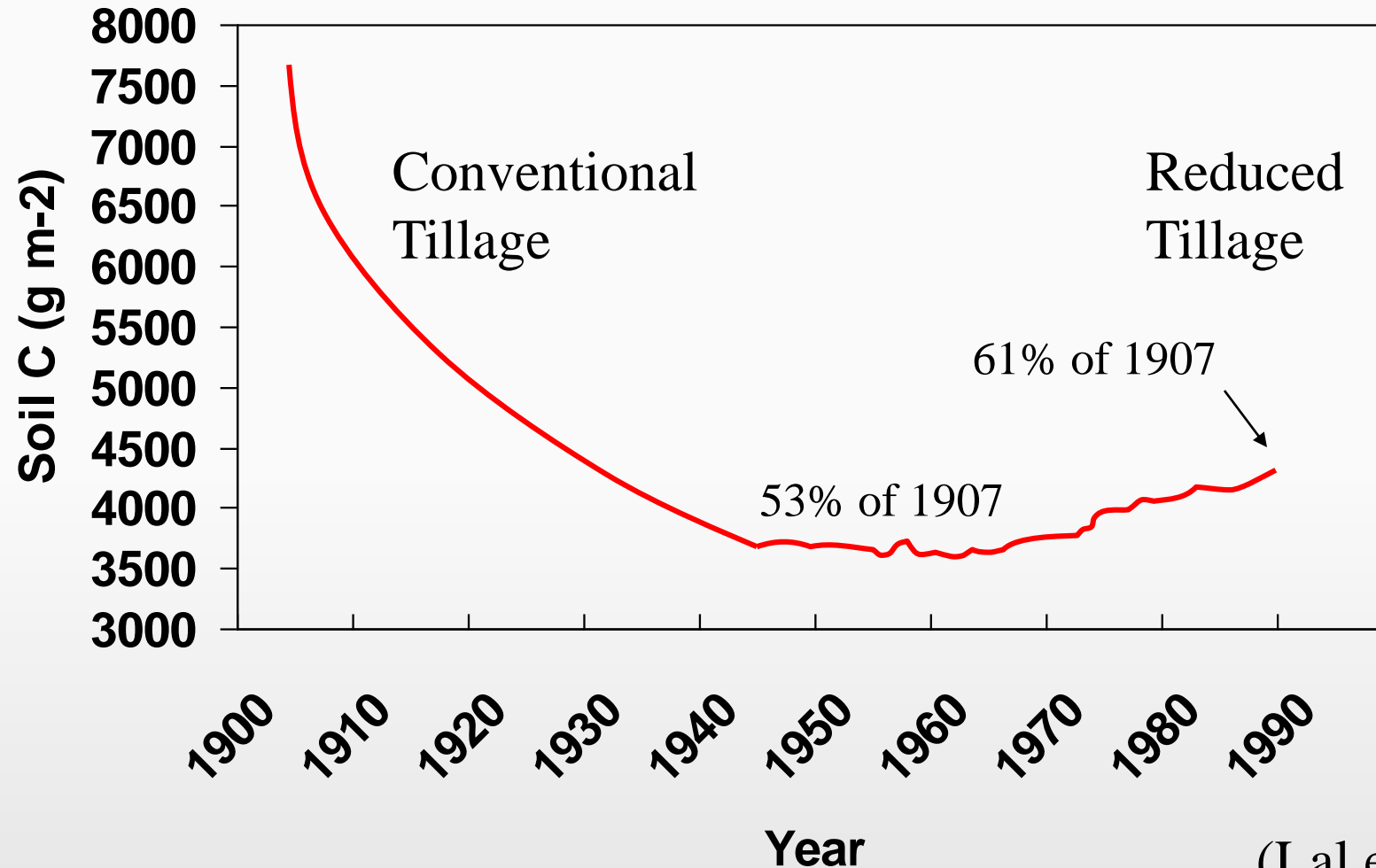




Crop System considerations resulting from intensified and varied precipitation events

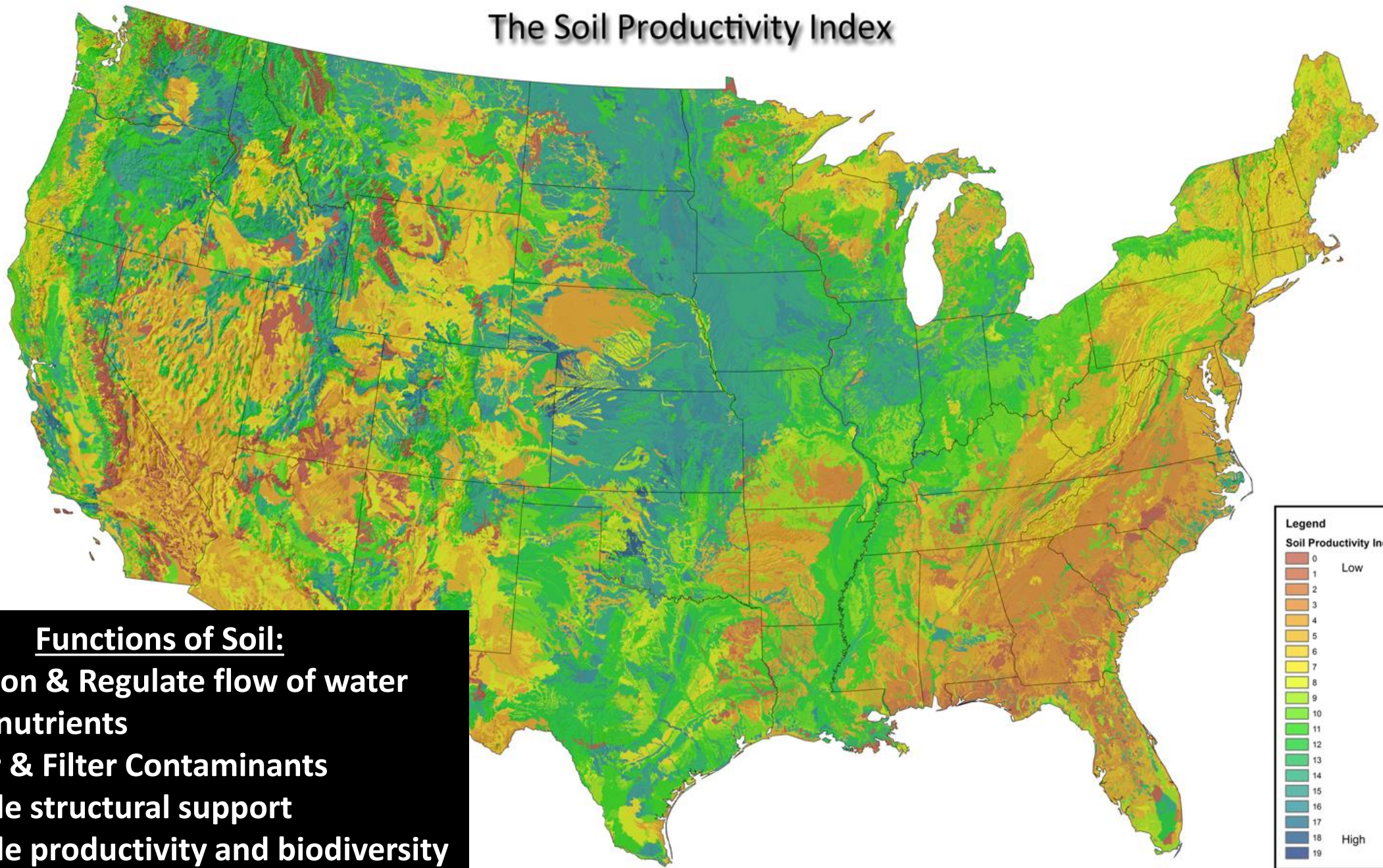
- Precipitation variability:
 - ✓ Spatially (locality)
 - ✓ Temporally > precip intensity outside of growing season
 - ✓ More weather events resulting in excessive soil loss
- Increased nutrient loss likelihood
 - ✓ Leaching
 - ✓ Runoff
 - ✓ Surface Manure applications moving offsite
 - ✓ Atmospheric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

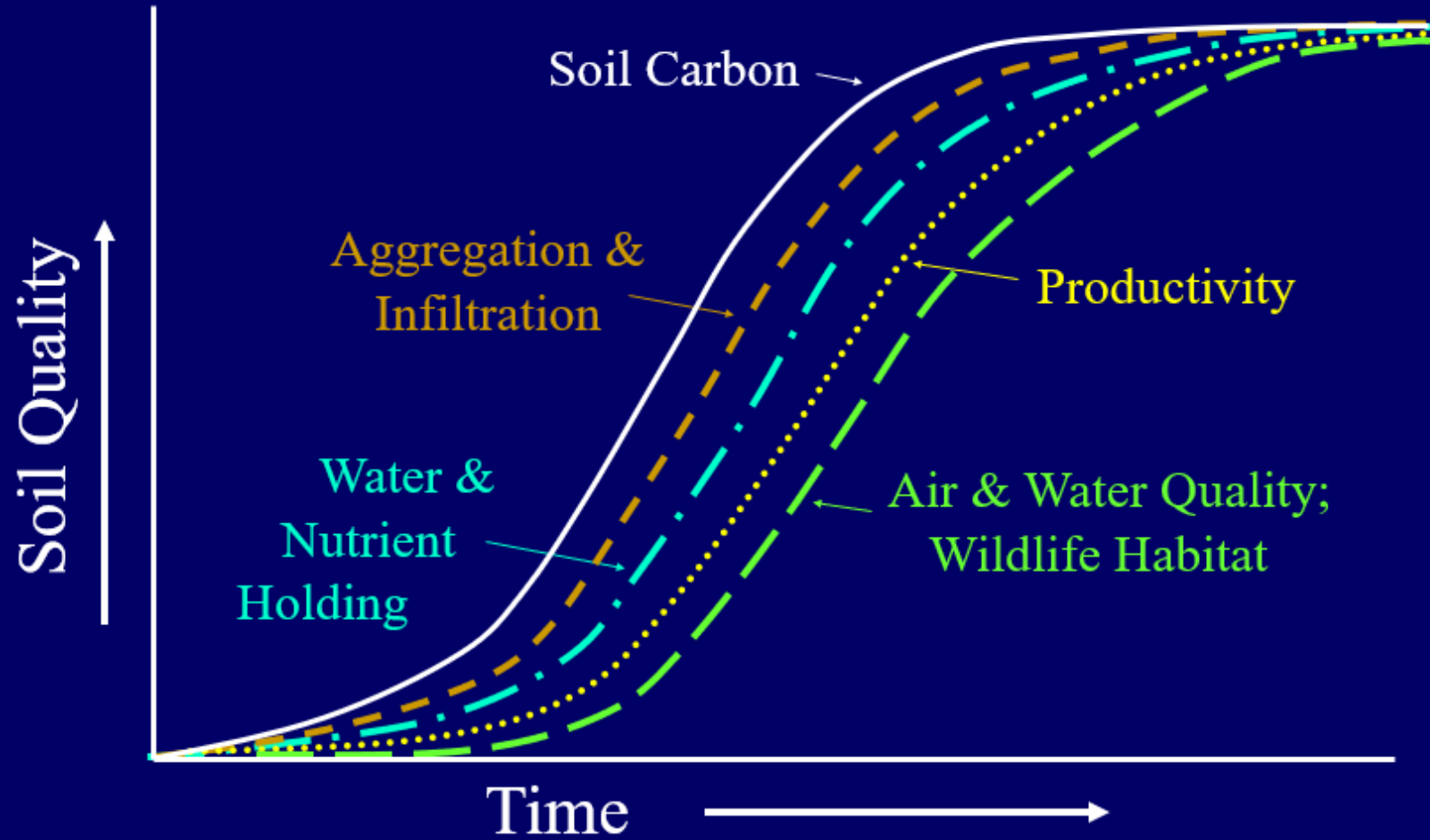
The Soil Productivity Index



Functions of Soil:

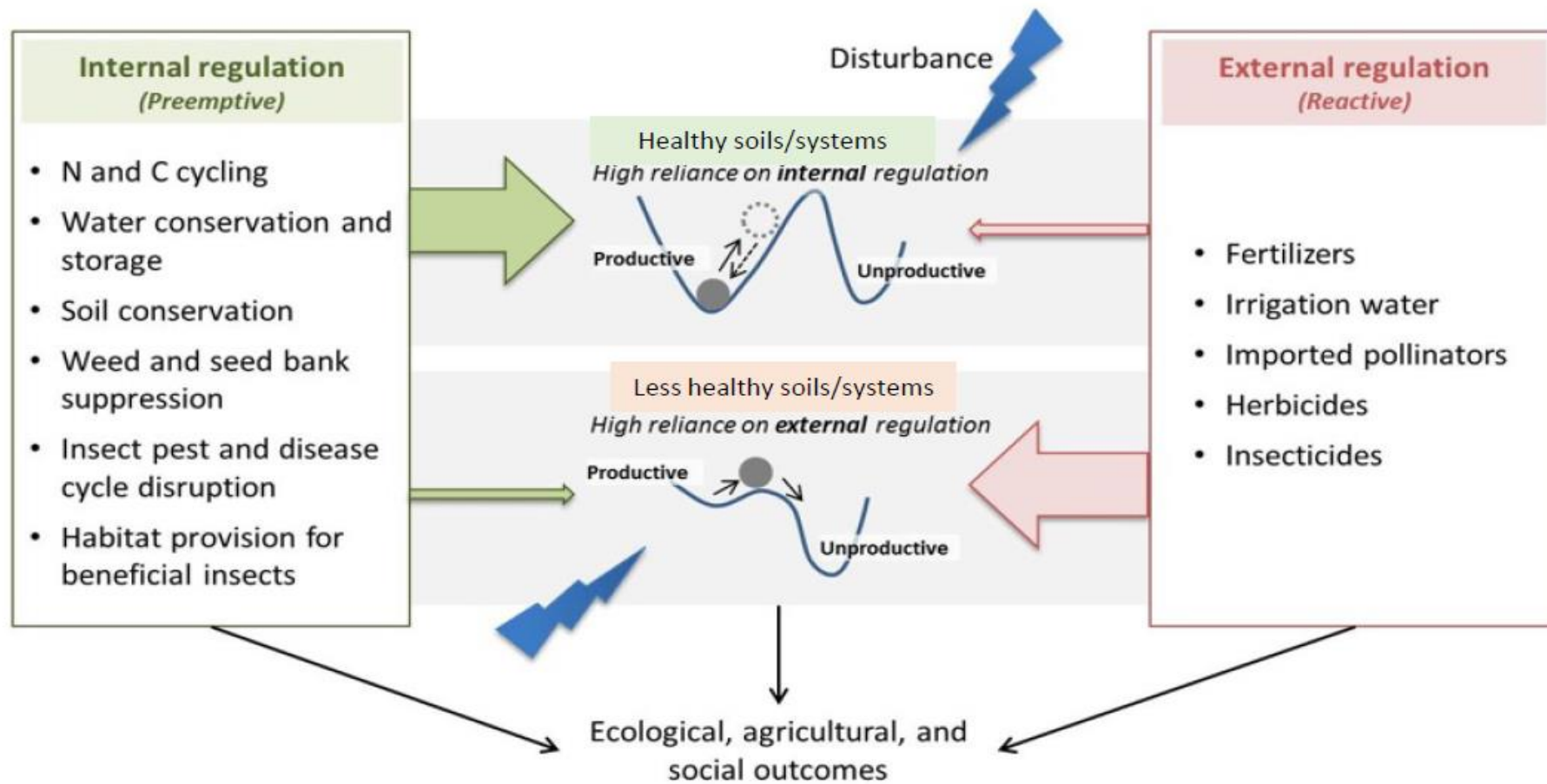
- ✓ Partition & Regulate flow of water
- ✓ Cycle nutrients
- ✓ Buffer & Filter Contaminants
- ✓ Provide structural support
- ✓ Provide productivity and biodiversity

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?





Soil Conditioning Index (SCI) formula is:

$$(\underline{OM} \times 0.4) + (\underline{FO} \times 0.4) + (\underline{ER} \times 0.2) = \text{SCI}$$

- 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:

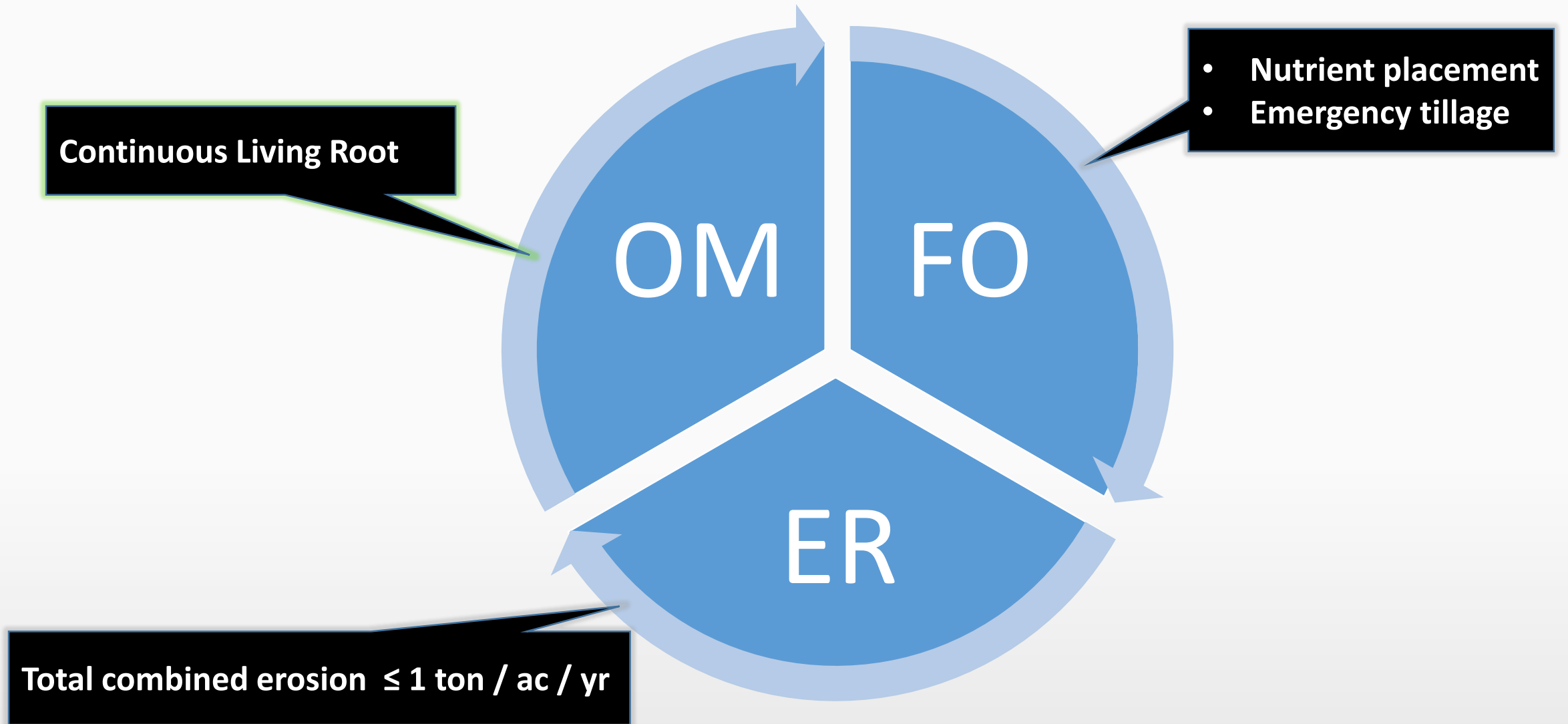
- ✓ Sheet erosion
- ✓ Rill erosion

Wind-induced erosion:

- ✓ Saltation
- ✓ Creep
- ✓ Suspension

* Monitor fields for Ephemeral and Gully Erosion.

Soil Conditioning Index (SCI) – crop management goals



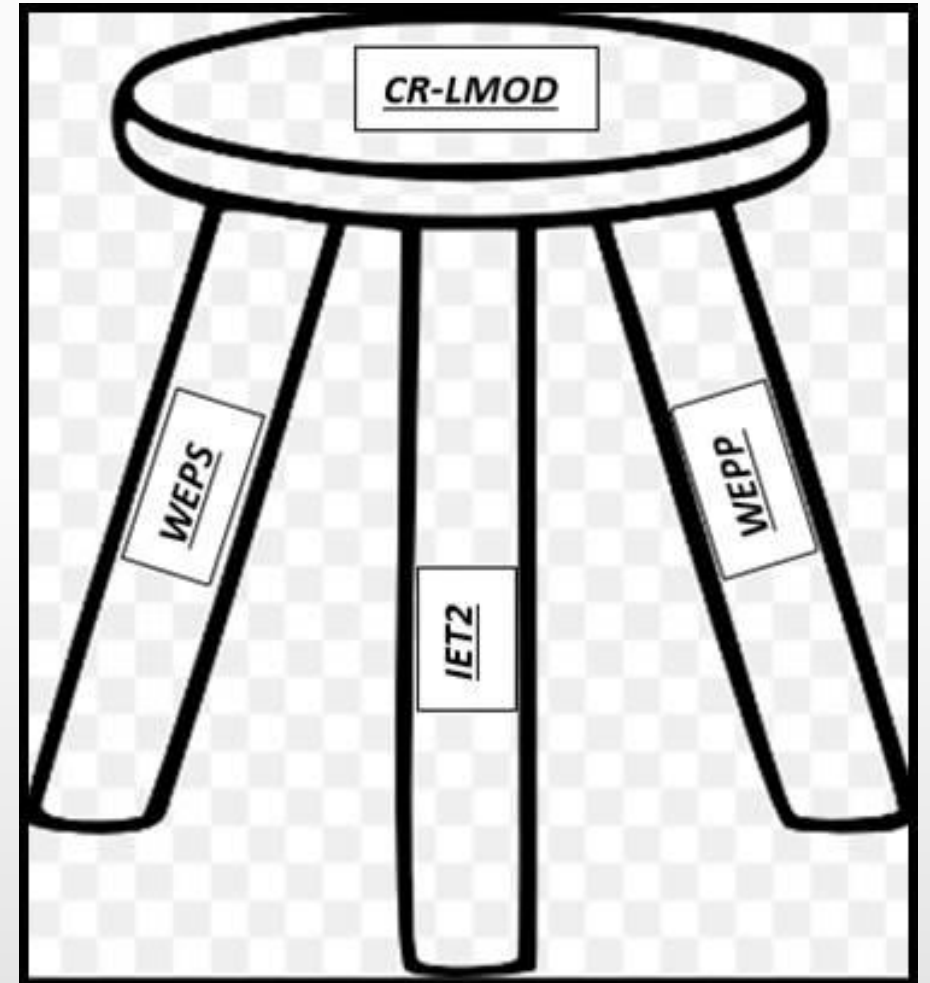
Integrated Erosion Tool (IET)

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

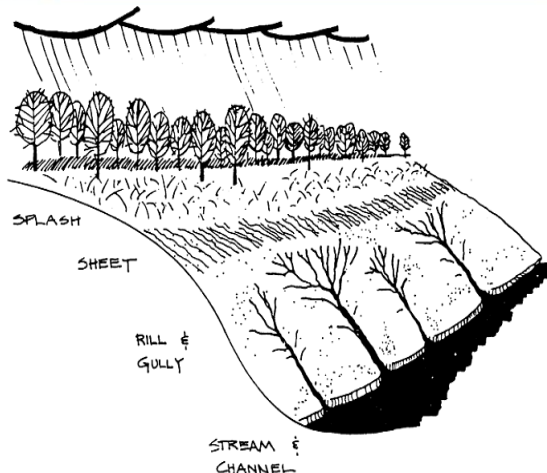
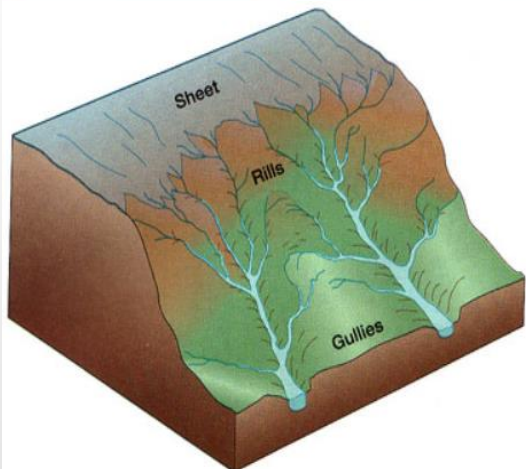
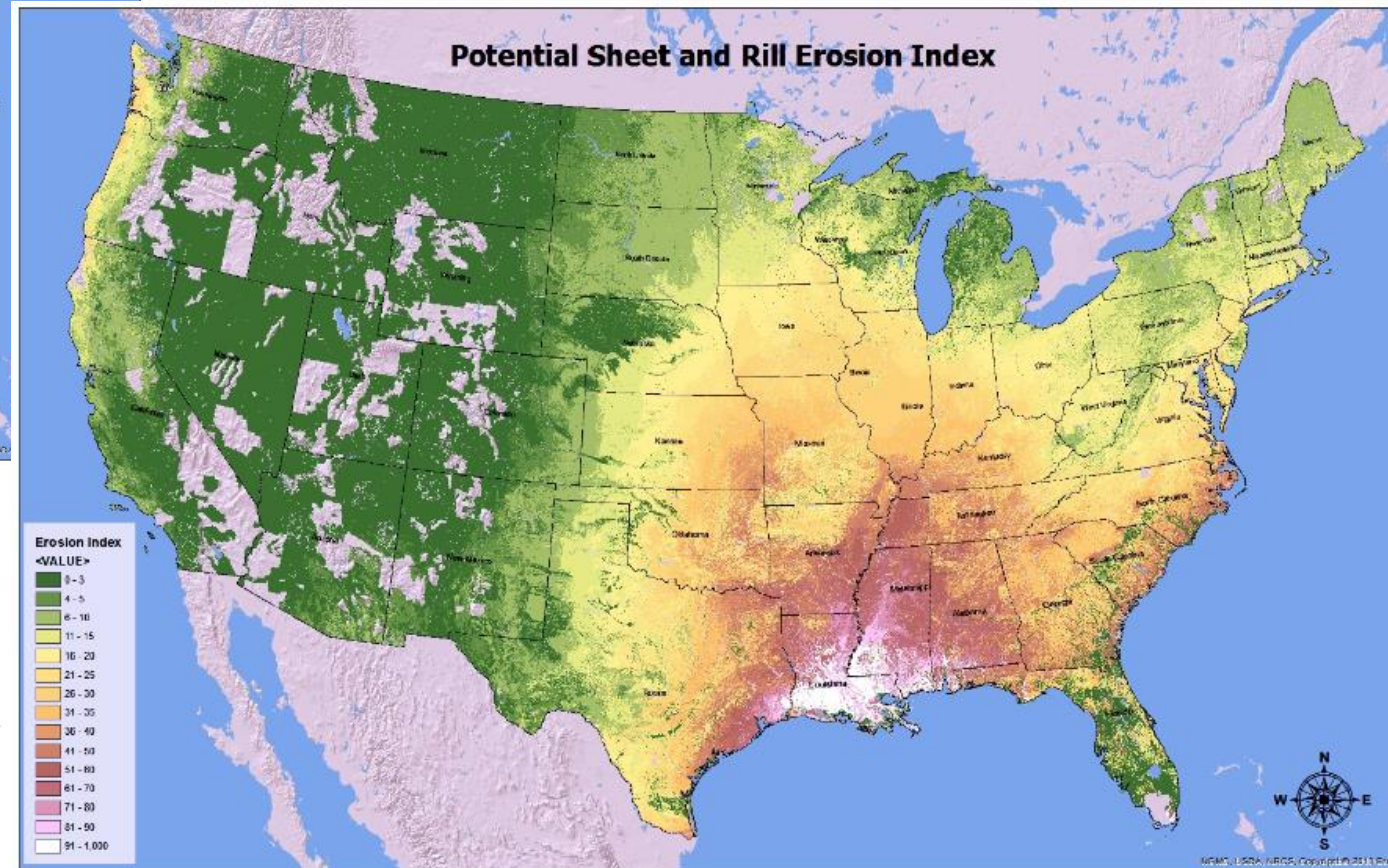
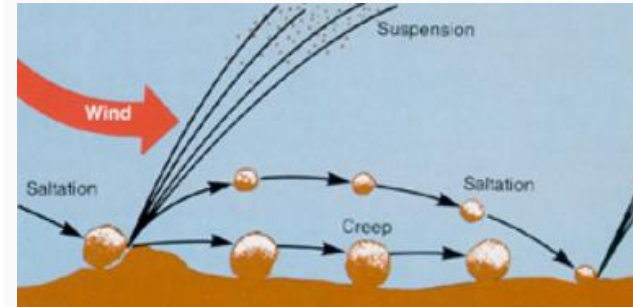
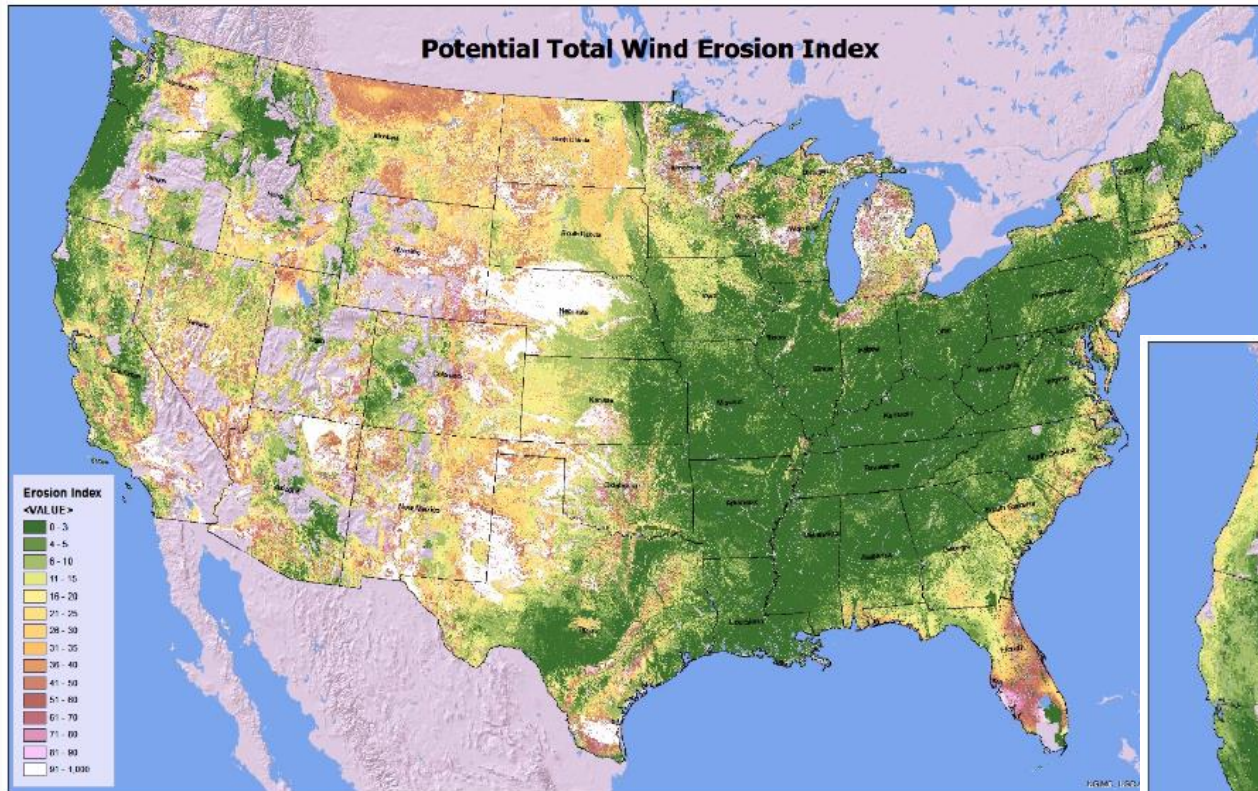
WEPP = Water Erosion Prediction Project

WEPS = Wind Erosion Prediction System

CR LMOD = Conservation Resources
Land Management Operations Database



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.

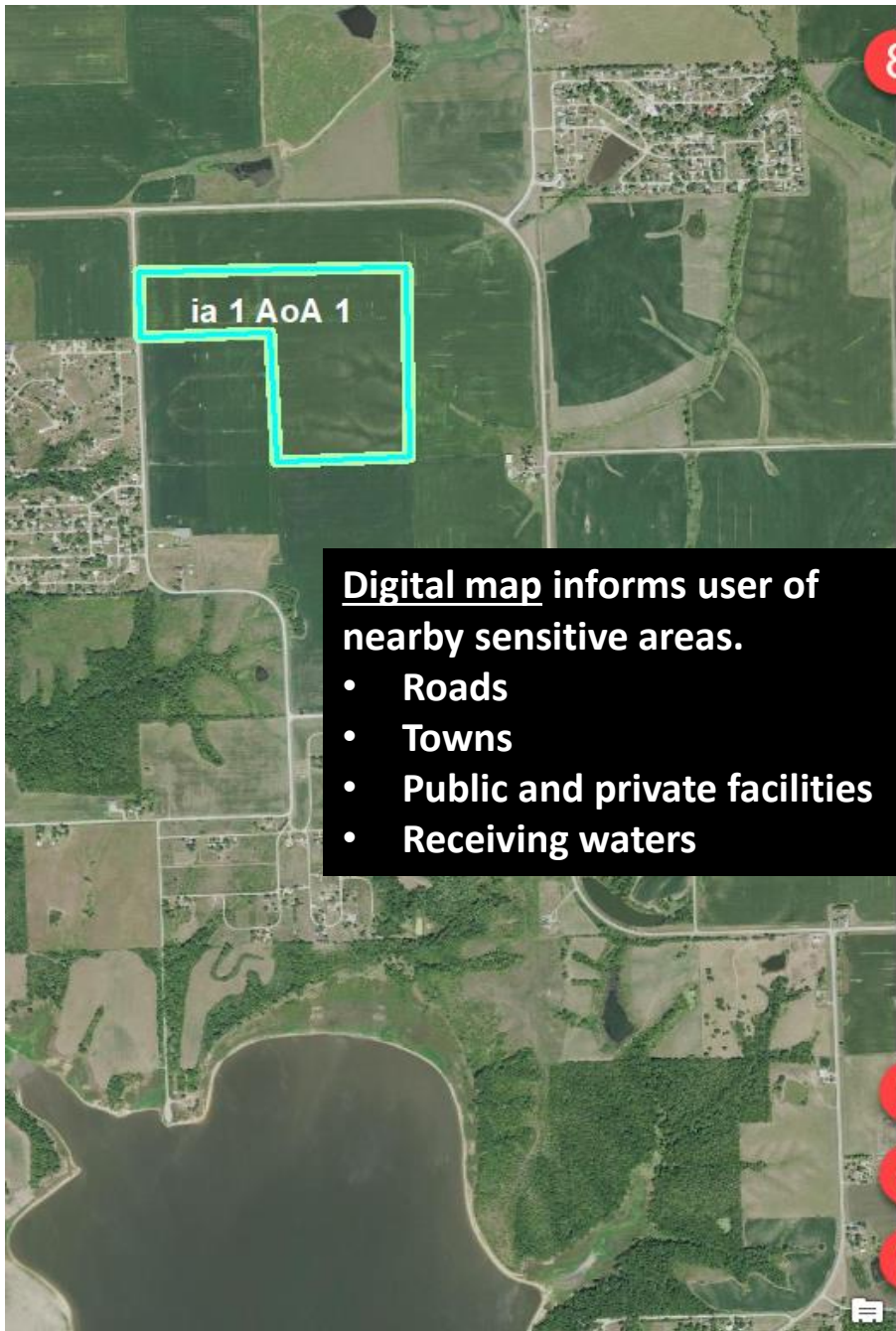
Purposes of IET:

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 farmer



Digital map informs user of nearby sensitive areas.

- Roads
- Towns
- Public and private facilities
- Receiving waters

Integrated Erosion Toolkit

File Options Help [ia 1: AoA 1](#)

8 **Soil / Climate** 1

This step assigns representative soil components in order to supply parameters for calculating water and wind erosion, and when needed assigns a climate location for water erosion

Field Size (acres) 120.2

Water Erosion:

MU (% AoA)	%	K factor
364B Grundy silty clay loam, 2 to 4 ft	22.63	0.32

Soil Component: Grundy Tvalue = 5
Rock Cover (%): 0

Wind Erosion:

MU (%AoA)	%	% Sand
362 Haig silty clay loam, 0 to 2 ft	61.46	8

Soil Component: Haig Tvalue = 5
Rock Cover (%): 0

Climate Location:

State: IA
County: Monroe County, Iowa
Lat / Long: [redacted]

2 Slope / Practice
3 Region / Barriers
4 Crops / Operations
5 Run Simulation
6 Analyze Results
7 Planning Summary

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.

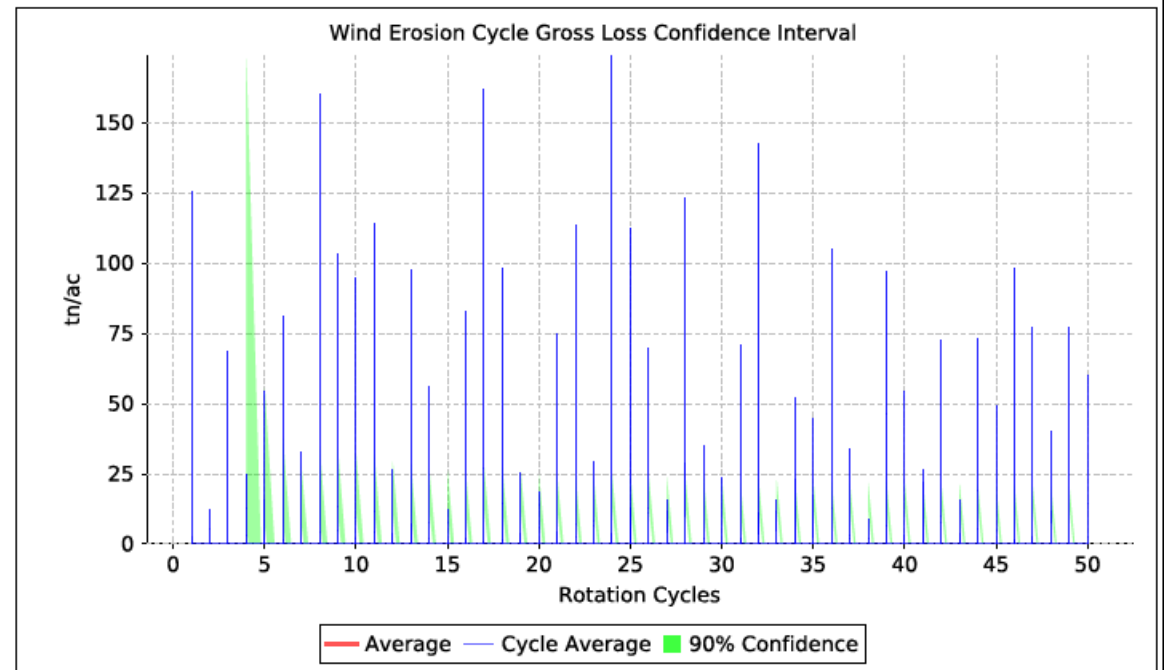
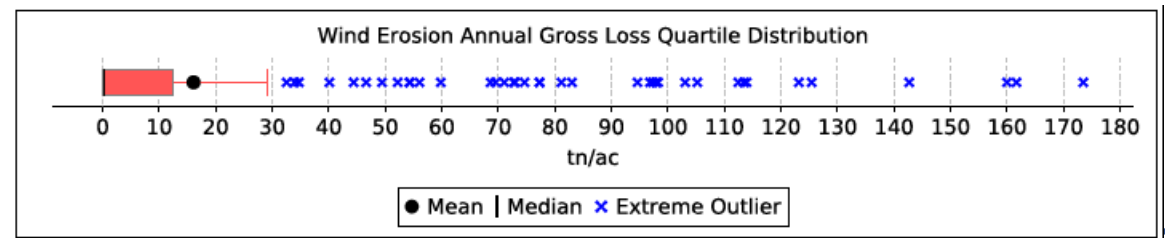
Date	Interval End	Operation	Crop	Residue	Residue (lb/ac)	Yield	Yield Unit	Row / Ridge Dir
05-10-20	<input type="checkbox"/>	Sprayer, pre-emergence		weed residue; 0-3 mo	50			0
05-12-20	<input type="checkbox"/>	Drill or air seeder, double disk	Soybean, grain			70	bu/ac	0
06-07-20	<input type="checkbox"/>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

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

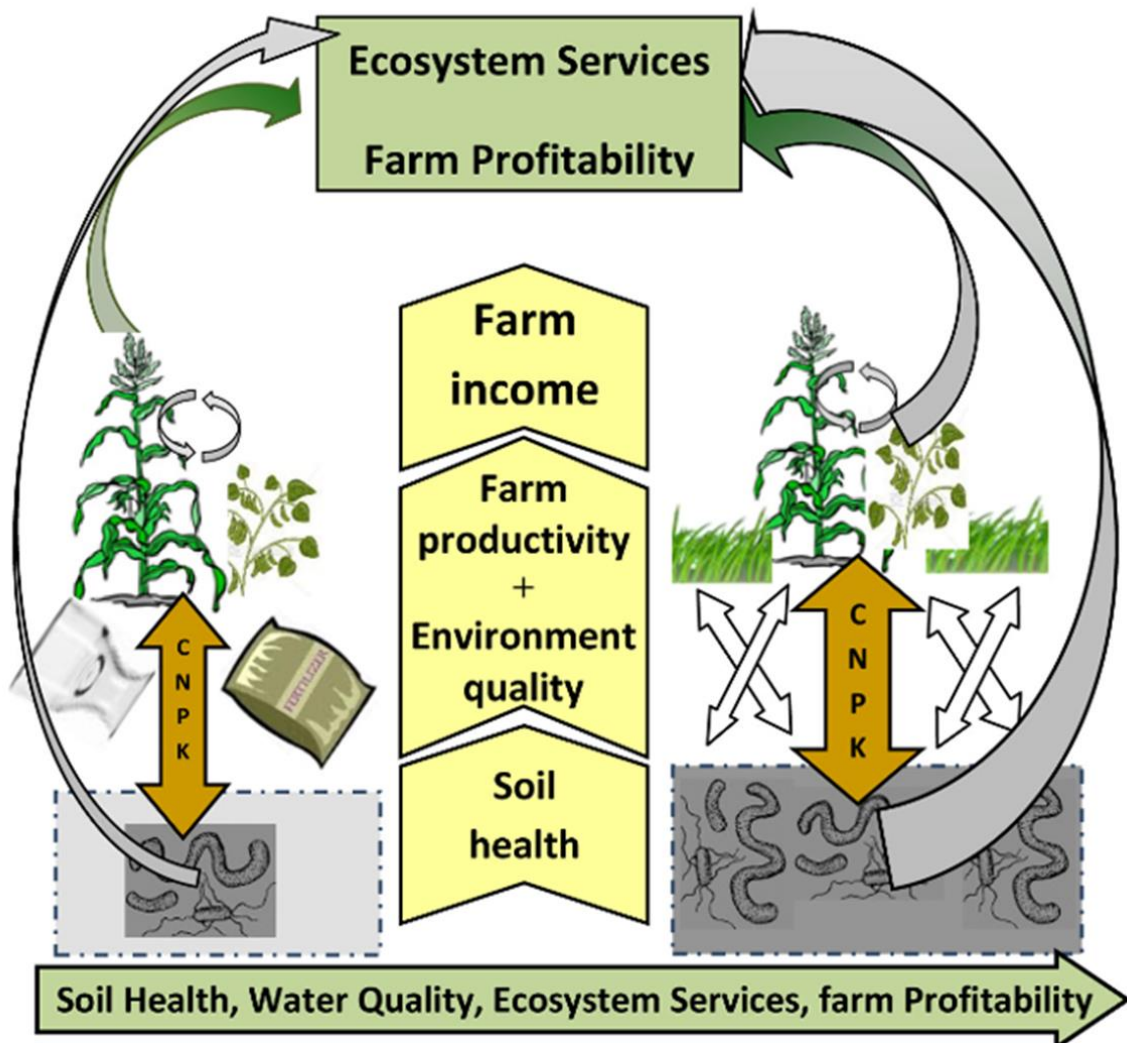
Segment	Model Output	Mean	Median	Standard Deviation	Coef. Of Variation	Min	Max
Hillslope	Precipitation	41	41	6.4	0.2	27	63
Hillslope	Soil Loss	9.5	8.3	6.8	0.7	0.05	42
Hillslope	Sediment delivery	1.4	1.2	1	0.7	0.007	6.3
1	Irrigation	0	0	0	0	0	0
1	Runoff	7.5	7.1	3.4	0.5	1.2	20
1	Plant Transpiration	17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

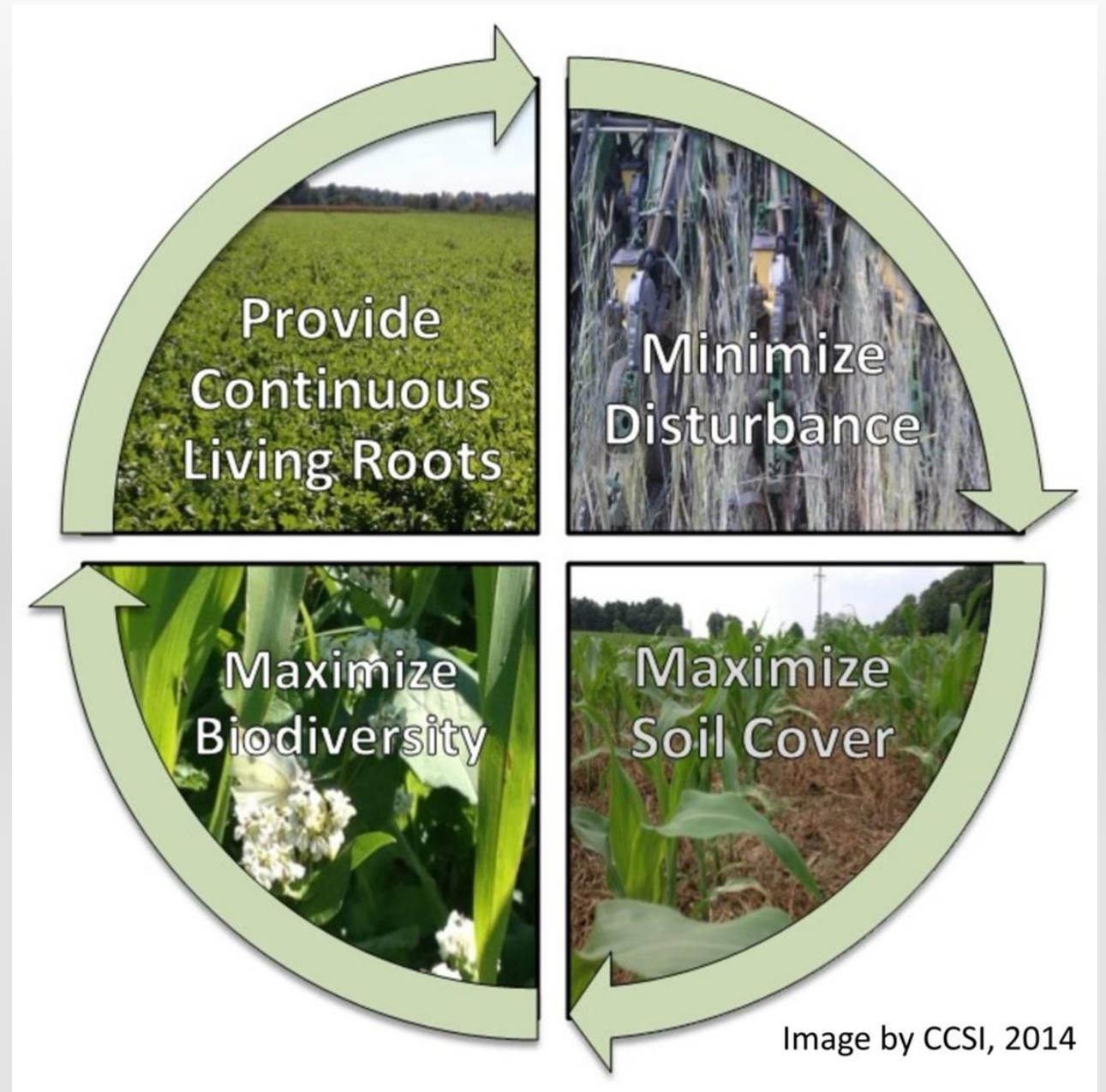
Long term

- ✓ 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 designed and implemented to increase soil carbon:

- 328 Conservation Crop Rotation
- 329 No Till / Strip Till / Direct Seed
 - requires < 20 annual Soil Tillage Intensity Rating {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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About Us Original Site Contact Us

REGIONAL HUBS ALL TOPICS ALL CLIMATE IMPACTS ALL ACTIONS & RESOURCES

Midwest Climate Hub About Topics Climate Impacts Actions & Resources Climate Outlooks

ABOUT THE MIDWEST CLIMATE HUB

Our goal is to provide information that will help producers cope with climate change through linkages of research, education and extension partnerships. Encompassing Michigan, Ohio, Wisconsin, Minnesota, Iowa, Missouri, Indiana and Illinois, this region represents one of the most intense areas of agricultural production in the world with a wide array of products.

[Read more](#)

Climate and Agriculture

Agriculture is indelibly connected to surrounding weather and climate conditions, which impact crop growth along with diseases and soils. Understanding current weather and climate issues is imperative to supporting sustainable crop production in the Midwest.

Upcoming Events

Agriculture in the Midwest

The Midwest represents one of the most intense areas of agricultural production in the world and consistently affects the global economy. Agriculture is impacted by climate. Find out how and how best to adapt agricultural practices to maintain yields here.

Additional Resources

For the most up to date newsletters, research publications and events, check out this Additional Resources page. Access to the Midwest Climate Hub archives and additional Tools can also be found here.

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