Re-Carbonizing Row Crop Ag Lands: Evidence-based management strategies to increase soil carbon and promote financial resilience for farmers.

Justin Mount
2019 NRCS Liaison to Midwest Climate Hub Liaison
July 2019
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 IET outputs and intended use
- Propose short and long term strategies to promote adoption
USDA Climate Hubs

Assessments and Syntheses
*delivering relevant information*

Outreach and Education
*enabling climate-informed decisions*

Technical Support
*facilitating engagement, discovery and exchange*

USDA Midwest Climate Hub
U.S. DEPARTMENT OF AGRICULTURE
Learn more about the Midwest Climate Hub

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https://www.climatehubs.ocio.usda.gov/hubs/midwest
Observed U.S. Precipitation Change
Summer (June-August) rainfall in Iowa
Soil Carbon and Crop Available Water

Assuming an average rate of crop water use during the grain-filling period for corn.
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:
  - Pre-plant operations
  - Planting
  - Crop nutrient applications
  - Crop protection chemical applications
  - Harvest
  - Cover crop planting
Loss of Soil Carbon in Corn Belt (mollisol)

(Lal et al., 1998)
Functions of Soil

- Partition & Regulate flow of water
- Cycle nutrients
- Buffer & Filter Contaminants
- Provide structural support
- Provide productivity and biodiversity
Healthy soils have a major role to play helping boost the internal regulatory mechanisms of a system.

**Internal regulation (Preemptive)**
- N and C cycling
- Water conservation and storage
- Soil conservation
- Weed and seed bank suppression
- Insect pest and disease cycle disruption
- Habitat provision for beneficial insects

**Disturbance**

**Healthy soils/systems**
- High reliance on internal regulation
  - Productive
  - Unproductive

**External regulation (Reactive)**
- Fertilizers
- Irrigation water
- Imported pollinators
- Herbicides
- Insecticides

**Less healthy soils/systems**
- High reliance on external regulation
  - Productive
  - Unproductive

**Ecological, agricultural, and social outcomes**
Benefits of Soil Carbon

- Soil Carbon
- Aggregation & Infiltration
- Water & Nutrient Holding
- Productivity
- Air & Water Quality; Wildlife Habitat

Soil Quality

Time
Soil Conditioning Index (SCI) formula is:

\[(OM \times 0.4) + (FO \times 0.4) + (ER \times 0.2) = SCI\]

- **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** = 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.
IET Workflow:
Area of Analysis has been identified on digital map.

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

Crop System Conversation
Engage Farmer with IET outputs to demonstrate crop system and soil benefits of strongly positive SCI values.
IET digitally documents the farmer’s cropping system

<table>
<thead>
<tr>
<th>Date</th>
<th>Interval End</th>
<th>Operation</th>
<th>Crop</th>
<th>Residue</th>
<th>Residue (lb/ac)</th>
<th>Yield</th>
<th>Yield Unit</th>
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<td>bu/ac</td>
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<tr>
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<td>60</td>
<td>bu/ac</td>
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<td>Soybean, grain</td>
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<td>Wheat, winter, grain</td>
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<td>80</td>
<td>bu/ac</td>
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<td>bu/ac</td>
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<td>Cover crop, mix, cool season, win</td>
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Crop Year STIR Information

STIR = Soil Tillage Intensity Rating

<table>
<thead>
<tr>
<th>Number</th>
<th>Crop Name</th>
<th>STIR</th>
<th>Start Date</th>
<th>End Date</th>
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<tbody>
<tr>
<td>1</td>
<td>Corn, grain, seed</td>
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<td>6/6/2019</td>
<td>10/1/2019</td>
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<td>2</td>
<td>Cover crop, mix, cool season, winter</td>
<td>12</td>
<td>10/2/2019</td>
<td>10/1/2020</td>
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<tr>
<td>3</td>
<td>Wheat, winter, grain</td>
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<td>10/2/2020</td>
<td>6/20/2021</td>
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<tr>
<td>4</td>
<td>Sorghum, grain, Cover crop, mix, cool</td>
<td>9</td>
<td>6/21/2021</td>
<td>10/21/2021</td>
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</tbody>
</table>
Annual Segment Statistics for 100 years

<table>
<thead>
<tr>
<th>Segment</th>
<th>Model Output</th>
<th>Mean</th>
<th>Median</th>
<th>Standard Deviation</th>
<th>Coef. Of Variation</th>
<th>Min</th>
<th>Max</th>
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<tbody>
<tr>
<td>Hillslope</td>
<td>Precipitation</td>
<td>41</td>
<td>41</td>
<td>6.4</td>
<td>0.2</td>
<td>27</td>
<td>63</td>
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<td></td>
<td>Soil Loss</td>
<td>9.5</td>
<td>3.3</td>
<td>8.8</td>
<td>0.7</td>
<td>0.05</td>
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<td>Sediment delivery</td>
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<td>1.2</td>
<td>1</td>
<td>0.7</td>
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<td>1</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>1</td>
<td>Runoff</td>
<td>7.5</td>
<td>7.1</td>
<td>3.4</td>
<td>0.5</td>
<td>1.2</td>
<td>20</td>
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<tr>
<td>1</td>
<td>Plant Transpiration</td>
<td>17</td>
<td>17</td>
<td>3.7</td>
<td>0.2</td>
<td>11</td>
<td>23</td>
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<tr>
<td>1</td>
<td>Soil Evaporation</td>
<td>13</td>
<td>13</td>
<td>2</td>
<td>0.1</td>
<td>8.3</td>
<td>18</td>
</tr>
</tbody>
</table>

Wind Erosion Annual Gross Loss Quartile Distribution

Wind Erosion Cycle Gross Loss Confidence Interval

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
Integrated Erosion Tool (IET) – some graphs available for analysis

**Net surf. cover (WEPP)**

- **Graph 1:**
  - X-axis: Date (January-01-2020 to January-01-2023)
  - Y-axis: Net surf. cover
  - Line: Cropping System

**Live Root Mass (WEPP)**

- **Graph 2:**
  - X-axis: Date (January-01-2020 to January-01-2023)
  - Y-axis: Live Root Mass
  - Line: Cropping System
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 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)**
Thank you for making time to attend.

Please provide feedback at: or

https://forms.gle/3NTMPM1LiDsLiKtr7