Using the Soil Conditioning Index and the Soil Tillage Intensity Rating in Conservation Planning

USDA Natural Resources Conservation Service

Soil Quality National Technology Development Team
Benefits of Soil Carbon

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

Soil Quality vs. Time
<table>
<thead>
<tr>
<th>Year</th>
<th>Soil C (g m$^{-2}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1907</td>
<td>8000</td>
</tr>
<tr>
<td>1920</td>
<td>61% of 1907</td>
</tr>
<tr>
<td>1940</td>
<td>53% of 1907</td>
</tr>
</tbody>
</table>

Historic Loss of Soil Carbon

(Lal et al., 1998)
SOIL QUALITY CONCEPTS ARE BEING INTEGRATED INTO CONSERVATION PLANNING BY NRCS

• Soil Conditioning Index (SCI)
  – Model that predicts the impact of adjusting rotation, tillage, and other management on soil organic matter
  – Assumes SOM is a major indicator of soil quality
  – Impacts erosion and is related to C sequestration
  – Calculated within RUSLE2
  – Scaled from -2 to +2
  – Goal is to plan to increase SCI
Soil Conditioning Index

(SCI = Soil Disturbance - Plant Production - Erosion)

Carbon (lbs)

- 1

Degrading

SCI

+ 1

Improving

Sustaining
SCI Model Variables:

Biomass Production
The SCI formula is:
\[(OM \times 0.4) + (FO \times 0.4) + (ER \times 0.2) = SCI\]

Where:

- **OM** accounts for organic material returned to the soil (as a function of biomass produced)
- **FO** represents field operation effects
- **ER** is the sorting and removal of surface soil material by sheet, rill and/or wind erosion
Regression of SCI Outcomes and Measured Carbon Change

\[ y = 18.038x \]
\[ R^2 = 0.7608 \]

Trend Accuracy 97%
Rate Change Prediction 87%
CONSERVATION PLANNING IS CHANGING

- Going are the days of measuring residue
- Soil Tillage Intensity Rating (STIR)
  - Reflects the impact of tillage type, operation speed, traffic management, depth, rotation, percent of surface disturbed
  - Calculated within RUSLE2
  - Lower STIR values = reduced soil erosion
  - Values range between 0 and 200
  - Typical no-till at 30 or less
  - Some “imbedded” credit for energy savings
## Soil Tillage Intensity Rating (STIR)

<table>
<thead>
<tr>
<th>FIELD OPERATIONS</th>
<th>SOIL DISTURBING ACTIONS</th>
<th>Soil Tillage Intensity Rating (STIR)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary tillage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plow, moldboard, complete inversion</td>
<td>5 5 5 5 5 4 29</td>
<td></td>
</tr>
<tr>
<td>Plow, moldboard, incomplete inversion</td>
<td>4 5 5 5 5 4 28</td>
<td></td>
</tr>
<tr>
<td>Plow, deep chisel, twisted point</td>
<td>4 4 5 5 5 2 25</td>
<td></td>
</tr>
<tr>
<td>Plow, deep chisel, straight point</td>
<td>3 4 4 4 5 2 22</td>
<td></td>
</tr>
<tr>
<td>Plow, chisel, twisted point</td>
<td>3 4 5 5 5 2 24</td>
<td></td>
</tr>
<tr>
<td>Plow, chisel, straight point</td>
<td>2 3 4 4 4 2 19</td>
<td></td>
</tr>
<tr>
<td>Plow, chisel, sweeps</td>
<td>2 3 5 4 4 3 21</td>
<td></td>
</tr>
<tr>
<td>Plow, disk plow</td>
<td>4 5 5 5 5 4 28</td>
<td></td>
</tr>
<tr>
<td>Disk, offset</td>
<td>4 5 4 5 5 4 27</td>
<td></td>
</tr>
<tr>
<td>Disk, Tandem primary (&gt; 6&quot; depth)</td>
<td>4 5 4 4 5 4 26</td>
<td></td>
</tr>
<tr>
<td>Power rotary tiller</td>
<td>5 5 5 5 4 4 29</td>
<td></td>
</tr>
<tr>
<td>Ground driven rotary tiller</td>
<td>4 5 5 5 5 4 28</td>
<td></td>
</tr>
<tr>
<td>Paratill/paraplow</td>
<td>0 0 5 5 3 2 15</td>
<td></td>
</tr>
<tr>
<td>Undercutter (8-12&quot; sweeps)</td>
<td>0 0 5 5 4 3 17</td>
<td></td>
</tr>
<tr>
<td>V-blade</td>
<td>0 0 5 5 4 3 16</td>
<td></td>
</tr>
<tr>
<td>Vee ripper/subsoiler</td>
<td>3 3 4 5 5 2 22</td>
<td></td>
</tr>
<tr>
<td>Bedder-ridger</td>
<td>5 5 5 5 5 3 28</td>
<td></td>
</tr>
<tr>
<td><strong>Secondary tillage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disk, Tandem finishing (&lt; 6&quot; depth)</td>
<td>2 3 3 3 3 4 3 18</td>
<td></td>
</tr>
<tr>
<td>Field cultivator, straight point</td>
<td>3 3 3 4 3 2 18</td>
<td></td>
</tr>
</tbody>
</table>
CSP PROGRAM USES SCI AND STIR

Examples
$1.16/a increase in cost-share for every 0.1 increase in the SCI in selected Wis. watersheds

• 2006 – Lake Dubay (NC Wis.)
  Grant/Maquoketa (SW Wis.)

• 2005 – Duck Creek/Pensaukee (NE Wis.)
  Crawfish (SE Wis.)
  Kishwaukee (Mostly in Illinois)

• 2004 – Lower Chippewa (WC Wis.)

Other states
Up to $2.00/a in Colorado for low STIR values, double if using auto-steering
Summary

• Easy to use tool to estimate soil condition
• Validated using long term research data
• SCI is being used nationally for conservation assessment in CSP & CEAP
• Now part of RUSLE2 and coming to a field office near you!!