Building Better Soils

Defining soil health
- Defined as: The capacity of a soil to function
- Measurable physical, chemical, biological properties
- Is organic matter a P, C, or B property?
  - Yes
- How long does it take to change?

What’s a soil function?
- Diversity and habitat
- Filter and buffer
- Water relations
- Cycle nutrients
- Filters
- Detoxifies
- Balances

Where do soils come from?
- 5 soil forming factors
  - Climate
  - Organisms
  - Relief
  - Parent material
  - Time

Soil Health Definition
- “The capacity of soil to function as a vital living system, within ecosystem and land-use boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and promote plant and animal health” (Doran and Zeiss, 2000).
• Good news: Past research says we can improve soil health
• Information about soil high in demand by farmers and agronomists
  – Productivity?
  – Water?
  – Weeds?
  – How fast will my soil change?

Complex, beneficial relationships

Overview

• Importance of soil physical properties
  – Precipitation capture and storage
• Physical soil properties we can measure
• Reversing the effects of soil degradation

Summary of Soil Physical Properties

Mean Weight Diameter (mm)

Wichita Spring 15

Wet aggregate measurement illustrated

Wet aggregate measurement illustrated
Relationships: Organic matter is key

- Both soils received the same N rate for 30 years
- One tilled, other not tilled

Bulk density

- Soils with more organic matter have better aggregation
- Better aggregation means less compactable
- Excavate a known volume of soil and determine dry mass

Study 1: Long-term, 27.5\textdegree, silty clay soil (lots of smectite)

Winter wheat–Grain sorghum rotation
15 years

Summer legume after wheat options:
- Sunh hemp
- Crotalaria juncea

Alternatives:
- Cowpea, soybean, mungbean
After 15 years, 0-3” SOC differed


Or maybe it was the worms?

• Measured worms by digging up soil in December 2009 in grain sorghum stalks.
• How long had it been since the covers were green and living?
• About 13-14 months. Worms still preferred the cover crop plots.

Better Soils Were Actually More Productive Too

Notice the yield boost with no applications of N.
The boost comes from improvements in soil productivity.
For sunn hemp, this persists, even with increasing N.
Is it high enough with N credit to cover establishment costs?

Units are bushels and pounds

More SOC, Faster Ponded Infiltration

• Infiltration: Movement of water through the surface
• Double-ring
• Precipitation capture and storage is CRITICAL in semi-arid cropping
• Cover crops planted every other year

Don’t feed the bears!

“Worms prepare the ground in an excellent manner for the growth of fibrous-rooted plants and for seedlings of all kinds.”
Charles Darwin, 1881

Nice ongoing work in western KS being done by Augustine Obour and John Holman

Methods

• Garden City

• Four treatments:
  – Fallow
  – Pea (grain)
  – CC standing
  – CC hayed

• Measured:
  – Bulk density and soil organic C
  – Multiply the BD, the SOC, and depth = SOC in tons/ac
  – This is important! Because the % SOC is misleading, and this is really the best way to know if you are really storing C (example, C trading)

Table 4. Effect of cover crop management on mean weight diameter (MWD) of wet aggregates from the 0- to 2-inch soil depth in fall 2018 and summer 2019

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fall 2018</th>
<th>Summer 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MWD</td>
<td></td>
</tr>
<tr>
<td>Fallow</td>
<td>0.053 ab</td>
<td>0.082 a</td>
</tr>
<tr>
<td>Pea (grain)</td>
<td>0.056 b</td>
<td>0.070 a</td>
</tr>
<tr>
<td>Cover crops (standing)</td>
<td>0.064 a</td>
<td>0.090 a</td>
</tr>
<tr>
<td>Cover crops (harvested)</td>
<td>0.062 ab</td>
<td>0.080 a</td>
</tr>
</tbody>
</table>

*Means with the same lower case letter within the same column are not significantly different among management strategies.

Table 5. Cover crop management effect on wet aggregate size distribution for the 0- to 2-inch soil depth in fall 2018 and summer 2019

<table>
<thead>
<tr>
<th>Sample period</th>
<th>Treatment</th>
<th>Percent of each size fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt; 0.01 in.</td>
</tr>
<tr>
<td>Fall 2018</td>
<td>Fallow</td>
<td>23 ± 5</td>
</tr>
<tr>
<td></td>
<td>Pea (grain)</td>
<td>30 ± 4</td>
</tr>
<tr>
<td></td>
<td>Cover crops (standing)</td>
<td>26 ± 4</td>
</tr>
<tr>
<td></td>
<td>Cover crops (harvested)</td>
<td>23 ± 3</td>
</tr>
</tbody>
</table>

*Means with the same lower case letter within the same column are not significantly different among management strategies.

More large aggregates, which is helpful for erosion and water infiltration

Need to capture and store precip when it comes


No negative effects on BD
Soil Organic C %

DIY: SLAKES app
- Google Play store only
- Free app
- Take photos of your own soil falling apart in water
- I’ll be trying it out this winter
- Early but promising

Conclusions
- Some properties are slow to change, like soil organic matter
- Could see more immediate results for reducing erosion losses
- “Fixing” the surface is so important for precipitation capture and storage, starting with aggregate stability
- Building soil health is a long-term investment for feeding the world

Questions?