Don’t Treat Your Soil Like Dirt

Jodi DeJong-Hughes
Regional Extension Educator, Willmar
320-235-0726 x 2006
dejon003@umn.edu
dejon003
Soil Organic Matter in the US

Hargrove and Luxmoore
The Value of Soil Organic Matter
Soybean Production Field

Early August

Late August

Yield variability comes from soils inability to supply water during grain-filling

25 bu/acre

65 bu/acre

Jerry Hatfield, USDA-ARS
Available Water Content (Inches)

Organic Matter (%) vs Available Water Content (Inches) for different soil types:

- **Sand**
  - 1% Organic Matter: 1.9 inches
  - 2% Organic Matter: 1.4 inches
  - 3% Organic Matter: 2.9 inches
  - 4% Organic Matter: 2.2 inches
  - 5% Organic Matter: 4.0 inches

- **Silt Loam**
  - 1% Organic Matter: 2.5 inches
  - 2% Organic Matter: 3.0 inches
  - 3% Organic Matter: 4.0 inches

- **Silty Clay Loam**
  - 1% Organic Matter: 1.7 inches
  - 2% Organic Matter: 2.5 inches
  - 3% Organic Matter: 3.0 inches
  - 4% Organic Matter: 4.0 inches

Hudson, 1994
Additional Days of Available Water Content (based on corn use of 0.25”/day)

Organic Matter (%)
Soil won’t turn to mush when wet
(water stable aggregates)
Water Infiltration
Infiltration

Run off
Less Tillage Improves Water Infiltration

Measurements with Cornell Sprinkle Infiltrometer on moist soil
Standing Residue Acts Like a Straw
Benefit to Farmer: Resilient Soil

Strip Till  Double Disk

Get into the fields sooner after rainfall
## Nutrients in Organic Matter

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Amount</th>
<th>Price PER Lb</th>
<th>Total Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>1,000 lbs</td>
<td>0.45/lb</td>
<td>$450</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>100 lbs</td>
<td>0.38/lb</td>
<td>$38</td>
</tr>
<tr>
<td>Potassium</td>
<td>100 lbs</td>
<td>0.30/lb</td>
<td>$30</td>
</tr>
<tr>
<td>Sulfur</td>
<td>100 lbs</td>
<td>0.42/lb</td>
<td>$42</td>
</tr>
<tr>
<td>Carbon</td>
<td>10,000 lbs</td>
<td></td>
<td>$0</td>
</tr>
</tbody>
</table>

**Value of 1% SOM Nutrients/Acre ~$560**

**Assumptions:**
- 2,000,000 lbs. soil in top 6 inches.
- 1% organic matter = 20,000 lbs.
Build Soil Organic Matter

resilience:
the ability to bounce back when faced with stress or pressure.
• Reduce or no tillage (>40% residue cover)

• Keep the soil covered
  o diverse crop rotation
  o cover crops
• Add organic inputs
  o compost
  o livestock manure
  o green manure

• Add livestock
Less Tillage = More Organic Matter

Soil Organic Matter (%)

0-3 Inch Depth

- Moldboard Plow
- Deep Tillage
- No-Till
- Grass

G. Hoyt, 2005
Organic Matter is ~ 50% Carbon

and microbes eat C and respire CO$_2$
MR. GEM

ARS Morris, MN
Tillage-Carbon Study

OM lost as CO$_2$ in 19 days (lb/ac)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>OM Lost (lb/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MP</td>
<td>3,830</td>
</tr>
<tr>
<td>DH</td>
<td>1,640</td>
</tr>
<tr>
<td>CP</td>
<td>1,535</td>
</tr>
<tr>
<td>NT</td>
<td>765</td>
</tr>
</tbody>
</table>

2,845 lb/ac from residue of previous wheat crop
Destroy Soil Organic Matter
• Residue removal

• **Tillage**
  (recreational, aggressive)

• **Erosion**

• Tight crop rotation
Soil Erosion

http://nrcca.cals.cornell.edu/soil/
Acceptable Soil Loss

5 T of soil = 1 dime’s width
40 acres = **16 dump trucks** of soil!

400,000 pounds of soil!
Value of Topsoil

If you lost 5T/ac
At $25/T to replace
= $125/ac
Over 40 acres

That’s $5,000 per year!

(1,000 ac = $125,000)
Fun Fact:

Wind Erosion =
wind speeds >13 mph
on smooth, wide, bare fields

Photo Courtesy of MN Ag Services
Average **Annual** Wind Erosion Loss
<table>
<thead>
<tr>
<th>DITCH</th>
<th>SOIL LOSS (TONS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.6</td>
</tr>
<tr>
<td>2</td>
<td>2.6</td>
</tr>
<tr>
<td>3</td>
<td>2.8</td>
</tr>
<tr>
<td>4</td>
<td>5.5</td>
</tr>
<tr>
<td>5</td>
<td>9.3</td>
</tr>
<tr>
<td>6</td>
<td>33</td>
</tr>
<tr>
<td>AVE</td>
<td><strong>9 TONS</strong></td>
</tr>
</tbody>
</table>

45% residue

15% residue

J. DeJong-Hughes and D. Gatchell
Fun Fact:

If a 20 mph wind increases to 30 mph...

The erosion rate will triple.
Let’s Talk About
Tillage Erosion
Tillage moves soil up and forward
Gravity moves the soil downward

Lindstrom et al, USDA-ARS in Morris MN
Tillage Erosion Study W. Minnesota

Water, wind, and tillage erosion
Long term MBP field
Net soil loss by tillage erosion exceeded 27 T/ac/yr

Lindstrom et al, USDA-ARS in Morris, MN
Variation in Wheat Yield

2003 Wheat Yield (bushels per acre)

Lindstrom et al, USDA-ARS in Morris
How do you manage this much variability?

<table>
<thead>
<tr>
<th></th>
<th>Top of Slope</th>
<th>Bottom of Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>OM</td>
<td>1.3</td>
<td>4.1</td>
</tr>
<tr>
<td>pH</td>
<td>8.4</td>
<td>7.3</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>Potassium</td>
<td>115</td>
<td>175</td>
</tr>
</tbody>
</table>
Strip Tillage
Maintains surface residue between the rows

Considered “enhanced no-till”
Seed planted directly in cleared strips in Spring

P and K applied 6-8” deep in berm

N can be applied in berm, at planting, or side dressed
Potential for one-pass across field

Less energy and less erosion than conventional systems
Concern #1

Reduced till fields won’t warm-up or dry in time for early planting
Data by Aaron Daigh, NDSU. Data averaged between 3 locations.
Fun Fact:

Denitrification in a Saturated Soil

Can Lose 2-4 lbs of Nitrogen/ac/day

Photo Courtesy of Dave Franzen, NDSU
Concern #2

Yield Will Suffer
90% of Research Conducted in Farmer’s Fields
3-Year Yield and Residue Averages in WC MN (2010-12)

Yield (bu/ac)

<table>
<thead>
<tr>
<th></th>
<th>ST</th>
<th>VT</th>
<th>CP/VT rotation</th>
<th>DR/CP rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>50</td>
<td>51</td>
<td>50</td>
<td>51</td>
</tr>
<tr>
<td>Year 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Residue (%)

<table>
<thead>
<tr>
<th></th>
<th>ST</th>
<th>VT</th>
<th>CP/VT rotation</th>
<th>DR/CP rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td></td>
<td></td>
<td></td>
<td>64*</td>
</tr>
<tr>
<td>Year 2</td>
<td></td>
<td></td>
<td></td>
<td>48</td>
</tr>
<tr>
<td>Year 3</td>
<td></td>
<td></td>
<td></td>
<td>39</td>
</tr>
</tbody>
</table>

* Yields are not statistically different from each other. Residue was significantly different with an LSD (0.10) = 7.
Soybean yield response to tillage for 17 site years in E. North Dakota and NW Minnesota (2005 – 2012)
### 3-Year Yield and Residue Averages in WC MN (2010-12)

<table>
<thead>
<tr>
<th>Yield (bu/ac)</th>
<th>Residue (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST</td>
<td>VT</td>
</tr>
<tr>
<td>154</td>
<td>43*</td>
</tr>
<tr>
<td>156</td>
<td>26</td>
</tr>
</tbody>
</table>

* Yields are not statistically different from each other. Residue was statistically different with an LSD (0.10) = 4.
Corn yield response to tillage for 18 site years across E. North Dakota and NW Minnesota through 2005 - 2012.
Weather Has More Affect on Yield Than Tillage
2004-2005 Corn Averages* (13 site years)

Yield (bu/ac) and Residue (%)

2004 Yield

Residue (%)

NT | ST | FC | CP

168* | 175 | 174 | 177
59  | 47  | 29  | 22
Plant Roots and Microbes

*Form* Soil Structure
Fun Fact: If you build it – they will come
Summary

• We’ve overestimated the importance of tillage affect on yield
• Tillage costs money ($20/ac)
• Increases soil erosion (3 - 20 T/ac)
• Lost soil costs money ($25 per ton)

Cost per acre = $95+
Other Costs

• Lost organic matter equals
  – less water to grow crops (lose 1-4 days of crop moisture)
  – less nutrients for crops ($560 in 1% OM)

• Less water and nutrients = lowers yields and increases the need for more fertilizer

• More labor costs

• More wear and tear on equipment
Respect tradition, but keep an open mind
Fun Fact:

You can manage this resource
Questions?
2009 Fall Rut Affects on Yield

- 7 fields were GPS’d in Fall 2009
  - Frenchie with Crop One and 4 local growers
  - All but 1 field was CP + SFC

- Ruts vs No Ruts were flagged-off

- Data collection and hand harvest w/in the flagged area
# Spring Corn Plant Data -2010

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Ave. Ht (in.)</th>
<th>Early Pop. (plants/ac)</th>
<th>Growth (V) Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Ruts</td>
<td>31.0</td>
<td>29,900</td>
<td>10.4</td>
</tr>
<tr>
<td>Ruts</td>
<td>22.5</td>
<td>28,900</td>
<td>9.1</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>6.5</td>
<td>NS</td>
<td>0.7</td>
</tr>
</tbody>
</table>
## Corn Yield Data - 2010

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Final pop. (plants/ac)</th>
<th>Moist (%)</th>
<th>Yield (bu/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Ruts</td>
<td>29,100</td>
<td>14.9</td>
<td>158.6</td>
</tr>
<tr>
<td>Ruts</td>
<td>29,100</td>
<td>15.1</td>
<td>131.3</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>NS</td>
<td>NS</td>
<td>11.1</td>
</tr>
</tbody>
</table>

Average yield drop was 17% and was very consistent.

One field had a 37% yield decrease. Ruts were on headlands = compaction + ruts (121 vs 77 bu/ac). 
## Soybean Data 2011

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Ave Ht (inches)</th>
<th>Early Pop (plants/ac)</th>
<th>Growth Stage (vegetative)</th>
<th>Growth Stage (reproductive)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Ruts</td>
<td>14.9</td>
<td>148,300</td>
<td>V8</td>
<td>R2.0</td>
</tr>
<tr>
<td>Ruts</td>
<td>9.6</td>
<td>138,500</td>
<td>V6</td>
<td>R1.1</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>2.3</td>
<td>NS</td>
<td>0.6</td>
<td>0.6</td>
</tr>
</tbody>
</table>
# Soybean Yield - 2011

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Moisture (%)</th>
<th>Yield (bu/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Ruts</td>
<td>8.1</td>
<td>26.1</td>
</tr>
<tr>
<td>Ruts</td>
<td>8.0</td>
<td>22.1</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>NS</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Average yield decrease is 15%

Harvested 3 of the 7 plots