Does Organic Matter Really Matter?

Jodi DeJong-Hughes
Regional Extension Educator, Willmar
320-235-0726 x 2006
dejon003@umn.edu
Soil health affects the **resiliency** of the soil or the ability of a soil to **resist adverse changes** and return to a new equilibrium.
Specific to each soil type
**Dynamic** - producer can change soil health with management
Components of Soil Health

- Biological
- Chemical
- Physical
Biological Components

- Organic matter (OM)
- Microorganisms (MO’s)
- Plant roots
- Large and small flora and fauna
Soil Organic Matter

- Food for soil organisms
- Decreases bulk density
- Plant nutrient source
Soil Organic Matter

- Buffers soil pH
- Enhances biological diversity
- Improves soil structure
- Approx 50% carbon
SOM in the United States

Hargrove and Luxmoore
65% of mo’s live in top 12” of soil

Bacteria

Actinomycetes

Nematodes

Fungi
In One Cup of Soil There Are…

• Over 9 billion mo’s
• 600 million bacteria (over 4,000 species)
• 5T of biomass/acre

E. Ingham (www.soilfoodweb.com)
Functions

- Store and release nutrients
- Improve soil aggregation
- Biological and physical protection of diseases
- And much more
Mycorrhizae

Aerobic fungi need:

• Soil moisture at field capacity
• Soil pH around 6.5 to 7.0
• Sunlight
• Nutrients
Arbuscular Mycorrhizae (AM)

- Can convert insoluble nutrients, mainly phosphorus, into biological form
- Form a physical barrier around the root
- Bring in nutrients and water
Chemical Components

- pH
- Nutrient holding capacity
- Nutrient availability
- Salts
CEC

- Major source of nutrients like K, Ca, Mg, NH$_4$, Zn, and Cu

- The higher the CEC:
  - Longer the soil will hold the nutrients
  - Protect from nutrients leaching
  - pH will remain consistent over longer periods of time (*buffered*)
CEC based on:

- Soil texture
- Organic matter percent
Nitrogen Cycle - Inputs

Nitrogen Gas ($N_2$)

- N Fertilizer, $NH_3$, $NO_3^-$
- Legume $N_2$ Fixation
- Plant residue and manure
Nitrogen Cycle

Nitrogen Gas ($N_2$)

- N Fertilizer, $NH_3$, $NO_3^-$
- Legume $N_2$ Fixation
- Plant residue and manure

- Mineralization
- Immobilization
- Nitrification
- $NH_4^+$
- $NO_3^-$
Nitrification (aerobic)

a. Nitrosomonas

\[ \text{NH}_4^+ + 1.5 \text{O}_2 \rightarrow \text{NO}_2^- + 2\text{H}^+ + \text{H}_2\text{O} \]

Ammonium to Nitrite

b. Nitrobacter

\[ \text{NO}_2^- + 0.5 \text{O}_2 \rightarrow \text{NO}_3^- \]

Nitrite to Nitrate
Temperature and Leaching Potential

<table>
<thead>
<tr>
<th>Date Applied</th>
<th>Soil Temp at 6”</th>
<th>Converted to NO$_3$ in 2 weeks (lb/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct 7</td>
<td>60</td>
<td>70 (~50%)</td>
</tr>
<tr>
<td>Oct 15</td>
<td>45</td>
<td>20 (~15%)</td>
</tr>
<tr>
<td>Oct 24</td>
<td>37</td>
<td>5</td>
</tr>
</tbody>
</table>

150 lb/a Urea applied

Averaged over no-till, chisel and moldboard
Nitrogen Cycle - Outputs

Nitrogen Gas ($N_2$)

- **Legume $N_2$ Fixation**
- **Plant residue and manure**
- **Crop removal**

- **Volatilization**
  - $NH_4^+ \rightarrow NH_3$

- **Mineralization**
  - $NH_4^+$

- **Immobilization**
  - $NH_4^+ + NO_3^-$

- **Nitrification**
  - $NO_3^- \rightarrow N_2 + N_2O$

- **Leaching**
Denitrification (anaerobic)

**13 different bacteria:**

\[ \text{NO}_3^- \rightarrow \text{NO}_2^-, \text{NO}, \text{N}_2\text{O}, \text{N}_2 \]

Nitrate to gaseous forms of N
(nitrite, nitric oxide, nitrous oxide, N gas)

Can lose up to 2-4 pounds/acre/day
Nitrogen Mineralization in MN

- Organic matter stores 1,000 # of N/ac
- Only a small percent is mineralized each year*:
  - NW – 10 #/ac per percent
  - WC – 15 #/ac
  - SW – 20 #/ac
  - SE – 25 #/ac

*based on temperature and precipitation
What is the Nutrient Value of Soil Organic Matter??

Assumptions:
2,000,000 lbs. soil in top 6 in.
1% organic matter = 20,000 lbs.
## Nutrients

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Amount</th>
<th>Price/Unit</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>1,000 lbs</td>
<td>$0.63/lb</td>
<td>$630</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>100 lbs</td>
<td>$0.60/lb</td>
<td>$60</td>
</tr>
<tr>
<td>Potassium</td>
<td>100 lbs</td>
<td>$0.42/lb</td>
<td>$42</td>
</tr>
<tr>
<td>Sulfur</td>
<td>100 lbs</td>
<td>$0.45/lb</td>
<td>$45</td>
</tr>
<tr>
<td>Carbon</td>
<td>10,000 lbs or 5 ton</td>
<td></td>
<td>$0</td>
</tr>
</tbody>
</table>

**Value of 1% SOM Nutrients/Acre** ~$775
Physical Components

- Aggregation
- Porosity
- Bulk density
- Water movement, availability and storage
Water Dynamics and OM

- 1% of OM can hold 27,000 gallons of water per acre

- Decreases evaporation
Leave some residue intact
Many Benefits from Soil Structure
#1 Natural Defense Against Soil Compaction

And Tillage DESTROYS Structure!
Water Stable Aggregates

photo by Ray Weil
Recap

Soil health is the lifeline for *your* soil
Many Factors Affect Soil Health

- Texture
- Topography
- Climate
- Organic matter
- Aggregation
- Water holding capacity
- Drainage
- Bulk density

We can manage
Management #1

Provide a Longer and More Diverse Food Source

Will Affect Biological and Chemical and Physical
Satellite Images of Vegetative Activity

April 20 – May 3

May 18 - 31
Satellite Images of Vegetative Activity

June 15 - 28

July 13 - 26
Satellite Images of Vegetative Activity

October 5 - 18
Crop Rotation
## Carbon in Manure

<table>
<thead>
<tr>
<th>Specie</th>
<th>Liq./Dry</th>
<th>Carbon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy</td>
<td>Dry</td>
<td>35 #/T</td>
</tr>
<tr>
<td></td>
<td>Liq.</td>
<td>39 #/1000 gal</td>
</tr>
<tr>
<td>Beef</td>
<td>Dry</td>
<td>30 #/T</td>
</tr>
<tr>
<td>Swine</td>
<td>Liq.</td>
<td>39 #/1000 gal</td>
</tr>
<tr>
<td>Poultry</td>
<td>Dry</td>
<td>34 #/T</td>
</tr>
</tbody>
</table>

Samples taken in 2004, AgVise Analysis
### MO Plate Counts

<table>
<thead>
<tr>
<th>Trt</th>
<th>MO Biomass (ug/g)</th>
<th>Fungi (cfu/g)</th>
<th>Bacteria (x1,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manured</td>
<td>371</td>
<td>29.6</td>
<td>2,920</td>
</tr>
<tr>
<td>Non-manured</td>
<td>204</td>
<td>17.8</td>
<td>1,670</td>
</tr>
</tbody>
</table>

Samples taken at the WCROC on July 18\textsuperscript{th}, 2002 on soybean fields.

ARS analyzed soil samples.
Management #2

Reduce Tillage

Will Affect Biological and Chemical and Physical
Effect of Tillage on Organic Matter

Soil Organic Matter (%)

0-3 INCH DEPTH

Mold Board
Plow
Deep Tillage
No-Till
Sod

G. Hoyt, 2005
MR. GEM
Tillage-Carbon Study

2,844 lb. organic matter/ac from residue of previous wheat crop

Reicosky and Lindstrom, 1993
Tillage and Microbes

- Buried residue is exposed to greater MO activity
- Decrease the density of the soil = faster warm-up
- Break-up of soil aggregates exposes organic matter to MO activity
Percent Residue

Water Erosion

Wind Erosion

Adapted from Dickey at al., 1984
The Value of Snirt
<table>
<thead>
<tr>
<th>Nutrient</th>
<th>$/lbs</th>
<th>Lbs of Nutrient Lost/Acre</th>
<th>Money Lost/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>T Nitrogen</td>
<td>$0.63</td>
<td>55</td>
<td>$34.65</td>
</tr>
<tr>
<td>T Potassium</td>
<td>$0.42</td>
<td>37</td>
<td>$15.54</td>
</tr>
<tr>
<td>T Phosphorus</td>
<td>$0.60</td>
<td>13</td>
<td>$ 7.80</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>$57.99/ac</strong></td>
</tr>
</tbody>
</table>

Ave - 9T/ac of soil accumulated in ditch (2-33 T/ac)
TN 8-173#/ac, TP 2-47#/ac, TK 5-124#/ac
Residue Makes a Difference
SOM Benefits to Farmer

- Get into the fields sooner after rainfall
- Less plant stress during dry months
• Potential for higher N mineralization

• Break up pest cycles
Less compaction

Less fuel, labor and parts
Less erosion

Soil and nutrients stay in field

Photo by Dorian Gatchell
Tillage Economics ($/acre)

- NT: $13.05
- ST: $29.80
- CP: $45.65
- DR: $55.10
- MBP: $56.65
Equals...
Bottom Line

You manage this resource
Any Questions?

WHY AM I NAKED? I'M STRIP TILLING YOU DARN FOOL!