Developing a farmer friendly soil organic matter calculator

Rafiq Islam, Vinayak Shedekar, and Randall Reeder
Ohio State University

Jerry Grigar
USDA-NRCS Michigan, State Agronomist

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Soil Organic Matter

- **Goal:** maintain *Soil Organic Matter*

- There are few tools available to quantify SOM changes when crop residue is removed
Soil organic matter is the nation’s most precious resource.”

Daniel Albright, 1938, “Soils and Men”
It requires 4000 to 6000 pounds of crop residue just to maintain the soil organic matter.

And this depends on the soil type, tillage, and climate.
Go beyond “T” and manage for “C”!

Substitute “C” for “T” in erosion and soil quality control!
CCA’s asked: “What’s the Bottom Line? How does selling residue for Bio-fuel affect my cash flow and SOM/soil health?”
What is Corn Residue Worth?
Harvest Efficiency?

50 %
## Residue- Nutrient Value

<table>
<thead>
<tr>
<th>Residue Type</th>
<th>N</th>
<th>P$_2$O$_5$</th>
<th>K$_2$O</th>
<th>$$/ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley Straw</td>
<td>13</td>
<td>3.2</td>
<td>52</td>
<td>$38.80</td>
</tr>
<tr>
<td>Corn Stover</td>
<td>22</td>
<td>8.2</td>
<td>32</td>
<td>$36.90</td>
</tr>
<tr>
<td>Oat Straw</td>
<td>13</td>
<td>2.8</td>
<td>57</td>
<td>$41.34</td>
</tr>
<tr>
<td>Rye Straw</td>
<td>8.6</td>
<td>3.7</td>
<td>21</td>
<td>$19.44</td>
</tr>
<tr>
<td>Wheat Straw</td>
<td>13</td>
<td>3.3</td>
<td>23</td>
<td>$22.99</td>
</tr>
</tbody>
</table>

Source: MSUE Bulletin E-550 Table 1: Nutrient removal ... MI field crops ;& local Fertilizer prices : N- 28% $385/ton; P$_2$O$_5$- MAP-640/ton ; K$_2$O - $570/ton
Residue for Bio-Energy Goal

GOAL = SOM GAINS = or < SOM LOSSES

Quantify SOM (Lbs./ac)?

• Change rotation
• Adopt No tillage
• Add manure or cover crops
• Add Irrigation
• Sell crop residue
Alternative C Sources to maintain SOM if selling residue for bio-energy?

• Manure
• Cover Crops
• Crop Rotation
• Tillage/No-tillage
• Water management
The “Founding Fathers”!

Dr. Robert Lucas

Dr. David Jenkinson
Lucas Model to predict SOM

- Developed by Dr. Robert Lucas at MSU.

- A two-pool exponential decay model that uses decomposition constants based on Plant Residue Equivalent (PRE).

- Tested by Dr. Lucas and myself using data from several long-term Michigan State University SOM research studies.
Soil Organic Matter Pools

- Active (living) new
- Stable (dead)
- Slow (very dead) old
Farmer-friendly Soil Organic Matter Calculator

Project funded by

Corn Marketing Program of Michigan

- User-friendly software for predicting soil organic matter, nutrients and overall soil quality.
- Management guidelines which farmers can use to ensure the long term viability and sustainability of Michigan agriculture.
## Lucas OM Model Version 1.5x

### Data Entry Form

<table>
<thead>
<tr>
<th>Rotation</th>
<th>Years</th>
<th>Crop</th>
<th>Yield (bu/ac)</th>
<th>PRE</th>
<th>SOM %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Corn</td>
<td>120</td>
<td>9240</td>
<td>1.00</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>Soybeans</td>
<td>55</td>
<td>7331</td>
<td>0.00</td>
</tr>
</tbody>
</table>

### Tillage Depth

- 0: No-till
- 7: Conventional

### Tillage Type

- 0: No-till
- 1: Conventional

### Average PRE (Crop)

- 5524

### Residue Removal Rate

- \% 0 after every 1

### Residue Removal (lbs/acre-year)

- 0

### Average PRE 5 yrs before 1990

- 8285

### Manure Type

- NONE

### Manure PRE (lbs/ton)

- 0

### Manure Rate (tons/ac)

- 5

### Average Manure PRE (lb/ac)

- 0

### Overwrite Crop PRE (lbs/ac)

- 0

### Erosion Rate (tons/acre per year)

- 3

### Dominant Tillage Type

- No-till

### Cropping System

- Corn-Soybean Rotation

### Overwrite Weight of Furrowslice (lbs/ac)

- 2,410,320

### Soil Bulk Density (lbs/cu.ft)

- 1.1

### Crop Rotation

<table>
<thead>
<tr>
<th>Previous Crops</th>
<th>Crop</th>
<th>Yield (bu/ac)</th>
<th>Estimated PRE</th>
<th>Total PRE</th>
<th>Avg Crop PRE</th>
<th>Active OM Pool</th>
<th>Old OM Pool</th>
<th>OM Pool %</th>
<th>Cumulative Per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Corn</td>
<td>1990</td>
<td>120</td>
<td>8285</td>
<td>5468</td>
<td>47559</td>
<td>53027</td>
<td>2.200</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Soybeans</td>
<td>1991</td>
<td>55</td>
<td>972</td>
<td>5933</td>
<td>47574</td>
<td>53507</td>
<td>2.207</td>
<td>0</td>
</tr>
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<td></td>
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<td>1992</td>
<td>120</td>
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<td>0</td>
</tr>
</tbody>
</table>

### Fertilizers

- Adequate (Recommended)

### Drainage Type

- Subsurface Drainage

### Manure Recommendations

- Beef Cow, calf, pasture paddies

### Initial SOM (%)

- 2.2

### Old OM Decay rate (%)

- 1.1

### Cumulative Crop Yield

- Unit: bu/ac

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**Note:** The table above represents a specific scenario within the Lucas OM Model. It includes data entry forms, tillage type, average PRE, manure type, erosion rate, cropping system, overwriting weight of furrowslice, soil bulk density, and cumulative crop yield.
Cont. Corn Erosion Study- 20 yr.
2 ton mulch added

<table>
<thead>
<tr>
<th></th>
<th>Ave</th>
<th>Mulch</th>
<th>Soil Test SOM</th>
<th>SOC Predicted</th>
<th>Model error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marlette Loam Erosion</td>
<td>bu/ac</td>
<td>Rate**</td>
<td>1985</td>
<td>2004</td>
<td>SOM%</td>
</tr>
<tr>
<td>Slight</td>
<td>126</td>
<td>2 ton</td>
<td>1.1</td>
<td>1.4</td>
<td>1.57*</td>
</tr>
<tr>
<td>Moderate</td>
<td>108</td>
<td>2 ton</td>
<td>0.9</td>
<td>1.3</td>
<td>1.35</td>
</tr>
<tr>
<td>Severe</td>
<td>83</td>
<td>2 ton</td>
<td>0.7</td>
<td>1.3</td>
<td>1.25</td>
</tr>
</tbody>
</table>

*8- inch furrow slice. Annual SOM decay 1.3%.

**Used SOC Manure source for straw- Beef Finishing, straw solid @ 2tons/acre  Added each year beginning in 1993

Source: Dr. Del Mokma-MSUE Soil Scientist unpublished data  Assumed 8 inch furrow slice
Cont. Corn Erosion Study- 20 yr.

<table>
<thead>
<tr>
<th>Marlette Loam</th>
<th>Ave bu/ac</th>
<th>NO MULCH</th>
<th>Soil Test</th>
<th>SOM</th>
<th>SOC</th>
<th>Predicted</th>
<th>Model error</th>
<th>SOM%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erosion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slight</td>
<td>129</td>
<td>no</td>
<td>1.1</td>
<td>1.4</td>
<td>1.49*</td>
<td>.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>120</td>
<td>no</td>
<td>0.9</td>
<td>1.3</td>
<td>1.29</td>
<td>.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>96</td>
<td>no</td>
<td>0.7</td>
<td>1.2</td>
<td>1.28**</td>
<td>.08</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*8- inch furrow slice. Annual SOM decay 1.3%. Added straw @ 2 ton/ac beginning 1993

** Bulk density of 1.8 reduced plow depth to 6-inch furrow slice

Source: Dr. Del Mokma-MSUE Soil Scientist unpublished data  Assumed 8 inch furrow slice
% OM Change With 3% /yr yield gain & Annual Crop Residue Removed

85 bpa

- 6000 lb
- 6000 + 3%
- 4000 lb
- 4000 + 3%
- 2000 lb
- 2000 + 3%
Cont Corn + 3% yield gain/year & residue for energy

85 bpa
Cont. Corn 85 bpa & 1,2,3 % yield gain/yr - 2000 lb residue

85bpa

2000 lb
2000+1%
2000+2%
2000 + 3%
% OM Morrow Plots IL

Continuous Corn - Moldboard Plow
10 ton Manure / yr & 2000 lb residue removal

Continuous Corn Loamy Sand 85 b/a

85 bpa
Continuous Corn 85 b/a Loamy Sand

85 bpa/yr

10 ton beef manure/yr 1, 2 or 3 ton residue removed