Assessing Soil Amendments for Agriculture

Opportunities and Challenges

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Ministry of Agriculture, Food & Rural Affairs
Outline

• Why should we care about soil health?
• What are the organic amendment options for agriculture?
• What are the challenges?
• Where are the opportunities?
Currently many Ontario fields are:

- Over tilled
- Eroded
- Low or decreasing soil organic matter

= Improved Sustainability

**The Goal:**

- ↑ forages/cover crops in the rotation
- Residue management = ↑ 30% cover all year
- Regular organic matter additions
Impact of Rain on Poor Structured Soils

Thunder storms often deposit a lot of rain in short timeframe. Rain can’t infiltrate into soil quickly enough, resulting in runoff and erosion.
Sheet, Rill and Gully erosion rob fields of topsoil and nutrients
Impact of Rain on Poor Structured Soils

Runoff results in concentrated overland flow and ponding
Eroded top soil results in poor crop growth
What is Soil Health?

Defined as "the soil’s fitness to support crop growth without becoming degraded or otherwise harming the environment."

from AAFC Health of Our Soils Report
Soil Function, Soil Properties and Soil Health

**PHYSICAL**
- Aggregate Stability
- No Compaction
- Water Infiltration

**CHEMICAL**
- pH balance (6.5 to 7.2)
- Macro/micro nutrients in balance (N, P, K, Mg, Ca, S, Mn, Zn)
- Nutrient cycling

**BIOLOGICAL**
- High Organic Matter Levels in Soil
- High Earthworm population
- Soil micro-organisms – Soil Respiration

**SOIL BALANCE**

[Diagram showing soil balance with organic matter in the center, connected to physical, chemical, and biological aspects.]
Different Amendments provide Different Benefits to Soil

Organic amendments provide a variety of food for a diverse soil microbial population.

- **Cover crops**
- **Digestate**
- **Manure/Biosolids**
- **Compost**
Diversity benefits the soil

Bacteria

- sugars
- cellulose
- proteins
- hemicellulose
- polyphenols
- lignin
- humus

Actinomycetes

Fungi

Cover crops

Sugars

Cellulose

Proteins

Hemicellulose

Polyphenols

Lignin

Humus
### Video Clip 1 – Rainfall Simulator

<table>
<thead>
<tr>
<th></th>
<th>Soil Type</th>
<th>Land Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Brant Silt Loam</td>
<td>Pasture</td>
</tr>
<tr>
<td>2</td>
<td>Beverly Silty Clay</td>
<td>Grapes - Tillage</td>
</tr>
<tr>
<td>3</td>
<td>Beverly Silty Clay</td>
<td>Grapes – No-Till</td>
</tr>
<tr>
<td></td>
<td></td>
<td>manure + compost</td>
</tr>
<tr>
<td>4</td>
<td>Walsher Loamy</td>
<td>Fine Sand</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dairy rotation</td>
</tr>
<tr>
<td>5</td>
<td>Gobles Clay Loam</td>
<td>Corn-Soy-Wheat (red clover)</td>
</tr>
</tbody>
</table>

Showing the impact of soil health using rainfall simulator
Aggregate Stability in soil:
The glue that holds the soil together

Corn-Soybean Rotation
Conventional Tillage

Long term sod
no tillage
Showing Aggregate Stability from Organic Amendments

1. Brant Silt Loam
   - Pasture

2. Beverly Silty Clay
   - Grapes - Tillage

3. Beverly Silty Clay
   - Grapes – No-Till
   - manure + compost

4. Walsher Loamy
   - Fine Sand
   - Dairy rotation

5. Gobles Clay Loam
   - Corn-Soy-Wheat
   - (red clover)

Video Clip 2 – Aggregate Stability
Putting it all together

When inputs or losses are changed, SOM quantity changes to a different level and a new steady state condition is reached….but it take time
Organic Amendment Synergy

Cover Crops without digestate

Cover Crops with digestate
- More top growth and root biomass
**Digestate – Cover crop Synergy?**

**Multi species cover crop mix**
- No Digestate ~1.75 ton/ac dm

- Multi species cover crop mix
- With Digestate ~2.1 ton/ac dm

**33% Oats**
- 4% Nitro Radish
- 2% Vivant Hybird Brassica
- 2% Sorghum Sundangrass
- 1% Phacelia
- 2% Sunflowers
- 4% Sun Hemp
- 5% Turnips
- 24% Crimson Clover
- 23% Austrain Winter Peas

40 lbs/ac seeded
## Approximate Biomass Yield of Three Cover Crop Mixes with and without Organic Amendments

<table>
<thead>
<tr>
<th>Cover Crop</th>
<th>With Manure</th>
<th>Without Manure</th>
<th>Increase from manure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Approximate Yield (ton/ac)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oats</td>
<td>3.6</td>
<td>2.8</td>
<td>33 %</td>
</tr>
<tr>
<td><strong>Multi-Species Mix: Planted at 40 lbs/ac</strong></td>
<td>2.10</td>
<td>1.75</td>
<td>17 %</td>
</tr>
<tr>
<td>33% Oats, 4% Nitro radish, 2% Brassica, 2% Sorghum Sudangrass, 1% Phacelia, 2% Sunflowers, 4% Sun hemp, 5% Turnips, 25% Crimson Clover, 23% Austrian Peas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>3 Species Mix: Planted at 30 lbs/ac</strong></td>
<td>2.85</td>
<td>1.83</td>
<td>36 %</td>
</tr>
<tr>
<td>14% Nitro Radish, 16% Crimson Clover, 70% Oats</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* biomass yield that includes top-growth and comparative root mass
The above data represents one site—one year
Sources of Organic Matter
(& Nutrients)

- Cover crops
- Manure
- Biosolids
- Biosolids Pellets
- N-Viro
- Biochar
- Digestate
- Lystegro
- Compost (manure & municipal)
### Organic Amendments Comparison – Matching material with needs

Estimates in this chart are based on lab analysis – it is always recommended that organic amendments be sampled for “manure” analysis at time of application.

<table>
<thead>
<tr>
<th>Description</th>
<th>Dairy Compost</th>
<th>Lystek</th>
<th>SSO Greenbin Compost</th>
<th>Biosolids Pellets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw press separator then compost</td>
<td>30.8%</td>
<td>616</td>
<td>Processed biosolid, high pH, high nitrogen material. CFIA registered</td>
<td>76.6</td>
</tr>
<tr>
<td>Dry Matter %</td>
<td>0.54</td>
<td>3.2</td>
<td>12-13%</td>
<td>2.78</td>
</tr>
<tr>
<td>Total Nitrogen %</td>
<td>16</td>
<td>2,238</td>
<td>16.8 + 8.7 = 25.5</td>
<td>0.62</td>
</tr>
<tr>
<td>NH₄-N (ppm)</td>
<td>0.10</td>
<td>0.34</td>
<td>62.6 (P₂O₅)</td>
<td>0.77</td>
</tr>
<tr>
<td>Phosphorus %</td>
<td>0.20</td>
<td>0.29</td>
<td>31.1 (K₂O)</td>
<td>51.6</td>
</tr>
<tr>
<td>Potassium %</td>
<td>16.4</td>
<td>5.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organic Matter %</td>
<td>7.6</td>
<td>9.5</td>
<td>7.6</td>
<td>6.3 - 6.8</td>
</tr>
<tr>
<td>pH</td>
<td>49 : 1</td>
<td>6 : 1</td>
<td>13 : 1</td>
<td></td>
</tr>
<tr>
<td>Bulk Density (kg/m³)</td>
<td>599</td>
<td>37.4</td>
<td>455</td>
<td>590-800</td>
</tr>
<tr>
<td>Sulphur (ppm)</td>
<td>734</td>
<td>1.5</td>
<td>3,966</td>
<td>9,000</td>
</tr>
<tr>
<td>EC (conductivity) (ms/cm)</td>
<td>1.35</td>
<td>1.7</td>
<td>15.68</td>
<td>0.13</td>
</tr>
<tr>
<td>Sodium %</td>
<td>0.07</td>
<td>1.4</td>
<td>0.86</td>
<td>14,500 - 44,200</td>
</tr>
<tr>
<td>Aluminum (ppm)</td>
<td>399</td>
<td>0.8</td>
<td>1.726</td>
<td>10,700 - 40,200</td>
</tr>
<tr>
<td>Boron (ppm)</td>
<td>12</td>
<td>0.02</td>
<td>20.4</td>
<td>0.4 - 0.6</td>
</tr>
<tr>
<td>Calcium (%)</td>
<td>1.58</td>
<td>32</td>
<td>3.98</td>
<td>4.3</td>
</tr>
<tr>
<td>Copper (ppm)</td>
<td>1.398</td>
<td>2.8</td>
<td>1.970</td>
<td>330 - 550</td>
</tr>
<tr>
<td>Iron (ppm)</td>
<td>11.2</td>
<td>0.02</td>
<td>41.3</td>
<td>330 - 550</td>
</tr>
<tr>
<td>Magnesium (%)</td>
<td>64</td>
<td>0.13</td>
<td>90.9</td>
<td>330 - 550</td>
</tr>
<tr>
<td>Zinc (ppm)</td>
<td>54.3</td>
<td>0.11</td>
<td>385.5</td>
<td>330 - 550</td>
</tr>
<tr>
<td>Description:</td>
<td>OrgaWorld Compost-Ottawa</td>
<td>Miller Compost</td>
<td>Try Recycling Compost</td>
<td>Peel Region Compost</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------</td>
<td>---------------</td>
<td>----------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Analysis</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
<tr>
<td>Available^1 (lbs/ton)</td>
<td>81.9</td>
<td>49.5</td>
<td>61.7</td>
<td>57.9</td>
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<tr>
<td>Dry Matter %</td>
<td>1,638</td>
<td>990</td>
<td>1,234</td>
<td>1,158</td>
</tr>
<tr>
<td>Total Nitrogen %</td>
<td>1.54</td>
<td>0.89</td>
<td>0.98</td>
<td>1.43</td>
</tr>
<tr>
<td>NH₃-N (ppm)</td>
<td>1.143</td>
<td>16</td>
<td>142</td>
<td>840</td>
</tr>
<tr>
<td>Phosphorus %</td>
<td>1.84</td>
<td>8.8</td>
<td>7.7</td>
<td>13.2</td>
</tr>
<tr>
<td>Potassium %</td>
<td>0.50</td>
<td>0.24</td>
<td>0.21</td>
<td>0.36</td>
</tr>
<tr>
<td>Organic Matter %</td>
<td>46.9</td>
<td>21.2</td>
<td>30.2</td>
<td>42.3</td>
</tr>
<tr>
<td>pH</td>
<td>8.4</td>
<td>8.1</td>
<td>7.6</td>
<td>8.2</td>
</tr>
<tr>
<td>C:N ratio</td>
<td>17:1</td>
<td>17:1</td>
<td>13:1</td>
<td>16:1</td>
</tr>
<tr>
<td>Bulk Density</td>
<td>351 kg/m³</td>
<td>630 kg/m³</td>
<td>596 kg/m³</td>
<td>349 kg/m³</td>
</tr>
<tr>
<td>Sulphur (ppm)</td>
<td>3,106</td>
<td>1,073</td>
<td>1,171</td>
<td>1,313</td>
</tr>
<tr>
<td>EC (conductivity) (μS/cm)</td>
<td>6.3</td>
<td>3.83</td>
<td>3.15</td>
<td>5.86</td>
</tr>
<tr>
<td>Sodium %</td>
<td>0.57</td>
<td>0.09</td>
<td>0.07</td>
<td>0.34</td>
</tr>
<tr>
<td>Aluminum (ppm)</td>
<td>3,785</td>
<td>2,267</td>
<td>2,183</td>
<td>670</td>
</tr>
<tr>
<td>Boron (ppm)</td>
<td>17.7</td>
<td>10.4</td>
<td>15</td>
<td>24.7</td>
</tr>
<tr>
<td>Calcium (%)</td>
<td>3.68</td>
<td>3.45</td>
<td>3.70</td>
<td>2.48</td>
</tr>
<tr>
<td>Copper (ppm)</td>
<td>37.4</td>
<td>37.9</td>
<td>35.5</td>
<td>14.9</td>
</tr>
<tr>
<td>Iron (ppm)</td>
<td>6,404</td>
<td>5,584</td>
<td>5,644</td>
<td>1,492</td>
</tr>
<tr>
<td>Magnesium (%)</td>
<td>0.61</td>
<td>0.29</td>
<td>0.79</td>
<td>0.23</td>
</tr>
<tr>
<td>Manganese (ppm)</td>
<td>199</td>
<td>218.5</td>
<td>219.2</td>
<td>68.6</td>
</tr>
<tr>
<td>Zinc (ppm)</td>
<td>109</td>
<td>93.9</td>
<td>251.0</td>
<td>51</td>
</tr>
</tbody>
</table>
## Comparison of Organic Amendments

<table>
<thead>
<tr>
<th></th>
<th>Solid Cattle</th>
<th>Biosolid Pellets (Toronto)</th>
<th>N-Viro (Sarnia)</th>
<th>Municipal Greenbin Compost AIM - Hamilton</th>
<th>Red Clover plowdown</th>
<th>Digestate Solids (Niagara)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dry Matter</strong></td>
<td>35.9</td>
<td>95.1</td>
<td>77.0</td>
<td>47.8</td>
<td>26</td>
<td>37.5</td>
</tr>
<tr>
<td><strong>Lbs per ton</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total N</strong></td>
<td>14</td>
<td>92</td>
<td>11.4</td>
<td>31</td>
<td>12</td>
<td>17.8</td>
</tr>
<tr>
<td><strong>Available N</strong></td>
<td>4</td>
<td>47</td>
<td>4</td>
<td>10</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td><strong>P$_2$O$_5$</strong></td>
<td>2.2</td>
<td>91 (high)</td>
<td>15</td>
<td>11</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td><strong>K$_2$O</strong></td>
<td>4</td>
<td>3 (low)</td>
<td>79 (high)</td>
<td>10</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total Salts</strong></td>
<td>---</td>
<td>5</td>
<td>32</td>
<td>8</td>
<td>---</td>
<td>1.4</td>
</tr>
<tr>
<td><strong>Carbon added</strong></td>
<td>280</td>
<td>644</td>
<td>240</td>
<td>434</td>
<td>156</td>
<td>338</td>
</tr>
</tbody>
</table>
## Composition of Organic Amendments

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Matter</td>
<td>%</td>
<td>35.9</td>
<td>94.8</td>
<td>95.1</td>
<td>77.0</td>
<td>69</td>
<td>47.8</td>
<td>44.8</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>6.3</td>
<td>6.8</td>
<td>12.6</td>
<td>6.0</td>
<td>4.9</td>
<td>5.3</td>
<td>8.3</td>
</tr>
<tr>
<td>Bulk Density</td>
<td>kg/m³</td>
<td>--</td>
<td>588</td>
<td>795</td>
<td>836</td>
<td>~338</td>
<td>~338</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>lbs/ft³</td>
<td>--</td>
<td>36.7</td>
<td>49.6</td>
<td>52.2</td>
<td>~21</td>
<td>~21</td>
<td>--</td>
</tr>
<tr>
<td>C:N Ratio</td>
<td></td>
<td>50:1</td>
<td>9:1</td>
<td>7:1</td>
<td>21:1</td>
<td>25:1</td>
<td>14:1</td>
<td>18:1</td>
</tr>
</tbody>
</table>

What is the significance of pH, bulk density and C:N ratio?
What an Agricultural Analysis Looks Like

### Table: Nutrient Analysis

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>ANALYSIS RESULT</th>
<th>POUNDS PER 1,000 GAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Matter</td>
<td>2.8 %</td>
<td></td>
</tr>
<tr>
<td>Nitrogen (Total)</td>
<td>0.442 %</td>
<td></td>
</tr>
<tr>
<td>NH4-N</td>
<td>3085 ppm</td>
<td>44.2</td>
</tr>
<tr>
<td>Phosphorus (Total)</td>
<td>0.0683 %</td>
<td></td>
</tr>
<tr>
<td>Phosphate (P as P2O5)**</td>
<td>0.1525 %</td>
<td>15.2</td>
</tr>
<tr>
<td>Potassium (Total)</td>
<td>0.0684 %</td>
<td></td>
</tr>
<tr>
<td>Potash (K as K2O)**</td>
<td>0.0797 %</td>
<td></td>
</tr>
<tr>
<td>Organic Matter *</td>
<td>1.9 %</td>
<td></td>
</tr>
<tr>
<td>Carbon:Nitrogen Ratio (C:N)</td>
<td>2 : 1</td>
<td></td>
</tr>
<tr>
<td>Sulfur</td>
<td>334.5 ppm</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>8.00</td>
<td>---</td>
</tr>
<tr>
<td>Conductivity (@ 25 deg C)</td>
<td>17.72 ms/cm</td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td>0.07 %</td>
<td>7.3</td>
</tr>
<tr>
<td>Aluminum</td>
<td>145.4 ppm</td>
<td></td>
</tr>
<tr>
<td>Boron</td>
<td>1.0 ppm</td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>0.1249 %</td>
<td>12.5</td>
</tr>
<tr>
<td>Copper</td>
<td>3.3 ppm</td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>654.4 ppm</td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.0105 %</td>
<td>1.1</td>
</tr>
<tr>
<td>Manganese</td>
<td>4.4 ppm</td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td>9.8 ppm</td>
<td></td>
</tr>
</tbody>
</table>

Helps determine macro and micro nutrient content - reduce commercial fertilizer needs - and helps determine best management.
Livestock Manure (Solid)

What Is It?
• Livestock waste with bedding materials (straw, wood chips etc)

Benefits:
• Available on-farm
• provides many of the required macro and micro nutrients (ration based)
• supplies organic matter which will help maintain or improve soil health

Challenges:
• contains odours and pathogens which,
  – can lead to water contamination
• application to wet soils
  – can cause soil compaction.
• Nutrient content
  – usually not in proportions needed by crops
• Application to crops further from manure storage
  – takes time and planning
What Is It?

• Material with specific C:N ratio and moisture content that goes through a process of heating, turning and curing provides nutrients and organic matter with reduced volume and odour compared to the original material.

Benefits:

• Provides many of the required macro and micro nutrients (ration based).
• Low odour and pathogen content.
• Low risk of nitrogen loss (leaching or volatilization).
• Supplies organic matter which will help maintain or improve soil health.

Challenges:

• Higher labour requirement than with manure.
• Could have odour issues if C:N ratio or moisture content is too high or low.
Municipal Greenbin Compost

What Is It?
• Municipal food waste mixed with high carbon materials (ie wood chips) and composted in-vessel under specific conditions to meet MOE un-restricted compost guidelines
• Analysis will vary for each facility, depends on process and length of curing.

Benefits:
• High OM product with good balance of available N-P-K and micro nutrients.
• Cured compost = low odour & low risk of N loss (leaching, volatilization)
• Uniform application is easier than with most solid manure types
• Ideally applied once in the rotation (after cereal harvest) at ~10-15 ton/acre
Municipal Greenbin Compost

Challenges:
• Low bulk density of about 20 lbs/cubic foot, makes transport expensive
• Contaminants – plastics
• Maturity – could result in class B compost = NASM 3 = more work
• Odour - Un-cured or green compost can have a distinct odour that re-occurs when wetted if material is not incorporated
• Temporary field storage can cause some compaction damage
• Timing of product availability and application
• Some variability in product – time of year input availability
• Un-incorporated, surface applied = soluble P runoff risk?
Biosolids

What Is It?
• Dried & dewatered sewage biosolids
• Pulp & paper waste
• Processing waste

Benefits:
• similar to manure from nutrient and organic matter perspective
• custom applied and applied at no cost for the farm (usually)
• regulatory changes in 2010 - application rates set to meet crop needs

Challenges:
• Sewage biosolids contain little or no potash
• contain trace elements (ie lead, copper)
• wider setbacks are required from residences and sensitive features
• setback areas = additional trip with commercial fertilizer
• regulatory requirements – NASM plan required pre-application
Biosolids Pellets

What Are They?

- Process takes digested sewage to biosolids cake (dewatered, thickening agents added) then pelletization (heating and drying) process occurs
- Regulated through CFIA - treated as a fertilizer

Benefits:

- excellent source of organic matter, nitrogen, phosphorus and micro-nutrients
- Regulated through CFIA = product consistency and no need for NASM plan
- processed biosolids pellets are available from Windsor and Toronto and are similar in nutrient content

Challenges:

- Low K = not the product of choice if potash is an important requirement
- Water treatment processes result in differences in aluminum, calcium, iron levels which could affect phosphorus availability, especially in low pH soils
- Pellets application rate restricted to meet heavy metals limits (~1 T/ha for Toronto pellets)
What Is It?

- Biosolids material processed with kiln dust to provide liming benefit
- Regulated through CFIA - treated as a fertilizer material

Benefits:

- High calcium and potassium = liming capacity
- Relatively high sulphur content
- Ideal product for sandy soils with low pH
- Regulated through CFIA = product consistency and no need for NASM plan

Challenges:

- Nitrogen contribution and organic matter is relatively low.
- N-Viro is dusty and should be applied under low wind conditions
What Is It?

- Regulated through CFIA - treated as a fertilizer material
- Patented process that combines sewage biosolids + potassium hydroxide + heat (70 °C) + a lysing process

Benefits:

- 12-13% dry matter
- ~ 30 – 27 – 31 lbs/1000 gal of available N-P_2O_5-K_2O in year of application
- relatively high sulphur (~12 lbs) and high organic matter (~ 500 lbs) content
- regulated through CFIA = product consistency - no need for NASM plan
- Custom applied

Challenges:

- Ideal rate between 3,000 – 4,000 gal/ac for corn
- High pH, high NH4-N = high volatilization risk
- Requires immediate incorporation (cover crops)
Anaerobic Digestate

What Is It?
- By-product of anaerobic digesters – main program for GHG
- Composition will vary with inputs – testing is important
- Opportunity for liquid solid separation – further composting

Benefits:
- Higher nitrogen & lower C:N ratio compared to pre-AD
- Spring application to growing crops is ideal
- Odour and pathogens lower (closed system)
- Liquid application can be difficult if N content is high

Challenges:
- Higher NH$_4$-N and lower C:N ratio – similar composition to liquid hog manure
- Higher risk = more management
  - Application rate, uniformity, timing is more important
  - High pH, high NH4-N – Higher risk of volatilization & leaching
Biochar

What is It?
• Black carbonaceous material produced from a thermochemical process (pyrolysis) of organic feedstocks
• Stable, inert material that can adsorb nutrients and increase nutrient retention without carbon release to atmosphere

Benefits:
• Increases water holding capacity when applied at high rates
• Yield response to biochar when added to fall applied liquid manure:
  – Viscosity (thickness) increased
  – Provided odour control
  – Benefit from immobilization of NH$_4$-N and NO$_3$-N to slow release / could reduce N loss

Challenges:
• Soil applied (without manure) - little or no impact on biomass or grain yield
• Difficult to handle and apply in a practical operation
• Composition influenced by feedstock and manufacturing conditions
• Supply driven by energy industry (carbon offsets) - limited Ontario supply
Opportunities with Organic Amendments

Issues:
• municipal organics production - daily
• application –
  o limited to growing season
  o no application when soils are frozen or snow covered.
• Storage of liquids is expensive
• Storage of solids (temporary field storage options)
• Solids have lower environmental risk

Opportunities: Mixing materials to match needs
• Example: high carbon solid with high N liquid can increase nutrient concentration and marketability to agriculture (e.g. digestate mixed with leaf-yard based compost)
• Example: match nutrient needs vs organic matter
• Example: match products where they have greatest benefit
Opportunities with Organic Amendments

Opportunities:

• Marketing to agriculture
  • Example immature compost – as a potential market
  • Mixing products to match niche markets
  • Government initiatives
    • Soil Health (GLASI funding for adding organic matter)
    • Lake Erie phosphorus reduction
    • Climate Change

• Improving logistics
  • Shared transportation? Improved efficiency?
  • Working with fertilizer industry
    • 4R initiative
    • Storage/marketing/application opportunities for “August-October” applications with cover crops
Summary:

- Ontario soils are at risk for erosion, compaction, OM depletion
- Farm interest in soil health is increasing
  - Cover crops, organic amendments, GPS tools, and funding programs
- Livestock manure is less available
- Municipal sources of organic amendments are increasing with urban population
- Policy to decrease organics from landfill
- Policies in soil health, great lakes water quality, climate change and pollinator health all have organic matter as a key element
- Various markets and end uses for organic waste (competition)
- Cooperative efforts in marketing, policy (red tape reduction), innovation
- The future is filled with opportunities – lets make it happen!
Summary:
BMPs (4Rs) to Maximize Nutrient & OM Value of Organic Amendments

**Right rate**
- Uniform application
- Frequent analysis - nutrient content
- Calibrate equipment - apply rate to meet crop needs

**Right application timing**
- Apply in spring or into growing crops
- Don’t apply in fall without a cover crop
- Use of nitrogen inhibitors? (late fall applications?)

**Right field**
- Select crop that needs the nutrients
- Ensure soil conditions maximize infiltration / minimize runoff

**Right placement**
- Rapid incorporation/injection to minimize ammonium-N volatilization
- Avoid concentrated deep placement to minimize leaching /movement to tile

**Right storage management**
- Permanent cover helps eliminate storage losses
- Runoff management of temporary storages (fields)
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“But... how do you know how healthy a soil is?”