Composting Manure
2006-2007 Certified Livestock Manager Training Workshops

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Outline

- What is composting?
- Pros and cons
- Conditions needed for composting
- Performance of composted manure
Some Definitions of Composting

- **Managed** decomposition of organic materials.

- **Aerobic** decomposition of manure or other organic materials at thermophilic temperature range (104 – 149°F).

- **Biological process** in which microorganisms convert organic materials (manure, sludge, leaves, paper, food wastes, etc.) into a soil-like material.
Composting is nothing new . . .

- Composting is the same process that decays organic debris in nature. Composting merely controls the conditions so that materials decompose faster.

- Overall, livestock manure is a good composting material.
What can Composting Manure Accomplish?

- Reduce manure volume
- Concentrate manure nutrients
- Reduces / eliminates weed seeds
  - Temperature & duration needed is species-dependent
- Reduces / eliminates pathogens
- Improves manure handling characteristics
  - Moisture content reduced from 80 to 20-25%
- Reduce odor of manure
- Easier to spread
  - More uniform particle size
- Value added product, if market available
- Compost being used as bedded-pack in dairy barns
Some Disadvantages of Composting Manure

- Loss & reduced availability of nutrients (NH$_3$N)
- Increased processing time
- Cost for handling equipment and labor
- Available land for composting
- Marketing
## Conditions for Rapid Manure Composting

<table>
<thead>
<tr>
<th>Condition</th>
<th>Reasonable</th>
<th>Preferred</th>
</tr>
</thead>
<tbody>
<tr>
<td>C to N ratio</td>
<td>20:1 to 40:1</td>
<td>25:1 to 30:1</td>
</tr>
<tr>
<td>Moisture</td>
<td>40 to 65%</td>
<td>50 to 60%</td>
</tr>
<tr>
<td>$O_2$ Concentration</td>
<td>&gt; 5%</td>
<td>Much &gt; 5%</td>
</tr>
<tr>
<td>Particle size, di.</td>
<td>$\frac{1}{8}$ to $\frac{1}{2}$ inch</td>
<td>Depends on material</td>
</tr>
<tr>
<td>pH</td>
<td>5.5 to 9.0</td>
<td>6.5 to 8.0</td>
</tr>
<tr>
<td>Temperature ($^\circ$F)</td>
<td>104 to 150</td>
<td>130 to 140</td>
</tr>
</tbody>
</table>

NCR Pub. 600
Another definition . . .

- **C:N Ratio**

  - The ratio of the weight of organic carbon (C) to that of total nitrogen (N) in an organic material.

  - If the ratio is too high (insufficient N), the decomposition slows.

  - If the ratio is too low (too much N), it will likely be lost in the form of ammonia gas.

  C is source of energy for microorganisms. N is a nutrient.
## C:N Ratio of Manure

<table>
<thead>
<tr>
<th>Livestock Species</th>
<th>C:N Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef feedlot</td>
<td>10:1 to 20:1</td>
</tr>
<tr>
<td>Swine</td>
<td>15:1 to 21:1</td>
</tr>
<tr>
<td>Dairy</td>
<td>8:1 to 30:1</td>
</tr>
<tr>
<td>Chicken</td>
<td>4:1 to 18:1</td>
</tr>
<tr>
<td>Broiler</td>
<td>6:1 to 24:1</td>
</tr>
<tr>
<td>Turkey</td>
<td>4:1 to 18:1</td>
</tr>
</tbody>
</table>

NCR Pub. 600
# C:N Ratios of Bulking Materials

<table>
<thead>
<tr>
<th>Material</th>
<th>C:N Ratio (common range or average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn stalk</td>
<td>60 - 73</td>
</tr>
<tr>
<td>Straw</td>
<td>80</td>
</tr>
<tr>
<td>Bark, hard woods</td>
<td>223</td>
</tr>
<tr>
<td>Bark, soft woods</td>
<td>496</td>
</tr>
<tr>
<td>Newsprint</td>
<td>398 - 852</td>
</tr>
<tr>
<td>Sawdust</td>
<td>200 - 750</td>
</tr>
<tr>
<td>Wood chips</td>
<td>641</td>
</tr>
<tr>
<td>Leaves</td>
<td>54</td>
</tr>
</tbody>
</table>

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Nutrient Availability from Composted Manure

- Cattle manure compost may lose 50 to 60% of total N. Mainly due to volatilization of NH$_3$ –N.
- Compost may contain significant amounts of nitrate-N.
- P & K concentrations in compost are > raw manure; some may be lost via leaching.
Affect of Manure on Corn Yield

- 2000 and 2001 near Boone, Iowa
- Fresh and composted hog manure (deep-bedded hoop structure) applied at total N rate of 300 lbs./acre in spring prior to planting.
- 2-year average corn yield:
  - Fresh manure: 126.0 bpa
  - Composted manure: 138.7 bpa (10% increase)

Iowa State University; Crop Sci. 44177-184 (2004)
### N Supply Efficiency of Fresh vs. Composted Manure

<table>
<thead>
<tr>
<th>Time of Application</th>
<th>Form</th>
<th>N Supply Efficiency*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>Fresh manure</td>
<td>24.3</td>
</tr>
<tr>
<td>Fall</td>
<td>Composted manure</td>
<td>34.7</td>
</tr>
<tr>
<td>Spring</td>
<td>Fresh manure</td>
<td>10.9</td>
</tr>
<tr>
<td>Spring</td>
<td>Composted manure</td>
<td>25.0</td>
</tr>
</tbody>
</table>

* N fertilizer equivalency expressed as a % of total N applied, 300 lbs./acre

Effect of 3 Bedding Types on Dairy Manure Composting

Straw, sawdust, and sand bedded dairy manures were amended w/ either sawdust or straw, and composted.

Results:
- All composts stable after 100 days
- Initial C:N ratios ranged from 25:1 to 50:1
- Manure N lost during composting was 2 to 38%
- Neg. correlation between initial compost C:N and N loss ($R^2 = 0.59$) during composting.
- An initial C:N > 40 resulted in N losses < 10% during manure composting with all 3 bedding types.

The Ohio State University, OARDC
Effect of Composted Beef Feedlot Manure on Coliform Bacteria

- 1998 and 1999 study in Alberta, Canada with windrow composting of manure from pens bedded with straw or wood chips.

- Numbers of total coliforms (TC) and *E. coli* declined as the composting period progressed.
  - > 99.9% of TC and *E. coli* was eliminated in the first 7 days when average windrow temperature ranged from 92 to 107°F.

- Type of bedding had no effect on TC or *E. coli*.

- Land application of compost instead of raw manure should significantly reduce the risk of water quality degradation.

J. Environ. Qual. 32:1508-1515
Weed Seed Viability in Composted Manure

- Weed seed viability destroyed by high temperatures (> 140°F) achieved during the process.
- Alberta, Canada study with 5 weed species in 1997 and 13 in 1999 in open-air compost windrows:
  - Compost temperatures as low as 102°F achieved over a 7-day period without turning was lethal for some weed species.
  - Some weed seeds (wild buckwheat) remained viable even after 70 days of composting.
- Factors affecting weed seed viability:
  - Temperature and duration (appear to be species-dependent)
  - Phytotoxic leachates?

Regulations?

- Generally, livestock waste composting on the farm can be conducted and the finished compost applied to farmland **without** a permit from the IEPA.

- A compost permit **is not required** if livestock manure is mixed with farm generated carbon sources such as corn stalks or wheat straw.
Summary

- 3 important factors to manage:
  - Initial C:N ratio
  - Moisture content
  - Temperature of pile

- Evaluate the composting advantages and disadvantages for your operation.

- Composting may be a good option in certain situations, and may make the generated waste more desirable to crop producers.
Thank you. Best wishes for 2007!