Composting on the Farm

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http://www.puyallup.wsu.edu/soilmgmt/
Let’s consider composting

- Time and Money
- Lack of Equipment
- Land
- Odor
- Weather
- Materials
- Nitrogen Loss
What can I compost?

- Animal manures
- Stray hay
- Vegetable matter
- Yard debris
- Wood shavings/chips
- News paper
- Animal mortalities
- Fish processing waste
Composting

Decomposition of organic materials by aerobic microorganisms under controlled conditions
This is not composting
Aerated Static Piles

Turned Windrow/piles
The Composting Process

Organic Matter, Minerals, Water, Microorganisms → Compost Pile → CO₂, O₂, Finished compost

Raw Materials:
- Organic Matter
- Minerals
- Water
- Microorganisms
A = mesophilic
B = thermophilic
C = curing
D = maturation
Phases of Aerobic Composting

Mesophilic phase: moderate temps, lasts for a few days

Thermophilic phase, high temps. Lasts from a few days to several weeks

Curing and maturation phase, moderate to ambient temps. Lasts 1-2 months.
Succession of Microbial Communities During Composting

1. Mesophilic bacteria break down soluble, readily degradable compounds (sugars, starches), initiating the compost process
Succession of Microbial Communities

2. Thermophilic bacteria take over as the temperature increases, breaking down proteins, fats, cellulose, and hemicellulose.
Succession of Microbial Communities

3. Fungi and actinomycetes are important during curing phase in attacking the most resistant compounds.
Factors that affect composting

C:N ratio
Moisture
Oxygen
Particle size
pH
Temperature
<table>
<thead>
<tr>
<th>Material</th>
<th>C:N Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compost</td>
<td>15-25:1</td>
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<tr>
<td>Grass clippings</td>
<td>15:1</td>
</tr>
<tr>
<td>Biosolids</td>
<td>5:1</td>
</tr>
<tr>
<td>Food wastes</td>
<td>15:1</td>
</tr>
<tr>
<td>Dairy manure</td>
<td>20:1</td>
</tr>
<tr>
<td>Leaves and foliage</td>
<td>60:1</td>
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<tr>
<td>Straw</td>
<td>80:1</td>
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<tr>
<td>Bark</td>
<td>115:1</td>
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<tr>
<td>Paper</td>
<td>170:1</td>
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<tr>
<td>Wood or sawdust</td>
<td>500:1</td>
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</tbody>
</table>
Carbohydrates (sugars, starches)

Cellulose

Hemicellulose

Chitin

Lignin

Fats and oils

Plant and animal structural components
Effects of Moisture on Decomposition

- Microbes need water to carry out life functions.
- Try to keep pile moisture content at 40 to 65% by weight.
Moisture

- To dry microbes can’t move round and break down organic matter

- Too wet not enough $O_2$ for aerobic microbes and produce foul odors
Oxygen Management
The Biochemistry of Microbial Breathing

Aerobic & Anaerobic respiration
Substrate (Feedstock) Quality Affects Composting Process
Effects of Particle Size and Porosity on Aeration

- Loosely packed, well structured
- Loosely packed, uniform size
- Tightly packed, uniform size
- Tightly packed, varied size
pH: Measure of Acidity or Alkalinity

- Bacterial decomposers prefer pH 6.0 to 7.5.
- Fungal decomposers prefer pH 5.5 to 8.0.
- Ideal range is 5.8 to 7.2.
- pH exceeding 7.5 can promote ammonia gas loss.

The pH Scale

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
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</thead>
<tbody>
<tr>
<td>stomach acid</td>
<td>lemon juice</td>
<td>vinegar</td>
<td>milk</td>
<td>pure water</td>
<td>blood</td>
<td>milk of magnesia</td>
<td>ammonia</td>
<td></td>
<td></td>
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</table>

Acidic [H+] Basic

Adapted from library.thinkquest.org
• **Oxygen:** aerobic vs anaerobic microbes and odor production, slower process >5%

• **Particle size:** too large won’t break down, too small effects oxygen content

• **pH:** Ideal range 5.5-8.0 high pH promotes ammonia
Temperature

PFRP Process to Further Reduce Pathogen
Pathogens

Escherichia coli, Salmonella spp., Staphylococcus aureus, Bacillus subtilis, Cryptosporidium, and Giardia are most common.
Pathogen Destruction

- Heat
- UV light
- Desiccation
- Competition
- Toxicity

Which of these are at work during composting?
Pathogen Reduction (PFRP)

Turned pile composting
At least 15 days above 131°F with 5 turns

Aerated Static piles or in vessel composting
At least 3 days above 131°F
Aerated Static Pile Composting

Maintains aerobic conditions
Controls objectionable odors
Manage pile temperatures
• Expedite active composting & curing
• Produce superior compost products
• Changes PFRP times
• Bigger piles
• Moisture needs to be right from the get go
• Potential for over aerating (heat and moisture loss)
• Disposable materials
Insulating layer is needed because edges of pile are cooler than center.

Finished Compost

Porous material

Raw Feed Stocks
Turned Windrow Composting

Controls objectionable odors
Manage pile temperatures
• Expedite active composting & curing
• Changes PFRP times
• Smaller piles
• Easier to add water
• Bigger composting foot print required
• No electricity required
<table>
<thead>
<tr>
<th></th>
<th>Reasonable ranges</th>
<th>Preferred ranges</th>
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</thead>
<tbody>
<tr>
<td>C:N ratio</td>
<td>20-40:1</td>
<td>25-30:1</td>
</tr>
<tr>
<td>H₂O content</td>
<td>40-65%</td>
<td>50-60%</td>
</tr>
<tr>
<td>O₂</td>
<td>&gt;5%</td>
<td>&gt;5%</td>
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<tr>
<td>Particle size</td>
<td>1/8-1/2in.</td>
<td>varies</td>
</tr>
<tr>
<td>pH</td>
<td>5.5-6.5</td>
<td>6.5-8.0</td>
</tr>
<tr>
<td>Temperature</td>
<td>110-150°F</td>
<td>130-140°F</td>
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</tbody>
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Turned Windrow/piles
NRCS Compost Facility Design
Ag Bag
Aerated Static Pile
Aerated Static Pile
Passively Aerated Static Pile
Turned Windrow
Turned Bins
Turned Bins
Rotating Drum
Wood Wire
Portable Bin

Earth Machine
Rotating Drum

Tilterator

Washington State University Extension
Mortality
Slaughter Waste
Offal Composting
Find a good location away from any ground water, neighbors, or other animals. Make sure there is adequate drainage.

Start with a 2-3 ft base of high carbon, absorbent material.

Add the carcass in the middle. Be sure there is at least 2 ft of the base material on each side.

Cover with another 2-3 ft of material. This is very important! If there is not enough material covering the carcass it will smell bad, attract pests, and take longer to break down.