<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection</td>
<td>Initial gathering of manure from animal confinement area</td>
</tr>
<tr>
<td>Transport</td>
<td>Movement of manure after collection</td>
</tr>
<tr>
<td>Storage</td>
<td>Containment until treatment or utilization</td>
</tr>
<tr>
<td>Processing</td>
<td>Solids separation, moisture adjustment</td>
</tr>
<tr>
<td>Treatment</td>
<td>Anaerobic, Aerobic</td>
</tr>
<tr>
<td>Utilization</td>
<td>Land application</td>
</tr>
</tbody>
</table>
Manure Handling Options

SOLID
Moisture < 70% to handle mechanically

LIQUID
Moisture > 90% to handle hydraulically
Manure “as excreted” cannot be effectively handled as a solid or liquid
Can handle as a solid, depending on type of bedding added

Standard irrigation equipment
Manure pumping equipment

“As excreted”
87-89% Water
Dairy, Beef, Swine
75% Water Poultry
## Difference in solid vs liquid

Approx. available nutrient values of animal manures (lbs/ton).

<table>
<thead>
<tr>
<th>Specie</th>
<th>Solid</th>
<th>Liquid</th>
<th>Solid</th>
<th>Liquid</th>
<th>Solid</th>
<th>Liquid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy</td>
<td>11</td>
<td>22</td>
<td>7</td>
<td>14</td>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>Beef</td>
<td>25</td>
<td>18</td>
<td></td>
<td></td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Swine</td>
<td>13</td>
<td>27</td>
<td>13</td>
<td>19</td>
<td>9</td>
<td>15</td>
</tr>
</tbody>
</table>
Manure Handling Systems

By Specie:

Beef
Dairy
Swine
Beef Cow-Calf “Pasture” Systems
Backgrounding on Pasture
Beef “Feedlot” Systems
Dairy Waste Management Systems

- Liquid Storage – Lagoon, Holding Pond, Tank
- Dry-Pack Systems - Mechanical Collection
Dairy Waste Management Systems

- **Dry-Stack Systems** – Mechanical Collection

- **Pasture Systems** – Confined only in parlor
Swine Waste Management Systems

- Shallow Pit Recharge – Lagoon Storage
- Deep Pit Collection – Under House Pit Storage
- Gutter Flush – Lagoon, holding pit
- Hoop Structure Housing – Dry Manure in Hoop
- Outdoor systems
Manure Treatment/Processing

- Solid separator
- Anaerobic digester
Solid separator

**Advantages**
- Increases handling flexibility
- Extend time between cleanout of lagoon (control odor), decrease sludge buildup
- Solids can be hauled farther

**Disadvantages**
- Solid and liquid handling equipment needed
- Solid separation may not be cost effective for small operations
Anaerobic digester

- Biochemical degradation converting OM (manure) into methane and by-products
- Covered anaerobic lagoon – 2% solids, warm climates only
- Complete mix – 3-10% solids
- Plug flow – 11-14% solids, not swine
- Odor control
Manure Application Techniques

Applying Solid Manure

- Load with front end loader
  - Truck mounted beater
  - Flail or spinner-type spreader boxes
  - Pull-type spreaders

- Limitations
  - Spreader size
  - Distance
Manure Application Techniques

Liquid manure
- Agitate before and during
- Pump from storage to hauling equipment

Limitations
- Pump flow rate
- Volume of tank
- Distance
Manure Application Techniques

- Spreading Liquid
  - Conventional tank wagon
  - Box-type spreader for liquid

- Drag hose
  - Injected and incorporated immediately
  - Continuous flow advantage
  - Distance can be disadvantage

- Lagoon
  - May or may not be agitated
  - Effluent removed by pumping (irrigation equipment)
Composting

- Natural breakdown of organic matter
- Controlled decomposition
  - Speeds the process
  - Improves the quality of the product
Advantages of composting Manure

- Reduces weight and volume
- Easier handling characteristics
- Reduce/eliminate pathogens and weed seeds
- Reduce odors
- Stabilize nitrogen
- May create a saleable product
Function of Microbes

- Feed on organic matter
- Consume oxygen
- Produce heat
- Produce carbon dioxide
- Produce water vapor
**Compost Process**

- **Raw Materials**: OM, Minerals, Water, Microbes
- **Compost Pile**: Water, Heat, CO₂, O₂
- **Finished compost**: OM, Minerals, Water, Microbes
Optimum Conditions for Composting

- Balance between carbon and nitrogen
- Adequate oxygen
- Moisture
- Temperature
C/N Ratio

- C/N ratio low – Excess N is lost as ammonia

- C/N ratio high – Microbes lack sufficient N and composting is slow
Optimum C/N Ratio?

- Composting microbes assimilate C
- Need starting ratio of 30/1 or 40/1
Optimum Oxygen Level

- Composting microbes require at least 5%
- Optimum is 10% or more
- Atmosphere is 21%
- Insufficient oxygen?
  - Anaerobic decomposition, little heat produced, slow composting
  - Produces methane and other odorous compounds
Optimum Moisture

- 40-65% water

- Composting results in water vapor
  - Start on the wetter side
Composting Temperature

- 50-105°F Mesophilic bacteria
  - Slow process, anaerobic organisms

- 105°F and higher – Thermophilic bacteria
  - Ideal composting temperatures
Ideal Composting Temps

- 110-150°F
- 131°F destroys pathogens
- 145°F destroys weed seeds
- Over 150°F may kill beneficial microbes
Composting Technologies

- Static piles
- Windrow composting
- Passively aerated windrows (PAWS)
- Forced aeration, static piles
- Enclosed (in-vessel) composting
- Vermicomposting (worms)
Windrow Composting

- Windrow 10 feet wide and 5 feet high
- Rise and then fall of temp indicates time to turn
  - Adds oxygen may need water
- No longer reheating - allow to cure
Composting Mortalities

Alternative to rendering, burying or incineration

Advantages
- Environmentally safe
- Conserves nutrients
- Low odor

Disadvantages
- High initial cost
- Labor (monitoring and maintenance)
Mortality Management

- Surround dead animal with >12 inches of bulking agent (straw or sawdust)
- Maintain moisture content of bulking agent
- Anaerobic microbes work on carcass
- Odorous gases diffuse into bulking agent where aerobic composting takes over
Mortality Management

- Compost is turned when temps drop
  - Attain 130 to 150°F
- Allow at least one more heating cycle
- 7 to 24 week process
  - Animal size
Thank you