Land Application of Waste
Why land application?

- Facilitates disposal of accumulated waste materials
  - solid manures
  - lagoon effluents
  - Wastewater treatment plant effluents
  - sludges
Why land application?

- Allows utilization of nutrients and organics in waste materials
  - good fertilizer source
  - soil conditioner
- Fairly inexpensive if transportation is limited (costs are offset by savings on commercial fertilizer purchase)
Disadvantages

- Over-application can lead to pollution of nearby waterways
- Extreme over-application may cause plant toxicity
- Wastes may contain salts that must be managed during application
- Wastes may contain pathogenic bacteria
Disadvantages (cont.)

- Balance of nutrients in the waste (N-P-K) may not match the balance of nutrients required by the crop.
- Area required for proper disposal of wastes may exceed that available to the producer.
- Producer may not provide uniform application over the required area.
What information is needed?

- Soil fertility
- Crop nutrient requirements
- Waste nutrient content
Soil Fertility

- Collect soil sample from application area
  - Analysis services provided for a nominal fee by state Extension services
- Soil test will yield suggested application rates (lb/ac) for N-P-K
  - nitrogen as N
  - phosphorus as $P_2O_5$ (phosphorus pentoxide)
  - potassium as $K_2O$ (potassium oxide)
Soil Fertility

- Convert $P_2O_5$ to elemental P

\[ P = P_2O_5 \times 0.4364 \]

0.4364 = molar mass $P_2$ / molar mass $P_2O_5 = 61.947 / 141.942$

- Convert $K_2O$ to elemental K

\[ K = K_2O \times 0.8301 \]

0.8301 = molar mass $K_2$ / molar mass $K_2O = 78.197 / 94.196$

- This will make results compatible with crop requirements and waste composition information
Crop nutrient requirements

- Available from
  - handbooks
  - county Extension agent
  - soil testing service based on soil analysis
Waste nutrient content

- Send sample to analytical lab for analysis
  - Extension lab may provide this service
- Nutrient content normally reported as
  - elemental N
  - elemental P
  - elemental K
- Nutrient content normally reported in % on mass basis (e.g., lb N/100 lb waste)
Loss of Nitrogen

- Much of the nitrogen in waste is present as ammonia which is volatile
- Losses of N occur
  - during storage (does not include time in treatment such as an anaerobic lagoon)
    - volatilization of ammonia
    - denitrification
  - during application
Liquid sludge spreading
Dried sludge spreading
Knifing in liquid sludge
Knifing with umbilical line
Sludge irrigation
**Application loss of N**

<table>
<thead>
<tr>
<th>Application Technique</th>
<th>% Loss of N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadcast application without incorporation</td>
<td>10 – 30</td>
</tr>
<tr>
<td>Broadcast with immediate incorporation</td>
<td>1 – 5</td>
</tr>
<tr>
<td>Knifing</td>
<td>0 – 2</td>
</tr>
<tr>
<td>Sprinkler irrigation</td>
<td>15 – 40</td>
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</tbody>
</table>
Plant Available Nitrogen (PAN)

- Not all nitrogen in applied waste is immediately available to plants
  - tied up as organic nitrogen in proteins and nucleic acids and other biological components

- Of N left after storage and application losses, only 50% is considered plant available nitrogen (PAN)
Basic Procedure

- Determine nutrient requirements for crop
- Determine total mass or volume of waste to be applied
- Determine nutrient content of waste
- Determine nitrogen losses and PAN
- Select nutrient to use as basis for application
Basic Procedure (cont.)

- Determine acreage required for application of waste based on selected nutrient
- Determine amounts of other nutrients applied
- Determine amounts of other nutrients required to meet crop needs or amounts over-applied to crop