NUTRIENT MANAGEMENT PLAN DEVELOPMENT AND IMPLEMENTATION

Chris Augustin, Nutrient Management Specialist, CREC 701-652-2951, Chris.Augustin@ndsu.edu, www.ndsu.edu/nm
The objective of the Nutrient Management Plan is to ensure livestock manure, including bedding, litter, waste feed and process wastewater, and runoff from livestock areas is land applied to crop or grass land at a rate the nutrients will be utilized by the vegetation grown. The manure shall be handled in a manner so as not to impact waters of the state, exceed air quality standards while it is stored on site, and minimize odors to residences or public areas during land application.
NMPs Need

- Type of livestock
- # of days/year on site
- Estimate of manure production
- Duration of manure storage
- Crop rotation
- Soil/manure test results
- Recommended fertilizer rates
  - North Dakota Livestock Program Design Manual
- Map of application and mark sensitive areas

NDSU Extension Service
North Dakota State University
NMPs Need

- Duration of manure storage
- 270 days or between empty frequency “whichever is longer.”
  - Application Frequency
  - Raw Manure/Compost
- Map of application and mark sensitive areas
### Manure Production

<table>
<thead>
<tr>
<th>Animal Type and Production Grouping</th>
<th>Total Manure</th>
<th>Moisture</th>
<th>Total Solids</th>
<th>Volatile Solids</th>
<th>N</th>
<th>P</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs/day-animal</td>
<td>ft³/day-animal</td>
<td>% wet basis</td>
<td>-----------------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td><strong>Beef</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finishing cattle</td>
<td>64</td>
<td>1</td>
<td>92</td>
<td>5</td>
<td>4.2</td>
<td>0.36</td>
<td>0.05</td>
</tr>
<tr>
<td>Confined cow³,⁴</td>
<td>-</td>
<td>-</td>
<td>88</td>
<td>15</td>
<td>13</td>
<td>0.42</td>
<td>0.097</td>
</tr>
<tr>
<td>Confined growing calf</td>
<td>50</td>
<td>0.81</td>
<td>88</td>
<td>6</td>
<td>5</td>
<td>0.29</td>
<td>0.055</td>
</tr>
<tr>
<td><strong>Dairy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lactating calf</td>
<td>150</td>
<td>2.4</td>
<td>87</td>
<td>20</td>
<td>17</td>
<td>0.99</td>
<td>0.17</td>
</tr>
<tr>
<td>Dry cow</td>
<td>83</td>
<td>1.3</td>
<td>87</td>
<td>11</td>
<td>9.2</td>
<td>0.5</td>
<td>0.066</td>
</tr>
<tr>
<td>Heifer (970 lb)</td>
<td>48</td>
<td>0.78</td>
<td>83</td>
<td>8.2</td>
<td>7.1</td>
<td>0.26</td>
<td>-</td>
</tr>
<tr>
<td><strong>Horse⁵ (1,100 lb)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sedentary</td>
<td>56</td>
<td>0.9</td>
<td>85</td>
<td>8.4</td>
<td>6.6</td>
<td>0.2</td>
<td>0.029</td>
</tr>
<tr>
<td>Intensive exercise</td>
<td>57</td>
<td>0.92</td>
<td>85</td>
<td>8.6</td>
<td>6.8</td>
<td>0.34</td>
<td>0.073</td>
</tr>
<tr>
<td><strong>Poultry</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Layer</td>
<td>0.19</td>
<td>0.0031</td>
<td>75</td>
<td>0.049</td>
<td>0.036</td>
<td>0.0035</td>
<td>0.0011</td>
</tr>
<tr>
<td><strong>Swine</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gestating sow (440 lbs)</td>
<td>11</td>
<td>0.18</td>
<td>90</td>
<td>1.1</td>
<td>0.99</td>
<td>0.071</td>
<td>0.02</td>
</tr>
<tr>
<td>Lactating sow⁶ (423 lbs)</td>
<td>25</td>
<td>0.41</td>
<td>90</td>
<td>2.5</td>
<td>2.3</td>
<td>0.19</td>
<td>0.055</td>
</tr>
<tr>
<td>Boar (440 lbs)</td>
<td>8.4</td>
<td>0.13</td>
<td>90</td>
<td>0.84</td>
<td>0.75</td>
<td>0.061</td>
<td>0.021</td>
</tr>
</tbody>
</table>

¹Total manure is calculated from total solids and manure moisture content
²As excreted manure moisture contents range from 75 to 90 percent. At these moisture levels as excreted manure has a density equal to that of water and specific gravity 1.0 was assumed in calculation of manure volume.
³Solids estimates do not include solids in urine.
⁴Beef cows values are representative of animals during non-lactating period and first six months of gestation.
⁵These values apply to horses 18 months of age or older that are not pregnant or lactating. The representative number applies to 1,100 lb horses and the range represents horses from 880 to 1320 lbs. "sedentary" applies to horses not receiving any imposed exercise.
⁶Nitrogen and phosphorus values include contribution of nursing pigs.

Adapted from ASABE Standard D384.2
## Typical Manure Analysis

<table>
<thead>
<tr>
<th>Solid Manure Type</th>
<th>Total N</th>
<th>P$_2$O$_5$</th>
<th>K$_2$O</th>
<th>NH$_4$</th>
<th>NO$_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef (142 Samples)</td>
<td>16.0</td>
<td>7.1</td>
<td>14.5</td>
<td>0.8</td>
<td>0.6</td>
</tr>
<tr>
<td>Beef Range</td>
<td>6.7 - 64.8</td>
<td>1 - 21.6</td>
<td>0.9 - 63.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Composted Beef (10 Samples)</td>
<td>16.6</td>
<td>13.0</td>
<td>14.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Composted Beef Range</td>
<td>8 - 36</td>
<td>5 - 20.2</td>
<td>9 - 19.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheep (3 Samples)</td>
<td>22.0</td>
<td>14.2</td>
<td>40.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turkey (92 Samples)</td>
<td>44.3</td>
<td>41.6</td>
<td>27.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equine (5 Samples)</td>
<td>9.4</td>
<td>9.9</td>
<td>24.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Liquid Manure Type</th>
<th>Total N</th>
<th>P$_2$O$_5$</th>
<th>K$_2$O</th>
<th>NH$_4$</th>
<th>NO$_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swine (17 Samples)</td>
<td>21.9</td>
<td>12.5</td>
<td>13.2</td>
<td>12.8</td>
<td>1.5</td>
</tr>
<tr>
<td>Swine Range</td>
<td>10.6 - 41.1</td>
<td>1.2 - 85.5</td>
<td>5 - 23.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dairy (19 Samples)</td>
<td>19.5</td>
<td>6.7</td>
<td>12.5</td>
<td>9.6</td>
<td>0.1</td>
</tr>
<tr>
<td>Dairy Range</td>
<td>8 - 40</td>
<td>0.2 - 14.2</td>
<td>1.7 - 24.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beef Containment Pond (7 Samples)</td>
<td>2.3</td>
<td>1.7</td>
<td>11.2</td>
<td>0.3</td>
<td>0.1</td>
</tr>
<tr>
<td>Swine Containment Pond (3 Samples)</td>
<td>4.7</td>
<td>1.1</td>
<td>8.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dairy Containment Pond (2 Samples)</td>
<td>3.3</td>
<td>0.5</td>
<td>3.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data collected from NDSU Soil Testing Lab.

### Compost

- 50% Total N Mineralized 1st Year
- 80% Total P Mineralized 1st Year
- 90% Total K Mineralized 1st Year
- 20% Total N Mineralized 1st Year
- 30% Total P Mineralized 1st Year
- 30% Total K Mineralized 1st Year
Manure Nutrient Balancing

- **Type of livestock**
  - 700 Finishing Beef

- **# of days/year on site**
  - 365

- **Estimate of manure production**
  - ***Beef Feeding Operation Siting and Design Basics (NM-1155)*
    - 64 lbs/day = 8,176 tons/year
    - 16 lbs N/ton = 130,816 lbs N/year
    - 7.1 lbs P/ton = 58,050 lbs P/year
    - 14.5 lbs K/ton = 118,882 lbs K/year

- **145lbs N/14 ton Corn Silage =452 acres**
  - 18 tons/acre, 128lbs P/acre
Prioritizing Fields

- **Soil fertility**
  - Apply N for crop needs
    - Corn does well with manure
  - Monitor PI
  - Do not apply manure on fields $125 \geq$ ppm P

- **Crop sequence**

- **Proximity to neighbors**
  - Be courteous about timing
  - Incorporate w/in 24 hours of application

- **Proximity to surface waters**
  - At least 100ft away from surface waters unless 35ft buffer strip or if buffer is deemed not necessary
## Prioritizing Fields

<table>
<thead>
<tr>
<th></th>
<th>Field 1</th>
<th>Field 3</th>
<th>Field 2</th>
<th>Field 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N (lbs/ac)</strong></td>
<td>28</td>
<td>42</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td><strong>P$_2$O$_5$ (ppm)</strong></td>
<td>8 (Med)</td>
<td>13 (Med-High)</td>
<td>22 (High)</td>
<td>55 (High)</td>
</tr>
<tr>
<td><strong>K$_2$O (ppm)</strong></td>
<td>181</td>
<td>90</td>
<td>121</td>
<td>354</td>
</tr>
<tr>
<td><strong>Crop/Yield Goal</strong></td>
<td><strong>Corn Silage (18ton/ac)</strong></td>
<td><strong>Corn Silage (18 ton/ac)</strong></td>
<td><strong>Alfalfa (5ton/ac)</strong></td>
<td><strong>Pasture (2ton/ac)</strong></td>
</tr>
<tr>
<td><strong>Required N (lbs/ac)</strong></td>
<td>157</td>
<td>143</td>
<td>0</td>
<td>29</td>
</tr>
<tr>
<td><strong>Required P (lba/ac)</strong></td>
<td>67</td>
<td>41</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Required K (lbs/ac)</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

- Recommended fertilizer rates
- North Dakota Fertilizer Recommendation Tables and Equations SF-882
Map of Application and Sensitive Areas
Map of Application

Livestock Unit

Fields:
- Field 1
- Field 2
- Field 3
- Field 4
- Field 5
- Field 6
- Field 7
- Field 8
- Field 9
- Field 10
- Field 11
- Field 12
- Field 13
- Field 14
- Field 15
- Field 16
- Field 17
- Field 18
- Field 19
- Field 20
- Field 21
- Field 22
- Field 23
- Field 24

Butts

N

Map of Application
Sampling Manure

- Collect 10-15 subsamples
- Mix
- Package
  - Leave 1 inch of air space
- Account for differences
  - Animals, Storage Facilities, Age
- Keep samples cool/freeze
- Send samples on Monday
Manure/Soil Testers

- NDSU Soil Science Department
  - [http://www.soilsci.ndsu.nodak.edu/services/Testing/soiltesting/soiltesting.html](http://www.soilsci.ndsu.nodak.edu/services/Testing/soiltesting/soiltesting.html)
  - 701-231-9589
- Agvise
  - 701-587-6010
- DHIA
  - 800.369.2697
- Manure Test Cost $25-50
- Soil Test Cost $10-40
Spreader Calibration

- Reduces Pollution Potential
- Ensures Proper Application
- Meet Yield Goals

- Sheet Method
- Axle Weight Method
- Manure Spreader Calibration for Nutrient Management Planning (NM-1418)

ndsu.edu/nm
SHEET METHOD

\[
\text{Tons/acre} = \frac{\text{lbs of Manure on Sheet} \times 21.8}{\text{Plastic Sheet ft}^2}
\]

- \(8' \times 2' 8.75''\)
- \(7' \times 3' 1.25''\)
- \(6' \times 3' 7.5''\)
- \(5' \times 4' 4.25''\)
SHEET METHOD

Materials

• Bucket, Scale, Sheet
• Weigh empty bucket and sheet
• Lay out the sheet
Anchor sheet
Measure square feet of sheet.
• Record tractor gear, engine RPM, and spreader settings
• Apply the manure
• Weigh the manure covered sheet in the bucket
AXLE WEIGHT METHOD

Materials

• 100ft tape measure or measuring wheel & truck scale
• Weigh manure loaded spreader
• Record tractor gear, engine
• Apply manure
• Measure the area of application
• Weigh empty spreader
AXLE WEIGHT METHOD

Tons/acre = 
\[ \frac{(\text{Ibs before} - \text{Ibs after})}{2000\text{lbs}} \] 
\[ \frac{\text{Area Applied ft}^2}{43560} \]
# AXLE WEIGHT METHOD

<table>
<thead>
<tr>
<th>Example</th>
<th>Area Applied (Square Feet)</th>
<th>Square Feet per Acre (43,560)</th>
<th>Acres Applied (Use Later)</th>
<th>Manure Loaded Spreader Weight (lbs)</th>
<th>Spreader Weight After Application (lbs)</th>
<th>÷ 2000 lbs</th>
<th>÷ Acres Applied (From Earlier)</th>
<th>= Tons of Manure per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16,438</td>
<td>43,560</td>
<td>0.377</td>
<td>37,188</td>
<td>19,321</td>
<td>2000</td>
<td>0.377</td>
<td>23.7</td>
</tr>
<tr>
<td>2</td>
<td>43,560</td>
<td>43,560</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>2000</td>
<td>=</td>
<td>=</td>
</tr>
<tr>
<td>3</td>
<td>43,560</td>
<td>43,560</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>2000</td>
<td>=</td>
<td>=</td>
</tr>
<tr>
<td>4</td>
<td>43,560</td>
<td>43,560</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>2000</td>
<td>=</td>
<td>=</td>
</tr>
</tbody>
</table>
Flag 1 = 3 field lengths/load
Flag 3 = 4 field lengths/load
2 field lengths/load for longest field length

CREC Livestock Unit

© 2010 Google Image USDA Farm Service Agency
4 tons/acre
16 tons/acre
42 tons/acre
MORE INFORMATION

Nutrient Management News
http://www.ndsu.edu/nm
http://www.extension.org
http://www.manure.umn.edu
http://www.health.state.nd.us/WQ/AnimalFeedingOperations/AFOProgram.htm
WORKS CITED


• American Society of Agricultural and Biological Engineers (ASABE). 2205. ASABE D384.2 manure production and characteristics. http://www.extension.org/mediawiki/files/f/f7/Table1and2excretion.pdf.
QUESTIONS?