Application of manure to cropland is an efficient use of the manure resource because costs are usually less than for treatment in special facilities and the manure nutrients, nitrogen, phosphorus, and potassium benefit crop growth. Manure nutrients build and maintain soil fertility. Manure improves soil tilth, increases water holding capacity, reduces water and wind erosion, improves aeration, and promotes beneficial organisms. There are two paramount objectives when applying manure to cropland:
(1) maximize use of manure nutrients by crops,
(2) minimize potential of contaminating surface water and groundwater.

Testing manure and manure wastewater for the plant nutrients, nitrogen, phosphorus, and potassium in a laboratory or by field tests is prerequisite to accurate calculation of manure application rates. Manure sampling procedures for common storages are presented to insure representative samples. Laboratory results are commonly reported as percent (wet or dry basis) and can also be as parts per million. For calculating application rates, it is more convenient to convert laboratory results for liquid manure to pounds per thousand gallons, and solid manure to pounds per ton. This worksheet provides and illustrates methods to convert laboratory results to the units desired for manure application calculations. Although manure application rates can be determined using a calculator and special forms, the method is slow and cumbersome for commercial operations with several fields and more than one crop. Matching manure nutrients to fields and crops is easily done with a program for personal computers designed for the northwest and especially Washington. MNB: Manure Nutrient Balancer (MCP0026) is available through your local Washington State University Cooperative Extension Office.

I. SAMPLE COLLECTION

A. SEMISOLID LOT MANURE

1. Scraped directly from lot into spreader: From loaded spreader, collect about 2 lbs. manure from different locations using nonmetallic collectors.

2. From storage: Collect about 2 lbs. manure from under the surface crust avoiding bedding materials and using nonmetallic collectors.

B. LIQUID MANURE SLURRY

1. Under-slotted-floor pit
a) Extend a 1/2-in. nonmetallic conduit open on both ends into manure to pit floor.
  b) Seal upper end of conduit (e.g., by placing a thumb over end of conduit) trapping manure that has entered lower end, remove and empty slurry into plastic bucket or nonmetallic container.
  c) Take subsamples from 5 or more locations totaling at least 1 quart.
  d) Mix and add about 3/4 pint to nonmetallic sample container.

2. Exterior storage basin or tank
   a) Make sure manure has been well mixed with a liquid manure chopper-agitator pump or propeller agitator.
   b) Take subsamples from about 5 pit locations, from agitator pump or from manure spreader and place in a plastic bucket.
   c) Mix and add 3/4 pint to a nonmetallic sample container.

C. LAGOON LIQUID

1. Collect about 3/4 pint of recycled lagoon liquid from inflow pipe to flush tanks in a nonmetallic sample container.

2. From lagoon
   a) Place a small bottle (1/2 pint or less) on end of 10-15 ft. pole.
   b) Extend bottle 10-15 ft. away from bank edge.
   c) Brush away floating scum or debris.
   d) Submerge bottle within 1 ft. of liquid surface.
   e) Empty into a plastic bucket, repeat about 5 times around lagoon, mix, and add 3/4 pint to nonmetallic sample container.

D. FRYER

1. House litter
   a) Visually inspect litter for areas of varying quality (e.g., areas around feeders and waterers) and estimate percent of floor surface in each area.
   b) Take about 5 litter subsamples at locations proportionate to item a. E.g., if 20% of litter of similar visual quality is around feeders and waterers, take 1 subsample there and the other 4 subsamples from remainder of floor surface.
   c) At each location, collect litter from a 6-in. by 6-in. area down to earth floor and place in a plastic bucket.
   d) After 5 subsamples have been added to the bucket, mix, and add about 2-3 lbs. litter to a nonmetallic sample container such as a 1-gallon freezer bag and seal.

2. From stockpile
   a) Take subsamples from about 5 locations at least 18 in. into pile.
   b) Mix, add 2-3 lbs. to nonmetallic sample container and seal.

II. SAMPLE PREPARATION AND TRANSFER

A. Place sample into an expandable container that can be sealed. Rinse residues from outside of container with clean water before using, but do not use disinfectants, soaps, or treat in any other way.

B. Pack sample in ice, refrigerate, freeze, or transfer to laboratory quickly.
C. Hand-delivery is most reliable way to transfer sample.

D. If mailed, protect sample container with packing material such as newspaper, box or package with wrapping paper, and tape.

E. Include the following information with sample:

1. Livestock species (dairy, swine, layer, etc.).
2. Livestock use (swine: nursery, finishing; poultry: grower, number flocks grown on litter; etc.).
3. Waste type (dairy: lot scraped manure, liquid slurry; swine: pit slurry, lagoon liquid, sludge; fryer: house litter, stockpile; etc.).

F. Laboratory analyses

1. Routine analyses performed on all samples: N, P, K.
2. Additional analyses performed upon request: Dry matter.

### III. INTERPRETATION OF ANALYTICAL RESULTS

A. Results are usually on a percent (%) of total weight or a parts per million (ppm) or milligrams per liter (mg/L) basis. Note that ppm and mg/L are the same.

B. Results may be reported on a dry weight basis (db) or on an "as is" or wet weight (wb) basis.

C. Results expressed as dry basis should be converted to wet basis before calculating land application rates by multiplying reported values by percent dry matter (percent expressed as decimal). If a dry matter analysis is not performed, average dry matter values may be obtained from appropriate tables of average characteristics.

D. If ammonium-nitrogen tests are not performed, refer also to appropriate tables for average percentages of the total nitrogen as ammonium.

E. Phosphorus and potassium results can be reported as elemental P and K or in fertilizer forms of P$_2$O$_5$ and K$_2$O. Recommended fertilization rates of various crops are usually reported as P$_2$O$_5$ and K$_2$O.

### IV. MANURE ANALYSIS CONVERSION TO WORKING UNITS

Laboratory analyses are reported as percent of total weight on a wet basis, parts per million (ppm) or the equivalent milligrams per liter (mg/L). For spreading manure you use pounds per 1,000 gallons (lb./1,000 gal.) and pounds per ton (lb./ton). Pounds per acre-inch are included because the units are convenient when using big gun sprinklers.

Conversion equations are given for liquid and solid manure with worked examples. If you test with a Slurry Meter or an Agros meter the results will be in lb./1,000 gal. as desired, but the Agros Meter tests only available N, not P and K.

The following equations and example calculations show how to convert the laboratory analysis to the values you will use. Unit conversions for liquid manure are based on the density at 60°F. Conversion from P and K to P$_2$O$_5$ and K$_2$O are accomplished by the relationships:
\[ P\text{O}_5 = P \times 2.29137 \]

\[ K\text{O}_2 = K \times 1.20459 \]

which are incorporated in the multiplier constants used in the conversion procedure. The multiplier constants were derived from basic constants using several digits for accuracy. The final multiplier constants were rounded to two or three digits as appropriate.

A. Liquid Manure - Laboratory Analysis Reported in Percent and Parts per Million.

**DAIRY LAGOON**

**EXAMPLE ANALYSIS**

TOTAL N = 0.28 % WET BASIS.

NH₄-N = 0.11 % WET BASIS.

P = 0.18 % WET BASIS.

K = 0.21 % WET BASIS.

<table>
<thead>
<tr>
<th>Component</th>
<th>Calculation</th>
<th>Example Value</th>
<th>Your Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL N</td>
<td>( \text{TOTAL N} \times 83.4 )</td>
<td>23.4 LB./1,000 GAL.</td>
<td>( \text{TOTAL N} \times 83.4 )</td>
</tr>
<tr>
<td>NH₄-N</td>
<td>( \text{NH}_4-N \times 83.4 )</td>
<td>9.2 LB./1,000 GAL.</td>
<td>( \text{NH}_4-N \times 83.4 )</td>
</tr>
<tr>
<td>P₂O₅</td>
<td>( \text{P} \times 191 )</td>
<td>34.4 LB./1,000 GAL.</td>
<td>( \text{P}_2\text{O}_5 \times 191 )</td>
</tr>
<tr>
<td>K₂O</td>
<td>( \text{K} \times 100 )</td>
<td>21.0 LB./1,000 GAL.</td>
<td>( \text{K}_2\text{O} \times 100 )</td>
</tr>
<tr>
<td>TOTAL N</td>
<td>( \text{TOTAL N} \times 2,264 )</td>
<td>634 LB./AC. IN.</td>
<td>( \text{TOTAL N} \times 2,264 )</td>
</tr>
<tr>
<td>Substance</td>
<td>Formula</td>
<td>Percentage X</td>
<td>Calculation</td>
</tr>
<tr>
<td>-----------</td>
<td>---------</td>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>NH₄-N</td>
<td>NH₄-N</td>
<td>% X 2,264</td>
<td>______ LB./AC. IN.</td>
</tr>
<tr>
<td>EXAMPLE:</td>
<td>NH₄-N</td>
<td>0.11 % X 2,264</td>
<td>249 LB./AC. IN.</td>
</tr>
<tr>
<td>YOUR VALUE:</td>
<td>NH₄-N</td>
<td>______ % X 2,264</td>
<td>______ LB./AC. IN.</td>
</tr>
<tr>
<td>P₂O₅</td>
<td>P</td>
<td>% X 5,188</td>
<td>______ LB./AC. IN.</td>
</tr>
<tr>
<td>EXAMPLE:</td>
<td>P₂O₅</td>
<td>0.18 % X 5,188</td>
<td>934 LB./AC. IN.</td>
</tr>
<tr>
<td>YOUR VALUE:</td>
<td>P₂O₅</td>
<td>______ % X 5,188</td>
<td>______ LB./AC. IN.</td>
</tr>
<tr>
<td>K₂O</td>
<td>K</td>
<td>% X 2,727</td>
<td>______ LB./AC. IN.</td>
</tr>
<tr>
<td>EXAMPLE:</td>
<td>K₂O</td>
<td>0.21 % X 2,727</td>
<td>573 LB./AC. IN.</td>
</tr>
<tr>
<td>YOUR VALUE:</td>
<td>K₂O</td>
<td>______ % X 2,727</td>
<td>______ LB./AC. IN.</td>
</tr>
</tbody>
</table>

**EXAMPLE ANALYSIS**

TOTAL N = 2,800 PPM  
NH₄-N = 1,100 PPM  
P = 1,800 PPM  
K = 2,100

<table>
<thead>
<tr>
<th>Substance</th>
<th>Form</th>
<th>PPM</th>
<th>Calculation</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL N</td>
<td></td>
<td>PPM</td>
<td>0.00834 X</td>
<td>______ LB./1,000 GAL.</td>
</tr>
<tr>
<td>EXAMPLE:</td>
<td></td>
<td>2,800</td>
<td>0.00834 X</td>
<td>23.4 LB./1,000 GAL.</td>
</tr>
<tr>
<td>YOUR VALUE:</td>
<td></td>
<td>______</td>
<td>0.00834 X</td>
<td>______ LB./1,000 GAL.</td>
</tr>
<tr>
<td>NH₄-N</td>
<td></td>
<td>PPM</td>
<td>0.00834 X</td>
<td>______ LB./1,000 GAL.</td>
</tr>
<tr>
<td>EXAMPLE:</td>
<td></td>
<td>1,100</td>
<td>0.00834 X</td>
<td>9.2 LB./1,000 GAL.</td>
</tr>
<tr>
<td>YOUR VALUE:</td>
<td></td>
<td>______</td>
<td>0.00834 X</td>
<td>______ LB./1,000 GAL.</td>
</tr>
<tr>
<td>P₂O₅</td>
<td>P</td>
<td>PPM</td>
<td>0.0191 X</td>
<td>______ LB./1,000 GAL.</td>
</tr>
<tr>
<td>EXAMPLE:</td>
<td>P₂O₅</td>
<td>1,800</td>
<td>0.0191 X</td>
<td>34.4 LB./1,000 GAL.</td>
</tr>
<tr>
<td>YOUR VALUE:</td>
<td>P₂O₅</td>
<td>______</td>
<td>0.0191 X</td>
<td>______ LB./1,000 GAL.</td>
</tr>
<tr>
<td>K₂O</td>
<td>K</td>
<td>PPM</td>
<td>0.01 X</td>
<td>______ LB./1,000 GAL.</td>
</tr>
<tr>
<td>EXAMPLE:</td>
<td>K₂O</td>
<td>2,100</td>
<td>0.01 X</td>
<td>21.0 LB./1,000 GAL.</td>
</tr>
<tr>
<td>YOUR VALUE:</td>
<td>K₂O</td>
<td>______</td>
<td>0.01 X</td>
<td>______ LB./1,000 GAL.</td>
</tr>
</tbody>
</table>
B. Solid Manure - Laboratory Analysis Reported in Percent.

**DAIRY DRYLOT**

**EXAMPLE ANALYSIS**
TOTAL N = 0.43 % WET BASIS.  
NH₄-N = 0.10 % WET BASIS.  
P = 0.20 % WET BASIS.  
K = 0.65 % WET BASIS.

<table>
<thead>
<tr>
<th>Component</th>
<th>Formula</th>
<th>Example</th>
<th>Your Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL N</td>
<td>TOTAL N % x 20</td>
<td>(0.43 \times 20 = 8.6)</td>
<td>(\text{<strong><strong><strong><strong>} \times 20 = \text{</strong></strong></strong></strong>} )</td>
</tr>
<tr>
<td>NH₄-N</td>
<td>NH₄-N % x 20</td>
<td>(0.10 \times 20 = 2.0)</td>
<td>(\text{<strong><strong><strong><strong>} \times 20 = \text{</strong></strong></strong></strong>} )</td>
</tr>
<tr>
<td>P₂O₅</td>
<td>P % x 45.8</td>
<td>(0.20 \times 45.8 = 9.2)</td>
<td>(\text{<strong><strong><strong><strong>} \times 45.8 = \text{</strong></strong></strong></strong>} )</td>
</tr>
<tr>
<td>K₂O</td>
<td>K % x 24.1</td>
<td>(0.65 \times 24.1 = 15.7)</td>
<td>(\text{<strong><strong><strong><strong>} \times 24.1 = \text{</strong></strong></strong></strong>} )</td>
</tr>
</tbody>
</table>

**FRYER LITTER**

**EXAMPLE ANALYSIS**
TOTAL N = 4.6 % DRY BASIS  
NH₄-N = 0.71 % DRY BASIS  
P = 2.2 % DRY BASIS  
K = 2.4 % DRY BASIS  
DRY MATTER = 78.0% WET BASIS

<table>
<thead>
<tr>
<th>Component</th>
<th>Formula</th>
<th>Example</th>
<th>Your Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL N</td>
<td>TOTAL N % x DRY MATTER x 0.20</td>
<td>(4.6 \times 78.0 \times 0.20 = 71.8)</td>
<td>(\text{<strong><strong><strong><strong>} \times \text{</strong></strong></strong></strong>} \times 0.20 = \text{________} )</td>
</tr>
</tbody>
</table>
\[
\text{NH}_4\text{-N} = \text{NH}_4\text{-N} \times \text{MATTER} \times 0.20 = \underline{\text{______}} \text{ LB./TON}
\]

**EXAMPLE:**
\[
\text{NH}_4\text{-N} = 0.71 \% \times 78.0 \% \times 0.20 = 11.1 \text{ LB./TON}
\]

**YOUR VALUE:**
\[
\text{NH}_4\text{-N} = \underline{\text{______}} \% \times \underline{\text{______}} \% \times 0.20 = \underline{\text{______}} \text{ LB./TON}
\]

\[
\text{P}_2\text{O}_5 = \text{P} \times \text{DRY MATTER} \times 0.458 = \underline{\text{______}} \text{ LB./TON}
\]

**EXAMPLE:**
\[
\text{P}_2\text{O}_5 = 2.2 \% \times 78.0 \% \times 0.458 = 78.6 \text{ LB./TON}
\]

**YOUR VALUE:**
\[
\text{P}_2\text{O}_5 = \underline{\text{______}} \% \times \underline{\text{______}} \% \times 0.458 = \underline{\text{______}} \text{ LB./TON}
\]

\[
\text{K}_2\text{O} = \text{K} \times \text{DRY MATTER} \times 0.241 = \underline{\text{______}} \text{ LB./TON}
\]

**EXAMPLE:**
\[
\text{K}_2\text{O} = 2.4 \% \times 78.0 \% \times 0.241 = 45.1 \text{ LB./TON}
\]

**YOUR VALUE:**
\[
\text{K}_2\text{O} = \underline{\text{______}} \% \times \underline{\text{______}} \% \times 0.241 = \underline{\text{______}} \text{ LB./TON}
\]

**LAYER**

**EXAMPLE ANALYSIS**

\[
\text{TOTAL N} = 1.7 \% \text{ WET BASIS}
\]
\[
\text{NH}_4\text{-N} = 1.3 \% \text{ WET BASIS}
\]
\[
\text{P} = 1.0 \% \text{ WET BASIS}
\]
\[
\text{K} = 1.4 \% \text{ WET BASIS}
\]

\[
\text{TOTAL N} = \text{TOTAL N} \% \times 20 = \underline{\text{______}} \text{ LB./TON}
\]

**EXAMPLE:**
\[
\text{TOTAL N} = 1.7 \% \times 20 = 34.0 \text{ LB./TON}
\]

**YOUR VALUE:**
\[
\text{TOTAL N} = \underline{\text{______}} \% \times 20 = \underline{\text{______}} \text{ LB./TON}
\]

\[
\text{NH}_4\text{-N} = \text{NH}_4\text{-N} \% \times 20 = \underline{\text{______}} \text{ LB./TON}
\]

**EXAMPLE:**
\[
\text{NH}_4\text{-N} = 1.3 \% \times 20 = 26.0 \text{ LB./TON}
\]

**YOUR VALUE:**
\[
\text{NH}_4\text{-N} = \underline{\text{______}} \% \times 20 = \underline{\text{______}} \text{ LB./TON}
\]

\[
\text{P}_2\text{O}_5 = \text{P} \% \times 45.8 = \underline{\text{______}} \text{ LB./TON}
\]

**EXAMPLE:**
\[
\text{P}_2\text{O}_5 = 1.0 \% \times 45.8 = 45.8 \text{ LB./TON}
\]

**YOUR VALUE:**
\[
\text{P}_2\text{O}_5 = \underline{\text{______}} \% \times 45.8 = \underline{\text{______}} \text{ LB./TON}
\]

\[
\text{K}_2\text{O} = \text{K} \% \times 24.1 = \underline{\text{______}} \text{ LB./TON}
\]

**EXAMPLE:**
\[
\text{K}_2\text{O} = 1.4 \% \times 24.1 = 33.7 \text{ LB./TON}
\]

**YOUR VALUE:**
\[
\text{K}_2\text{O} = \underline{\text{______}} \% \times 24.1 = \underline{\text{______}} \text{ LB./TON}
\]
SUMMARY

Testing manure for the nutrients, nitrogen, phosphorus, and potassium is clearly the most accurate procedure for calculating manure application rates to match the nutrient needs of crops while protecting surface water and ground water quality. Sampling manure storages to obtain representative samples is important. Manure sampling procedures are presented in detail so you can provide the laboratory or your field test method with good samples for good results. A straightforward worksheet method is presented for converting laboratory results to the practical units producers use when applying manure. Further, computer software is recommended for easily determining the manure application rate by balancing the available nutrients with field characteristics and crop nutrient uptake.

Combining manure tests, converting manure test units to practical units, and the computer software MNB will develop the best manure application rates for producing your crop yield goals and protecting water quality.