Water Quality Fact Sheet

Step 2: Understanding a Manure Sample

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Bulletin #2429

You need to know what is in the manure if your goal is to maximize the dollar value of this resource (especially since you already "bought" the nutrients in the manure in the form of feed).

Taking both good soil and manure samples are important early steps in using nutrients wisely. (See Cooperative Extension bulletin #2428, "Step One: Getting a Manure Sample" and #2286, "Testing Your Soil.") After you take a manure sample and have it analyzed, you may be faced with simple questions: *What does the analysis mean, and how do I use this information?*

The Importance of Manure Analysis

There are two very good reasons to get a manure analysis. The first reason is obvious: you need to know what is in the manure if your goal is to maximize the dollar value of this resource (especially since you already "bought" the nutrients in the manure in the form of feed).

The second reason is not quite so obvious: the nutrient content of manure (N, P and K) changes drastically from one farm to the next, depending on:

- animal species;
- ration fed to animals;
- amount and type of bedding material; and
- handling and storage systems.

Table 1 shows this variation quite clearly. Nearly 400 liquid samples and 400 solid samples are summarized. Note the range in N, P and K content!

Many people ask if there is a good "average" nutrient content that they can use for liquid or solid manures. The information in Table 1 argues against taking this approach. Let's quickly compare the average values from Table 1 to a couple of real values (one liquid and one solid) from Maine dairy farms. (See figures 1 and 2 on the next page.)

Table 1: Variation in manure nutrient content.

	Lowest Value	Highest Value	Average
	lb/1,000g (liquid)		
Nitrogen	1	71	28
Phosphorus (P_2O_5)	1	118	13
Potassium (K_2O)	1	171	29
	lb/ton (solid)		
Nitrogen	3	33	10
Phosphorus (P_2O_5)	0.2	35	6
Potassium (K_2O)	0.2	24	11

From: Combs and Peters. *Manure variability: a sampling and laboratory analysis survey.* Presented Sept. 23-24, 1996, Raleigh NC.

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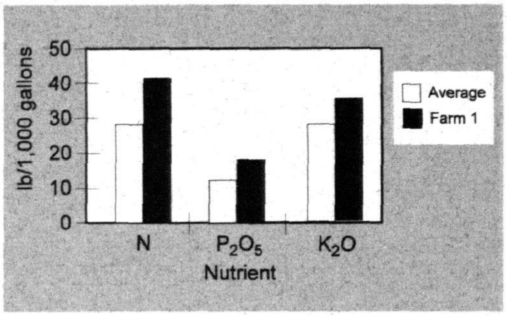

Figure 1: Average versus Real (Liquid)

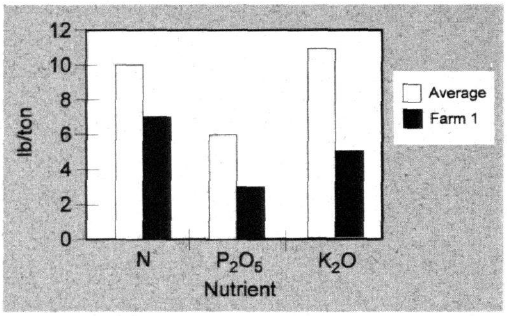

Figure 2: Average versus Real (Solid)

What do these graphs mean? For the liquid manure (Figure 1), which has a fairly high nutrient content, it means that if you use an "average" value, you are applying more nutrients than you thought. In fact, you have over-applied N by 50 percent, P_2O_5 by 38 percent, and K_2O by 21 percent. Not only are the extra N and P an environmental threat, they are also nutrients that won't be used by the crop or on another field.

The picture is not very good for the solid manure, either. Using an "average" instead of the actual analysis, you applied only 70 percent of the N, 50 percent of the P_2O_5, and 45 percent of the K_2O that the crop needs. The point is, there is too much variation between farms to use an average. If you underestimate nutrient content, you lose valuable nutrients. If you overestimate nutrient content, you short-change the crop. Take a sample and get an analysis!

Reading a Manure Analysis

Before you use the information from an analysis, you need to be able to read and understand the analysis sheet. An example analysis (for a liquid manure) is included as Figure 3. Let's look at the major components of the analysis.

Sample ID:

The information at the top of the analysis sheet simply tells 1) where the analysis was done (University of Maine, in this case), and 2) who sent the sample to the lab. One suggestion: give the sample a specific name and year, so the results won't be confused with earlier or later samples.

Nutrient content on wet basis (as received):

This section provides information on specific nutrients in the manure, as a percentage of total manure weight. For example, the analysis reads "% Nitrogen = 0.35%." This means that each 100 pounds of raw manure contains 0.35 pounds of total nitrogen. The analysis also provides information on NH_4-N (ammonium nitrogen), P and K. The P and K are then converted to P_2O_5 and K_2O, respectively, since these are the forms used on soil test recommendations.

1,000 gallons of this manure (handled as a liquid) contains:

This section takes the information above and converts it to units you can use on the farm. For example, there is 13 pounds P_2O_5 / 1,000 gallons. If you apply 5,000 gallons per acre, you have applied 65 pounds of P_2O_5 (5 x 13 lb./1,000 gallons).

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MANURE ANALYSIS REPORT

Eric Giberson 05-17-1995
5722 Deering Hall
Campus

Sample name: Manure #2 JOB #: 903

NUTRIENT CONTENT ON WET WEIGHT BASIS (AS RECEIVED)

% Nitrogen =	0.35		
% NH4-N =	0.17		
% Phosphorus =	0.07	x 2.29 =	0.17 % P205
% Potassium =	0.36	x 1.21 =	0.43 % K20
% H20 =	91.1		

1,000 gallons of this manure (handled as liquid material) contains:

28 pounds of total nitrogen (TKN)
14 pounds of ammonia-nitrogen (NH4-N)
13 pounds of phosphate (P205)
34 pounds of potash (K20)

Sincerely,

William P. Cook
Assistant Chemist

Figure 3: Example analysis for a liquid manure

Using the Information from a Manure Analysis

The information on the manure analysis is only one piece of information needed to balance nutrient application and removal. The other important pieces of information are:

- Crop nutrient needs (from a soil test)
- Nutrient availability from the manure
- Manure management, especially incorporation of manure

The best way to learn these concepts is through an example.

Crop Nutrient Needs:

In this example, you are growing silage corn. The soil test recommendations are shown in Figure 4.

The soil test actually estimates plant-available P and K. The estimate for N is based on a standard N response curve. There is no pre-season soil test for N requirement. If recommendations for P_2O_5 and K_2O are zero (or near zero), it is probably the result of long-term applications of manure at rates higher than crop requirements.

Nutrient Availability from Manure:

Soil factors like soil pH will affect the availability of nutrients (especially P) from any nutrient source. The P_2O_5 and K_2O in manure are essentially as available as the same nutrients supplied by fertilizer. Applying 100 pounds K_2O/acre from manure is the same as applying it as muriate of potash (0-0-60) fertilizer.

The big differences in nutrient availability is for N. A manure analysis (for a solid manure) is shown in Figure 5, with nutrient content in "pounds per ton."

The ammonium nitrogen (NH_4-N) is the same as the N in ammonium-based fertilizers. It is quickly converted to nitrate (NO_3-N) available to the plant, although it may be lost in other ways (as we will see later). As a starting point, we can say that it is "100 percent available."

The difference between ammonium nitrogen (NH_4-N) and total N (TKN) is **organic N.** For the plants to use this N, it must first be broken down or *mineralized* by soil microbes. Over the course of a growing season, 30 to 40 percent of this organic N will be converted to plant-available forms (first NH_4-N, then NO_3-N). An additional 10 to15 percent will become available the year following application, and three to five percent the following year. Using this information, we can move from total N content to available N content (Figure 6).

Nutrient	Pounds Needed/Acre
N	150
P_2O_5	60
K_2O	140

Figure 4

Nutrient	Pounds per Ton of Manure
Total N (TKN)	13
Ammonium nitrogen (NH_4-N)	5
Phosphate (P_2O_5)	4
Potash (K_2O)	10

Figure 5

N Form	Pound per Ton	Percent Available	Pound Available
Ammonium nitrogen (NH_4-N)	5	100	5 lb./ton
Organic N (total N minus NH_4-N)	8	35	3 lb./ton
Total N available			**8 lb./ton**

Figure 6

Calculating Application Rates:

We have estimated the amount of *available* nutrients per ton of manure. Now we can calculate the amount of manure needed to meet crop nutrient needs. To find the tons of manure needed per acre, we simply divide the nutrient requirement by the nutrient content of the manure. As a starting point, we can do this for all three major nutrients (Figure 7).

Nutrient Need	divided by	Nutrient Content	Rate to Apply
150 lb. N/acre	/	8 lb. N/ton	18.8 ton/acre
60 lb. P_2O_5/acre	/	4 lb. P_2O_5/ton	15.0 ton/acre
140 lb. K_2O/acre	/	10 lb. K_2O0/ton	14.0 ton/acre

Figure 7

In many cases, the rate that is actually applied is determined by the N requirement, because N is easily lost and is commonly the most limiting nutrient for crops like corn. In the situation described above, this means that we will over-apply P and K (by 15 lb. P_2O_5/a and 48 lb. K_2O/a). In the short term, this probably would not concern us, since these nutrients can be held in the soil and used by following crops. In the long term, however, this *nutrient loading* can lead to situations where the manure supplies only N for the growing crop. This reduces its real value as a nutrient source because you waste the P and K that could be used on other fields. Such fields are easy to spot using soils tests; the recommendations for P and K are zero.

Manure Management:

In the example above, it looks like manure nutrients can be closely matched to crop needs. If this is true, why are excessive P and K levels commonly found on corn fields with a history of manure application? There are two possibilities:

1. **Over-Application of Manure**
   Rather than applying the 19 ton/acre in the example above, say that applications are 30 tons/acre. If this is done, N, P_2O_5 and K_2O are over-applied by 88, 60 and 160 lb./acre every year. This scenario is actually fairly common as dairy herds expand faster than the land base available for manure application.

2. **Application Management**
   The available N in the example includes a very important assumption: that the manure is incorporated immediately after it is applied. This prevents *ammonia volatilization,* where NH_4-N is converted to NH_3 (ammonia gas) and is quickly lost to the atmosphere. This volatile loss of surface-applied N occurs quickly, and is accelerated by high temperatures and wind. An example of just how quickly it occurs is shown in Figure 8.

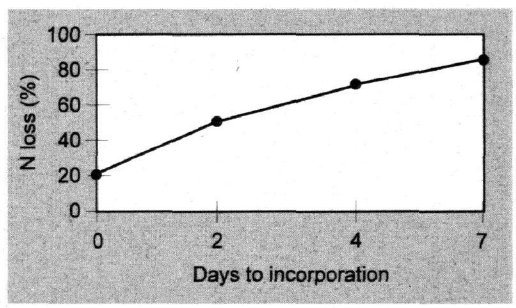

Figure 8

If the same manure was applied but not incorporated for two days, we could expect approximately 50 percent of the NH_4-N to be lost. The impacts of this?

- Instead of 8 lb. N/ton of manure, we get 5.5 lb. N/ton.
- To supply the same amount of available N, we must apply almost 50 percent more manure.

It is easy to see why rapid incorporation is a Best Management Practice: it saves N from being lost and reduces P and K build-up in the soil.

Conclusion: Three Easy Steps

A manure analysis provides farm-specific information that helps match manure nutrient applications with crop demands. There are three things to remember:

1. **Have manure analyzed.** If nutrition, bedding or manure storage change, take a new sample. If you have different systems for different groups of animals, sample them separately.
2. **Calculate application rates, based on crop needs.** If calculated rates are similar to meet N, P and K needs, then use that rate. If they are not similar, past management has wasted nutrients and additional applications will do likewise. Look for other ways to use manure to increase its value.
3. **Pay attention to application management.** Nutrient loss in the first several days after application can be high, especially if manure is not tilled in. Make this incorporation part of your management plan.

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