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Manure Sampling for Nutrient Management Planning

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Environmental regulations adopted by the United States Environmental Protection Agency and the North Dakota Department of Health require some animal feeding operations to adopt structural and management measures to minimize impacts on waters of the state.

Some of these animal feeding operations will be required to develop a nutrient management plan or NMP to assure that manure nutrients, particularly nitrogen and phosphorus, do not pollute surface water or groundwater. Nearly all NMP's will involve utilizing manure nutrients for crop production.

Applying manure to cropland can reduce fertilizer purchases and improve soil health. Manure can increase the capacity of soil to hold moisture and nutrients, increase infiltration and reduce erosion. Even small animal feeding operations will find that utilizing manure nutrients for crop production is both economically and environmentally sound.

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Why sample manure?

Compared to commercial fertilizer which has a known, balanced and guaranteed analysis, manure is highly variable in composition and nutrient availability. Average manure nutrient values are available in the MidWest Plan Service *Manure Management Systems Series MWPS-18, Section 1 – Manure Characteristics*. These numbers can be used for planning purposes. However, actual manure nutrient values depend on many things including animal type, size, diet, bedding, production period, manure handling and storage systems and weather conditions.

Sampling and laboratory testing provides actual manure nutrient information that a crop producer needs to plan for maximum crop yields and minimal manure nutrient impact to the environment. Sampling and testing of manure is a good management practice and may be required by regulations.

What tools are needed?

Manure samples should be taken with clean steel or plastic instruments such as shovels, scoops, or cups and composited in a clean five-gallon plastic bucket. Composite samples are sent to the laboratory in re-closable plastic bags (solids) or plastic bottles (liquids). Using tools made of non-reactive materials (stainless steel and plastic) that are cleaned between samplings will prevent contamination of samples. Ice chests should be used in warm weather to cool the samples.

Some designs for sampling devices for solid and liquid manure are found in *MWPS-18, Section 1 – Manure Characteristics*.

How should manure be sampled?

The greatest challenge of sampling is getting a sample that truly represents the manure that is to be land applied. Separate samples should be taken from each manure storage site that represents a different animal type, size, age, diet, management practice, type of manure storage and handling, production period, or other factor that could affect nutrient values.

Manure may be handled as a solid material (greater than 15 percent dry matter), a slurry (5 to 10 percent dry matter), or liquid (less than 5 percent dry matter). Each form requires a specific sampling protocol.

Sampling solid manure

Research and experience has shown that 20 to 25 sub samples, each ½ to 1 pint in volume, should be taken. Using a spade, shovel, or soil probe, sample various locations and depths in the pile. Avoid sampling the dry top crust or other parts of the stockpile that may not be representative of the majority of the pile. It may be necessary to dig into the pile with a loader to expose various depths and locations. Sub-samples need to be thoroughly mixed in a sample bucket. From the bucket, collect one to two pints and place in a recloseable plastic bag or plastic bottle with a lid.

It is very difficult to obtain a representative sample from a manure pack in an open lot or shed.

Traffic patterns of animals produce an uneven pattern of manure droppings and bedding materials. If it is necessary to sample a manure pack, take sub-samples from locations that represent a major portion of the manure volume. It is better to sample manure from a pack by taking samples from several loads as it is being hauled.

Sampling slurry manure

Hog manure (about 10 percent solid as excreted) and dairy manure (about 12 percent solid as excreted) is often collected and stored as a slurry in earthen, concrete, or steel storage structures. Since solids tend to settle, slurry is agitated and mixed with a pump prior to removal to assure that solids are removed from the structure. After the slurry has been agitated, usually two to four hours, a good sample can be taken. Sub samples can be dipped from the storage, taken from a spigot on the pump or transfer pipe, or dipped from spreader tank loads. Sub samples should be taken with a plastic cup and composited in a plastic bucket. Because the material has already been mixed by the agitating pump, only five or six sub samples are needed. A composite sample of one or two pints should be poured into a plastic sample bottle and sealed with a lid. Leave about 1 inch of air space in the bottle for expansion and gas production.

If the top area of the storage is accessible, as in the case of a pit under a slotted floor, a composite sample may be obtained without agitation. Extend a length of ½ or ¾ inch diameter PVC pipe vertically down into the manure until it contacts the floor. Seal the upper end of the pipe with your hand, withdraw the length of pipe and empty the contents into a plastic sample bucket. Collect six or eight of these sub samples to yield a representative composite sample. Once all sub samples have been collected, collect one to two pints in a plastic bottle with a lid. This method is not as accurate as sampling agitated slurry, but allows sampling before land application begins.

Sampling from storage areas can be dangerous. There is a risk of falling into the manure or becoming overwhelmed by manure gases. Let someone know when you will be working around storage units and take measures to insure good ventilation.

Sampling liquid manure

Liquids, such as the effluent from a solid separator or runoff from an outdoor open feedlot, are often stored in earthen structures. They can be sampled similar to the methods for sampling slurry, although most of the solids in liquid manure are suspended, and agitation for mixing may not be necessary.

How should manure samples be handled?

It is best to contact the lab before samples are taken, as each lab may have its own preferences for sample size and how it should be packaged and delivered. Some labs will furnish sample containers and mailers free of charge.

Solid manure samples can be packaged in either reclosable Ziploc type plastic bags or plastic bottles. When using bags, squeeze air out before closing. Slurry and liquid manure samples can be packaged in plastic bottles with screw-on lids. Leave an inch of empty space at the top of the bottle. The plastic bottle should in turn be sealed in a reclosable plastic bag in case of leakage.

Manure, being biologically active, is constantly changing in physical, chemical and biological characteristics. Samples should be placed on ice, in a cooler, when gathered during warm weather and delivered to the lab as soon as possible. Samples should not be held at room temperature for more than 12 hours. If delivery is delayed, refrigerating or freezing will help preserve the sample's integrity. One good strategy is to freeze samples immediately after collection.

Send samples early in the week so they do not spend the weekend in transit.

When should manure be sampled?

Ideally, manure samples should be taken and analyzed just before the time of land application so that results can be used to plan manure nutrient application. However, that may not always be possible. For example, manure slurry is usually agitated and mixed just before it is pumped out of storage, making it unlikely that the results will be available before land application. The test results are still valuable. First, it is important to know how much manure nitrogen and phosphorus were land applied. Secondly, the analysis and land application records establish a history. If no major changes are made in the animal feeding operation, the manure analysis will tend to remain close to historical values.

It may be desirable to sample manure from several spreader loads of solid manure or tanks of slurry manure as the manure is being land applied. These samples should be taken immediately after the spreader or tank is loaded. Samples can also be obtained by using pans or other devices placed on the ground to catch samples from solid manure spreaders, slurry tank spreaders, or irrigation application of liquid manure. This type of sampling is the most accurate since samples are material that actually was applied to the field. While results will not be available until after land application, they will help establish nutrient application history.

What manure analyses are needed?

Total nitrogen and phosphorus as P_2O_5 analyses are needed. Potassium as K_2O is usually included, although it is seldom a limiting factor when using manure nutrients and is not considered an environmental problem.

It is also desirable to have total nitrogen divided into the ammonium-nitrogen and organic-nitrogen fractions. The ammonium fraction will be immediately available to plants after land application but the organic fraction is available over several years. Solid manure that has been stockpiled a long time or composted probably has little ammonium-nitrogen. There is usually little nitrate-nitrogen in manure.

The relative percentages of water and dry matter in the manure may be helpful. Electrical conductivity may be useful if total salts are a problem in the manure or the soil to which manure is to be applied.

Although N, P and K are the most important fertilizer elements, testing for other nutrients may be useful if they are a consideration for a particular crop or soil.

How should results be reported?

Manure test results should be reported "as-is" or on a "wet-basis," since that is the way manure will be land applied. If results are on a dry matter basis, values can be multiplied by the manure dry matter percentage (expressed as a decimal) to obtain the equivalent wet weight.

Example:

If total N = 2 percent dry basis and
the sample is 60 percent dry matter,
then N = 2.0 x 0.6 = 1.2 percent wet basis.

Also, the nutrient content of the manure should be in the same units as the units used in calibrating the land application equipment. That is:

Pounds per ton for solid manure

Pounds per 1000 gallons for slurry manure

Pounds per acre-inch for liquid manure

Phosphorus should be reported as P_2O_5 since this is the value used in fertilizer application planning. If results are in elemental **P**:

$P \times 2.29 = P_2O_5$

Potassium should be reported as K_2O since this is the value used in fertilizer application planning. If results are in elemental **K**:

$K \times 1.20 = K_2O$

Conversion factors

If results are given in percent, parts per million (ppm), or milligrams per liter (mg/L), the following conversion factors can be used to get results in more usable forms:

Percent x 20 = pounds per ton

Percent x 83 = pounds per 1000 gallons

Percent x 2266 = pounds per acre-inch

ppm or mg/L x 0.002 = pounds per ton

ppm or mg/L x 0.0083 = pounds per 1000 gallons

ppm or mg/L x 0.2266 = pounds per acre-inch

How can manure analyses be used?

Using the NDSU Extension Service publication AE-1187 "Manure Application Planning Workbook," the proportion of manure nutrients which will be available to the crop can be estimated. The manure nutrient analyses combined with soil tests and crop nutrient requirements can be used to determine the proper application rate for manure.

NDSU Extension Service publication AE-1189 "Manure Storage and Field Records" should be used to document manure nutrient utilization for management purposes and to meet the requirements of the NMP.

Figure 1. Example Manure Analysis Report

Modern Ag Test Laboratory
PO Box XXX
Frostbite, MN

Sample Number:	99999
Sample Type:	Solid manure – beef
Sample ID:	Jones farm feedlot
Date Processed:	mm/dd/yy

To: A. Jones Farm
9999 Beanstalk Road
Cornucopia, ND

Results:

Wet Chemistry Analysis:

	As Received Basis
Moisture, %	55.9
Dry Matter, %	44.1
Nitrogen, %	0.60
Organic N, %	0.55
Ammonium N, %	0.05
P_2O_5, %	0.62
K_2O, %	0.27

Nutrient Pounds per Ton

Nitrogen	12.0
Organic N	11.0
Ammonium N	1.0
P_2O_5	12.4
K_2O	5.4

For more information on this and other topics, see: www.ag.ndsu.nodak.edu

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