

Unit IV **Reporting Manure Analysis Results**

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1. Introduction

Manure analysis reports are designed to meet primary customer needs in planning land application rates or determining nutrient credits from applied manure.

However, the use of different report formats, reporting units, analysis and reporting bases, conversion factors, and estimates of nutrient availability and fertilizer value often results in confusion for livestock producers and difficulty in interpreting the report. Differences in reporting conventions can also result in the perception by producers that laboratory manure analysis is inaccurate. These problems may explain why some producers do not analyze their manure on a regular basis, do not use the results properly, or fail to analyze their manure at all. The perception that manure nutrient credits are inaccurate can then lead to over-application of commercial fertilizer in order to reduce the risk of crop yield losses.

2. Considerations for reporting manure analysis results

There are three types of information usually included on manure analysis reports. The first is descriptive information about the sample and the customer, including customer identification, sample identification, description and date of analysis. The purpose of providing most of this information is self-explanatory. A more complete description of the sample is usually requested if information on nutrient availability is provided, because this is influenced by livestock species, storage and handling system, animal production phase and application method.

The second type of information provided on manure analysis reports is the actual analytical results. In reporting results, three things must be considered in addition to the accuracy of the results: reporting units, reporting basis and use of conversion factors. Typically, manure analysis results are recorded in the laboratory in units of percentage or parts per million (ppm), and then converted to the units needed by the customer to calculate application rates or nutrient credits (lbs/1000 gal for liquid manures, lbs/T for solids). Some laboratories report just percentage, some report just lbs/1000 gal or lbs/T, and others report both. Having more than one type of unit on the

report form can sometimes be confusing for clients, if they are unfamiliar with how the different units are related, or which ones they need to use for nutrient management planning.

For liquid manures, conversion of percentage to lbs/1000 gal must account for the manure density, which can be estimated or determined. Laboratories vary widely as to the manure density or conversion factor used. Some use the density of water (approximately 8.33 lbs/gal), others use a higher density value (ranging from 8.4 to 9.5 lbs/gal) to account for the presence of solids, some vary the density value according to solids content, and others use measured density or specific gravity. Only infrequently is the conversion factor identified on the analysis report.

In addition, manure samples may be analyzed and results reported on either a dry matter basis or an as-is basis. If the laboratory dries and grinds manure for analysis (as is sometimes done for mineral analysis of heterogeneous solid manures), the results must then be converted to an as-is basis using the dry matter determination. Most laboratories report results on an as-is basis, regardless of analysis basis, because manure is applied "as-is." Again, having more than one type of unit or reporting basis can be confusing for farmers, but dry matter basis results do allow direct comparison of nutrient value between two manures. For research purposes, this can be invaluable.

Reported results can be inaccurate due to calculation and typographical errors. Typical problems seen in manure nutrient analysis reporting include not accounting for dilutions, use of incorrect conversion factors, transposition of values, misplaced decimal points and switched samples.

The third type of information found on manure analysis reports is interpretive, including estimates of nutrient availability and fertilizer value, and use of results in application rate planning. Many laboratories provide estimates of nutrient availability, either in addition to or in place of the actual nutrient content of the manure. These values can be a significant source of confusion for producers. Although virtually all availability estimates are based on livestock species,

manure type (liquid or solid) and application method, considerable differences exist between values published by various State Extension Services. In addition, some laboratories use availability factors from other sources. Reported nitrogen availability estimates can differ by 30 percentage points or more for manures from the same species and using the same application method. Reported phosphorus and potassium availability estimates can range from approximately 50 to 100%. Therefore, laboratories should report the availability factors coinciding with the state where the sample was taken.

Additional confusion may arise when customers live outside the state in which the laboratory operates and are provided Extension or other availability values that differ from those used by their own state Extension Service, or when the application method used by the customer is not listed in the availability estimates provided. Also, computer programs designed to generate nutrient availability estimates may default to incorrect values if the sample information provided by the customer is insufficient for determining the correct availability factor.

In order to promote manure testing and other practices which optimize use of manure nutrients, some laboratories provide estimates of the economic or “fertilizer” value of manure nutrients on their analysis reports. Most often a dollar value is assigned to the nutrients present in the manure or estimated to be available to a crop, based on current local fertilizer prices (fertilizer *equivalent* value). However, this information is often misleading. The economic value of the nutrients in manure is equivalent to only the cost of the fertilizer being replaced on a particular field (fertilizer *replacement* value). If the producer’s fields and crops need all the nutrients applied in the manure, and fertilizer and manure application costs are equal, then the fertilizer replacement value is the same as the fertilizer equivalent value. If all the nutrients in the manure are not needed on a particular field, due to low crop need or high soil test values, then the excess nutrients have little economic value to the producer. Manure application costs also vary between fields and can overshadow the fertilizer value of the nutrients. Therefore, manure nutrients have different economic values depending on the fields to which they are being applied.

3. Guidelines for reporting manure analysis results

Manure analysis reports should provide information that is easy to use and interpret, and should help fulfill the record-keeping needs of the customer. Ideally, livestock producers should be able to look at analysis reports from several different laboratories and be able to come to similar conclusions regarding application rates and nutrient credits for their manure. This may not be realistic, due to different approaches to estimating nutrient availability. Manure analysis reporting could still benefit from standardization in other areas, however. The following guidelines are suggested in order to encourage dialogue within the testing industry that will result in some level of standardization of reporting, with simplicity and ease of interpretation being the primary goals. Two example laboratory reports are given at the end of this chapter to illustrate the guidelines suggested. Any number of formats can work equally as well, as long as the information presented and the purpose for presenting it is clear to the customer.

3.1 Descriptive information

Descriptive information should include the following:

Laboratory name, mailing address, telephone number, e-mail address;

Customer name, mailing address, telephone number, e-mail address (farmer name also, if different than customer);

Sample identification (laboratory number and customer-provided identification);

Sample description (at a minimum, include livestock species, liquid or solid, manure application method; may also include storage and handling system, application timing, days until incorporation); and

Date received by the laboratory as well as date analyzed and reported.

Sample submission sheets should have spaces for customers to record the above information. The more information the customer can supply about the sample, the more assistance the laboratory can provide for interpreting the results. Having this information on the analysis report also simplifies record-keeping for the customer. For laboratories, an additional benefit of having descriptive sample information is being able to analyze cumulative data for differences in manure nutrient content between different livestock

species and different manure handling and storage systems. Currently there is very little information of this type available that is state-specific and that reflects current trends in production and management. This information would be invaluable for improving outdated 'table' values of nutrient content and nutrient availability indices.

3.2 Analysis results

Units and reporting basis: Report dry matter as percent solids, to at least the nearest 0.1%. Samples should always be analyzed for total solids content, and the results reported (rather than moisture content), even if the customer does not request it specifically. Dry matter determination is often necessary to convert the results of analyses performed on dried samples to an as-is basis. Also, most laboratories include solids in the fee charged for routine manure analysis. Reporting of dry matter or solids content also makes it easier to compare results between different samples.

Report total nitrogen (N), ammonium-nitrogen ($\text{NH}_4\text{-N}$), total phosphorus as phosphate (P_2O_5), total potassium as potash (K_2O) and other minerals in units of lbs/1000 gal for manures applied as liquids, and lbs/T for manures applied as solids. A strong effort should be made to obtain the desired reporting units from the client. The type of spreader being used will dictate how the results should be reported, not the dry matter content. If a particular dry matter level is used to generate reporting units, there should be an option in the computer program to over-ride this default if the sample dry matter falls outside the normal dry matter ranges for liquid and solid manures.

Report N, $\text{NH}_4\text{-N}$, P_2O_5 and K_2O to at least the nearest 0.1 lb/1000 gal or lb/T to provide consistency for samples with low concentrations of particular nutrients. Do not report beyond the number of significant digits that are appropriate for the analysis methods and calculations you are using. Report phosphorus and potassium as P_2O_5 and K_2O . This is necessary to be consistent with standardized reporting of soil fertility recommendations and nutrient content of fertilizers.

Results may also be reported in units of percent or ppm, but these should be reported separately from the results reported as lbs/T or lbs/1000 gal, and clearly labeled in order to prevent confusion. It should then be indicated on the report which values should be used to calculate application rates and nutrient credits.

Results reported in units of percent or ppm should be reported on an as-is basis. Results reported on a dry matter basis can be useful for comparing results between different manures, or for generating more accurate table values for different regions. Most producers, however, will have little use for dry-matter basis results. If they are reported, they should be clearly labeled, and the relationship between different units should be indicated. Dry matter content should always be reported, to allow conversion of results to dry matter basis results, if desired.

Conversion factors: Most conversion factors are simply mathematical standards used by all laboratories. These include multiplying percentage by 20 to get lbs/T, multiplying ppm by 10^{-4} to get percent, multiplying P by 2.29 to get P_2O_5 , multiplying K by 1.2 to get K_2O , and multiplying dry matter basis results by the dry matter fraction to get as-is basis results. For liquid manures, the factor used to convert percentage to lbs/1000 gal for is based on the density of the sample, and different laboratories use different factors. Some laboratories use the density of water (8.33 lbs/gal) and others use measured or estimated density values. This is done to account for the presence of solids in liquid manures and thereby improve the accuracy of the reported value. This practice is probably not justified, however.

In order to assess the affects of solids content and manure density on conversion factors and reported analysis values, 262 liquid dairy and swine manures from a variety of storage and handling systems were analyzed for density, solids content, specific gravity and total nitrogen (N) content (Jarman, 1999). The samples ranged in solids content from 0.3 to 16%. Nitrogen content in lbs/1000 gal was calculated using the density of water, measured sample density or measured specific gravity, or an estimated density of 9 lbs/gal. Calculated N content in lbs/1000 gal was similar when based on specific gravity, measured density or the density of water. Significantly larger N content values were obtained when a density value of 9.0 lbs/gal was used. Therefore, in order to standardize results between laboratories, it is recommended that the density of water (8.33 lbs/gal) be used, and percentage (as-is basis) would then be multiplied by 83.3 to obtain lbs/1000 gal.

If standardized conversion factors are used, it is not necessary to report these factors. If they are reported, caution should be used in their placement on the report. In order to streamline the report and avoid

confusion, conversion factors and calculations could be placed on the back of pre-printed reporting forms.

Accuracy of reported results: All results should be examined for transcription and other errors. The results should fall within the expected range of values for that manure type, unless unusual conditions are present. Computerized calculations should be checked for accuracy, and assumptions used in computer generation of numbers should be updated periodically. Check and verify every number on every report before it leaves the laboratory.

3.3 Interpretive information

Nutrient availability estimates: It is not likely that differences in availability estimates between State Extension Services are likely to be resolved in the near future, although some regions and groups of states are currently working towards consistency in their values. This is desirable when climate and typical storage, handling and application methods are similar. Differences in factors which affect manure nutrient availability do exist, however, between regions and states and even within states, and use of consistent values across large regions would be inappropriate. Also, some states have conducted extensive research in order to determine the most accurate availability estimates for the conditions within their states, and there is no scientifically valid reason for recommending use of other values.

The simplest solution for dealing with these issues is to report only the actual analysis values and refer the customer to their State Extension Service for assistance in determining nutrient availability, application rates and nutrient credits. However, many laboratories want to provide these services to their customers. Information about nutrient availability and how to calculate nutrient credits and application rates does help producers interpret their results, as long as the information is correct for that producer.

The ideal situation would be to provide Extension availability estimates that originate from the state in which the producer lives. Because the time and expense of setting up the computer programs required to do this for customers in several states might be prohibitive, it may be easier to provide availability factors recommended by the Extension Service in the state where the laboratory operates (usually where the laboratory does the most busi-

ness). Providing availability factors (percentage of total nutrients available) rather than calculating the amounts of nutrients available, solves the problem of incorrect calculations in situations where insufficient information is provided by the customer to accurately determine the correct availability factors to use. However, providing amounts of available nutrients instead of availability factors can make it easier for the producer to interpret the results.

Regardless of the availability values provided, the actual analysis results should always be reported first, and the source of the availability values should always be stated prominently on the report, especially for the benefit of out-of-state customers.

Laboratories should also check each report to ensure that the values provided (and the factors on which they are based) apply to that customer's particular sample. Due to development of new storage, handling and application methods, and the availability of their own large databases of manure nutrient content, laboratories could also help gather information to assist Extension in developing or modifying availability factors for their region.

Manure nutrient value: As stated previously, the economic value of manure nutrients is only equal to the cost of the fertilizer that is being saved on the particular fields to which the manure is applied, and must account for application costs. Unless a laboratory has access to information about fertility levels, crops being grown, manure and fertilizer rates applied and application costs for each of a customer's fields, then estimates of manure nutrient value are usually inaccurate and misleading. These estimates may provide some value to a producer as long as he or she understands what is being estimated.

4. References

1. Jarman, J.K. 1999. Fact sheet on use of liquid manure density values in reporting manure nutrient analysis results. Laboratory Certification Programs, Minnesota Department of Agriculture, St. Paul, MN.

Example laboratory report 1
(analysis results only, no interpretive information)

Laboratory Name
Laboratory Address
Tel. No. Fax No.
E-mail Address

Manure Analysis Report for: *Producer/Farm name*
Submitted by: *Customer name*
Customer address
Customer tel. no.
Customer e-mail address

Date received: *Mo/Day/Yr* Date reported: *Mo/Day/Yr*
Lab No. *M1934*
Sample ID *Finish*
Manure Type *Liquid swine*
Storage Type *Outdoor Lagoon*
Application method *Knife injected*
Incorporation *Immediate*
Total solids *5.5 %*

ANALYSIS

| Lab No. | M1934 |
|---|---------------------|
| Unit | lbs/1000 gal |
| Total nitrogen (N) | 39.2 |
| Ammonium nitrogen (NH₄-N) | 17.5 |
| Total Phosphorus expressed as P₂O₅ | 30.0 |
| Total Potassium expressed as K₂O | 21.6 |

Manure analysis values must be multiplied by an availability factor to obtain pounds of available nutrients per 1000 gallons of manure.

Availability factors depend on animal species and management, manure storage and handling system, application method and timing, days until manure incorporation, and other factors.

The amount of available nutrients is then multiplied by the application rate to obtain pounds of available nutrients applied per acre.

Contact your County Extension office for further information on manure nutrient availability and manure nutrient management.

Example laboratory report 2
(analysis results plus interpretive information)

Laboratory Name
Laboratory Address
Tel. No. Fax No.
E-mail Address

Manure Analysis Report for: *Producer/Farm name*
Submitted by: *Customer name*
Customer address
Customer tel. no.
Customer e-mail address

Date received: *Mo/Day/Yr* Date reported: *Mo/Day/Yr*
Lab No. *M1934*
Sample ID *Finish*
Manure Type *Liquid swine*
Storage Type *Outdoor Lagoon*
Application method *Knife injected*
Incorporation *Immediate*
Total solids *5.5 %*

| | Analysis | 1st Year Availability Factor | 1st Year Available Nutrients | 2nd Year Availability Factor | 2nd Year Available Nutrients |
|---|---|---|---|---|---|
| | lbs/1000 gal | % | lbs/1000 gal | % | lbs/1000 gal |
| Lab No. M1934 | | | | | |
| Total nitrogen (N) | 39.2 | 70 | 27 | 15 | 6 |
| Ammonium nitrogen (NH₄-N) | 17.5 (included in total N availability) | | | | |
| Total Phosphorus expressed as P₂O₅ | 30.0 | 80 | 24 | | |
| Total Potassium expressed as K₂O | 21.6 | 90 | 19 | | |

Nutrient availability factors are those provided by the State/University Extension Service.

Nitrogen availability is based on livestock species, manure type, storage, application method and time until incorporation. Availability of P₂O₅ and K₂O is the same for all manure types and application methods, and is only for the first year following application.

Contact your County Extension office for further information on manure nutrient availability and manure nutrient management.