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NUTRIENT MANAGEMENT
FOR DAIRY PRODUCTION

Which test is best?

Customizing dairy manure nutrient testing

D. Sullivan, C. Cogger, and A. Bary

Manure is a nutrient resource. To get the most value from this resource, you need accurate information on manure nutrient content. A regular manure testing program will:

- Help you save money on fertilizer
- Assist in refining application rates to meet, but not exceed, crop needs
- Demonstrate your commitment to protecting surface and groundwater quality
- Establish the value of manure for off-farm marketing
- Serve as a reliable data source for long-term farm plans

Both laboratory analyses and on-farm quick tests of manure nutrient content play an important role in manure management. Laboratory testing is the most reliable method of manure nutrient testing and is valuable for long-term planning and as a check on quick test results. Quick tests are valuable for rapid assessment of manure N content. Quick tests help guide daily management decisions.

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This publication discusses the following aspects of a successful manure testing program:

- Collecting a manure sample that reflects average nutrient composition
- Selecting an analytical laboratory
- Requesting key nutrient analyses and usable reporting units from analytical labs
- Determining testing needs for different manure handling and storage systems
- Choosing on-farm tests for manure N content

On-farm quick tests determine manure N content within a few minutes.

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Manure application plans often are based on average manure analyses for a particular manure handling and storage system. However, manure nutrient composition also is related to your specific management practices, including:

- Source and quality of feed
- Water added to manure
- Type and amount of bedding
- How long the manure is stored

Because these factors often vary during the year, manure nutrient content also varies.

The importance of nitrogen

Nitrogen (N) usually is the most important nutrient in a manure testing program. Farm management plans approved by your local conservation district, the Natural Resources Conservation Service, or the Oregon Department of Agriculture require an agronomic manure application rate. The agronomic rate usually is based on N. Agronomic rates supply appropriate amounts of plant-available N for crop growth without excessive loss of nitrate to groundwater.

Crops take up N from the soil in the ammonium or nitrate forms (plant-available N). Manure usually contains little or no nitrate as applied. Nitrogen in manure usually is present as ammonium and organic forms (amino acids, proteins, etc.). Manure ammonium-N is plant-available immediately after application. Soil microorganisms slowly convert manure organic N to plant-available forms after application.

Manure analytical methods determine total N and ammonium N. Organic N is not measured directly. It is calculated as the total N content minus the ammonium-N content.

You can use nitrogen analyses of manure for both long-term planning and short-term decision making. First, analyses collected over a period of years serve as a good data source for long-term farm plans (e.g., determining land area needs for manure utilization). Second, you can use analyses to guide daily management decisions (e.g., calculating an application rate for a particular field). Simple, rapid on-farm testing procedures are well-suited for daily management decisions.

Effect of manure storage and handling on nitrogen content

How predictable is manure N content from your operation? The more variable the manure, the more samples you need to accurately characterize manure N content. Factors contributing to variability include:

Storage. Generally, the longer manure is stored, the higher the proportion of total N in the ammonium form, which is immediately available to plants. Organic N in stored manure is converted to ammonium-N by microbes; some of the ammonium-N then is lost as ammonia-N to the atmosphere.

Drying. Dried manure generally is low in ammonium-N; it is lost as ammonia during the drying process. Drying increases manure total N concentration (per unit volume).

Dilution. The more water added to manure, the lower its nutrient content. If you periodically add fresh water to a lagoon for summer irrigation, manure N content is reduced. Straw or other bedding materials usually are low in N and also reduce manure N concentration.

Tables 1 through 4 summarize the range in nutrient analyses for different manure-handling systems in the Pacific Northwest. We make the following observations:

Lagoon liquid pumped without agitation usually contains less than 5 lb N/1,000 gal; most of the N is in the ammonium form. Average total N content reported for two-cell Yakima Valley lagoons is 2.0 lb N/1,000 gal (Stevens and Prest, 1992, unpublished data). This is considerably lower than the average content reported for two-cell Willamette Valley lagoons, which is 4.4 lb N/1,000 gal (Table 1).

Agitated slurry from a lagoon or storage tank is highly variable; its N content varies with the total solids content of the slurry (Table 2).

Dry stack manure can have highly variable N contents because of variability in straw and moisture content (Table 3).

Separated manure solids from a mechanical separator are quite uniform in N content across a variety of separator and bedding types (Table 4).

Composted dry stack manure or composted separated solids are quite uniform in N content. Piles are mixed repeatedly during the composting process.

Table 1.—Nitrogen content of secondary lagoon liquid.[a]

Dairy	Usual range[b]		
	Low	High	Average
	lb N/1,000 gal		
A	3.0	6.0	4.4
B	1.8	3.5	2.6
C	3.0	6.0	4.9
D	2.0	7.0	4.2
E	3.0	6.0	4.9
F	3.0	7.0	5.6
G	3.0	4.5	3.8
H	3.5	6.0	5.0
Average	2.8	5.8	4.4

[a]Source: Gangwer, M., and M. Graham, 1994.

[b]"Usual range" contains 80 percent of monthly measurements over a 2-year period (locations A-E), or a 1-year period (locations F-H). Nitrogen determined via an Agros meter. For these lagoons with less than 1 percent total solids, Agros nitrogen was approximately equal to total nitrogen.

Table 2.—Nutrient content of dairy slurries from agitated lagoons or agitated storage pits.[a]

Total solids	Total N	Total P	Total K
%	lb/1,000 gal		
2	6–10	1.4–2.0	7–15
4	10–14	2.8–3.4	10–18
6	14–18	4.0–4.8	14–22
8	18–24	5.2–6.2	17–25

[a]Source: Sullivan, et al., 1994. Based on 37 analyses (Whatcom County, WA). Average total N was 3.7 percent, average total P was 0.9 percent, and average total K was 4.4 percent on a dry weight basis.

Table 3.—Nutrient content of dry stack manure.[a]

Nutrient	Analysis	
	Average	Standard deviation
	% (dry matter basis)	
Total N	1.3	0.30
Total P	0.81	0.19
Total K	1.86	0.51
	lb/wet ton (as-received basis)[b]	
Total N	8.6	1.6
Total P	4.0	0.8
Total K	13.1	2.8

[a]Source: Stevens, R.G., and V.I. Prest, 1992, unpublished data. Analyses are an average of composite samples from 14 dry stack facilities in the Yakima Valley (WA).

[b]lb/wet ton based on an average total solids content of 35 percent (65 percent moisture). Standard deviation in total solids content was 8 percent.

Table 4.—Nutrient content of separated manure solids.

Nutrient	Analysis	
	Oregon[a]	Washington[b]
	% (dry matter basis)	
Total N	1.2 (0.28)[c]	1.5 (0.33)
Total P	0.21 (0.11)	0.26 (0.15)
Total K	0.46 (0.22)	0.51 (0.26)
C:N Ratio	33.1 (7.0)	25.6 (5.0)
	lb/wet ton (as-received basis)[d]	
Total N	4.6	5.6
Total P	0.8	1.0
Total K	1.7	1.9

[a] Source: Gangwer, M., and M. Graham, 1995. Analyses are an average of 51 Willamette Valley (OR) facilities.

[b]Source: Sullivan, D., and H. Bierlink, 1992, unpublished data. Analyses are an average of nine Whatcom County (WA) facilities.

[c]Values in parentheses are standard deviations in dry matter nutrient analyses.

[d]lb wet/ton based on an average total solids content of 19 percent (81 percent moisture). Standard deviation in total solids content was 4 percent.

Collecting samples and choosing a test

You can analyze composite samples by on-farm quick tests or ship them to an analytical laboratory for analysis. We recommend using both laboratory and quick tests.

Quick tests are less precise than laboratory analyses. You can use quick tests frequently during the application season to check the variability in manure nutrient content. Use laboratory tests periodically to:

- Check the accuracy of the quick test results
- Obtain nutrient analyses not provided by the quick tests

See "Setting up a sampling program for your farm" for a detailed discussion of when to choose a laboratory analysis and when to use a quick test.

Collecting samples

Collecting a sample that represents the average composition of a manure source (lagoon, dry stack, etc.) is essential in obtaining accurate information from manure analyses. Usually, a number of individual samples are collected and mixed together to make a composite sample, which is analyzed for nutrient content.

The choice of sample collection methods depends on the kind of manure storage or application equipment. The greater the potential variability in manure composition, the more individual samples ("grab" samples) you should mix to obtain a composite sample. Call upon local experts (extension agents, conservation district or NRCS staff, private consultants) to assist you in designing an appropriate sampling strategy for your dairy.

For liquid manure, sample agitated manure immediately before application. Some operators have installed sampling ports in irrigation lines, so liquid manure can be easily sampled as it is pumped.

Sprinkler-applied liquid also can be collected in buckets placed in the field. Samples collected after sprinkling usually have lower ammonium-N content because of ammonia volatilization.

For solid manure, take 10–20+ small grab samples from the pile to make one composite sample. If piles have substantially different amounts of bedding, you will get better information by taking a separate composite sample from each pile.

After collection, thoroughly mix the grab samples and remove a composite sample (approximately 1 quart) for analysis.

Preparing samples for shipment to a lab

Preserve samples for laboratory analysis by refrigeration or freezing. Plan shipment so that samples are not left unrefrigerated over a weekend. Samples should arrive at the laboratory within 48 hours of shipment.

Check with your laboratory to discuss containers, preservation methods, and sample delivery schedules. Generally, laboratories prefer receiving samples in plastic containers with wide mouths and screw-top lids. Plastic bags are not recommended. (Nobody wants leaky manure samples!) Fill containers no more than two-thirds full to allow room for gases produced by fermenting manure.

Laboratory nutrient analysis

Description: Nutrient content determined via laboratory instruments.

Test procedure: Sample is homogenized, and analyses are run on a small subsample.

How it works: There are established procedures for each nutrient.

Manure type where it works best: Tests are valid for all forms of manure.

Nutrients estimated: Total N, ammonium-N, total P, total K, and total solids

Cost (for above analyses): $30–$60 per sample

Accuracy: Excellent. Major differences between laboratories usually are due to sample handling and preparation techniques, not analytical procedures.

Other comments: It is best to consistently use the same laboratory. See "Choosing a laboratory" for suggestions on selecting a laboratory, sample preservation, and shipping.

Choosing a laboratory

Find a lab that knows how to test manure and report results in a usable form. We suggest reporting manure analyses on both an “as-received” and a “dry weight basis” (Table 5). The “as-received” analysis can be used to determine application rates. The “dry weight” analyses can be used to track the consistency of manure nutrient composition over time. To develop a track record of manure analyses over time, use the same laboratory for each test.

To help you locate a suitable analytical laboratory, the Oregon State University Extension Service and Washington State University Cooperative Extension periodically compile lists of analytical laboratories serving the Pacific Northwest (see “Extension directories of analytical laboratories” at the end of this publication). Some extension and NRCS offices also have lists of laboratories doing business in their local areas.

Important questions to ask laboratory representatives include:

- Is the lab equipped to analyze manure samples for total N, ammonium-N, total P, total K, and total solids? How long will it take to provide results?
- How are analytical results reported? It’s a good idea to obtain a sample laboratory report. Table 5 shows the preferred reporting units.
- How does the lab prepare the sample for analysis? For ammonium analysis, it is recommended that labs thoroughly mix and subsample wet samples. Drying samples prior to analysis results in loss of much of the ammonium-N.
- Does the lab participate in regional or national sample exchange programs coordinated by unbiased third parties (universities or trade associations)? Is the lab willing to share performance results from such sample exchange programs? Participation in sample exchange programs is a good indicator of a laboratory’s commitment to precise and accurate results.

For composts marketed off-farm, we recommend additional analyses for pH, nitrate-N, cation exchange capacity, exchangeable bases (calcium, magnesium, potassium, and sodium), and conductivity (salinity). These analyses will help your customers successfully utilize compost.

Choosing an appropriate quick test

Quick tests are less precise than laboratory analyses. We recommend using both laboratory and quick tests (see “Setting up a sampling program for your farm”). Suggested applications for currently available quick tests are shown in Table 6.

Table 6.—Suggested on-farm quick tests for dairy manure N.

Type of manure	Hydrometer for total N	Nova meter for ammonium-N
Liquid less than 2% total solids	No	Yes
Liquid 2–6% total solids	Yes	Yes
Semi-solid 6–15% total solids	Yes[a]	Yes

[a]Sample must be diluted with water to 2–6 percent total solids; appropriate only for solid manure with little bedding; not suitable for separated solids.

Table 5.—Preferred reporting units for laboratory manure analyses. Results should be reported on both an “as-received” and “dry weight” basis.

Analysis	“As-received” basis		Dry weight basis
	Solid manure	Liquid manure	
Total solids[a]	%	%	
Total N, ammonium-N, total P, and total K	lb/wet ton	lb/1,000 gal	%[b]

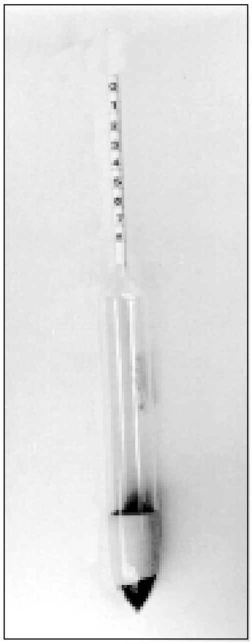
[a]Total solids is another way to express the moisture content of the manure “as-received.” For example, a sample having 20 percent total solids would have 80 percent moisture content.

[b]For liquid manure with a total solids content less than 2 percent, laboratory nutrient analyses reported on a dry matter basis often have substantial variability. This usually is due to small differences in total solids analyses.

The hydrometer is a useful quick test for agitated lagoon slurry or semi-solid manure that has been scraped and stored in a pit or tank. Such manure sources, with solids contents above 2 percent, usually contain a substantial portion of their N in the solid part of the manure.

The hydrometer works best for slurries containing from 2 to 6 percent total solids. It is not appropriate for estimating the nutrient content of separated solids or of solid manure with large amounts of bedding.

On-farm quick test: Hydrometer



Description: Floating glass apparatus with a weighted bottom.

Test procedure: Collect a representative sample of slurry in a 5-gallon bucket. Stir to suspend solids. Place the hydrometer in the bucket and read the result after 15 seconds. If the slurry is too thick for the hydrometer to float freely, mix the slurry with water, stir well, and take a hydrometer reading. For a 1:1 dilution (water:slurry), double the hydrometer reading to get the correct value for undiluted slurry.

How it works: Measures the density (specific gravity) of liquid manure.

Manure type where it works best: Slurries, 2 to 6 percent total solids.

Initial cost: $30 to $60. No additional cost per sample.

Nutrients estimated: Total solids, total N, and total P.

Accuracy: Fair. We developed the following regression equations for agitated manure slurries (Sullivan, et al., 1994):

Total N (lb/1,000 gal) = 3.7 + 2.14 x (percent total solids), $R^2 = 0.72$
Total P (lb/1,000 gal) = 0.42 + 0.66 x (percent total solids), $R^2 = 0.84$

These regression equations were based on 37 composite samples collected from dairies in Whatcom County, WA over a 4-month period. Our regression equations for the hydrometer are similar, but not identical, to those previously reported for dairy slurry from North Carolina (Chescheir, 1985).

If your hydrometer is calibrated in units of specific gravity, use this table to estimate total solids:

Specific Gravity	Total Solids (%)
1.011	2.0
1.020	4.0
1.028	6.0

Other comments: To use a hydrometer to estimate slurry nutrient content, you must have a calibration equation to relate slurry density to nutrient content. Calibration equations given in this publication are valid only for dairy manure. Hydrometers are available that read out in units of specific gravity, percent total solids, or percent total N. Measurement scales for hydrometers that read out in units other than specific gravity are based on manufacturers' regression equations.

The hydrometer measures slurry density and estimates total slurry N via a regression equation (see page 6). It also provides an estimate of slurry P content.

The Nova meter, which measures only ammonium-N, provides a helpful quick test for the N that is immediately plant-available. It is the quick test of choice for lagoon liquids, which contain most of their N in the ammonium form.

On-farm quick test: Nova meter or Agros meter

Description: Stainless steel or plastic chamber with a built-in pressure gauge. The Nova meter (plastic chamber) is a recent replacement for the Agros meter (stainless steel chamber). Both Nova and Agros meters use the same chemical process to estimate manure N.

Test procedure: Add manure to the main chamber using the scoop provided by the manufacturer. Add hypochlorite reagent to a separate reservoir inside the chamber. After the lid is secured, mix the hypochlorite and the manure inside the chamber following the manufacturer's instructions. Wait 2–5 minutes. Manure N content is given on the pressure gauge.

How it works: Hypochlorite oxidizes ammonium-N to form nitrogen gas (N_2) inside the chamber. The higher the manure ammonium-N, the more pressure is generated. The pressure gauge is calibrated by the manufacturer to read out in units of N.

Manure type where it works best: This quick test gives results very similar to a laboratory ammonium-N analysis. Use for manure where ammonium-N is a major proportion of total N. This is the best quick test for liquid manure with less than 2 percent solids.

Cost: Initial cost is $350 to $500. Hypochlorite reagent is consumed with each test.

Nutrients estimated: Ammonium-N only.

Accuracy: Excellent (See Sullivan, et al., 1994; Chescheir, et al., 1985).

Caution: Hypochlorite reagent is hazardous to eyes and irritates the nose and skin. Protect yourself with safety glasses, gloves, and a dust mask. Perform the tests outdoors in a well-ventilated area. Hypochlorite also is corrosive. Rinse metal parts with water after each use. Don't dispose of excess reagent in the garbage; it is a strong oxidizer.

Other comments: On some Nova or Agros meters, the pressure gauge has units of kg N/m^3. To convert kg/m^3 to lb/1,000 gal, multiply by 8.34.

Setting up a sampling program for your farm

Manure from different handling systems (dry stack, lagoon liquid, etc.) should be sampled and analyzed separately. The amount of time and money devoted to sampling manure from different sources should reflect its relative importance as a nutrient source and its potential variability. The more variability, the more sampling is required. Samples collected close to the time of application best reflect the nutrients applied to the field.

Let's take a look at how the general principles of manure sampling and testing apply to a specific dairy operation. For our example, let's consider a large dairy in western Washington or western Oregon with a flush barn-cleaning system, a mechanical solids separator, and a two-cell lagoon. Manure is generated from three sources: the separated solids, the secondary lagoon liquid, and periodic agitation of the primary and secondary lagoon for solids removal.

The suggested sampling plan is shown in Table 7 and is discussed below. To check the accuracy of the quick tests (Nova meter and hydrometer), we recommend splitting a composite sample once each year and analyzing it via both laboratory and quick test methods.

Secondary lagoon liquid. For this dairy operation, the most frequent manure application is in the form of secondary lagoon liquid. A yearly laboratory test is recommended to serve as a reliable record of the nutrient value of the secondary liquid (see Table 5 for recommended analyses). The samples for laboratory analysis can be taken at almost any time, but are most useful if taken when the lagoon is at least half full.

Since the secondary lagoon liquid contains N primarily in the ammonium form, its N content can be estimated using a Nova meter. Testing with the Nova meter can be used throughout the application season to refine application rates. It is especially helpful in the summer when the operator mixes secondary lagoon effluent with fresh irrigation water.

Agitated lagoon slurry. Each spring, the operator agitates the lagoon to remove accumulated solids from the bottom. The slurry produced by agitation is much higher in N content because of the suspended solids. We recommend at least one laboratory analysis per year. A hydrometer can be used on a daily or weekly basis to measure changes in N content due to differing amounts of suspended solids.

Separated solids. The nutrient analysis of the separated solids is not expected to vary significantly from published values (Table 4). Furthermore, for the current growing season, the separated solids represent only a small risk of excess N application, because most of the N is present in organic compounds that are slow to release plant-available N. Therefore, using average analytical values for separated solids (Table 4) is acceptable. We do not recommend routine testing of separated solids for on-farm utilization.

Table 7.—Example of a yearly sampling plan utilizing both laboratory and on-farm quick test methods.[a]

		Suggested test frequency	
Manure applied as:	Application period	Lab test	Quick test
Secondary lagoon liquid	April–Sept.	yearly	Nova—monthly
Separated solids	April–Sept.	none	none
Agitated lagoon slurry	April–May	yearly	Hydrometer—weekly

[a]Example location: western Oregon/Washington. Two-cell lagoon storage with solids separator.

Calculating manure application rates

A manure analysis is only part of the information you need for site-specific estimates of appropriate N application rates (volume or weight per acre). Other information needed includes:

- Crop N requirement
- Proportion of manure-N that will be plant-available during the growing season (less than 100 percent)
- Quantity of N supplied from other sources (e.g., decomposition of soil organic matter, fertilizer N)
- Crop N uptake efficiency—proportion of plant-available N removed by the crop (less than 100 percent)

We suggest you work with an agronomist in calculating site-specific application rates. You can get a rough idea of appropriate manure N application rates by assuming that crop N uptake is approximately equal to the needed manure N inputs. An example of this approach is found in OSU Extension publication EM 8585, *Manure Application Rates for Forage Production* (Hart, et al., 1996). It is a reasonable approach if manure is applied every year to the same fields.

Periodic soil testing also helps you apply manure at rates that match crop requirements.

Manure testing as part of whole-farm nutrient management

Manure testing is a more powerful tool when used together with other tools for nutrient management. Records of feed inputs, field-by-field manure application amounts and timing, fertilizer applications, and soil and plant tissue test results are some of the other components of whole-farm nutrient management. When data from these sources are used together, you can consider environmental as well as economic consequences when making long-range management decisions.

The references listed at the end of this publication can help you get started with whole-farm nutrient management. Together with manure analyses, these tools can help you adjust manure management to meet economic and water-quality goals.

Suppliers for quick tests

Both hydrometers and Nova meters may be available for short-term use from your local conservation district or NRCS office.

Hydrometers

Whatcom Conservation District, 6975 Hannegan Rd., Lynden, WA 98264; phone: 360-354-2035.

Various laboratory supply companies. Choose a hydrometer used for measuring the specific gravity of soil suspensions. We recommend a model that is equivalent to ASTM #151H specifications (measures specific gravity from 0.995 to 1.038 g/cm^3).

Nova meters

Farm Home Offices, Inc. 1965 64th St., Box 840, Vinton, Iowa 52349; phone: 800-788-7218 (sells a version of the Nova meter called "On-the-farm manure nitrogen test kit").

Grass Roots Project Management, P.O. Box 136, Chilliwack, BC, Canada V2P 6H7; phone: 604-795-2350 (sells a version of the Nova meter called the "Nova MK2 meter").

For more information

Selected research publications

Chescheir, G.M., P.W. Westermann, and L.M. Safley. 1985. Rapid methods for determining nutrients in livestock manures. Transactions of the ASAE 28 (6): 1817–1824 (American Society of Agricultural Engineers, St. Joseph, MI).

Sullivan, D.M., H. Bierlink, and W. Matthews. 1994. Tools for getting more value out of dairy manure. pp. 55–65. In: Proc. 26th Annual Dairy Producers Short Course, Feb. 8–9, 1994, Clearbrook, BC, Canada. BC Ministry of Agriculture, Fisheries and Food, Chilliwack, BC (available from Dan Sullivan, Department of Crop and Soil Science, Oregon State University).

Manure analyses for Willamette Valley dairies

Available from:

M. Gangwer
Marion County Office
OSU Extension Service
3180 Center St. NE, Room 1361
Salem, OR 97301
Phone: 503-588-5301

Gangwer, M., and M. Graham. *Wastewater volume and nitrogen concentrations in Willamette Valley, Oregon dairy ponds*, SR 939 (Oregon State University, Corvallis, 1994). No charge.

Gangwer, M., and M. Graham. *Analysis of separated manure solids from selected manure separators in Willamette Valley, Oregon dairy facilities*, SR 945 (Oregon State University, Corvallis, 1995). No charge.

Extension directories of analytical laboratories

See ordering instructions on page 11.

Hart, J. *A list of analytical laboratories serving Oregon*, EM 8677 (Oregon State University, Corvallis, 1997). No charge.

Schreiber, A., and C.H. Daniels. *Analytical laboratories and consultants serving the Pacific Northwest*, EB 1578 (Washington State University Cooperative Extension, Pullman, 1994). $1.50

Extension publications on whole-farm nutrient management

See ordering instructions on page 11.

Sullivan, D.M., C.G. Cogger, and A.I. Bary. *Date, rate, and place: The field book for dairy manure applicators*, EM/PNW 506 (Oregon State University Corvallis, 1997). $5.50

Gardner, E.H., and J. Hart. *How to take a soil sample . . . and why*, EC 628 (Oregon State University, Corvallis, revised 1995). No charge.

Grusenmeyer, D., and B. Peterson. *Manure management guidelines for western Washington* (Washington State University Cooperative Extension, Whatcom County, 1995). Available from Whatcom County Office, 1000 N. Forest, Bellingham, WA 98225.

Hart, J., M. Gangwer, M. Graham, and E. Marx. *Dairy manure as a fertilizer source*, EM 8586 (Oregon State University, Corvallis, reprinted 1997). 75¢

Hart, J., E.S. Marx, and M. Gangwer. *Manure application rates for forage production*, EM 8585 (Oregon State University, Corvallis, reprinted 1997). $1.00

Hermanson, R.E. *Manure sampling for nutrient analysis with worksheets for calculating fertilizer values*, EB 1819 (Washington State University, Pullman, 1996). $1.00

Hermanson, R.E., A.C.S. Rao, W.L. Pan, K.F. Duncan, and M.A. Wright. *MNB: Manure nutrient balancer* (computer software for IBM-compatible computers) (Washington State University, Pullman, 1995). Order number MCP 0026. $25.00

Marx, E.S., J. Hart, and R.G. Stevens. *Soil test interpretation guide*, EC 1478 (Oregon State University, Corvallis. reprinted 1997). $1.50

Marx, E.S., N.W. Christensen, J. Hart, M. Gangwer, C.G. Cogger, and A.I. Bary. *The pre-sidedress soil nitrate test (PSNT) for western Oregon and western Washington*, EM 8650 (Oregon State University, Corvallis, reprinted 1997). 75¢

Moore, J., and M.J. Gamroth. *Calculating the fertilizer value of manure for livestock operations*, EC 1094 (Oregon State University, Corvallis, reprinted 1993). $1.00

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Manure testing quick tips

A regular manure testing program will:

- Help you save money on fertilizer
- Assist in refining application rates to meet, but not exceed, crop needs
- Demonstrate your commitment to protecting surface and groundwater quality
- Establish the value of manure for off-farm marketing
- Serve as a reliable data source for long-term farm plans

Variability in manure analyses. The more variable the manure source, the more often you need to test it to characterize its nutrient content. This publication summarizes the variability observed for different manure handling systems in the Pacific Northwest. Use this information to budget your testing dollars.

Collecting samples for nutrient analysis. Collect a sample that represents the average composition of a manure source (lagoon, dry stack, etc.) to obtain accurate results.

Laboratory testing is the most reliable testing method. Find a lab that knows how to test manure and report results in a usable form. We recommend analysis for total N, ammonium-N, total phosphorus (P), total potassium (K), and total solids (moisture content). Ask the lab to report nutrient analyses on both an "as-received" and a "dry weight" basis.

Quick tests for nitrogen. Although laboratory tests are more accurate, quick tests provide information to guide daily management decisions. Two simple, rapid, on-site test procedures for N analysis are described in this publication (the hydrometer and the Nova meter). Verify quick test results with periodic laboratory analyses.

Calculating agronomic manure application rates. A manure analysis is only part of the information you'll need. An agronomist can help you calculate site-specific manure application rates to meet crop needs.

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