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NUTRIENT MANAGEMENT
FOR DAIRY PRODUCTION

# Manure application rates for forage production

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*Most dairies can supply all the nitrogen, phosphorus, potassium, and other nutrients needed for forage production by applying manure to forage crops. As a manager, your goal is to match nutrient supply with crop needs by deciding when and how much manure to apply.*

This publication explains how to estimate the amount of manure to apply for forage production. To do so, you need:

- A current manure analysis for your dairy (see *Dairy Manure as a Fertilizer Source*, EM 8586)
- A list of forage crops to be produced
- A soil test for phosphorus and potassium from each field where manure will be applied

Applying too much manure leads to several problems. First, plants take up excess amounts of nutrients such as potassium. High-potassium grass forages can lead to health problems, especially in dry cows. Second, excess manure can add nutrients and microorganisms to runoff or surface water, and can provide nitrogen that can leach into groundwater.

Application rates in this publication are based on soil tests and growing conditions in western Oregon.

## Manure analysis

Analyzing manure is critical to determining the correct application rate. If you don't test your dairy's manure, you can only guess its nutrient value.

Manure testing in western Oregon has shown more variation among dairies than within one dairy. Develop a manure nutrient history for your dairy by testing manure two or three times a year for 2 or 3 years. These records will help you manage nutrient resources.

Have manure analyzed for total nitrogen (N), ammonium nitrogen ($NH_4$-N), phosphorus (P), and potassium (K). Laboratories often perform these as a standard analysis package.

Call your county office of the OSU Extension Service or your local USDA Natural Resources Conservation Service office for sampling directions. *Laboratories Serving Oregon: Soil, Water, Plant Tissue, and Feed Analysis* (EM 8677) lists laboratories that test manure.

## Crop nitrogen requirements

Nitrogen (N) typically is the limiting nutrient for crop production on dairies. Table 1, page 3, shows the estimated nitrogen removal rate (or uptake) for average yields of the most common forage crops grown on dairies. Values in the upper part of the table are on a dry matter (DM) basis; in the lower part, as-harvested values are adjusted for moisture. For example, 1 ton of forage dry matter is equivalent to 4 tons of harvested forage if the silage is 25 percent DM. When discussing nutrient removal, you need to know whether you are dealing with as-harvested or dry-matter values so that you can interpret values correctly.

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## Determining manure application rate

Your goal is to match manure nutrient application rates with crop removal rates. Table 1 and Figures 1 and 2 provide the information you need to determine nutrient removal for many annual and perennial crops. Instructions for using the table and figures follow.

1. In Table 1, find the crop you will grow. Let's assume it's perennial ryegrass. The table is arranged to help you separate different levels of intensity. For example, low-intensity harvesting might be only one or two cuttings per year, medium will be three to five cuttings, and high intensity is six to seven cuttings per year.
2. For our example, let's assume you harvest four times a year, and your ryegrass averages 15 percent protein. That is equivalent to 48 lb of nitrogen per ton of dry matter, yielding around 5 tons of dry matter (240 lb N) per year.
3. You need to replace 240 lb N/a/year from the four cuttings. This is equivalent to 60 lb/a of nitrogen per cutting.
4. Find the figure below (Figure 1 or 2) that represents the type of manure you want to apply. Let's assume you want to apply lagoon effluent, so you'll use Figure 2.
5. Figure 2 contains three lines representing N application rates of 50, 100, and 150 lb N/a. Find the line closest to the rate you need to apply. In this example, you'll use the line for 50 lb/a.
6. Select the manure analysis from your dairy for nitrogen on the left side of the graph. Assume a manure test shows that the effluent contains 6 lb/1,000 gal or 750 ppm N. Move to the right across the graph until you meet the line for the application rate you have chosen (50 lb N/a).
7. Now move straight down to the line labeled "effluent acre-inches to apply" and estimate the number of acre-inches of effluent to apply (in this case, about 0.3 acre-inch). Remember that you will need about 20 percent more nitrogen because no line exists for 60 lb N/a. Your final result will be about 0.4 acre-inch.

## Testing your soil for P and K

Test your soil for phosphorus (P) and potassium (K) before applying manure. Table 2 (back page) provides interpretations of P and K soil tests.

If you've applied manure for more than 5 years, additions of P and K usually are not needed. For example, potassium usually is not deficient in soils

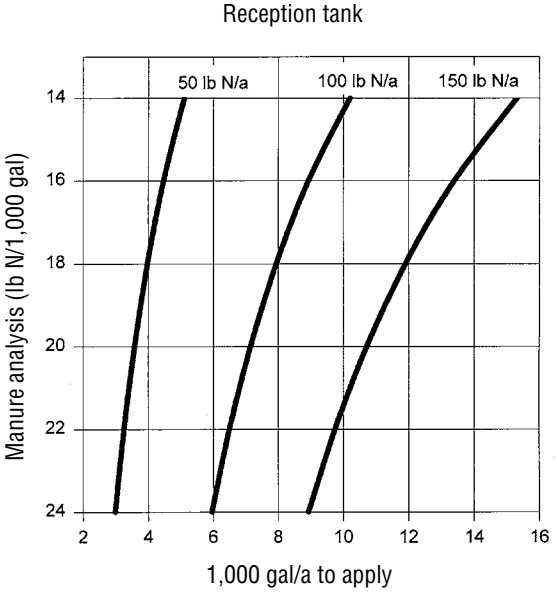


*Figure 1.—Determining application rate for reception tank manure.*

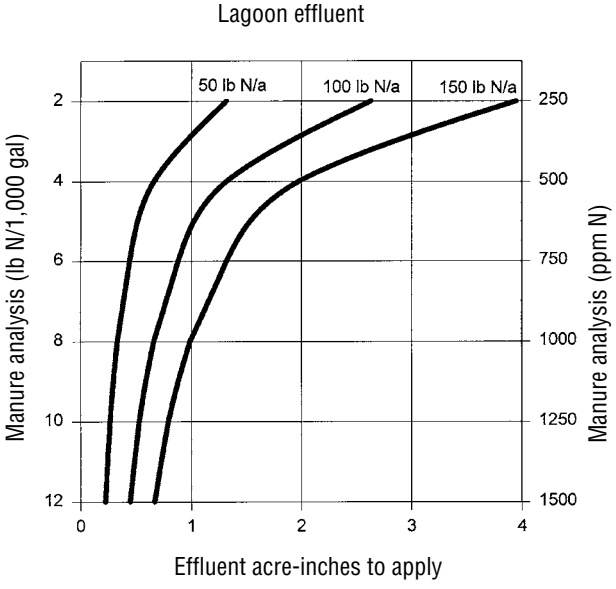


*Figure 2.—Determining application rate for lagoon effluent.*

*Note*: For reception-tank manure, approximately 70 percent of the total N is considered available. For lagoon effluent, 100 percent of the total N is considered available.

**Table 1.—Nitrogen, phosphorus, and potassium removal of common perennial and annual forage crops.**

| Crop (dry matter) | Cuttings (no.) | DM[1] (%) | CP[1] (%) | N (lb/t) | P (lb/t) | K (lb/t) | DM (t/a) | N used (lb/a) |
|---|---|---|---|---|---|---|---|---|
| Red clover | 1 | 100 | 18 | 58 | 8 | 48 | 4 | 232 |
| Alfalfa hay | 3 | 100 | 20 | 64 | 8 | 42 | 5 | 320 |
| Perennial grass (low intensity) | 1–2 | 100 | 10 | 32 | 6 | 38 | 4 | 128 |
| Perennial grass (medium to low intensity) | 2–3 | 100 | 12 | 38 | 6 | 38 | 4.5 | 171 |
| Perennial grass (medium intensity) | 4–5 | 100 | 15 | 48 | 7 | 38 | 5 | 240 |
| Perennial grass (medium to high intensity) | 5–6 | 100 | 18 | 58 | 8 | 40 | 6 | 348 |
| Perennial grass (high intensity) | 6–8 | 100 | 20 | 64 | 8 | 40 | 7 | 448 |
| Annual ryegrass | 1 | 100 | 12 | 38 | 6 | 38 | 4 | 152 |
| Annual ryegrass | 2 | 100 | 15 | 48 | 7 | 40 | 5 | 240 |
| Corn silage | 1 | 100 | 8 | 25 | 4 | 20 | 8 | 200 |
| Small grains (boot stage) | 2 | 100 | 12 | 38 | 5 | 32 | 5 | 190 |
| Small grains (soft dough) | 1 | 100 | 8 | 25 | 5 | 30 | 4 | 100 |
| **Crop (as harvested)** | **Cuttings (no.)** | **DM[1] (%)** | **CP[1] (%)** | **N (lb/t)** | **P (lb/t)** | **K (lb/t)** | **AH[1] (t/a)** | **N used (lb/a)** |
| Red clover | 1 | 25 | 5 | 14 | 2 | 12 | 16 | 232 |
| Alfalfa | 3 | 30 | 6 | 19 | 2 | 12 | 16 | 320 |
| Perennial grass (low intensity) | 1–2 | 30 | 3 | 10 | 2 | 11 | 13 | 128 |
| Perennial grass (medium to low intensity) | 2–3 | 30 | 4 | 11 | 2 | 11 | 15 | 171 |
| Perennial grass (medium intensity) | 4–5 | 30 | 5 | 14 | 2.1 | 11 | 17 | 240 |
| Perennial grass (medium to high intensity) | 5–6 | 30 | 5 | 17 | 2.4 | 12 | 20 | 348 |
| Perennial grass (high intensity) | 6–8 | 30 | 6 | 19 | 2.4 | 12 | 23 | 448 |
| Annual ryegrass | 1 | 30 | 4 | 11 | 1.8 | 11 | 13 | 152 |
| Annual ryegrass | 2 | 25 | 4 | 12 | 1.8 | 10 | 20 | 240 |
| Corn silage | 1 | 25 | 2 | 6.7 | 1 | 5 | 30 | 200 |
| Small grains (boot stage) | 2 | 30 | 4 | 11 | 1.5 | 10 | 16 | 190 |
| Small grains (soft dough) | 1 | 30 | 2 | 8 | 1.5 | 9 | 13 | 100 |

[1]DM=dry matter; CP=crude protein; AH=as harvested

where manure has been applied unless the applications were light and a high yield of grass hay was removed. A manure application that meets crop N needs usually supplies sufficient amounts of P and K. Manure contains as much, if not more, K than N. For more information, see *Dairy Manure as a Fertilizer Source* (EM 8586).

In fact, fields that have received manure for a decade or more often have high soil test values for P and K. Fields with soil test K above 1,000 ppm can produce grass forage with a high K concentration. Dry cows fed grass forage containing more than 3 percent K may become seriously ill or die.

In some cases, a soil test shows excessive K, but N is needed. In this case, if another area is available for manure application, apply manure there and buy N fertilizer for the area that has excess K.

Contact your county office of the OSU Extension Service for additional information.

## Soil and plant tissue testing for N

The tables and figures in this publication only estimate manure application rates. A soil test for nitrate nitrogen or a stalk nitrate test for silage corn can aid in adjusting manure application rates.

**Table 2.—Interpretation of soil tests for P and K.**

| | Nutrient (ppm) | |
|---|---|---|
| Soil status | Phosphorus (P) | Potassium (K) |
| Deficient | below 25 | below 150 |
| Sufficient | 25–50 | 150–500 |
| High | 50–75 | 500–1,000 |
| Excess | above 75 | above 1,000 |

For more information, see *The Presidedress Soil Nitrate Test* (EM 8650) and *Post-harvest Soil Nitrate Testing for Manured Cropping Systems West of the Cascades* (EM 8832).

## For more information

### *OSU Extension Service publications*

Many OSU Extension Service publications may be viewed or downloaded from the Web. Visit the online Publications and Multimedia catalog at http://extension.oregonstate.edu/catalog/

Publications and videos also are available from OSU Extension and Experiment Station Communications. For prices and ordering information, visit our online catalog or contact us by fax (541-737-0817), e-mail (puborders@oregonstate.edu), or phone (541-737-2513).


Pirelli, G., J. Hart, S. Filley, A. Peters, M. Porath, T. Downing, M. Bohle, and J. Carr. *Early Spring Forage Production for Western Oregon Pastures*, EM 8852-E (2004)

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Marx, E.S., N.W. Christensen, J. Hart, M. Gangwer, C.G. Cogger, and A.I. Bary. *The Presidedress Soil Nitrate Test*, EM 8650 (reprinted 1997)

Sullivan, D.M. and C.G. Cogger. *Post-harvest Soil Nitrate Testing for Manured Cropping Systems West of the Cascades*, EM 8832 (2003)


### *Other publications*


Marx, E. *Evaluation of Soil and Plant Analyses as Components of a Nitrogen Monitoring Program for Silage Corn* (Master's thesis, Oregon State University, 1995)