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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 (or see EM 8586, *Dairy Manure as a Fertilizer Source*)
- A list of forage crops to be produced
- A soil test from each field where manure will be applied

Too much manure results in excess plant uptake of nutrients such as potassium. High-potassium grass forages can lead to health problems, especially in dry cows. In addition, excess manure contributes to nutrients and microorganisms in runoff water and potential nutrient leaching to groundwater.

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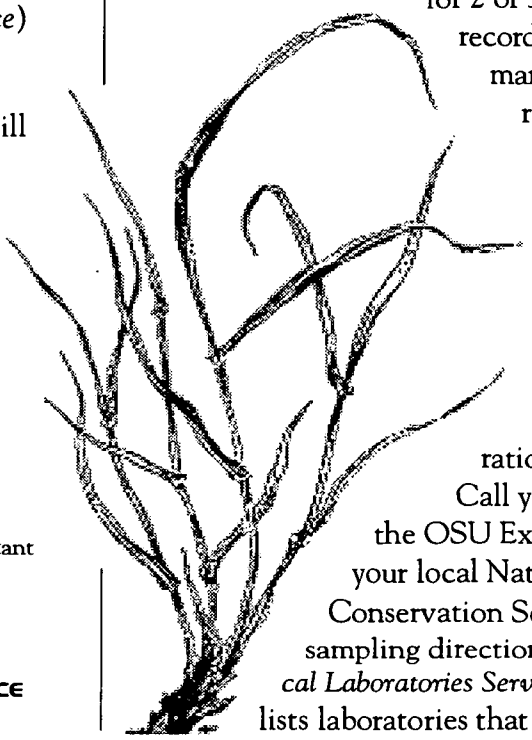
OREGON STATE UNIVERSITY EXTENSION SERVICE

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

## Manure analysis

Analyzing your 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.



Also test manure when you expect a change in nutrient content; for example, when you make a large change in the ration.

Call your county office of the OSU Extension Service or your local Natural Resource Conservation Service office for sampling directions. *A List of Analytical Laboratories Serving Oregon* (FG 74) lists laboratories that test manure.

## Crop nitrogen requirements

Nitrogen (N) is the nutrient needed for crop production on dairies. Tables 1 and 2 show the estimated nitrogen removal rate (or uptake) for average yields of the most common forage crops grown on dairies.

## Determining manure application rate

Your goal is to match manure nutrient application rates with crop removal. Table 1 and Figures 1–3 provide the information you need for perennial crops, and Table 2 and Figures 4–6 apply to annual crops. Instructions on how to use them follow. (An example is illustrated on page 3.)

### Perennial crops

1. In Table 1, find the crop you will grow and the average yield per cutting. Let's assume you grow perennial ryegrass. Table 1 shows that an average yield per cutting is 1.2 tons per acre of dry matter (about 3 tons of harvested grass).
2. Now find the nitrogen removal rate for the average yield. Table 1 shows that perennial ryegrass takes up about 60 pounds of N per acre for each cutting. Thus, you should apply about 60 lb N/a after cutting the ryegrass.
3. Find the figure below (Figures 1–3) 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.
4. Figure 2 contains three lines representing N application rates of 50, 100, and 150 lb N/a. Find the line that is closest to the rate you need to apply. You'll use the line for 50 lb/a because it is closest to 60 lb/a.
5. Select your manure analysis for nitrogen on the left side of the graph. Let's assume a manure test shows that the effluent contains 6 lb/1,000 gallons 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).

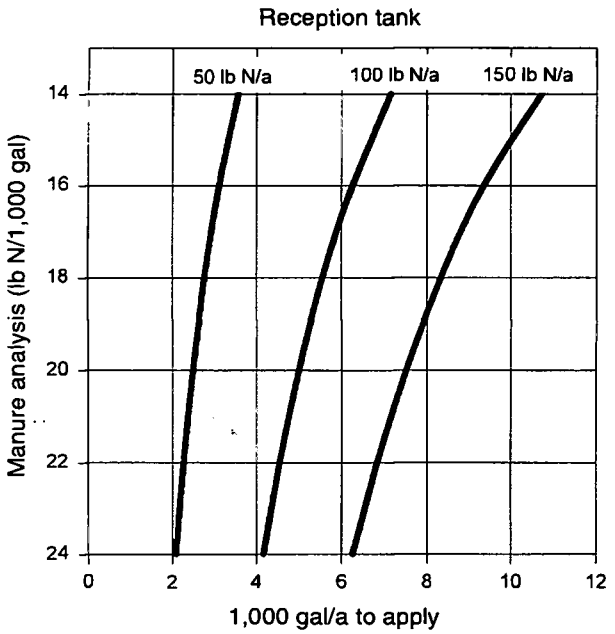



*Figure 1.—Determining application rate for reception tank manure.*

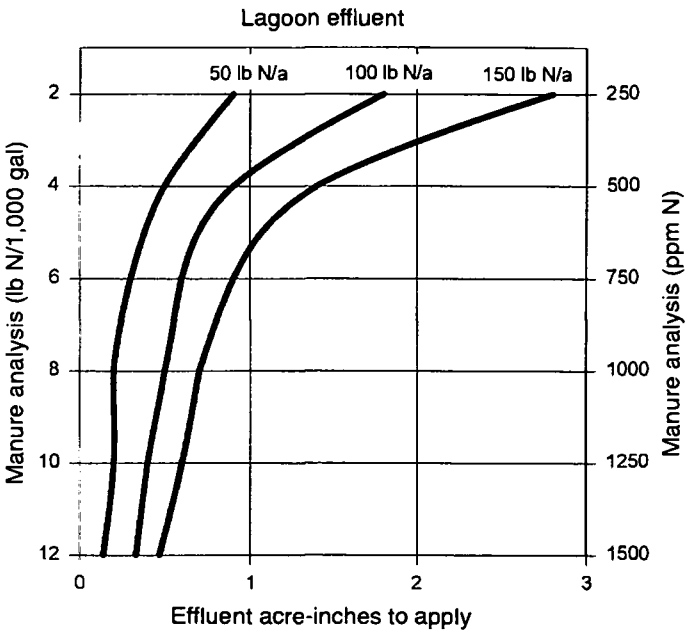



*Figure 2.—Determining application rate for lagoon effluent.*

*Note:* Recommendations in Figures 1–6 assume that nitrogen applications should not exceed crop removal. We assume that N mineralization will offset any volatile losses that occur during application.

Table 1.—Approximate nitrogen removal by perennial forage crops and suggested nitrogen application rates.

| Crop | Average yield per cutting (t/a) | N removal rate for average yield per cutting (lb N/a) | Suggested N application rate (lb N/t of forage*) |
|---|---|---|---|
| Orchard grass | 1.4 | 70 | 50–60 |
| Perennial ryegrass | 1.2 | 60 | 50–60 |
| Tall fescue | 1.4 | 70 | 50–60 |

*All rates are on dry matter basis unless noted otherwise.

6. Now move down to the line labeled "effluent acre-inches to apply." Estimate the number of acre-inches of effluent to apply (about 0.3 acre-inch). Remember that you will need about 10 percent more nitrogen because no line exists for the 60 lb N/a required by ryegrass. Your final result will be about 0.4 acre-inch.

*Note*: If you know your own yield per cutting, you can figure your nitrogen need more accurately. To do so, multiply your tons per acre per cutting by the "suggested N application rate (lb N/t of forage)" in Table 1. The result is your N removal rate. Use the line in the appropriate figure that is closest to that rate.

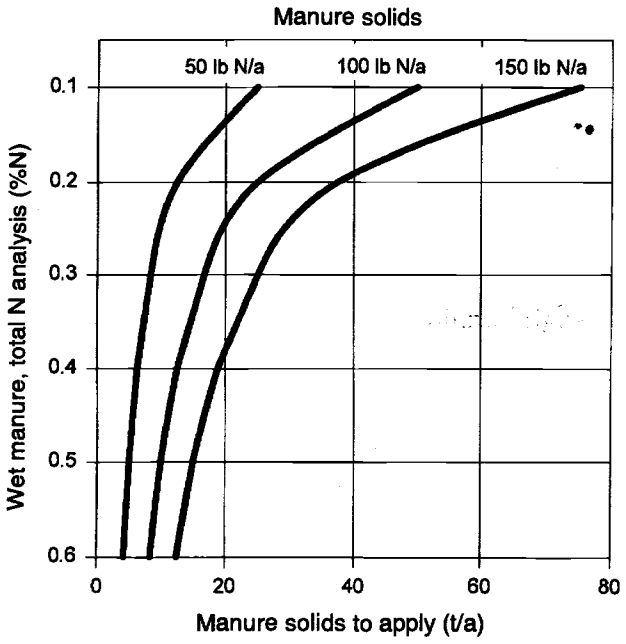



*Figure 3.—Determining application rate for manure solids.*

## Example

*Crop*: perennial ryegrass

*Manure*: lagoon effluent

1. Average yield per cutting = 1.2 t/a (Table 1).
2. Nitrogen removal rate = 60 lb N/a per cutting (Table 1).
3. Find the lagoon effluent graph (Figure 2).
4. Use the 50 lb/a line because it is closest to the 60 lb/a you need to apply.
5. Your manure test shows 6 lb/1,000 gal. Find this line on the left of the graph. Move across to the 50 lb/a line.
6. Move down to the bottom line to find the number of acre-inches to apply (0.3 acre-inch).

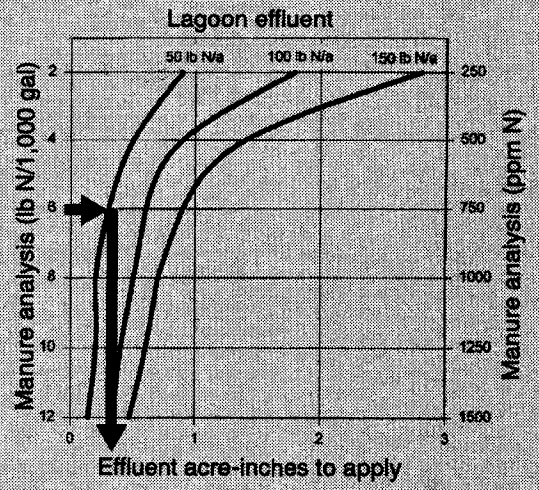


Table 2.—Approximate nitrogen removal by annual forage crops and suggested nitrogen application rates.

| Crop | Average total yield (t/a) | N removal rate for average yield (lb N/a) | Suggested N application rate (lb N/t of forage*) |
|---|---|---|---|
| Silage corn | | | |
| 75% moisture | 30 | 180 | 5–7 |
| dry matter basis | 7 | 180 | 20–30 |
| Annual ryegrass | 5 | 100 | 15–25 |
| Triticale | 8 | 160 | 15–25 |
| Oats | 4 | 80 | 15–25 |
| Sudan grass | 5 | 250 | 50–60 |

*All rates are on dry matter basis unless noted otherwise.

## Annual crops

You can follow a similar procedure to estimate the amount of manure needed for annual crops. For example:

1. From Table 2, find the total amount of N that is needed by the annual crop you will grow. We will use silage corn as an example. A 30-ton yield of silage corn requires 180 lb N/a.
2. Find the figure (Figures 4–6) that represents the type of manure you want to apply. Let's assume you'll apply separated solids, so use Figure 6.
3. Figure 6 contains three lines representing N application rates of 50, 100, and 150 lb N/a. Find the line that is closest to the rate you need to apply. You'll use the line for 150 lb/a since it is the closest to the rate you need to apply (180 lb/a).
4. Find your manure analysis for nitrogen on the left side of the graph. Let's assume your manure test shows that the solids contain 5 pounds of N/t or 0.25 percent N on a wet basis. Since 0.25 percent N is not on the graph, estimate a point halfway between 0.2 and 0.3. Move to the right until you meet the line for 150 lb N/a.
5. Now move down to the line labeled "manure solids to apply (t/a)." You should find 30 tons. Remember that 20 percent more nitrogen will be needed because no line exists for the 180 lb N/a required by the silage corn. The total estimated amount of solids required should be 35 t/a.

*Note*: If you know your own yield, you can figure your nitrogen need more accurately. To do so, multiply your tons per acre by the "suggested N application rate (lb N/t of forage)" in Table 2. The result is your N removal rate. Use the line in the appropriate figure that is closest to that rate.

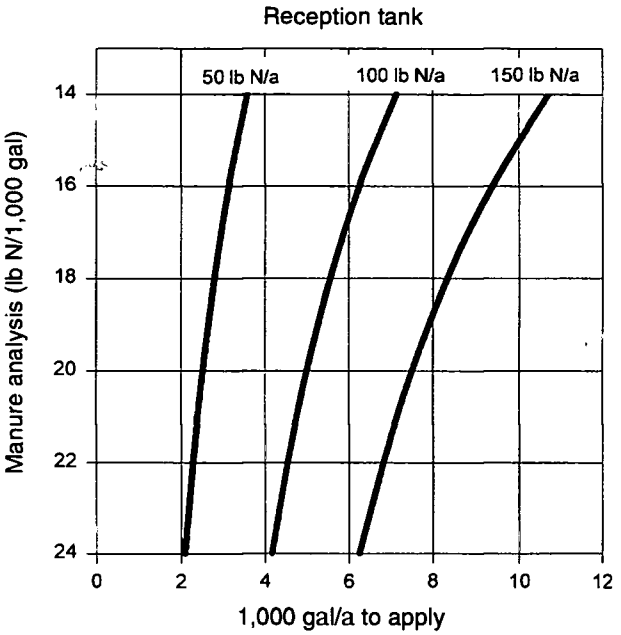



*Figure 4.—Determining application rate for reception tank manure.*

## Special cases

The manure application rates in this publication are based on the assumption that manure already has been applied to fields for at least 4 consecutive years, not including the current year.

If your fields have received manure for less than 4 years, increase rates as shown in Table 3 if you use reception tank, separated solids, or dry stack material. Lagoon effluent provides sufficient available N for any situation when applied during the growing season.

## Checking your application rate for silage corn

With silage corn, you can confirm that you applied sufficient manure by using the pre-sidedress soil nitrate test (PSNT). When the corn is 12 inches tall or at the five-leaf development stage, sample soil between rows to a depth of 12 inches. Have the sample analyzed for nitrate nitrogen ($NO_3$-N).

Compare the soil test results to Table 4. Apply the appropriate amount of lagoon effluent or fertilizer N to the growing crop based on the PSNT and Table 4.

It is important to handle samples properly. For more information, see *The Pre-sidedress Soil Nitrate Test (PSNT)*, EM 8650.

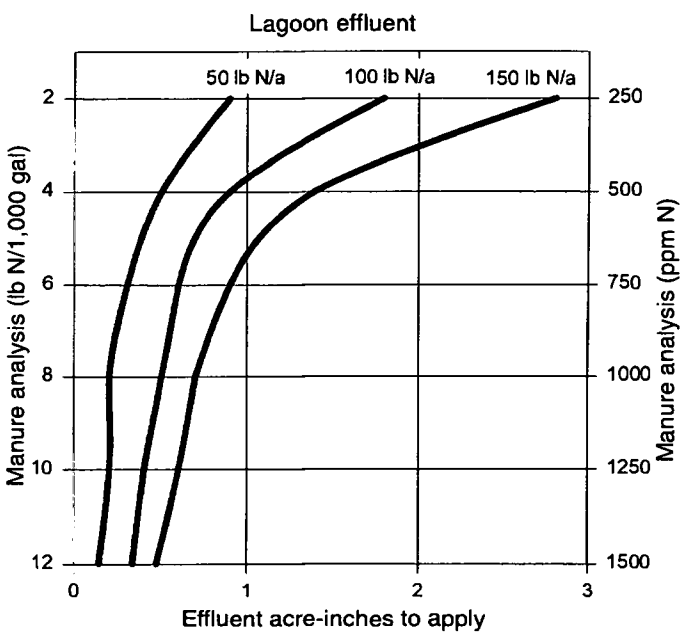



*Figure 5.—Determining application rate for lagoon effluent.*

**Table 3.—Manure application rates based on number of years field has received manure.**

| If your field has received manure this many years: | Multiply suggested application rate by: |
|---|---|
| 0 | 3.0 |
| 1 | 2.5 |
| 2 | 2.0 |
| 3 | 1.5 |
| 4 or more | Use suggested rates |

**Table 4.—Amount of nitrogen to apply for silage corn production based on the PSNT.**

| PSNT (ppm) | Nitrogen (lb/a) |
|---|---|
| 0–10 | 100–150 |
| 10–20 | 50–100 |
| 20–25 | 0–50 |
| above 25 | 0 |

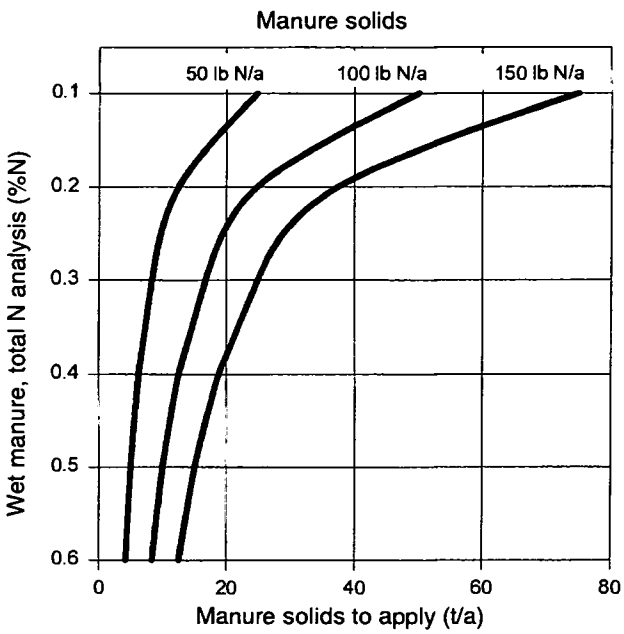



*Figure 6.—Determining application rate for manure solids.*

## Testing your soil for P and K

Test your soil for phosphorus (P) and potassium (K) before applying manure. Table 5 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 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 nitrogen needs usually supplies sufficient amounts of P and K. Manure contains as much, if not more, K than N. For more information, see EM 8586, *Dairy Manure as a Fertilizer Source.*

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. When grass forage with more than 3 percent K is fed to dry cows, serious illness or death may occur.

In some cases, a soil test shows excessive K, but N is needed. In this case, you have two options:

- Apply separated solids, which are lower in K than other forms of manure.
- 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.

## New plantings

Little N is needed by new plantings. After N, phosphorus is the nutrient most likely to limit forage production. For new plantings or annual crops where manure has not been applied, apply 30 lb $P_2O_5$/a in a band-placed starter fertilizer. For more information, see FG 63, *Pasture Fertilizer Guide.*

Table 5.—Interpretation of soil tests for P and K.

| | Nutrient | |
|---|---|---|
| Soil status | Phosphorus (P) (ppm) | Potassium (K) |
| deficient | below 25 | below 150 |
| sufficient | 25–50 | 150–500 |
| high | 50–75 | 500–1,000 |
| excess | above 75 | above 1,000 |

If P is deficient (see Table 5), also apply one of the following :

- 25 tons of separated solids
- 5,000 gallons of reception tank manure
- 5 wet tons of dry stack manure

## End-of-season testing

The tables and figures in this publication provide only an estimate of manure application rates. An end-of-season soil test for nitrate nitrogen or stalk nitrate test for silage corn can aid in adjusting next season's manure application rates.

### "Report card" soil testing

1. Sample soil to a depth of 12 inches as described for PSNT sampling. Sample from between rows, and avoid fertilizer bands. See EM 8650 for more information.
2. Prepare and handle the sample as described for PSNT sampling.
3. Have the sample analyzed for nitrate nitrogen ($NO_3$-N).

If soil $NO_3$-N test results are above 15 ppm, nitrogen probably was supplied in excess of crop needs. (To convert ppm to lb/a, multiply by 3.65.)

## Corn stalk nitrate testing at harvest

1. Collect 10 mature corn plants by cutting the stalks just above the brace roots. Select representative plants away from edges of the field.
2. Cut an 8-inch section of stalk from the bottom of each harvested plant.
3. Remove the dried outer leaves from each 8-inch section.
4. Split each section of stalk lengthwise to aid in drying.
5. Place the split stalks together in a bag and send to a lab for nitrate nitrogen ($NO_3$-N) analysis.
6. Use Table 6 to interpret results.

**Table 6.—Interpretation of corn stalk nitrate tests.**

| Stalk $NO_3$-N concentration at harvest | Interpretation |
|---|---|
| <3,500 ppm | N may have limited yield |
| 3,500–5,500 ppm | N sufficient for optimum yield |
| >5,500 ppm | N supplied in excess of crop demand |

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Hart, J. *A List of Analytical Laboratories Serving Oregon*, FG 74 (Oregon State University, Corvallis, revised 1996). No charge

Hart, J., G. Pirelli, L. Cannon, and S. Fransen. *Pastures Fertilizer Guide*, FG 63 (Oregon State University, Corvallis, 1993). No charge

Hart, J., M. Gangwer, M. Graham, and E. Marx. *Dairy Manure as a Fertilizer Source*, EM 8586 (Oregon State University, Corvallis, reprinted 1996). 75¢

Marx, E., N.W. Christensen, J. Hart, M. Gangwer, C.G. Cogger, and A.I. Bary. *The Pre-sidedress Soil Nitrate Test*, EM 8650 (Oregon State University, Corvallis, 1996). 75¢

### Other publications

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

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