AW93-011

Nutrient Management for Dairy Production

DRAFT

FACT SHEET 1

Manure Nutrient Value and Application

Management of manure is probably the biggest challenge Oregon dairy producers face. The key to successfully managing manure is to treat it as a resource, using the nutrient value to produce forage. This series of publications is designed to aid dairy producers manage manure as a nutrient source for forage production.

Manure is the total excreted volume of feces and urine. Fresh dairy manure has the following characteristics based on a 1,400 pound cow producing 70 pounds of milk and consuming 48 pounds of dry matter daily.

- Daily manure production is 160 pounds, 20 gallons, or 2.2 cubic feet.
- Daily quantity is 100 pounds feces and 60 pounds urine.
- Feces contains 0.4 pounds of total nitrogen, 0.2 pounds total phosphorus and 0.1 pounds of potassium.
- Urine contains 0.4 pounds of total nitrogen, 0.02 pounds total phosphorus and 0.35 pounds of potassium.
- The dry matter content of this daily volume is 12.5%, or 20 pounds.

On an annual basis, a cow produces 29 tons, 7,300 gallons or 803 cubic feet of freshly excreted manure. This represents

- 7,300 pounds of dry matter (which is equivalent to 42% of dry matter intake)
- 300 pounds of nitrogen
- 80 pounds of phosphorus or 180 pounds of P_2O_5
- 160 pounds of potassium

Organic and inorganic nutrients in freshly excreted manure are not distributed evenly.

- The feces contains 50% of total nitrogen, 90% of total phosphorus, and 10% of total potassium. These represent primarily organic nutrients.
- The urine contains 50% of total nitrogen (as urea), 10% of total phosphorus, and 90% of total potassium. These represent primarily inorganic nutrients that are readily available to plants.

Fertilizer Value of Manure

The value of manure shown in Table 1 is calculated using nitrogen at 30¢/lb, phosphorus (P_2O_5) at 20¢/lb, and potassium (K_2O) at 15¢/lb.

Table 1. Daily and annual values per cow on a fresh manure basis.

	Day	Annual
Nitrogen	$ 0.25	$ 91
Phosphorus (P_2O_5)	$ 0.10	$ 36
Potassium (K_2O)	$ 0.07	$ 26
Total Value	$ 0.43	$153

Nutrients can be lost in the following situation:

- Volatilization of ammonia gas into the atmosphere occurs after nitrogen is converted to ammonium from urea or other organic sources.
- Denitrification occurs when nitrate is converted into nitrogen gas. This occurs in conditions of limited oxygen availability such as water-logged soils.
- Phosphorus and potassium are lost as soils erode. Phosphorus is a pollutant when it enters surface water through erosion.

Typical values of stored manure from selected handling systems are provided in the following sections. Nutrient values for separated solids and dry stack are on a wet weight basis.

	Reception tank	Storage pond
	----- lb/1,000 gal -----	
Total N	20	5
Ammonium	8	4
Total P	3	0.25
P as P_2O_5	7	0.6
Total K	15	12
K as K_2O	18	15

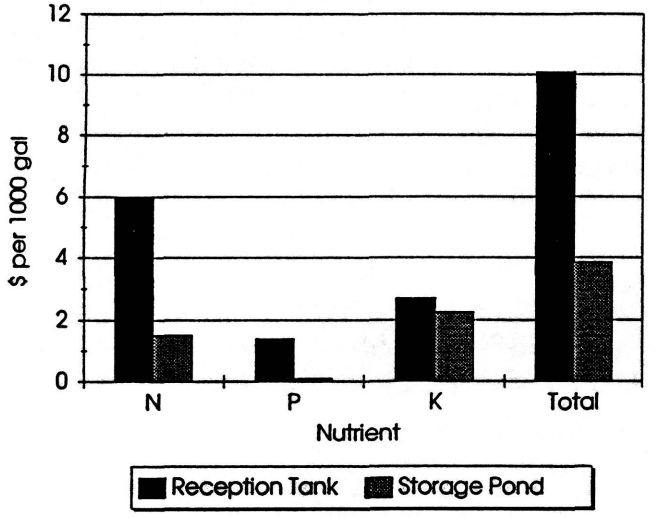

Figure 1. Nutrient value of wastewater.

If you receive a laboratory report with ppm as the units for liquid manure and wish to convert to pounds per 1,000 gallons, divide ppm by 120.

	Separated Solids		Dry Stack	
	%	lb/wet t	%	lb/t
Dry matter	20	400	30	600
Total N	0.24	5	0.45	9
Total P	0.04	0.8	0.20	4
P as P_2O_5		1.8		9.5
Total K	0.09	1.8	0.60	12
K as K_2O		2.2		15

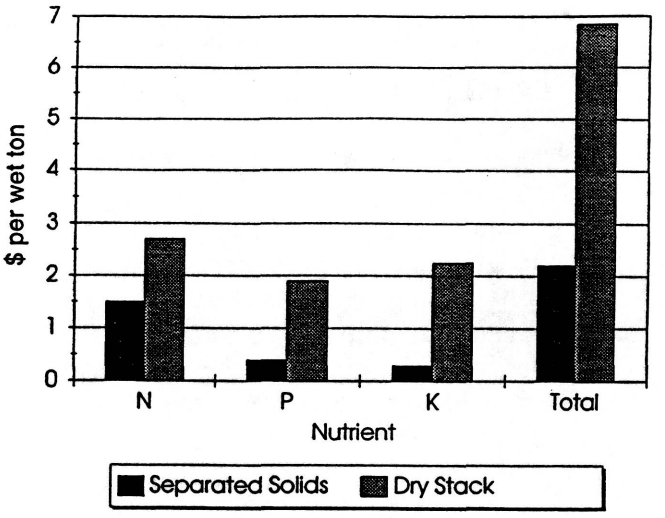

Figure 2. Nutrient value of separated solids.

Calculation of manure application rates

The first step in determining manure application rates is to determine the nutrient concentration of manure. The second step is to determine the volume or weight per acre of manure that is applied.

Collect a sample of wastewater or manure for laboratory analyses. Send the laboratory a sample of liquid manure (one pint) or a solid sample of manure (2-3 pounds in a freezer baggie) taken from a representative spot or location. This sample may be from the reception tank, manure storage pond, a separated manure pile beneath the separator, or from a bucket placed beneath the spray volume of wastewater in the field at time of application. Refrigerate the sample if it will not be delivered to the laboratory within half a day after sampling. A list of commercial wastewater laboratories are found in FG 74 *Analytical Labs in Oregon.* See the "For More Information" section for ordering instructions.

Analyze the sample for

- Total N or total Kjeldahl nitrogen (organic and inorganic N)
- Ammonium (inorganic N) liquid only
- Total P
- Total K

Determination of volume or weight per acre

Once the nutrient concentration is determined, the next step is to convert the analysis to an application

rate, usually expressed in tons/acre for solid manure and acre-inches for liquid manure.

Example 1. A tandem axle truck is 18 feet long, 6 feet high, and 8 feet wide. It can carry 864 cubic feet. Screened manure solids weigh 40 lb/cubic ft. Manure in the truck weighs (864 x 40) 34,560 pounds or 17.3 tons. Your laboratory analysis shows the nutrient content of screened manure solids is 5 lb N, 4 lb P_2O_5, and 2.2 lb K_2O/wet ton. The truck contains 86 lb N, 69 lb P_2O_5, and 38 lb K_2O (17.3 x 5, 17.3 x 4, and 17.3 x 2.2).

The desired application rate of nitrogen is 200 pounds/acre. Spread this load on just under one-half acre to achieve the desired rate (86/200 x 43,560). This application rate is equivalent to 1.8 lb manure/sq ft, or one cubic foot is applied to 22 sq ft. For application purposes, visualize an acre as 660 feet long by 66 feet wide.

Example 2. An irrigation system pumps wastewater from a manure storage pond at 600 gal/min. A sample of waste-water is taken in a five gallon bucket set in the field. The reel irrigator travels at 4 ft/min covering a radius of 120 feet. The application area is 120 x 2 x 4 = 960 sq ft/min. In just one minute, 600 gallons are applied to 960 sq ft. In 45 minutes, one acre inch of waterwater is applied (600 x 45 = 27,154). The irrigator covers an acre of field in 45 minutes (43,560 sq ft per acre/960 sq ft per minute). If the nutrient concentration of the wastewater is 5 lb N, 0.6 lb P_2O_5, and 15 lb K_2O/1,000 gallons, then the nutrient application/acre inch is 135 lb N, 16 lb P_2O_5, and 407 lb K_2O (27.154 x 5, 27.154 x 0.6, 27.154 x 15).

If ammonium (NH_4) concentration is reported by a laboratory, convert it into nitrogen by multiplying NH_4 by 0.778. Similarly, if an estimation of inorganic fertilizer is desired, nitrogen may be converted to urea (46% nitrogen) by multiplying nitrogen concentration of the wastewater (ammonium fraction) by 2.2. For instance, if the ammonium concentration of wastewater is 4 lb/1,000 gal, this is equivalent to 3.1 lb nitrogen.

3.1 x 2.2 = 6.8 lb urea/1,000 gal

Total phosphorus is multiplied by 2.3 to yield P_2O_5. For example, if total P concentration of wastewater is 0.25 lb/1,000 gal, this amount is equivalent to .56 pounds of P_2O_5/1,000 gal.

Wastewater total potassium in wastewater is multiplied by 1.2 to yield K_2O. For example, if total K concentration of wastewater is 12.5 lb/1,000 gal, this amount is equivalent to 15 lb of K_2O/1,000 gal.

For more information

To order FG 74, *Analytical Laboratories Serving Oregon* write Publication Orders, Agricultural Communications, Oregon State University, Administrative Services A422, Corvallis, OR 97331-2119. There is no charge for this publication.

Gangwer, M. and M. Graham. 1994. *Wastewater Volume and Nitrogen Concentrations in Willamette Valley, Oregon Dairy Ponds,* Special Report 939, Oregon State University, Corvallis, Oregon.

Units of measure used for calculation of manure application.

1 acre = 43,560 square feet

1 gallon water = 8.34 pounds

1 cubic foot water = 62.5 pounds = 7.5 gallons

1 acre inch water = 27,154 gallons = 225,378 pounds = 3,611 cubic feet

1 acre foot water = 325,848 gallons = 2,717,572 pounds = 1,359 tons

1 million gallons water = 3.07 acre feet = 8,342,946 pounds = 4,171 tons

1 ppm = 1 mg/liter = 1 mg/kg = 1 mg/1,000 grams = 0.0083 pounds/1,000 gallons

1 pound NH_4 = 0.778 pound N

1 pound NO_3 = 0.226 pound N

1 ppm NH_4-N = 3.65 lb N/acre foot soil

1 ppm NO_3-N = 3.65 lb N/acre foot soil

1 pound P = 2.3 pounds P_2O_5

1 pound K = 1.2 pounds K_2O

1 acre inch water/hour = 450 gallons per minute

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