Archived Publication

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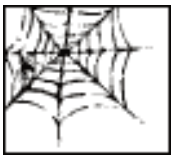

EPA promulgated regulations for Concentrated Animal Feeding Operations (CAFOs) in February 12, 2003 that expanded the number of operations covered by the CAFO regulations and included requirements to address the land application of manure from CAFOs. The rule became effective on April 14, 2003. NPDES-authorized states were required to modify their programs by February 2005 and develop state technical standards for nutrient management. On February 28, 2005, in response to litigation brought by various organizations, the Second Circuit court issued its decision in *Waterkeeper Alliance et al. v. EPA*, 399 F.3d 486 (2d Cir. 2005). EPA has updated the CAFO rule to reflect the changes requested by the Court. Visit www.epa.gov/npdes/caforule to view the 2008 CAFO Final Rule and supporting documents.

APPENDIX I - AGRONOMIC NUTRIENT APPLICATION RATE

Good nutrient management includes proper land application of animal wastes. To do this, determine the most appropriate rate at which your animal waste should be applied. Calculate this application rate using results from your soil and animal waste analyses, crop nutrient recommendations, and land availability. It is important to consider all of these factors when calculating your nutrient application rate to reduce commercial fertilizer costs, reduce potential for crop damage, and reduce environmental impact.

Description

Animal waste nutrient application rates should be based upon Land Grant University guidance and site-specific test results. You should consider current soil test results, nutrient credits from previous legume crops and animal waste applications, crop yield goals, and other pertinent information when determining your nutrient balance, which is used to calculate your application rate.

Base your application rate on realistic yield goals. You can calculate an appropriate application rate, or agronomic rate, using the nutrient availability of the animal waste and the crop requirement for the nutrient having the highest nutrient need (nitrogen or phosphorus). Most state guidelines/policies allow animal waste applications at rates sufficient to meet, but not to exceed the nitrogen needs of agronomic crops, which typically results in over application of phosphorus. However, in areas with high soil phosphorus levels, animal waste should be applied at rates sufficient to meet, but not to exceed the phosphorus needs of agronomic crops.

To calculate your nutrient application rate you need to perform a nutrient balance to determine whether animal waste nutrient spreading is necessary. To do this, first determine your crop nutrient needs, accounting for the nutrients currently available in your soil (as determined in your soil analyses) and from nitrogen credits. Next, determine how many gallons (or tons) of animal waste you collect between each land application (see Appendix D for more information on estimating animal waste volumes). Then, using the results of your nutrient animal waste analysis (see Appendix E), calculate the amount of nutrients available each year from your animal waste. Now you can calculate the amount of animal waste needed to meet your nutrient needs, which is done by dividing your crop nutrient need by your nutrient animal waste analysis for a few key nutrients (e.g., nitrogen and phosphorus). These steps are described in more detail below.

Performing A Nutrient Balance

To determine your agronomic nutrient application rate, you need to perform a nutrient balance for your crops. The nutrient balance accounts three components needed to calculate an application rate: 1) the nutrients your crops need, 2) the nutrients available to your crops from prior nutrient applications (i.e., nutrient credits), and 3) the nutrients available from your animal waste.

Most crop nutrient requirements and nutrient credits are calculated from many years of field research. There is no “real time” method available for calculating your crops’ nutrient requirement or the nutrients available at any one time. Rather, both components are based on past performance for your climate and soil condition.

A nutrient budget is a method for matching the nutrient needs of your crop with your available nutrients. It can easily determine if there is a gross imbalance between the nutrients that are available and the amount required and can be used to calculate a nutrient addition rate.

There are two methods for calculating a nutrient budget. The first is based on a soil test analysis and crop nutrient recommendation as given by an agronomic specialist (e.g., USDA, land grant university). The

nutrient requirement of your crop is determined from historical field research for your soil and climate. The nutrient credits are derived from analysis of soil and historical animal waste spreading data. This method is EPA's preferred method because it takes into account your local climate and soil conditions. Typical crop nutrient requirements can be obtained from USDA and state agricultural Cooperative Extension Offices. Some states have even developed agronomic plant nutrient recommendations based on soil tests and yield goals for the major agronomic crops grown in that state.

The second method is based on the balance between nutrients supplied to the crop and nutrients removed by the crop. You need to know the crop for which you are planning a nutrient budget. Nutrient budgets can be calculated for a single crop or over the entire crop rotation. You need to know your expected crop yield based on realistic soil, climate, and management parameters. Yield expectations can be calculated from historical records, soil productivity tables, or local research.

Estimating the Nutrients Removed by the Crop

The nutrients removed by the crop can be used to represent your nutrient crop need when it is not available from other sources. When a crop is harvested and removed from the field, the nutrients in that crop are also removed. These removed nutrients represent a net loss to the soil. Other losses, such as erosion and runoff, and leaching can occur and must be estimated if you are trying to maintain a constant level of nutrients in your field. The USDA/NRCS Agricultural Waste Management Field Handbook, Table 6-6, can be used to estimate nutrient content in harvested crops. This handbook can be found on the Internet at **http://www.ftw.nrcs.usda.gov/awmfh.html**. Chapter 11 of this handbook can be used to estimate nitrogen nutrient losses from the field system. Use the following form to calculate the nutrients removed by your crop.

Step 1: Yield (units of measure/acre) * Unit weight (lbs) = pounds crop material harvested

_____ * _____ = _____ lb/acre

Step 2: Nutrient content of harvested material (refer to Table 6-6 of the Agricultural Waste Management Field Handbook)

% N = _____ % P = _____ % K = _____

Step 3: Crop nutrient Content (multiply results in Step 1 by results in Step 2)

N = _____ lb/acre * _____ %N P = _____ lb/acre * _____%P K = _____lb/acre * _____%K

N = _____lb/acre P = _____ lb/acre K = _____ lb/acre

Step 4: Convert to fertilizer equivalent units

N =N lb/acre P_2O_5 = P lb/acre * 2.29 K_2O = K lb/acre * 1.2

N = _____ lb/acre P_2O_5 = _____ lb/acre K_2O = _____ lb/acre

Source: Core4 Conservation Practices, August 1999.

Estimating Nitrogen Credits

Nitrogen is a mobile nutrient and exists in the soil and plants in many forms. It is stored in the soil's organic matter and released as the organic matter decomposes. This nitrogen is available to crops during this time and should be accounted for in performing your nutrient balance. There are at least four groups of nitrogen credits that you need to account for: 1) legume nitrogen credits from your previous crop, 2) residual nitrogen from previous manure applications, 3) irrigation water nitrate nitrogen, and 4) other sources. These are described below.

- Legume Nitrogen Credits - Legumes can produce, through atmospheric fixation, enough nitrogen to meet their nutrient requirements. When the legume is harvested, organic nitrogen is mineralized, releasing available nitrogen to the following crop. Refer to your local extension information for the legume nitrogen credits.

- Nitrogen residual from previous manure applications - Organic nitrogen mineralizes according to a decay series which is specific for each manure type and composition. This concept recognizes the gradual mineralization of organic nitrogen over several years. Refer to your local mineralization rates to determine the residual release of nitrogen.

- Irrigation Water Nitrate Nitrogen - Irrigation water, especially from shallow aquifers, contain some nitrogen in the form of nitrate nitrogen. To calculate the amount of nitrogen applied with irrigation water, determine the concentration of nitrate nitrogen in water (in mg/L). The application amount will equal the nitrate nitrogen concentration multiplied by the volume (in acre-inches) times 0.23 to calculate pounds of nitrate per acre.

- Other Nitrogen Credits - Other credits come from atmospheric deposition from dust and ammonia in rainwater. This value is recorded by weather stations and can obtained from the National Atmospheric Deposition in Fort Collins, Colorado. The atmospheric deposition can range from a few pounds per acre per year to over 30 pounds per acre per year.

Use the following chart to calculate your nitrogen credits.

A.	Legumes Credits from Previous Crop	_____ lb/acre
B.	Residual from Previous Animal Waste Applications	_____ lb/acre
C.	Irrigation Water Nitrate Nitrogen	_____ lb/acre
D.	Others (atmospheric deposition, other fertilizer applications)	_____ lb/acre
Total Nitrogen Credits (Sum of A through D)		_____ lb/acre

Calculating the Number of Pounds of Each Nutrient Available During Land Application

To calculate the number of pounds of each nutrient that is available during land application, you need to know how much animal waste you produce (see Appendix D) and the nutrients contained in it (see Appendix E). Using your animal waste sampling results, multiply the amount of animal waste in storage (or available for application) by the concentration of nutrients found in your animal waste, as shown below.

Nutrient	Amount of Animal waste Available (gal or tons)		Concentration of Nutrient in Animal waste Analysis (lb/gal or lb/ton)		Pounds of Nutrient Available
Nitrogen		x		=	
Phosphorus (P2O5)		x		=	
Potassium (K2O)		x		=	

Source: Iowa State University, 1995.

After calculating the pounds of nutrients available, you need to correct for the nitrogen that is lost to the air during application. (It is assumed that there are no losses of phosphorus or potassium during application.) The remaining amount is the amount of nitrogen that will remain after spreading. To do this, multiply your pounds of nitrogen available (from the above chart) by the correction factor below that best describes your animal waste application method, and then plug that factor into the following form.

- Direct injection - 0.95
- Broadcast and incorporate within 24 hours - 0.95
- Broadcast and incorporate after 24 hours - 0.8
- Broadcast, no incorporation - 0.7

If you use a combination of application methods, you will need to account for this difference in the total pounds of nitrogen available, using the appropriate ratio of pounds available with the appropriate correction factor.

Pounds of Nitrogen Available		Correction Factor		Nitrogen Remaining after Application Loss (lbs)
	x		=	

Source: Iowa State University, 1995

The result is the nitrogen remaining after application losses; however, only 50 to 80% of the organic nitrogen will be available to plants the first year after spreading. The percentage available depends on the type of animal waste spread. Beef and dairy animal waste has approximately 50% available, while poultry waste has approximately 80% available. Next, multiply your nitrogen amount by your factor (e.g., 0.50 or 0.80) using the following chart. The result is the net usable nitrogen in your animal waste (in pounds).

Pounds of Nitrogen Remaining after Application Loss		Percent of Nitrogen Available (as a decimal)		Net Usable Nitrogen in Animal Waste (lbs)
	x		=	

Source: Iowa State University, 1995

Account for the nitrogen credits by adding the total estimated nitrogen credits to the net usable nitrogen in animal waste to calculate the total nitrogen available sources.

To calculate the usable amount of each nutrient available during application, divide the total usable amount of nutrient in animal waste (using the adjusted amount for nitrogen) by your available volume of animal waste, to calculate a rate in pounds of nutrient per gallon of animal waste, or pounds of nutrient per ton of animal waste.

Instructions for Determining Animal Waste Volume to Apply

After calculating your nutrient needs, total pounds of nutrients available and the pounds of nutrients available to plants in each gallon (or ton) of animal waste spread, you have determined your nutrient balance and can calculate the amount of animal waste to apply to your crops. For each nutrient, divide your net nutrient needs (calculated or estimated from published rates) by the usable nutrient amount available (in pounds per gallon or pounds per ton) to calculate the amount of animal waste you need to apply. Do this for both nitrogen and phosphorus. You will base your application rate on whichever nutrient requires less animal waste. Next, divide your total volume of animal waste needed by your land area (in acres) to calculate your animal waste application rate (in gallons per acre or tons per acre).

References

U.S. Department of Agriculture. CORE4 Key Conservation Practices, August 1999.

Iowa State University, University Extension. Land Application for Effective Manure Nutrient Management, Pm-1599, October 1995.

Wolkowski, Richard P. A Step-by-Step Guide to Nutrient Management. Nutrient and Pest Management Program, A3568.

Who to Contact for More Information

Your Local Cooperative Cooperative Extension Office
Your Local Land Grant University
National Water Management Center/Natural Resources Conservation Service (USDA)