ALABAMA A&M AND AUBURN UNIVERSITIES

ALABAMA COOPERATIVE Extension SYSTEM

ANR-790-4.6.6

Animal Waste Management To Protect Water Quality

Calculating Rates Of Application Based On Nitrogen Needs

Many producers have discovered that animal waste is an excellent source of plant nutrients for nearby pastures and crops. When animal waste is land-applied, the nitrogen content is the most important consideration.

Nitrogen is not only the most valuable fertilizer nutrient applied to crops, but it is also the nutrient of primary environmental concern if it gets into the water supply. The amount of manure required to supply all N needs may lead to excessive levels of phosphorus and salts and may lead to potential nitrate contamination of groundwater.

To calculate the rate of application based on nitrogen needs requires both a knowledge of crop needs and of nitrogen availability and losses.

Crop Needs

The application rate for animal wastes should be based on crop nutrient requirements, the nutrient pool of the soil, and the nutrient value of the manure. Nitrogen requirements of selected crops are given in Table 1. These are also given on a soil test recommendation.

Nitrogen Availability

Unlike commercial fertilizers, not all N in animal waste is immediately available to the crop. This is because much of the total N is organic and very slowly available.

Different types of manure have different amounts of nitrogen available over differing time periods. For example, with broiler litter, only 30 percent of the actual N may be readily available with 35 percent slowly available during the season (Figure 1).

In general, the amount of manure required to supply a given amount of N decreases with repeated applications over years. If manure is applied to the same field year after year, the available N becomes very important in determining land application rates.

Table 1. Nitrogen Requirements Of Selected Crops.

Crop	Expected Yield	Nitrogen (lb./A)
Corn	75 to 99 bu./A	75 to 100
	100 to 149 bu./A	110 to 165
	150 to 200 bu./A	180 to 240
Cotton	1.0 bales/A	40
	1.5 bales/A	60
	2.0 bales/A	80
	2.5 bales/A	100
Grain Sorghum	1500 to 2000 lb./A	30 to 40
	2000 to 4000 lb./A	40 to 80
	4000 to 6000 lb./A	80 to 120
	6000 to 8000 lb./A	120 to 160
Wheat	20 to 30 bu./A	40 to 60
	30 to 40 bu./A	60 to 80
	40 to 60 bu./A	80 to 120
	60 to 80 bu./A	120 to 160
	80 to 100 bu./A	160 to 200
Coastal Bermuda	Grazing only	100 to 160
	1 cutting plus grazing only	160 to 220
	3 cuttings	300 to 350
	4 to 6 cuttings	400 to 600
Alfalfa[a]	Non-irrigated, annually	0
	Irrigated, 6 tons/A	0
	Irrigated, 8 to 12 tons/A	0
Wheat	Light grazing	160
	Moderate grazing	200
	Heavy grazing	240
Sorghum/Sudan	1 cutting or light grazing	80
	2 cuttings ormoderate grazing	160
	3 cuttings or heavy grazing	200

[a]Alfalfa is a legume which can get its nitrogen from the atmosphere. If fertilized, it can utilize up to 180 pounds of N per acre in producing a yield of 4 tons.

Source: U. S. EPA, 1993.

To estimate the amount of manure that will supply the N needed for successive years of application, see Table 2.

For more information on the value and use of poultry waste as fertilizer see Extension publication ANR-244, "Value And Use Of Poultry Manure As Fertilizer."

Nitrogen Losses

As much as 25 percent of the N that is applied in animal waste may be lost by volatilization, depending on method of application. With broadcasting and sprinkler irrigation, N losses to volatilization can be as much as 25 percent. On the other hand, broadcasting followed by immediate incorporation and knifing can reduce N volatilization losses to only 5 percent.

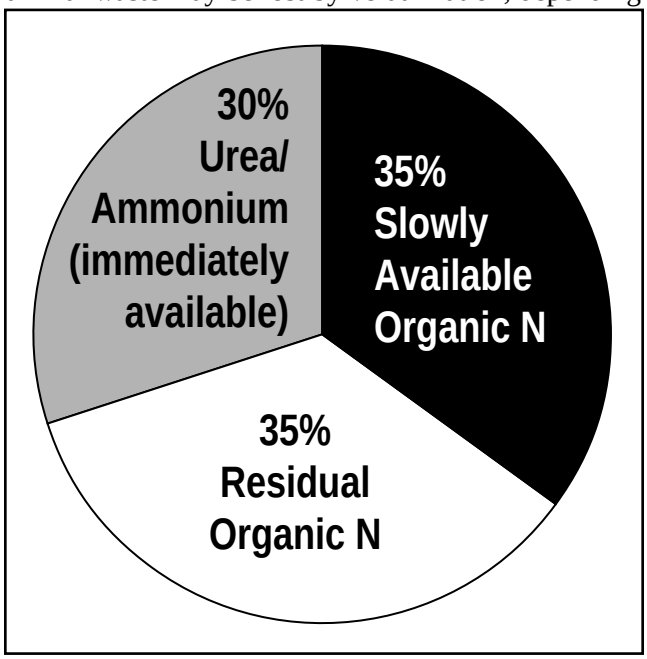

Figure 1. Nitrogen availability in broiler litter.

Denitrification loss of manure-applied N is common, especially on clayey soils (Table 3). Most agricultural soils, however, are not clay. Other variables like management, rainfall, irrigation, amount of organic matter, and texture can affect denitrification losses of N. Table 3 shows multiplication factors to use in adjusting manure-applied N rates under two management schemes on Group A, B, C, and D soils to ensure adequate crop needs after volatilization and denitrification losses.

Calculating Nitrogen Application Rate

The following examples illustrate how to calculate the amount of manure or liquid lagoon waste needed to produce 100 to 150 bu/A of corn on sandy (Group B) soils. If spreader equipment is not carefully calibrated, however, the application rate can be incorrect. Calibration of manure spreaders is discussed in another article in the water quality series.

Determine Nitrogen Needs And Manure Application Rate:

• Nitrogen Requirement: Soil test report suggests 120 pounds of N per acre (expected yield of corn is 100 to 150 bushels per acre from Table 1).

• Broiler litter will be used as the source of N. A manure analysis indicates the N-$P_2 0_5$-$K_2 0$ content is 60-60-40 pounds per ton.

Table 2. Quantity Of Livestock Or Poultry Manure Needed To Supply 100 Pounds Of Nitrogen Over The Cropping Year.[a]

Length Of Time Applied (Years)	Nitrogen In Manure (Percent) *(Pounds Per Ton)*									
	0.25 *(5)*	0.50 *(10)*	0.75 *(15)*	1.0 *(20)*	1.25 *(25)*	1.5 *(30)*	2.0 *(40)*	2.5 *(50)*	3.0 *(60)*	4.0 *(80)*
	(Tons Of Manure/100 lb N)[b]									
1	154.1	60.7	34.1	22.2	15.7	11.6	7.0	4.6	3.1	1.4
2	79.3	36.6	22.5	15.6	11.6	9.0	5.8	3.9	2.8	1.4
3	53.8	27.2	17.6	12.7	9.7	7.7	5.1	3.6	2.6	1.4
4	40.9	22.0	14.8	11.0	8.6	6.9	4.7	3.4	2.5	1.3
5	33.0	18.7	13.0	9.8	7.8	6.3	4.4	3.2	2.4	1.3
10	17.0	11.2	8.5	6.9	5.7	4.9	3.7	2.8	2.2	1.3
15	11.5	8.3	6.7	5.6	4.8	4.2	3.3	2.6	2.0	1.2
20	8.7	6.7	5.6	4.8	4.2	3.8	3.0	2.4	2.0	1.2

[a]The values are for repeated application on the same acreage.
[b]As measured for nitrogen content.

Source: Adapted from USDA and U.S. EPA, 1979.

Table 3. Multiplication Factors To Adjust Livestock Or Poultry Manure Quantities For Nitrogen Volatilization And Denitrification Losses After The Wastes Are Applied To The Soil.

Hydrologic Soil Group	Manure Management	
	Surface-Applied	Soil-Incorporated
A (sandy)	1.33	1.05
B (sandy, silty loam)	1.33	1.18
C (shallow, relatively clayey soils)	1.33	1.33
D (clay soils)	1.33	1.67

Source: USDA, 1979.

• Figure 1 suggests that approximately two-thirds (65 percent) of the N is available the first year. Therefore, the amount of litter needed is:

120 lb/A divided by 60 lb/ton = 2 tons/A

2 tons/A divided by (⅔ available) = 3 tons/A

• Since this will be applied to a sandy loam soil and incorporated, the multiplication factor from Table 3 to account for losses is 1.18. Therefore,

3 tons/A x 1.18 = 3.54 tons/A

• 3.5 tons per acre of broiler litter should provide adequate N for the corn crop. The estimated value from Table 2 is 3.1 tons to supply 100 pounds of N or 3.72 tons to supply 120 pounds (3.1 x 1.2) for poultry manure containing 60 pounds of N per ton. If broiler litter has been applied in previous years, residual organic N will have to be considered and the total rate applied will be lower. If litter averaging 60 pounds of N per ton has been applied for 10 years, then only 2.64 tons would be needed to supply 120 pounds per acre of N (2.2 x 1.2 = 2.64 from Table 2).

Research is underway to refine our understanding of the capacity of animal waste to supply crop nitrogen requirements, especially with broiler litter, Alabama's number one animal waste product. The high rates of litter needed to supply complete nitrogen needs may cause other problems that are not yet well defined. Excessive phosphorus accumulation in the top few inches of soil may lead to surface water quality problems, and accumulation of other elements could lead to salinity or toxicity problems for sensitive crops.

Determine Amount Of Lagoon Waste To Surface Apply:

• Nutrient Analysis: As determined by lab analysis or field measurement of electrical conductivity, assume that a particular lagoon waste contains 18 pounds of N per 1,000 gallons.

• Assume a yield goal of 175 bushels per acre of corn and an N recommendation of 200 pounds per acre.

• Amount Of Lagoon Waste Needed: The per acre rate would be 11,111 gallons (200 pounds per acre divided by 18 pounds per 1,000 gallons = 11,111).

• Nitrogen Losses: To compensate for volatilization-denitrification losses on Group B soils with surface application, the multiplication factor from Table 3 is 1.33.

• Amount To Apply: Since calculations must account for nitrogen losses, the actual amount to apply would be 14,778 gallons per acre (11,111 x 1.33 = 14,778). Use 15,000 gallons per acre as the application rate.

For irrigated application, use 0.55 inches per acre (15,000 gallons per acre divided by 27,152 gallons per acre-inch = 0.55 inch per acre). Use coffee cans to catch irrigation water during application to check for accuracy.

• Land Area Covered: If lagoon waste is used as the only source of N, then an 8,000 cubic foot lagoon (40 x 25 x 8) contains 60,000 gallons (8,000 cubic feet x 7.5 gallons per cubic foot) and will fertilize 4 acres of corn at 200 pounds per acre (60,000 gallons divided by 15,000 gallons per acre = 4 acres).

Conclusion

It is not advisable to apply very high rates of N as a single application, even with animal manure. In warm, humid climates, this N may be released faster than plants can absorb it, leading to water quality problems. Many agronomists now recommend split applications from any source of N where more than 100 pounds per acre are available for plant uptake or leaching within a 3- to 4-week period.

References

Mitchell, Charles C., James O. Donald, and John Martin. 1989. Circular ANR-244, "The Value And Use Of Poultry Waste As Fertilizer." Extension Circular ANR-244. Alabama Cooperative Extension Service. Auburn University, AL.

U.S. Department Of Agriculture and U. S. Environmental Protection Agency. 1979. Animal Waste Utilization On Cropland And Pastureland: A Manual For Evaluating Agronomic And Environmental Effects. USDA Research Report No 6. or EPA-600/2-79-059. Office of Research and Development. Washington, DC.

U.S. Environmental Protection Agency. 1993. EPA Region 6 General Permit For Discharges From Concentrated Animal Feeding Operations (CAFOs). EPA Water Division. Dallas, TX.

Willrich, T. L., D. O. Turner, and V. V. Volk. 1974. Manure Application Guidelines For The Pacific Northwest. ASAE Paper No 74-4061. American Society of Agricultural Engineers. St. Joseph, MI.

This publication, supported in part by a grant from the Alabama Department of Environmental Management and the Tennessee Valley Authority, was prepared by James E. Hairston, *Extension Water Quality Scientist,* assisted by Leigh Stribling, *Technical Writer.*

For more information, call your county Extension office. Look in your telephone directory under your county's name to find the number.

ALABAMA COOPERATIVE Extension SYSTEM

ANR-790-4.6.6

UPS, **New June 1995,** Water Quality 4.6.6