Nitrogen Credits from Manure

Nitrogen in Manure

Animal manure is a rich source of all seventeen nutrients essential for plant growth and reproduction. In terms of nitrogen (N), there are two primary forms: (1) inorganic (ammonium) N, and (2) organic N (Figure 1). The two forms behave very differently and as a result, both sources should be considered when making manure N rate decisions.

This fact sheet provides an overview of both N sources in manure and describes how to credit N from manure to a crop.

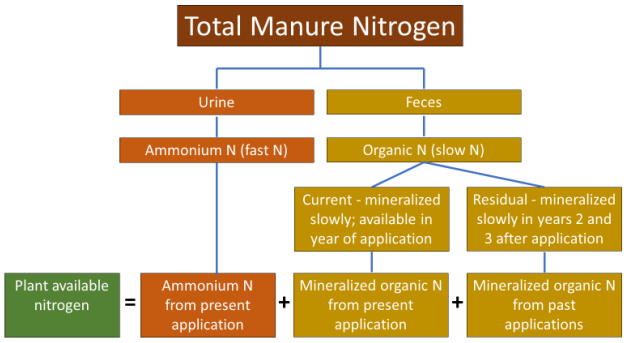

Figure 1: Manure N consists of ammonium and organic N (modified from Klausner, 1997).

Ammonium N in Manure

The inorganic N in manure is initially present in urine in the form of urea. Urea in manure is no different from urea in commercial fertilizer. It converts rapidly to ammonium when conditions allow. Although all ammonium-N could become plant available N, timing of application and the way in which manure is applied will determine how much of the ammonium N is expected to be captured, reflecting that ammonium is rapidly converted to ammonia gas. When manure is spread on the surface of the soil (especially high pH soils), ammonia enters the air or "volatilizes". Whenever manure is exposed to air on the barn floor, in a feedlot, in storage, or after spreading, N loss occurs as well. Testing of manure is essential to determine how much inorganic N could potentially be conserved and plant available. Samples should be taken while loading the spreader or while spreading in the field for a good estimate of the nutrient value of the manure. For more information, see Agronomy Fact Sheet #38 for more details on manure sampling.

Table 1 shows the estimated amount of ammonium N available for plant use for different application methods and timing. The table shows the benefits of manure incorporation shortly after spreading in the spring. For example, if manure contains 10 lbs inorganic N per 1,000 gallons, incorporation of 7,500 gallons per acre within 1 day in the spring can replace about 50 lbs of fertilizer N.

Table 1: Estimated ammonia-N losses as affected by manure application method (modified from Klausner, 1997).

Manure Application Method	Ammonium N utilized by the crop (%)
Injected into a growing crop	100
Spring injected without a growing crop	65
Spring incorporated within 1 day	65
Spring incorporated within 2 days	53
Spring incorporated within 3 days	41
Spring incorporated within 4 days	29
Spring incorporated within 5 days	17
No incorporation or injection	0
Injected or incorporated in the fall	0

Figure 2: Surface application of manure without incorporation will result in rapid loss of inorganic N from the manure.

Organic N in the Manure

The feces in manure contain organic N that is more stable. The organic N breaks down over time, some the first year after application, some in the following years. Repeated application to the same field results in an accumulation of a slow-release manure N source.

A decay or mineralization series is commonly used to estimate the rate of N availability from stable organic N over the years following application. A decay series of 35, 12, and 5% in years 1, 2, and 3 is used to estimate the rate of decomposition of organic N in liquid (<18% dry matter) dairy manures in New York (Table 2). This sequence of numbers means that 35% of the organic N is mineralized and potentially taken up by the growing crop during the year the manure was applied, 12% of the initial organic N application is mineralized and taken up during the second year, and 5% is mineralized and taken up in the third year after the application.

There is evidence that manure containing large amounts of bedding may mineralize at a slower rate than fresh manure so the estimated availability of N during the year applied is reduced from 35% to 25% when the dry matter content of manure exceeds 18%. Nitrogen fertilizer recommendations from Cornell University need to be adjusted for the release of N from previous years' applications. For more detail, see Nitrogen Guidelines for Field Crops in New York.

Table 2: Decay series for stable organic N in manure by animal type. A "Next Year" release rate of 12% indicates that an estimated 12% of the organic N applied in the manure is expected to be utilized by the crop a year after application. Similarly, 5% signals that 5% of the organic N applied becomes available two years after the initial application.

		Release rate for organic N in manure (%)		
Source	Dry matter (%)	Present year	Next year	In two years
Cows	<18	35	12	5
Cows	≥18	25	12	5
Poultry	<18	55	12	5
Poultry	≥18	55	12	5
Swine	<18	35	12	5
Swine	≥18	25	12	5
Horses	<18	30	12	5
Horses	≥18	25	12	5
Sheep	<18	35	12	5
Sheep	≥18	25	12	5

Practical Applications

- Base manure application rates on field histories (rotation and manure), soil characteristics and environmental conditions.
- Minimize fall and/or winter manure application on good grass and/or legume sods that will be rotated the following spring.
- Conserve ammonia. Losses can either be reduced by immediately incorporating after spreading in the spring or directly injecting manure as a sidedress application into a growing crop.
- Established mixed legume-grass stands with more than 50% grass are better alternatives for manure application than fields rotating into a perennial legume seeding or more legume-rich mixed stands.
- When legumes represent more than 50% of the established legume-grass stand, it is recommended to limit total application rates to no greater than 150 lbs of crop available N per acre or 85% of the estimated N removal per acre with harvest.
- While established stands could receive higher rates of manure, depending on the actual manure analysis, applications that exceed 4,000 gallon per acre per cutting could lead to burn, smothering, and/or salt injury to the stand, especially when applications are delayed beyond 3-4 days after cutting. For more details, see Considerations for Manure Use for Soybean and Perennial Legume Production in NY.

Additional Resources

- Cornell Nutrient Management Spear Program Agronomy Fact Sheets #18: Manure spreader calibrations; #38: Manure Sampling, Handling and Analyses; #53: Manure Cost, Value and Time Management Calculator; and #122: Reading and Interpreting Dairy Manure Analyses. http://nmsp.cals.cornell.edu/guidelines/factsheets.html.
- Wilson et al. (2022). Recommended Methods of Manure Analyses, 2nd edition. University of Minnesota Twin Cities: https://conservancy.umn.edu/handle/11299/227650.
- NMSP Value of Manure Calculator User's Guide: http://nmsp.cals.cornell.edu/publications/extension/ValueManure2025.pdf.
- The NMSP Value of Manure Project website: http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/Value_of_Manure.html.

Disclaimer

This fact sheet reflects the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of particular discharge levels from agricultural land.

For more information

Cornell University Cooperative Extension

Nutrient Management Spear Program
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