

4RS OF LITTER MANAGEMENT POULTRY

The “4R”s of nutrient management in agriculture refer to using the *Right Source* of nutrients, at the *Right Rate*, at the *Right Time*, and in the *Right Place* to maximize crop uptake and production, while minimizing edge-of-field nutrient losses. Poultry litter is a valuable soil amendment that can improve soil organic matter, reduce soil compaction, and improve soil tilth. Poultry litter also contains all the essential nutrients used by plants, making it a valuable source of fertilizer for crop production. But how do 4R principles apply to crop nutrients coming from manure applications, which can be more variable and less easily quantified compared to commercial fertilizer?

Right Source

Poultry litter nutrient content can vary considerably depending upon where and how it was generated. The amount and type of bedding material used, feed formulation and conversion efficiency, the number of flocks grown on the bedding, litter management, and conditioning, and litter storage duration and method will all influence the nutrient composition and concentrations in the litter.






Photo Credit: Edwin Remsberg

For example, a 2022 report from the University of Maryland Extension summarizing the properties of poultry litter samples submitted with nutrient management plans showed that total nitrogen (N) content among samples ranged from 0.82% to 4.82%, phosphate (P2O5) content ranged from 0.16% to 5.43%, and potassium (K2O) content ranged from 0.11% to 2.95%. This variability in nutrient *Source* content requires special management to accurately match plant needs with applied material.

Broiler Cake or Crust comprises fresh manure, spilled feed, and bedding material that is removed after each flock. Cake tends to contain higher N concentrations compared to poultry litter compost or whole house cleanout, but cake can be more variable in consistency and nutrient content. **Total or Whole House Cleanout** involves removal of all poultry litter within a house. During a whole house cleanout, cake material is mixed with the rest of the house bedding material, resulting in lower average nutrient content than cake alone. However, this material has the potential to be more thoroughly mixed and consistent than broiler cake. **Mortality Compost**, generated from composting of dead chickens, is lower in N and slightly higher in phosphorus (P) and potassium (K) than other poultry manures. Nutrient release from this composted material is slower compared to whole house cleanout or cake but compost is more uniform in consistency and nutrient content. **Poultry Litter Ash** results from burning litter for energy production. As a result of its combustion, it is lower in organic matter, N, and plant-available P. When used as a soil amendment, poultry litter ash can act as a liming agent, stimulate microbial activity and increase soil water holding capacity.

Right Rate

The first step in determining the right *Rate* at which to apply poultry litter is to collect a representative soil sample to understand the current nutrient status of your soil. The next step is to know what *Source* of fertilizer you will be using to close the gap between soil nutrients and needed crop nutrients, and how to correctly sample the material. To obtain a litter sample that is representative of the material you will be applying to your fields, follow these rules of thumb:

-  Sample manure annually or every time you are using a new *Source* of manure (e.g., stockpiled vs. fresh whole house cleanout, or compost vs. broiler cake). Take 15 to 20 subsamples that are representative of the *Source* and mix these thoroughly before collecting a portion to be sent to a lab for nutrient analysis.
-  Use plastic bags rather than metal containers or glass bottles.
-  Follow directions from the laboratory regarding storage and shipment to preserve nutrient content during transit.

The *Rate* you apply will also depend on whether you plan to meet the N or P needs of your crop. If you choose to apply litter at an N-based rate, the amount of P applied will exceed crop uptake in one season; continued application of litter at N-based rates will result in the build-up of P in the soil over time. With P-based litter rates, the readily available ammonium-N and mineralized N are available in small amounts at early corn growth stages, but you will need to supplement with commercial fertilizers at later stages. This will allow for better N use efficiency. To reduce additional soil P build-up, the Maryland Department of Agriculture, Delaware Department of Agriculture, and Virginia Department of Conservation and Recreation cost-share Manure Transport Programs for transporting poultry litter from poultry farms to crop farms. This transport cost-share is available to prevent application of litter on soils with a high risk for P loss. Maryland Department of Agriculture maintains a list of registered brokers and spreading services who can be hired to move and spread poultry litter on farms (MDA, 2024).

Right Time

An ideal *Time* to apply poultry litter is for use by a crop with high N requirements, such as corn. Poultry litter application to legume crops should be avoided as the N supplied can reduce microbial root colonization and N fixation. A small portion of the N in poultry litter is readily available as ammonium-N, however, the majority of litter N is in organic form (i.e., bound to carbon). Organic N is slowly available over the course of the growing season as the material is broken down, or mineralized, by soil microbes and N is released as ammonium-N. The rate at which this organic N become plant-available depends upon soil temperature, soil moisture, pH, the type of manure, and the extent to which it has been incorporated into the soil. In fact, anywhere from 30 to 80% of organic N can be mineralized in the season of application. The best recommendations for accounting for this mineralization on the Delmarva Peninsula can be found through the Mid-Atlantic Nutrient Management Handbook (Abaye et al., 2006) or the University of Maryland's Agricultural Nutrient Management Program website.

With careful management, N availability from poultry litter application can be synchronized with high plant uptake of N, which will minimize the risk of loss of N to the environment. For example, with favorably warm temperatures and moderate moisture levels in fields, most of the plant available N in litter will mineralize within a 3-to-4-week period after application. This mineralization window can most closely match the period when the largest amount of N is taken up by corn, between the time it is knee-high to when tassels form, by applying poultry litter as close to corn planting as possible. Less mobile nutrients, like phosphorus and micronutrients, will remain in the soil and will be available to crops that are planted later in the rotation.



Application Method	Dry Litter
Broadcast, immediate incorporation	90%
Incorporated after 2 days	80%
Incorporated after 4 days	65%
Incorporated after 7 days	50%



Table 1. Percent of ammonia in manure that is conserved based on method and timing of application (Abaye et al., 2006).

Photo Credit: Edwin Remsberg

Right Place

The right *Place* to apply poultry litter depends upon available equipment and the importance of other management practices, like avoiding tillage. While surface application is quick and easy, it results in significant gaseous losses of ammonia-N from the litter - in excess of 50% - and excess litter to rainwater that can dissolve P or wash poultry litter away. Incorporating poultry litter the same day it is applied can keep ammonia-N losses to 20%, conserving valuable N and increasing the precision of using manure as a fertilizer. In addition, incorporating poultry litter helps to fix P to aluminum (Al) and iron (Fe) minerals in the soil, which reduces the risk of P loss. However, many growers on Delmarva use no-till and are reluctant to disturb these soils, especially since they are already low in organic matter. Deciding whether to surface apply litter or incorporate it into the soil will have significant impacts on your planned application rates and potential for environmental losses of N and P (Table 1). Conservation tillage, which allows for minimal soil disturbance but helps to partially incorporate litter into the soil, can be a good compromise in annual crops. Rotations can be managed with manure and conservation tillage in corn followed by no-till soybean. There is no alternative to surface application for perennial crops, so timing should be considered. It is not a good idea to apply litter right before rain because of the risk of P loss, or when it is hot and windy, due to increased risk of N loss.

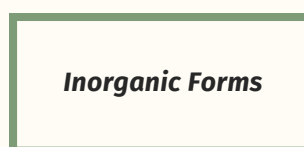
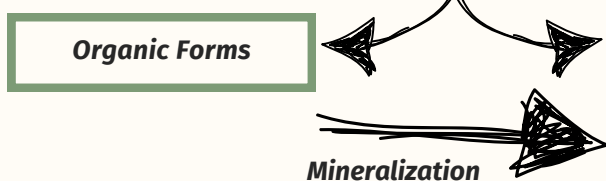


Photo Credit: Delmarva Chicken Association



Volatilization

Plant Uptake



Summary

Poultry litter is a valuable source of nutrients for agricultural crops that is comparable to or less expensive than commercially available forms of N, P, and K (Table 3), and has the benefit of also containing other valuable nutrients and organic matter. By following the “4Rs” of manure management, you can maximize your plant uptake of these nutrients and minimize unintended losses to the environment. Farmers can get the full benefit of poultry litter only if they apply the right *Source* of manure at the right *Rate*, at the right *Time*, and in the right *Place*.

- ✚ *Source:* Recognize the differences in sources of poultry litter and litter by-products to plan nutrient applications to crops more precisely.
- ✚ *Rate:* Following sampling recommendations for nutrient analysis of poultry litter to increase confidence in reported results and plant nutrient availability.
- ✚ *Time:* Apply poultry litter to a crop that has high N requirements and synchronize high N availability with crop use. Plan for later crops to have access to P and other nutrients also supplied by the litter.
- ✚ *Place:* Consider the pros and cons of incorporating poultry litter into the soil, and account for how your method of application will impact N volatilization when planning nutrient budgets for crops.

Fertilizer Name	Nutrient Content (lb/ton) N - P2O5 - K2O	Fertilizer Cost (\$/ton)	Nutrient Cost (\$/lb) N - P2O5 - K2O
Ammonium Sulfate (21-0-0)	420 - 0 - 0	\$350	0.83 - 0 - 0
Urea (46-0-0)	920 - 0 - 0	\$527	0.57 - 0 - 0
UAN Solution (32-0-0)	640 - 0 - 0	\$390	0.80 - 0 - 0
Monoammonium phosphate (18-46-0)	360 - 920 - 0	\$809	0 - 0.87 - 0
Diammonium phosphate (10-46-0)	200 - 920 - 0	\$735	0 - 0.80 - 0
Amonium polyphosphate (10-34-0)	200 - 680 - 0	\$601	0 - 0.88 - 0
Potash (0-0-60)	0 - 0 - 1200	\$509	0 - 0 - 0.42
Poultry Litter	66 - 48 - 47	\$21	0.53 - 0.49 - 0.45

Table 3. Nutrient content and average cost for various commercial fertilizers and poultry litter.

Authors

University of Delaware, Sapana Pokhrel
The Nature Conservancy, Kristin Fisher



References and additional information can be found on our website.

Partners








Mid-Atlantic 4R Nutrient Stewardship Association
The Nature Conservancy
Delaware Maryland 4R Alliance
Pennsylvania 4R Alliance

Funded By

The Keith Campbell Foundation



Fact Sheets with Additional Details on the 4Rs of Poultry Litter Management:

-  University of Delaware information on manure sampling and analysis:
<https://www.udel.edu/academics/colleges/canr/news/2023/april/value-of-manure/>
-  University of Maryland Extension information on manure nitrogen availability, depending upon timing and method of application:
<https://extension.umd.edu/sites/extension.umd.edu/files/2021-04/infocard.pdf>
-  University of Maryland Extension's 2022 Manure summary report of manure analyses submitted to the Agricultural Nutrient Management Program:
https://extension.umd.edu/sites/extension.umd.edu/files/2023-09/Manure%20SummaryReport_2022_9-21-23Correction.pdf
-  University of Maryland Extension information on manure spreader calibration:
<https://extension.umd.edu/resource/manure-spreader-calibration>
-  University of Delaware information on phosphorus in poultry litter:
<https://www.udel.edu/academics/colleges/canr/cooperative-extension/fact-sheets/phosphorous-in-poultry-litter-guidelines-from-the-university-of-delaware/>
-  University of Delaware information on potential of poultry litter as a valuable nutrient source:
<https://www.udel.edu/academics/colleges/canr/cooperative-extension/fact-sheets/maximizing-potential-of-poultry-litter-for-crop-production/>
-  University of Delaware information temporary field storage of poultry litter:
<https://www.udel.edu/academics/colleges/canr/cooperative-extension/fact-sheets/temporary-storage-poultry-litter/>

References

- Camberato, J. (2016). Chapter 5a: Land Application of Poultry Litter.
https://www.clemson.edu/extension/camm/manuals/poultry/pch5a_16.pdf
- Chastain, J.P., J.J. Camberato, P. Skewes. (nd). Poultry Manure Production and Nutrient Content. Clemson University Cooperative Extension Service.
https://www.clemson.edu/extension/camm/manuals/poultry/pch3b_00.pdf
- Abaye, A.O., Basden, T.J., Beagle, D., Binford, G.D., Daniels, W.L., Duiker, S.W., Evanylo, G.K., Haering, K.C., Hansen, D.J., Mullins, G., Taylor, R.W. (2006). The Mid-Atlantic Nutrient Management Handbook. (Haering, K.C. and G.K. Evanylo, Eds.). Mid-Atlantic Regional Water Program.
- University of Maryland Extension. Agricultural Nutrient Management Program. College of Agriculture and Natural Resources. <https://extension.umd.edu/programs/agriculture-food-systems/program-areas/integrated-programs/agricultural-nutrient-management-program/>. Accessed 24 Apr. 2024.
- [UD] University of Delaware. Fact Sheets and Publications <https://www.udel.edu/academics/colleges/canr/cooperative-extension/fact-sheets/>. Accessed 25 Apr. 2024.
- [MDA] Maryland Department of Agriculture. Manure Transport Program. https://mda.maryland.gov/resource_conservation/Pages/manure_management.aspx. Accessed 25 Apr. 2024.