AMMONIA EMISSIONS FROM FIELD-APPLIED MANURE: MANAGEMENT FOR ENVIRONMENTAL AND ECONOMIC BENEFITS

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Livestock manure has the potential to provide significant benefits for soil health and crop nutrient supply; but it also can contribute to a range of environmental problems, including ammonia emission. In particular, maximizing crop utilization of manure N requires careful management to control N losses.

Manure N can be lost by several different processes—nitrate leaching, gaseous denitrification, and surface runoff of N. But the process that commonly has the potential for the greatest N loss from manure – and the one most readily controlled by management – is ammonia volatilization (Fig. 1). Besides the obvious economic loss requiring replacement with purchased fertilizer N, there are potential environmental concerns as well. Ammonia emission can contribute to eutrophication of surface waters (esp. marine and estuarine) via atmospheric deposition. The decreased amount of available N in manure reduces the N:P ratio and leads to a more rapid build-up of P in the soil for a given amount available N. And ammonia in the atmosphere can form fine particulates that lower air quality.

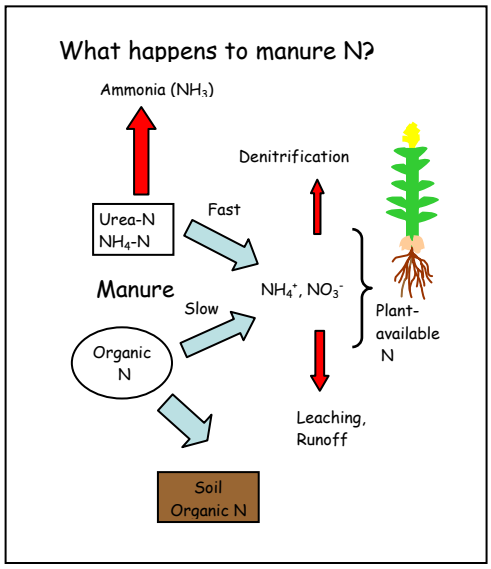

Figure 1. Processes that contribute to losses or crop availability of manure N.

Most ammonia emissions are from livestock production, with cattle farming, especially dairy, regarded as the largest source (Bussink & Oenema 1998). Land application of manure contributes the most ammonia emissions from cattle in the UK, with animal housing a close second (Fig. 2; Misselbrook et al., 2000). This article will focus on ammonia volatilization of manure N, in particular the management practices to control ammonia loss and increase the benefits for crop production. Most examples will be with dairy manure.

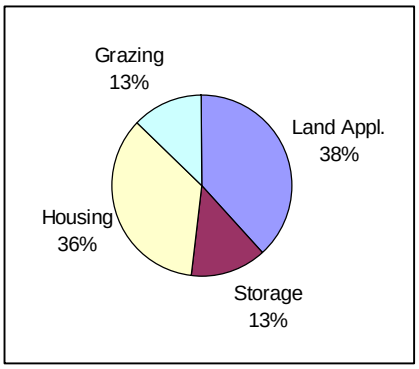

Figure 2. Ammonia emission from different segments of cattle farming in the UK (Misselbrook et al., 2000.

Nitrogen Content of Manure

Improving the management of manure N starts with knowing the N content of manure and the relative amounts of the different forms. The total ammoniacal N (ammonium-N plus ammonia-N plus urea-N) is the portion of manure N that is immediately susceptible to loss. We

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would be required to meet the crop need of 100 lb N per acre. Because of the greater ammonia loss with delayed incorporation, the second scenario would require about 14,500 gallons per acre to meet the same N need. If there is additional land available with N and P need, the difference in application rates (6600 gallons/acre) would have a potential nutrient value of about $67/acre ($42 for N and $25 for P_2O_5). Both management options supply excess phosphorus, but only 39 lb P_2O_5 /acre in the first case compared to 105 lb lb P_2O_5 /acre in Case 2.

Example: Comparison of Time of Manure Incorporation for Silage Corn

- Nutrient Recommendation: 100 lb N, 40 lb P_2O_5 /acre (after accounting for starter N, previous crop, and past manure N)
- Dairy Manure Analysis, lb/1000 gal.
  - Total N: 23; NH_4-N: 11; P_2O_5: 10
  - 8% DM
- Fertilizer prices: N $.50/lb, P_2O_5 $.38/lb

While manure has historically been applied to meet the crop need for N, concerns about runoff of phosphorus from fields into surface waters has led to a need to apply manure on a P basis on some fields. How would the two scenarios compare in this regard? In both situations the manure rate required to meet the P recommendation would be the same – 4000 gallons per acre (assuming 100% fertilizer equivalent for manure P). In scenario 1 (quick incorporation) 49 lb/acre of additional fertilizer N would be needed; but in the delayed incorporation case 72 lb N/acre would be required. The difference in cost would be about $11 per acre, based on a price of $.50/lb N.

Summary

Ammonia volatilization can be a major nitrogen loss pathway for field-applied manure, and can have both economic and environmental consequences. Fortunately, there are effective and practical management practices to address these concerns – manure analysis as a basis for application rate, timing manure application to better coincide with crop N uptake, and timely incorporation of manure by tillage or one of several direct incorporation methods. Because of the temporal pattern of ammonia emission, most loss occurring in the first few hours after application, incorporation of manure immediately or shortly after application is particularly important to cut N losses, thereby saving fertilizer expense and minimizing undesirable environmental impacts.

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