Conserving Ammonia in Fall Surface-Applied Dairy Manure

K. Campbell-Nelson, S. Herbert, M. Hashemi, S. Weis, and J. Carlevale

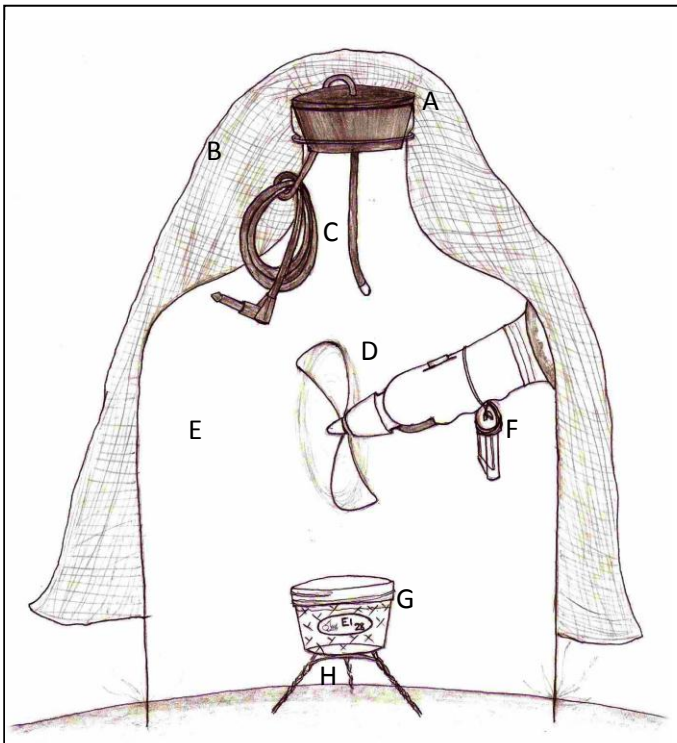
The need for improved manure management by dairy farmers becomes increasingly apparent as fertilizer costs continue to rise and environmental degradation continues to occur due to atmospheric nitrogen (N) deposition and eutrophication of waterways. Conserving N in manure is one way farmers can reduce the need to purchase expensive N fertilizer. Over half of the N in 4 dairy manure can be in the form of ammoniacal-N (NH +) which is readily lost to volatilization under hot, aerated conditions. If the ammonia volatilizes, only one half of the total available N is left in the organic form which takes much longer to decompose. Proper management of the factors influencing ammonia volatilization will maximize N retention for crop utilization and reduce air pollution. Animal type, diet, housing, manure storage, and method of land application as well as weather conditions must be considered when choosing an ammonia mitigation practice.

Many studies have indicated that up to 90% of the ammoniacal-N found in manure can volatilize within the first day of application if not injected or incorporated into the soil immediately. Of the many methods for reducing ammonia volatility, rapid incorporation of manure can be the most cost effective and have the greatest impact as well as improve N utilization by crops. Although rapid incorporation of manure is proven to greatly reduce ammonia volatility, many farmers in Massachusetts simply do not have the time to harvest a crop, plant a cover crop, and spread manure in a timely way at the end of the season. Due to lack of manure storing capacity and time constraints, farmers need to empty their manure storage twice a year; typically in the fall and spring. The microbes producing urease enzymes found in manure thrive under high pH and warm temperatures, and if given plenty of protein to break down, will quickly produce ammonia. Air to manure contact will increase the transportation of this ammonia to the atmosphere, causing undesirable losses and air pollution. It is also known that urease activity is low between 41 and 50°F (5 - 10°C) and increases exponentially above 50°F. Cooler fall temperatures are expected to slow urease activity and, therefore, slow ammonia volatilization.

Table 1: Ammonia emissions from surface-applied liquid dairy manure in the first week of each month.

Month	Av.Chamber Temp. (^{o} F)	Total Nirtogen Applied (lb/ac)	Ammoniacal-N Applied (lb/ac)	Ammoniacal-N Lost (lb/ac)	Percent Lost
September	90	125	80	46	57.5
October	64	150	85	16	18.8
November	55	169	90	23	25.6
December	45	169	95	9	9.5

Postponing manure applications until air temperatures drop in late fall, but before the ground freezes may be effective in conserving more NH +-N with cover crops for crop use the following spring. Research was conducted at the Crop and Animal Research and Education Center in South Deerfield, MA during the fall of 2008 on this ammonia mitigation technique for use by dairy farmers. The specific research question to be answered was: Do cooler fall temperatures have an effect on reducing ammonia volatility from surface-applied liquid dairy manure? This question was answered by studying the effect of temperature on ammonia volatility from surface-applied liquid dairy manure applied in the first week of every month over a period of four months from September to December, 2008. Manure was surface applied to a field cover cropped with winter rye (Secale cereale L.) on the UMASS Extension recommended seeding date of September 15th. Liquid manure for this experiment came from Mt. Toby Farm in Sunderland and was tested for nutrient content each month before application to the field. Manure was applied at a rate of 6,000 gallons/acre to obtain an estimated 150 lbs-N/acre based on the assumption that every 1,000 gallons of manure contains about 25 lbs of N (half ammonia and half organic N).



A. Size 12 rubber stopper

B. 50% shade cloth

C. Thermistor

D. D-cell battery-operated fan with mounting base

E. 20-liter carboy with the bottom cut off

F. Onset UA-002-64 light and temperature data logger

G. 4 oz. Ball jelly jar containing 50ml of .02N H_2SO_4

H. Steel wire tripod

Ammonia was measured using a dynamic chamber method that was modified from several designs used in other ammonia and air pollution research. Results showed ammonia losses from surface-applied manure over a week in December were about one fifth of the losses encountered over the same length of time in September; saving the farmer 37 lbs-N/acre by applying manure in December (see table). Although average temperatures in October were warmer than in November, the total volatilized ammonia was less. Rain occurring in the first week of October may have been responsible for reduced volatilization. Overall, colder fall temperatures significantly reduced the rate of volatility from surface-applied manure. Despite current Massachusetts Best Management Practices strongly discouraging the application of manure to frozen ground, the results from this research conclude that the greatest N retention for crop growth came from manure applied to frozen ground in December. More research is needed to determine if this N is retained by an earlier planted cover through the winter period. However, as a preliminary suggestion for a management practice; surface application of liquid dairy manure is needed; it should be done as late as possible in the fall before snow falls as long as a cover crop has been well established to reduce surface runoff. A late application of manure should increase the total N available for crop growth in the spring. Managing manure for the greatest N retention means limiting surface runoff, nitrate leaching, and ammonia volatilization.