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Best Management Practices for Reducing Ammonia Emissions: Manure Application

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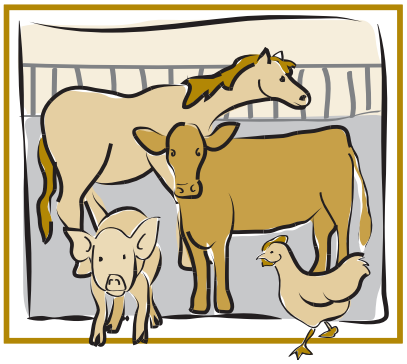

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Ammonia volatilization rates following land application of manure are influenced by the method of application, weather conditions, and time of year. In this factsheet, we review application methods that can reduce volatilization following land application of animal manure, and practices for identifying and targeting weather and soil conditions that result in reduced ammonia volatilization rates.

Solid Manure

Solid manure is produced on drylots (both feedyards and dairies) and is often collected by scraping it from the pen surface. Manure collected from dairy freestalls can then be added to solid manure piles or allowed to dry. The most effective method for reducing ammonia emissions from manure application sites is to incorporate that manure into soil as quickly as possible. This drastically reduces volatilization losses resulting from exposure to air. Immediate incorporation of surface-applied manure (within 1 hour) can reduce ammonia loss by 85-90%. Even achieving incorporation within 24 hours has value. The depth of incorporation can be as shallow as 2-4 inches to achieve good N conservation.

The primary challenge to incorporating manure quickly is timing; both the availability of labor and equipment and growth stage of the crop. Since ammonia losses have the greatest potential to negatively impact mountain ecosystems in the springtime, it is most important to prioritize immediate incorporation for spring applications. In addition, timing application and rapid incorporation to take place during relatively cool, calm weather can also help minimize ammonia losses. For example, applications in the evening, at night, and in the early morning have been shown to reduce emissions by 50% compared with spreading during the middle of the day.

In general, applying compost to land will result in lower NH_3 emissions than applying raw manure because NH_3 has already been lost during the composting process, and there is very little ammonium left in the compost if it is properly finished. It is less important to incorporate compost into the soil and, therefore, compost can be used as a topdressing on perennial crops such as grass hay or alfalfa.

Manure Slurry

Slurry manure may be produced on dairies that use a vacuum system for manure collection. Below, we describe a variety of application options for incorporating manure slurry into soil; however, of the options below, injection is the most efficient and effective means to reducing ammonia loss from slurry manure applications to land.

Broadcast application of liquid manure slurry has the highest rates of airborne nitrogen loss because there is greater exposure of the manure to wind and sun/heat, which increases ammonia volatilization potential. During broadcast application, liquid manure is spread using a 'honey wagon' or surface broadcaster with a splash plate applicator, distributing manure on the surface of the soil. While this method is quick and inexpensive, it tends to result in uneven distribution of manure (and subsequent uneven crop response), may damage grass swards, can contaminate standing plants with microorganisms that can hurt

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Quick Facts

- Application of animal manure to crop fields is a potential source of ammonia (NH_3) emissions from agriculture.
- Volatilization of ammonia from land-applied manure is a loss of valuable nitrogen, and can contribute to air quality concerns because NH_3 contributes to the formation of particulate matter, which can be hazardous to human health and degrade sensitive ecosystems.
- Targeting weather and soil conditions may be more cost effective for producers, as it avoids purchasing or hiring new equipment.

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Further Reading

From the eXtension.org website:

A Review of Manure Injection to Control Odor and Ammonia Emissions During the Land Application of Manure Slurries

From the Colorado State University Extension website:

1.631 *Best Management Practices for Reducing Ammonia Emissions*

silage fermentation, and may be prone to runoff into nearby waterways under certain conditions. Rapidly incorporating manure after broadcast application reduces ammonia losses, but increases the costs associated with application. *Surface banding* using drop hoses or a 'sleighfoot' applicator deposits liquid manure under the vegetation at the soil surface, increasing contact with and incorporating it into the soil. Standing vegetation provides shade, reduces wind speeds at the surface, and may reduce volatilization loss. Surface banding can increase nitrogen availability and reduce ammonia emissions by up to 80%, compared to traditional surface broadcasting.

Shallow injection conserves more nitrogen than surface broadcast application (by 90% or more in one study) because more nitrogen comes into contact with and infiltrates into the soil, reducing contact with the air, and therefore reducing volatilization potential. Manure slurry injection works well in both conventional and no-till systems with currently available equipment. In addition, slurry tanker wagons currently used for broadcasting can be retrofitted with injection tool bars.

Shallow injection and surface banding seem to be equally effective at reducing emissions compared to broadcast application. Where shallow injection may not be practical on stony soils, sloped land, or for producers with inadequate tractor horsepower, surface banding may be a better method.

It's very important than the slurry application rate is not too high because if the slurry cannot quickly infiltrate into the soil and puddles in the injector furrows (just like over-irrigating) the effectiveness of the injection in N conservation will be limited.

Deep injection prevents exposure of manure to the environmental conditions that cause ammonia volatilization while improving incorporation of manure into the soil. To be most effective, the rate of manure applied should not exceed the capacity of the injection slit, as slit closing is essential. Soil conditions and equipment design play an important role in the effectiveness of deep injection application. Soils that are saturated or compacted can hinder slit closing and interfere with injector function.

Injection is more costly than broadcast application due to the higher horsepower requirements (up to 30% more), additional equipment needed (injection tool bars), and higher maintenance costs, but it remains the most effective method for reducing ammonia loss, thereby improving nitrogen availability to plants.

Liquid Manure

Liquid manure may be produced on dairies that use a flush system for manure collection from freestalls or on feedlots that irrigate their runoff water onto neighboring fields. Since liquid manure is 98-99% water, it is usually applied through sprinkler irrigation systems.

Fertigation with liquid manure can be an efficient way to deliver N to the crop if the application timing is planned to meet crop N needs. In addition, the water itself serves as a means to incorporate the N below the soil surface if ¾ inch or more of water is applied at any one time. Turning off the end gun of a center pivot and using drop nozzles can be helpful to minimize NH_3 loss during an irrigation event.

Other Considerations

Timing manure application can help reduce ammonia volatilization and retain nitrogen. Nitrogen loss can be minimized by avoiding application on warm, windy days or when weather conditions are forecast to be sunny and dry. In one study, emissions were reduced by 10% when manure was applied during 54° F and 75% relative humidity conditions compared to 59° F and 60% relative humidity. Although it is not always feasible to wait for ideal environmental conditions, application soon before a light rain on a cool, cloudy day, or in the early morning or evening (versus the middle of the day) will help to minimize ammonia volatilization and improve nitrogen availability.

Applying manure at agronomic rates is one easy, effective, and important way to make sure you are not over applying manure nitrogen and increasing ammonia loss potential. Have the nutrient content of your manure tested regularly to ensure that application rates match crop nutrient requirements. In addition, knowledge of crop requirements and manure nutrient levels can help avoid over-application. Higher application rates generally result in greater emissions, so applying what is needed based on soil type, yield goals, and nitrogen availability, but no more, will also help maximize efficiency and minimize emissions.

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