Atlantic Swine Research Partnership Inc.

Nova Scotia Agricultural College

factsheet

Ammonia Management From Manure Storage & Spreading

Introduction

The total nitrogen (N) from the livestock manure produced in Atlantic Canada is sufficient to meet a large portion of the fertility requirements for field crops grown in the region. However, a significant percentage of this N is lost when ammonia (NH_3) escapes to the atmosphere through a process called NH_3 volatilization. Within 3 to 5 days of spreading, losses have been found to range from 20 to 80% of the total NH_3 in the applied manure. This in turn makes the manure less efficient as a fertilizer, and is also a source of atmospheric pollution.

Losses of NH_3 are greatest when manure cannot be incorporated into the soil, as is the case with forage or pasture systems. This is a major concern in Atlantic Canada as a large percentage of agricultural land is in some level of permanent cover.

Emphasis has recently been placed on the identification of farm management practices which maximize the resource potential of manure while minimizing environmental impacts. By controlling NH_3 losses, other problems associated with manure utilization such as odours, greenhouse gases and fly production may also be avoided.

Sources of Ammonia

Ammonia can originate from all livestock manure and from commercial fertilizers such as ammonium and urea. Sources of NH_3 from agriculture include grazing livestock, livestock housing, manure storages and through the land application of manure and fertilizer. Decomposing plant residues and even foliage from living plants can also be NH_3 sources.

Environmental Impacts of Ammonia Volatilization

Ammonia emissions are recognized as a major environmental concern. Agriculture is the main source of atmospheric NH_3, resulting from the production of animal manure and the use of inorganic fertilizers. The introduction of NH_3 and ammonium (NH_4^+) into the environment can result in the eutrophication and acidification of ecosystems.

Estimated NH_3 emissions from Canada exceeded 500 thousand tonnes of N in 1990, with 90% from agriculture. While this number is low compared to other countries, excessive losses may occur in local areas with intensive livestock production. Currently, there are no air quality standards in Canada which regulate NH_3 emissions. In Europe however, NH_3 is a significant air quality concern that is substantially changing many agricultural practices. European standards, particularly in the Netherlands, have strict regulations regarding the management of manure. These include requiring

The largest losses of NH_3 occur with top discharge manure spreaders utilizing splash plates.

the injection of manure during field application and limiting the amount of manure that can be stored without a cover.

Direct injection of liquid manure.

Nutrient Management Planning

It is important for producers to understand the magnitude of NH_3 loss following manure application to ensure that sufficient N is left for crop production. Errors in calculating N rates can reduce crop production and waste valuable manure nutrients. Nutrient management plans help reduce NH_3 losses through improved utilization of manure and minimize the amount of inorganic N that needs to be applied. This is done by testing soil and manure for N content, determining the amount of N required by crops, ensuring proper timing of application, equipment calibration and the use of controlled release fertilizers.

Reasons for Ammonia Loss

Ammonia is a colourless gas which is lighter than air, allowing it to easily volatilize into the atmosphere. Once NH_3 is formed it can:

React with water, forming NH_4^+;
Convert to other forms of N; or
Volatilize into the air.

The amount of NH_3 which is lost through volatilization depends on a variety of factors including; the amount of NH_3/NH_4 in the manure, the method and timing of manure application, manure and manure/soil pH, the prevailing weather conditions, the type of surface that the manure is applied to, the soil moisture status and the manure storage conditions.

Ammonia Content in Manure

The higher the concentration of NH_3 in applied manure the greater the amount which will volatilize. Ammonia concentration in manure depends on livestock type, manure form and storage. Poultry manure contains the highest amount of NH_3 , with beef manure containing the least. Concentrations are typically higher in anaerobic lagoons (>80%) compared to semi-solid (60-70%) and solid manure storage (10-20%). Generally, as the amount of solids in manure increases, the amount of NH_3 decreases.

Ammonia Content in Manure
(Kg / T semi-solid)

Poultry manure	4.2
Swine manure	2.4
Dairy manure	1.9
Beef manure	0.8

Method of Manure Application

Reducing the time manure is exposed to the air helps reduce NH_3 losses. Ammonia volatilization occurs immediately after manure application and is the greatest within the first day. It is recommended that surface applied manure be incorporated within 24 hours of application. Immediate incorporation by plowing or injection can reduce NH_3 emissions by 25 to 75% (Fig. 1). This rapid incorporation also helps to maximize nutrient retention for future crop use.

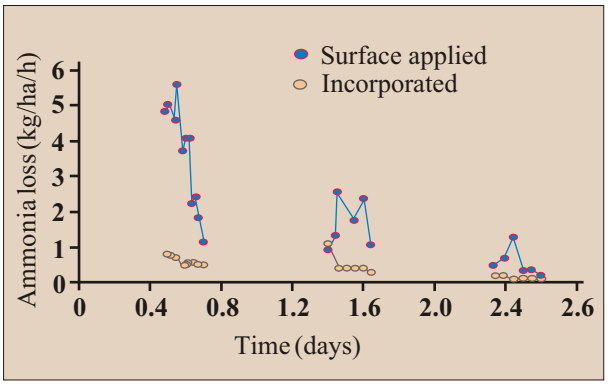

Figure 1. Ammonia losses for incorporated manure compared to surface applied manure over a 3 day period (adapted from Brunke et al. 1988).

When incorporation is not possible, surface-band applications can be used to reduce NH_3 losses. Spreading machinery required for surface banding applications includes dribble bar, drop tubes or sleighfoots. Surface banding generally works best by applying the manure under the crop canopy, which both reduces wind induced losses and provides for volatilized NH_3 to be absorbed by the crop. The proper use of N from manure based on crop requirements and split fertilizer applications are other strategies that may limit emissions.

Ammonia Losses and pH

Both soil and manure pH can affect NH_3 losses. Soils differ in their ability to resist changes in pH, with volatilization losses being greater in sandier soils and those low in organic matter. Little NH_3 is released if the pH of the soil is < 7. As pH increases, the amount of NH_3 increases, creating a greater potential for losses. In relation to manure, chemical additives can be used to reduce NH_3 volatilization by reducing its pH.

Sleighfoot for surface banding of manure.

Drop tube manure spreader.

Listening to the Weather Forecast

Ammonia volatilization losses from manure are greatly affected by several weather factors. Losses are increased as the air temperature, windspeed and solar radiation increase. On the other hand, periods with increased humidity typically result in reduced losses.

It has been shown that manure applications later in the day reduce potential losses by ensuring that these contributing meteorological affects are minimized. The hay drying index which is commonly forecasted by many rural weather broadcasts indicates the potential for dryness. This index is based on potential evaporation, temperature, wind and relative humidity. Therefore, days with a high forecasted drying index should be avoided in relation to manure spreading.

Weather Factors Increasing Ammonia Losses

Increased air temperatures
High solar radiation (amount of sunshine)
High windspeeds
Low relative humidity

Moisture and Ammonia Losses

Rainfall can influence NH_3 losses. If a light rainfall event occurs (< 5 mm) within a day following application it can help reduce losses by taking the N into the soil. Under heavy wet conditions (> 5 mm) up to 40 % of applied N may be lost in run-off on some soils.

The dry matter content, has a significant effect on the NH_3 loss in the first few hours following manure application. Typically, the greatest NH_3 losses are from manures with dry matter content between 4 and 12%. Higher or lower dry matter contents result in only minor changes in NH_3 loss.

Manure Storage Losses

Losses of NH_3 from manure storages can be reduced by minimizing exposure to air and lowering temperature. Impermeable storage covers can reduce losses by up to 75%. For liquids or slurries, bottom load pits are preferred because they allow a crust to form which effectively seals the surface, generally resulting in less than 40% loss of NH_3 during storage. Loss of NH_3 in a comparable top loaded pit can be as high as 80%. Frequent transfer from housing units to storage can lower manure temperatures resulting is less NH_3 emissions. Ammonia is also lost when manure is agitated prior to loading into the manure spreader. Adding acids (peat moss, sulfuric acid or phosphoric acid) to manure can also help to reduce NH_3 losses. Ammonia is readily absorbed and held by acid, preventing escape to the atmosphere.

Negative air pressure cover for earthen manure storage.

Summary

How manure is handled from the barn through storage and subsequent spreading can significantly impact NH_3 volatilization. A number of practices can be utilized to reduce NH_3 losses while increasing the value of manure as a fertilizer. Manure and soil testing allow for proper rates to be calculated to better meet crop requirements.

For more information

CONTACT

Nova Scotia Agricultural College
(www.nsac.ns.ca), or the Atlantic Swine Research
Partnership (www.asrp.ca)

Support for this factsheet provided by the Atlantic Swine Research Partnership, the Nova Scotia Agricultural College and the Greenhouse Gas Mitigation Program of the Canadian Pork Council.