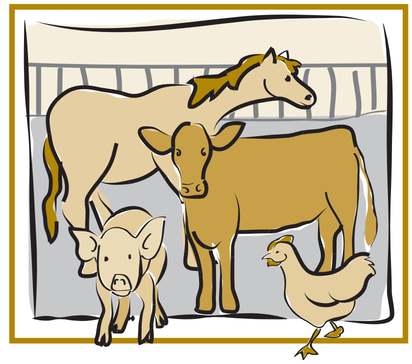
Colorado State University Extension

Best Management Practices for Reducing Ammonia Emissions

Fact Sheet No. **1.631** Livestock Series | **Management**



by S. Lupis, N. Embertson, J. Davis*

What is Ammonia?

Ammonia (NH_3) is a chemical compound composed of one nitrogen (N) and three hydrogen (H) molecules. It is usually found in gaseous form and known for its pungent odor. Agricultural operations – cropping and livestock production – can be potential sources of ammonia, along with non-agricultural sources such as synthetic fertilizers (used on lawns, golf courses, and parks), biomass burning, plant decomposition, native soils, ocean processes, and human waste.

Ammonia is produced on livestock operations when urea (present in urine) is broken down by the enzyme urease (present in feces and soil) to form ammonia gas and carbamine acid, which further decomposes to release another molecule of ammonia gas and carbon dioxide. When urine mixes with feces or soil, ammonia is volatilized (lost to the air) within minutes, but the reaction may continue for several hours depending on a variety of factors, taking anywhere from a few hours to half a day to reach peak levels. The rate is dependent on the amount of urea and urease available for reaction as well as meteorological conditions such as temperature and wind speed.

Ammonia Transport

When in gaseous form and not blown aloft, ammonia has a short atmospheric lifetime of only a few hours and usually will deposit near its source (distance varies depending on climatic conditions) via wet deposition in rain and snow, or dry deposition. Studies have shown that the majority of gaseous ammonia gets deposited within a half mile of its source (for example, from the perimeter of a livestock operation), but some studies have shown trace amounts measured up to six miles away.

Gaseous ammonia can travel further and last longer in the atmosphere if it reacts with other chemicals and is transformed into a particle. Gaseous ammonia can react with other ambient gases and particles, including nitric and sulfuric acids (formed from NOx and SOx, respectively), contributed by industrial and vehicle combustion processes. These reactions result in the formation of solid ammoniated particles, such as ammonium nitrate and ammonium sulfate, that contribute to fine particulate matter, or PM2.5, so named because it is particulate matter that is 2.5 microns in diameter or smaller. In comparison, a human hair is a whopping 60 microns in diameter! Due to its small diameter and increased atmospheric lifetime (from several days to weeks), PM2.5 may travel nearly 100 times further than gas phase ammonia before settling or falling out of the air.

Why be Concerned about Ammonia?

Ammonia gas and particulates can impact human and animal health and cause environmental degradation. If inhaled, the fine particulate (PM2.5) forms of ammonia pose a risk to human and animal health. These particles can travel deep into lung tissue and cause a variety of respiratory

*S. Lupis, Colorado State University, Institute for Livestock and the Environment; N. Embertson, Whatcom Conservation District, Lynden, WA; J. Davis, Colorado State University Extension specialist; soil and crop sciences, Institute for Livestock and the Environment. 11/2010

Quick Facts

- Ammonia is produced when urea (present in urine) comes into contact with an enzyme (urease, present in feces and soil), catalyzing a chemical reaction that results in the formation of ammonia gas.
- Gaseous ammonia emitted into the atmosphere can deposit quickly near the source. If ammonia is lofted high above the surface or reacts with acidic gases, its atmospheric lifetime can increase up to several weeks and can be transported more than 600 miles from the source.
- Ammonia can transform into ammonium when it comes in contact with moisture and is a key component of nitrogen deposition that can impact the environment.

www.ext.colostate.edu

ailments such as bronchitis, asthma, and coughing.

In Colorado, transport and deposition of ammonia gas and ammoniated particles into pristine mountain regions, such as Rocky Mountain National Park, has been documented to result in ecosystem changes such as soil acidification, plant community changes (e.g., promoting grasses, sedges, and weedy plants while choking out native plants and wildflowers) and water eutrophication (i.e., an increase in aquatic plant production, harmful because it can lead to a lack of oxygen), which can have cascading effects throughout the entire ecosystem. In addition to ecosystem changes, ammonium, in combination with other pollutants, can contribute to smog formation and decreased visibility.

Increasingly, regulatory and policy discussions at the federal and state levels are focusing on air quality concerns from agricultural sources. In Colorado, concerns about impacts from ammonia emissions prompted the formation of the Rocky Mountain National Park Initiative, a multi-stakeholder effort to evaluate and reduce ammonia impacts to the Park. As part of that effort, a sub-group called the Rocky Mountain National Park Ag Team has been working with CSU to develop BMPs with the greatest potential for reducing ammonia emissions from agriculture.

Best Management Practices for Reducing Ammonia Emissions

Production of ammonia is an inevitable part of livestock production, but ammonia emissions can be reduced through good management. Strategies to reduce ammonia emissions from livestock production have focused primarily on preventing ammonia formation and volatilization, or downwind transport of ammonia after it is volatilized.

This fact sheet was written to provide guidance on practices appropriate in a variety of feedlot and dairy settings that have demonstrated to reduce ammonia emissions. The goal of this fact sheet is to help agricultural producers become proactive in developing practices that reduce ammonia emissions, with the hope that this will allow the livestock industry to better adapt to today's uncertain regulatory climate, as well as demonstrate leadership on the issues in a way that continues to conserve our natural resources for future generations of agriculturalists.

References and Further Reading

Colorado Department of Public Health and Environment, Air Pollution Control Division, Rocky Mountain National Park Initiative, http://www.cdphe.state.co.us/ap/rmnp.html

N. M. Embertson and J. G. Davis. 2009. Efficacy of best management practices for ammonia reduction on feedlots and dairies. Proceedings, Western Section, American Society of Animal Sciences 60:96-99, www.asas.org/westernsection/proceedings09.asp

Fenn, M. E., R. Haeuber, G.S. Tonnesen, J. S. Baron, S. Grossman-Clarke, D. Hope, D.A. Jaffe, S. Copeland, L. Geiser, and H.M. Rueth. 2003. Nitrogen emissions, deposition, and monitoring in the western United States. BioScience 53:404-420.

Issley, S. S, and E. Lang. 2001. Ammonia toxicity. eMedicine [serial online], www.emedicine.com/emerg/topic846.htm.

Krupa, S. V. 2003. Effects of atmospheric ammonia (NH3) on terrestrial vegetation: a review. Environ. Poll. 124:179-221.

Merchant, J. A., J. Kline, K. J. Donham, D. S. Bundy, and C. J. Hodne. 2003. Human health effects. p.121-145. In Iowa concentrated animal feeding operation air quality study. University of Iowa, Ames, Iowa, www.public-health.uiowa.edu/ehsrc/cafostudy.htm

National Park Service. 2009. Rocky Mountain Atmospheric Nitrogen and Sulfur Study, http://nature.nps.gov/air/Pubs/regionPark.cfm. (under "Park Specific.")

National Park Service. 2010. Rocky Mountain National Park Air Quality Factsheet, http://ile.colostate.edu/ammonia_symposium.html