The Science of Smell Part 4:
Principles of odor control

Methods to control and reduce odor are of great interest to livestock producers. Choosing which odor control practices to employ can be a difficult decision. However, understanding the principles behind effective odor control strategies can help make the decision easier.

Manure malodor formation is the result of the biological anaerobic (in the absence of oxygen) decomposition of manure. During this natural process intermediate decomposition products can accumulate if the rate of formation exceeds the rate of further decomposition to low odor end products. Effective odor control employs one or more of the following approaches: 1) control of the precursors to malodor formation, 2) dilution of odors and odorous compounds below the detection threshold, 3) reducing or inhibiting emission, or 4) biological or chemical transformation to something less odorous.

Controlling malodor precursors

Dietary manipulation can be effective by reducing the concentration of odorous emissions that can be produced upon anaerobic decomposition of the manure. By altering the composition of manure, it seems plausible that degradation products and resultant odors can be altered as well. By reducing excess nutrients, smaller amounts of precursors are present. The most studied method to reduce odor has been by reducing dietary crude protein concentration.

Many of the most odorous compounds in manure are the result of protein decomposition. Manure contains approximately 5 percent nitrogen, or greater than 30 percent protein. Some research suggests that balancing dietary protein with dietary carbohydrate optimizes nutrient use by providing a more suitable energy ratio for protein digestion. Feedstuff selection may impact manure odor when excreted or during storage as some feedstuffs have strong odors (bloodmeal, fishmeal, fermented grains) and fermentation products are slightly different from one feed to the next (e.g., barley versus sorghum).

Mineral selection is of importance as well. For example, use of sulfated minerals may result in dietary excess of sulfur, contributing to sulfur emissions such as hydrogen sulfide (e.g. magnesium sulfate versus magnesium chloride or magnesium oxide). Changing animal diets to reduce manure odors completely is unlikely however avoiding the overfeeding of nutrients will contribute to an odor control plan and only makes sense.

Drying, such as the use of fans to dry manure in poultry houses, can stop further production of odorants at the production site by creating less anaerobic conditions. Similarly, composting provides an aerobic environment where the odorous intermediate decomposition products do not accumulate. In open lot facilities dust control and control of lot runoff serve as the principle means by which odor from the housing facilities is managed. Designing lots that are well drained and avoiding unnecessary addition of water (e.g., overflowing waterers) and rainwater collection from roofs will help to reduce odors. Quite often beef or dairy facilities that use open lots will house animals in facilities with bedded-packs. Control of odor from these housing facilities can best be achieved by maintaining a dry bedding area through proper maintenance of the packs. Adequate bedding must be added on a routine basis and unnecessary addition of water avoided.

Odor dilution

Diluting odors by trapping a portion of the odor or by diverting the odor plume such that the plume covers greater area and the odor within it is therefore less concentrated can be effective tools in an odor strategy.

Landscaping can reduce the emission of housing odors, as well as odors generated by other components of the livestock operation, beyond the property line by acting as a permeable filter for particle emissions. Trees and shrubs act as biofilters for odorous compounds that are attached to fine particles. By landscaping with both a treeline and a row of shrubs, particles at various heights within a plume can be adsorbed. Landscape materials also serve to divert the plume higher, diluting the concentration of odor and gases at ground level. Windbreak walls or elbows cause the plume to be diverted higher, thereby widening the plume and increasing the area of the plume.

Reducing emission

Minimizing the opportunity for volatilization can reduce emission of odors and gases. Volatilization is influenced by surface area, temperature, and air movement across the exposed manure surface. Therefore, by reducing any of these factors you can reduce odor emission potential. Methods to reduce surface area of odor sources, primarily manure storages, include proper sizing of manure storage areas, orientation of manure storage areas with respect

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to frequency of wind direction, and the use of permeable and impermeable covers that reduce the amount of surface area directly exposed to outside air.

A second approach involves reducing the volatilization of odorous compounds by reducing the net radiation, and therefore temperature, on a manure storage facility. Methods to implement this strategy commonly involve the use of permeable and impermeable covers. Covers also minimize the influence of airflow effects on storage surfaces. Odors travel attached to particles, so by effectively trapping particle emissions, odorous compounds can be trapped as well. Biofilters are one example that function in this manner.

Injecting manure or incorporating manure shortly after surface application can best prevent odorous emissions that occur as the result of land application. Pivot irrigation systems can be a substantial source of downwind odor. Using systems that spray close to the canopy can minimize dispersion of odorants by altering the dispersion plume. Nozzle selection may also contribute to improved odor control.

Biological or chemical transformation

Some manure storage facilities are designed and sized to allow for biological treatment and complete decomposition of manure to low-odor endproducts. These are considered low-load systems. Other manure storage facilities serve the purpose of storage only (high load). High-load systems are more prone to accumulation of the odorous compounds and, thus, odor concerns.

Odor control strategies between high- and low-load systems must be fundamentally different. In a high-load system biological processing is incomplete due to an imbalance in microbial populations. Loading rate exceeds the microbial ability to use the waste to an extent necessary to prevent the accumulation of odorous intermediate compounds. Strategies to increase the processing rate are therefore futile.

In a system where the nutrient load is low relative to the biological processing capability of the system, such as a lagoon, further reduction of the nutrient load on the system is a plausible strategy for reducing odors. Bacterial populations are more likely to occur in quantities sufficient to provide a balanced production and use of intermediate degradation compounds. Addition of supplemental bacteria to a low-load system may enhance the rate of processing because conditions are suitable for bacterial growth and function. Reduced odor from lagoons where the pink-rose color, indicative of the bacterial populations, is present is likely the result of degradation and use of odorous intermediates.

Enzymatic or chemical additions are more likely to have a greater benefit on odor intensity in a low-load system than a high-load system due to the stability of the environment. Mode of action of many commercially available products remains unknown, but it is plausible that some enzymes could enhance biological decomposition of odorous compounds to less odorous end products.

A number of commercial products are available that claim to reduce or improve odor. Some of these products are bacterial or enzymatic in nature while others may be chemical. Chemicals can bind odorants by adsorption, absorption, or chelation. Effectiveness of the products on today's market varies widely, with many of those products untested in a controlled, unbiased setting. Producers electing to use such products should carefully evaluate if any improvements are observed. The probability of success in employing commercial products is likely greater when low-load manure storages are used.

Conclusions

If someone can provide solutions that will work at any of these levels economically, they will be providing great tools to have available for manure and organic waste management. Most often, however, changing management practices that affect one or more of the factors discussed in this publication will be the first line of action.

Resources

Additional information regarding odor control practices can be found in PM 1970a, Practices to Reduce Odor from Livestock Operations; PM 1971a, Practices to Reduce Ammonia Emissions from Livestock Operations; PM 1972a, Practices to Reduce Hydrogen Sulfide from Livestock Operations; PM 1973a, Practices to Reduce Dust and Particulates from Livestock Operations available on the Air Quality and Animal Agriculture Web page at: http://www.extension.iastate.edu/airquality

This publication along with PM 1963a, *Science of Smell Part 1: Odor Perception and Physiological Response;* PM 1963b, *Science of Smell Part 2 Odor Chemistry;* and PM 1963c, *Science of Smell Part 3 Odor Detection and Measurement* can be found on the Air Quality and Animal Agriculture Web page at:
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