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Managing a Livestock Facility to Minimize Odors

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Public concern over air and water quality has grown as the number of confined animal feeding operations increases and the rural areas of Arkansas become more populated. Some among this growing population are unaccustomed to the odors associated with livestock and poultry production. Odors from livestock production systems are generally regarded as nuisance pollutants. However, they are not regulated under the Federal Clean Air Act. Nor are there any Arkansas air quality regulations that specifically address livestock production. The Arkansas Department of Environmental Quality administers Regulation No. 5, which regulates only liquid manure management systems, does require "control to the degree practicable the generation of offensive odors." Aside from minimal distances between animal housing, manure storages, land application sites and neighbors, the recommendations for odor control practices is the responsibility of the professionals writing the ADEQ approved waste management plans.

Odor is generated by anaerobic digestion of wet organic matter such as manure, litter and animal mortality by bacteria under warm and moist conditions. Wet litter in a warm poultry house, poorly operated mortality compost bins and stockpiled manure or litter on a warm day are a few potential odor sources. For an odor to be detected downwind, it must be formed, released to the atmosphere and transported to the neighbors. Therefore, inhibiting any one of the steps will help reduce odors.

Facility Siting

The goal of siting and designing a new or expanding an existing livestock operation to minimize odor conflict potential can be accomplished several ways.

1. **Distance to the neighbors.** As a rule, odor concentrations decrease with distance from the source. Therefore, greater buffering distances are desirable. Arkansas does not have any required minimal distances for all animal housing or manure application sites for solid manure. The ADEQ Regulation 5 for liquid manure is often suggested as a guidance for minimal distances. This regulation specifies that for small farms the minimum distance between animal barns or manure storages and the nearest existing neighbors is 500 feet. For farms with more than 600 beef cows, 430 dairy cows, 1,500 finishing hogs, 600 sows, 6,000 nursery pigs, 33,000 turkeys or 130,000 chickens, the minimum distance is 1,320 feet. The regulation also specifies that liquid manure is not to be applied within 50 feet of property lines or 500 feet of neighboring occupied dwellings. For more details and information on exemptions to these requirements, refer to UA factsheet *Regulation No. 5: Liquid Animal Waste Management Systems, FSA-3004*.
2. **Prevailing winds.** Because odors and dust are carried by air movement, attempts should be made to maximize the distance to neighbors in the prevailing downwind direction.
3. **Terrain and land cover.** Under calm, cool conditions (evenings

and nighttime), the air near the ground cools and drifts downslope, picking up odors, and may create a nuisance around dwellings in its path. On the other hand, terrain and land cover features such as trees and brush can serve to shelter potential odor sources from the wind so that less odor is transported downwind. These same types of features can help disperse odors, thereby reducing their strength.

4. **Visual isolation.** It is often the case "out of sight, out of mind." Therefore, it is desirable for the facilities not to be readily visible to the public. Consider what steps can be taken so that they are less visually noticeable. Planting trees as windbreaks around the facility can be one of the techniques.

Best Management Practices

Decomposition of manure begins as soon as it is excreted. As manure is collected, handled and stored prior to land application, several measures may be employed to reduce the potential for odor generation.

Prevent Odor Production

Good housekeeping inside animal facilities is the best strategy to prevent odor generation. Monitor and fix any leakage from poultry drinkers, adjust height of drinkers as chickens grow, clean up spilled feed, dispose of carcasses promptly and properly and wash manure handling equipment shortly after use. Good ventilation in poultry houses helps keep litter moisture in an optimal range – not too wet to cause ammonia and odor problems or too dry to create dust issues.

Bottom-loading manure storage tanks or pits generate fewer odors than top-loading systems because, in top-loading tanks or pits, part of the surface crust that was formed over time is disrupted. Solid separation from liquid manure by screening, filtration or centrifugation allows for the removal of larger-size materials and may reduce the odor generation potential. Separated manure solids need to be dried, composted or otherwise processed to manage odor generation and fly propagation. In-house manure conveyor belts allowing separate collection of swine feces and urine have demonstrated a promising way to maximize the value of manure and minimize ammonia emissions from swine housing. Due to economics and increase in management requirements, such practices are not implemented solely for odor control benefits. This especially proves to be the case if the previously mentioned recommendations provide adequate odor control.

Oxygenation of Liquid Manure Lagoons

Lagoons that treat and store manure as a liquid or slurry can be designed as either anaerobic or aerobic lagoons. Many lagoons are often anaerobic because only a small amount of the manure is in contact with air. As the manure in the lagoon decomposes anaerobically, it releases methane (CH_4), volatile organic compounds (VOCs), ammonia (NH_3) and hydrogen sulfide (H_2S). However, if sufficient oxygen is provided to the system, aerobic bacteria, which break down these organic compounds into odorless compounds, can thrive.

Aerobic lagoons can be designed with either natural or mechanical aeration. Naturally aerobic lagoons are typically shallow and have a large surface area to increase contact with the atmosphere; however, this large land footprint is not practical for many farms. Mechanical aeration is commonly used in municipal and industrial wastewater treatment plants to eliminate almost all of the undesired odor by ensuring that oxygen is supplied evenly to all parts of the wastewater. However, the energy required at an animal production operation to introduce enough oxygen for complete aerobic treatment is very expensive, so circulation and surface aeration are strategies that may be used to create an aerobic layer at the top of an anaerobic lagoon.

Circulation of manure can promote aerobic conditions in lagoons with less extensive energy requirements than complete aeration systems. It creates aerobic conditions by circulating the liquid in the lagoon so that it increases surface contact with air and returns oxygenized liquid throughout the lagoon, minimizing the number of areas that may develop anaerobic "pockets." Systems that float on the lagoon surface and circulate the liquid by either forcing air down through the lagoon profile or bringing liquid up to the surface for air exchange in order to mix and oxygenate beyond the top layer of a lagoon are now commercially available.

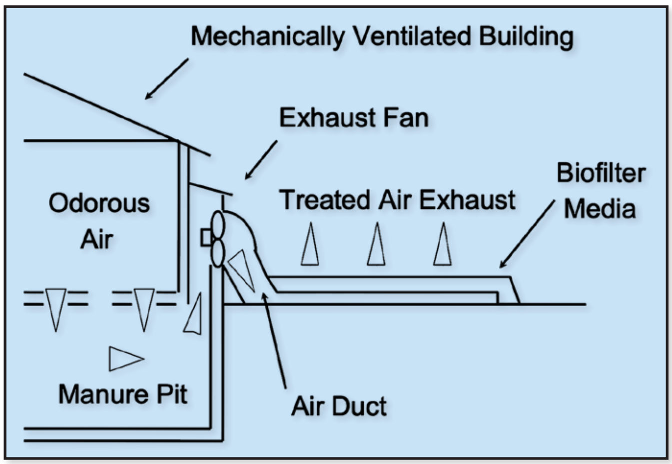
Composting

Composting is a biological method of decomposing manure in a controlled manner that involves maintaining specific carbon to nitrogen (C:N) ratios, moisture levels, temperature and aeration levels. Similar to the benefits of aeration for liquid or slurry manure, properly managed compost operations can reduce ammonia emissions and odors from solid manure. In addition to reduced odors, composting can also reduce the microbial/pathogen load in manure and destroy weed seeds. Finished compost is a stable product that can serve as a valuable soil amendment. However, composting requires supplemental energy to maintain proper aeration, either by forced air or turning the compost piles. Protecting the compost pile from wind and rain, such as by containing it in a vessel or covered building, and building a windbreak around it, will reduce odors and potential gas emissions.

Prevent Odor Transport

Biofilters

Biofilters, which channel air through a filter containing organic material (e.g., compost, sawdust, woodchips) with an active microbial population, can be used to treat vented air from animal housing. Biofilters trap particulates and the attached odorous compounds, providing an environment for biological degradation of the trapped compounds. They are potentially suitable to reduce odorous emissions from mechanically ventilated buildings. Odor reductions of 90 percent from swine and dairy facilities with biofiltration systems have been reported. To function properly, they must be properly sized. The size of a biofilter depends on the amount of air being filtered. To date, treating large volumes of air, such as all the air discharged from a tunnel ventilated poultry house, has not been viewed as practical. However, consideration has been given to the concept of filtering the air discharges when minimal ventilation of the house occurs.



Capture/Treatment of Discharged Gases

Anaerobic Digestion

Anaerobic digestion, AD, is a process in which microorganisms break down manure in the absence of oxygen. While AD occurs naturally in traditional manure storage and treatment **lagoons** under anaerobic conditions, it is usually incomplete and inefficient. By using a higher loading rate (with a solid content of 11 through 13 percent), incorporating mixing, heating the process and maintaining a consistent volume, anaerobic digestion can provide maximum odor reduction and other benefits. Covered lagoons or tanks with gas collection systems are most commonly used for AD, but a variety of specialized technologies exist depending on the moisture content of the manure. When properly managed, AD yields a stable end product that is a valuable soil amendment with a reduced pathogen load. During AD, organic feedstocks are converted into a gas mixture, called biogas, which contains 50 to 90 percent methane and the rest carbon dioxide.

Odors can be greatly reduced while volume and overall nutrient (nitrogen, phosphorus, potassium) levels remain the same. Much of the organic nitrogen is converted to ammonium during the digestion process. Thus, during post-digestion storage, ammonia emissions from the digester effluent are increased compared to undigested manure. Anaerobic digestion can be expensive, depending upon the complexity of the digester system used that could increase both the capital costs and operation and maintenance expenses. Energy recovery through AD has become a recent focus to treat animal manure, food waste and other organics. It has been suggested that AD projects on livestock operations are eligible to earn carbon offsets in various emission trading systems and may generate credits that can be sold, creating additional revenue for a project. However, this effort will likely have its own set of management requirements.

Agricultural biogas capture can be profitable for pro ducers. Revenue is generated from electricity sales and reduced costs for fertilizer. Recent advancement has shown that the use of anaerobic digesters is often equiva lent to simple storage from an economic standpoint.

Manure Storage Covers

Manure is often stored on farms prior to land application – either as a liquid or slurry in open earthen basins or tanks or as a solid material in stacks or piles. Ammonia and other gases are generated due to biological activity within the decomposing manure. Air exchange caused by wind passing over these storages is a source of emissions as pollutants are dispersed from areas of higher concentration (manure storages) to areas of lower concentration (fresh air). The use of a cover allows producers to significantly limit the release and transport of these emissions.

There are many different types of covers in use for manure storages, ranging from natural to synthetic, with varying degrees of complexity and cost. Covers may be permeable or impermeable and flexible or rigid. The type of cover that is appropriate for each animal production operation depends on the size and type of manure storage, environmental factors and the goals of the producer. For example, natural covers are impractical if the surface area of the storage is very large due to high maintenance requirements. Geotextile/HPDE fabric covers are not recommended for storages that are frequently uncovered for various management practices (e.g., agitation or pumping).

Natural covers include (1) the crust that develops on some liquid manure storages and (2) fibrous mats, such as floating covers of chopped straw or other organic materials (barley, cornstalks) available on a farm. These covers are permeable, allowing rainfall to enter the storage, but slow down odor emission from the surface. Synthetic options, such as clay balls or geotextile materials (e.g., HDPE fabrics), may also be used (Nicolai et al., 2005; Bicudo et al., 2002).

These covers are more expensive than the natural options but have wider applicability and, typically, a longer life.

Impermeable synthetic covers are the most effective covers for reducing the release of odors and other air emissions from manure storages. There are both flexible (plastic) and rigid (concrete, wood, fiberglass) options. Flexible covers can either float on the liquid surface or be inflated. Inflated flexible covers are at risk of damage by high winds. Rigid covers are more resistant to wind damage and other external loads but are generally the most expensive option for manure covers. As such, floating flexible covers are used more often compared with inflated flexible covers. Regardless of the type of impermeable cover used, gases (e.g., methane) will collect passively under the cover and must be removed. Once collected, gases should be burned on site (flared) and/or otherwise utilized. Collected biogas can be processed and refined before use in various applications, such as boilers or engines, as a source of heat or electricity. Solid manure piles can also be covered to reduce dust, ammonia and nitrous oxide emissions and prevent moisture addition to the solid manure. Covers for solid manure piles can range from tarps or other flexible plastic covers to roofed manure storage buildings.

Enhanced Dispersion of Odors

Structural **windbreak** and vegetative **shelterbelts** represent impermeable and permeable barriers, respectively, to reduce downwind dust particles and odor concentrations. Structural windbreaks resist the force of the wind flow, deflecting the wind upward and increasing turbulence in the area downwind of the windbreak. Shelterbelts, a vegetation system that uses trees and shrubs to filter dust particles, also have the potential to decrease odor and dust leaving production sites. When combined with separation distances, they have been reported to effectively reduce the odor perception levels reaching populated areas, reduce the number of people affected by odor and reduce the time duration of exposure to odors.

Different techniques exist to mitigate the impact of odor from livestock operations. Strategies that reduce the generation of manure odor are usually the most cost-effective. Strategies to reduce emissions often impose additional cost to a farm operation and are more attractive if economic and/or environmental benefits can be simultaneously achieved.

References

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