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Improving the Air Quality of Animal Feeding Operations

with Proper Facility and Manure Management

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The two most common complaints the public has about animal feeding operations (AFOs) are the excessive odors and dust they emit. Livestock and poultry odors are caused by noxious gases and volatile organic compounds emitted by animals and by the decomposition of manure. Depending on the animal species, type of housing, and manure management method, manure may contain urine, feces, feathers, waste feed, and bedding material. The dust from AFOs may contain soil, poultry litter, dander, bedding material and dried manure.

There are several practical ways to improve air quality by reducing the amount of odor and dust from animal manure and housing facilities.

Siting of New Animal Facilities

When choosing sites for new animal facilities, including housing and manure storage and treatment structures, three important factors to consider are set-back distances, wind and topography.

An AFO should have a set-back distance of at least half a mile from residential and public-use areas (parks, schools, commercial buildings), and from areas that will be developed for such uses in the future.

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Animal facilities and manure storage structures should never be located directly upwind from neighbors. For example, if the predominant wind direction is from south to north, do not build animal facilities directly south of residential and public-use areas.

Topography influences the transport of odor and dust from AFOs. Locate facilities on relatively flat terrain where there is good air movement to mix, dilute and disperse odors. Native trees and shrubs planted near the facilities will help to dissipate odors and screen the facilities from public view. Avoid building AFOs near large bodies of water, where temperature and wind direction can change abruptly and frequently. Also, while rare, air carrying odors may drain from a hilltop to lower terrain during the calm wind and stable atmospheric conditions that generally prevail from dusk to dawn.

The exposure angle from an odor and dust source (AFO) to its neighbors is determined by the sum of the wind angles when the wind is blowing and by the set-back distance. As Figure 1 shows, the potential for wind to carry odors and dust to neighbors is reduced when facilities are constructed with smaller exposure angles and longer set-back distances.[1] Figure 1 also shows the effect of site layout on exposure angle.

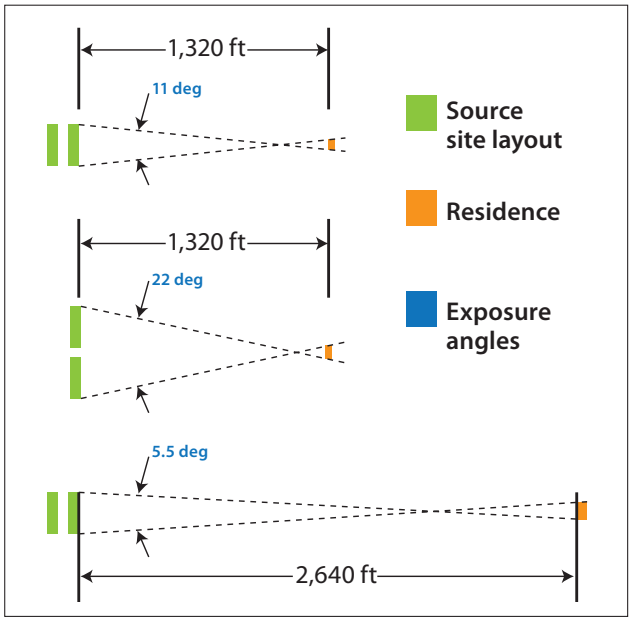

Figure 1. The effect of source exposure angle and distance on the potential for odor and dust to be carried to downwind residences (source: Harmon and Hoff, 2007a).

Researchers have developed an animal facility siting tool called the Community Assessment Model (CAM) to minimize odor and dust problems in a neighboring community. This odor-assessment model has been used extensively to evaluate a community's exposure to odor and dust from existing swine production facilities. The model also predicts how different odor-control technologies may affect odor exposure. To use this tool, an on-site visit is conducted to assess and map both the AFO and its neighbors. The mapped data are then used in CAM to predict the odor exposure. According to information provided by its developers, CAM can be used to determine the adequacy of a site for a new AFO of up to 20 animal production sources with as many as 100 neighboring homes and other community sites. Such tools help in planning and locating new AFOs to decrease conflicts with surrounding communities.

Best Management Practices for Existing Animal Facilities

If an existing animal facility produces excessive odor and dust, the cause is poor management that allows conditions on the farm to become either too wet (anaerobic) or too dry. AFOs that handle solid animal waste such as manure scraped from livestock feedlots (manure and soil scraped from unpaved surfaces) and litter from poultry operations (a combination of poultry excreta, waste feed, feathers and bedding material) must be managed so that the waste accumulating in the facility is neither too wet to cause nuisance odor nor too dry to generate dust.

Figure 2 shows the qualitative relationship between odor and dust potential and the moisture content of an unpaved beef feedlot surface. When the moisture content of the lot surface is 25 percent to 40 percent, both odor and dust are reduced. When the moisture content is less than 25 percent, the potential for dust increases; when it is higher than 40 percent, the potential for odor increases.

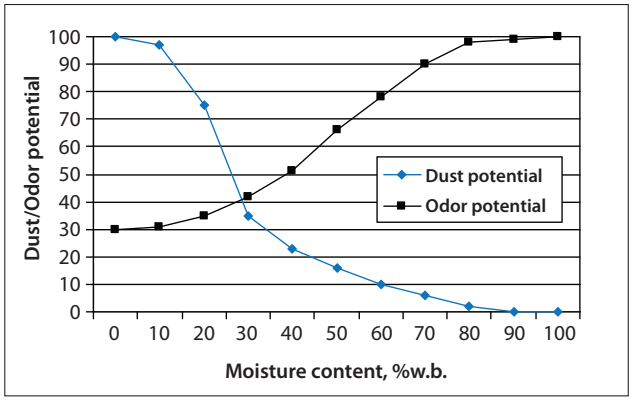

Figure 2. The relationship between the moisture content of a feedlot surface and the potential for dust and odor problems (source: Auvermann, 2000).

Open feedlot surfaces must be designed and managed for good drainage (Fig. 3, left). A poorly drained surface with thick, loose soil and manure (Fig. 3, right) will emit more dust when the feedlot is dry and more odors when it is wet.

Follow these best management practices (BMPs) to reduce dust and odor from cattle feedlots.[2,3]

- For good drainage, maintain a feedlot surface slope of about 4 percent.
- Keep the moisture content of the feedlot surface between 25 percent and 40 percent to prevent dusty conditions, especially 2 to

Figure 3. The feedlot surface on the left is well drained and properly managed, while the surface on the right is poorly managed (source: Rahman et al., 2008).

4 hours before and after sunset when animals are most active.
- Scrape the feedlot surface every 3 to 4 months to remove excessive manure accumulation, keeping a manure layer less than 2 inches deep.
- Properly compact the feedlot surface and subsurface layers to prevent cattle from loosening the manure.
- To reduce dust, allocate 150 square feet or less of corral surface area per animal so the animals' excreted moisture helps keep the surface moist.

These BMPs will reduce odor and dust from indoor poultry-growing facilities such as broiler and turkey barns where birds are raised on litter.[4]

- Keep the moisture content of poultry litter between 30 percent and 35 percent to reduce odors and dust.
- Operate the barn ventilation system at or above the minimum recommended rate. Keep the fans and fan shutters clean and fan belts properly maintained. Dirty fans and shutters and worn-out belts reduce air flow by more than 30 percent.
- Replace the water-misting system with evaporative cooling pads. If using a water-misting system, adjust it properly to keep litter from becoming too wet.
- Ensure that the correct flow of water is provided to evaporative cooling pads; prevent water from leaking onto the litter.
- To reduce water spillage onto the litter, replace bell-type drinkers with more efficient nipple drinkers.
- To reduce odors, compost the litter before applying it to land.

For more information see Texas AgriLife Extension publication E-544, "Managing Nuisance Odor and Dust from Poultry Growing Operations."

Neighbors often complain when manure and litter are applied to land. These BMPs should be followed to reduce odor and dust.[4]

- Transport litter or manure to the field in properly covered and spill-proof vehicles and avoid public roads with heavy traffic.
- Apply the correct amount of manure or litter, based on a soil test and the nutrient needs of plants. If too much manure is applied, excessive odor results.
- Apply manure or litter when wind is blowing away from neighbors. Avoid land application on weekends and holidays.
- Apply manure or litter between mid-morning and early afternoon when the atmosphere is less stable and air and surface temperatures are rising. Air flow patterns at this time will lift odors high up into the air, dispersing and diluting them. Do not apply on hot, still afternoons or extremely windy days, when dust problems are likely. Also, avoid evening application when people are at home and the atmosphere is more stable.

- Do not apply litter or manure during or soon after rain or when rainfall is imminent.
- If possible, incorporate manure or litter into the soil to reduce odors and dust and prevent the loss of nutrients to runoff or volatilization.
- To minimize odor, use low-trajectory manure spreaders, big gun nozzles, or an irrigation system for surface application.

Other methods of controlling odor and dust problems include installing windbreaks and using biofilters to filter exhaust air from ventilated animal housing and manure structures.

Windbreaks such as evergreen trees and walls serve two purposes. As shown in Figure 4, an entire facility can be hidden from public view to help reduce the perception of odors.[5] Windbreaks also filter dust and help odors dissipate more quickly by diverting the polluted air plume vertically and diluting and dispersing it in the wind. Properly designed and installed windbreak walls reduce the amount of dust traveling to downwind neighbors. These walls are generally 12 to 13 feet high and made of wood, metal, UV-resistant tarpaulin or plastic. The walls are installed in front of the exhaust fans of tunnel-ventilated swine or poultry buildings at a distance of four to five times the fan diameter.[6]

Studies show that dust and odorous gases in the exhaust air from liquid manure pit fans or from ventilated livestock and swine buildings can be reduced by 50 to 90 percent with biofilters that filter and treat the air.[5,7] Biofilters are usually constructed from a mixture of compost and wood chips and designed to retain polluted air in the filter for 3 to 4 seconds. When properly designed and maintained, biofilters efficiently convert odorous air into carbon dioxide and water at biofilter temperatures of 68 to 90 degrees F and a moisture level of 40 to 60 percent (on a wet basis).

Figure 4. A windbreak around a swine barn (source: Harmon and Hoff, 2007b).

Dairy, poultry and swine operations that store and/or treat manure, either in pits inside the building or in outdoor slurry tanks and lagoons, are generally more concerned with odor rather than dust. Follow these steps to reduce odor emissions from manure storage pits and treatment structures.

- Remove manure from barn gutters and alleys as quickly as possible.
- Fill shallow pits with about 2 inches of water and recharge deep pits with water.
- Avoid overloading pits and treatment lagoons with manure.
- Do not dump dead animals in lagoons.
- Manage the lagoon sludge properly and remove it at the intervals prescribed in the lagoon maintenance plan. Allowing excessive sludge and organic matter to accumulate promotes nuisance odors and hinders the dilution and treatment of manure.

The improper handling and disposal of animal carcasses increases odor problems, fosters disease, and threatens soil, water and air quality. Quickly isolate dead animals and dispose of them properly within 24 to 48 hours. Transport dead animals in covered, leak-proof containers to off-site disposal facilities.

Notes

[1] Harmon, J. and S. Hoff. 2007a. Siting and Building Design Considerations to Reduce Odor Potential from Swine Facilities. National Pork Board Publication 04804.

[2] Auvermann, B.W., D.B. Parker and J.M. Sweeten. 2000. "Manure Harvesting Frequency—The Key to Feedyard Dust Control in a Summer Drought." Texas AgriLife Extension Publication E-52.

[3] Rahman, S., S. Mukhtar and R. Wiederholt. 2008. "Managing Odor Nuisance and Dust

from Cattle Feedlots." North Dakota State University Extension Publication NM-1391.

[4] Mukhtar, S., J.L. Ullman, J.B. Carey and R.E. Lacey. 2004. A Review of Literature Concerning Odors, Ammonia and Dust from Broiler Production Facilities: 3. Land Application, Processing and Storage of Broiler Litter. *The Journal of Applied Poultry Research.* 13: 514-520.

[5] Harmon, J. and S. Hoff. 2007b. Basic Management Practices to Mitigate and Control Odors from Swine Buildings. National Pork Board Publication 04811.

[6] Bottcher, R.W., R.D. Munilla, K.M. Keener and R.S. Gates. 2001. Dispersion of Livestock Building Ventilation Using Windbreaks and Ducts. 2001. American Society of Agricultural Engineers Annual International Meeting, Sacramento, California.

[7] Nicolai, R and D. Schmidt. 2005. "Livestock Development in South Dakota: Environment and Health- Biofilters." South Dakota State University Extension Publication FS 925-C.

Other References

Auvermann, B.W. 2000. Controlling Dust and Odor from Open Lot Livestock Facilities. Chapter 42 in Livestock and Poultry Environmental Stewardship Curriculum. Available at *http://www.lpes.org/les_plans.html.*

Hoff, S., J. Harmon and C. Johnson. 2008. Research Summary: Siting Swine Facilities Using Iowa State's Community Assessment Model. Retrieved on November 28, 2008 from: *http://www.extension.org/pages/Research_Summary:_Siting_Swine_Facilities_Using_Iowa_State's_Community_Assessment_Model.*

Lorimor, J. 2003. Open Feedlot Construction and Management for Water and Air Quality Protection. Retrieved on November 25, 2008 from: *http://www.cals.ncsu.edu/waste_mgt/natlcenter/modules/Module%208.doc.*

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