Practices to control particulate and dust emissions associated with livestock production can be applied to animal housing and manure storage areas. This document provides an overview of various practices for each situation, highlights their advantages and disadvantages, and allows producers to make informed choices after evaluating production and economic aspects of their operations.

Dust and Particulate Control Strategies for Livestock Housing
Dust and particulate matter (PM) generated in livestock housing can exit the facility and make its way to downwind neighbors. Within the housing area, dust particles from the feed and the animals themselves will be present. Reducing dust and PM from animal housing will contribute to improved odor conditions because some portion of odor is carried on dust particles.

Filtration and Biofiltration
Filtration serves as a mechanism for trapping dust and particulates. Mechanical filtration traps approximately 45 percent of particles between 5 and 10 μm, and 80 percent of particles greater than 10 μm from animal housing areas. Mechanical filtration reduces the odor dilution threshold by 40 to 70 percent. The odor dilution threshold is defined as the concentration at which 50 percent of a human panel can identify the presence of an odor or odorant without characterizing the stimulus. Biofilters trap particulates and also provide an environment for biological degradation of trapped compounds, contributing to odor reduction beyond that accounted for by dust removal alone. Although mechanical filtration may be costly, biofiltration can be a low-cost means for effectively reducing exhaust dust. Biofiltration costs, at a 700-head farrow-to-wean swine facility, are estimated at $0.25 per piglet produced, amortized over a 3-year life of the biofilter. Odor reductions at the operation exceeded 90 percent with similar reductions in hydrogen sulfide (90 percent) and ammonia emissions (74 percent). Similar odor and hydrogen sulfide reductions were observed using biofiltration on a dairy facility. Performance in a poultry facility, however, was poorer, with an odor and hydrogen sulfide reduction of less than 40 percent, likely due to the volume of dust present in the facility.

Biofilters must be designed to provide suitable conditions for the growth of a mixture of aerobic bacteria within the biofilter. Oxygen concentration, temperature, residence time, and moisture content are among the parameters that must be considered when building a biofilter. Although management must be taken into consideration, it is clear that low-cost biofiltration systems ($150 to $200 per 1,000 cfm of air treated) can be implemented in livestock housing facilities.
**Impermeable Barriers**

Following the concept that odor is transmitted on dust particles, an alternative to filtering particles from the exhaust air is to decrease the concentration of odors downwind by impeding their movement altogether. Windbreak wall or air dam designs have proven effective in reducing both downwind dust particle concentrations and odor concentration. Windbreak walls have been constructed with 10-foot × 10-foot pipe frames and tarpaulins, and placed at the end of swine-finishing buildings, immediately downwind of the exhaust fans. Downwind dust and odor concentrations were reduced on demonstration facilities, in areas with the windbreak walls, due to plume deflection. The materials used for the barriers (tarpaulins on a frame or solid wood, for example) determine the barrier life, which may be from a few years to decades before replacement is needed.

**Oil Sprinkling**

Coating surfaces to control dust has involved the use of vegetable oil, which is either sprayed or sprinkled in animal pens. Effectiveness in reducing dust concentrations is not documented. However, a Minnesota study reported a 40 to 70 percent reduction in odor following a detailed protocol for oil application. Hydrogen sulfide concentrations were reduced 40 to 60 percent in the oil-sprinkled rooms. No effect on ammonia concentration was observed. Oil sprinkling involves safety issues, such as the slippery conditions of pens and alleys, following repeated application. Costs are minimal for the vegetable oil, and other costs involve a sprayer and the labor needed for the daily oil application.

**Landscaping**

Landscaping can reduce downwind concentration of housing dust and odors, beyond the property line, by trapping and treating particle and gas emissions. Trees and shrubs act as biofilters for fine particles and odorous compounds that are attached to them. By landscaping with both a treeline and a row of shrubs, particles at various heights within a plume can be adsorbed. To maximize adsorption, landscape materials with large surface areas are recommended. Trees and shrubs placed around the facility should not impede building ventilation and are often located on the property lines.

Costs associated with landscaping will vary depending on selected trees and shrubs, and perimeter size. Estimates of a shelterbelt planted around a 3,000-head hog facility using “higher” cost trees ($25 per shrub or tree), calculated out to $0.68 per pig for one year, amortized over 20 years at 5 percent interest, is just $0.09 per pig. These costs include maintenance costs. In addition to acting as a natural filtration system for odors, landscaping has the additional benefits of being aesthetically pleasing to the eye and of
restricting the view of the operation. So, while documented effectiveness on emissions is scarce, the value of creating a facility that is pleasant to the eye cannot be underestimated.

**Dietary Manipulation**

Feedstuff selection may impact manure dust when excreted or during storage. Studies with pigs and cattle suggest that by adding fat or oil to diets the feces become stickier, reducing dust concentrations in the house. Adding ground, full-fat soybeans to pig diets reduces aerial dust levels. In confinement buildings, dust may be decreased by 30 to 40 percent when full-fat soybeans are included in pig diets instead of soybean meal. Lower dust levels improve the health of pigs and people who work in confinement buildings. However, in order to avoid negative animal performance impacts, dietary energy content should not exceed nutrient recommendations.

**Dust and Particulate Control Strategies for Manure Storage Facilities**

Following is a summary of practices that can be employed to reduce dust stemming from manure storage facilities. The principle behind these practices is that dust movement will be slowed or prevented.

**Impermeable Covers**

Covering a manure storage area with an impermeable cover prevents the release of dust and gases into the atmosphere. Polyethylene covers typically range in price from $1.00 to $1.40 per square foot, installed.

Liquid swine manure in concrete pit covered with Leka rock. Wind damage and snow-load damage present the greatest challenges to implement the extended use of impermeable covers. Damage due to weather effects alters the life of the cover, impacting the capital investment required over time. Many manufacturers list a useful life of 10 years if the facility is constructed to prevent snow accumulation on the cover but do not provide any guarantee against wind damage.

**Permeable Covers**

Permeable covers, or biocovers, act as biofilters on the top of manure storage areas. Materials often used as covers include straws, cornstalks, peat moss, foam, geotextile fabric, and Leka rock. Permeable biocovers reduce dust by acting as a barrier. Although dust reductions are undocumented, reports of odor reductions of 40 to 50 percent and greater are common when various straw materials are used. An 85 percent reduction in odor has been noted following the use of a floating mat or corrugated materials.

Costs for biocovers vary widely depending on material used and method of application. Straws and cornstalks cost approximately $0.10 per square foot, applied; peat moss and foam cost about $0.26 per square foot, and Leka rock is approximately $2.50 per square foot for a 3-inch layer. Leka rock is a product of
Dust Control Strategies for Open Lots

Dust emissions from open feedlots are controlled primarily by moisture content. The moisture content of the open lot surface is between 25 and 40 percent, both dust and odor potentials are at manageable levels. To reach the optimum range, open lots must be designed to reduce the ponding of water on the lot as well as the buildup of manure along fence lines and bunk areas.

Cover depth is very important for permeable covers. Most recommendations for straw and stalk covers suggest a minimum of 8-inch depth, preferably 10- to 12-inch depth of coverage on a manure storage surface, whereas Leka rock requires only a 3-inch depth. New covers (except Leka rock) need to be applied at least annually, and one study showed that only 50 percent of the straw cover remained four months after installation. However, an operation in Minnesota employed a thin geotextile material that cost $0.25 per square foot, plus installation costs. Straw was added on top of the geotextile cover for additional odor control. Management and re-investment costs, and the removal of large, fibrous material during storage cleanout must be considered before selecting this option.

Dust emissions from open feedlots are controlled primarily by moisture content. However, because at high moisture content odor can also be a problem, it is impossible to minimize dust and odor by moisture management alone. Researchers have found that when the moisture content of the open lot surface is between 25 and 40 percent, both dust and odor potentials are at manageable levels. To reach the optimum range, open lots must be designed to reduce the ponding of water on the lot as well as the buildup of manure along fence lines and bunk areas.

Beyond design, maintenance of lots will also help control dust. The key is to keep the lot surface hard, smooth, as dry as possible, and with a firm 1- to 2-inch base of compacted manure above the mineral soil. In flat feedlots or where rainfall is plentiful, an interval of 120 days or more between manure-removal activities will almost certainly lead to lot conditions that generate odor. In Texas, a few modern, large feedlots (capacity greater than 35,000 head) have experimented with continuously harvesting the manure across the yard with two or three tractors with box scrapers, even with cattle present. Lot conditions are excellent, and managers report little to no depression in feed-to-gain performance or increased cattle stress.

Stocking density (number of animals per unit of lot area), or its inverse, animal spacing, may be adjusted to compensate for increases in net evaporative demand (evaporation depth less the effective or retained precipitation), shifting the moisture balance in favor of dust control.
A commercial feedlot in the Texas Panhandle found that decreasing cattle spacing from 150 to 75 square feet per head reduced net PM10 concentrations, at the lot fence line, by about 20 percent. Net PM10 concentrations are the measured particulate matters that are smaller than 10 microns in diameter (PM10), less the background. As daily net evaporation increases, the effectiveness of increased stocking density is likely to decrease. Furthermore, increasing stocking density may induce behavioral problems and reduce overall feed-to-gain performance.

Open lot surface amendments are still under experiment for dust and odor control. Crop residue mulches (waste hay, cotton gin trash) may cushion hoof impact, reduce the shearing that causes dust, and decrease the net evaporative demand by storing additional water and reducing evaporation rates. Resins and petroleum-based products, which have been shown to reduce dust emissions from unpaved roadways significantly, may also be effective. However, the continuous deposition of manure on lot surface suggests that these compounds would need to be reapplied frequently and would therefore be costly.

Solid-set sprinkler systems are an effective but expensive means of dust control in cattle feedlots. Research in California showed that dust concentrations in interior lots increased 850 percent after sprinkler operation had stopped for two days.

Sprinkler systems require site-specific design based on seasonal water balance calculations, but in general, systems should have sufficient capacity to deliver 0.25 inch or more of water per day across the entire yard. Sprinkler patterns should overlap by 50 percent of the diameter of throw, and sprinklers should be located so that their throw does not extend all the way to the feed apron.

If possible, avoid long-term stockpiling of manure. Unmanaged stockpiles will eventually exclude oxygen, and even if the stockpiles are not odorous, old, stockpiled manure releases more odor when land applied than manure that is exposed to oxygen. If stockpiling is necessary, minimize stockpile size.

The general approach to dust control consists of (1) removing dry, loose manure from the lot surface; (2) manipulating the moisture at the lot surface to achieve optimum moisture content; and (3) attempting to reduce peak cattle activity during the critical, late afternoon hours, when dust nuisance is most likely to occur.
Conclusions
Employing practices to control dust from livestock facilities can result in less odor and fewer nuisance concerns. A number of practices are available but not all are suited for all operations. Careful consideration and selection will ensure that you obtain the desired results. Regardless of the practice selected, common sense and consideration of neighbors are necessary components of a sound dust control plan.

Resources
For a list of research reports, ISU Extension publications, and links to current news regarding air quality and animal agriculture, please visit the Air Quality and Animal Agriculture Web page at: http://www.extension.iastate.edu/airquality.


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File: Environmental Quality 4-1

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