NEBRASKA DEPARTMENT OF ENVIRONMENTAL QUALITY
ENVIRONMENTAL GUIDANCE DOCUMENT

05-034 February 2005

Best Management Practices for Odor Control

The trend towards larger and larger animal feeding operations, coupled with the influx of nonagricultural people into rural areas, has brought the issue of livestock odors to the forefront, in addition to concerns about water quality and the environment. Although water quality can be directly measured, odor strength and offensiveness can vary through personal perceptions. Perceptions are influenced by personal preference, opinions, experiences and variability in individual olfactory systems.

Total elimination of odor from animal feeding operations probably never will be accomplished. However, management practices and technology are becoming available that are capable of reducing odor. Economic issues control the implementation of new odor technologies. The livestock industry is very competitive, with low profit margins. However, most producers agree that continued productivity, profitability, and sustainability of livestock production depends in part upon cost-effective technologies and management practices to mitigate odor. The following is a quick overview of some available practices and technologies. Most odor technologies work best in very specific situations, and should be thoroughly researched before being implemented.

Odors in Buildings

Odors associated with livestock buildings are often overlooked for the more obvious odor source -- the waste storage structure.

Cleanliness goes a long way to prevent odor from buildings.

- Keep floors as clean and dry as possible to avoid anaerobic decomposition of organic material.
- Avoid manure buildup, thereby decreasing odor sources.
- Provide adequate ventilation to prevent buildup of dust, gases, moisture, and heat that may intensify odor.
- Make sure building interior surfaces are as smooth as possible to facilitate cleaning and reduce area for dust and debris to accumulate.
- Modify feed delivery systems to release as little dust as possible. Odorants readily attach to airborne feed particles and dust, which can be easily released to outside air.

- Clean exhaust fans and shutters regularly of dust and debris to maximize warm season ventilation.
- Recharge, flush or scrape underfloor manure storage areas as frequently as possible.

Small changes that may have a positive effect include:

- Cover recycle flush tanks.
- Extend recharge pipes and fill-water lines to the bottom of the pit and fit them with anti-siphon vents in order to reduce agitation of liquids.
- Cover outside collection and junction boxes, sump tanks and storage basins, if possible.

Waste Storage Structures:

Lagoons or holding ponds that are designed and managed properly usually have low odor potential. However, if an anaerobic lagoon is undersized or organically overloaded, it may be a significant odor source.

- Make sure lagoons are large enough to consistently treat and store manure.
- Fill new or emptied lagoons with four feet of water prior to the introduction of manure so waste solids will be submerged. This gives the different bacterial populations enough room to work and reduces the amount of complex and odorous compounds that will be released from the lagoon.
- If possible, start loading new lagoons during the warmer summer months so that the bacteria needed for proper lagoon function may become established.
- Refrain from using harsh anti-microbial feed products, like copper sulfate, that may disrupt the microbial population of the lagoon.

Land Application:

The application of liquid manure onto cropland maybe a significant source of odors and nuisance complaints from surrounding neighbors. The following procedures may help alleviate those concerns.

- Adjust sprayers and spreaders so the waste is applied at low pressures. High pressures can aerosolize the waste and allow for more air contact.
- Apply wastes as close to the ground as possible. The higher the effluent is applied, the more air can mix with it and cause odors to be carried off the application site.
- Apply manure during times when the air is warming and rising from the ground. This would normally be between the hours of 8 AM and 3 PM. Also, take into account prevailing winds, so odors won't be carried towards homes or businesses.
- Avoid application on hot humid days (where odors will stay close to the ground) and on weekends or holidays.

- Incorporation of the manure into the soil is a very effective technique of reducing odors. As soon as possible, incorporate manure if the soil type and costs aren't prohibitive.
- Establish setback distances from neighbors.

Open Lots:

Although odor from open lots is highly subject to climate changes. A number of things that can be done. Dust from feedlots is a primary concern because dust can absorb and concentrate odor compounds. Dust can also be carried long distances by wind, and tends to stay closer to the ground than gaseous odor compounds. Other odors can come from decaying organic matter.

- Lightly sprinkling pens with water or establishing shelterbelts has shown success in reducing the amount of fugitive dust leaving a facility.
- Decaying manure produces more offensive odors that fresh manure. Keep pen areas free from puddles and fairly dry to inhibit anaerobic decomposition.
- Clean pens regularly and land apply the manure on cropland as soon as possible to prevent it becoming an odor source. Proper composting the material can also reduce odors within a short period of time.
- Regularly clean any runoff areas that have especially high organic loading rates (i.e. settling basins).

Additional Measures:

Additional technologies or management practices exist that may be implemented to reduce odors. Many of these available technologies are new and costly, but have proven effective in certain instances.

Facility Site Selection and Perception:

The primary method of reducing the number of odor complaints begins with the selection of the site for the livestock waste control facility. Sites located near residences, commercial enterprises, recreational areas, or major roads are particularly prone to complaints. When selecting a site, also consider topography and prevailing wind directions.

Research has shown that perception plays a role in how pleasant or offensive an odor is to any individual. Aesthetically pleasing livestock operations have fewer complaints. A clean, well-landscaped and well-maintained operation is perceived to be less odorous. Trees and shrubs can help to reduce odor through air mixing and can add to the overall quality of appearance.

Anaerobic Lagoon:

The most common form of waste treatment for swine producers in Nebraska is an anaerobic lagoon. Lagoons break down organic waste into gases, liquids, and biosolids through microbial action. Many waste control facilities are called lagoons, but actually are earthen

storages. Lagoons are built much larger and contain a permanent bacterial and water pool. Most cattle feedlots use earthen storages, while pork producers tend to use anaerobic lagoons.

Improperly designed or managed lagoons can emit odorous gases like H_2S (Hydrogen Sulfide) and intermediate VOCs (Volatile Organic Compounds). On the other hand, correctly functioning anaerobic lagoons can treat wastewater with very little odor. As the size of a lagoon increases, the potential for odors, the rate of sludge buildup, and the number of pathogenic organisms decrease, while nitrogen losses increase.

Lagoons operate more efficiently in warmer temperatures. They may produce considerable odor in the spring as bacterial populations are restored. Two main groups of bacteria exist in lagoons -- the acid-producing and methane-producing.

The acid-producing bacteria work at the lower temperatures, breaking down organic matter into VOCs and VFAs (Volatile Fatty Acids), both of which are odorous. The methane-producing bacteria, which flourish at higher temperatures, convert these complex odorous organic by-products into simple, nonodorous compounds like methane and CO_2, (Carbon Dioxide). However, the methane-producing bacteria don't get started as early in the spring as the acid-producing bacteria.

An anaerobic lagoon that is operating properly will have a pH of 7 to 8 (slightly basic). Overloaded lagoons tend to be more acidic (6.5 or less). This problem can be solved temporarily with the addition of hydrated agricultural lime on the surface. Excessive additions of antibiotics or metals, like copper sulfate, to animal feeds may disrupt bacterial populations and cause odor.

Many lagoons exhibit a purple/reddish color on the surface. This color is caused by a phototrophic sulfur oxidizing bacteria that can occur naturally. The color is a good sign that the lagoon is functioning properly and odor, NH_4-N (Ammonia-Nitrogen), and soluble phosphorus are reduced. Research is being done at the University of Nebraska to determine how these bacteria reduce odor.

Manure Storage Covers:

Manure storage structures are often the focus of odor control efforts. Therefore, many producers have covered them. In Nebraska, storage structures tend to be very large, like anaerobic lagoons. Covering them isn't always economically feasible, due to the high costs per square foot of material. However, several types of covers exist that have been successful.

- Geomembrane covers, like high-density polyethylene or reinforced polypropylene materials, can float or be supported through a structure on top of the storage unit. Geomembranes greatly reduce odors and they eliminate the addition of rainwater into the structure. However, they do have their limitations. Producers need to find ways to remove rainwater from floating covers or they will become submerged. Also, biogas

will collect under the cover. The gas could be vented and burned, or captured and used as an alternate energy source.

- Biocovers are becoming very popular among pork producers in Iowa. Biocovers consist of floating layers of chopped barley, wheat, flax, brome straw, corn stalks, or peat moss. Biocovers can greatly reduce odor from waste storage structures and cost less than synthetic covers. The drawback to biocovers is that they need to be replaced frequently, as the floating material sinks to the bottom and adds to the sludge build-up. They function best over semi-solid storages and are impractical in a lagoon setting because of the huge amount of material needed to cover it. Also, the material sinks much faster in a total liquid environment, wind easily breaks up the cover, and the cover adds to the sludge build-up, which may be difficult to remove.
- Other new types of covers are being tested for their odor-reducing potential. One such cover is leka rock -- a man-made molten rock product that floats on water and stays afloat considerably longer than biocovers.

Solids Separation:

If a lagoon is odorous due to heavy organic overloading, or is under-sized, incomplete anaerobic degradation and produce odors can result. The producer can either increase the size of the lagoon or lower the amount of organic matter entering the lagoon. Solid separation can be done mechanically or through gravity (i.e. debris basins). This technology might be even more useful if recycled for flush water. The separated solids may be an extreme odor source.

Aeration:

In classical animal waste treatment systems, manure is treated anaerobically. Aeration adds dissolved oxygen into the treatment process, promoting the growth of aerobic bacteria. Properly aerated, these lagoons have been proven to reduce odors, due to the complete breakdown of complex organic molecules like volatile fatty acids. However, aeration is costly -- the addition of oxygen to water requires considerable energy usage, and equipment is expensive. Also, sludge builds up in the bottom of the lagoon faster in an aerobic system.

Anaerobic Digester:

Anaerobic digesters are designed to optimize waste degradation and capture the gaseous by-products, primarily carbon dioxide and methane. Methane can be used on-farm for heating through a furnace or in electricity production. Mesophilic digesters are the most common type, and support a bacterial population in a temperature range of 70^0 to 115^0F. Higher temperature digesters are more efficient, but are not as stable. Effluent from digesters can still be odorous without further treatment, and nutrients aren't reduced substantially. The high cost of the system, erratic biogas production, and remaining nutrient content limits the building of digesters. These systems are used more frequently in Europe where government subsides help finance them.

Product Additives:

An increasing number of companies have been recently claiming to be able to reduce odor and H_2S and NH_4 emissions, break down organic sludge, control flies, improve animal health, and increase fertilizer value for the manure -- all through the addition of certain additives to manure storages.

These compounds can be chemical, enzymatic, bacterial, odor adsorbents, and masking agents. Numerous compounds have been tested by the ISU and NCSU to determine their effectiveness on odor reduction. A few products tested showed some positive odor-reduction capabilities, but the vast majority had no effect. However, the costs of such products are usually low when compared to other odor-reducing strategies.

Biomass Filters:

Biofilters can be used to treat ventilation air coming out of confined animal production buildings. Biofilters provide a medium for the growth of certain bacteria, which convert odorous compounds like VOCs, VFAs, and NH_4 into simple non-odorous compounds. Industrial biofilters can be very expensive, but biomass filters can be constructed and operated for as little as $0.22 per weaned pig produced. Buildings must use only mechanical ventilation, because naturally ventilated air can't be forced through the bacterial medium.
The University of Minnesota has shown that inexpensive biomass filters can be constructed with wood pallets and wood chips or other fibrous material. They had removed as much as 95% of the odor and 90% of the H_2S with little resistance to air flow in the building.

Windbreak walls also are used to reduce odors and dust coming from production buildings. The walls are placed downwind of ventilation fans, settling dust out and forcing odorous air upwards. They have limited success due to wind directions and atmospheric conditions, but are used heavily in Asian poultry operations at low costs.

Diet Manipulations:

Research has already shown that altering the diet can greatly reduce excreted nutrients like nitrogen, phosphorus, copper and zinc. This technology is beginning to be applied to odor issues and shows future promise that may revolutionize the way animals are fed. However, at this time, any odor reduction gained through dietary manipulation is lost once the manure undergoes anaerobic degradation.

Oil Sprinkling:

Recent research has demonstrated that sprinkling a small amount of oil (2 ounces per 100 sq. ft.) in totally housed confinement operations can reduce gas and dust concentrations substantially. On average, this practice reduced total dust by over 80%, H_2S by 27%, and NH_4 by 30%. The decrease in dust not only reduced odor, but also improved worker and animal health. It is important that the oil is sprinkled and not sprayed at high pressures because aerosolized oil can be detrimental to human health. Also, when too much oil is used, surfaces become very slick creating a hazardous working environment. The main cost is labor, but automation could solve this problem.

Other Odor-Reducing Technology:

Industrial and municipal systems faced odor issues for a long time and have used a number of odor-reducing technologies very successfully. Some of these technologies have shown to be adaptable to animal production systems. The main drawbacks are very high costs and increased management concerns. If odor issues are very sensitive in a facility site, these options should be researched fully to see if they could mitigate any concerns. Some of this technology includes:

- Sequencing Batch Reactors (SBR)
- Ozonation
- Activated Sludge
- Extended Aeration
- Aerobic Upflow Biofilters
- Wet Scrubbers
- Condensation
- Incineration
- Activated-Carbon Adsorption
- Air dilution