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## EC95-745 Managing Livestock Odors: Principles, Assessment and Planning

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# Managing Livestock Odors: Principles, Assessment and Planning

Rick Koelsch, Extension Engineer—Livestock Systems

Odors associated with livestock manure represent a growing challenge for livestock producers. Livestock production trends such as more animals per farm and expanded reliance upon manure storage have added to the odor nuisance. Implementing other environmentally friendly practices such as manure nutrient management and maintenance of surface crop residues for soil conservation also have resulted in additional odor challenges.

Odors originating from livestock wastes are a common source of irritation between producers and neighbors. Confrontations may lead to more stringent local zoning regulations, greater scrutiny of other farm environmental issues, and litigation.

This publication summarizes the underlying causes of livestock odor nuisance, reviews prevention and treatment options, and allows an individual to self-assess design and management procedures for potential risks.

## The Problem

### Common Odors

Odors originating from livestock manure are a result of a broad range of odor-producing compounds.

Researchers have identified 168 compounds, 30 of which have very low odor detection thresholds (less than 1 part per billion). Commonly reported compounds associated with livestock waste include sulfur-containing compounds, ammonia, volatile organic acids, phenols, alcohols and others (see *Table 1*). The substantial range of odorous compounds from manure adds to the complexity of odor control solutions.

### Contributing Biological Processes

If manure can be maintained in an aerobic state (free or dissolved oxygen present), chemical reactions will stabilize the organic compounds and minimize odors (*Figure 1*). Heavily bedded manure spread daily has only modest odor because aerobic conditions are more prevalent. Anaerobic processes, dominant in manure storages, add to the odor nuisance associated with manure. Concentrations of odorous compound in liquid manure can increase by factors two- to 10-fold for storage periods of only 24 hours.

Two broad groups of bacteria are involved in anaerobic decomposition (*Figure 1*). Acid-forming bacteria react with manure solids, forming acids and other compounds. Many have strong odors.



Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Kenneth R. Bolen, Director of Cooperative Extension, University of Nebraska Institute of Agriculture and Natural Resources.



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Table I. Characteristics of common odorous compounds from livestock manure.

Compound	Odor	Conditions Causing Nuisance	Other Notes
Ammonia	Sharp, pungent irritating odor	Both aerobic and anaerobic conditions	Lighter than air; disperses quickly Soluble in water Released more quickly at higher pH and warmer temperatures
Hydrogen sulfide and other sulfur compounds	Powerful, rotten egg odor	Anaerobic conditions	Toxic Very low detection threshold Heavier than air, disperses slowly
Volatile organic acids	Key source of livestock odor	Anaerobic conditions	Results when conditions allow only partial completion of anaerobic processes
Phenolics	Highly odorous	Exist in raw manure and worse with anaerobic conditions	Lower detection threshold than hydrogen sulfide

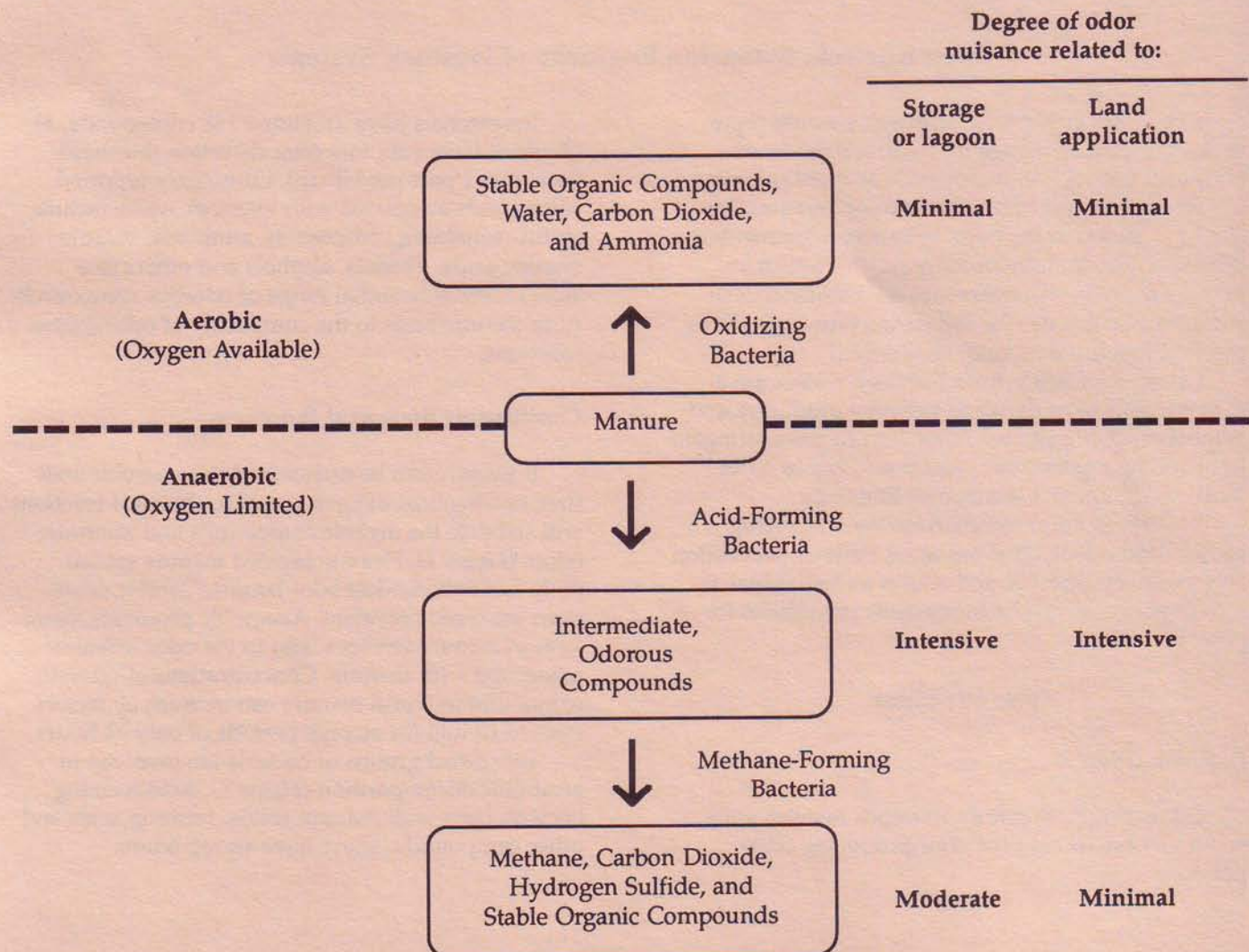


Figure 1. Odor nuisance is related to whether anaerobic or aerobic conditions exist.



Next, methane-forming bacteria convert the acids to odorless methane and carbon dioxide. Greater sensitivity of methane-forming bacteria to lower temperatures, low pH, and overloading of organic solids allows acid-forming processes to outpace methane-forming processes in manure storages and most lagoons. This imbalance causes the high concentration of volatile, odorous compounds in stored manures. If conditions allow the anaerobic process to proceed to completion such as in a properly sized anaerobic lagoon or anaerobic digester, the manure solids are stabilized and few odors result during land application. Odor nuisance from sulfur compounds produced by the lagoon or digester still can be extremely pungent unless the lagoon or digester is enclosed.

The ammonia-related odors originating from manure result from a different set of chemical processes. Urea, the primary source of nitrogen in urine, is quickly converted to an ammonium ion state under most conditions. The ammonium ion is converted to ammonia and lost to the atmosphere at a slightly slower pace. Elevated temperatures and pH values contribute to more rapid losses of ammonia.

Most odors perceived by people as associated with manure are products of anaerobic decomposition (i.e. sulfur-related compounds, volatile organic acids, phenols). Ammonia concentration is a poor indicator of the level of odor nuisance experienced by neighbors.

### *Other Contributing Conditions*

Physical conditions to which manure is exposed also affect the level of odor produced by manure. Those contributing factors include:

- 1) *Temperature.* A 20°F increase in temperature doubles the speed of the biological reactions that volatilize ammonia and anaerobically decompose manure.
- 2) *Manure moisture content.* Liquid manure promotes anaerobic conditions. Dry manure encourages aerobic conditions.
- 3) *Time.* If manure accumulates longer than 3 to 5 days, offensive odors are a greater nuisance.
- 4) *pH.* Manure pH normally ranges from 7 to 8, a preferred level for both aerobic and anaerobic processes. A pH of 9 or more dramatically slows anaerobic activity.

## **Management Options for Controlling Odors**

### *Community and Neighbor Relations*

Despite the best intentions, odors cannot be eliminated from livestock manure and production practices.

An appropriate goal for odor control is not odor elimination but rather control to an acceptable level.

A critical component of an odor control program includes neighbor relations. The nuisance caused by odor is a function of individual perception. A neighbor's tolerance to odor is often influenced by their understanding of local farms and farm families. Some of the most effective odor control programs emphasize good neighbor relations.

Good neighbor relations rely upon improved communications and greater understanding. When and for how long will you be spreading manure? What current efforts reduce odors? Who should be contacted if a concern exists? What current practices are designed to protect the environment (i.e., IPM or conservation tillage) or ensure animal health and welfare?

Some producers have found letters to their neighbors addressing these issues prior to major odor-producing activities are helpful. Farm tour or open house for neighbors or local government officials is another effective tool. Producer involvement with local community groups or school programs provides additional opportunities for improving understanding.

### *Site Selection*

Site selection for barns and storages is an effort to utilize odor dilution to your advantage. Four critical considerations are:

- direction and distance from neighbors,
- isolation of lagoons or storages,
- prevailing wind directions, and
- air drainage.

Separation distance between odor-producing facilities and neighbors influences odor complaints. One research survey suggested to minimize the number of neighbors viewing a livestock farm as a nuisance (less than 20 percent of neighbors) required a separation distance of 2,500 feet for swine, 1,500 feet for beef and 1,000 feet for poultry operations (*Figure 2*). Separation distance of one mile to communities, schools and outdoor recreational areas may be more appropriate.

When a manure storage is added to a livestock facility, the ideal location for a manure storage is not always next to the barn. Remotely located storages placed in proximity to the fields to receive manure may provide options that better meet site selection guidelines for odor. In addition, remotely located storages may remove an unsightly component of the livestock farmstead and reduce the equipment and labor hauling requirements when storage is being emptied, often a peak demand period.

Most odor nuisances are seasonal in nature. Neighbor complaints are common during warmer



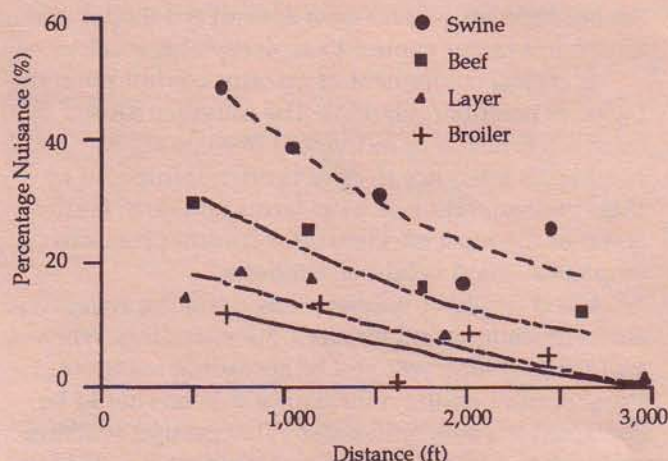


Figure 2. Percentage of neighbors reporting a farm as being a nuisance versus separation distances between the farm and neighbor. Source: VanKleeck, R.J., N.R. Bulley. "An Assessment of Separation Distance as a Tool for Reducing Farm/Neighbour Conflict." Agricultural Waste Utilization Management Proceedings of the 5th International Symposium on Ag Wastes. 1985.

weather when houses are open and outdoor activities occur. Some facilities such as lagoons experience seasonal odors. Land application is a seasonal task for many producers that can produce odor complaints. When are odor complaints most common within your community?

Consider prevailing wind directions during periods of highest odor risk when considering location of new facilities (Figure 3). For most sites in Nebraska, producers should be most concerned about neighbors to the north and northwest of any sources of odor.

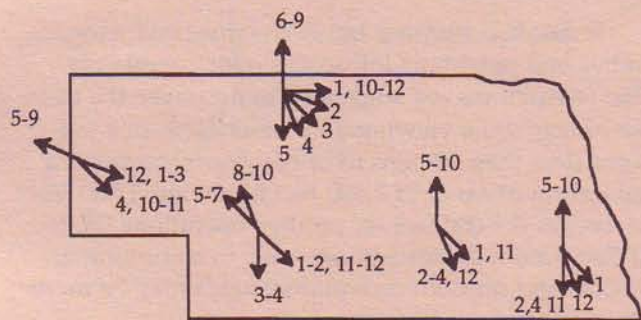


Figure 3. Prevailing wind direction for various times of the year. Numbers represent months of the year.

Neighboring residences downslope from a livestock facility, especially those in a valley, are more susceptible to odor problems. During calm summer evenings, cooled air near the ground moves downslope and is trapped in a valley. Odors from a livestock facility travel with this air.

## Livestock Housing

Livestock housing facilities are a common cause of odor. It is estimated that 65 percent of the odor from swine housing is associated with odor-causing compounds attached to dust particles. Feed handling, animal movement and other activities contribute dust to ventilation air. Dust-related odors disperse into the atmosphere more slowly than odors from storages or lagoons where dust is not involved. As a result, housing-related odors can be noticed at greater distances than other odors from other origins.

Limiting manure residence time is the primary odor-control opportunity in animal housing. Systems that regularly flush or continuously mechanically scrape the manure from the barn are preferred. Structures that store manure under the barn floor increase the odor risk. The one exception to this is where livestock are heavily bedded to maintain manure as dry as possible and minimize anaerobic conditions.

Removing dust from the ventilation air is a desired alternative, but commercial installations where dust is removed currently are not available. Barn ventilation systems designed to outlet ventilation air at the roof peak as opposed to near the ground may encourage better odor dilution. This approach has not been evaluated for odor control performance.

## Manure Storage Facilities

From an odor-control perspective, not storing manure and spreading it every day is ideal. However, water quality issues dictate that storage will be a critical component of most manure management systems. A more appropriate goal is to minimize the odor nuisance associated with a storage or lagoon.

A floating crust on a beef or dairy manure storage minimizes odor releases except during loadout. Bottom loading of storages and limited water additions encourage crust formation. For swine manure where crusts do not commonly form, concrete lids or floating covers represent an alternative. Artificial crusts formed from crop residue and floating, gas permeable membranes have demonstrated benefits in research applications but have not been used commercially at this time.

Odor nuisance associated with storage agitation and emptying can be reduced by minimizing the agitation of the manure surface. Maintenance of a crusted manure surface during manure loadout is of value in controlling odors in dairy and beef manure storages. This value must be balanced against a reduced effective capacity for the storage, greater variability of nutrient content of non-agitated manure, and modification of clean out procedures.



Trees may reduce odors from storage facilities as well as improve the visual appearance. By reducing air movement across a lagoon or storage, fewer odorous compounds are volatilized. Trees should be located to slow prevailing wind movement across the storage as well as block visual lines of site for neighbors. Fast growing trees that produce barriers near the ground are preferred. Trees should be located sufficiently distant from the storage to prevent root growth into the storage.

### **Field Application**

Two principles are key in defining the level of odor associated with field application. First, mixing manure into the soil substantially reduces odor. Aggressively mixing manure with the air adds to odor intensity. Second, timing field applications of manure affects the associated nuisance.

High pressure and high trajectory spray patterns atomize liquid manure (and odorous compounds) into aerosols that can travel great distances. As a result, irrigation and conventional liquid manure tank wagons with splash plates produce significant odors. Shallow incorporation and deep injection systems allow the soil to filter odors and stabilize manure through aerobic processes. Low trajectory surface application also substantially reduces emissions.

Timing for storage emptying and field application is an important control measure that requires consideration of the following principles:

- 1) Cold weather application produces fewer odor nuisances than warm weather application.
- 2) Dry, windy days produce fewer odor complaints than calm, humid days.
- 3) Morning or early afternoon manure application (8 a.m. to 2 p.m.) provides optimum conditions for drying manure and dispersing odors. Rising air temperatures and higher wind velocities produce fewer odor nuisances.
- 4) During warmer weather, avoid spreading manure when outdoor recreational activities of neighbors are most likely (evenings, weekends, and holidays).

### **Treatment Options for Odor Control**

If odor management practices do not produce an acceptable odor level, several treatment options may be considered. A number of odor treatment technology alternatives exist — at a price.

### **Lagoons**

Anaerobic lagoons, both properly sized and undersized, face substantial odor challenges. Purple lagoons are a good odor-controlling treatment option.

Anaerobic lagoons are a common treatment option for diluted manure waste streams and process waste waters. If properly designed and managed, complete anaerobic decomposition of manure can occur within the lagoon and the resulting land-applied effluent is relatively stable and odor free (see Figure 1).

The lagoon itself will produce substantial pungent smelling, sulfur-containing compounds and be an odor liability. Standard lagoon design procedures will stabilize the effluent for minimizing land application odors but still produce odor nuisances associated with the lagoon. Standard design procedures are available in the 1985 Livestock Waste Facilities Handbook, Midwest Plan Service, provided by Cooperative Extension, and the 1992 Agricultural Waste Management Field Handbook, prepared by the Soil Conservation Service.

Undersized lagoons will exceed the limits of the biological processes and become substantial odor liabilities. Separating the manure solids fraction from the waste stream or expanding lagoon size reduces the organic load and partially resolves odor challenges.

Lagoons sized by standard procedures face additional challenges in the spring. Winter operation results in reduced biological activity and incompletely digested organic material. Spring temperatures produce vigorous biological activity causing lagoon turnover and a release of offensive odors. Spring lagoon operation can present a difficult odor challenge for both correctly sized and undersized anaerobic lagoons.

To avoid these conditions, lagoons sometimes are constructed sufficiently large to encourage growth of purple bacteria that consume odorous sulfur compounds. A very dilute slurry allows sunlight penetration near the surface and growth of purple sulfur bacteria. Purple lagoons and their effluent when land applied produce very few odor nuisances. Their primary drawback is the additional construction cost and space requirements resulting from a structure that may be three times larger than more standard design recommendations.

### **Other Treatment Technologies**

Anaerobic digestion systems provide an effective means of controlling manure odors during and after treatment. The controlled environment preferred for an anaerobic digester provides the ideal conditions for completing the anaerobic decomposition processes.



Table II. Design recommendations for an in-the-building oxidation ditch. (Source: Loehr, R.C. Pollution Control for Agriculture. Orlando. Academic Press, Inc. 1984.)

Animal	BOD <sub>5</sub> produced (lb per animal per day)	Required Oxygenation Capacity (lb per animal per day)	Ditch Volume (ft <sup>3</sup> per animal)	Power Requirement (kWh per animal per day)
<b>Swine</b>				
Sow with litter	0.79	1.58	23.7	0.83
Growing pig	0.14	0.28	4.2	0.15
Finishing pig	0.32	0.64	9.6	0.33
<b>Dairy Cow</b>	2.21	4.42	66	2.33
<b>Beef (900 lb)</b>	1.35	2.70	40	1.42

Combustion of gas produced by an anaerobic digester in a boiler or engine eliminates the odorous sulfur compounds. The slurry is stabilized and few odors are associated with land application. Energy is recovered from these systems and a more homogeneous, liquid manure is produced as a result of the destruction of some solids. A combination of these benefits must be balanced against relatively high investment and operating costs.

Aeration systems have been used with swine and poultry manure for odor control. Aerobic processes produce gases that contain little odor and stabilize the solids so odor does not result from land application of slurry. Aerobic treatment requires addition of large quantities of air by mechanical systems to supply the oxygen needs of aerobic processes (Table II). To date, the significant energy and capital cost of aeration systems have prevented this odor control option from gaining greater acceptance.

Biofiltration is an emerging technology for removing odors from enclosed structures such as enclosed animal housing, covered manure storages or indoor composting operations. It is growing in acceptance in Europe, and to a lesser extent in North America, as a means of odor treatment. Biofilters have been used for ammonia and odor reduction from chicken and pig housing and indoor composting sites.

A biofilter can be viewed as performing a function similar to the practice of filtering odors from landfills, leach fields or septic systems by covering them with soil caps. Biofiltration involves moving odor-fouled air through a filter consisting of soil, organic residues (i.e., tree trimmings and leaves), compost or other appropriate media (Figure 4). Odorous compounds are removed by aerobic degradation and adsorption onto organic particles and water. Although biofiltration provides an attractive new odor control option, limited design and management experience exists within North America.

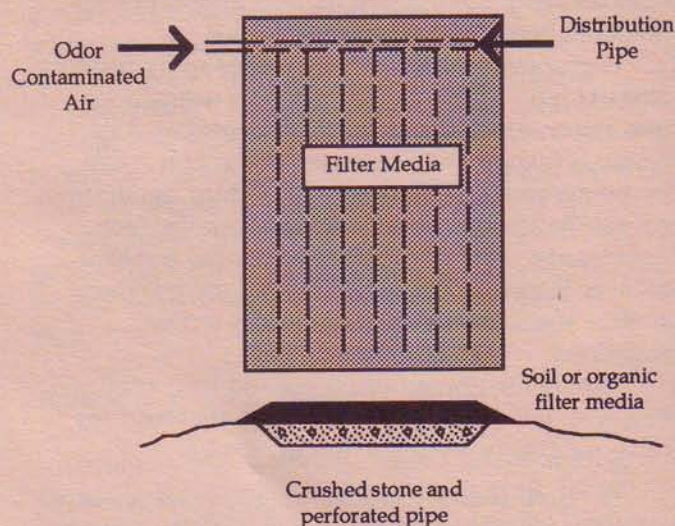


Figure 4. Typical biofilter schematic (top and end views) for odor control.

#### Chemical and Biological Additives

A variety of feed and manure additives have been proposed or marketed for odor control. These agents can be grouped into six categories:

- 1) **Masking agents** are aromatic oils designed to cover up manure odor with a strong, less offensive, odor of their own.
- 2) **Counteractions** cancel or neutralize the manure odors so the resulting odor is less intense.
- 3) **Digestive deodorants** containing bacteria and enzymes eliminate odor through digestive processes.
- 4) **Absorbents** utilize the large surface areas of some compounds to absorb odors before release to the environment.
- 5) **Feed additives** are intended to improve animal performance and reduce odors at the source.



- 6) **Chemical deodorants** are oxidizing agents designed to chemically oxidize odorous compounds or germicides that alter or eliminate bacteria action.

The research literature is "littered" with numerous unsuccessful attempts to reduce odor with chemical or biological additives. A few approaches have received positive reviews.

Additives that alter pH have produced positive results. Additions of hydrated lime to manure to attain a pH of 12 ends all microbial activity. A pH of 9 or greater may substantially reduce odor levels. (Table III). Ammonia releases will rise with increasing pH. However, ammonia is not considered to be a main odor contributor.

Research applications of hydrogen cyanamide, potassium permanganate and hydrogen peroxide have been used successfully in odor reduction from some livestock wastes. Testimonials by farmers have indicated some success with digestive deodorants and feed additives, but the range of odor-controlling products available has not allowed each of these products to be independently evaluated.

Chemical and biological treatment must be approached with caution. To date the successes with

odor-control agents have been far fewer than the failures. Promising alternatives such as oxidizing agents or pH adjustment often have had no farm scale application or limited review of costs. Generally, additives should be considered an option after good odor management practices have failed to achieve an acceptable compromise. If commercial products are to be tried, the following questions should be addressed:

- What odors will this product control? Odors from livestock manure are a result of a very broad range of compounds. Efforts to control only a few of these compounds may not reduce the odor perceived by neighbors.
- Does independent verification of a product exist? If independent verification of a product does not exist, have other livestock producers used this product? Was their success dependent upon a set of conditions that may not exist at your operation?
- Can a small, inexpensive, comparative trial of a commercial product be conducted before a greater investment is made? Two 55 gallon drums filled with manure, one treated and a second untreated, stored away from the odors of your farm and regularly evaluated by your neighbors, provide experience with a product before a major investment is made.

Table III. pH and odor units after adding hydrated lime to cattle manure. (Reproduced with permission of International Thompson Publishing Services, source: A. Klasnik, G. Steffens and H. H. Kowalewsky. "Odour and Ammonia Emissions from Grassland and Arable Land." *Odour and Ammonia Emissions from Livestock Farming*, Table II, page 172. 1991.)

Treatment (lb lime/1,000 gallons manure)	pH of slurry	Odor units per 1,000 gallons
0	7.37	104,400
21	7.73	110,500
42	8.82	18,424
63	9.82	2,424

## Farm Assessment and Planning

### Identifying Odor Risks

Variations between farms result in substantially different degrees of odor nuisance. Before selecting appropriate control measures for odor, the practices that create the greatest risk of odor need to be identified. Table IV provides a logical process for identifying those practices most likely contributing to an individual farm's odor nuisance. Use this table to identify the level and source of risks related to odors from your livestock operation and then select appropriate preventive or control measures.



**Table IV. How does my farm rate? Circle the response (from the four right-hand columns) that most closely matches your situation for the questions at left concerning potential environmental risks. Direct your attention to the high-risk responses.**

Potential odor risk:	High Risk	Medium to High Risk	Low to Medium Risk	Low Risk
1. Do neighbors complain?	<ul style="list-style-type: none"> <li>Several complaints within last year.</li> </ul>	<ul style="list-style-type: none"> <li>Several complaints within recent years.</li> </ul>	<ul style="list-style-type: none"> <li>Occasional complaints in recent years.</li> </ul>	<ul style="list-style-type: none"> <li>Never.</li> </ul>
2. Nearby land use?	<ul style="list-style-type: none"> <li>Several residences, a school, sub-division or recreational area are within 1,000 feet of manure storage or concentrated animal housing.</li> <li>OR</li> <li>Neighbors are located in valley below farm.</li> </ul>	<ul style="list-style-type: none"> <li>Several residences are within 1,000 to 2,500 feet of manure storage or concentrated animal housing.</li> <li>OR</li> <li>A school, sub-division, or recreational area is within 1 mile.</li> </ul>	<ul style="list-style-type: none"> <li>1 to 3 residences are within 1,000 to 2,500 feet of manure storage or concentrated animal housing.</li> <li>AND</li> <li>No schools, sub-division, or recreational areas are within 1 mile.</li> </ul>	<ul style="list-style-type: none"> <li>No neighbors within 2,500 feet of manure concentrated animal facility.</li> <li>AND</li> <li>No schools, communities or recreational areas are within one mile.</li> </ul>
3. Are animal housing and outdoor lots kept clean?	<ul style="list-style-type: none"> <li>Manure can run off into areas where it is not collected.</li> <li>OR</li> <li>Manure or waste feed is collected less often than once a month.</li> </ul>	<ul style="list-style-type: none"> <li>Manure and waste feed are contained within housing, lot, or runoff control structure but are collected at more than one-week intervals.</li> </ul>	<ul style="list-style-type: none"> <li>All manure and waste feed are contained within housing, lot, or runoff control structure and collected at least every week.</li> </ul>	<ul style="list-style-type: none"> <li>All manure and waste feed are contained within housing, lot or runoff control structure and collected daily.</li> </ul>
4. Are outdoor lots dry?	Part or all of lots remain wet much of year due to inadequate slope, off-site drainage, or limited lot maintenance.	Part or all of lot remains wet for more than a week after a precipitation event.	Most but not all of "Low Risk" practices that encourage rapid lot drying are in practice.	Outdoor lots dry quickly after precipitation due to: <ul style="list-style-type: none"> <li>sufficient slope,</li> <li>diversion of off-site drainage,</li> <li>good lot maintenance preventing isolated wet locations.</li> </ul>
5. How is manure stored (excluding anaerobic or purple lagoons)?	<ul style="list-style-type: none"> <li>Manure is stored as a liquid in an open storage tank and does not form a crust.</li> <li>OR</li> <li>Liquid manure storage crust is broken by aggressive agitation during emptying.</li> </ul>	<ul style="list-style-type: none"> <li>Stored liquid manure forms thick crust that is partially disturbed by top loading of storage.</li> <li>OR</li> <li>Liquid manure is stored under animal housing floor.</li> </ul>	<ul style="list-style-type: none"> <li>Manure contains substantial bedding and is stored as a solid.</li> <li>OR</li> <li>Stored manure forms thick crust not disturbed during loading (bottom loaded).</li> <li>OR</li> <li>Manure is stored less than one week and emptied completely.</li> </ul>	<ul style="list-style-type: none"> <li>Manure is not stored, it is spread daily.</li> <li>OR</li> <li>Manure is held in enclosed manure storage tank.</li> </ul>
6. How is manure stored (anaerobic or purple lagoon)?	<ul style="list-style-type: none"> <li>Manure is stored in an inadequately sized lagoon.</li> <li>OR</li> <li>Manure volume exceeds original lagoon size.</li> </ul>	<ul style="list-style-type: none"> <li>Manure is stored in an adequately sized lagoon but lagoon does not turn purple or is purple only during the summer and fall.</li> </ul>	<ul style="list-style-type: none"> <li>Manure is stored in properly sized lagoon that turns purple when it is not frozen over.</li> </ul>	<ul style="list-style-type: none"> <li>Manure is not stored it is spread daily.</li> <li>OR</li> <li>Manure is held in covered lagoon.</li> </ul>



Potential odor risk:	High Risk	Medium to High Risk	Low to Medium Risk	Low Risk
<b>7. When is manure applied?</b> <ul style="list-style-type: none"> <li>• Time of day?</li> <li>• Conditions?</li> </ul>	<ul style="list-style-type: none"> <li>• Time of day, weekends, and holidays are seldom considered in selecting application time.</li> <li>• Wind direction and weather conditions are not generally considered in selecting timing of applications.</li> </ul>	<ul style="list-style-type: none"> <li>• Manure is sometimes applied in mid to late afternoons, and on weekends or holidays.</li> <li>• Manure is sometimes applied on still, humid days and wind direction and lower elevation neighbors are rarely considered.</li> </ul>	<ul style="list-style-type: none"> <li>• Manure is normally applied before 2 p.m., and weekends and holidays are often avoided.</li> <li>• Manure is applied usually on dry, windy days and sometimes wind directions and lower elevation neighbors are considered.</li> </ul>	<ul style="list-style-type: none"> <li>• Manure is always applied before 2 p.m., and weekends and holidays are avoided.</li> <li>• Manure is applied only on dry, windy days and where practical wind direction and lower elevation neighbors are considered.</li> </ul>
<b>8. Land application of:</b> <ul style="list-style-type: none"> <li>• Stored manure?</li> <li>• Manure stored less than five days from time of animal excretion?</li> <li>• Lagoon effluent?</li> </ul>	<ul style="list-style-type: none"> <li>• Spread onto land by spray irrigation system.</li> <li>• Effluent from inadequately sized lagoon is spread onto land by sprinkler irrigation system.</li> </ul>	<ul style="list-style-type: none"> <li>• Spread on land with conventional equipment and no incorporation.</li> <li>• Inadequately sized lagoon effluent is surface applied with no incorporation using conventional equipment.</li> </ul>	<ul style="list-style-type: none"> <li>• Incorporated by afternoon of the same days as applied. OR Applied with equipment that minimizes mixing of air and manure (i.e. drop hose).</li> <li>• Surface applied.</li> <li>• Incorporated by afternoon of the same day as applied. OR Applied with equipment that minimizes mixing of air and manure (i.e., drop hose). OR • Properly sized lagoon effluent is surface applied.</li> </ul>	<ul style="list-style-type: none"> <li>• Incorporated during or immediately following application.</li> <li>• Incorporated same day as applied.</li> <li>• Incorporated during or immediately following application.</li> </ul>
<b>9. Have other odor control measures been adopted?</b>		<ul style="list-style-type: none"> <li>• Anaerobic lagoon.</li> </ul>	<ul style="list-style-type: none"> <li>• Purple lagoon.</li> </ul>	<ul style="list-style-type: none"> <li>• Anaerobic digestion or aerobic treatment.</li> </ul>

Total (count number of responses):



## ***Your Odor Management Plan***

A range of alternative management and technology-based odor-control options exist. Select those alternatives that best address the previously identified high risk issues as well as fit within your management and resource constraints. Your objective should be to find an acceptable odor nuisance level compromise for you and your neighbors, not eliminate odor.

**Site Selection:** Distance is one of the best odor management tools.

- \_\_\_\_\_ Maintain adequate separation distance of the facility site from neighbors:
  - \_\_\_\_\_ 2,500 feet minimum for swine facilities or beef feedlots;
  - \_\_\_\_\_ 1,500 feet minimum for beef (farmer-feeder) and dairy;
  - \_\_\_\_\_ 1,000 feet minimum for poultry.
  - \_\_\_\_\_ Double above separation distance to communities, schools, and recreation areas.
  - \_\_\_\_\_ Increase above distances for larger-than-average livestock facilities.
- \_\_\_\_\_ Avoid locating facilities upwind of neighbors based on prevailing summer wind directions.
- \_\_\_\_\_ Avoid locating upslope from neighbors in low-lying or valley areas.
- \_\_\_\_\_ Locate manure storage or lagoon near center of cropping area or other remote area instead of near livestock housing.
- \_\_\_\_\_ Block visual line of site from neighbors and public roads to farm facilities.
- \_\_\_\_\_ Other: \_\_\_\_\_

**Animal Housing:** Regular manure removal and a dry outdoor lot reduce odor nuisances.

- \_\_\_\_\_ Filter dust from animal housing exhaust air.
- \_\_\_\_\_ Minimize the time manure is on barn floors (continuous mechanical scraping or regular flushing).
- \_\_\_\_\_ Minimize accumulation of waste feed around animal housing.
- \_\_\_\_\_ Keep outdoor lots as dry as reasonable by:
  - \_\_\_\_\_ providing good lot drainage, especially around waterers;
  - \_\_\_\_\_ preventing upslope water from entering the lot;
  - \_\_\_\_\_ preventing roof water from entering the lot.
- \_\_\_\_\_ Clean areas of greatest manure accumulation frequently (i.e. feeding and watering areas).
- \_\_\_\_\_ Remove manure accumulation under fence lines frequently.
- \_\_\_\_\_ Other: \_\_\_\_\_

**Manure Storage and Lagoon Facilities:** Reducing the exposure of storage surfaces to air currents limits odor release.

- \_\_\_\_\_ Encourage crust development on manure storages by:
  - \_\_\_\_\_ bottom loading storages;
  - \_\_\_\_\_ minimizing water additions;
  - \_\_\_\_\_ minimizing surface agitation and breakup of crust;
  - \_\_\_\_\_ encouraging artificial crusts using crop residues or grass clippings.



\_\_\_\_\_ Cover storage with concrete caps or floating membranes.

\_\_\_\_\_ Reduce organic solids loading on undersized lagoon by:

\_\_\_\_\_ separation of solids with settling basin or liquid-solids separator;

\_\_\_\_\_ construction of a second lagoon operated in parallel with the original lagoon;

\_\_\_\_\_ expansion of the original lagoon capacity;

\_\_\_\_\_ moving part of the herd to a different site (i.e., replacement heifers in dairy herd).

\_\_\_\_\_ Plant trees or other windbreaks to counter prevailing spring and summer winds.

\_\_\_\_\_ Consider wind direction before agitation of storage.

\_\_\_\_\_ Other: \_\_\_\_\_

**Land Application and Storage Agitation and Emptying:** Minimize mixing of air and manure to reduce land application odor problems.

\_\_\_\_\_ Agitation and emptying of storage and land application creates the least nuisance if timed:

\_\_\_\_\_ between 8 a.m. and 2 p.m. during warm weather;

\_\_\_\_\_ to avoid periods when outdoor recreational activities are most likely (evenings, weekends, and holidays);

\_\_\_\_\_ during cooler weather conditions;

\_\_\_\_\_ during dry, windy days.

\_\_\_\_\_ Minimize mixing of air and manure by:

\_\_\_\_\_ immediate incorporation of manure by injectors or shallow tillage implements mounted on tool bar attached to liquid manure tankers;

\_\_\_\_\_ same day incorporation of manure by separate tillage operation following manure application;

\_\_\_\_\_ drop hose or other low trajectory spreading equipment;

\_\_\_\_\_ avoiding manure application through irrigation systems unless treated in properly sized lagoon or anaerobic digester.

\_\_\_\_\_ Select appropriate land application site according to wind direction and location of neighbors.

\_\_\_\_\_ Other: \_\_\_\_\_

**Treatment Technologies:** Chemical and biological treatment should be approached with caution. To date the successes with odor-control agents have been far fewer than the failures. These additives should generally be considered an option only after good odor management practices have failed to achieve an acceptable solution. In addition, all treatment processes deserve close scrutiny of the cost, safety and management requirements.

\_\_\_\_\_ anaerobic digestion system;

\_\_\_\_\_ aeration systems such as oxidation ditches;

\_\_\_\_\_ properly sized purple lagoons for diluted manure streams or milking center wastes;

\_\_\_\_\_ biofiltration of ventilation air from enclosed structure such as enclosed animal housing, covered manure storages or indoor composting operations;

\_\_\_\_\_ settling basins and mechanical liquid-solid separators to reduce lagoon loading (collected solids must be composted or land-applied to avoid fly and odor nuisances).

\_\_\_\_\_ adjust manure pH above 9.0;

\_\_\_\_\_ add oxidizing agents (i.e. potassium permanganate or hydrogen peroxide);

\_\_\_\_\_ Other: \_\_\_\_\_



**Neighbor Relations:** Despite one's best intentions and efforts, odors from manure will always exist. A vigilant effort to find a middle ground acceptable to both you and your neighbors is constantly required. Samples of activities designed to find that middle ground include:

- \_\_\_\_\_ Send letter to neighbors updating them on farm plans and changes. Discuss openly practices that may affect them (i.e. manure spreading) and define when and for how long these practices will last. Encourage neighbors to inform you of special events around which manure spreading activities could be planned.
- \_\_\_\_\_ Host farm tour or open house for neighbors and their families. Tours might include demonstration of farm practices, hay ride and refreshments.
- \_\_\_\_\_ Host tour of local farms for local government decision-makers. Emphasize current efforts to protect environment such as IPM and conservation tillage and ensure animal health and welfare.
- \_\_\_\_\_ Support "Agriculture in the Classroom" curriculums in local schools.
- \_\_\_\_\_ Share farm produce with neighbors when odors are particularly annoying.
- \_\_\_\_\_ Become more visible in the community by:
  - \_\_\_\_\_ supporting a little league team;
  - \_\_\_\_\_ participating in local chamber of commerce or other community organizations.
  - \_\_\_\_\_ Other: \_\_\_\_\_

### Odor Management Plan

Identify your three highest risk practices or odor-causing situations and the associated changes that you plan to implement in the near future.

#### Highest Risk Practices

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#### Odor Control/Neighbor Relations Plans

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### Conclusions

No simple solutions exist to controlling the vast range of odorous compounds contained within livestock manure. Management decisions related to siting facilities, managing lagoons or storage, and selecting equipment and conditions for field application of manure are critical to minimizing odor nuisances. If odors remain unacceptable, technology and chemical treatment options may provide additional alternatives. The cost and effectiveness of these options should be carefully evaluated.

Mother Nature provides no guarantees of being odor free. Farm odors are likely to always be present. A good community relations effort may be the best odor nuisance control measure available.