THE OHIO STATE UNIVERSITY EXTENSION

FACT SHEET

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Odor Control for Land Application of Manure

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Applying animal manure to crop land is a traditional and effective means of recycling nutrients and improving the structure of the soil by adding organic matter and biological activity. Applying manure can also enhance animal and crop production by reducing the costs of fertilizer. However, manure application can cause odor complaints from neighbors and surrounding communities.

Appropriate application methods and management practices based on odor emission and dispersion principles can effectively reduce odor concerns during manure application. This fact sheet presents a basic understanding of odors and odor dispersion and highlights best management practices for controlling odors during manure application.

What Is Odor?

Odor is an unpleasant smell caused by odorous gases and volatile organic compounds (VOCs). These volatile organic compounds are organic acids, and they evaporate easily. Under ideal anaerobic conditions, manure is degraded by acid-forming microorganisms into volatile organic compounds (Figure 1). These compounds are further metabolized by methane-producing bacteria into methane, carbon dioxide, and water, which are odor-free compounds.

If conditions are not correct for methane bacteria, excess volatile organic compounds are generated. Manure stored in a well-functioning treatment lagoon (purple lagoon) will be less odorous than manure from non-treatment

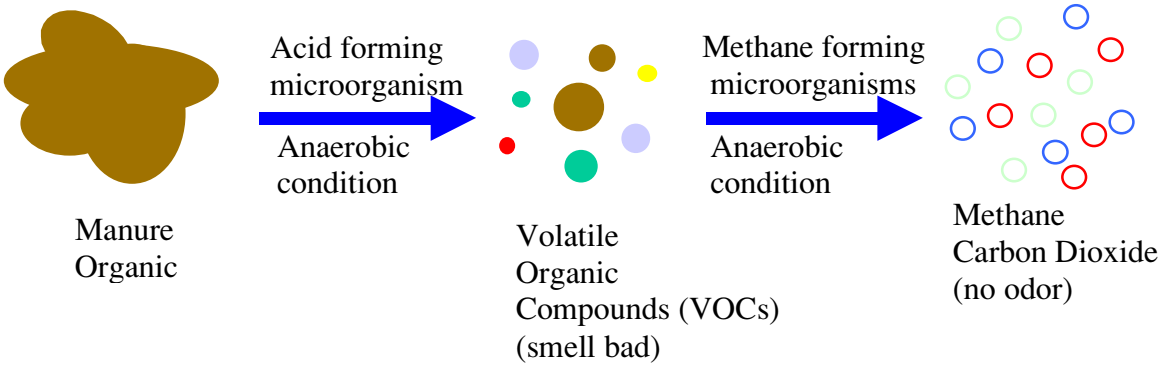

Figure 1. Processes for producing odor and odorless gases.

storages, such as earthen, above-ground structures, or deep-pit structures.

How Odor Is Emitted and Dispersed

Warm temperatures increase the microbial activity in manure storage structures, which usually results in odorous compounds being generated. Once the odorous compounds are generated, exposure of manure to the air will facilitate their release. A large contact surface area between the air and the manure will result in more odors being released. Disturbance of manure, such as agitation prior to application and wind blowing over the surface of the manure, will increase odor emission as well. Dry air will also enhance evaporation of odorous volatile organic compounds.

In short, odor emissions are affected by manure surface area, airflow, air temperature, relative humidity, and the type of manure storage and treatment system. Once the odorous compounds are emitted, wind or warm air rising during the day will help transport and disperse odors.

Assess Manure Characteristics Before Land Application

The major source of odor from animal operations is manure. Understanding the characteristics of manure is the first step to controlling odor emissions during manure application. Generally, solid manure generates fewer odors than liquid manure. Moreover, effluent from an anaerobic treatment lagoon causes fewer odor problems than from non-treatment manure storage structures. If manure comes from an untreated storage structure, then dilution, treatment, or special application practices will be necessary to minimize odors.

Effective Manure Application Methods for Odor Control

Three typical types of liquid manure application methods are used in Ohio — surface application, surface application with incorporation, and direct injection. For solid manure, surface application and surface application with incorporation are the two primary application methods. Depending upon the weather and type of application equipment used, odor emissions and the perception of odor by neighbors can be significant. Minimizing contact surface areas with the air by applying manure as close to the surface as possible and complete incorporation of manure into the soil are the fundamental ways to minimize odor emission.

Surface Applications Methods

Irrigation equipment, including traveling gun systems (Figure 2) and center pivot systems, can spread manure over a large area quickly and efficiently. However, these systems tend to generate more odors and higher ammonia-N losses by elevating manure high into the air, especially if manure is untreated or has a high nutrient content. Odor-reducing practices include using nozzles and pressures that create large irrigation droplet sizes (greater than 150 microns), using drop nozzles on center pivot systems, and adding dilution water prior to application.

Figure 2. Broadcasting liquid manure with an irrigation system. (Photo © MWPS (Midwest Plan Service), Iowa State University, Ames, Iowa, www.mwps.org. Used with permission: LPES Curriculum, Lesson 44.)

Manure tanker or drag-line systems apply manure directly to the soil surface (Figures 3, 4, and 5). These methods create large surface areas of manure in contact with the air, causing a release of odors. Since the primary means of reducing odors is to minimize the surface area and contact time of manure with ambient air, bottom unloading tanks (Figure 3) are better than top discharge tanks (Figure 4) in terms of odor control.

Drag-line surface applicators (Figure 5) are widely used in Ohio. These systems have the potential to create odor problems as well, but are a better system than spray irrigation and tankers because manure drops are closer to the soil surface, minimizing the time manure is in contact with the air.

Low-level surface applications drop manure low to the soil surface to minimize the distance manure travels through the air for odor control. In Europe, an effective odor control practice is to apply manure directly to the surface through a series of drop hoses (Figure 6), much like

a sprayer boom. These drop hoses drag across the surface as manure is applied through a series of tubes, minimizing the travel distance through the air. In addition, surface applying manure below a crop canopy has also been shown to be an effective odor control method.

Figure 3. Surface spreading liquid manure with tanker manure applicator.

Figure 4. Surface spreading liquid manure with a top-discharge tanker manure applicator.

Figure 5. Surface broadcasting liquid manure with drag-line manure applicator.

Figure 6. A European drop hoses manure applicator. (Photo © MWPS (Midwest Plan Service), Iowa State University, Ames, Iowa, www.mwps.org. Used with permission: LPES Curriculum, Lesson 44.)

Incorporation

Incorporation of manure into the soil after surface application has been shown to reduce odors and ammonia-N losses. Soil incorporation of manure can greatly reduce odor and conserve ammonia-N because the gases must travel through the soil profile where filtration and microbial processes will convert them into less odorous compounds or adsorb them to soil particles.

Common manure applicators for soil incorporation include a manure tanker with shallow incorporation (Figure 7), a drag-line applicator with shallow incorporation (Figure 8), and a manure surface applicator with incorporation.

Figure 7. Manure tanker with modified shallow incorporation.

Figure 8. Drag-line manure applicator with shallow incorporation.

Figure 9. Liquid manure tanker with injectors.

The odor reduction effects by incorporation of manure are determined by how soon and how well manure is incorporated after it is applied. Research has shown that incorporation of manure into the soil immediately can reduce odor level by 20 percent to 90 percent. Therefore, incorporation during application is more effective in reducing odors than spreading the whole field prior to incorporation.

Direct Injection

Direct injection incorporates manure directly beneath the soil surface and is an effective way to minimize odors during application. Research shows a 90 percent odor reduction when manure is injected directly compared to surface broadcast applications. Manure injection can also reduce ammonia-nitrogen losses by minimizing volatilization.

Some common types of direct injection applicators are liquid tankers with injectors (Figure 9) and drag-line systems with injectors (Figure 10). The commonly used injectors are narrow tines, sweeps, disk openers and covers, and conventional chisel plows.

Each system requires specific amounts of power, which is an important factor when considering an injector system. Generally, newer injectors, such as disks and sweeps, use less power and distribute the nutrients better while maintaining surface residue levels.

Figure 10. Drag-line manure applicator with injectors.

Direct injection is the most effective odor control application method, especially for untreated manure, since it minimizes manure exposure to the air by directly incorporating manure into the soil. However, direct injection involves the cost of owning and operating the toolbar and the increased fuel consumption necessary to inject manure. This extra cost can be offset by the value of the nitrogen conserved.

In summary, land application of manure is an effective means of recycling nutrients. It also causes the most odor complaints from neighbors, surrounding communities, and the public. Understanding odors, odor dispersing conditions, and manure characteristics are the first steps to minimizing odor emissions.

Odor emissions are affected by manure storage systems, air temperature, relative humidity, manure surface area, manure exposure time, wind speed, wind direction, and other weather conditions. Manure application methods such as immediate incorporation and injection can effectively reduce odor emissions. Other best management practices such as choosing appropriate fields, weather conditions, and communicating spreading times and locations with neighbors can significantly reduce odor complaints.

When applying manure, especially surface applications, consider weather conditions and location of the application. Avoid applying manure during the heat of the day. Applying manure in the morning is better for vertical dispersion of the odors as air temperatures increase. Avoid applying manure on fields in close proximity to neighbors when the wind is blowing towards them and on weekends, holidays, or just prior to their special events.

If manure incorporation has to be done after manure application, then incorporate manure as soon as possible to reduce manure-to-air exposure time. Lastly, odor is subjective and will vary by individuals. Communicating with your neighbors about your operation will minimize misunderstandings and complaints.

Reference

LPES. 2001. Lesson 44—Emission control strategies for land application. National Livestock and Poultry Environmental Stewardship Curriculum. Midwest Plan Service (MWPS), Iowa State University, Ames, Iowa, www.mwps.org. LPES Curriculum.)

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