Manure Pollution Potential and Choosing an Appropriate Manure Handling System

D.R. Schmidt
Department of Biosystems and Agricultural Engineering
University of Minnesota, St. Paul

Introduction

Environmental protection is no longer just a good idea, it has become a major decision making factor for all industries. The push for a clean environment has come from environmental groups, lawmakers, the general public and family members. For the beef industry to remain vital, it is essential that environmental issues be addressed. Manure CAN be a significant contributor to air and water quality degradation. It is up to feedlot owners and managers to make certain this does not happen - for everyone's benefit. Preventing this pollution is simply a matter of controlling the manure from production to end use.

Manure and the Environment

Manure is a source of water quality degradation. Has manure changed somehow so what was not a problem for generations past is now a problem? No, manure has not changed - the livestock industry has. Farms no longer consist of 2 dairy cows, 100 chickens and a few sheep. Livestock operations are much larger and continue to increase in size. With this concentration of livestock comes an increased concentration of manure. What was once a few cows on pasture has become 500 steers on 2 acres. This concentration of manure and manure nutrients is the source of the problem. Manure management systems must reflect these industry changes.

Nitrogen

Nitrogen can enter a water body through direct discharge of manure, runoff or leaching. Beef cattle produce approximately 0.34 lb nitrogen/day/1,000-lb animal (Table 1). This is approximately 124 lb nitrogen/year/animal. Although this nitrogen is a valuable crop nutrient, it can also leach into the ground water or move through runoff to surface waters. Once in the water, it is considered a pollutant. Nitrogen in the form of nitrate, NO_3, will cause human health problems in concentrations of approximately 10 ppm. This amount, 10 ppm, is equivalent to 1 lb of nitrate-nitrogen (NO_3-N) per 12,000 gallons of water. Fortunately, most nitrogen in manure does not have direct contact with surface or ground water. In a good manure handling system, some of the nitrogen is lost to the atmosphere in the form of ammonia, while the rest is used to fertilize crops. Approximately 50% of the nitrogen in manure is organic nitrogen, the remaining is in the form of ammonia and nitrate. Both ammonia and nitrate are available for uptake by crops. Organic nitrogen breaks down to form ammonia and nitrate over the course of 1 or 2 years.

Nitrogen, in the form of ammonia, is soluble in water. Feedlot runoff or runoff from cropland where manure has been surface applied contains high levels of ammonia-nitrogen. Inputs of nitrogen may contribute to increased plant growth in the affected water body. Water with high ammonia concentrations is toxic to fish.

Table 1. Beef manure and production characteristics (MWPS-18)

	Per day per 1,000-lb animal
Total manure, lb/d	60
Total manure, ft^3	0.95
Total solids, lb	8.5
Total volatile solids, lb	7.2
Total Kjeldahl nitrogen, lb	0.34
Ammonia, lb	0.086
Phosphorus, lb	0.11
Potassium, lb	0.25

Nitrate nitrogen is negatively charged, as are soil particles. Because negative charges repel each other, nitrate-nitrogen does not attach to soil particles. Therefore, nitrate-nitrogen is easily washed through the soil profile and into the groundwater. Leaching of nitrate-nitrogen into groundwater occurs when there is high concentrations of nitrogen in the soil. Nitrate-nitrogen

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leaching is very rapid in sandy soils because of the quick movement of water through the soil profile.

Phosphorus

A 1,000-lb steer produces approximately 0.11 lb phosphorus/day. This phosphorus can benefit crop production or be detrimental to water quality. Phosphorus is a limiting nutrient in most aquatic systems. Therefore, additions of phosphorus will increase the amount of plant growth in a lake, wetland or stream. Increased growth of aquatic plants, and their subsequent death and decay, causes the oxygen supply of the water body to decrease. The amount of oxygen in a water body determines the number and species of fish it can support. Game fish typically need higher concentrations of oxygen to survive.

Phosphorus attaches to soil particles because of its positive charge. Soil erosion moves this phosphorus into nearby lakes and streams. Reducing soil erosion reduces the amount of phosphorus entering the lakes and streams.

Organic Matter

Recently there have been several manure spills which have been linked to fish kills. Fish kills are a result of sudden decrease in the oxygen supply of a water body. Organic material is an energy and nutrient source for microbes. However, microbes also need oxygen. Therefore, an increase in microbial activity means a decrease in the dissolved oxygen content of the water body. When a large amount of organic matter, such as manure, is introduced into a water body (e.g., a direct discharge), the microbial population quickly responds with a "feeding frenzy." This quickly degrades the organic matter and reduces dissolved oxygen content in the affected lake or stream.

Air Quality

One of the newest issues facing livestock operations is air quality - most notably, odors. Odors are created during the breakdown of organic matter by anaerobic microbes. Various gases are given off by these microbes, many of them are odorous. Production of odorous gases can be reduced by several methods. The most dramatic reductions will be gained by limiting the exposure of manure to air. Covering a manure storage area will reduce odors by approximately 50%. Injection of manure vs surface application will reduce odors by as much as 95%. Site selection and proper manure management will also reduce the potential for nuisance problems.

Pollution Prevention

Several aspects of manure have the potential to degrade water quality and be a risk to human health. The best way to avoid this risk is to make certain YOU are in control of your manure from collection to end use. Manure cannot be allowed to enter surface waters, should be collected and stored until land application, and should be land applied at rates based on crop nutrient requirements. Manure applications practices should limit the potential for runoff. Over application of manure increases the risk of manure nutrients moving into ground or surface waters.

Choosing Appropriate Manure System Components

Decisions about manure systems must be based on the entire livestock operation. Each farm operation is unique and requires an appropriate manure handling system. A 12-month manure storage capacity is not appropriate for every operation. Nor should every operation handle manure as a liquid. The only requirement is that every option be environmentally and economically sound.

A manure handling system is typically broken into four segments: collection, storage, treatment and land application. Each of these affect the entire manure system and impact the entire farming operation. A producer cannot consider manure storage options without considering land application strategies, nor can land application strategies be evaluated without considering labor requirements and cropping practices.

Many will say that it is not economical to manage manure properly. They are correct! Unfortunately, not managing manure properly is not an option. Air and water quality degradation has impacts beyond the individual livestock operation. Individual producers may not be concerned about the impact of manure on the environment and human health, but others certainly will be. Once manure leaves a farm, either through runoff or leaching, the manure becomes a risk to the public and a liability for the producer. Some policy makers believe the cost of manure management should not be an issue. Those in business know that cost is always an issue. Manure management and proper manure handling systems will cost money. Therefore, it is important to choose a system that will be the most economical for your particular situation. Capital investment, operation and maintenance, cropping practices and animal production issues must all be considered in this economic analysis.

Capital investment

There is a wide range in initial costs for manure systems. A concrete lot will cost more than an earthen lot. The cost of an earthen lot will be affected by the particular site and availability of proper soils for constructing the mounds. An open lot may not be as economical as a total confinement building if the site demands an extensive runoff collection system. A concrete storage structure will cost more than an earthen basin; however, earthen basins may not be as economical for sites where there is no clay soil to line the basin. Typically, capital investment increases as manure storage time increases. Long-term storage requires more capital investment than a daily haul system. Often, however, the cost of manure handling equipment is not considered. A daily haul system, or short-term storage, will require the purchase of a manure spreader or a tank wagon. This capital cost could be avoided by using long-term storage and a custom manure hauler.

Operation and maintenance

A main cost factor in any manure system is operation and maintenance of tractors, skid steers, pumps, etc. For many systems, a large part of this cost is labor. Manure handling can be very labor intensive and labor supply varies between feedlot operations. Therefore, labor needs must be evaluated for each system. A deep pit system will have high capital cost but low labor requirements. A daily haul system requires constant labor year round - both for cleaning the lot and for land application.

Cropping practices

Manure nutrients and the availability of cropland for these nutrients must also be considered. If the nutrient value of the manure can be fully utilized, then a system that conserves nutrients may be more economical. Nitrogen loss occurs in various stages of manure handling and to different degrees depending on the type of system (Tables 2 and 3). Land availability may also be an issue. A daily haul system requires land to be available for manure application throughout the year. Although several options exist to provide this land, these options must be evaluated in terms of the entire feedlot operation.

Animal Production

To some extent, the manure system impacts animal production. Open lots will subject animals to extremes of wind, rain and temperature. Some of these environmental conditions may put increased energy demands on the animals, possibly increasing feed-to-gain ratio.

Table 2. Estimated nitrogen losses from different beef cattle waste management systems. (MWPS-18)

System	Nitrogen loss %
Open lot - unpaved/mounds	40-60
Open lot - paved (scraped regularly)	10
Open lot (daily haul)	15-35
Stacks, bunkers, bedding packs	20-40
Earthen pit	20-40
Above-ground storage	10-30
Anaerobic lagoon	79-80

Table 3. Percent of nitrogen losses during land application. (MWPS-18)

Application method	Type of waste	Nitrogen Loss %
Broadcast (incorporation within 4 days)	Solid	15-30
	Liquid	10-25
Broadcast with immediate incorporation	Solid	1-5
	Liquid	1-5
Injection	Liquid	0-2

Conclusions

Choosing a manure system can be a difficult decision. Several options are available that provide adequate environmental protection. These systems are not equal in terms of capital investment or operation and maintenance requirements. These systems may also impact cropping practices and animal production. Therefore, it is important that all system components (collection, storage, treatment and land application) be evaluated in terms of the whole operation. Evaluation of these systems must also include the future goals of the operation.