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G80-531 Swine Manure Management Systems

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NebGuide

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Swine Manure Management Systems

This NebGuide examines the advantages and disadvantages of various types of swine manure management systems.

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Manure management is an integral part of any swine production system and must be carefully considered when planning new or remodeled facilities. Manure management objectives may include 1) optimum nutrient retention and utilization; 2) minimum land, labor or capital requirements; 3) odor control; 4) animal and/or human health and performance considerations; or 5) some combination of these objectives. Because of differences in land availability, climate, capital, labor and management skills among producers, a single, best management system for manure cannot be defined.

Swine manure can be handled as a solid or semi-solid, a slurry, or a liquid (*Figure 1*). Several options for collecting and storing manure are available, depending on the manure form. Common storage methods include underfloor pits, outdoor above or below ground structures, earthen pits, lagoons and holding ponds. Flushing gutters and scraper systems are among the methods used to collect and transport manure to appropriate storage facilities. Regardless of the manure form, well-designed collection, storage, transport and land application components for both liquids and solids are required for an acceptable manure management program. This NebGuide discusses design and management considerations for several manure management systems.

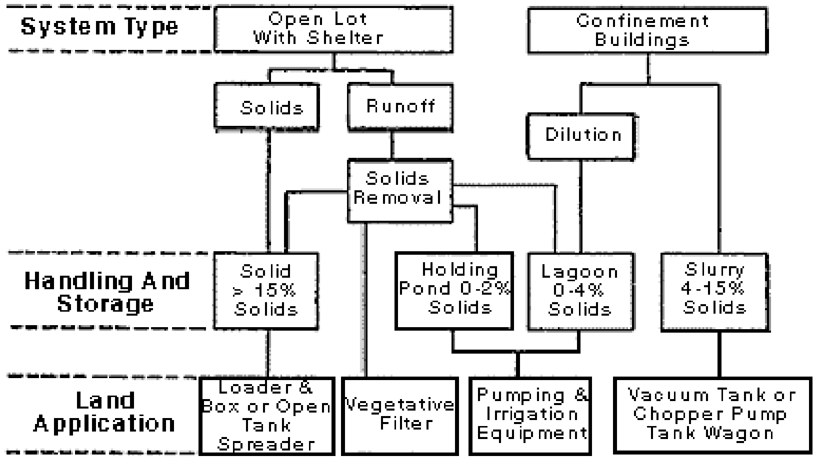

Figure 1. Flow chart of common swine manure management systems.

Manure Management in Confinement Buildings

Underfloor Manure Storage--Slurry

Underfloor storage pits are commonly associated with slotted floors (*Figure 2*). The reinforced concrete storage pit is generally sized for 1.0 cubic foot of storage per 1000 pounds of hog per day. Nebraska regulations require that manure storage systems have a minimum storage capacity of 120 days. When land is accessible and weather permits, the manure is hauled to the field. Since land is not always accessible at 120-day intervals, a 180-day storage capacity is recommended. Because pits cannot be completely emptied and should not be allowed to fill completely, an additional 1 foot should be added to the pit design depth after minimum storage requirements have been met.

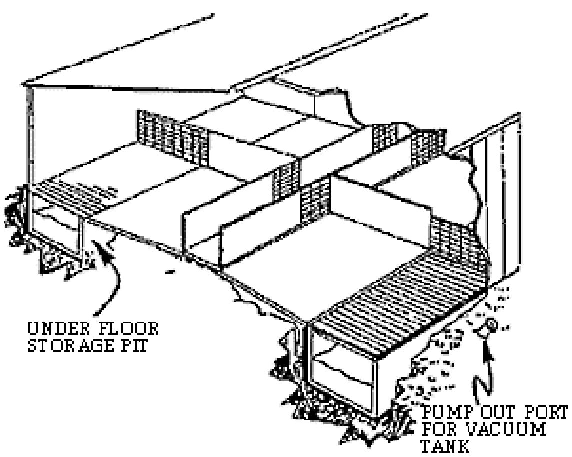

Figure 2. Confinement building with partially slotted floors and underfloor pit storage.

Manure stored in pits usually contains 4 to 8 percent solids and is considered a slurry. Slurries containing up to 15 percent solids can be pumped with special equipment. Solids will settle during storage and thorough agitation is required before pumping. Vacuum loading tanks are used extensively to remove swine manure stored in pits and tanks, but agitation capacity of vacuum loading equipment is limited. Pit access ports should be spaced approximately 20 feet apart to assure adequate removal with vacuum tanks. In addition, pit access for chopper pumps should be considered as a means of providing more thorough agitation of solids. The spacing between such ports should not exceed 75 to 100 feet.

Odors and gases pose a potential problem with underfloor manure storage systems. Well-designed ventilation systems which incorporate underfloor pit ventilation help reduce odor problems with these system However, even with pit ventilation, failures resulting in no ventilation in totally confined buildings may cause death losses due to gas and heat buildups within as little as 1 to 2 hours. Extreme caution must also be used when agitating an underfloor storage pit. Gases released from the stored manure can cause illness and even death to both humans and pigs within a few minutes following initiation of agitation.

Underfloor manure storage pits provide for easy collection and storage of manure, thus minimizing daily labor requirements. Pit storage also has relatively low nitrogen losses (*Table I*) and minimizes the possibility of water pollution. However, underfloor storage systems generally have higher investment costs than other manure management systems due in part to the slatted floor and storage pit construction costs.

Systems combining a pit and an anaerobic lagoon or outdoor storage for the pit overflow have been successful, but allowing the liquids to overflow into the lagoon should not be a routine management practice. Instead, the manure should be thoroughly agitated and pumped or drained into the lagoon. Frequent and complete emptying of the storage system results in better lagoon operation and less solids buildup in the pit. This system gives the producer more flexibility in spreading operations and allows the use of the less costly outdoor earthen storage. Additional equipment will be needed to efficiently pump the lagoon effluent onto adjacent cropland.

Table I. Estimated nitrogen losses during storage, treatment, and handling for various manure management systems.

System	Nitrogen Loss* percent
Liquid pit or silo storage, liquid spreading	30 to 65
Anaerobic lagoon, irrigation, or liquid spreading	60 to 80
Bedded confinement, solid, spreading	30 to 40
Open lot, solid spreading, runoff collected and irrigationd	50 to 60

*Nitrogen loss values assume that manure is applied to the ground surface and is incorporated within a few hours. If not incorporated, an additional loss of 30 percent on the average can be expected.

Outside Storage--Slurry

Outside storage of slurry manure can be provided in either above or below ground structures. Earthen storage basins are also being used due to differences in construction costs between earth, concrete and steel. Concrete and steel storage facilities cost about 10 times more per unit of volume than earthen storage structures. Manure handled as a slurry and stored outside assists in removing odors from the building, but the manure must be conveyed to the outside storage structure. Mechanical removal of undiluted manure with scrapers to outside storage is used by some producers (*Figure 3*). Narrow gutters with little dilution water are also used to hydraulically convey slurries to outside storage structures.

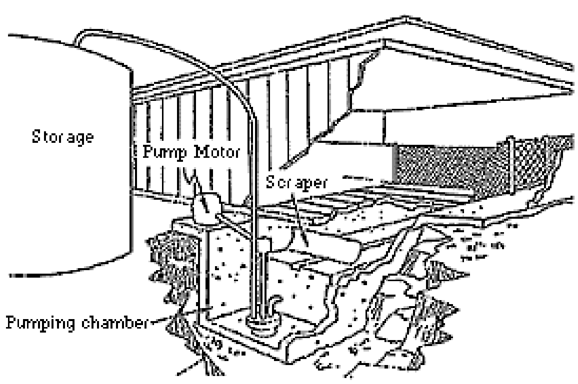

Figure 3. Under-slat scraper system with pumping chamber and above-ground storage.

Open channel scrapers as well as under-slat scrapers have both been proven reasonably successful and easily adapted to most existing buildings. The open channel scraper is less expensive to install and easier to maintain, but pigs can be injured if they are caught between the scraper and pen partitions. To avoid injuries, use scrapers which stop or reverse if an obstacle is encountered. Possible disease and drug transmission to other pens is another potential disadvantage of open gutter scraper systems. Scraping under slats minimizes these disadvantages. However, repair and replacement of parts under slats is more difficult and construction costs are higher. Provision for removing some slats when maintenance or repair of the scraper is needed is recommended. Ammonia within the building can also be a disadvantage with scraper systems.

Depending on topography and type of storage structure, a manure pump may be necessary to load manure into

the outside storage, especially if the structure is above ground. A manure pump will add to the overall cost and maintenance requirements of this system. High retention of fertilizer nutrients is usually considered a benefit with outside slurry storage structures, but this depends in part on the quantity of dilution water present.

The combination of a chopper-agitator pump and non-vacuum tank wagon is a good alternative to replace vacuum tanks for handling manure from all types of slurry storage. During land application, manure injection units on tank wagons will reduce odor potential and nitrogen losses. Slurry manure can be irrigationd directly with little or no dilution by using special pumping and agitation equipment. Slurry application rates must be limited, however, to prevent nutrient overloading. Odor potential during land application with irrigation equipment is high.

Outside Storage--Liquid (Lagoon)

Adding sufficient dilution water to manure results in a mixture that can be handled in a manner similar to water. For ease of handling and efficient pump operation, the solids content of these liquid manure systems should be less than 4 percent. Due to the volume, lagoons are commonly used to store and treat the liquid manure. Although anaerobic lagoons are the most common, swine manure lagoons may also be aerobic as well as single- or double-cell. Proper design and management of anaerobic lagoons is critical to minimize odor problems and to obtain maximum decomposition of swine manure. Recommended minimum design volumes for single-cell anaerobic lagoons are 2 cubic feet per pound of hog. Additional volume is required for spillage, wash water, flushing water, precipitation and freeboard.

Liquid manure handling systems often use a partially or totally slatted floor and a shallow pit or gutter to provide temporary storage of the manure. Manure collected in the gutter (3 to 7 days' quantity) is released manually to flow by gravity to the lagoon.

Another popular method for transferring manure from a building to a lagoon is the flushing gutter. This system incorporates a shallow channel which is flushed periodically, usually 2 to 6 times per day. Two types of tanks designed for flushing are the tipping bucket and the dosing siphon. Flushing is done in open gutters or under slats. Possible disease and drug transmission is a disadvantage with open flush gutters. Under-slat flushing requires a higher initial investment due to the slats, but disease and drug transmission among pens is minimized.

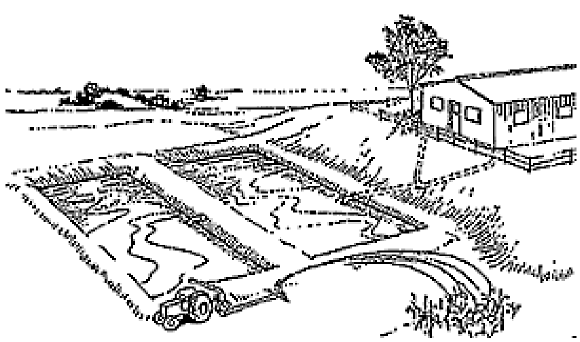

Figure 4. Two-cell anaerobic lagoon system for treatment of manure.

Flushing systems minimize odors within buildings and are easily adapted to many existing structures. Labor requirements are low, but management and maintenance of flushing tanks and pumps are required. In areas where water conservation is a concern, some flushing water can be recirculated from the second cell of the lagoon during cooler months (*Figure 4*). The annual volume of recirculated flush water should not exceed 50 percent of the total flushing requirements. If recirculation is practiced, a low volume pump with a plastic or rubber impeller and casings should be used. Recirculation of lagoon water is not recommended with open gutter flushing.

Using irrigation equipment to pump out lagoons is more feasible in terms of labor, energy, and investment than pumping and hauling with a tank wagon. Land application by irrigation is gaining popularity because of problems with labor, storage, field accessibility, compaction and limited times for hauling. If irrigation is the goal of the lagoon system, flushing with fresh water is an alternative to recirculation since the added water is a resource.

Open Lot Manure Management

Open lot systems include paved and unpaved lots. These systems may include shelters which require bedding during winter conditions. Manure from these systems is usually handled as a solid. Lots are scraped periodically to reduce buildup of solids and to control odor and fly production. Manure scraped from open lots may vary from 15 to 30 percent solids, depending on climatic conditions. It is handled with front end loaders, scrapers or blades and may be stockpiled for later spreading or hauled directly to the field with box or open tank manure spreaders.

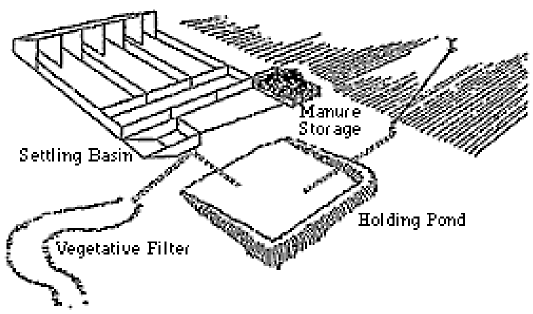

Figure 5. Open lot with solid manure handling and either a vegetative filter or a holding pond for control of runoff.

Runoff from open lots contains high levels of pollutants and must be controlled to avoid contaminating surface waters. A settling basin in combination with a runoff holding pond is the most acceptable runoff control system for large facilities (*Figure 5*). For smaller lots, replacing the holding pond with a vegetative filter or soil infiltration area is another acceptable alternative. Manure from settling facilities can usually be handled as a solid. On occasion, manure in a settling facility may be too fluid to handle with conventional solid manure handling equipment and slurry handling equipment may be required. Holding ponds can be pumped out similarly to lagoons, and pumping is required to provide capacity for storing additional runoff. Standard irrigation equipment can often be used for pumping holding ponds. Although low in investment costs, open lots have substantial labor requirements and require manure handling equipment for both liquids and solids.

Summary

Some advantages and disadvantages of common swine manure management systems are summarized in *Table II*. Consider these and other variables before selecting a manure management system. The system with the lowest capital investment may not be the most advantageous or most acceptable to you and your neighbors. Remember--all systems have disadvantages, but some will work better than others for specific situations.

Portions of this material were adapted from Pork Industry Handbook-67, "Swine Waste Management Alternatives" by S.W. Melvin, F.J. Humenik and R.K. White.

Table II. Advantages and disadvantages of alternative manure management strategies.

Unit	Engineering Considerations	Advantages	Disadvantages
Below floor slurry	• Design dependent on depth soil and drainage. • Volume based on storage time desired. • Pit access for equipment. • Agitation requirements. • Pit ventilation.	• Easy collection and storage. • Minimum volume. • Maximum fertilizer value.	• Odors and gases. • Solids accumulation. • Solids agitation and removal problems.
Outside	• Conveyance from	• Manure gases in	• Extra cost for

storage slurry	building to storage. • Cold weather operation. • Agitation requirements. • Above ground, below ground or earthen structure.	building minimized. • Adaptable to liquid/solid separation and methane production. • Maximum fertilizer value.	storage and transfer. • Dependence on transfer system. • Solids removal.
Mechanical scraper	• Length, width of scraper surface. • Power requirement. • Cable or chain unit. • Layout for efficient use of equipment. • Cold weather operation.	• Positive removal. • Handle in slurry form.	• Higher cost. • Equipment and time dependency. • Cold weather, ice. • Possible disease and drug transmission in open gutter. • Maintenance. • Ammonia in building.
Flushing-open gutter	• Slope, width, length and cross section of gutter. • Flush volume and frequency. • Plumbing and pump selection. • Flush mechanism. • Recycle or fresh water • Lagoon requirements.	• Lower construction cost. • Quick manure removal. • Lower odors within building. • Manure movement aided by animal access. • Animals attracted to gutter, good dunging patterns.	• Cleanliness dependent on proper design. • Possible disease and drug transmission. • Lagoon requirement. • Equipment dependency.
Flushing-below slat	• All of those with open gutter. • Equipment for greater flushing action required.	• Retrofit to existing buildings. • Low odor and ventilation requirements. • Minimized possible disease and drug transmission.	• Higher cost than open gutter. • Cleanliness dependent on design. • Lagoon requirement. • Equipment and time dependency.
Anaerobic lagoons	• Volume, depth and shape requirements. • Distance to neighboring residences. • Distribution to irrigable land. • Organic loading rate. • Dilution water availability.	• Storage and application flexibility. • Low solids liquid for simple irrigation and recycle for flushing system. • Low cost, low labor.	• Land requirement. • Odor potential. • Nitrogen loss. • Sludge buildup. • Recycle salt problems.

Open lot	• Runoff control system. • Manure storage area. • Dewatering equipment for holding pond. • Pen slope and accessibility for scraping.	• Low cost, management. • Nutrient retention in solids. • Easily constructed.	• High labor. • Liquid and solids handling equipment. • Cold weather effects on pigs and producer.

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