

1969

## EC69-784 Agricultural Engineers' Digest : Handling Swine Manure

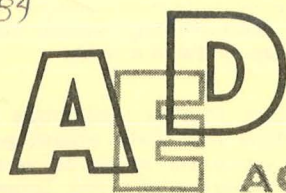
Follow this and additional works at: <http://digitalcommons.unl.edu/extensionhist>

---

"EC69-784 Agricultural Engineers' Digest : Handling Swine Manure" (1969). *Historical Materials from University of Nebraska-Lincoln Extension*. 3929.

<http://digitalcommons.unl.edu/extensionhist/3929>

This Article is brought to you for free and open access by the Extension at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Historical Materials from University of Nebraska-Lincoln Extension by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

HANDLING SWINE  
MANURE

## AGRICULTURAL ENGINEERS' DIGEST

RECEIVED  
OCT 18 1972  
COLLEGE OF AGRICULTURE  
LIBRARY

## INTRODUCTION

Manure management is an important aspect of the complete swine production system. The manure collection, storage, treatment, transportation, and disposal facilities must be compatible with the other aspects of the hog feeding and housing program.

Modern standards of sanitation and pollution control are extremely important to anyone thinking of the confinement handling of swine. A major objective is the protection of water sources from manure and the seepage from manure. It's also important that the byproducts of the swine operation be handled in such a way as to minimize odors, flies and other nuisances, and guarantee the safety of nearby people and animals.

## CHARACTERISTICS OF HOG MANURE

Approximate total daily production per 100 lbs. live weight:  
1/8 cu. ft.; 1.0 gal.; 7.5 lbs.

Average density of manure: 59 lbs. per cu. ft.

Table 1. Approximate daily manure production

Age (Weeks)	Weight (lbs)	Waste Production		Wet Solids Only	
		Liquids & Solids			
		Cu Ft	Gal	Cu Ft	lbs
Pigs					
6-9	40	.06	.5	.04	2.4
9-13	100	.13	1	.1	5.9
13-18	150	.21	1.7	.15	8.8
18-23	210	.30	2.2	.2	12
Sow, boars					
20-52	300	.43	3	.3	17.5
52+	500	.71	5	.5	30
Sow + Litter		.55	4	.5	30

Fertilizer content of a ton of manure is about:

10 lbs. of nitrogen  
3 lbs. of phosphorous  
8 lbs. of potassium

Note: The above figures are median values for undiluted, fresh manure without bedding.

## SOLID MANURE HANDLING

SOLID MANURE is made by catching and holding excrement in bedding or other material, or by allowing the liquids to run off, leaving the solids to be handled separately.

Handling solid manure requires the following equipment and facilities:

Solid floors that can be bedded and easily cleaned.

Equipment to haul and spread the solids.

An area on which to spread the solids.

Available labor to spread manure frequently.

The advantages of solid manure handling are that it requires a minimum of equipment and conserves the soil building characteristics of the manure.

## RECOMMENDATIONS

Install sloping floors; locate waterer where manure accumulation is desired; and keep pens full of pigs.

Haul manure directly to fields when possible.

When a stockpile is necessary, locate it for convenient loading in a spreader, out of natural drainageways, and away from any water source. Divert surface water away from the storage area.

Check local regulations for recommended runoff control systems. Collect manure runoff from stockpiles or lots in a basin if runoff will cause stream pollution. Divert runoff around pounds.

## RUNOFF FROM LOTS AND MANURE PILES

Rainfall which falls on or flows across manure-covered areas or stockpiles produces a runoff capable of causing severe pollution to streams, lakes or ponds. This runoff must be intercepted and kept from reaching useable or public waters.

Impound runoff in a properly-designed lagoon; a one-, two-, or three-pond detention system; or other facility adequately meeting local conditions and appropriate regulations.

The detention basin may be emptied with irrigation equipment, liquid spreading tanks, or by natural seepage and evaporation.

Controlled release to the ground surface is acceptable in certain locations with the approval of the state water pollution control agency.

## LIQUID MANURE HANDLING

Many swine producers are handling manure as a liquid for one or more of the following reasons:

The manure contains more nutritive and organic value than can be saved by storing the wastes as solids or semi-solids.

Liquid manure handling usually requires less total time and labor. Solid manure must usually be handled at regular intervals to prevent excessive accumulations, while liquid manure can be stored in tanks or lagoons until decomposed or spread.



Disposal of the liquid manure can be postponed to fit into field schedules, soil conditions, and expected rainfall.

Objectionable odors, unsightliness, and fly problems can be controlled when excrement is stored as liquid manure in a covered storage. The odors that occur when manure is spread on a field are occasional instead of daily, but the odor of field-spread liquid manure may be more objectionable than that from solid manure.

Handling liquid manure requires the following facilities and equipment:

Equipment or facilities to get the excrement into storage; scrapers, gutters, slotted floors, drains.

A watertight storage unit to which water can be added.

Equipment that will stir and remove the liquid manure; pumps, agitators, augers.

Equipment or facilities that will dispose of the manure; tank trucks or wagons, irrigation fields, available land, a lagoon.

### Storage of Liquid Manure

The storage unit may be a separate outdoor tank or it may be part of the livestock facility, that is, a pit under slotted floors.

The storage unit should be located at least 100' from any water supply. Special precautions are necessary when the storage unit is to be constructed over creviced bedrock or other subsoil conditions where uneven settling could cause the unit to break, leak, and pollute underground water supplies.

Storage capacity depends on the number and size of pigs, the amount of manure dilution by spilled and cleaning water, and the desired length of time between emptying. Large storage units have maximum labor advantage. Three to six months storage capacity is desirable if manure is to be field spread, to avoid spreading on frozen or snow-covered ground or on crops.

Storage Capacity = number of animals x daily manure production x desired storage time (days) + extra water.

Cleaning swine facilities with high-pressure water may double the volume of wastes. From 1/5 to 3/5 of the storage volume may be needed for extra water if the manure is to be pumped and used with an irrigation system.

Storage units should be watertight. Cast-in-place concrete is recommended. If concrete block walls are used, they should be treated with concrete plaster and a bituminous coating. Insulate storage tanks with waterproof insulation in cold climates. When construction is completed clean out chips, nails, lumber and other foreign material, and put in about 4" of water before using the unit.

### Filling Liquid Manure Storage

Add water to the storage unit before filling it with manure. Add 3"-4" to pits under slotted floors; add 6"-12" when the unit will be loaded with batches of scraped wastes.

Keep tanks closed when not in use, and maintain a program of fly control, including bait and spray insecticide and repellants. Fly reproduction can be discouraged by keeping all solids submerged.

Never add frozen manure to a storage tank.

### Scraping, Washing

Scrape wastes into a gutter or storage unit frequently to keep them wet. Wastes are sometimes hard to reliquify.

For washing, high pressure is needed to do a good job. Consider draining off some of the stored liquid to a lagoon. The solids and semi-solids left would have less nutritive value, but the time interval between emptying could be longer.

### Narrow Gutters

Wastes from solid floors can be washed or scraped to this type of storage unit for short holding periods. The gutter is nearly self cleaning if emptied twice a week.

### Partially slotted floor:

Put slats over manure gutters. Provide solid floors in the feeding area and alleys. Slope solid floors toward gutters. Arrange pens so slotted areas are within 16' of all parts of the pen and preferably at the end of a pen. Longer solid floor sections tend to get dirty. Solid sections permit limited feeding on the floor which helps keep pens clean.

### Completely slotted floor:

The whole floor is usually laid level. Partitions can be located in any position. It is easier to move alleys or adjust pen sizes, to meet changing needs or management. Feed dropped on the slotted floor is wasted. Cover part of the floor and/or use feeders with feed flow control.

### Emptying Liquid Manure Storage

It is usually necessary to agitate stored contents just prior to emptying as some solid excrement settles.

Effective agitation is possible with recirculating pumps operating at about 2000 gallons per minute in storages with ports about 30' apart. See Figure 1.

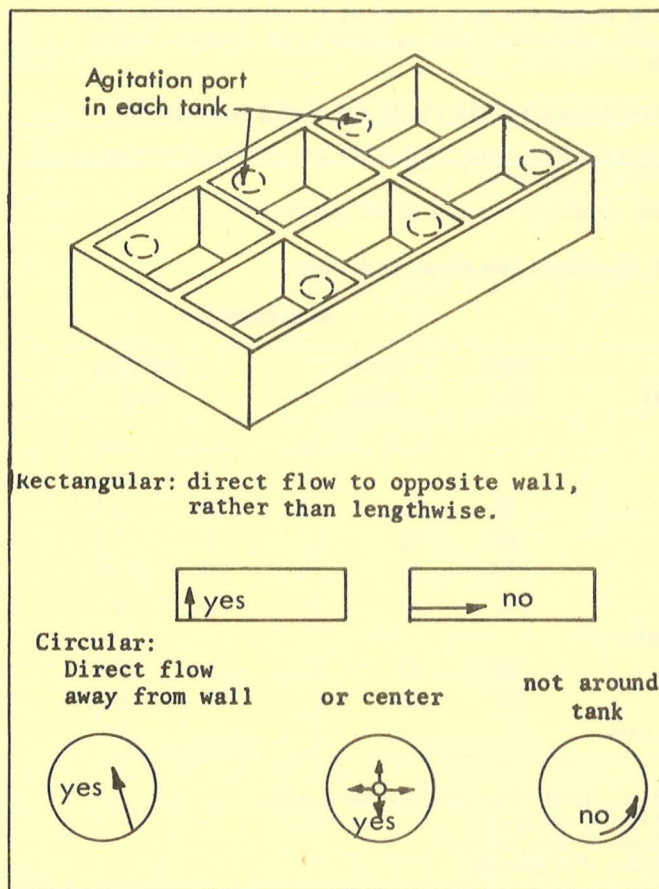


Figure 1. Locating agitation pump in undivided storage

Agitation is usually not needed for narrow gutter storage space. Open the outlet or plug and run wastes to a separate storage tank or lagoon about twice a week.

Paddle agitators are usually effective only in smaller tanks. Augers are sometimes used, but are usually not too effective.



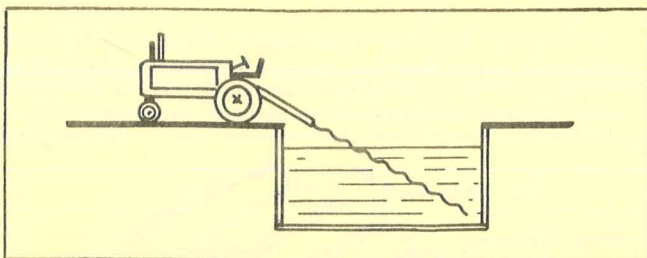


Figure 2. 12-inch or 14-inch auger agitator

Gases escaping from agitated manure may have ill-effects on animals and humans. Operate all ventilation fans and open doors and windows when agitating and unloading manure storages. See section on gases, below.

Remove the agitated manure with pumps, augers, or gravity flow to tank wagons, irrigation lines, or a lagoon.

### Pumps

Many types and sizes of pumps are available to handle the liquid manure. Some common types are listed below:

**Pump on a wagon** creates a vacuum within the wagon which sucks the liquid from the storage; creates pressure within the wagon for unloading. Small storage units can sometimes be agitated satisfactorily by partially filling the wagon, then reversing the pump and emptying the wagon back into the tank. A PTO unit pumps about 300 g.p.m.

**Centrifugal pump without choppers** is submerged in the manure and can pump into a tank wagon or irrigation system. Pump sizes range from 1-1/2 to 5 horsepower. They deliver up to 2000 g.p.m. Bedding may clog centrifugal pumps without choppers. Some pumps have a by-pass for agitation.

**Chopper-impeller pumps** are designed to pump manure that contains chopped bedding. Typical sizes range from 5 to 30 hp. They deliver from 300 to 2500 g.p.m. Some have a by-pass for tank agitation.

**Diaphragm and helical screw pumps.** A 2 hp pump will lift 50 to 70 g.p.m., and can handle thick slurries.

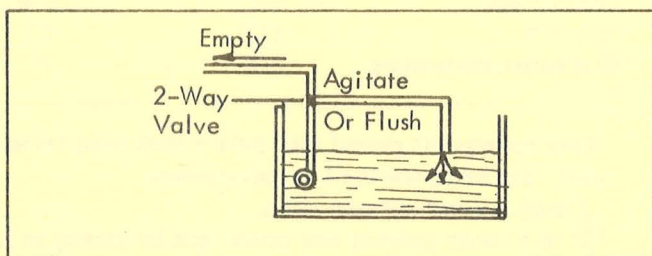


Figure 3. Centrifugal pump with by-pass to agitate storage or flush long gutters

### Augers

Augers are not very efficient for moving liquid manure. Augers are commonly powered with PTO-driven hydraulic motors. One to 5 hp. will lift 40 to 180 g.p.m. through 4"-6" augers. An auger with close tolerances between screw and housing and operated at about 1500 r.p.m. is usually necessary.

### Gases From Stored Liquid Manure

Gases from agitated liquid wastes stored inside a building create a hazard and undesirable odors. Most gas problems have occurred when manure is agitated or when ventilation fans have failed. Most (99% or more) of the gases are methane, ammonia, hydrogen sulfide, and carbon dioxide. The remaining fraction is primarily gases that are heavier than air; many have undesirable odors.

Heavier-than-air gases tend to accumulate in a layer just above the slurry. In a slotted floor house with the pit nearly full, animals lying on the slats may inhale air containing an excessive amount of gases.

**Methane** Colorless and odorless; 1/2 the weight of air; forms explosive mixtures with air, even when present only to the extent of 5% of the volume; acts as an asphyxiant by displacing air.

**Carbon Dioxide** Colorless and nearly odorless; about 1.3 times denser than air; an asphyxiant.

**Ammonia** Colorless with a pungent odor; about 2.3 times the weight of air; low concentrations irritate eyes and mucous membranes; 5000 parts per million (p.p.m.) is a dangerous level.

**Hydrogen Sulphide** Colorless with a rotten egg odor; slightly heavier than air; very poisonous; an irritant and asphyxiant. Concentrations of 20 to 150 p.p.m. irritate eyes; 500 p.p.m. for 30 minutes causes severe headaches, dizziness, excitement and staggering gait; exposure of 800 to 1000 p.p.m. may be fatal in 30 minutes. This gas is released as agitation begins.

The primary hazard to animal health generally occurs with inadequate ventilation. Animals asphyxiate because methane and carbon dioxide displace oxygen. Ammonia can irritate respiratory tracts and make them more susceptible to disease.

### RECOMMENDATIONS for building design include:

Locate the electrical entrance outside the building, and as much wiring and fixtures as possible above the ceiling or behind a vapor barrier to minimize corrosion.

Provide positive ventilation, especially during agitation or pumping of the storage pits.

Exhaust some ventilation air from above the stored liquids; even a low-volume continuous fan pulling air from above one corner of a tank will aid in reducing the accumulation of heavier-than-air gases at animal level.

Provide an alarm system (loud bell or readily noticed light) to warn of power failures in totally enclosed buildings. Tightly closed buildings can have a rapid build-up of gases at animal level which eliminate sufficient oxygen.

### Ventilation

Indoor storage pits should be positively ventilated. Locate an exhaust fan to exhaust air directly from the manure pits.

Remove animals from the building or provide positive ventilation during agitation and emptying of storage tanks. Gases which escape may reach toxic levels. Fans for a minimum winter ventilation rate may be installed to draw air from below slotted floors to bleed off heavy odorous gases. This causes drying of surface manure, and additional agitation will be required for removal.

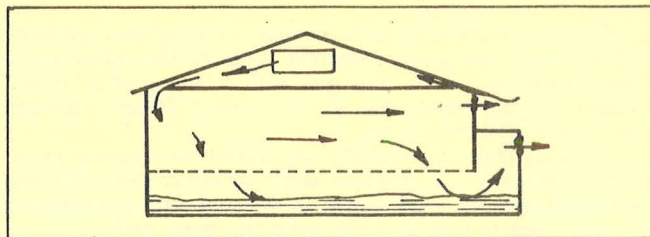


Figure 4. Ventilation

### Disposal of Liquid Manure

#### Field Spreading-Tank Wagon

Keep extra water to a minimum if the manure will be spread with a tank wagon. Wagon tanks are available in sizes of 750 to 2500 gallons. The tires for the wagon should be of wide floatation construction to minimize damage to a field. An agitator in the tank improves uniform delivery and reduces plugging.



### Field Spreading-Irrigation Equipment

The liquid manure should be less than 5% solids and thoroughly agitated for irrigation. Contact your County Extension Director or consult one of your state's agricultural engineers for irrigation designs.

### Lagoons

Some livestock producers are draining or pumping any extra storage water and some of the liquid excrement to a lagoon. The solids and semi-solids left in storage are then spread on a field when convenient. A lagoon does not have to be as large when the solids will not be decomposed. Some of the nutritive value for the field-spread manure will be lost.

Lagoons for manure treatment are sometimes sources of objectionable odors. Odors are also present during field spreading.

See AED-1, "Lagoon Manure Disposal," at your County Extension Office.

Where evaporation rates do not exceed rainfall rates sufficiently to control the lagoon waste level, some means of effluent disposal is required. Lagoon effluent is generally unacceptable for discharge to surface streams. Effluent discharge may be subject to regulation.

### Oxidation Ditches

The popularity of oxidation ditches has been based upon the need for a low-odor producing means of manure storage. The basic components are the storage ditch and a rotor, which keeps the manure agitated and adds oxygen to the system. Excess sludge and treated liquid manure require periodic removal for disposal.

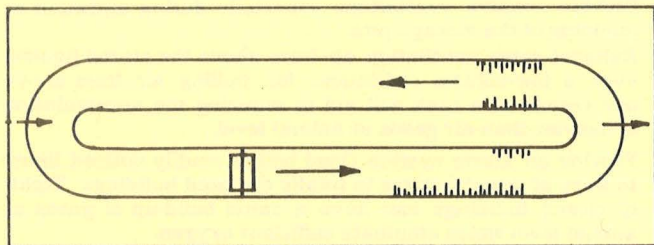


Figure 5. Oxidation ditch

### Slotted Floor Construction

Construction details and dimensions for slats, framing, and support systems are included in "Swine Housing and Equipment Handbook", MWPS-8.

#### Slats

Concrete slats last the longest; then hardwood, then corrosion-resistant steel. Concrete slats are heaviest, requiring strongest supports. Wood tends to wear, leaving irregular slat spacing.

Concrete slats may be homemade or purchased precast. When using ready-mix concrete, specify the following to the contractor; a 7½ bag mix with a slump of 2" to 3", maximum aggregate size of ½", and a 28-day strength of at least 3500 lbs. per sq. in.

Concrete slats are usually supported on concrete piers or masonry walls. If concrete block walls are used, the top course should be solid block or covered with a pressure-treated plank to provide a sill under the beam ends.

Walls which divide the storage into long tanks may aid in future adoption of oxidation ditch equipment.

Slotted floor systems are being manufactured from special corrosion-resistant steel. Preformed slats and slotted planks are easy to install and maintain. Before starting construction, discuss your floor supporting system with the steel supplier.

Flattened, expanded steel mesh (¾ in., 9-gage) with a smooth upper face has proven satisfactory for pigs up to about 50 lbs. It is almost completely self-cleaning. Supports under the mesh should be 3 to 4 ft. on center.

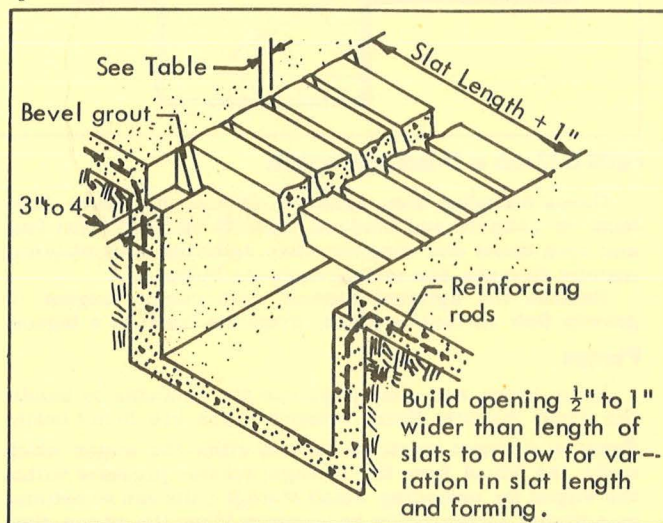


Figure 6. Slat and shallow pit construction

Openings must be large enough to allow solid manure to be worked through rapidly. Some scraping or washing may be necessary if the entire floor is not slotted. Provide a small opening with a removable cover at the rear of farrowing stalls for cleaning.

Table 2. Recommended slot widths (slotted floors)

Recommended slot widths (slotted floors)		
Slat Width:	1 1/4" to 2"	3" to 5"
New-born pigs	3/8"	3/8" & 1" <sup>1</sup>
25 to 40 lb	1/2"	1" <sup>2</sup>
40 to market, and farrowing	3/4"	1" <sup>3</sup>

<sup>1</sup> Cover openings with plywood, sheet metal or mesh during farrowing. Use 1" slots behind sow; Use 3/8" slots elsewhere.

<sup>2</sup> 3" width preferred over wider widths.

<sup>3</sup> 3" to 5" width preferred over narrow slots for finishing on fully slotted floor.

Leave a 2 to 3 in. space between slats and a wall or partition. Do not use bedding with slotted floors.

Hardwood slats of oak, elm, hickory, or maple may last 2 to 5 years. Softwoods will splinter and wear away. Use cleaned and dried preservative-treated lumber as the preservative may cause skin irritations. Provide spacers to assure uniform slot widths; ¾ in. dowels through slats or 1x3's nailed to the top surface, 3 to 4 ft. apart.

#### Floor Framing

Narrow slotted areas can be spanned with slats of concrete, wood, or steel with only end support. Wide slotted areas must have joists or walls installed to support the floor.

Use pressure-treated lumber for wooden joists.