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Planning a LIQUID MANURE Handling System

Charles L. Peterson

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By CHARLES L. PETERSON
Extension Agricultural Engineer

The trend toward confinement housing of livestock has complicated the problem of waste disposal. Manure is produced in large volume, and most of the new systems use little or no bedding. This results in manure of a consistency that is difficult to handle. Attempts to solve the problem have resulted in some systems which eliminate the manure while returning little, if any, of the valuable plant nutrients to the soil.

Regardless of the system selected, there will be some expense connected with its operation. To reclaim some of this cost, the manure should be spread on fields where the fertilizer value will partially offset the cost of operation.

Equipment of several types is available for handling manure in a fluid state. Proper handling requires a coordinated system made up of four essential elements — storage pit or tank, agitation of material within the tank, a method for emptying the tank and field distribution. This system is commonly referred to as "liquid manure".

In planning a system for use with any livestock operation, each of these essential elements deserves careful consideration.

Figure 1. Complete system includes storage tank, pump, spreader tank and method for filling the storage tank. Tractor and scraper can replace or supplement a mechanical barn cleaner.

Figure 2. At least one manufacturer distributes glass-lined steel tanks of 20,000 and 34,000 gallons capacity. Cast-in-place reinforced concrete tanks are very satisfactory.

STORAGE TANKS

The storage tank should include adequate capacity for the longest anticipated storage period from the maximum number of animals. Allow for water which may be added. Table 1 gives the daily manure production rates, including wash water, per animal. Use the high figure if you use a large amount of water and the low figure if little water is used.

Be realistic in choosing a storage period. No one wants to stop in the middle of harvest to empty a manure tank. There may be periods when no fields are available to receive the manure. Other problems may arise which prevent emptying the tank at a particular time. Storage periods of 30 to 90 days are most common.

Determining Storage Requirement

Required tank capacity can be found from the following formula: Tank capacity in gallons=No. of animals x no. of days x gallons per day per animal

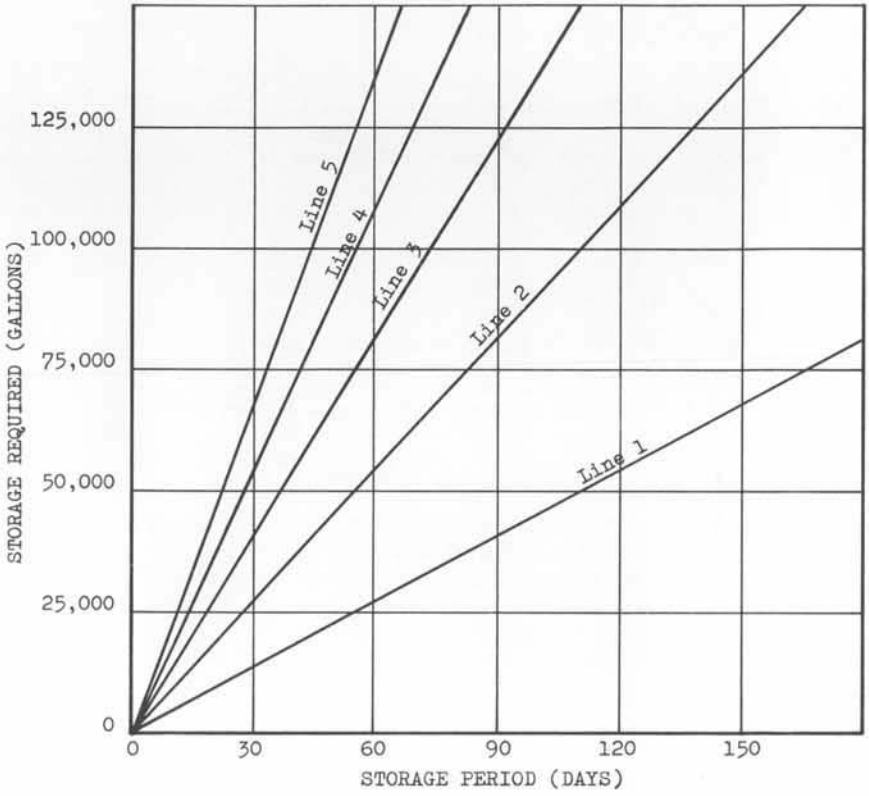
Example: 50 cow dairy herd, and 60 day storage.
Tank capacity=50 cows x 60 days x 16 gallons per cow per day
=48,000 gallons

At 7.5 gallons per cubic foot, this is 6,400 cubic feet of storage.

Tank depth should not exceed 10 feet with 8 feet being more common.

Table 1. Livestock manure production per animal including wash water

	Gallons Per Day	
	Minimum	Maximum
Dairy Cattle	14	18
Beef Cattle	8	10
Hogs	1.5	2.0
Laying Hens	0.03	0.04



	Dairy Cattle	Beef Cattle	Hogs	Laying Hens
Line 1	30	53	275	14,000
Line 2	60	106	550	28,000
Line 3	90	159	825	41,000
Line 4	120	212	1100	55,000
Line 5	150	265	1375	68,000

Figure 3. Average storage capacity required for various numbers of livestock and for various storage periods.

Figure 3 gives the storage capacity needed for various animal numbers and storage days. This chart can be used for a quick approximation of the amount of storage which will be required. Use it as follows: Suppose an individual raises 800 hogs and desires sufficient storage for 60 days without emptying the tank. Referring to the bottom of the chart, we see that line 3 is for 825 hogs. This is close enough to 800 for an approximation. Then find 60 day storage period on the bottom line of the chart, follow up vertically until line 3 is intersected. Then move horizontally to find the gallons of storage required, which in this case is about 80,000 gallons. This figure is close enough for use in determining if a "liquid manure" system is feasible. However, before final plans are made, use the formula to figure the exact requirements.

Storage Tank Construction

Tanks may be constructed of reinforced concrete or reinforced concrete blocks. They should be designed to carry side wall pressures and to allow for equipment and animal travel over the top. A qualified engineer should check all plans to insure proper and safe design. Tanks may be either circular or rectangular; however, rectangular tanks should have the corners rounded to avoid accumulation of sludge.

Plans for Manure Tanks

The University of Idaho Farm Building Plan Service has plans available which will fit the needs of almost any operation. They may be obtained from the Department of Agricultural Engineering at the University of Idaho. These plans have been designed by engineers to carry loads encountered under most normal conditions. They are illustrated at the end of this bulletin.

At least one commercial manufacturer has available glass-lined steel storage tanks of 20,000 and 34,000 gallon capacities.

Tank Location

When selecting a location for your storage tank consider the following items. The final tank location should be the best balance of each.

1. It should be convenient to the lot and housing facilities.
2. It should have convenient access for manure removal.
3. It should have sufficient slope from water sources to permit gravity flow.
4. The distance which manure must be pushed should be minimized.
5. It should be possible to divert surface runoff away from the tank.

AGITATION

Agitation of liquid manure is essential to obtain proper mixing of solids and liquids so that pumping will be possible. The agitation method should be compatible with the pump selected. The most common methods of agitation are:

(1) paddle wheels
(2) propeller mixers
(3) augers
(4) re-circulation.

Paddle wheels, propeller mixers, and augers all require special equipment while the re-circulation method makes use of the pump for agitation. With the re-circulation method, the discharge of the pump is connected to a pipe extended to the opposite side or center

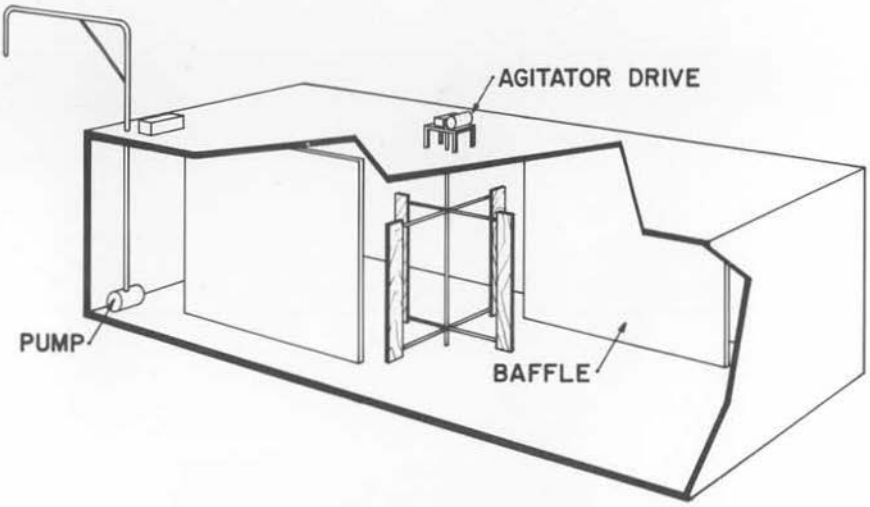


Figure 4. One system uses a paddle wheel agitator and baffles for circulating material in the pit. A separate pump is used for emptying.

of the tank. The material is then continuously circulated through the tank. This breaks up the solids and mixes the tank contents into a pumpable slurry.

Mechanical agitation is accomplished by periodic operation of the equipment. It may be connected to a time clock operating for 15 minutes two or three times a day. Complete agitation prior to pumping is accomplished by continuous operation of the equipment until solids and liquids are well mixed. Tractor PTO-operated agitators require daily connection of the tractor to the equipment.

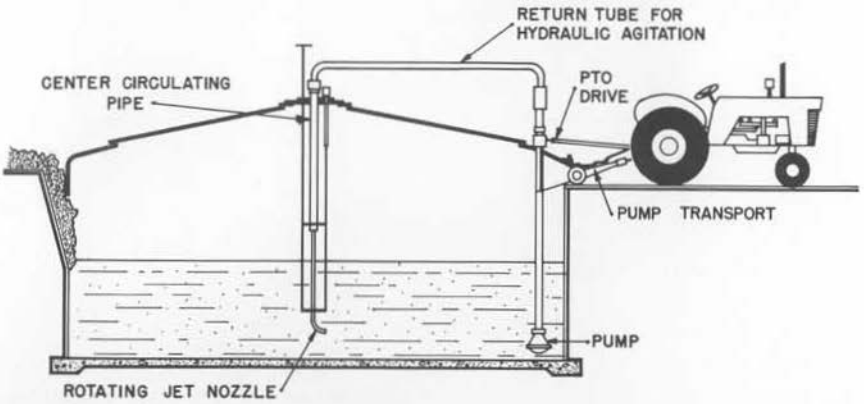


Figure 5. Some companies presently offer liquid manure equipment utilizing a dual purpose pump and recirculating agitator system.

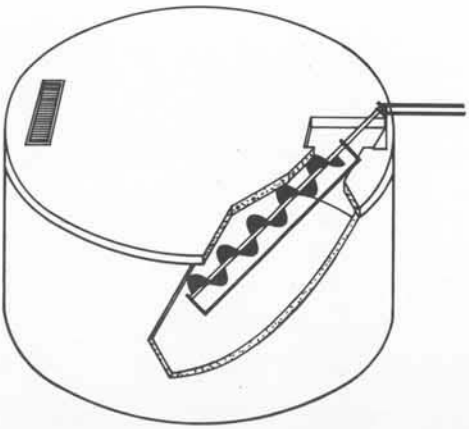


Figure 6. Augers can be used in round and rectangular pits as agitators.

EMPTYING THE TANK

To empty the tank, the manure must be mixed with sufficient water to allow pumping. The most common pump types include centrifugal, vacuum or diaphragm pumps. Augers have been used with some success but are much slower than pumping and are reported to wear rapidly.

Centrifugal pumps are available with a cutter-impeller and cutter bar which makes possible handling material such as hay and straw. This type of pump is highly recommended for most efficient operation. These pumps can handle 1,200 to 2,500 gallons per minute. Vacuum pumps handle from 200 to 400 gallons per minute.

Experience at the University of Idaho dairy center indicates that even with a chopper pump, long hay or straw can cause difficulties in pumping and should not be allowed to enter the tank. These materials build up around the pump inlet and exclude all other materials from entering.

Pumps can be permanent in the tank with an electric power source, or they can be portable. Portable pumps allow the use of one pump in two or more tanks. They are usually tractor PTO-driven thus removing the necessity of the electric power source. Portable pumps are available with either three-point hitch or trailer mounting for ease of transportation between tanks and to facilitate installation or removal from the tank.

When using a vacuum type unloader, the distribution tank may be crushed unless it has been specifically designed for high vacuum. For this reason, homemade vacuum tanks are not recommended.

Figure 7. A tractor scraper similar to this one may be used to fill the tank or to supplement a mechanical barn cleaner.

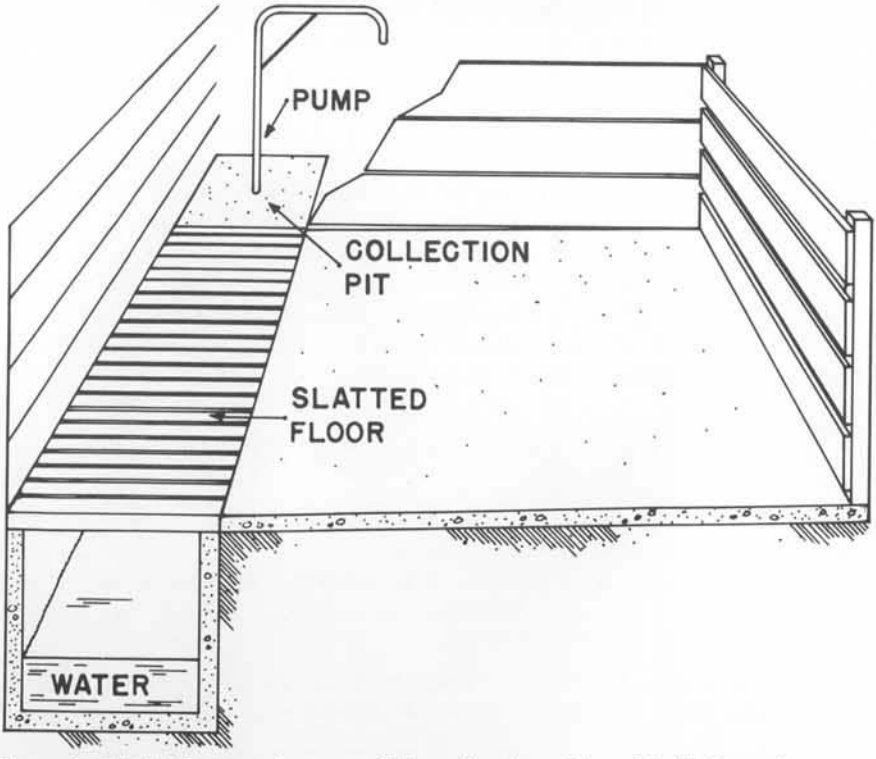


Figure 8. Slatted floors work very well in conjunction with a "Liquid Manure" system.

Figure 9. A combination tank wagon and vacuum pump. The tank is filled by its own vacuum pump and is emptied under pressure from the same pump. The only additional equipment necessary is an agitator in the pit.

DISTRIBUTION SYSTEM

Two types of distribution systems are in use, tank wagons and sprinkler systems.

Tank wagons are available in many sizes and types from commercial manufacturers. Most are unloaded by gravity flow; others have mechanized or pressurized thrower systems. Tanks of 1,000 and 1,500 gallons are common. Fit the distribution tank size to the storage tank size. It takes 65 trips to empty a 65,000 gallon storage tank with a 1,000 gallon tank wagon.

Nozzles have been developed which allow handling of liquid manure through sprinkler pipe. In situations where the tank is close to the field the use of sprinklers will greatly reduce labor requirements. However, for distant fields pipe cost would probably offset any savings in labor.

SCRAPING AND CLEANING EQUIPMENT

A tractor and scraper blade should be available for daily cleaning of alleys and feed areas.

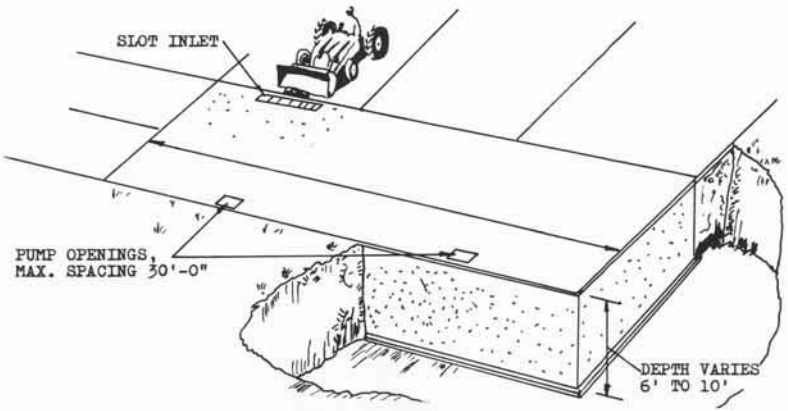
Mechanical barn cleaners which carry the manure directly into the tank may be desirable. The tractor can be used to scrape manure into the gutter.

In some cases the use of slatted floors in barns or feedlots to allow manure to drop directly into the tank may be beneficial.

Never use slatted floors in barns where cows are milked.

MANAGEMENT CHECK LIST

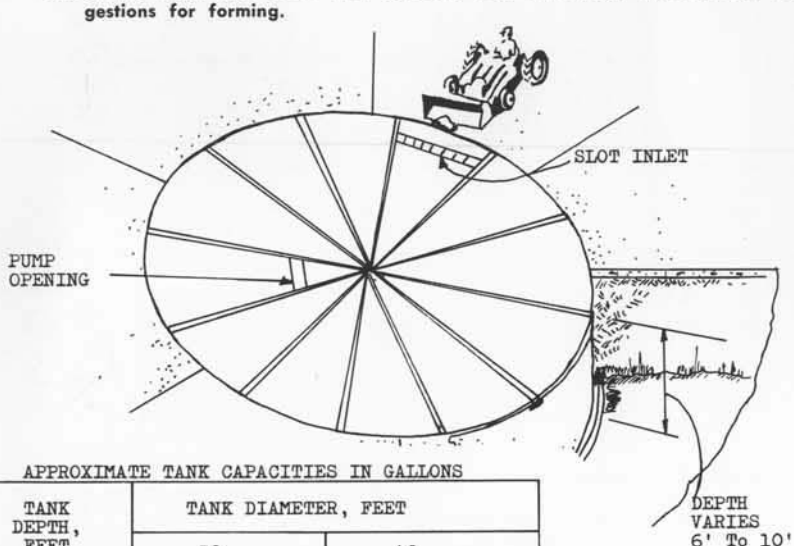
1. Locate the tank for easy cleaning of facilities and access for unloading.
2. Cover all openings when not in use and use expanded metal or other types of grating for a permanent cover. This will prevent children, animals, or equipment from falling into the tank.
3. Consult your local Department of Public Health for regulations and advice concerning health and safety.
4. Water should be available to keep manure at proper consistency during dry periods.
5. Runoff water should be diverted away from the tank to prevent excess water and resulting unnecessary trips to the field during extremely wet periods.
6. Limit the amount of bedding or feed wastes that enter the tank —these materials cause problems during agitation and pumping.
7. Provide adequate space in lots and buildings to maneuver equipment. Alleys and driveways should be at least twelve feet wide for efficient use of equipment. Concrete curbs, where used, should be at least twelve inches high to confine manure when cleaning.
8. No human wastes or septic tank effluent should be emptied into the tank.
9. Plan your complete system carefully. Consider allowances for future expansion.



APPROXIMATE CAPACITIES IN GALLONS - 20 FT. INSIDE WIDTH

	LENGTH, FT.				
DEPTH, FT	20	40	60	80	100
6	18,000	36,000	54,000	72,000	90,000
8	24,000	48,000	72,000	96,000	120,000
10	30,000	60,000	90,000	120,000	150,000

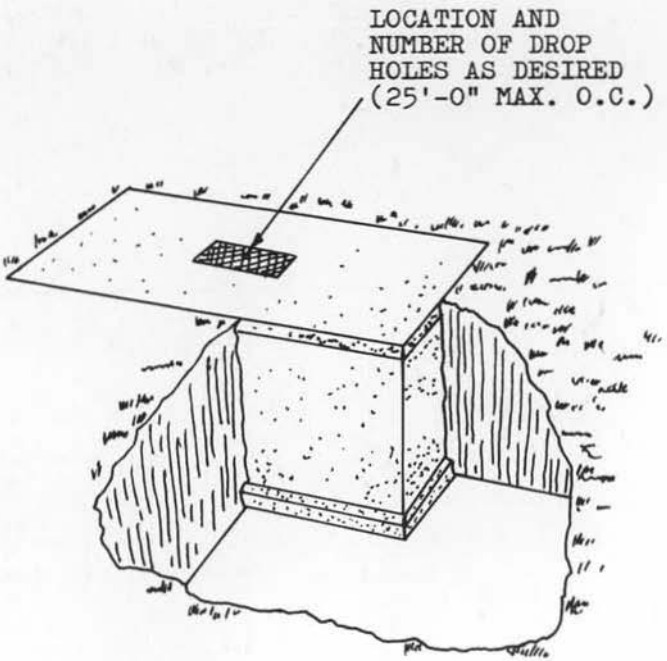
Figure 10. PLAN NO. 5981—Plan complete with reinforcing schedule and suggestions for forming.



APPROXIMATE TANK CAPACITIES IN GALLONS

TANK DEPTH, FEET	TANK DIAMETER, FEET	
	32	48
6	36,000	81,000
8	48,000	108,000
10	60,000	135,000

Figure 11. PLAN NO. 5984—A design for a circular reinforced concrete tank. Plans show placing of the reinforcing steel and all necessary details.



TANK SIZE			
WIDTH "W"	LENGTH "L"	DEPTH "D"	GALLON CAPACITY
12	OPTIONAL	10	900 x L
15	"	10	1125 x L
18	"	10	1350 x L
20	"	10	1500 x L
24	"	10	1800 x L

Figure 12. PLAN NO. 5987—Rectangular reinforced concrete tank with provisions for varying the width and length to obtain desired capacity.

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