HANDLING HOG MANURE AS A LIQUID

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CIRCULAR 820

UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE
EXTENSION SERVICE IN AGRICULTURE AND HOME ECONOMICS

MANURE HANDLING HAS BECOME A major problem for farmers who are raising large numbers of swine in confinement. This is especially true for swine growers who clean regularly instead of using a built-up litter system. Since hog manure is never really solid, liquefying all of the manure is one way to handle it. As used in this circular, the term "liquid manure" means both urine and feces mixed with water.

Washing floors regularly is an aid to sanitation and gives better control of odors and flies. Properly planned, a washing system can also save time and labor.

The liquid manure is at least as valuable for fertility as the same manure handled in solid form, and returning it to the land is a commendable practice. Since the rate of dilution with wash water varies considerably, however, it is difficult to measure the value of hog manure. While in storage, there is some bacterial action that causes decomposition and release of ammonia to the air. Then, because storage capacity is usually limited, the manure must sometimes be spread at a time when the land can't make best use of it. And there may be times during the growing season when it would simply have to be dumped.

Manure Management Systems

As you know, some excess liquids are not soaked up in the bedding under any livestock program. One method of handling manure, then, is to remove the solids with the usual equipment but have controlled disposal of the excess liquids. In other words, you should have something better than simple drainage off the edge of the paved lot.

Another plan that works well for some northern Illinois swine growers is to handle the manure as a solid in the winter and as a liquid in the summer. This method takes two sets of equipment, but a tractor loader and spreader is probably already a part of your farm equipment for removing deep litter from cattle sheds.

In a third system, all manure from a confinement hog operation is handled in liquid form year around. It has been demonstrated that this system can be used at least in central Illinois and farther south. Bedding is used sparingly or completely eliminated. A closed building is recommended in order to maintain above-freezing temperatures. Under-floor heat may be advisable, although during the rigorous winter of 1958-1959, one Illinois producer demonstrated that 100-pound hogs can thrive on an unheated concrete floor without bedding.

One of these systems should fit your situation, and some of the following sections of this circular will help you with your planning.

Planning a System

A liquid-manure system consists of floors, gutters, underground tanks, and some method of disposal. Let's discuss these parts in order.

Floors

The concrete floor for a liquid-manure system should be carefully planned, placed, and cured. Failure to do so will result in an unsatisfactory job that cannot be easily corrected.

Slope the floors a minimum of ¼ inch per foot and a maximum of 1 inch per foot. One-half inch per foot is a practical slope for flushing off the floor. It will be easier to get the desired slope if you place small sections of the floor at a time.

Finish the floor to a uniform dense surface. A fine gritty surface is desirable to give footing for the hogs and to make cleaning easy. This surface can be obtained by carefully finishing the concrete with a wood float. Another method is to steel trowel the floor and to pull a soft bristle broom or brush over the surface to remove the slick finish.

Use quality concrete. Concrete floors receive hard use in confinement systems. Only good-quality concrete should be used, and it should be properly cured to get all the strength and durability possible.

When ordering concrete, ask for a mix with 6 bags of cement per yard of concrete with ¾-inch maximum-sized aggregate for a 4-inch floor. And specify air-entrained concrete.

The mix should be mushy, not soupy. Order small loads unless you have plenty of help. It requires time to finish these floors properly.

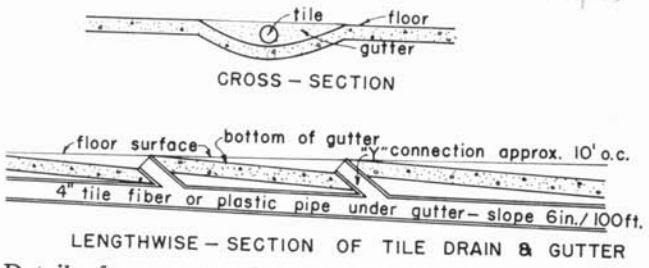
Cure the concrete by preventing it from drying out for 7 days. Cover it with polyethylene or building paper to hold the moisture in, or use straw or sand and keep it wet. The strength and durability of the concrete depend upon how well it is cured.

Gutters

Use the same care in forming, finishing, and curing concrete for gutters as you did for floors.

The required slope for gutters is debatable. The gutters will probably not be entirely self-cleaning no matter how much they slope, so it is suggested that they slope a minimum of ¼ inch per foot and more if the building site will permit.

A small-diameter underground pipe will be self-cleaning at much less slope. Figure 1 shows how the



Details for a stepped gutter with underground pipe. (Fig. 1)

surface gutter can be stepped while the underground pipe slopes continuously toward the outlet.

Underground Tanks

Three types of underground tanks are being used to collect liquid manure from hog floors: storage tanks, septic tanks, and combination storage and septic tanks.

Since the storage tank is designed to hold cleanings from the floor for only a limited time, it is necessary to have a regular schedule for hauling the material to the field.

The septic tank with underground disposal eliminates regular cleaning and hauling, but the manure is lost.

A combination storage and septic tank (a septic tank with a cleanout hole in the top similar to the storage tank) offers some advantage because it can be emptied whenever time and weather permit, and it will operate as a septic tank if the tanks cannot be cleaned regularly.

Storage-Tank Capacity and Design

Washing floors daily with a hand-operated high-pressure hose produces about 2 gallons of liquid manure for each 175- to 200-pound hog. You should plan storage capacity for at least two weeks' accumulation — even more is desirable. If your floor is not completely roofed, you will have to make additional allowance for rain and snow. A 1-inch rain, for example, adds 0.62 gallons of water for every square foot of exposed floor. The following table, calculated on an average liquid depth of 5 feet, will help you decide on tank dimensions to meet your capacity needs.

Inside tank width	Capacity when inside tank length is 10 feet	20 feet	30 feet	40 feet
	(gallons)			
4 feet.....	1,500	3,000	4,500	6,000
6 feet.....	2,250	4,500	6,750	9,000
8 feet.....	3,000	6,000	9,000	12,000

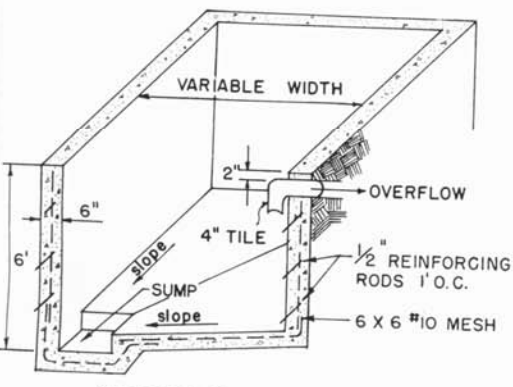
You will probably choose concrete or concrete block for constructing your tank, although a steel tank of sufficient size could be used. Details for a reinforced concrete tank and a concrete block tank are shown in Figure 2. The sump shown in the drawing could be at the end, along one side, or near the center, depending on the dimensions of the tank and the type of pump selected.

You will want a cover on your tank. A wood frame covered with sheet metal is satisfactory for wide tanks. Narrow tanks can be covered either with wood or reinforced concrete planks (Figure 2, right). Two practical applications of these tank-cover designs are shown in Figures 3 and 4.

Septic-Tank Capacity and Design

At the University of Illinois, a septic tank has been used with an automatically cleaned hog floor. Results indicate that a septic tank for hog manure should

Details for reinforced concrete tank, concrete block tank, and tank cover. (Fig. 2)



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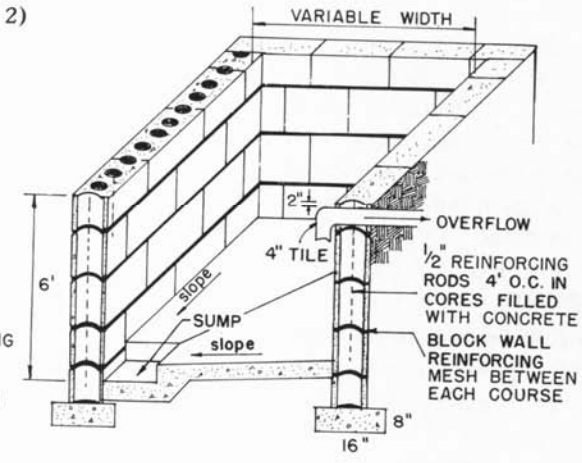

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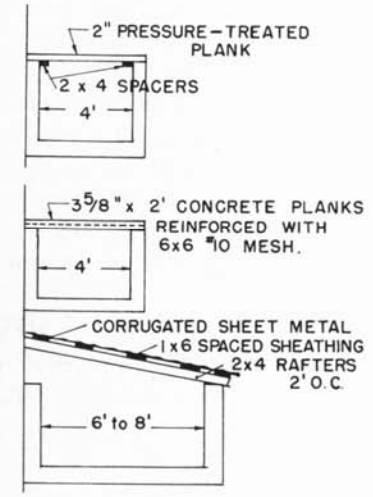
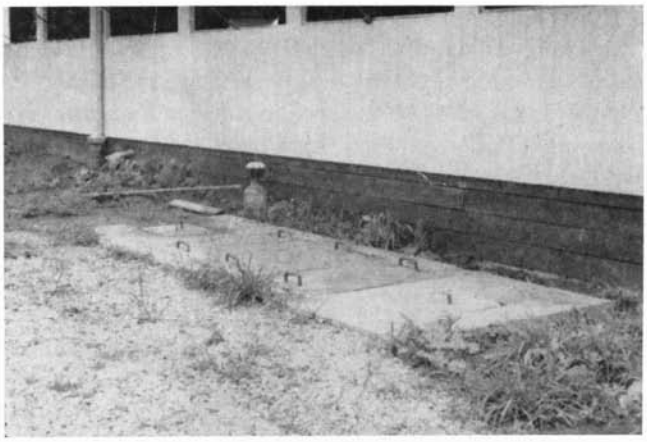


TANK COVER DETAILS



Reinforced concrete cover for liquid-manure storage tank. (Fig. 3)

Wood and sheet-metal cover for 8-feet-wide storage tank. Note hinged section for inspection and clean-out. (Fig. 4)

have a capacity of 15 to 20 gallons per 200-pound hog. The volume of water must be large enough to prevent a high concentration of solids in the tank, and if you have enough water, you should use more than the 2-gallon minimum per hog mentioned earlier. The tank should be cleaned whenever it is half full of solids.

Manufactured septic tanks are round or rectangular and are satisfactory for small installations. Large tanks are usually rectangular. A baffle is necessary at the outlet tile, and the outlet should be 1 to 3 inches lower than the inlet. A liquid depth of at least 30 to 60 inches is recommended. The shape of the tank is relatively unimportant.

Disposal

Good conservation practices require returning manure to the land. But this means using special equipment. Liquid must be moved out of storage throughout the year, often causing a burden during times of peak labor demands on the farm. Frequently it is difficult to find a convenient place to put the manure because sometimes the land is not suitable for travel with heavy equipment and at other times the crops are too high to drive through. Because of these difficulties, underground- or lagoon-disposal methods of wasting the manure are also discussed in this section.

Spreading on Cropland

Most Illinois farmers with liquid-manure systems are spreading the material on cornland for as long as they can drive through the crop. Then they spread it on pastures. Figure 5 shows a tank wagon with a splash spreader that spreads the manure about 6 feet wide. A 20-foot spread is obtained with the fan spreader shown in Figure 6. Neither of these two methods has caused any serious burning of crops. Details of tank wagons are discussed later.

Underground Disposal

To dispose of the effluent from a septic tank, an underground disposal system is used. The design of

Spreading liquid manure in pattern 6 feet wide with simple "splash" system. (Fig. 5)

Spreading liquid manure in pattern 20 feet wide with "fan" system. (Fig. 6)

this system should follow accepted practices for household-disposal systems.

First, determine how many gallons of liquid must be disposed of in 24 hours. Next, estimate the area of trench needed to soak up this amount. Dig the trench 12 to 36 inches wide, and place a layer of gravel about 6 inches deep in the bottom. Lay the disposal tile from the tank on this gravel.

The area of trench bottom depends upon how fast the water will percolate into the soil. A simple method of determining the area is as follows:

1. Dig 6 holes about the depth of the tile.

2. Add 2 inches of gravel in the bottom.

3. Pour in 12 inches of water and let it seep away. Add more if necessary to keep water in for 4 hours.

Then, 24 hours later —

4. Put in 6 inches of water over the gravel.

5. Measure water level every 30 minutes for 4 hours. Calculate the average time in minutes for water to fall 1 inch. This is the percolation rate.

6. Use the table below to determine the area of trench needed.

Percolation rate (time for water to fall 1 inch) (minutes)	Maximum rate of sewage application for area of trench bottom (gallons per square foot per day)
1 or less	5.0
2	3.5
3	2.9
4	2.5
5	2.2
10	1.6
15	1.3
30	0.9
45	0.8
60	0.6

Maximum length of laterals: 100 feet

Grade: 2 to 4 inches per 100 feet

Minimum distance between trenches (12 to 18 inches wide): 6 feet

Depth of trench: 18 inches minimum. Use 6 inches of gravel in bottom of trench.

Hooking onto a field tile from the septic tank is not recommended. This practice may cause pollution farther downstream.

Lagoon Disposal

Lagoon disposal is a method that does away with the storage tank and pumping-and-spreading equipment. The liquid manure flows into a lagoon or pond where it is stabilized by bacterial action. The fertility value of the manure is wasted, but the savings in equipment and labor offset most of the loss.

Although lagoons have been used for city sewage and factory wastes for years, they have had only limited trial for manure disposal. Early experiences have been satisfactory. Manure is much more concentrated than domestic wastes, however, and no one knows at present how well the lagoons will continue to work or what maintenance problems may arise.

Farmers who are using lagoons report no problems with odors or flies. Naturally, you can expect some odors on still, humid days in the summer and for a period in the spring while the lagoon reestablishes itself after it has been frozen over in the winter.

You should place the hog operation, including the lagoon, on the side of the farmhouse away from prevailing winds. If the lagoon is located next to the concrete finishing floor, manure can be scraped or washed directly into it; or if the lagoon is to serve several buildings, manure can be piped to it through 6-inch to 8-inch sewer tile. Fall on the tile should be 2 feet per 100 feet. The inlet pipe can discharge into the lagoon above the surface of the water.

Other suggestions for planning and building a lagoon are as follows:

1. Provide at least 15 square feet of water-surface area for each hog. In general, the more the manure is diluted, the better, and a lagoon that is larger than the minimum will allow for later expansion of the hog enterprise. Three test lagoons at the University of Illinois provide 20 square feet, 40 square feet, and 60 square feet of water-surface area. These lagoons have not been in use long enough, however, to justify any definite conclusions.

2. Make the bottom as level as possible. Avoid gravel or limestone areas. Artificial sealing of the bottom may be necessary in porous soils.

3. Build well-compacted embankments and dikes of impervious soil according to standard practice for pond construction.

4. Build embankments with side slopes of three feet horizontally to one foot vertically. Make the top of the embankment 8 feet wide to permit easy maintenance.

5. Build the lagoon at least 6 feet deep to allow some freeboard above the water line. The minimum liquid depth should be 3 feet and the maximum liquid depth should be 5 feet.

6. Under normal conditions, divert storm water and surface runoff away from the lagoon. Surface water may be temporarily diverted into the lagoon to provide initial filling and to keep the water level above the 3-feet minimum.

7. Seed the embankments above the water level, put a fence around the lagoon, and post a sign indicating the contents of the lagoon.

Special Equipment

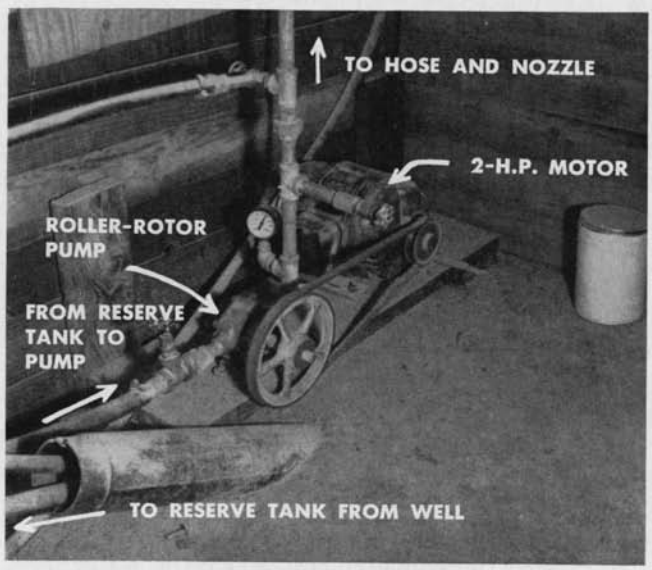
Washing Equipment

Research work at the University of Illinois has been directed toward the development of completely automatic floor-washing units. Successful models have been built for both circular and rectangular floors. But these models serve a single pen of 50 hogs. No automatic installations have been made in commercial-sized swine buildings.

Research has shown that at least 70 p.s.i. water pressure is needed to dislodge the manure and propel it toward a gutter. To get this pressure or a higher one, you need a booster pump and a reserve water supply. A 500-gallon tank float-controlled and filled from the regular farm water system will be at least large enough for a finishing floor with 500 hogs. A high-pressure pump is used to draw the water from the reserve tank and deliver it to the nozzle at pressures above 70 p.s.i. Most farm systems use 125 to 150 p.s.i. High-pressure turbine pumps or roller-rotor farm-sprayer pumps can be used. A 2-horsepower motor is needed to drive the pump. A farm installation with a roller-rotor pump is shown in Figure 7.

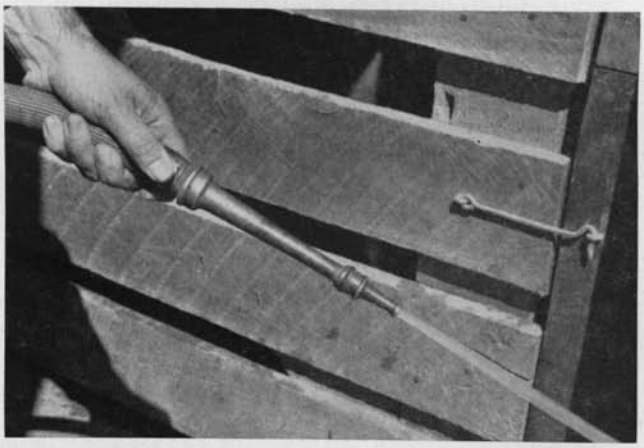
For hand washing, a 1-inch heavy-duty hose is recommended. The pens should be arranged so that they can be washed from a service alley (see Figure 8). When it is necessary to enter the pens to clean them, try to keep the hose away from the hogs because they will chew holes in it. If you use numerous hose bibs, you won't need a long hose.

Nozzles should give a solid stream of water so that the energy is concentrated (Figure 9). In experimental work at the University of Illinois, the nozzle that performed best was made from a pipe cap. The face of the cap was ground flat, and a hole was drilled in the center and countersunk from the inside until the edge was sharp (Figure 10). With a 3/16-inch hole, this nozzle will deliver 5.0 gallons of water per minute at a pressure of 95 pounds per square inch; with a ¼-inch hole, it will deliver 9.2 gallons at a pressure of 86 pounds.



Booster pump and motor for increasing water pressure to 100-125 p.s.i. (pounds per square inch). (Fig. 7)

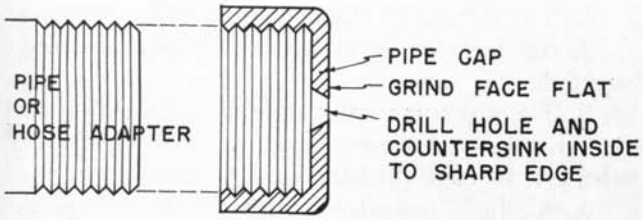
Washing floor of pen from service alley. Since most manure collects near outside wall, water is directed over backs of hogs. (Fig. 8)



A commercial nozzle with ¼-inch straight hole that gives good solid stream of water. (Fig. 9)

Manure Pumps

Several types of pumps are available to empty the underground manure-storage tanks. Three-inch or 4-inch diaphragm pumps work very well. A 3-inch pump will deliver about 85 gallons per minute.



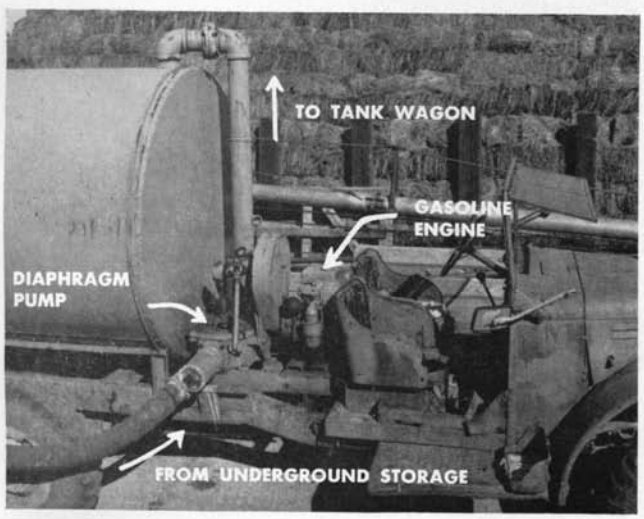
Homemade nozzle that gave excellent results in research work at University of Illinois. (Fig. 10)

Figure 11 shows a diaphragm pump mounted on a tank-wagon spreader. It is powered by a gasoline engine, but some farmers have made a linkage to drive the pump from the tractor power take-off.

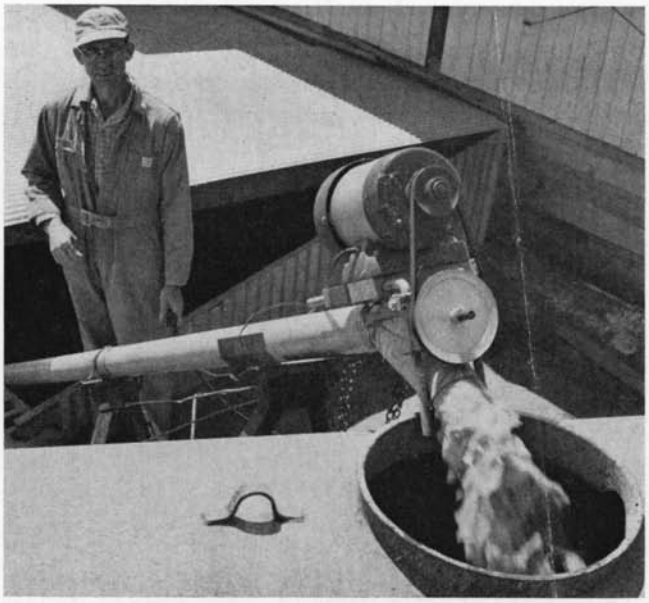
If no bedding is used, the manure may be sufficiently liquefied to use a centrifugal pump. A 1½-inch centrifugal pump will deliver about the same amount of liquid manure as a 3-inch diaphragm pump.

Augers are also successful liquid-manure pumps. Figure 12 shows a nominal 4-inch auger pouring out liquid manure. A 4-inch auger will pump about 50 gallons per minute when run at 1,600 r.p.m. A 1-horsepower motor is required.

Although a 6-inch auger has a greater capacity than a 4-inch auger, its use presents certain problems. The 6-inch auger moves the liquid up the casing faster than it can be discharged at the upper end, causing a tendency for the motor to be overloaded. Paddles welded to the auger shaft seem to relieve this condition. Because of the limitations at the discharge end, test results with 6-inch augers are not conclusive. The tests seem to show that a 6-inch auger driven at



Diaphragm pump mounted on liquid-manure tank wagon and powered by gasoline engine. (Fig. 11)



Liquid manure being pumped with a 4-inch auger. (Fig. 12)

1,200 r.p.m. by a 2-horsepower motor will pump 150 gallons or more per minute at angles under 60 degrees from the horizontal.

The auger and casing should be heavy-duty. The welds between the auger flighting and the shaft have been known to fail because of the high speed. In at least one case, the original thin-walled galvanized housing developed fatigue cracks and had to be replaced with a rigid pipe housing.

Tank-Wagon Distributors

If you want to spread liquid manure on cropland, you will need a tank wagon. Although manufactured equipment is beginning to appear on the market, our experience is limited to what farmers have done with homemade or custom-made tank wagons.

Figure 13 shows a custom-built wagon with an auger in the bottom to draw out any material that settles. A fan distributor at the rear, run from the tractor power take-off, spreads the manure about 20 feet (see Figure 6).

The 500-gallon tank wagon shown in Figure 14 has no agitator and uses a simple splash system that spreads the manure about 6 feet wide. Since the tank is small, the time from the start of filling to the start of spreading is shorter than with a larger tank. As a result, settling and clogging of the discharge hole does not seem to be a problem. A 2½-inch discharge hole was found to be about the right size to minimize clogging and still not get a spread that was too heavy.

Figure 15 shows another 1,000-gallon tank wagon mounted on a 4-wheel trailer. The front of this tank

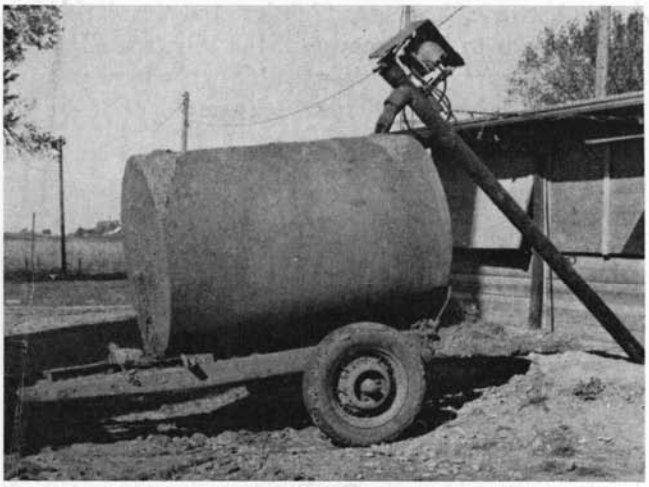
is higher than the back, and there is no agitator. It uses a splash system of spreading by means of a fan-shaped plate with angle irons attached (Figure 16).

From limited farm observations, we have reached the following conclusions about tank wagons for hauling and spreading liquid manure.

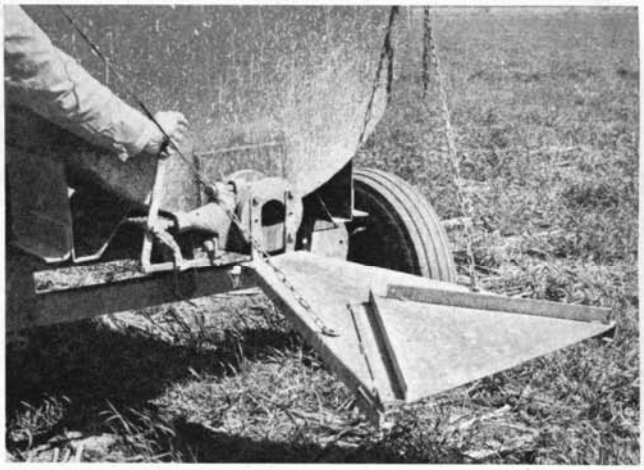
1. The maximum size should be 1,000 gallons.
2. An agitator is desirable but not absolutely essential.
3. The discharge valve should be 2½ to 3 inches in diameter. A linkage should be built so that this valve can be controlled from the tractor seat.
4. A "fan" spreader is superior to a "splash" spreader for uniform spread and to minimize the possibility of burning the crops.

A 1,000-gallon tank wagon with "fan" spreader driven by tractor power take-off through auto differential. Auger through bottom of tank serves as drive shaft as well as tank cleaner. (Fig. 13)

A 1,000-gallon tank wagon without agitator. Front of tank is 6 inches higher than rear. Manure spreads about 6 feet. (Fig. 15)



A 500-gallon tank wagon without agitator being filled with auger pump. (Fig. 14)



Three-inch quick-opening valve and fan-shaped spreader on tank wagon shown in Figure 15. (Fig. 16)

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