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Liquid Manure Handling for the Dairy Operation

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Liquid Manure Handling
for dairy cattle

Cooperative Extension Service
PURDUE UNIVERSITY
Lafayette, Indiana
in cooperation with
Indiana State Board of Health
LIQUID MANURE HANDLING FOR DAIRY CATTLE

These Guidelines were prepared jointly by the Indiana State Board of Health and Purdue University

Authors: H. W. Koenig, Indiana St. Board of Health, B. W. Mitchell and J. E. Mentzer, Extension Agricultural Engineers, N. J. Moeller, Dairy Extension Specialist

Introduction

Proper disposal of manure, bedding, wash water and other wastes is a major responsibility and problem for dairymen. To find faster and easier ways to handle manure many Indiana dairymen are considering a liquid manure system. This kind of system is still relatively new. Many construction, management and economic factors are not yet definitely established.

Sufficient acreage to spread the amount of manure produced must be available during the crop growing season.

Installation costs are still relatively high.

For these reasons, each dairymen will have to carefully consider all factors affecting the system before adapting this method of manure disposal to his own dairy operation.

This publication suggests guidelines for meeting the basic requirements for liquid manure disposal systems. Visits to existing installations and a review of other available literature will be very helpful.

A good disposal system will:

7. Make dairymen's work easier at minimum cost.

Purpose of these Guidelines

These guidelines and suggestions were developed to help Indiana dairymen in making decisions concerning liquid manure handling.

Liquid manure systems can be effective manure disposal systems. To meet at least minimum sanitation requirements and to be an efficient system careful planning, good design and construction are necessary.

If water supply contamination or pollution, fly breeding or other unsanitary conditions occur, the sanitation requirements are not satisfied. Good management and operation are just as important as proper design and construction. Proper maintenance and repair of the entire system is also essential.

Public Health Requirements

The requirements listed are consistent with those of surrounding states. Compliance with these guidelines is intended to meet requirements of milk regulatory agencies not only in Indiana but in other states as well.

Submit Plans for Approval -- Before construction begins, get approval from the health department that inspects your farm. Submit two copies of plans to the health department with a request for approval. Your dairy plant fieldman can help you prepare these plans.

Plans submitted for approval should show:

- Layout and location of cow lot, surrounding buildings and the liquid manure storage tank.
- Location of liquid manure storage tank in relation to any water supply -- give distance in feet.

- Number of animals to be handled by this system -- include cows, heifers and any other animals.

- Type of material used to construct the manure storage tank and inside dimensions -- depth, length and width or diameter of tank.

- Cross section of the tank in relation to ground level or floor level if in a building. Also, show the opening where the tank will be emptied and how the tank will be ventilated if it is inside a building.

- Ground slope of area where tank is to be installed and where manure is to be stored if it is not hauled directly to the field or put into the tank.

- How surface water will be kept from flooding the tank.

**Fly Control** -- Any manure handling system should be designed and operated to prevent fly breeding. Since flies carry disease, their presence in milk, or on surfaces contacted by milk, could possibly transmit diseases. Every possible effort must be made to control flies. The best system to control fly population is to eliminate breeding places. For that reason, manure should not be allowed to accumulate and manure tanks must be built to minimize fly breeding. Because of the problems involved in keeping slotted floors and gutter gratings clean, present milk regulations do not permit their use.

Concrete lots can be scraped with a tractor blade.

Cattle holding areas need curbs high enough to prevent spillover when manure is scraped. Manure spilled over curbs provides an excellent place for flies to breed.

**Prevent Dirty Cows** -- Keeping lots clean will help keep cows clean and prevent excessive **runoff of manure** from the lot during heavy rains. Don't let manure accumulate in loafing areas or holding pens. These areas should be routinely scraped every day. Time spent cleaning these areas will save time when washing udders and flanks before milking.

Never push large chunks of frozen manure into the storage tank. In severe cold weather frozen manure may need to be pushed to a surface storage area away from the milking herd until it can be spread on fields or put into the tank after thawing.

**Don't Contaminate Ground Water Supply** -- Liquid manure tanks should be at least 100 feet from any water supply. The exact location of the manure tank in relation to the water supply may vary in different localities according to topography, soil composition and other considerations. If possible, locate the tank down grade from the water supply. Tanks should not be placed in crevice bedrock until the location and construction is approved by the health department. Manure tanks must be watertight.

**Don't Pollute Streams and Ponds** -- Animal wastes discharged into streams reduce
the amount of oxygen in the water and provide favorable conditions for breeding of those insects or growth of bacteria capable of transmitting diseases.

As herd sizes increase more cows are handled in the cow lot and the problem of water pollution from animal sources becomes more and more apparent.

Surface water that drains from the cow lot must be diverted away from the manure storage tank so that manure will not be flushed out of the tank into a stream or pond. This surface water should be diverted to an area where wastes won't collect in pools and cause unsatisfactory conditions.

Keeping the cow lots scraped clean is the best way to prevent large amounts of manure from washing into streams and ponds. Gutter downspouts should not empty into the cow lot or manure storage tank.

Liquid manure should not be repeatedly spread on a field in the winter time because a considerable layer of manure could build up which could be washed into a stream or pond by heavy rains.

A lagoon might be considered to keep excess runoff from entering streams. Before constructing a lagoon, be sure to contact the Sanitary Engineering Division of the Indiana State Board of Health. Additional consultation with representatives of the Sanitary Engineering and Agricultural Engineering Departments of Purdue University might be desired.

Treatment of Household Wastes -- Household septic tank wastes must not be added to liquid manure tanks. They should be treated in a separate system. While spreading human wastes on the ground is common in some countries, public health authorities in the United States are opposed to the practice because of disease bacteria possibly present in the wastes.

Odor Control -- When liquid manure is agitated or spread odors may become quite distinctive. For this reason weather conditions and wind direction, in relation to populated areas, should be considered before agitating or spreading liquid manure. When possible, avoid agitating or spreading liquid manure early in the morning or during foggy weather. During these times odors will stay near the ground and be more noticeable.

Construction and Operation of the System

Storage Tanks -- The storage tank (or tanks) is a basic part of a liquid manure handling system. For successful operation the location, size, shape, construction and methods of filling and emptying should be carefully planned.

To comply with Indiana State Board of Health requirements the tank must be built no less than 100 feet from any water supply.

The tank should be placed where manure from the cow lot area, the free stall alleys and the holding area can be easily scraped.

Liquid manure tank opening inside the lot.
into the inlets. By locating the tank on the lowest side of the lot, the manure can be scraped down the slope. In some installations it may be advantageous to locate the tank inside the lot.

**Size of Tank** -- How big the tank should be depends on the number and size of the animals and how often manure will be hauled. However, it may be necessary to add water to the tank occasionally, and all the volume in a liquid tank is not usable. Ordinarily pumps do not completely empty a tank, and usually tanks are not filled completely. Frequently, water from the milk house and milking parlor is run into the tank to provide needed additional water in the tank. This is a satisfactory disposal system for milk house and milking parlor waste.

The addition of human waste to the liquid tank is not permitted.

Dairymen have tended to construct the liquid tanks too small, which demands frequent hauling. It seems wise to have enough tank capacity to store manure for at least 30 days or more. Tank capacity needed can be easily calculated by multiplying the number of cows by the appropriate value from Table 1. The values in Table 1 include an allowance for the non-usable tank space and for adding extra water.

**Example:** Storage required = number of cows times storage per cow (from Table 1). The storage requirement for sixty 1,400-pound cows for 30 days is found by using values shown in Table 1.

60 cows x 72 cubic feet per cow = 4,320 cubic feet. Or, 60 cows x 540 gallons per cow = 32,400 gallons. The tank dimensions can be selected from Table 2.

**Tank Construction** -- Health regulations require watertight and fly-tight construction of liquid manure tanks. Normally, liquid manure tanks will be built below ground where tank failure could be caused by inward pressure of ground water when the tank is empty.

When tanks are properly designed and constructed, various building materials such as poured reinforced concrete, and protected metals can be used. It is difficult to construct a satisfactory tank with concrete blocks or conventional silo staves.

In most cases the tank top should be strong enough to support livestock and the equipment used to fill and empty the tank. Faulty tank and cover construction could be a serious safety hazard as well as health hazard. Therefore, the advice and experience of a competent construction specialist should be used. Plans for round and

<table>
<thead>
<tr>
<th>Animal size (pound)</th>
<th>Excrement 15 days cu. ft</th>
<th>Storage required per cow</th>
<th>Excrement 60 days cu. ft</th>
<th>Storage required per cow</th>
<th>Excrement 90 days cu. ft</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>cu. ft/gal.</td>
<td>cu. ft/gal.</td>
<td>cu. ft/gal.</td>
<td>cu. ft/gal.</td>
<td>cu. ft/gal.</td>
</tr>
<tr>
<td>500</td>
<td>.63</td>
<td>14.2</td>
<td>28.4</td>
<td>56.8</td>
<td>85.2</td>
</tr>
<tr>
<td>750</td>
<td>.94</td>
<td>21.1</td>
<td>42.2</td>
<td>84.4</td>
<td>126.6</td>
</tr>
<tr>
<td>1,000</td>
<td>1.26</td>
<td>28.4</td>
<td>56.8</td>
<td>113.6</td>
<td>170.4</td>
</tr>
<tr>
<td>1,200</td>
<td>1.35</td>
<td>30.4</td>
<td>60.8</td>
<td>121.6</td>
<td>182.4</td>
</tr>
<tr>
<td>1,400</td>
<td>1.60</td>
<td>36.0</td>
<td>72.0</td>
<td>144.0</td>
<td>216.0</td>
</tr>
</tbody>
</table>

a/ Based on 1 1/2 times storage requirements for total daily excrement to allow for non-usable space and addition of liquid.
Table 2. Storage capacities for tanks of different dimensions

<table>
<thead>
<tr>
<th>Tank dimensions</th>
<th>Rectangular tanks</th>
<th>Round tanks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total capacity</td>
<td>Diameter x depth</td>
</tr>
<tr>
<td></td>
<td>cu. ft.</td>
<td>gallons</td>
</tr>
<tr>
<td>W x D x L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 x 4 x 30</td>
<td>480</td>
<td>3,600</td>
</tr>
<tr>
<td>6 x 6 x 30</td>
<td>1,280</td>
<td>9,600</td>
</tr>
<tr>
<td>8 x 8 x 30</td>
<td>1,920</td>
<td>14,400</td>
</tr>
<tr>
<td>10 x 10 x 30</td>
<td>3,000</td>
<td>22,500</td>
</tr>
<tr>
<td>12 x 10 x 30</td>
<td>3,600</td>
<td>27,000</td>
</tr>
<tr>
<td>14 x 10 x 30</td>
<td>4,200</td>
<td>31,500</td>
</tr>
<tr>
<td>16 x 10 x 30</td>
<td>4,800</td>
<td>36,000</td>
</tr>
<tr>
<td>18 x 10 x 30</td>
<td>5,400</td>
<td>40,500</td>
</tr>
<tr>
<td>20 x 10 x 30</td>
<td>6,000</td>
<td>45,000</td>
</tr>
<tr>
<td>25 x 10 x 30</td>
<td>7,500</td>
<td>56,250</td>
</tr>
<tr>
<td>30 x 10 x 30</td>
<td>9,000</td>
<td>67,500</td>
</tr>
</tbody>
</table>

**NOTE:**

When choosing tank depth, consideration should be given to the ground water table. If the normal water table is above the base of the tank, construction will be difficult. If the water table is much above the base of the tank, water pressure from the outside of an empty tank might cave in the walls of the tank. Also, if the tank should become plugged the manure might need to be removed by hand, or auger. The tank should not be too deep for some type of auxiliary removal of manure.

Rectangular reinforced concrete tanks are available from the Farm Building Plan Service, Agricultural Engineering Department, Purdue University, Lafayette, Indiana 47907. These plans are available through your local Cooperative Extension Office.

Holes are needed in the tank cover to install equipment and to fill the tank. The fill hole should be about 8 to 12 inches wide and slightly longer than the width of the blade used to scrape the lot so that the manure can be shoved into the tank. The size, location and shape of holes for equipment should be determined by the equipment manufacturer. One hole should be large enough for a man to enter the tank for maintenance.

Tanks constructed under buildings should be vented to the outside.

**Agitation and Water Control** -- Dairy cattle manure averages about 85 percent moisture (feces and urine). This manure may not be of a pumpable consistency. If hay and bedding are mixed in the manure, the moisture content may be even lower. Therefore, some additional water is generally needed in the liquid tank. During hot, dry weather the manure on the lot may lose considerable moisture, so a fairly large amount of water will need to be added to the tank.

During rainy periods, excessive surface water might drain from a cow lot into a liquid manure storage tank and cause the tank to flood. A storage tank filled with rain water is useless. In addition, there is a possibility of polluting streams or ponds with the overflow from the tank. Surface water may be added
to the tank only by closely controlled methods. At all other times it must be diverted away from the tank. Tight lids on tank inlets will help avoid flooding. Downspout drainage from buildings should be directed away from the cow lot and manure storage tank.

Waste water from the milk house and milking parlor may be discharged into the tank to increase the moisture content and improve the pumping consistency of the manure.

Table 3 shows how much extra water is needed to raise the moisture content of the manure to pumpable consistency. The actual figures are not important. Most managers will rapidly develop a good judgment of the additional water needed. However, it is important to remember that additional water may be needed in fairly large quantities during part of the year. Therefore, a plentiful source of water is needed. Approximately one foot of water should be placed in tank before adding manure.

It is wise to keep as much long fibrous material as possible out of the tank. Although pumps with choppers have been designed to handle this material, long pieces or too much hay and bedding may plug the pump. Sand, gravel, shelled corn and other heavy solids should be kept out of the tank because they will settle to the bottom and be difficult to remove.

Large amounts of frozen material should not be scraped into the tank because they could damage the agitator or cause the entire

<table>
<thead>
<tr>
<th>Initial moisture</th>
<th>Volume manure</th>
<th>Volume water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (wet basis)</td>
<td>percent</td>
<td>cu. ft.</td>
</tr>
<tr>
<td>80 (quite thick slurry)</td>
<td>85</td>
<td>1</td>
</tr>
<tr>
<td>90 (fairly thin)</td>
<td>90</td>
<td>1</td>
</tr>
<tr>
<td>95 (irrigation consistency)</td>
<td>95</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moisture changed to:</th>
<th>Volume manure</th>
<th>Volume water</th>
<th>Water added</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (wet basis)</td>
<td>percent</td>
<td>cu. ft.</td>
<td>gallons</td>
</tr>
<tr>
<td>80 (quite thick slurry)</td>
<td>85</td>
<td>1.48</td>
<td>11.1</td>
</tr>
<tr>
<td>90 (fairly thin)</td>
<td>90</td>
<td>2.92</td>
<td>21.9</td>
</tr>
<tr>
<td>95 (irrigation consistency)</td>
<td>95</td>
<td>1.96</td>
<td>14.7</td>
</tr>
</tbody>
</table>
tank to freeze solidly and cease operation for some time. The frozen material can either be hauled to the field with conventional equipment or stored on the surface until it thaws.

When water is added to dairy manure the high moisture content and the organic matter content of this manure tend to cause solids to float in a holding tank. Floating solids may form a crust after about two weeks if the tank is not agitated. Once this crust is formed it will continue to thicken until the tank is agitated.

Frequent agitation will prevent crusting and buildup of manure under the pit openings, but it usually causes the dense particles such as corn and sand to settle out between agitations and form a layer on the bottom which is difficult to pump. Little is known about proper agitation. But, agitation is an absolute requirement if the tank is to be completely emptied. Manufacturers' recommendations should be followed.

**Equipment** -- Two types of agitation equipment are generally available.

1. **Low horsepower, mechanical agitators** driven by 3 to 5 horsepower electric motors. Agitation would probably be required from a minimum of once a day to as much as 10 minutes every hour. Longer periods would allow more solids to build up than these small units could handle.

2. **High horsepower, pump agitators**, usually tractor driven (20 to 40 horsepower). This type of agitation uses a high velocity pump to break up the solids and form a homogeneous suspension. Agitation is usually needed only before emptying the tank. This practice reduces the frequency of agitation, associated odor and will probably reduce settling.

**Pumping** -- Three systems of pumping liquid manure from the tank to the spreader have generally been used.

1. **Vacuum tanks.** These require separate agitators.

2. **Low horsepower chopper pumps driven** by electric motors. These units normally use a separate agitator and are driven by 5 to 7 1/2 horsepower electric motors.

3. **High horsepower pumps, tractor driven.** These units serve as their own agitators.

Since the liquid storage tanks must be fly-tight, the area around permanently installed pumps should be sealed or screened. For portable equipment, it seems logical to remove the equipment when it is not in use and cover the opening with a solid, tight fitting cover.

**Spreaders** -- Several brands of liquid manure spreaders are available. They vary in size from 750 to 2,400 gallon vacuum and non-vacuum tanks. The vacuum tanks can use pressure to unload. The gravity unloading tanks frequently use a hydraulic motor to spread the liquid. Operators of spreaders that spray the liquid manure in a relatively high pattern may not want to unload while going down wind.

Spreaders have been relatively trouble free, mechanically. Because of the heavy weight of the larger spreader tanks, tractors

![Gravity flow liquid manure spreader with baffle plate, manure deflector and large balloon tires.](image)
large enough to handle the spreader must be available. Wide, low compression tires on a liquid spreader are a desirable feature. Narrow tires will leave deep ruts in soft ground and possibly mire down or get stuck.

Lot Cleaning Equipment -- Lots are generally cleaned with a tractor scraper. A wide blade is desirable to scrape large areas of lots, but the blade must fit the alleys. Some farmers have placed wings on the end of the regular blade with some forward slope to help move the liquid manure. The tank opening should be sized and located to accommodate the scraping equipment. Curbing around lots will help keep manure from spilling outside the lot.

Safety Precautions -- All tank openings should be fitted with fly-tight covers and protected with grills to keep humans or animals from falling into the tank.

Ventilate the tank to remove toxic gases before entering. Never enter a tank alone. Always have someone outside the tank who can provide help if you happen to get into trouble.