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# PLANNING FOR A LIQUID MANURE DISPOSAL SYSTEM FOR A LIVESTOCK ENTERPRISE

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# Before Deciding on a Manure System, Consider These Points:

## Amount of Manure Produced

The volume of manure produced per animal per day varies with the size of the animal and the quantity and quality of feed consumed. The figures in Table 1 are average values obtained from various research data. In regard to dairy cows, add 3 gallons per day per cow to allow for washing of holding and milking areas. If a flush system is used for the total dairy cleaning practice, add 25 gallons per cow per day to the figures given in Table 1.

**Table 1. Amount of Manure Produced Per Animal Per Day**

| Animal | Weight (pounds) | Gals. per day (solids & liquid) | Cubic ft. per day | No. animals to produce 1 ton |
|---|---|---|---|---|
| Horses | 1,000 | 5.25 | 0.70 | 46 |
| Beef cattle | 500 | 5 | 0.67 | 48 |
| | 800 | 7 | 0.93 | 34 |
| | 1,000 | 8.5 | 1.13 | 28 |
| | 1,200 | 10 | 1.33 | 24 |
| Dairy cattle | 800 | 10 | 1.33 | 24 |
| | 1,000 | 12 | 1.60 | 20 |
| | 1,200 | 14 | 1.87 | 17 |
| | 1,400 | 16 | 2.13 | 15 |
| Hogs | 50 | 0.5 | .067 | 500 |
| | 100 | 1.0 | .133 | 250 |
| | 150 | 1.60 | .213 | 160 |
| | 200 | 2.10 | .28 | 120 |
| | 250 | 2.60 | .35 | 97 |
| Poultry | | | | |
| 79-80% $H_2O$ | | .028 | | 10,000 |
| 20-25% $H_2O$ | | | | |
| Sheep | | 0.40 | | 600 |

## Availability of Disposal Land

Soils with relatively high clay content usually retain large amounts of nutrients. Soils with low clay content have good internal drainage, but they have less ability to retain nutrients and excessive leaching of nutrients could occur. This downward leaching of nutrients from the top soil could cause groundwater pollution unless the nutrients, such as nitrates and phosphorus, are used by the plants. Manure should be disposed of on land having a cover crop, corn, or grasses.

In western Oregon the best area of disposal would be on the oldest grass stand preceding the planting of corn. The next desirable area would be on grasses with very little clover, or small grain crops. The amount spread on each field can be best determined by the plant nutrients required and the possible grazing following the liquid manure application. If the manure is applied by an irrigation system and washed off the leaves, another 15 days are required before proper pasturing for the livestock can be planned.

Table 2 shows the amounts of nitrogen, phosphorus, and potassium per ton of manure excreted from various livestock. One acre of land should be the minimum area for the disposal of the manure of 2 cows, 4 feeder cattle, 20 sheep, 10 hogs, or 200 laying hens. Fresh manure application under these conditions would place approximately 280 pounds of nitrogen on each acre, based on 365 days of livestock production. Nitrogen is lost from the manure while in storage and while the manure slowly filters into the soil after spreading. The urine contains approximately 50% of the nitrogen in the form of urea. Although the storage and field losses of nitrogen will not be as high when using a liquid manure system as with the dry manure spreader, losses of 20% or more could be expected. Tests at Wisconsin have shown that up to 60% of the nitrogen in fresh manure spread daily is lost within four days if the manure is not worked into the soil at once.

**Table 2. Average Amounts of Nitrogen, Phosphorus, and Potassium in Manures From Different Farm Animals[1]**

| Kind of manure | Percent water | Nitrogen | Phosphorus | Potassium |
|---|---|---|---|---|
| | | (pounds per ton of manure) | | |
| Chicken | | | | |
| From dropping boards without litter | 54 | 31.2 | 8.0 | 7.0 |
| With old floor litter | 61 | 33.8 | 12.4 | 12.8 |
| Dairy cattle | 79 | 11.2 | 2.0 | 10.0 |
| Fattening cattle | 80 | 14.0 | 4.0 | 9.0 |
| Hog | 75 | 10.0 | 2.8 | 7.6 |
| Horse | 60 | 13.8 | 2.0 | 12.0 |
| Sheep | 65 | 28.0 | 4.2 | 20.0 |

[1] From Michigan State University Circular Bulletin 231, 1961.

Under some experimental conditions the manure from 3,500 laying hens has been plowed into a half acre of land during three successive years. The repeated application of manure at these very high rates greatly increases the serious hazard of salt concentration in the soil, which can be toxic to soil bacteria and growing crops. In addition, the groundwater could become polluted if the soils are not checked annually for the amount of nutrients that may be accumulating. Soil with soluble nitrates exceeding crop needs could eventually cause nitrogen pollution of the groundwater.

Soils also can act as excellent bacteria filters. Percolation experiments at Wisconsin in 1969 revealed that soils can act as a good filter for the removal of bacteria Escherichia coli and enterococci found in animal waste. On a silt loam soil, over 50% of the coliform and enterococci were removed in the first 6 inches of soil, over 90% was removed in the first 10 inches, and 95% in the first 14 inches.

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## Determining Liquid Manure Tank Size

### *Using tractor and liquid manure wagon*

(1) Determine the necessary storage period. This is primarily determined by field conditions suitable for transport of a manure wagon without causing damage to the fields and equipment due to soft ground. In Tillamook County 60 days of storage are generally desired. The most common manure storage periods in Idaho are between 30 and 90 days.

(2) Use data from Table 1 to determine the amount of manure produced per animal.

(3) Determine the amount of rain water and wash water drained into the tank during the storage period. Use highest rainfall months for the storage period.

*Sample calculation:*

Number of dairy cows: 100
Storage period: 2 months
Rainfall: 18 inches (Jan. and Feb.)
Square feet of concrete feeding alley area not under roof that drains into tanks: 2,000
Wash water from milking parlor draining into tank: 3 gallons per cow per day.

Then: Tank size = A x B x C + (D x E)
Tank size = (14 + 3) x 60 x 100 + (2,000 x 1.5 x 7.5) gallons
Tank size = 124,500 gallons

Where A = manure per cow plus wash water in gallons per day
B = Storage time in days
C = Number of cows
D = Drainage area in square feet x rainfall in feet for 60 days
E = Conversion factor to convert cubic feet to gallons.

### *Using manure sprinkling system and pump*

(1) Determine necessary storage time. Normally you can pump the manure whenever the soil is not saturated with water, frozen, or covered with snow. You also may be limited by odors present under certain climatic conditions, such as hot weather and periods when the wind may carry the odors to nearby residences. Sometimes equipment failures, such as pump bearings, can cause as much as four to ten days' delay in pumping.

To operate a manure sprinkling system properly, be certain the manure slurry does not have more than 8% dry matter content. It would be best to reduce dry matter below 5% to reduce friction losses. Normally in western Oregon the wash water and feedlot drainage will supply sufficient water so the manure can be pumped from the pit into manure wagons with vacuum or centrifugal pumps. This manure has about 10 to 14% dry matter.

According to research conducted at Michigan State University, pipe friction losses for manure at 3% dry matter are double that of water at the same velocity and temperature. With 8% dry matter in the manure slurry the pipe friction losses could be 20 times that obtained with water at the same discharge conditions. As the amount of dry matter in the manure increases, the friction losses rise very rapidly. If the liquid is to be pumped long distances, the pumping rate, the size of pipe, pump characteristics, and manure characeristics become critical factors to consider. Follow your pump manufacturer's recommendations closely. Pump and motor failures can result from trying to pump manure that is too thick. Add water to the manure if an irrigation system is used. The additional amount of water necessary will vary from approximately 30 to 300 percent of the manure volume, depending on the type of handling equipment used and the water content of the manure. Some farmers use a clean water storage tank adjacent to the manure tank. By use of valves on the suction line of the manure pump, water from this reservoir can be used for diluting the manure, for cleaning the pipes, and for removing manure from foliage in the field after each manure sprink'ing period. This water storage tank should have sufficient capacity to fill the irrigation lines with clean water and operate the sprinkler nozzle for approximately five minutes.

(2) Use data from Table 1 to determine the amount of manure produced per animal.

(3) Determine the amount of rain water, wash water, and additional water added to the tank for the period. Normally part of the additional water is added each day as the manure is agitated. Frequent agitation of the manure provides a slurry that is easier to haul.

*Sample calculation:*

Number of dairy cows: 100
Storage: 1 month
Additional space for manure dilution: 30%
Wash water from milking parlor: 3 gallons per day per cow
Tank size = (14 + 3) x 30 x 100 + .3 x (51,000)
Tank size = 51,000 + 15,300 = 66,300 gallons.

Under proper soil and weather conditions, and with no possibility of pollution due to run-off, a seven-day storage period could be used. In all cases, consider future herd expansion.

Where dairy cows are in pastures during the day and the manure tank is used only for the feeding area manure and wash water from the parlor, the tank size can be approximately one-half the capacity as calculated for cows in confinement housing.

## Tank Construction

A circular tank is better for manure agitation than a rectangular tank. A rectangular tank should not be longer than 80 feet unless the manure can be agitated from more than one location on the tank. Special design precautions must be taken in the construction and operation of manure tanks to avoid damage to the tank from hydrostatic water pressure. In addition to the use of steel reinforcing bars within the concrete, the concrete should be placed as a single pouring within a 24-hour period in order to prevent cracks and tank failures along the pour seams. Conventional silo staves and concrete blocks should not be used.

The tank cover must have sufficient strength to support any equipment moved upon it. The top should be able to carry a farm tractor and trailer, having a total weight of 15 to 20 tons. Where large tanks are used, supporting posts are necessary in the tank. If the tank is under a building, provide ventilation for removing odors and gases, especially during agitation and emptying. This is essential for protecting man and animal from the dangerous gases produced.

The openings on the top of the tank for pumping and agitation equipment must be located to fit the equipment used. Consult the contractor and equipment manufacturer for specific details. Follow the manufacturer's instructions for best performance of the agitation system.

Contact the State Department of Environmental Quality prior to the installation of any new manure disposal system to determine if your proposed plan meets the present state requirements. Your county Extension agent or Health Department personnel can provide you with the address of the local Department of Environmental Quality District Engineer.

Suggested design guidelines are available. Obtain USDA Plan No. 5984 for a circular tank, and Plans No. 5981 and 5987 for rectangular tanks. Consult your local county Extension agent or Oregon State University Farm Building Plan Service for these plans.

## Key Points in Planning a Liquid Manure Disposal System

1. Study various possible methods of manure handling best suited for your enterprise. Include study of the farm land, soil characteristics, slope, water table, location of waterways, and crop production schedule.

2. Determine what type of equipment you will use.

3. Discuss your proposals with various manure equipment representatives and possibly with fieldmen of your production-associated enterprises or organizations. The county Extension agent can provide guidance on steps to follow.

4. Draw a proposed plan with dimensions of manure tanks, lagoons (if any), and animal production areas. Indicate slope of manure-handling areas and the location of waterways on the farm. The county Soil Conservation Service office can assist you in use of area maps.

5. Request the State Department of Environmental Quality to inspect your proposed manure-handling facilities.

6. Determine with the assistance of your county agent if any type of financial assistance might be available for the construction of manure-handling facilities from state or USDA agencies in your county.

7. If financial assistance is available, contact the agency concerned and obtain, if necessary, written approval of your plans prior to construction.

8. Have the manure tank and lagoons (if any) built by persons or contractors that have the knowledge and skill to construct them. Use USDA plans as guidelines to determine which tank design specifications are acceptable.

9. Be sure that the tank design, location of manure drops, and location of openings for manure-handling equipment are suitable for the equipment to be used.


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