

MANAGEMENT

Liquid Manure Application Methods no. 1.223

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Quick Facts...

Calibrate the application system to reduce potential groundwater contamination from over-application.

To minimize odor and drift problems, avoid windy and hot times of the day, especially with sprinkler systems.

Proper water management is a critical component for liquid manure application under irrigated conditions.

Liquid manure can be applied several ways. Under irrigated conditions, the irrigation system itself can be used. Liquid manure also can be applied with surface applicators using tankers or drag hose systems. A surface application system has certain advantages and disadvantages as compared to a sprinkler system.

	Surface Application	Sprinkler Application
Conservation of manure N	More	Less
Odor	Less	More
Soil compaction	More	None
Flexibility in application timing	Less	More

Calculate a calibrated application rate (gallons or acre-inches per acre) using one of the methods outlined below. Multiply it by the nutrient analysis of the liquid manure to determine the amount of nutrient applied.

Irrigation System Methods

The most widely used sprinkler application methods are center pivot and traveling gun. In addition, solid set, side roll and low-pressure drop nozzle systems can be adapted for effluent application. An above-canopy sprinkler application has an advantage during effluent application by providing nutrients to crop foliage in addition to soil surface application. However, this may result in increased odor problems and potential for burn.

Calibrating Sprinkler Systems

Three methods may be used to calibrate sprinkler systems. Under all three, nozzles should be the same size to ensure a uniform application rate. Also, the nozzle size must be suitable for applying effluent without plugging.

1. **Depth measurement method.** If there is no measurement device at the pump, the system can be calibrated as follows:

$$\frac{A \times (B - C) \times 0.62^*}{D \times E}$$

Where:

A = Surface area in square feet of the pond or lagoon (length x width).

B = Initial pond or lagoon depth in inches before application (depth₁).

C = Pond or lagoon depth in inches after application (depth₂).

D = Field area in acres under the sprinkler.

E = Portion of the field area completed (in decimal form where 1 is the whole field and half is 0.5, etc.).

* 0.62 is the conversion factor for inches to feet and cubic feet to gallons.

** 27,154 is the conversion factor for gallons to acre-inches.

2. **Volume measurement method.** If flow meters or other measuring devices are used, the application rate can be calculated as follows:

$$\frac{B - A}{C \times D}$$

Where:

- A = Initial flow meter reading either in gallons or acre-feet before pumping.
 - B = Final flow meter reading after application is completed.
 - C = Field area in acres under the sprinkler.
 - D = Portion of the field area completed (in decimal form where 1 is the whole field and half is 0.5, etc.).
3. **Can test method.** Set up 12 to 24 rain gauges under the sprinkler system with 5 to 10 feet between them. Run the sprinkler system with irrigation water prior to applying liquid manure. Repeat this test in different areas of the field to get a precise application rate. Measure depth of applied water in each rain gauge and calculate the average application rate in inches per acre.

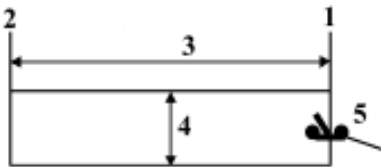


Figure 1: Calibrating traveling guns.

1. First stake.
2. Second stake.
3. Traveling distance.
4. Width of the wetted area.
5. Traveling gun and hose.

Calibrating Traveling Guns

To calibrate a traveling gun system (see Figure 1):

1. Estimate the surface area (square feet) of the pond or lagoon by measuring its length and width. Measure the initial pond or lagoon depth at the time of pumping (depth₁ in inches).
2. Mark the starting location of the traveling gun.
3. Measure the width of the area wetted by the irrigation nozzle. It should be perpendicular to the traveling distance (in feet).
4. Mark the final location of the traveling gun with a stake.
5. Measure the lagoon depth (depth₂) in inches.
6. Measure the travel distance between the two stakes in feet.
7. Calculate application rate as:

$$\frac{A \times (B - C) \times 27,154^*}{D \times E}$$

Where:

- A = Lagoon area in square feet.
- B = Lagoon depth when pumping begins, in inches (depth₁).
- C = Lagoon depth after pumping, in inches (depth₂).
- D = Travel distance, in feet (3 in Figure 1).
- E = Width of the wetted area, in feet (4 in Figure 1).
- ** 27,154 is the conversion factor for gallons to acre-inches.

Surface Application Methods

Transporting liquid manure to the field can be time-consuming and expensive. One method is to use large nurse tanks that can fill a tank wagon two to four times. Another is to pump manure to a remote storage site or directly into application equipment. A third option is a drag-hose system that delivers liquid manure directly to a field implement or injector unit pulled by a tractor.

The drag-hose system considerably reduces soil compaction as compared to tanker trucks. The reduced weight also allows for more flexibility in application timing. However, the flexible drag-hose requires at least two tractors and does not work well on irregularly shaped fields or sloping land.

Liquid manure (up to 4 percent solids) can be pumped with normal pumping equipment, but manure with 4 to 15 percent solids requires special equipment. (See 1.221, *Liquid manure management*.) Once the liquid manure is in the tank, agitation is necessary to prevent settling. Liquid tankers generally are fitted either with a splash plate or with drop hoses. Drop hoses can apply manure

Table 1: Impact of application method on nitrogen volatilization losses.

Application Method	Estimated Loss to the Atmosphere*
Broadcast without cultivation	10 - 25%
Broadcast with cultivation	1 - 5 %
Injection	0 - 2 %
Sprinkler irrigation	35 - 60 %

* Values reflect total N loss under each application method.

beneath the crop canopy, closer to the soil surface, and thereby reduce ammonia loss and odor and improve application uniformity. These systems rely on gravity to empty the load. This results in a changing application rate as the tank empties. Boom style application units for attachment to tank wagons are becoming more common.

Incorporating liquid manure significantly reduces ammonia loss to the air and the odor associated with these losses (Table 1). Injector knives are the traditional option for incorporation. They provide limited mixing with the soil by placing manure in a vertical band and require considerable power. Injector knives with sweeps place manure in a wider and shallower band, thus reducing power requirements and increasing potential application rates. S-tine cultivators and concave disks have low power requirements and provide good soil mixing.

Liquid manure should be surface-applied and incorporated as near to the planting date as possible to maximize nutrient availability. However, if planting immediately follows heavy manure application, germination and seedling growth could be reduced due to ammonia burn or salt damage.

Calibrating Surface Applicators

Calibration of manure applicators can be done either on a weight or a volume basis. Calculate the tank volume by one of the following methods:

1. **Weight Method.** Weigh the tank full, then weigh it again after spreading (empty). Calculate the difference between these two weights to get the weight of the liquid manure. To convert the weight (in pounds) to gallons, divide pounds by 8.3. Ideally, several loads should be weighed and averaged to improve accuracy.
2. **Volume Method.** Calculate the volume of the tank by measuring the tank size in feet: length, depth and width.
 - a. If the tank is round, depth = width, and volume = length x depth x depth x 0.8.
 - b. If the tank is oval (depth is less than width), then volume = length x depth x width x 0.8.

Convert the volume (in cubic feet) to gallons by multiplying cubic feet by 7.48. The tank must be completely full to use the calculated volume for calibration.

Determining Application Rate

After determining the volume of the tank in gallons, the next step is to measure the size of the area that is spread with one full load.

1. Measure swath width in feet of one pass at normal operating speed. Allow for typical overlap.
2. Measure distance traveled in feet while emptying the tank. This can be done several ways:
 - a. Count fence posts and measure the distance between them.
 - b. Measure the distance traveled by using a wheel meter, counting paces, or any other method.
3. Calculate the application rate:

$$\frac{\text{Tank volume} \times 43,560^*}{\text{Swath width} \times \text{Distance traveled}}$$

* The number of square feet per acre.

4. To determine pounds of N applied per acre, multiply the number of gallons applied by the nitrogen content in pounds per gallon from the liquid manure analysis.

Proper irrigation water management is critical for reducing leaching and runoff losses where liquid manure is applied.

Water Management and Irrigation Scheduling

Because of the potential for deep percolation or surface runoff with over-irrigation, proper water management is a critical component for liquid manure application. Irrigation scheduling using weather data, soil moisture monitoring devices such as gypsum blocks, soil probes, plant indicators, etc., is a key factor in managing liquid manure applied to irrigated fields. To manage and schedule irrigation efficiently, consider the following:

1. **System efficiency.** Know the efficiency of the irrigation system in order to apply the required amount of water. Upgrade the system to improve efficiency if losses are unacceptably high.
2. **Soil texture.** Texture dictates the maximum water-holding capacity of the soil. Excess water will cause movement of $\text{NO}_3\text{-N}$ and other contaminants to ground and surface water as deep percolation or runoff.
3. **Crop water needs.** Crop water needs are available from Colorado State University Cooperative Extension, Natural Resources Conservation Service, irrigation district offices, or crop consultants. Apply the correct amount of water at each irrigation to reduce the potential $\text{NO}_3\text{-N}$ contamination from liquid manure or any other N source.

References

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