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F 256

Irrigation of Liquid Manures With Center-Pivot Irrigation Systems

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This fact sheet emphasizing how to check a center-pivot liquid manure system for appropriate applcation rates is part of a fact sheet series. If you have not read, or are not familiar with the fact sheet F-254 *Irrigation of Liquid Manures: Basic Principles and Procedures*, please read it before trying to use the information in this fact sheet.

Center Pivot

A center pivot irrigation system is a single lateral, fixed at one end (the center of the field) and elevated on wheels that transport the lateral around the field at some speed of rotation. Center pivot laterals come in varying lengths from a few hundred feet to over 1000 feet. In Pennsylvania there are very few fields that can fully utilize the capabilities of a center pivot irrigation system. In addition, the center pivot has many disadvantages that make uniform application of manure extremely difficult. These include:

ï The sprinklers near the pivot must be very small to apply manure to the small areas near the center of the field. These small sprinklers may have nozzles as small as 1/16 inch; much too small to pass any liquid except clean pure water. To prevent plugging, inner sprinklers are usually oversized, thus applying excessive wateróin the case of manure excessive nutrients.

ï A second disadvantage is that the center pivot is a permanent installation. It cannot be moved. This usually leads to over application of nutrients under center pivot systems.

ï They do not work well on slopes and varying terrain. The maximum recommended variation in elevation is 30 - 40 feet.

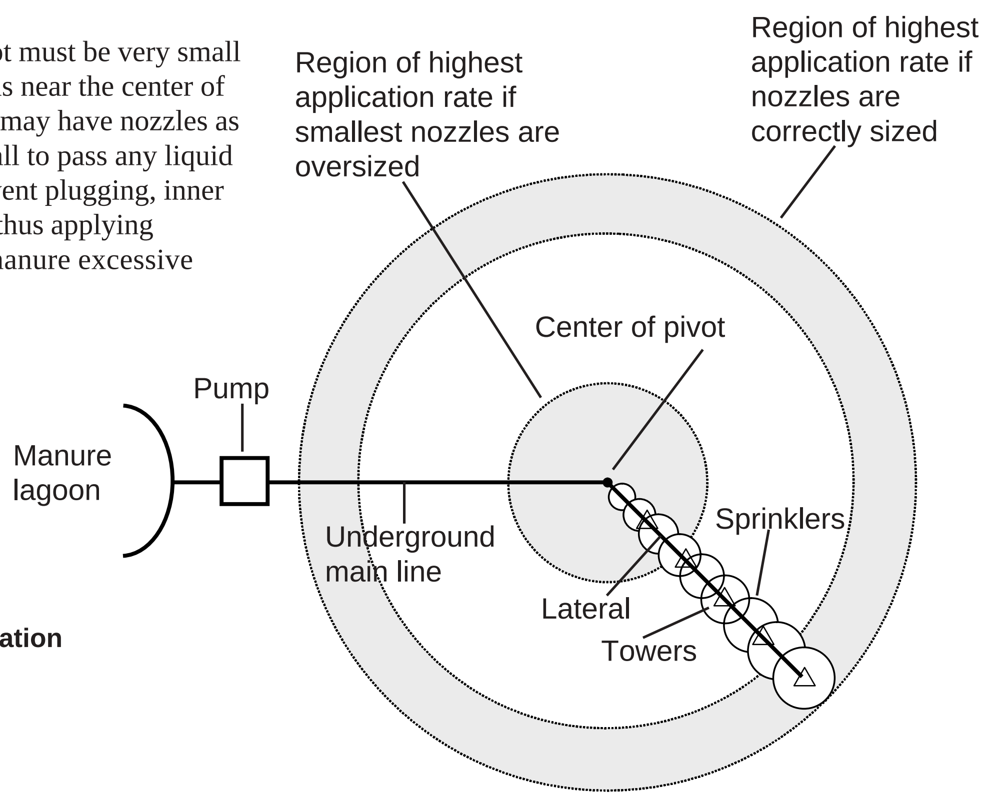

Figure 1. Center Pivot Irrigation System.

ï They do not irrigate corners of fieldsóthey were developed to be used on flat, square quarter sections in the western U.S.

There are several advantages to using center pivot systems. These include:

ï Low labor application of large volumes of manure onto large fields.

ï Low operating costs including fuel costs if low-pressure sprinklers are used.

Generally center pivot irrigation systems should not be used to apply manure unless the design is overseen by a qualified engineer. The field should also be regularly evaluated to ensure that the proper amount and uniformity of manure is being applied.

Center pivot irrigation systems are often used for applying supplemental irrigation water because they are easily automated. Because of this convenience, producers often look to center pivot systems as a convenient system to apply liquid manure. Center pivots, however, rarely provide the best performance for liquid manure application. Center pivot systems have two major drawbacks when it comes to irrigating liquid manure; (1) they have a fixed location (a center pivot system is installed in one field to irrigate that one field) and cannot easily be moved to an alternate location and (2) they have small sprinklers with small nozzles, especially near the source (or center) of the pivot.

Application Rate. The system designer is the best source of determining the application rate of a center pivot system. Another method is to place collection buckets at several locations along the length of the pivot and measure the amount of time they receive liquid and the depth they receive. Dividing the depth of manure by the length of time the bucket was receiving manure will give the application rate. The highest rate computed (from all the bucket-positions evaluated) should be used as the application rate for the center-pivot system. This is the application rate that must be less than the soil's infiltration rate if no manure runoff is to occur.

Jensen (1983) has derived a formula that can be used to estimate the maximum application rate under center-pivot irrigation systems designed to apply supplemental irrigation water. This formula assumes all the sprinklers on the center-pivot lateral are correctly sized to apply water uniformly over th entire field.

$$A_r = \frac{122.5Q_t}{LR} \qquad (1)$$

The 122.5 is a unit conversion constant. The largest sprinkler radius, R is usually about 70 feet, thus 70 feet can be used as the value of R. The application rate computed from Equation 1 reflects how rapidly the soil must infiltrate manure if no manure runoff is to occur. The following example will show how these equations are best used.

Example 3. A center pivot irrigation system with sprinklers will be used to apply manure to a field growing hay on a silt loam soil. The pivot lateral is 1,300 feet long and the total discharge of manure flowing to the lateral is 800 gpm. Determine the maximum application rate under the center pivot's lateral.

Solution: Assuming the center pivot's sprinklers have been slected to yeild a uniform application depth, the maximum applciation rate can be determined from equation 1. As noted above if we assume the largest sprinklers on this center pivot have a radius of 70 feet, the maximum application rate will be

$$A_r = \frac{122.5(800)}{1300(70)} = 1.08 \text{ inches/hr}$$

It should be noted that the application rate computed in Example 1 was 1.08 in/hr. Before proceeding with the liquid manure irrigation design, it is very important that you determine if this application rate exceeds the soil's ability to absorb liquid manure. Suggested resource include Tables 1,2 and 3 of Fact Sheet F-254 or a qualified soil scientist. When Tables 1 and 2 of Fact Sheet F-254 are examined, it is obvious that 1.08 in/hr is greater than the infiltration rate listed for a silt loam soil. Thus, **some runoff of manure would be expected** unless there was addtional data to show that this particular field had infiltration rates greater than 1.08 in/hr.

It should also be noted that equation 1 and the situation posed on Example 1 were based on the assumption that all sprinklers on the center pivot were selected to yield a uniform depth of application to the whole field. As noted above, it is not uncommon to modify the small sprinklers near the center of the field to have oversized nozzles so liquid manure can be applied without clogging these smallest sprinklers. If oversized nozzles have been installed in any of the sprinklers on your center pivot, especially the small sprinklers near the center of the field, the only way to properly determine the application rates is to use the bucket technique described above.

References

Jensen, M. E. 1983. *Design and Operation of Farm Irrigation Systems*. ASAE Monograph Number 3. Published by ASAE, 2950 Niles Road, St. Joseph, MI 49085.

Geohring, L. D. and H. M. van Es. 1994. Soil Hydrology and Liquid Manure Applications. In Liquid Manure Application Systems: Design, Management, and Environmental Assessment. NRAES-79. Northeast Regional Agricultural Engineering Service. Ithaca, NY. pp. 166-174.

MWPS. 1985. Livestock Waste Facilities Handbook MWPS 18. Midwest Plan Service. Ames, IA.

Other Related Penn State Ag Engineering Fact Sheets

E-27 Farm Pond Safety
E-28 Manure Storage Hazards
F-254 Irrigation of Liquid Manures
F-255 Irrigation of Liquid Manures with a Traveling Gun
F-257 Irrigation of Liquid Manures with Solid Set Systems
G-72 Dairy Manure Handling
G-79 Odor Control for Animal Production Operations
H-71 Environmental Issues, Environmental Considerations and Dairy Farms

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Evaluating a Center Pivot Liquid Manure Application System

Assessment Data. To be able to fully assess the suitability of a center pivot irrigation system design the following information should be provided:

1. Total Lateral Discharge (Q_T) = _______ gpm

2. Lateral Length (L) = ______________feet

3. Lateral Pressure at the pivot = ____________psi

4. Largest sprinkler radius (R) = ___________feet

5. A sketch of the field where the center pivot system will be used along with indications of where the lateral will cover.

6. A sketch of the field and all environmentally sensitive features within 1,000 feet of the field including streams, waterways, ponds, lakes, wells, springs, sinkholes, rock outcrops, homes, roads, subdivisions, steep slopes etc. Also show slope and wind direction.

Related Websites

Northeast Regional Agricultural Engineering Service - NRAES www.nraes.org

Penn State College of Agricultural Sciences (Publications) www.cas.psu.edu

Midwest Plan Service - MWPS www.bae.umn.edu/extens/mwps/

Agricultural and Biological Engineering www.abe.psu.edu

Other Information

Dougherty, M., L. D. Geohring, and P. Wright. 1998. Liquid Manure Application Systems Design Manual. NRAES-89. Northeast Regional Agricultural Engineering Service. Ithaca, NY. 168 pp.

MWPS. 199. Sprinkler Irrigation Systems. MWPS-30. Midwest Plan Service. Ames, IA. 250 pp.

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