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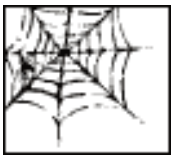

EPA promulgated regulations for Concentrated Animal Feeding Operations (CAFOs) in February 12, 2003 that expanded the number of operations covered by the CAFO regulations and included requirements to address the land application of manure from CAFOs. The rule became effective on April 14, 2003. NPDES-authorized states were required to modify their programs by February 2005 and develop state technical standards for nutrient management. On February 28, 2005, in response to litigation brought by various organizations, the Second Circuit court issued its decision in *Waterkeeper Alliance et al. v. EPA*, 399 F.3d 486 (2d Cir. 2005). EPA has updated the CAFO rule to reflect the changes requested by the Court. Visit www.epa.gov/npdes/caforule to view the 2008 CAFO Final Rule and supporting documents.

APPENDIX J - CALIBRATING ANIMAL WASTE SPREADERS AND IRRIGATORS

Animal waste should always be applied uniformly and at a rate consistent with nutrient demand. Although many equipment options exist, there are basically three general methods of application: subsurface application, irrigation, and surface application. The method of application, however, is generally dictated by the form of the animal waste (i.e., solid, semi-solid, liquid). For example, solid animal waste is generally best applied using a surface spreader or subsurface system. Liquid animal waste is applied by pump and liquid spreader, subsurface, or irrigation system. Semi-solid animal waste can be handled as a solid or a liquid; therefore, it can be applied with a surface spreader, liquid spreader, subsurface, or irrigation system. This appendix discusses calibration techniques for surface application, subsurface application, and irrigation.

Description

Animal waste spreader calibration is a key component of nutrient management. To properly calibrate your system, you will need to know your animal waste application rate (see Appendix I).

You can perform animal waste spreader calibration using two direct methods: load-area and weight-area. Both methods require measuring the amount of animal waste applied to the soil under different conditions. The load-area method involves measuring the amount of animal waste in a loaded spreader and then calculating the number of spreader loads required to cover a known land area. Subsurface application calibration should be done using the load-area method because soil-injected animal waste cannot be collected. The weight-area method requires weighing animal waste spread over a small surface and computing the quantity of animal waste applied per acre. You can measure the application rates for irrigation systems using the area of your liquid storage.

Animal waste should be collected after spreading, if possible. If calibrating using a large tarp or plastic sheet, then you can easily recollect the test volume. If the animal waste is spread on a known area, such as 500 or 1000 ft^3, this should be done in a field were the animal waste can be left on the surface.

Your calibration method used depends on the type of animal waste spreader used (e.g., liquid animal waste is best measured with the load-area method, while solid or semi-solid animal waste may be used with either method). Instructions for using load-area calibration and weight-area calibration, as well as for calculating irrigation rates from irrigation systems are provided below.

Instructions for Load-Area Calibration (Solid, Semi-solid, or Liquid Animal Waste)

Use this method when you know your animal waste spreader's capacity or animal waste weight. This approach works well with a liquid spreader filled to capacity, and is less accurate for box spreaders or other solid application systems where capacity is difficult to estimate.

Overview

1. Measure the capacity of animal waste (tons or gallons) held in the spreader load.
2. Spread a number of identical loads at a constant speed, spreader setting, and overlap.
3. Measure the total area of the spread.
4. Compute the amount of animal waste spread per acre.

Measure the capacity of animal waste (tons or gallons) held in the spreader load.

The capacity must be expressed in units compatible with the units used in the nutrient analysis and recommended application rate. The capacity is sometimes provided by the equipment manufacturer.

Liquid animal waste application is expressed in pounds of nutrient per gallon; the application rate is given in gallons per acre. Spreader capacity is given in gallons of animal waste.

Solid and semi-solid animal waste application is expressed in pounds of nutrient per ton; the application rate is given in tons per acre. Spreader capacity is given in tons of animal waste. Note that the moisture content in animal waste affects the weight. Therefore, the weight capacity of the spreader varies based on the animal waste held. The most accurate method of determining the weight of a load is to actually measure the load using farm scales.

If scales are not available, use the following steps to convert volumetric capacity to weight capacity:

- The manufacturer should supply the volumetric capacity of the spreader in cubic feet. Two capacities are usually provided: heaped load (animal waste piled higher than the sides of the box) and struck load (the volume contained within the box).
- The capacity of older spreaders is sometimes given in bushels; multiply the bushel capacity by 1.24 to determine capacity in cubic feet.
- Next, multiply the volumetric capacity (in cubic feet) by the bulk density of the animal waste (in pounds per cubic foot) and convert it to tons by dividing by 2,000.
- Bulk density depends on the amount of water, solids, and air in the animal waste and can be measured by weighing a known standard volume of animal waste. A 5-gallon bucket has a volume of two-thirds cubic foot and can be used as a standard volume by weighing an empty bucket and recording the weight, filling the bucket with animal waste from the loaded spreader (packed to the same density as in the spreader), weighing the full bucket, and subtracting the empty bucket weight to calculate the animal waste weight in pounds. Next, multiply the animal waste weight by 3, and then divide by 2 to calculate the animal waste bulk density in pounds per cubic foot of volume.
- Multiply the bulk density by the spreader capacity (in cubic feet) to calculate the weight of the spreader load in pounds, and then divide by 2,000 to calculate tons.
- Repeat this procedure at least three times, sampling the animal waste at different places and in different spreader loads.
- Average the results to obtain a representative composite of the animal waste.

Spread a number of identical loads at a constant speed, spreader setting, and overlap.

Spread at least three full loads of animal waste on the field, maintaining the same speed and spreader setting for each load. Try to spread in a rectangle or square for easy calculation.

Measure the total area of the spread.

Place flags at the four corners of the spread area. Measure the width and length between the flags (in feet) using a measuring tape, wheel, or consistent pace. Multiply the width by the length and divide that product by 43,560 to determine the area in acres.

Compute the amount of animal waste spread per acre.

Multiply the number of loads spread by the number of tons (or gallons) per load to determine the total amount of animal waste applied to the area. Divide the total amount of animal waste by the area of the spread (in acres) to determine the application rate in tons per acre (or gallons per acre).

Repeat this procedure for various speeds and spreader settings until the desired application rate is achieved, maintaining a record of the rates found at the different settings. This procedure needs to be repeated for each piece of equipment used to spread animal waste.

Instructions for Weight-Area Calibration (Solid or Semi-solid Animal Waste)

Use this method to estimate solid and semi-solid animal waste application rates.

Overview

1. Select a animal waste collection surface.
2. Secure the collection surface in the field.
3. Spread animal waste over the collection area.
4. Collect and weigh the animal waste.
5. Compute the application rate.

Select a animal waste collection surface.

Select a ground cover that can be used to collect the animal waste. The ground cover can be a cloth or plastic sheet of at least 100 square feet in area. Multiply the length of the sheet by the width to determine the area in square feet. If the animal waste is too liquid, use shallow plastic or metal pans on top of the ground cover, with a minimum area of 1 square foot each. Multiply the pan length by the width to calculate the area of one pan. Multiply the area of the one pan by the number of pans to determine the total collection area in square feet. For handling and cleaning convenience, place a plastic garbage bag inside the pan for each field test so that the bag and animal waste can be discarded, leaving the pan clean. Six or more pans are necessary for a test.

Weigh the ground cover or one pan and record the weights for use as a tare weight in calculations. You can use dirty sheets and pans for multiple tests only after removing major animal waste deposits. Weight dirty sheets and pans before each test so that any animal waste residue is included in the new tare weight.

Secure the collection surface in the field.

Lay out the ground cover, fully extended. Lay the sheet on the ground so that, as the sheet is removed from the field, the animal waste applied over the surface can be collected easily in its folds. If dirty sheets are being used for additional test, turn the dirty side up so that any animal waste residue included in the tare weight is not lost. Use stone, metal, or earth clods to hold down the cover so that the wind does not disturb it. Evenly space pans in a row perpendicular to the spreader's path. Be mindful of tires, as they can easily crush the pans. Place flags at designated wheel tracks to help avoid pan damage.

Spread animal waste over collection area.

Spread animal waste over and near the ground cover or pans in a pattern similar to that practiced during spreading. With rear outlet spreaders, make three passes: the first directly over the center of the collection area and the second two on each side of and overlapping the first pass. With side outlet spreaders, locate a first pass off of but along one edge of the collection area. Continue with subsequent passes farther away from the collection area and at the intended overlap until animal waste no longer reaches the surface.

In all cases, start spreading animal waste far enough before the collection area to ensure that the spreader is functioning. If a ground cover is folded or a pan is moved during a spread pass, investigate its condition before continuing with the test. Folded edges can be straightened without major loss of accuracy. If more than one-fourth of the surface has moved and did not receive animal waste, conduct the test again with a newly weighed sheet.

Collect and weigh the animal waste.

Remove the weights holding the ground cover in place. Fold the cover and animal waste in short sections from all sides and corners inward, avoiding animal waste loss. A 100-square-foot sheet folded with wet animal waste may weigh as much as 150 pounds and can be difficult to handle; place the folded cover in a feed tub or other container for easier handling. Pans typically weigh less than 5 pounds each and are usually easier to handle.

Select scales that can accurately weigh the type and quantity of animal waste collected (e.g., kitchen scales for pans, spring-tension milk scales, or platform balances for ground covers). The weight indicated on the scale includes the tare weight of the cover or pans. Subtract the tare weight from the indicated weight to determine the net weight of the animal waste collected.

Compute the application rate.

The application rate is based on the method of collection and the units per acre.

Using a ground cover: Divide the net pounds of animal waste collected by the ground cover area to obtain the animal waste application rate in pounds of animal waste per square foot. Multiply that result by 43,560 and then divide by 2,000 to convert to tons per acre.

Using pans: Add the net weights of the animal waste collected in the individual pans to calculate the total animal waste weight collected. Divide the total animal waste weight by the total collection area to obtain pounds of animal waste per square foot. Multiply that result by 43,560 and then divide by 2,000 to convert to tons per acre.

If working with liquid animal waste, make an additional measurement to calculate the weight per gallon of animal waste. Fill a 5-gallon bucket with liquid animal waste similar to that tested. Weigh the bucket of animal waste and subtract the tare weight of the bucket to determine the net weight of 5 gallons of animal waste. Divide the result by 5 to determine the weight in pounds per gallon. Multiply this weight by the number of pans collected. Divide the total animal waste weight by the total collection area to obtain pounds of animal waste per square foot. Multiply that result by 43,560 and then divide by pounds per gallon to convert to gallons per acre.

Instructions for Irrigation System Calibration

Use this method when a direct measure of volume is not available when pumping from a lagoon or animal waste storage. Different methods are used depending on whether you use a traveling gun irrigation system or center pivot irrigation system. Both methods are described below.

Measure surface area of lagoon or storage

Calculate the area (assumed to be a rectangle) by multiplying length (in feet) by width (in feet) to calculate the surface area in square feet. Take these measures at the liquid level and not at the top of the storage. Secure a yardstick or other measuring tool to a wooden stake, and plant the stake in the storage where the wastewater is several feet deep. Start your irrigation system.

If using a traveling gun irrigation system:

Note the starting location of the towed irrigation system and at the same time the liquid level in the storage tank on the yardstick (to the nearest quarter inch). Mark the irrigation nozzle location with a stake; this is considered Depth 1. Record results in inches.

Measure the diameter of the wetted circle from the irrigation nozzle (in feet). It is best if this measure is perpendicular to the direction of travel.

At some later time (at least an hour), note the liquid level in the storage tank again, generally after more than one foot change in depth has occurred. (The greater the change in depth, the more accurate the estimated application rate will be.) This is considered Depth 2. Record results in inches.

Note the location of irrigation nozzle with a second stake at the same time of the second depth measure. Measure the distance between the two stakes (in feet).

Calculate the application rate by multiplying the area by the difference between Depth 1 and Depth 2 (i.e., Depth 1 - Depth 2). Multiply this result by 27,200 (conversion factor). Divide this number by the distance between the two stakes, and divide this result by the diameter of the wetted circle. Your application rate will be given in gallons per acre. Note that this test assumes that your irrigation sprinklers do not overlap when applying. If your sprinklers do overlap, you need to ensure that you account for the overlap when calculating your rate. You can use the spacing between sprinkler pulls or run when calculating your rate.

If using a center pivot irrigation system:

Note the location of the pivot irrigation system and at the same time the liquid level in the storage tank on the yardstick. If possible, measure depth to the nearest quarter inch. Mark the irrigation nozzle location with a stake; this is considered Depth 1. Record results in inches.

When the pivot has completed an entire circle, note the wastewater depth again. This is considered Depth 2. Record results in inches.

Calculate the application rate by multiplying the area by the difference between Depth 1 and Depth 2 (i.e., Depth 1 - Depth 2). Multiply this result by 0.62 (conversion factor). Divide this number by the acres under the pivot, and divide this result by the fraction of the circle your pivot was able to complete. For example, if your pivot completes an entire circle, the fraction is 1. If it only completes 2/3 of the circle, the fraction is 0.667. Your application rate will be given in gallons per acre.

A center pivot is designed for a uniform pumping rate (GPM) and pressure. If this rate and pressure are used for animal waste, you already know how many gallons are applied per time unit and you know how long it take the unit to complete a circle (the ground drive is usually electric). Therefore, you can calculate

total gallons without running the system. Then divide by the acres under the system and you have the rate per acre. It is useful to check this periodically, though your rate should not change unless the pump is damaged or worn. If you add fresh water to the mix, then the total gallons of animal waste is reduced by a like amount, but the fact remains that a sprinkler will only put out a set volume at a given pressure.

References

Northeast Regional Agricultural Engineering Service. Fertilizer and Manure Application Equipment, NRAES-57, April 1994.

Maryland Institute for Agricultural and Natural Resources. Fact Sheet: Calibrating Manure Spreaders, Fact Sheet 419.

Cooperative Extension, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln. Manure Applicator Calibration, G95-1267A.

Who to Contact for More Information

Your Local Cooperative Cooperative Extension Office
Your Local Land Grant University
National Water Management Center/Natural Resources Conservation Service (USDA)