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Manure Spreader Calibration

Manure spreader calibration is an essential and valuable nutrient management tool for maximizing the efficient use of available manure nutrients. Planned manure application rates listed in nutrient management plans must correlate with actual application rates. Calibrating the manure spreader is the only way to know actual manure application rates.

Manure spreader calibration combined with soil test recommendations and manure analysis results enable the determination of nutrient application rates that meet crop nutrient needs. The most critical and challenging aspect of both soil and manure analysis is obtaining a representative sample to submit to the laboratory. It is critical to learn and follow recommended soil and manure sampling procedures in order to obtain a representative sample and test results. The manure nutrient levels and crop nutrient requirements from test results are used to determine manure application rates that will adequately meet crop needs. Manure spreader calibration ensures that manure application rates are realistic, practical, and attainable.

Manure application rates are determined by equipment speeds and settings along with application management, such as overlaps. Manure spreader calibration can be used two ways in nutrient management planning:

- Before planning—Spreaders can be calibrated to determine the rates that can be applied at typical application settings and speed. These rates are then used as the possible planned rates when the nutrient management plan is developed.
- After planning—Spreaders can be calibrated to meet planned application rates by changing speeds, settings, or management. In this case, desired application rates are determined as the nutrient management plan is developed and the spreader is calibrated accordingly.

OVERVIEW OF SPREADER CALIBRATION

An application rate is defined as the amount of manure applied per unit of land area. For manure, it is usually expressed in tons per acre (solid) or gallons per acre (liquid). Generally, application rate equals the amount of manure applied (in tons or gallons) divided by the area covered (in acres).

Manure spreader calibration requires reliable estimates of both the amount applied and area covered. There are two common calibration techniques. The **swath or load-area method** involves measuring both the amount of manure in a typical spreader load and the land area covered by applying one load of manure. While this method can be used for all manures, it is the best method for liquid manure applicators. The **tarp or weight-area method** involves weighing the manure spread over a small surface and computing the amount of manure applied per acre. This method is the best method for solid manure applicators.

CALIBRATION METHODS

Below are descriptions of the two most common calibration methods.

Swath (Load-Area) Method

Liquid manure applicators used in pump-and-haul application systems are best calibrated by the swath or load-area method, which involves land applying a full load of manure and measuring the land area covered. If possible, choose an area that is typical of the land where manure will be spread. If appropriate, a relatively level area long enough for the load to be applied in a single pass makes measurements and calculations simpler. A rectangular field pattern should be used to make measuring easier. The application rate of PTO-driven spreaders depends on ground speed. Therefore, it is important to maintain a uniform ground speed throughout the swath length. Ground-driven spreaders deliver reasonably uniform application rates regardless of ground speed.

For liquid application equipment, application rates and patterns vary depending on ground speed or PTO speed, gear box settings, gate openings, operating pressures, spread widths, and overlaps. To change the application rates, adjustments must be made in tractor/PTO speeds, spreader output settings, or application management. The

calibration process should be followed for each change or combination of changes. Several calibration passes may be necessary to determine the settings required for the desired application rate.

Use the swath (load-area) method procedure and record sheet provided at the end of this publication for this calibration method.

Tarp (Weight-Area) Method

Solid manure applicators are best calibrated by the tarp or weight-area method, which involves measuring the amount of manure (weight) applied over a small measured area (tarp). The application rate is determined by dividing the amount (weight) of manure collected on the tarp by the size of the collection area (tarp).

For solid application equipment, applications rates and patterns vary depending on ground speed or PTO speed, gear box settings, gate openings, operating pressures, spread widths, and overlaps. To change the application rates, adjustments must be made in tractor/PTO speeds, spreader output settings, or application management. The calibration process should be followed for each change or combination of changes. Several calibration passes may be necessary to determine the settings required for the desired application rate.

Use the tarp (weight-area) method procedure and record sheet provided at the end of this publication for this calibration method.

DETERMINING MANURE SPREADER CAPACITY

The load-area method of manure spreader calibration requires knowledge of the manure spreader's capacity. Manure spreader capacity can be determined by one of the following methods.

Manufacturer's Capacity Ratings

The rated capacity for liquid spreaders can be used directly if the spreader is typically filled to capacity. In many cases, the spreader is not fully loaded. Therefore, adjustments must be made for less than full capacity.

The rated capacity of box-type solid or semisolid spreaders must be adjusted according to the fullness of a typical load of manure. Make sure to note whether the rating specifications are for "heaped or piled" or "level" loads.

If there is any uncertainty about the rate capacity, then a more accurate method is needed to measure the actual volume of manure.

Measure Spreader Volume

Spreader volume can be estimated by using the calculations in Figure 1. All dimensions used in the following formulas must be in feet in order to obtain volumes that are in cubic feet. After calculating volume in cubic feet, convert the cubic feet to pounds and then convert pounds to tons or gallons based on manure density using the conversion factors in Table 1.

Figure 1. Calculating estimated manure spreader volumes.

SOLID OR SEMISOLID

[A] Box spreader (level load)*
volume = length x width x depth

[B] Box spreader (piled load)*
volume = length x width x [depth + (stacking height** x 0.8)]

[C] Round-bottom open-top spreader (level load)
volume = length x depth x depth x 1.6

[D] Round-bottom open-top spreader (piled load)
volume = length x depth x 1.6 x (depth + stacking height**)

LIQUID

[A] Box spreader (level load)*
volume = length x width x depth

[C] Round-bottom open-top spreader (level load)
volume = length x depth x depth x 1.6

[E] Tank spreader (round)
volume = length x tank diameter x tank diameter x 0.8

[F] Tank spreader (noncircular)
volume = length x width x depth x 0.8

*For a box spreader with sloping sides, use an average width.
**Stacking height is the height of any mounded manure above level.

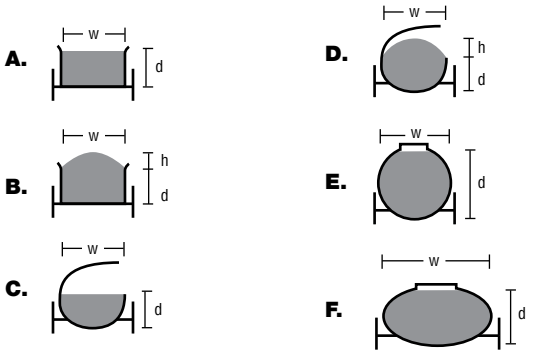

Table 1. Commonly required conversions for manure spreader volumes.

TO CONVERT FROM	TO	MULTIPLY BY
bushels	cubic feet	1.24
gallons	cubic feet	0.134
gallons	pounds	8.3 (liquid)
gallons	tons	0.0041 (liquid)
tons	gallons	240 (liquid)
cubic feet	gallons	7.48
cubic feet	tons	0.031 (liquid) or 0.0275 (solid)
cubic feet	pounds	62 (liquid) or 55 (solid)

See the next page for instructions to determine the actual manure density.

Weigh Manure Load

The most accurate way to determine the capacity of a spreader is to directly weigh the spreader. The spreader should be weighed using drive-on scales or weigh pads.

First, weight the spreader empty and then weight at least three typical loads of manure. Obtain an average weight of the full loads and subtract the weight of the empty load to determine the weight of the manure. Convert this weight to tons or gallons.

DETERMINING MANURE DENSITY

Manure density (weight per cubic foot) varies with moisture content primarily depending on the amount of bedding. To calculate a more accurate estimate of manure density, use the procedure below.

1. Weigh an empty 5-gallon bucket. Record the weight in pounds.
2. Fill the 5-gallon bucket with a typical sample of the manure to be applied and weigh the bucket and manure. Record the weight in pounds.
3. Subtract the weight of the empty bucket (step 1) from the weight of manure and bucket (step 2). Record the weight of manure in pounds.
4. Repeat steps 2 and 3 at least six times and calculate the average manure weight (add the six weights together and divide by six). Record average weight of manure in pounds.
5. Multiply the average manure weight (step 4) by 1.5 to obtain the estimated manure density in pounds per cubic foot. Record the manure density in pounds per cubic foot.

SWATH (LOAD-AREA) METHOD CALIBRATION PROCEDURE

Obtain calibration equipment and supplies.

- Measuring wheel (available from any farm supply catalog, such as NASCO).

1. Determine manure spreader capacity.
   - Use manufacturer's ratings or actual weighing of the spreader, or estimate by using spreader volume calculations described above.
   - Record the capacity in gallons (liquid manure) or tons (solid manure).
   - Load the spreader consistently with the capacity determination above.
2. Spread one full load of manure in a rectangular pattern. Note the details of the operating conditions (e.g., tractor gear, throttle setting, PTO speed, tractor speed, spreader settings).
3. Measure the length and the effective application width of the application coverage area.
   - Record the distances in feet.
   - An alternative method of measuring the application length is to note the ground speed and time required to make the application pass. To calculate length covered, multiply the ground speed (in mph) by the number of seconds by 1.46 feet per second.
4. Calculate the size of the coverage area.
   - Multiply the length by the width and divide by 43,560 square feet per acre.
   - Record the coverage area in acres.
5. Calculate the application rate.
   - Divide the volume of the spreader load of manure (step 1a) by the acres covered (step 4b).
   - Record manure application rate in gallons or tons per acre.
6. Repeat the calibration procedure one or two more times.
   - Repetition is necessary to increase reliability of the application rate. A certain amount of variation is inevitable. However, if there is significant variation among repetitions, check over the equipment and review your calibration procedure to try to determine the cause of the variation.
   - Repeat steps 2 through 5.
   - Calculate the average of each of the measured manure application rates.
   - Record the final calibrated rate in gallons or tons per acre.

MANURE SPREADER CALIBRATION RECORD SHEET—SWATH (LOAD-AREA) METHOD

SPREADER IDENTIFICATION

DATE

1. Determine the capacity of the spreader (use gallons for liquid manure and tons for solid manure).

a. Spreader capacity	gallons or tons

2. Spread one full load in a rectangular pattern.

Forward speed, gear, or throttle setting
PTO speed or setting
Spreader gate opening setting

3. Measure the coverage area.

	Trial 1	Trial 2	Trial 3
a. Spread area width	feet	feet	feet
b. Spread area length	feet	feet	feet

4. Calculate the area covered.

a. Spread area (3a x 3b)	ft^2	ft^2	ft^2
b. Spread area (4a ÷ 43,560)	acres	acres	acres

5. Calculate the manure application rate.

a. Application rate (1a ÷ 4b)	gallons or tons/acre

6. Average each of the calibration trials to determine the final application rate.

Final calibrated application rate (average of trials in 5a)	gallons or tons/acre

Tarp (Weight-Area) Method Calibration Procedure

Obtain calibration equipment and supplies.

- Tarp or plastic (heavy) sheet approximately 100 square feet in size (9 x 12, 10 x 10, 10 x 12, etc.)
- Tent pegs or long nails
- Scales (spring-tension or platform)
- Bucket (optional to assist in weighing)

1. Measure the exact surface area of the trap or plastic sheet (length x width).
   - Record the surface area in square feet.
   - Weigh the "empty" tarp or plastic sheet. If using a bucket, weigh the tarp or plastic sheet with the bucket.
   - Record the weight (empty) in pounds. (3a)
2. Position the tarp in the field where the manure can be spread.
   - Place it far enough into the field to allow enough distance to get the spreader in gear and the tractor up to the desired speed.
   - Avoid placing the tarp where the beginning or end of the load is likely to fall.
   - Secure each corner of the tarp with a tent peg or long nail.
   - Spread the first pass of manure directly over the center of the tarp.
   - Operate the spreader at the speed normally driven when applying manure.
   - Note the details of the operating conditions (e.g., tractor gear, throttle setting, PTO speed, tractor speed, spreader settings).
   - Spread two additional passes on opposite sides of the center of the tarp.
   - Apply these passes at the normal spreader overlap spacing.
3. Remove and fold the tarp.
   - Be careful not to spill any of the collected manure.
   - If using a bucket for weighing, place the manure and tarp in the bucket.
   - Weigh the tarp and manure (and bucket).
   - Record the weight (gross) in pounds (step 3b).
   - Subtract the empty tarp weight (and bucket if using a bucket) (step 3a) from the gross tarp weight (step 3b).
   - Record the weight of collected manure in pounds.
4. Determine the manure application rate.
   - Divide the amount of manure collected (in pounds) (step 3c) by the tarp area (in square feet) (step 1a).
   - Multiply this value by 21.8 (43,560 ft^2/acre ÷ 2,000 lbs/ton) to convert pounds per square foot to tons per acre.
   - Record the manure application rate in tons per acre.
5. Repeat the calibration procedure one or two more times.
   - Repetition is necessary to increase reliability of the application rate.
   - Repeat steps 2 through 4.
   - Calculate the average of each of the measured manure application rates.
   - Record the final calibrated rate in tons per acre.

MANURE SPREADER CALIBRATION RECORD SHEET—TARP (WEIGHT-AREA) METHOD			
SPREADER IDENTIFICATION			
DATE			
1. Measure tarp surface area. Weigh the empty tarp and record under 3a below. Spread and secure the tarp or plastic sheet in the field.			
a. Tarp surface area:	width x	length =	ft^2
2. Spread manure over the center f the tarp an on each side of the tarp at the normal overlap spacing.			
Forward speed, gear, or throttle setting			
PTO speed or setting			
Spreader gate opening setting			
3. Fold and weigh the tarp (and weighing container) with an accurate set of spring-tension or platform scales.			
	Trial 1	Trial 2	Trial 3
a. Empty weight	lbs	lbs	lbs
b. Gross weight with manure	lbs	lbs	lbs
c. Net weight (3b – 3a)	lbs	lbs	lbs
4. Calculate the manure application rate.			
a. Application rate (3c ÷ 1a)	lbs/ft^2	lbs/ft^2	lbs/ft^2
b. Application rate (4a x 21.8)	tons/acres	tons/acres	tons/acres
5. Average each of the calibration trials to determine the final application rate.			
Final calibrated application rate (average of trials in 4b)			tons/acre

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