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Manure Applicator Calibration

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Calibration methods for manure spreaders are discussed here.

Applying manure to land often is considered a waste disposal process rather than a fertilization process. Applying manure as a waste product is causing growing concerns about groundwater and surface water contamination. Increasing commercial fertilizer costs and regulatory mandates will encourage application of manure as a nutrient source in the future.

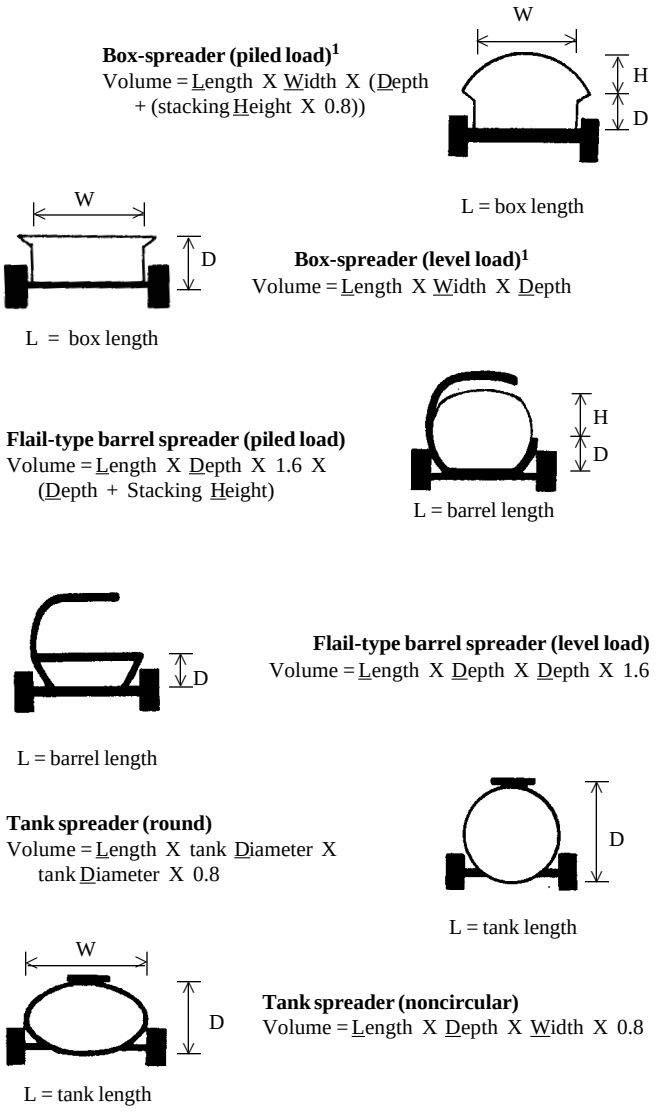
Calibration of manure spreaders, like calibration of any fertilizer spreader, is a key component of efficient nutrient use. Manure application rate needs to be based upon knowledge of crop nutrient needs, concentration of manure nutrients, and availability of nutrients in the soil.

This publication illustrates several calibration methods. Methods are included for direct calibration of manure spreaders when spreader capacity or weight is known (Method 1) or unknown (Method 2). An indirect measure can be based upon spreader loads applied to a field (Method 3). Manure application rates through irrigation systems can be determined by Methods 4 and 5. Select the method most easily adapted to your application.

Manure Spreader Volume

Many calibration procedures require knowledge of manure spreader holding capacity. Ideally, several spreader loads should be weighed, the empty spreader weight subtracted, and an average net weight calculated. However, scales are not always accessible.

Spreader volume can be estimated by calculations illustrated in *Figure 1*. A volume estimate from *Figure 1* and Calibration Method 1 provides a reasonable determination of application rate for liquid manure spreaders. Estimates from *Figure 1* are less accurate for solid and semisolid manure where stacking heights and manure density vary. If weighing is not possible, calibration by Calibration Method 2 is suggested for solid and semisolid spreaders.



[1]For a box spreader with sloping sides, use average width.

Figure 1. Procedures for estimating the manure volume held by a manure spreader. If dimensions are measured in feet, volumes will be in cubic feet. Conversion to other units of measure are given in *Table I*.

Table I. 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 (l)
Gallons	Tons	0.0041 (l)
Cubic feet	Gallons	7.48
Cubic feet	Pounds	62 (l) or 55 (s)
Cubic feet	Tons	0.031 (l) or 0.0275(s)

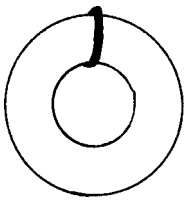
l...liquid manure s...solid manure

Method 1.
Application Rate Where Spreader Volume is Known

When the manure spreader's capacity or manure weight is known, the following calibration check provides a less "messy" measure. This approach is less accurate for box spreaders or other solid application systems where capacity is difficult to estimate. This approach works well with a liquid manure spreader filled to capacity. Access to scales allows this approach to work with all spreaders.

1. Fill spreader to known capacity or weigh spreader.
2. Measure width of one spreader pass. Avoid measurements near beginning or end of spread pattern where spreader may not be operating at capacity. Allow for typical overlap of adjacent passes.

   Width = _____ *feet*



3. Tie rope around rear tire of tractor.
4. Measure distance traveled by one full revolution of tire using cord as a reference.

   Distance/revolution = _____ *feet*

5. Again using the cord as a reference point, count the number of wheel revolutions required to empty spreader. (A measure of total length of spread pattern by a tape or measuring wheel can be substituted for steps 4 and 5).

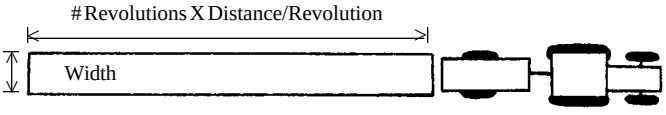
No. of revolutions =

_____

Distance traveled = Distance/Revolution X Revolutions

= _____ *X* _____

= _____*feet*



6. Calculate application rate by following formula:

$$\textit{Application rate (gallons/acre)} = \frac{\textit{Tank volume (gal.) X 43,560*}}{\textit{Distance traveled X width}}$$

$$= \frac{\textit{X 43,560}}{X}$$

= _____ *gallons/ acre*

*43,560 is a factor for converting square feet to acres.

$$\textit{Application rate (tons/acre)} = \frac{\textit{spreader net weight (lb.) X 22*}}{\textit{Distance traveled X width}}$$

$$= \frac{\textit{X 22}}{X}$$

= _____ *tons/ acre*

*22 is a factor for converting pounds to tons and square feet to acres.
22 = 43,560 ft²/ac ÷ 2,000 lb/ton

7. Repeat process for commonly used tractor speeds and spreader emptying speeds (PTO speeds or hydraulic settings).

Method 2.
Calibration Based Upon Plastic Sheet Sample

Solid and semisolid manure application rates can be estimated by measuring manure collected on a plastic sheet. For manure spreaders whose true manure capacity is difficult to estimate, this method provides the most accurate answer.

1. Cut three plastic sheets of equal size. See *Table II* for suggestions. If a sheet measures 22 square feet (for example, 48" x 66" or 36" x 88"), the measured manure weight in pounds equals the application rate in tons per acre.
2. Weigh large bucket (b) plus one plastic sheet (p) on a platform scale (or bathroom scale if more accurate alternative is not available).

   Empty weight = _____*lbs = b + p*

3. Lay sheets flat in field with corners held down securely. Space these sheets near beginning, middle and end of area to be spread with one spreader load.

4. Drive tractor at normal speed over sheets. Start spreader sufficiently early so that first sheet collects representative sample.
5. Did sheets remain flat and collect a representative sample? If not, repeat steps 3 and 4.
6. Carefully fold individual sheets without losing manure and place each sheet in separate bucket.

7. Weigh bucket, plastic and manure (m). Subtract empty weight of plastic and bucket.

Net weight of sheet = _____*lbs.* (*b + p + m*) - _____*lbs.* (*b + p*) = _____*lbs.* (*m*)

8. Determine application rate from *Table II* or by following formula:

$$\textit{Application rate (tons/ac)} = \frac{\textit{lbs. of manure X 22*}}{\textit{area of sheet (sq. ft.)}}$$

$$= \frac{\textit{X 22*}}{\quad}$$

$$= \_\_\_\_\_\textit{tons/acre}$$

*22 is a factor for converting pounds to tons and square feet to acres.
22 = 43,560 ft²/ac ÷ 2,000 lb/ton

9. Repeat steps 6, 7, and 8 for each sheet

10. Compute average application rate of three plastic sheet samples.

$$\textit{Average application rate} = \frac{(\quad + \quad + \quad)}{3}$$

11. Repeat process for commonly used tractor speeds and spreader emptying speeds (PTO speeds or hydraulic settings).

Table II. Manure application rates (tons/acre) based on manure weight (pounds) collected on different sizes of plastic sheets. Be sure to deduct weight of plastic sheet and bucket. 48" dimension is selected to fit between tractor tires.

Manure collected (lbs)	*Size of plastic sheet* 48" x 48"	48" x 66"	48" x 96"
	----------tons/acre----------		
6	8	6	4
8	11	8	5
10	14	10	7
12	16	12	8
14	19	14	10
16	22	16	11
18	25	18	12
20	27	20	14
22	30	22	15
24	33	24	16
26	35	26	18
28	38	28	19
30	41	30	20
32	44	32	22
34	46	34	23
36	49	36	25
38	52	38	26
40	54	40	27

Method 3. Application Rate Based on Spreader Loads Applied to Field

This method provides a means of estimating manure application rate after manure spreading is completed. Usually, a method that estimates rate prior to application is preferred. This method assumes an even application of manure has been spread across the field. Uniformity of application often depends upon the commitment and interest of the operator. This method is best used to provide a final check of calibration estimates made by the previous measures.

1. Determine a spreader's known volume by *Figure 1*, manufacturer's rating, or weighing representative sample of spreader loads. This approach is not accurate for solid and semisolid manure where capacity is difficult to estimate unless sample loads are weighed.

   Solid Manure (use *Table I* to estimate tons):

   Bushels = _____ *Cubic feet* = _____

   Tons = _____

   Liquid Manure (use *Table I* to estimate tons):

   Gallons = _____ *Tons* = _____

2. Count number of loads applied to field.

   Loads = _____

3. Determine area of field.

   Acres = _____

4. Calculate manure application rate.

$$\textit{Application rate (gallons/acre)} = \frac{\textit{Gallons per load X loads}}{\textit{Acres}}$$

$$= \frac{\textit{X}}{\quad}$$

$$= \_\_\_\_\_\textit{ gallons/ acre}$$

$$\textit{Application rate (tons/acre)} = \frac{\textit{Tons per Load X loads}}{\textit{Acre}}$$

$$= \frac{\textit{X}}{\quad}$$

$$= \_\_\_\_\_\textit{ tons/ acre}$$

Method 4. Application Rates through Irrigation System

Irrigation systems often apply manure at excess rates. Waste water or manure volumes need to be measured at a location prior to its dilution with clean water. Meters are available for measuring manure and waste water volumes. High cost and reliability in high solids applications have limited their use. If a direct measure of volume is not available, the following procedure may be helpful when pumping from a lagoon or manure storage. **The following method is for a traveling gun irrigation system.**

1. Measure surface area of lagoon or storage. Make these measures at the liquid level and not at the top of the storage.

Area = *Length X width*

= _____*X*_____

= _____ *square feet*

2. Secure a yardstick or other measuring tool to a wooden stake. Plant the stake in the storage where the waste water is several feet deep.
3. Begin pumping from storage.
4. Note the starting location of the towed irrigation system and at the same time the storage's liquid level on the yardstick. If possible, measure depth to nearest 1/4". Mark irrigation nozzle location with a stake.

   Depth 1 = _____ *inches*

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

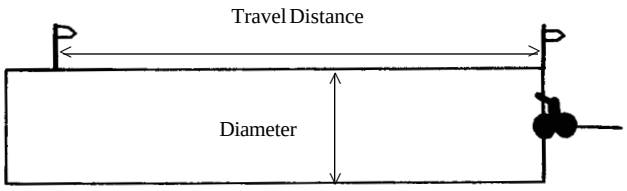
   Diameter = _____ *feet*

6. At some later time, note storage's liquid level again. If practical, make second measure when more than one foot change in depth has occurred. The greater the change in depth, the more accurate the estimate of application rate will be.

   Depth 2 = _____ *inches*

7. Note location of irrigation nozzle with second stake at same time of second depth measure. Measure distance between two stakes.

   Gun travel distance = _____ *feet*



8. Calculate application rate:

$$\text{Application rate (gallons/acre)} = \frac{\text{area X (depth 1 - depth 2) X 27,200*}}{\text{travel distance X diameter}}$$

$$= \frac{\text{X (} \quad \text{-} \quad \text{) X 27,200*}}{\text{X}}$$

= _____ *gallons/ acre*

*27,200 is a factor to convert inches to feet, cubic feet to gallons, and square feet to acres

27,200 = 7.48 gal./ft^3 X 43,560 ft^2/acre ÷ 12 inches/foot

For center pivot irrigation system, manure application rate can be estimated:

1. Repeat steps 1 through 3 above.

   Area = Length X width

   = _____ *X* _____

   = _____ *square feet*

2. Note the location of the pivot irrigation system and at the same time the storage's liquid level on the yardstick. If possible, measure depth to nearest 1/4". Mark the location of the pivot with a stake.

   Depth 1 = _____ *inches*

3. When the pivot has completed an entire circle, note waste water depth again.

   Depth 2 = _____ *inches*

   If pivot is not able to complete a full circle, estimate the portion of full circle completed.

   Portion of circle completed = _____
   (1.0 equals full circle)

4. Calculate application rate:

$$\text{Application rate (gallons/acre)} = \frac{\text{Area X (depth 1 - depth 2) X 0.62*}}{\text{Acres under pivot X Portion of circle completed}}$$

$$= \frac{\text{X (} \quad \text{-} \quad \text{) X 0.62}}{\text{X}}$$

= _____ *gallons/ acre*

*0.62 is a factor to convert inches to feet and cubic feet to gallons.
0.62 = 7.48 gal./ft^3 ÷ 12 inches/foot

Summary

Manure application equipment should be treated as any other fertilizer application equipment. Calibration is essential to knowing the rate of nutrient application. Guesses as to application rate can result in a costly waste of a nutrient resource and potential surface water and groundwater contamination from the excess nutrients. The potential producer liability from excess manure application is a risk that no longer can be overlooked. Manure spreader calibration results should be a permanent part of the farm's records for crop nutrient application. Calibration of manure application equipment is a critical tool in any well-managed crop fertilization program.

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