Manure Spreader Calibration

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Getting the most value from the manure on your farm, as well as minimizing potential for water pollution, requires careful management of the manure resource. This means applying manure at the proper time, incorporating the manure as soon as possible, knowing the nutrient content of the manure, and applying manure at the rate needed to meet the crop nutrient needs on each field (in combination with fertilizer). The only way to know what rate of manure you are applying is to calibrate the spreader. Then you can adjust accordingly to apply the desired application rate, based on a nutrient analysis of the manure.

General Approach

An application rate -- whether it is manure, fertilizer, or herbicide -- is defined as the amount of material applied per unit area of land. For manure, it is usually expressed in tons per acre (solid or semi-solid) or gallons per acre (liquid, or slurry), as follows:

Application Rate = Amount Applied (tons, gallons)/Area covered (acres)

So, to calibrate a manure spreader, you need to have reliable estimates of both ***amount applied*** and ***area covered***. There are a number of different ways to estimate each parameter.

Method 1. Based on Single Spreader Load: Solid, Semi-solid, or Liquid

1. Estimate ***amount applied***, or spreader capacity, based on one of following:

a) Manufacturer's rated spreader capacity
For full liquid spreaders use rated capacity directly. Adjust to account for less than full capacity, for example, because of foaming or non-level surface. Actual load may typically be 90% of rated capacity. For box type solid or semi-solid spreader, adjust rated capacity according to fullness of load. Be sure to note if rated capacity is "heaped" or "struck (level) load". (Some equipment specifications include both.) If rating is "heaped" capacity, adjust according to Figure 1 for your typical spreader load. If there is any uncertainty about the rated capacity, a more accurate method is to measure actual volume, as in b) below.

b) Measured volume of spreader
Measure and calculate volume of spreader in cubic feet (Figure 2). Convert cubic feet to pounds, and then to tons or gallons, based on manure density. (See Manure Conversion box.)

c) Weigh spread load directly.
If you have access to scales, weigh spreader full, then subtract spreader weight empty to get weight of manure. Convert to tons or gallons.

Manure Conversions

1 ton = 2000 pounds
1 cubic foot = 7.5 gallons
1 bushel = 1.25 cubic feet
1 gallon = 8.3 pounds
1 cubic foot = 62 pounds (wet) to 55 pounds (dry)*

*Manure density (weight per cubic foot) varies with moisture content, primarily depending on amount of bedding.
For a more accurate estimate, weigh a five-gallon pail of manure, then multiply the weight by 1.5 to get the density in pounds per cubic foot

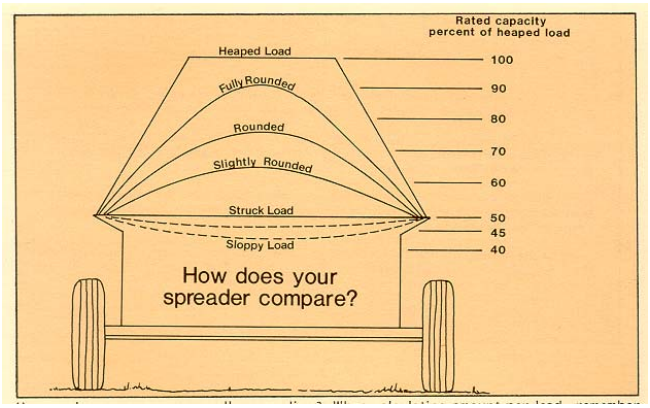

Fig. 1. Box spreader capacity with different types of loading (Way, 1983)

Table 1.2-17. Determining manure spreader capacity.

Spreader capacity, weight basis:

Tons per load = volume x density ÷ 2000

Density varies from 55 to 62 lb/cu ft depending on manure moisture:

dry manure is 55 and liquid manure is 62.

Spreader capacity, volume basis:

100 gal per load = volume ÷ 13.4

Calculate the volumes as follows (see diagrams at right):

Solid or semisolid manure

A. Box-shaped spreader[1] (level load)

Volume = length (l) x width (w) x depth (d)

B. Box-shaped spreader[1] (piled load)

Volume = length (l) x width (w) x [depth (d) + stacking height (h) x 0.8]

C. Flail-type barrel spreader (level load)

Volume = length (l) x depth (d) x depth (d) x 1.6

D. Flail-type barrel spreader (piled load)

Volume = length (l) x depth (d) x 1.6 x [depth (d) + stacking height (h)]

Liquid manure

Box-shaped spreader[1]—same as box-shaped spreader (level load)

Flail-type barrel spreader—same as flail-type spreader (level load)

E. Tank spreader (round)

Volume = length (l) x tank diameter (d) x tank diameter (d) x 0.8

F. Tank spreader (noncircular)

Volume = length (l) x width (w) x depth (d) x 0.8

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

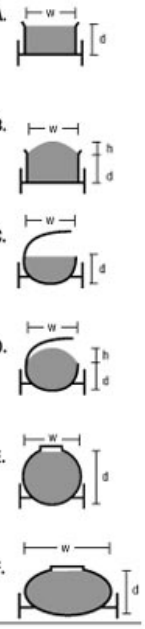

Fig. 2. Determining manure spreader capacity (Beegle, 2003)

2. Estimate ***area covered*** by one spreader load by doing the following:

a) Measure width of one spreader pass, allowing for any overlap with adjacent passes.

b) Measure distance traveled to empty spreader (adjusting for distance at beginning and end when spreading a partial rate) by one of the following:

1) Use measuring wheel or long tape measure
2) Measure number of tractor tire revolutions:
   (a) Tie cord around rear tire at top.
   (b) Measure distance traveled in exactly one revolution.
   (c) Count number of tire revolutions to empty spreader.
   (d) Distance = Number of revolutions x distance per revolution

c) Calculate area covered by one spreader load:

Spreader width (ft) x Distance (ft)/43,560 sq ft = Area (acres)

3. Calculate manure ***application rate*** by dividing ***amount applied*** by ***area covered***:

Method 2. Application Rate Based on Spreader Loads Applied to a Field: Solid, Semi-solid, or Liquid

1. Determine amount of manure per spreader load by a method in 1 above.
2. Count number of loads applied to field in a uniform application.
3. Determine accurate acreage of field.
4. Calculate manure application rate for field:

Application Rate = (No. loads x tons or gallons per load)/Field acreage

Method 3. Application Rate Based on Plastic Sheet Subsample: Solid or Semi-solid

This method involves measuring the amount of manure spread on a plastic sheet of known area (20 to 40 sq ft is a reasonable size). It is most useful where making an accurate estimate of spreader capacity is difficult, e.g. a heaped box spreader.

1. Cut three plastic sheets of similar size, e.g. 4 ft x 7 ft; 6 ft x 6 ft; 4 ft 8 in x 4 ft 8 in
2. Weigh large bucket (e.g. five gallon) and one plastic sheet on scale.
3. Lay sheets flat in the field some distance apart in the intended path of the manure spreader and hold down with stones or small stakes in the corners. Allow enough distance before the first sheet so that spreader is applying at full rate.
4. Drive tractor and spreader directly over plastic sheets at normal speed, being sure to begin spreading well ahead of first sheet.
5. Check manure-covered sheet to be sure wheel traffic did not shift position of plastic. If plastic has moved, remeasure area covered by plastic (and now manure).
6. Carefully fold manure-covered plastic and place in large bucket.
7. Weigh bucket, plastic, and manure and subtract weight of empty bucket and plastic to obtain weight of manure.
8. Repeat steps e-g for other plastic sheets.
9. Calculate manure application rate for each plastic sheet from Table 1 or use the following formula:

Application Rate (tons/acre) = (lbs. of manure on sheet x 21.8)/size of sheet (in sq ft)
Size of sheet (sq ft) = length (ft) x width (ft)
Note: If the sheet size is 21.8 sq ft, e.g. 4 ft 8 in x 4 ft 8 in (56 inches square or about 4 ft x f ft 6 in), then weight in lbs equals application rate in tons/acre.

10. Average the calculated rates from at least three plastic sheets. If two or more values are similar but one is unusually high or low, average only the similar ones.

Table 1. Manure application rates based on weight of manure on plastic sheets of different sizes.

Weight of Manure		Size of Plastic Sheet				
		4' x 7'		6' x 6'		56" x 56"
lbs		Manure Rate, Tons/Acre				
8		6		5		8
10		8		6		10
12		9		7		12
14		11		8		14
16		12		10		16
18		14		11		18
20		16		12		20
22		17		13		22
24		19		15		24
26		20		16		26
28		22		17		28
30		23		18		30
32		25		19		32
34		26		21		34
36		28		22		36
38		30		23		38
40		31		24		40
42		33		25		42
44		34		27		44
46		36		28		46
48		37		29		48
50		39		30		50

Method 4. Average Application Rate Based on Storage Volume Applied to Fields

This is not a calibration method in the same way as the others described here, but it is a way of estimating the average rate of manure applied to fields after emptying your manure storage. You need to know the capacity of your manure storage or an estimate of the portion applied on a given acreage.

Application Rate = Manure storage emptied (tons or gallons)/Area covered (acres)
If you know storage capacity only in volume (cubic feet), convert to gallons or tons using the conversion factors given earlier.

Adjustment to Obtain Desired Rate

Whichever calibration method is used, you will probably need to adjust the application rate to obtain the rate, or different rates, desired. Do this by changing a combination of tractor speed and spreader control. Then recalibrate the spreader by the same method. When the desired application rate is obtained, record the tractor and spreader settings for future reference. You may need to establish two or more rates for different crop types or varying nutrient needs.

References

Beegle, D. 2003. Penn State Agronomy Guide. p. 39-41. Penn State University. http://agguide.agronomy.psu.edu/PDF03/part1_2_4.pdf

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Way, W. 1983. Manure Primer. Br. 1339. Univ. of Vermont Extension. Burlington, VT.