

CHAPTER 6B

Manure Spreader Calibration

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Dairy manure with a moisture content in the range of 70 to 96% can be land applied using a side discharge spreader. A rear-discharge spreader works well with solid manure that has a moisture content of 85% or less. Tank spreaders can be used to land apply liquid dairy manure or slurry (94 to 99% moisture). All of these spreaders can be calibrated using the container method.

The basic information that must be recorded each time a calibration is performed is:

- description of the manure,
- moisture and nutrient content of manure,
- type of spreader used,
- settings of doors and gates that control the flow of manure (depends on spreader type),
- type and size (hp) of tractor,
- PTO rpm, and
- travel speed or engine rpm.

A representative sample should be taken from the manure that is being used to calibrate the spreading equipment. Have the sample analyzed for nutrient and moisture content and keep the report with the calibration record. The moisture content of the manure can greatly effect the manure calibration. Therefore, it is important that the calibration be done using manure with a moisture content that is typical for the manure that will normally be land applied with the equipment to be calibrated.

South Carolina regulations require livestock and poultry producers to calibrate spreading equipment at least once a year. The purpose of this section is to describe the container method using an example and provide work sheets that can be used as the calibration record.

It should be noted that the objective of calibrating a spreader is to determine the application rate in terms of nutrients applied per acre. Knowing the application rate in gal/acre or tons/acre is not sufficient. Furthermore, if the amount of manure nutrients applied per acre exceed crop needs then the spreader must be recalibrated to provide a lower application rate. In many cases, it will take several spreader runs and experimentation with different ground speeds, and discharge settings before a suitable application rate can be determined. Once the combination of discharge setting and ground speed is determined that is close to the desired application rate the procedure should be repeated two more times. The average result for the final three runs will provide the value needed for implementation of a nutrient management plan.

Spreader calibration is not an exact process. Variations in the flow of the manure from the spreader, variations in ground speed, and variations in pressure in the hydraulic lines of the equipment can influence the results. Expect variations of 10 to 20%.

SOLID MANURE CALIBRATION RECORD USING THE CONTAINER METHOD

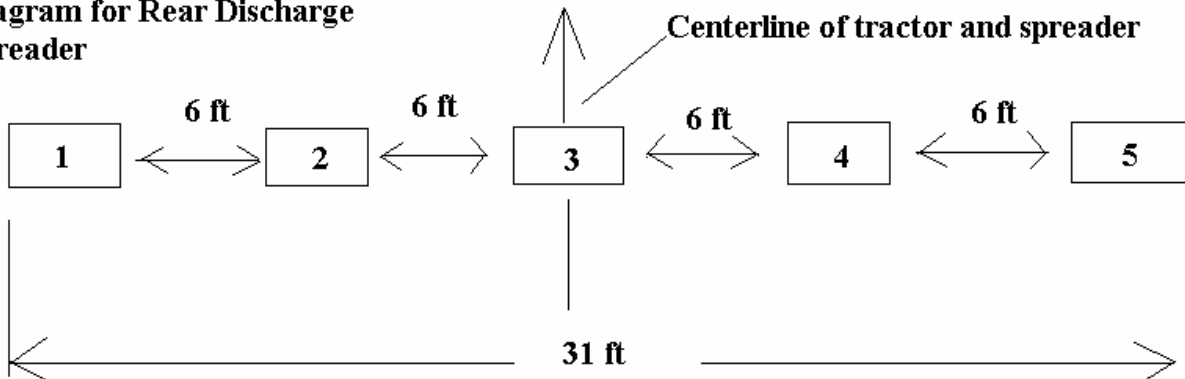
General Information

Farm Name:		Date:	
Person(s) Calibrating Spreader:		Manure Type:	
Spreader Description:			
PTO, rpm:	Gear:	Engine, rpm:	Speed, mph:
Description of Outlet Settings (i.e. Outlet gate open 2 inches):			

Example Diagram of Calibration Set-up

Show the number of containers used, the distance between each container and the centerline of the tractor and spreader as manure was applied. Also, give each container a number as shown below. Record container dimensions. It is important that all containers and the space between containers be the same.

Diagram for Rear Discharge Spreader



Container size: 16.5 inches x 11.5 inches

Container area = 189.75 sq. inches or 1.32 sq. ft.

**Example Data Table for Container Weight, Manure Weight,
and Manure Weight Per Area**

Container Number	Container Weight	Total Weight	Manure Weight	Manure Weight/Area
<i>Example</i>	<i>300 g</i>	<i>358.9 g</i>	<i>(358.9 g – 300 g) = 58.9 g</i>	<i>(58.9 g ÷ 1.32 ft²) = 44.6 g / ft²</i>
1	300 g	346.2	46.2	35 g / ft ²
2	300 g	367.3	67.3	51 g / ft ²
3	300 g	379.2	79.2	60 g / ft ²
4	300 g	372.6	72.6	55 g / ft ²
5	300 g	333.0	33.0	25 g / ft ²
6				
7				
8				
9				
10				
11				
12				
Average weight per container / ft ² for all containers =				45 g / ft ²
Average weight per container / ft ² for containers in effective swath =				55 g / ft ² (average of 2, 3 & 4)

**Data Table for Container Weight, Manure Weight,
and Manure Weight Per Area**

Container Number	Container Weight	Total Weight	Manure Weight	Manure Weight/Area
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
Average weight per container / ft ² for all containers =				
Average weight per container / ft ² for containers in effective swath =				

Uniformity of Application and Determination of Effective Swath Width

The uniformity of application and the effective swath width can be easily determined by comparing the manure weights in each container. In the example, it can be seen that the 3 containers closest to the tractor, containers 2, 3, and 4, contain more manure per square foot than the two outside containers (1 and 5). The *effective swath* is the “strip” of manure behind or to the side of the spreader that is relatively uniform. The effective swath is defined as ending when the manure applied per square foot decreases from the average application rate by 40 % or more.

In the sample data set the average amount of manure in all 5 containers was 45 g / ft². The amount of manure collected in container 1 was 22% lower than the overall average, which is not considered to be excessive. However, the amount of manure collected in container 5 was 55% lower than the average of 45 g/ft². Therefore, manure would be spread more uniformly if the effective swath is defined as the width from container number 2 through container 4. The effective swath width is equal to the width of three containers plus 12 ft. The total width = 16 ft in this example and two passes with the manure spreader would overlap about 7.4 ft.

Calculation of Application Rate in Tons per Acre

Calculate the average application rate to determine the average weight of manure applied per square foot using all of the containers within the effective swath. Therefore, if 3 containers are used then add up the weights for each container and divide by 3. The overall average weight of manure per square foot *in the effective swath* for the example is 55 g/ft².

Use the following conversion factors to calculate the application rate in tons/acre.

One ton of manure per acre is equal to:

$$0.046 \text{ lb} / \text{ft}^2, 0.736 \text{ oz} / \text{ft}^2, \text{ or } 20.82 \text{ g} / \text{ft}^2.$$

These are called application rate conversion factors. Use the one that corresponds to the unit that was used to weigh the manure (either lb, oz, or g).

Use the following formula to calculate the application rate in tons per acre.

$$\text{Average Manure Weight} / \text{ft}^2 \div \text{Application Rate Conversion factor} = \text{Tons per Acre}$$

	÷		=	
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Example:

55 g / ft ²	÷	20.82 g / ft ²	=	2.6 tons per acre
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Therefore, the average application rate is 2.6 tons per acre within the effective swath for the calibration example.

Calculation of Nutrient Application Rates

Once the amount of manure that is spread per acre is known then it is easy to determine the amount of plant available nitrogen, P₂O₅, or K₂O that will be applied per acre. Use the following equations to calculate the nutrient application rates. For the example, it will be assumed that the manure contains 9.0 lb PAN/ton, 8.0 lb P₂O₅/ton, and 14.0 lb K₂O/ton.

For PAN

$$\begin{array}{r} \text{lb PAN/ton} \\ \hline \end{array} \times \text{tons of manure / acre} = \text{lb PAN/acre}$$

	x		=	
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Example:

9.0 lb PAN/ton	x	2.6 tons/acre	=	23 lb PAN/acre
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For P₂O₅

$$\begin{array}{r} \text{lb P}_2\text{O}_5\text{/ton} \\ \hline \end{array} \times \text{tons of manure / acre} = \text{lb P}_2\text{O}_5\text{/acre}$$

	x		=	
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Example:

8.0 lb P ₂ O ₅ /ton	x	2.6 tons/acre	=	21 lb P ₂ O ₅ /acre
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For K₂O

$$\begin{array}{r} \text{lb K}_2\text{O/ton} \\ \hline \end{array} \times \text{tons of manure / acre} = \text{lb K}_2\text{O/acre}$$

	x		=	
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Example:

14.0 lb K ₂ O/ton	x	2.6 tons/acre	=	36 lb K ₂ O/acre
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LIQUID OR SLURRY MANURE CALIBRATION WORKSHEET USING THE CONTAINER METHOD

If the spreader is to be calibrated using liquid or slurry manure the nutrient content will be given in lb per 1,000 gal. The basic procedure is the same as for solid manure. However, the calculations are based on the volume of manure applied instead of the weight. This work sheet provides an outline of the steps needed to determine the average application depth and nutrient application rate for liquid or slurry manure using the container method.

Step 1. Place 8 to 10 identical containers on the ground in a line perpendicular to the direction the application equipment will travel. The cans need to be equally spaced. Be careful to place them so that they will not be run over by the application equipment.

Step 2. Place two flags in the line of travel *30 ft apart*. The amount of time required for the equipment to travel from flag-to-flag will be measured with a stop watch to determine ground speed.

Step 3. Begin manure application well ahead of the line of cans. Make sure the equipment is operating at the desired ground speed and the pump is operating at the desired flow rate or pressure before the equipment passes the first flag and over the cans. Continue operating the equipment at the desired speed until the equipment passes over the second flag. Have a person measure the amount of time it takes for the equipment to travel from flag-to-flag in seconds.

Step 4. Calculate the average ground speed as shown below.

Ground speed = (30 ft / _____ sec) x 60 = _____ ft per min

Ground speed in mph = _____ ft per min x 0.0114 .

Example: Ground speed = (30 ft / 11.4 sec) x 60 = 157 ft per min.

In mph the ground speed = 157 ft per min x 0.0114 = 1.8 mph.

Record the flow rate or pressure depending on the equipment.

Flow rate = _____

Pressure = _____

Step 5. Measure the average depth in the containers in inches. Write down the depth in each can and take the average.

Record the depth in each container in the table below.

Can	1	2	3	4	5	6	7	8	9	10
Depth										

Add the depth in each can and divide by the number of cans.

Sum of all depths= _____

Number of Cans = _____

Average application depth = ____ / _____

Example. The average depths were recorded in the following table.

Can	1	2	3	4	5	6	7	8	9	10
Depth	0.25	0.3	0.33	0.4	0.35	0.25	0.3	0.2		

Sum of all depths= 2.38

Number of cans = 8

Average application depth = 2.38 / 8 = 0.30 inches.

Step 6. Determine how many gallons were applied per acre.

Liquid application rate

= Application Depth _____ in x 27152 gal/ac-in = _____ gal per acre.

Example.

Liquid application rate = 0.3 inches x 27152 = 8,146 gal per acre.

Step 7. Determine how much plant available nitrogen (PAN) and P₂O₅ is applied per acre using the results from manure testing (typically the rolling average for the farm).

PAN Application rate

= _____ gal/ac x _____ lb PAN / 1,000 gal = _____ lb PAN/ac.

P₂O₅ Application rate

= _____ gal/ac x _____ lb P₂O₅/ 1,000 gal = _____ lb P₂O₅ /ac.

Example. Manure tests indicate that the manure applied on this farm contains 8.4 lb PAN/1,000 gal and 22 lb P₂O₅/1,000 gal. Calculate the nutrient application rates if the equipment applies 0.3 inches or 8,146 gal per acre.

PAN Application rate

*= 8,146 gal/ac x 8.4 lb PAN / 1,000 gal = 68 lb PAN/ac.
(don't forget to divide by 1,000)*

P₂O₅ Application rate

= 8,146 gal/ac x 22 lb P₂O₅/ 1,000 gal = 179 lb P₂O₅ /ac.