

## CHAPTER 6b

# Manure Spreader Calibration

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Poultry litter and dry manure from high-rise caged layer facilities can be land applied using a side discharge or rear 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 manure (94 to 99% moisture). Manure spreaders can be calibrated using either the “container method” or the “tarp method”.

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

- description of the manure,
- moisture and nutrient content of the 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 “typical” moisture content.

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” and “tarp” methods using examples 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 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 time. 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%.

## MANURE CALIBRATION RECORD USING THE CONTAINER METHOD

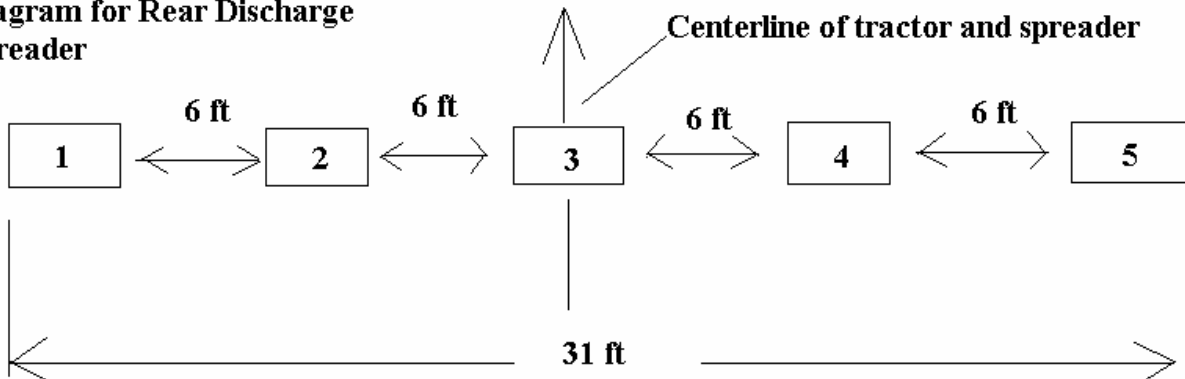
### General Information

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

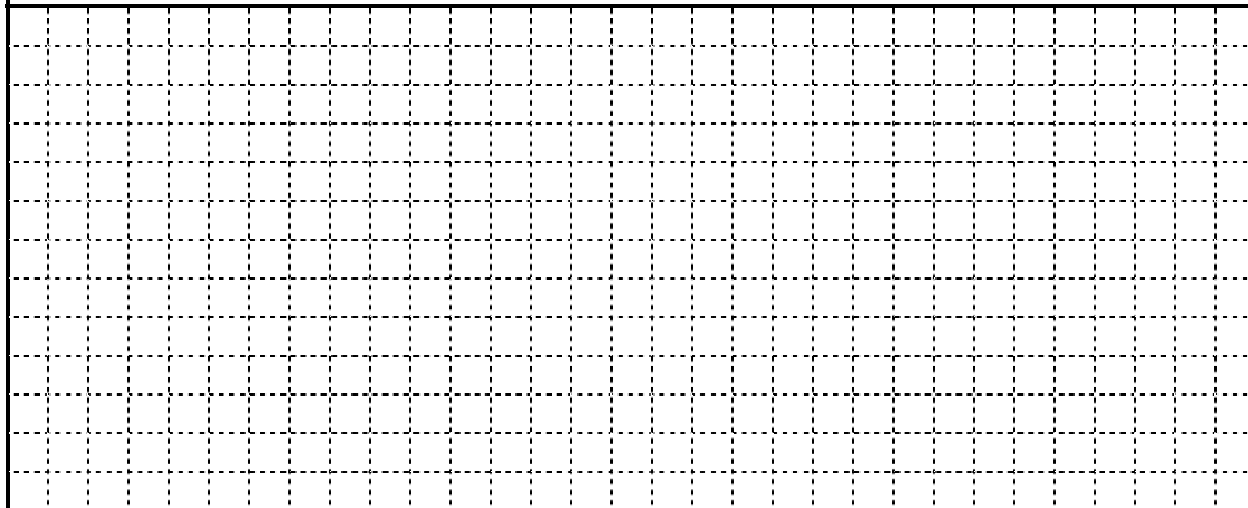


**Container size: 16.5 inches x 11.5 inches**

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

### 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.



### Container Information and Data

All of the containers should be the same. For example, if large round plastic pans are used then they should all have the same diameter and the same height. In this example, plastic rectangular containers were used.

#### Rectangular Containers

dimensions: length = \_\_\_\_\_ inches , width = \_\_\_\_\_ inches

Area = length  $\times$  width = ( \_\_\_\_\_  $\times$  \_\_\_\_\_ )  $\div$  144 = \_\_\_\_\_ ft<sup>2</sup>.

*Example = 16.5 x 11.5  $\div$  144 = 1.32 ft<sup>2</sup>*

#### Round Containers

dimensions: diameter = \_\_\_\_\_ inches

Area = (0.785  $\times$  diameter  $\times$  diameter )  $\div$  144 = \_\_\_\_\_ ft<sup>2</sup>.

### Calculation of Manure Weight Per Area

The weight of each container must be determined and recorded as shown in the following table. The containers are weighted again after the manure is spread. The total weight of the container and the manure is recorded. The manure weight is the total weight minus the container weight. The manure weight per area is determined for each container by dividing the manure weight by the container area. This number is recorded in the right-hand column.

**Example Data Table For Container Weight, Manure Weight, And Manure Weight Per Area (Indicate container that is closet to the tractor with a ✕)**

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

**Data Table For Container Weight, Manure Weight, And Manure Weight Per Area**

Number	Container Weight	Total Weight	Manure Weight	Manure Weight/Area
<i>Example</i>	300 g	358.9 g	$(358.9 \text{ g} - 300 \text{ g}) = 58.9 \text{ g}$	$(58.9 \text{ g} \div 1.32 \text{ ft}^2) = 44.6 \text{ g / ft}^2$
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
Average weight per container / ft <sup>2</sup> for all containers =				
Average weight per container / ft <sup>2</sup> 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 / ft<sup>2</sup>. 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/ft<sup>2</sup>. 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 is 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/ft<sup>2</sup>.

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 <sup>2</sup>	÷	20.82 g / ft <sup>2</sup>	=	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.

If it is desired to determine the average application rate for all 5 containers use the equation given above with the overall average manure weight per square foot. For the example, the

overall average was 45 g/ft<sup>2</sup> and the application rate associated with an effective swath of 31 ft was 2.2 tons/acre. This value is 15% lower than the application rate within an effective swath of 16 ft.

### 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, P<sub>2</sub>O<sub>5</sub>, or K<sub>2</sub>O 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 litter contains 45 lb PAN/ton, 69 lb P<sub>2</sub>O<sub>5</sub>/ton, and 46 lb K<sub>2</sub>O/ton.

For PAN

$$\begin{array}{r} \text{b PAN/ton} \\ \boxed{\phantom{000}} \end{array} \times \begin{array}{r} \text{tons of manure / acre} \\ \boxed{\phantom{000}} \end{array} = \begin{array}{r} \text{lb PAN/acre} \\ \boxed{\phantom{000}} \end{array}$$

*Example:*

$$\begin{array}{r} 45 \text{ lb PAN/ton} \\ \boxed{\phantom{000}} \end{array} \times \begin{array}{r} 2.6 \text{ tons/acre} \\ \boxed{\phantom{000}} \end{array} = \begin{array}{r} 117 \text{ lb PAN/acre} \\ \boxed{\phantom{000}} \end{array}$$

For P<sub>2</sub>O<sub>5</sub>

$$\begin{array}{r} \text{lb P}_2\text{O}_5\text{/ton} \\ \boxed{\phantom{000}} \end{array} \times \begin{array}{r} \text{tons of manure / acre} \\ \boxed{\phantom{000}} \end{array} = \begin{array}{r} \text{lb P}_2\text{O}_5\text{/acre} \\ \boxed{\phantom{000}} \end{array}$$

*Example:*

$$\begin{array}{r} 69 \text{ lb P}_2\text{O}_5\text{/ton} \\ \boxed{\phantom{000}} \end{array} \times \begin{array}{r} 2.6 \text{ tons/acre} \\ \boxed{\phantom{000}} \end{array} = \begin{array}{r} 179 \text{ lb P}_2\text{O}_5\text{/acre} \\ \boxed{\phantom{000}} \end{array}$$

For K<sub>2</sub>O

$$\begin{array}{r} \text{lb K}_2\text{O/ton} \\ \boxed{\phantom{000}} \end{array} \times \begin{array}{r} \text{tons of manure / acre} \\ \boxed{\phantom{000}} \end{array} = \begin{array}{r} \text{lb K}_2\text{O/acre} \\ \boxed{\phantom{000}} \end{array}$$

*Example:*

$$\begin{array}{r} 46 \text{ lb K}_2\text{O/ton} \\ \boxed{\phantom{000}} \end{array} \times \begin{array}{r} 2.6 \text{ tons/acre} \\ \boxed{\phantom{000}} \end{array} = \begin{array}{r} 120 \text{ lb K}_2\text{O/acre} \\ \boxed{\phantom{000}} \end{array}$$

## MANURE CALIBRATION RECORD USING THE TARP METHOD

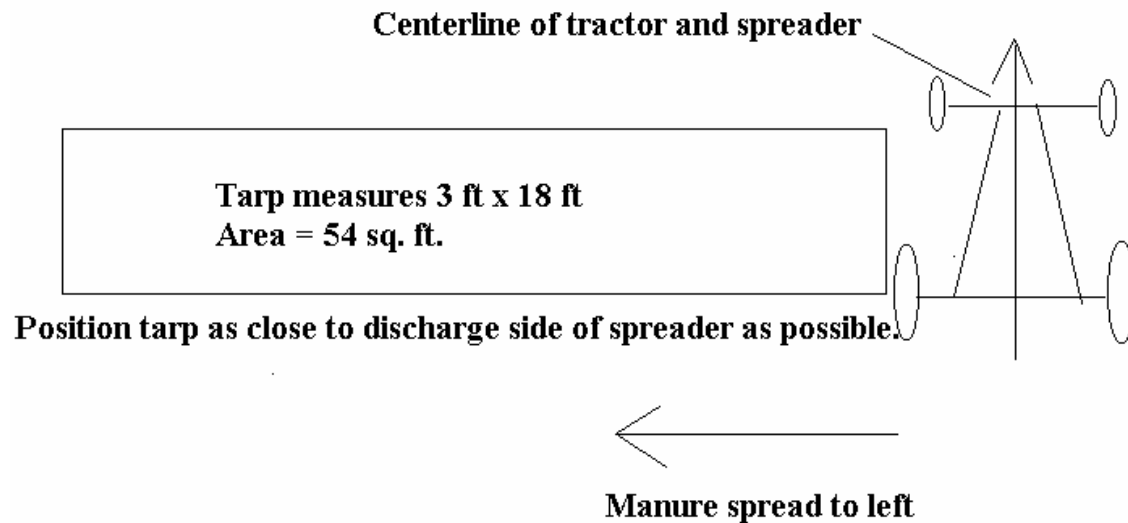
### General Information

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):			

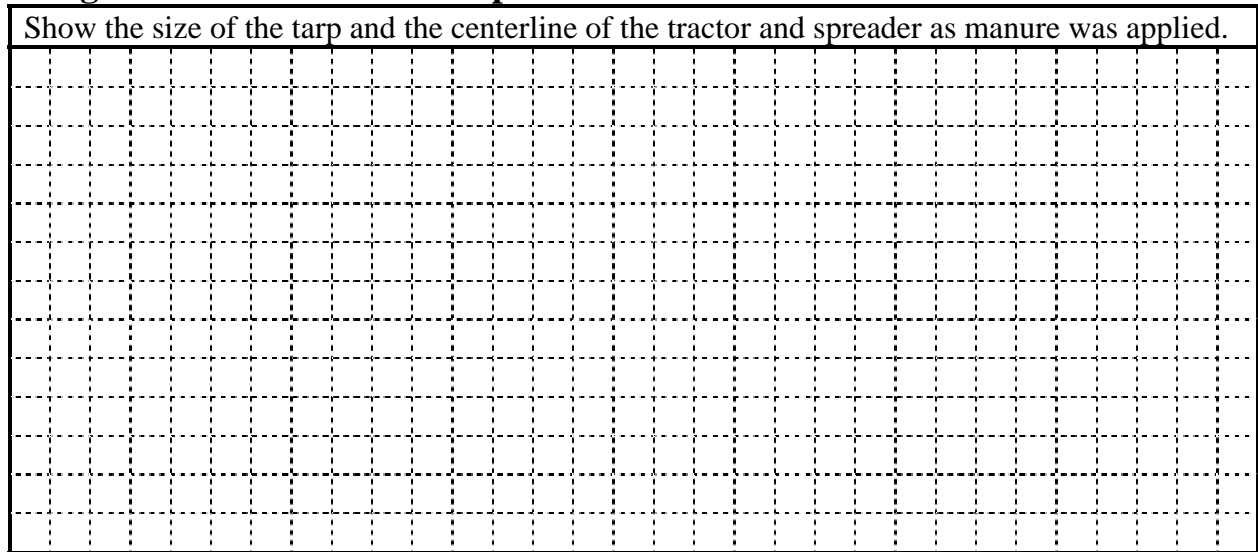
### Example Diagram of Calibration Set-up

Show the size of the tarp and the centerline of the tractor and spreader as manure was applied. (This method can be used for side or rear discharge spreaders.)

#### Diagram for Side Discharge Spreader



## Diagram of Calibration Set-up



## Determine the Weight of Manure Spread on the Tarp

The exact methods used to determine the weight of the manure that lands on the tarp will vary depending on the size of the tarp and the capacity of the scale. Typically, the manure will be weighed in a 5 gal plastic bucket using a platform or hanging scale that can weight up to at least 20 pounds. The basic steps are:

- (1) record the weight of the container that will be used to weigh the manure,
- (2) place all of the manure that fell on the tarp into the bucket,
- (3) record the weight of the container and the manure, and
- (4) determine the weight of the manure by subtracting the container weight from the total weight (manure + container).

If a small tarp is used the manure can be weighted by rolling up the tarp like a package so that all of the manure will stay in the tarp while it is placed in the bucket. If this is done the tarp should be placed in the bucket to determine the initial weight of the container and the tarp.

If a large tarp is used, the manure may need to be shoveled into the bucket and weighed several times. Subtract the container weight from each bucket full of manure, then add the manure weights from each bucket load to determine the total amount of manure that fell on the tarp.

The following table can be used to record the required information. The first data table corresponds to the example. In the example, the tarp and bucket were weighted together to give a container weight of 2.25 pounds. Therefore, only one weight was needed.



### Example Data Table for Container and Manure Weights

Container Weight (include tarp if needed) = 2.25 lbs		
Load No.	Manure + Container	Manure Weight (subtract container weight)
1	12.15 lb	9.9 lb
2		
3		
4		
5		
6		
7		
8		
9		
10		
<b>Total Manure Weight =</b>		9.9 lb

### Data Table to Record Container and Manure Weights

Container Weight (include tarp if needed) =		
Load No.	Manure + Container	Manure Weight (subtract container weight)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
<b>Total Manure Weight =</b>		

### Calculation of Manure Weight Per Area

The manure weight per unit area is calculated as shown below.

Total Manure Weight ÷ tarp area (in sq. ft.) = Weight per square foot

$$\boxed{\phantom{000}} \div \boxed{\phantom{000}} = \boxed{\phantom{000}}$$

*Example:*

$$\boxed{9.9 \text{ lb}} \div \boxed{54 \text{ ft}^2} = \boxed{0.18 \text{ lb / ft}^2}$$

## Calculation of Application Rate in Tons Per Acre

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

One ton of manure per acre is equal to:

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

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.

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

	÷		=	
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*Example:*

0.18 lb / ft <sup>2</sup>	÷	0.046 lb / ft <sup>2</sup>	=	3.9 tons per acre
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Therefore, the overall average application rate is 3.9 tons per acre over a swath of 18 ft in this example. If manure was very poorly distributed over the 18 ft long tarp the calibration should be redone using a shorter tarp. This can only be evaluated visually using the tarp method.

## 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, P<sub>2</sub>O<sub>5</sub>, or K<sub>2</sub>O 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 litter contains 37.9 lb PAN/ton, 33.8 lb P<sub>2</sub>O<sub>5</sub>/ton, and 42.7 lb K<sub>2</sub>O/ton.

For PAN

lb PAN/ton	x	tons of manure / acre	=	lb PAN/acre
	x		=	

*Example:*

37.9 lb PAN/ton	x	3.9 tons/acre	=	148 lb PAN/acre
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For P<sub>2</sub>O<sub>5</sub>

lb P <sub>2</sub> O <sub>5</sub> /ton	x	tons of manure / acre	=	lb P <sub>2</sub> O <sub>5</sub> /acre
	x		=	

*Example:*

33.8 lb P <sub>2</sub> O <sub>5</sub> /ton	x	3.9 tons/acre	=	132 lb P <sub>2</sub> O <sub>5</sub> /acre
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For K<sub>2</sub>O

lb K <sub>2</sub> O/ton	x	tons of manure / acre	=	lb P <sub>2</sub> O <sub>5</sub> /acre
	x		=	

*Example:*

42.7 lb K <sub>2</sub> O/ton	x	3.9 tons/acre	=	167 lb K <sub>2</sub> O/acre
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