Manure Management

MICHIGAN STATE UNIVERSITY EXTENSION

April 1995 Bulletin MM-5

Manure Spreader Calibration and Spreader Capacities

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Efficient use of manure nutrients can reduce fertilizer costs and minimize the risk of pollution to surface and groundwaters. To accomplish efficient utilization of manure nutrients, several things should be done:

1) complete soil fertility tests on each field that will receive manure;

2) determine the fertilizer recommendations for each field based on soil fertility test results, the crop to be grown, and a realistic yield goal you expect to achieve;

3) collect representative manure samples and have them tested to determine the nutrient content in your manure; and

4) calculate the amount of manure that should be applied on each field to provide the plant nutrients recommended for the crop to be grown.

For this process to be successful, the quantity of manure applied per acre must be known. Otherwise, responsible management of manure nutrients cannot be achieved.

To calibrate a manure spreader, some methodology is needed to estimate the amount of manure (either in gallons or tons) applied to a known area of land (in acres), so the rate of application (i.e., gallons per acre or tons per acre) can be determined. This process can be accomplished in a variety of ways and can be as simple as the following example:

> One hundred (100) tank wagons of liquid manure is uniformly applied to a field that is 40 acres in size. Capacity of the tank wagon is 3000 gal., so the application rate is:
>
> $$100 \text{ loads} \times \frac{3000 \text{ gal}}{\text{load}} = 300{,}000 \text{ gallons}$$
>
> Since this volume was applied to 40 acres, the rate of application is:
>
> $$\frac{300{,}000 \text{ gallons}}{40 \text{ acres}} = \frac{7500 \text{ gallons}}{\text{acre}}$$

This simple process essentially accomplishes a "spreader calibration" for this field. Some additional effort may be needed in order to vary the rate of application from one field to the next.

The initial calibration of equipment may require some time, so that different operating conditions can be determined that will deliver different rates of manure application. If multiple settings are available on a spreader, calibrate

several of them to determine the range of application rates that can be accomplished for the various manures produced by your operation.

Once the initial calibration procedure is completed, only an adjustment in operating conditions (e.g., ground speed, spreader setting, etc.) will be needed to apply manure at the desired rates. However, calibration may need to be repeated if some change in the density of the manure occurs due to modifications in things like the amounts or types of bedding, excluding or adding significant quantities of waters to the manure, etc.

Overall goals for any field receiving manure should be to: 1) know the gallons or tons of manure applied to a known area of land (i.e., number of acres); and 2) apply the manure as uniform as possible.

Calibration of Liquid Manure Applicators

A. Calibrating liquid spreaders by volume

To use this method, the volume of your liquid tank wagon must be determined. Since manufacturers often "roundup" the volume of their tanks, the value provided by the manufacturer for the gallonage of your tank wagon may be high and should be checked. The following procedure can be used.

1. Determine the total capacity (in gallons) of the liquid tank wagon (which can be done by using the worksheet in Bulletin MM-6); fill the tank full, spread the manure, and subtract any gallons left in tank from the calculated capacity.

2. Determine the area of land to which the tank of manure was applied. Doing this will be slightly different depending whether the liquid was applied to the soil surface or whether the liquid was injected. To determine the area for surface applications, measure the width of ground the liquid manure is covering (in feet) and multiply by the distance traveled (in feet) to empty the tank wagon.

If injection was used, the width of ground receiving manure will depend on the width of the injection equipment. To determine the application width, measure the distance between the two outside injectors and then add the width of the "spacing between injectors" to this distance.

Calculate the land area covered with one tank wagon by the following equation:

$$\frac{\text{width (ft) x distance (ft)}}{43{,}560\ \text{ft}^2\ \text{per acre}} = \text{total area treated in acres}$$

3. Divide the gallons of manure applied by the acreage covered:

$$\frac{\text{total gallons applied}}{\text{total acres treated}} = \text{gallons of manure applied per acre}$$

B. Calibrating liquid spreaders by weight

This method can be used if you have access to a drive-on scale. This option, if available to you, is preferred because it will be the easiest, and probably the most accurate, method. The following procedure can be used.

1. Weigh the loaded tank wagon and tractor, apply the manure, and re-weigh the tank wagon and tractor after application. Subtract the empty weight from the loaded weight to get the "lb of manure applied".

2. Determine the amount of land area treated (as suggested in step A.2. above).

3. Calculate the amount of manure applied per acre by the following equation:

$$\frac{\text{lb of manure applied}}{\text{total area treated (acres)}} = \text{lb of manure applied per acre}$$

4. To determine the gallons applied per acre, use the following equation:

$$\frac{\text{lb manure applied per acre}}{\text{8.3 lbs per gallon}} = \text{gal of manure applied per acre}$$

Calibration of Spreaders for Solid or Semi-Solid Manures

C. Calibrating spreaders by the weighing method

This method can be used if you have access to a drive-on scale. This option, if available to you, is preferred because it will be the easiest, and probably the most accurate, method. Use the following procedure.

1. Load the manure spreader to an average full level.

2. Weigh the spreader and tractor, spread the load of manure, and re-weigh the empty spreader and tractor. Subtract the empty weight from the loaded weight to get the "lb of manure applied".

3. Measure and record the average width of ground covered by manure (in feet) and the distance you traveled (in feet) to empty the spreader. Then calculate the land area covered by one spreader load of manure by the following equation:

$$\frac{\text{width (ft) x distance (ft)}}{43{,}560 \text{ ft}^2 \text{ per acre}} = \text{total area treated in acres}$$

4. Calculate the wet tons of manure applied per acre by the following equation:

$$\frac{\text{lb of manure applied}}{\text{total area covered in acres}} \times \frac{\text{ton}}{2000 \text{ lb}} = \text{wet tons of manure per acre}$$

D. Calibrating spreaders by the sheet method

This method can be used with a minimum of special equipment. Due to the variability we have experienced when using this method, we suggest that several sheets be used for this type of calibration and that only average values be used to calculate the rate of application.

The items needed for calibrating spreaders with this method are: several (4-6) plastic sheets (reasonably large garbage bags will work fine), a scale (milk, bathroom), and a 5 gallon bucket. The following procedure can then be used.

1. Weigh the plastic sheets with the bucket on a scale and record the weight.

2. Place the plastic sheets in the field in the path of the manure spreader, but far enough into the field so that the desired tractor speed is reached. Plastic sheets should be held in place by poking something through the corners of each sheet and into the ground to hold the sheets in place. (Wire flags work well).

3. Drive the tractor and spreader directly over the sheets while spreading manure, noting the ground speed, PTO and spreader setting.

4. Fold the plastic sheets without spilling the manure and place into the bucket. Weigh the sheets, manure and bucket.

5. Subtract the weight of the empty bucket and sheets (step 1.) from the weight of the manure, sheets, and bucket to get the "lb of manure" collected on the sheets.

6. Calculate the wet tons of manure applied per acre using the following equations:

$$\textit{Total area of all sheets (ft}^2\textit{)} = \frac{\text{length (ft) of one sheet (ft)}}{} \times \frac{\text{width (ft) of one sheet (ft)}}{} \times \text{no. of sheets}$$

$$\textit{Wet tons of manure applied per acre} = \frac{\text{lb of manure applied}}{\text{area of all sheets (ft}^2\text{)}} \times \frac{\text{ton}}{2000 \text{ lb}} \times \frac{43{,}560 \text{ ft}^2}{\text{acre}}$$

7. Repeat the above procedure, using the same operating conditions, and calculate the average amount applied from both loads.

8. The above procedure can be repeated at various ground speeds, spreader settings, and/or different RPM's for PT0 driven spreaders to obtain different rates of application. Then, dif-

ferent rates can be utilized to vary the quantity of manure (and manure nutrients) that can be applied.

E. Calibrating spreaders by the volume method

This method may be less reliable than the sheet method due to differences in density between manure packed into a 5 gallon bucket and manure loaded into a spreader. Another potential for error can come from the uncertainty in estimating the volume of material in the spreader. Refer to the "worksheet" in Bulletin MM-6 for guidance when using the following procedure.

1. Load the manure spreader to an average full level.

2. Weigh a 5 gallon bucket on a scale and record the weight.

3. Pack the bucket level full with manure to the same density as the manure loaded into the spreader. To get the density in the bucket to be the same as in the spreader will be more difficult as the amount of bedding in the manure increases, but do the best you can to make these the same.

4. Subtract the weight of the empty bucket (step 2.) from the weight of the manure and bucket to get the "weight of manure".

5. Repeat steps 3-4 until you have at least six manure weights and calculate the average value (i.e., add the six weights together and divide by six).

6. Measure, as best you can, the maximum average height of the material that is above the depth of the spreader box. (See "worksheet" in Bulletin MM-6 for help to do this.)

7. Spread the load of manure and determine the amount of land area treated (as suggested in step C.3. above).

8. Calculate the total volume of the spreader (i.e., box type or side slinger type) in cubic feet (ft^3) using the "worksheet" in Bulletin MM-6.

9. To calculate the wet tons of manure applied per acre, use the following equations:

$$\frac{\text{average wt. (lb) of manure in bucket}}{\text{5 (gal)}} \times \frac{\text{7.5 gal}}{\text{ft}^3} = \text{manure density in (lbs/ft}^3\text{)}$$

$$\text{volume (ft}^3\text{) of spreader} \times \text{density (lbs/ft}^3\text{) of manure} = \text{wt. (lb) of manure in spreader}$$

$$\frac{\text{lb of manure in spreader}}{\text{acres covered by one spreader}} \times \frac{\text{ton}}{\text{2000 lb}} = \text{wet tons of manure applied per acre}$$

Range of Application Rates for Various Manure Spreader Types

As a rule, very little information is provided from the manufacturer about the range of manure application for a particular spreader. The following rate information is provided from calibration experiences with several types of manure spreaders at the MSU University Farms and the MSU Kellogg Biological Station. These application rates have been determined by using ground speeds of between 3 mph (minimum) and 6 mph (maximum), in combination with varying the settings on the spreaders from high to low. All application rates given on the following page represent a single pass over the field.

Application Rates for Solid Manures

Spreader Type	Manure Density	Range (Tons/Acre)
Large box	Light (30-35 lbs/ft^3)	7 - 25
Medium box	Heavy (60-65 lbs/ft^3)	10 - 30
Side slinger	Heavy	5 - 21

Application Rates for Liquid Manures*

Spreader Type	Range (Gallons/Acre)
Large high pressure broadcast	2500 - 5000
Large vacuum (6" opening) broadcast	6500 - 10000
Large vacuum (4" opening) broadcast	4500 - 7000

* Application rates for liquid manures were calibrated for surface application only.

Funding for development of this fact sheet was made available through a grant from the Michigan Department of Natural Resources, Saginaw Bay National Watershed Initiative.