Manure Applicator Calibration
Michigan State University
Michigan State University Extension
Best Environmental Management Practices, Farm Animal Production
Charles Gould and Lee Jacobs, Michigan State University, and Daniel Ess and Stephen Hawkins, Purdue University
Issued 2002
2 pages

Range of Application Rates for Various Manure Spreader Types

The following are typical rates for ground speeds between 3 mph and 6 mph, in combination with varying the settings on the spreaders from high to low. All application rates shown represent a single pass over the field.

Typical Application Rates for Solid Manures

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

Typical Application Rates for Liquid Manures

Spreader Type	Range* (Gallons/Acre)
Large high pressure broadcast	2,500 - 5,000
Large vacuum (6"opening) broadcast	6,500 - 10,000
Large vacuum (4"opening) broadcast	4,500 - 7,000

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

Spreader Pattern Uniformity

Use a line of trays of known weight equally spaced at 2- to 4-foot intervals across the spreader path. Partially fill with absorbent material such as clay cat litter before weighing to prevent splashing if liquid manure. Make one spreader pass directly over the center pan. Weigh the contents of each pan and compare the amounts collected.

Effective spreader width can be found by locating the point on either side of the path where the containers received half of that received by the center container (if your spreader produces a symmetrical spread pattern). The distance between these containers is the effective spreader width. For the most uniform application patterns, this should be the spacing between spreader passes through the field.

Applicators Equipped with Flow Meters

Some liquid manure spreaders and drag hose injection systems use flow meters to provide a measure of manure flow rates during application. Flow meter data can be used with drag hose injectors to determine the number of gallons of manure applied per minute. If you know the desired application rate (gal/acre) and the width of application (ft), you can determine the appropriate travel speed needed in miles/hr:

$$\text{speed (mi/hr)} = (495 \times \text{gal/min})/(\text{rate} \times \text{width})$$

Example: Drag hose application travel speed. A custom manure applicator measured pumped manure at a flowrate of 750 gal/min. The injector boom is 22 feet wide and the desired application rate is 5,500 gallons per acre. How fast should the applicator travel?

$$\frac{495 \times 750 \text{ gal/min}}{5{,}500 \text{ gal/acre} \times 22 \text{ ft}} = 3.1 \text{ mi/hr}$$

Sprinkler Irrigation Systems

Sprinkler system calibration includes three types of systems: center pivot or lateral move, solid set, and traveling gun. The calibration process for such systems is more complex than for mobile application systems, but the process is basically the same:

1. Divide the volume pumped through the irrigation system in a given time by the land area covered to determine application rate (gal/acre).
2. Multiply the application rate in gal/acre by nutrient content in the manure (lb/1,000 gal) to determine the amount of nutrients applied per acre, and make adjustments as needed (Step A.5).

Selecting the Appropriate Manure Nutrient Application Method

- Spreaders and irrigation equipment need to be calibrated to provide controlled, uniform, targeted nutrient application rates.
- Equipment should be selected to avoid soil compaction and sized large enough to minimize odor by allowing timely and rapid application.
- Calibration should be repeated seasonally or when equipment is modified, replaced, or shows signs of misapplication.
- Spreader calibration should be repeated if there are changes in bedding and dilution, which affect application rates.

References

MSU Bulletins MM-5 and MM-6

Purdue CES publication ID-101

About this Publication

This publication was funded by USDA Special Needs, Purdue University, and Michigan State University.

It was adapted in part from the Livestock and Poultry Environmental Stewardship project, funded by the U.S. EPA, coordinated by the University of Nebraska-Lincoln, and published by the MidWest Plan Service, 122 Davidson Hall, Iowa State University, Ames, Iowa 50011-3080. See <www.lpes.org> or call (800/562-3618) to obtain access to this and other lessons.

Publications in this series:

- Land Application Records and Sampling
- Emergency Action Planning for Livestock Operations
- Mortality Management
- Inspecting Your Confined Feeding Operation
- Feeding Strategies to Lower N&P in Manure
- Building Good Neighbor Relationships
- Disposal of Farm Medical Wastes
- Manure Nutrient Recycling
- Environmentally Sensitive Field Characteristics
- Manure Applicator Calibration
- Odor Control Options for Confined Feeding
- Comprehensive Nutrient Management Plans

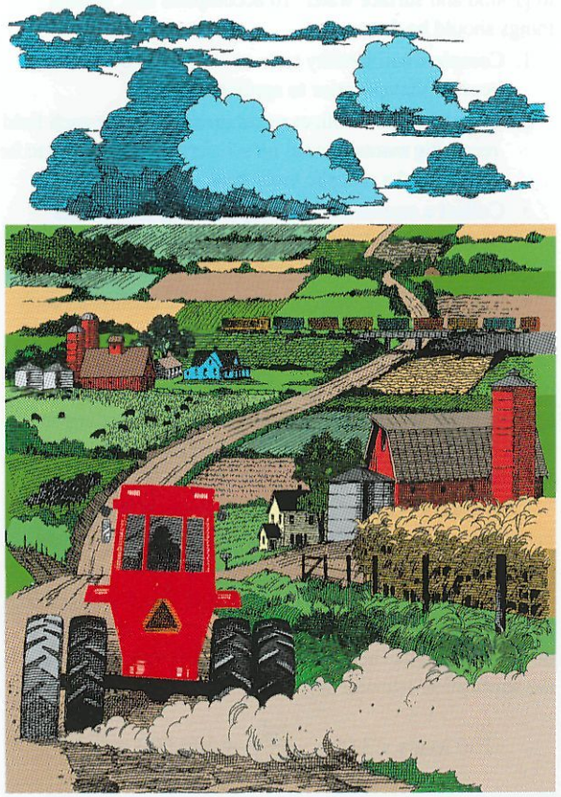
ID-309
E-2825

Best Environmental Management Practices

Farm Animal Production

Manure Applicator Calibration

Daniel Ess and Stephen Hawkins, Purdue University and Charles Gould and Lee Jacobs, Michigan State University



Best Environmental Management Practices

Farm Animal Production

Manure Applicator Calibration

Daniel Ess and Stephen Hawkins,
Purdue University and
Charles Gould and Lee Jacobs,
Michigan State University

Manure application is a critical component of any livestock production system. Proper use of manure nutrients can reduce fertilizer costs and minimize the risk of pollution to ground and surface water. To accomplish this, several things should be done:

1. Complete soil fertility tests on each field that will receive manure prior to application;
2. Determine the fertilizer recommendations for each field receiving manure based on soil fertility tests, crop to be grown, and a realistic yield goal;
3. Collect a representative sample from each manure source to be applied and have it analyzed to determine the nutrient content of each sample; and
4. Calculate the amount of manure to be applied on each field to provide the plant nutrients needed.

Applicator calibration can help determine not only manure nutrient application rate, but uniformity as well. Applicators apply manure at varying rates and patterns, depending on speed and/or power take-off (PTO) speed, gearbox settings, gate openings, etc.

Determining nutrient application rate can be accomplished in a variety of ways and can be as simple as the following example:

Example: One hundred (100) loads of liquid manure (30 lb plant available nitrogen/1,000 gal) are to be applied to a 60-acre field. The capacity of the tank wagon is 3,000 gal, so the application rate will be:

$$100 \text{ loads} \times 3{,}000 \frac{\text{gal}}{\text{load}} = 300{,}000 \text{ gal}$$

Since this volume is to be applied to 60 acres, the rate of application will be:

$$\frac{300{,}000 \text{ gal}}{60 \text{ ac}} = 5{,}000 \frac{\text{gal}}{\text{ac}}$$

And the nutrient application rate will be:

$$5{,}000 \frac{\text{gal}}{\text{ac}} \times \frac{30 \text{ lb N}}{1{,}000 \text{ gal}} = 150 \frac{\text{lb N}}{\text{ac}}$$

If this is not the desired nutrient rate, adjust operating conditions (e.g., ground speed, spreader setting, etc.) to apply manure at the desired nutrient application rate. Repeat calibration if there are changes in the amounts or types of bedding or the amount of dilution water added to the manure.

Conversely, one can determine the manure application rate needed to achieve a desired nutrient application by dividing the field nutrient rate needed (based on the nutrient needs of the crop to be grown and soil test results) by the nutrient content of the manure:

$$150 \frac{\text{lb N}}{\text{ac}} \times \frac{1{,}000 \text{ gal}}{30 \text{ lb N}} = 5{,}000 \frac{\text{gal}}{\text{ac}}$$

Calibration of Liquid Manure Applicators

A. Calibrating by volume (liquid manure)

1. Determine capacity (in gallons) of the liquid tank wagon. Since manufacturers often "round up" the capacity, the gallonage provided by the manufacturer for your tank wagon may be high.
2. Calculate the land area covered with one tank wagon load as:

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

3. Divide the volume of manure in one load by the acreage covered:

$$\frac{\text{total gallons}}{\text{total acres}} = \text{gallons applied per acre (gal/ac)}$$

4. Multiply the manure application (gal/ac) by the nutrient content of the manure (lb/1,000 gal) to determine nutrient application/acre.

$$\frac{\text{gal}}{\text{ac}} \times \frac{\text{lb nutrient}}{1{,}000 \text{ gal}} = \frac{\text{lb nutrient}}{\text{ac}}$$

5. Adjust application rate to obtain **desired nutrient rate per acre.**

$$\frac{\text{desired nutr. rate (lb/ac)}}{\text{current nutr. rate (lb/ac)}} \times \text{current appl. rate (gal/ac)}$$

B. Calibrating by weight (liquid manure)

Use this option if you have access to a drive-on scale because it is the easiest, and most accurate, method.

1. Weigh the loaded tank wagon and tractor, apply the manure, and re-weigh the tank wagon and tractor. Subtract the empty weight from the loaded weight to get the "lb of manure applied."
2. Determine the amount of land area treated (Step A.2).
3. Calculate the weight of manure applied per acre:

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

4. To determine the gallons applied per acre:

$$\frac{\text{lb manure applied/acre}}{8.3 \text{ lb/gal}} = \frac{\text{gal of manure}}{\text{ac}}$$

5. Multiply either the weight or volume of manure applied per acre by the nutrient content in lb per 1,000 gallons or per ton.
6. Adjust manure application to obtain the desired nutrient rate per acre (Step A.5).

Calibration of Spreaders for Solid or Semi-Solid Manures

C. Calibrating by the weighing method (solid manure)

Use this option if you have access to a drive-on scale because it is the easiest, and most accurate, method.

1. Load the spreader to an average full level.
2. Weigh the loaded spreader and tractor; spread the load and re-weigh the empty spreader and tractor. Subtract to get the "lb of manure applied."
3. Measure the land area covered when emptying the spreader (Step A.2).
4. Calculate the tons of manure applied per acre:

$$\frac{\text{lb manure applied}}{\text{total acres covered (acres)} \times 2{,}000 \text{ lb/ton}} = \frac{\text{wet tons}}{\text{ac}}$$

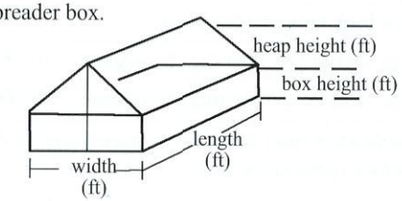
5. Multiply the tons/acre by the nutrient content in lbs/ton to estimate nutrient application rate.
6. Adjust manure application rate to obtain the **desired nutrient application rate.**

$$\frac{\text{desired nutr. rate (lb/ac)}}{\text{current nutr. rate (lb/ac)}} \times \text{current appl. rate (ton/ac)}$$

D. Calibrating by volume (solid manure)

This method is less reliable than weighing the entire spreader load due to differences in density between manure packed into a 5-gallon bucket and the loaded spreader.

1. Load the spreader to an average full level.
2. Weigh an empty 5-gallon bucket.
3. Pack the bucket level full with manure to the same density as the manure in the spreader. This will be more difficult as the amount of bedding in the manure increases, but make the densities similar.
4. Subtract the weight of the empty bucket (Step D.2) from the weight of the manure and bucket to get the "weight of manure."
5. Repeat steps D.3-D.4 until you have at least six manure weights. Calculate the average value (i.e., add the six weights together and divide by six).
6. Estimate the height, width, and length of the spreader box and the heaped height of manure above the top of the spreader box.



$$(\text{box ht} \times \text{length} \times \text{width}) + \tfrac{1}{2}(\text{heap ht} \times \text{length} \times \text{width}) = \text{approximate volume (ft}^3\text{)}$$

7. Spread the load of manure and determine the application area (Step A.2).
8. Calculate the wet tons of manure applied/acre:

$$\frac{\text{avg wt (lb) of manure}}{5 \text{ gallons}} \times \frac{7.5 \text{ gal}}{\text{ft}^3} = \text{manure density (lb/ft}^3\text{)}$$

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

$$\frac{\text{manure in spreader (lb)}}{\text{acres covered}} \times \frac{\text{ton}}{2{,}000 \text{ lb}} = \text{wet tons/ac}$$

9. Multiply tons/acre by the nutrient content in lb/ton to estimate nutrient application rate (lb/ac), and adjust as needed to obtain the desired nutrient rate/acre (Step A.5).