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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
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**Applicators Equipped with systems** use flow meters to provide a measure of manure flow rates during application. Flow meter data can be used to prevent splashing if liquid manure. Make one spreader pass through the field. Partially fill with absorbent material such as clay cat litter before weighing 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:

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

**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.

**Typical Application Rates for Solid Manures**

<table>
<thead>
<tr>
<th>Spreader Type</th>
<th>Manure Density</th>
<th>Range (Tons/Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large box</td>
<td>Light (30-35 lb/ft²)</td>
<td>7 - 25</td>
</tr>
<tr>
<td>Medium box</td>
<td>Heavy (60-65 lb/ft²)</td>
<td>10 - 30</td>
</tr>
<tr>
<td>Side slinger</td>
<td></td>
<td>5 - 21</td>
</tr>
</tbody>
</table>

**Typical Application Rates for Liquid Manures**

<table>
<thead>
<tr>
<th>Spreader Type</th>
<th>Range* (Gallons/Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large high pressure broadcast</td>
<td>2,500 - 5,000</td>
</tr>
<tr>
<td>Large vacuum (6&quot; opening) broadcast</td>
<td>6,500 - 10,000</td>
</tr>
<tr>
<td>Large vacuum (4&quot; opening) broadcast</td>
<td>4,500 - 7,000</td>
</tr>
</tbody>
</table>

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

**Sprinkler 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 to:

- Ensure timely and rapid application.
- Monitor equipment for signs of misapplication.
- Provide controlled, uniform, targeted nutrient application rates.

**References**

MSU Bulletins MM-5 and MM-6

Purdue CES publication ID-101

*Knowledge to Go*

http://www.ces.purdue.edu/extmedia
Best Environmental Management Practices

Farm Animal Production

Manure Applicator Calibration
Daniel Ess and Stephen Hawkins,
 Purdue University
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. Determine the fertilizer recommendations for each field receiving manure based on soil fertility tests, crop to be grown, and a realistic yield goal.
2. Collect a representative sample from each manure source to be applied and have it analyzed to determine the nutrient content of each sample.
3. 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. to apply manure at the desired nutrient application rate. Repeated 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:

\[ \text{rate of application in gallons/acre} = \frac{150 \text{ lb/acre} \times 1,000 \text{ gal}}{5,000 \text{ gal/acre}} \]

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:
   \[ \text{width (ft) \times distance (ft)} = \text{total area in acres} \]

   \[ 43,560 \text{ ft} \times 100 \text{ ft} = 4,356,000 \text{ ft}^2 \text{ per acre} \]
3. Divide the volume of manure in one load by the acreage covered:
   \[ \text{gallons per acre} = \frac{\text{total gallons}}{\text{total acres}} \]
4. Multiply the manure application (gal/ac) by the nutrient content (lb/1,000 gal) to determine nutrient application rate:
   \[ \frac{\text{gal}}{\text{ac}} \times \frac{\text{lb nutrient}}{1,000 \text{ gal}} = \frac{\text{lb nutrient per acre}}{ac} \]
5. Adjust application rate to obtain desired nutrient rate per acre:
   \[ \text{desired nutrient rate (lb/acre)} = \frac{\text{current nutrient rate (lb/acre)}}{\text{current appl. rate (gal/acre)}} \times \text{required appl. rate (gal/acre)} \]

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.
2. Subtract the empty weight from the loaded weight to get the “lb of manure applied.”
3. Determine the amount of land area treated (Step A.2).
4. Calculate the weight of manure applied per acre:
   \[ \frac{\text{lb of manure applied}}{\text{total area (acres)}} = \frac{\text{lb of manure}}{ac} \]
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 Manure

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:
   \[ \frac{\text{lb manure applied}}{\text{acres covered}} = \frac{\text{tons manure applied}}{\text{acres covered}} \]
5. Multiply the tons/acre by the nutrient content in lb/ton to estimate nutrient application rate.
6. Adjust manure application rate to obtain the desired nutrient application rate.