

Calibrating liquid tank manure applicators

As crop production technology, livestock production practices, and environmental regulations have changed over the years, so has the role of manure as a nutrient source for crops. Liquid manure can supply all the nutrients needed to attain optimum crop growth. However, knowing how much manure to apply per acre and what nutrients are available, and in what quantity, are keys to successfully using manure for crop production.

Why Calibrate?

Using correct application rates for manure has become critical. State and federal regulations will require management of phosphorus, which for most swine producers could mean lower application rates than those currently allowed. The responsibility of livestock producers is not just limited to completing manure management plans. Producers also have a responsibility to make sure application rates in the field comply with the approved manure management plan.

Producers or custom applicators must be familiar with their application equipment and manure characteristics to ensure accurate application rates in the field. Liquid manure applicators generally have a liquid tank fitted with a pump that feeds to the distribution chamber, which in turn

distributes manure to different points on the tool bar. A liquid tank is designed to hold a certain quantity of manure. However, due to manufacturing variations, manure foaming, and solids build-up, the liquid tank may not be filled to the rated capacity. Because of these inconsistencies, it is important to know how many gallons a given liquid manure tank can hold. Inaccuracies may result in under-application that may affect crop yields or over-application not allowed by the manure management plan and can be harmful to the environment.

How to Calibrate?

Producers and custom applicators can easily calibrate their manure applicators. This requires weighing the applicator (full and empty), measuring the density of manure, and measuring the application spread pattern (length and width of spread). These measurements can be recorded on the enclosed Calibration Worksheet so you can compute the correct manure application rate. A completed sample of the Calibration Worksheet is provided on page 4 of this publication.

1 Weighing the Applicator

Manure applicators can be weighed at local elevators. This requires two trips to the elevator, once to weigh the full applicator and again to weigh the empty applicator.

An alternative is to use weigh pads in the field or at the confinement site. Weigh pads to be used for calibrating manure applicators should have enough capacity to weigh each tire without the tires squatting over the pad and touching the ground (Fig. 1). When using weigh pads, weigh each wheel and the hitch (Fig. 2). Record both the empty and full weights for each axle tire and hitch on the provided calibration worksheet. If you weigh on a scale that weighs the complete unit, record the total full weight and total empty weight. Disregard hitch weights when using a scale that weighs the complete unit.



Figure 1. Weigh pad used to weigh a manure tank wagon.



Figure 2. Weighing the hitch on a manure tank wagon.

2 Measuring Manure Density

Water weighs 8.34 pounds per gallon. However, liquid manure may weigh more based on the presence of organic solids and heavier solids like sand and silt. Since all livestock operations are managed differently,

this number is most likely to vary from one operation to another. To calculate the density of manure, perform a five-gallon bucket test. The test requires a five-gallon bucket, a one-gallon measuring flask, and a scale. Fill the measuring flask up to the one-gallon mark with water and pour it into the five-gallon bucket. Repeat this process four more times. Place a mark in the bucket at the five-gallon level. Now, empty the bucket and fill it with manure up to the five-gallon mark. Weigh the five-gallon bucket on a scale. Repeat the process to get at least three weight readings.

3 Measuring Spread Pattern

A spread pattern refers to how wide an applicator applies and to how much linear distance it covers to empty the liquid tank. To calculate the spread pattern width, you will need to know the knife spacing and the number of knives on the applicator (Fig. 3). To measure the length of spread pattern, use a measuring tape, measuring wheel, or range finder. Measuring tapes may not be available in the length you will need. Range finders generally require a reflective surface to provide a measurable reading. Therefore, measuring wheels may be most practical, although their use does require walking the whole length of application.



Figure 3. Measuring the application width.

Calibrating the Application Rate

After all measurements have been made and recorded in the calibration worksheet, you can calculate your application rate for a liquid tank application.

Use the Calibration Worksheet to calculate the rate at which the manure has been or will be applied. One easy way to adjust application rates is to change the driving speed. Drive slower to increase application rates by reducing spread pattern length. Alternatively, drive faster to lower application rates by increasing spread pattern length. Other

options may have to be explored if application rates cannot be altered by changing speeds. More accurate and precise manure application rates can be achieved with the addition of a flow controller on liquid tanks. Flow controls should be considered to achieve maximum nutrient efficiency from liquid manure. However, the distribution of liquids uniformly across the tool bar should be considered when applying liquid manure. For more information, contact your ISU Extension county office to reach the extension agricultural engineer in your area.

Additional Resources

- PM 1941 *Calibration and uniformity of solid manure spreaders*
<http://www.extension.iastate.edu/Publications/PM1941.pdf>
- PM 1558 *How to sample manure for nutrient analysis*
<http://www.extension.iastate.edu/Publications/PM1558.pdf>
- PM 1811 *Managing Manure Nutrient for Crop Production*
<http://www.extension.iastate.edu/Publications/PM1811.pdf>

Additional resources may be found on the Iowa Manure Management Action Group (IMMAG) Web page at <http://extension.agron.iastate.edu/immag/> or by visiting the ISU Extension Web page at www.extension.iastate.edu.

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Calibration Worksheet

Name: _____ Tank ID: _____

Applicator description (including brand name, model number, expected gallons, number of axles, how applied, number of injectors, injector spacing, width of application, etc.):

Target application rate per acre: _____

Net tank weight	Axles	Hitch	Other	Total
Full tank weight (pounds)	<u>67,200</u>	+ <u>3,500</u>	+ <u>N/A</u>	= <u>70,700</u> (1)
Empty tank weight (pounds)	<u>11,800</u>	+ <u>600</u>	+ <u>N/A</u>	= <u>12,400</u> (2)
Net tank weight (pounds) (line 1 – line 2)	_____	+ _____	+ _____	= <u>58,300</u> (3)
Liquid manure density	Rep 1	Rep 2	Rep 3	Average
Full bucket weight (pounds)	<u>48.6</u>	+ <u>35.2</u>	+ <u>47.0</u> / 3 =	<u>43.6</u> (4)
Empty bucket weight (pounds)	<u>2.2</u>	+ <u>2.4</u>	+ <u>2.3</u> / 3 =	<u>2.3</u> (5)
Net manure weight (pounds) (line 4 – line 5)				<u>41.3</u> (6)
Manure density (pounds/gallon) (line 6 / 5 gallons)				<u>8.3</u> (7)
Gallons applied (line 3 / line 7)				<u>7,025</u> (8)
Application area				
Width of application (feet)				<u>18</u> (9)
Length of application (feet)				<u>5,750</u> (10)
Acres applied (line 9 × line 10 / 43,560)				<u>2.38</u> (11)
Manure application rate (gal/acre) (line 8 / line 11)				<u>2,952</u> (12)
N, P ₂ O ₅ , or K ₂ O value per 1,000 gallons				<u>N = 55</u> (13)
Nutrient rate per acre (pounds / acre) (line 12 × line 13 / 1,000)				<u>162.4</u> (14)