

## Nutrient Management

## Making Manure Spreader Calibration Practical and Useful

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Calibration of manure application equipment is a critical part of routine farm management as manure management is being examined closely in Michigan and across the country. Knowing and managing how much manure along with its nutrients is being applied to a particular field is paramount for several reasons.

1. Manure spreader calibration and the application records that depend on it are required of all dairy and livestock farms to be in compliance with Michigan Right to Farm guidelines. For farms having a Comprehensive Nutrient Management Plan (CNMP) calibration is no longer voluntary, but mandatory.

2. The inadvertent or advertent over-application of manure is considered a primary factor contributing to the risk of discharge of manure associated with field application into surface waters via surface runoff or field tile drainage.

3. Manure is a valuable source of nutrients for crop production; however, just like commercial fertilizer, manure needs to be applied and credited accurately and uniformly based on crop needs.

Although all three reasons for calibrating manure application equipment potentially can affect a farm's profitability, the ability to confidently credit the fertilizer value of manure is the one reason that is absolutely certain to have a financial impact year after year.

Once a field has been identified as a potential recipient of manure, a desired application rate needs to be calculated based on a recent soil test (within the last 3 years), realistic yield goals, and the nutrient content of the manure as determined by laboratory analysis. Many crop consultants are proficient at recommending manure application rates, but accurately applying manure at the desired rates has at times been a guessing game. The resulting inaccurate application rates can result in inadequate nutrient levels available for maximum crop yields. More commonly, however, manure is applied in excess to insure adequate nutrients for crops, but the risk of build-up of soil phosphorus levels, direct discharge to surface water and contamination of ground water are increased under these conditions. Not only are there potential environmental costs associated with inaccurate application of manure, but the over- or under-application of manure results in inefficient use of nutrients. Under-application results in compromised crop yields, whereas over-application has an opportunity cost because the excess nutrients could have reduced purchased fertilizer costs in the cropping system.

## Simple Calibration Method

Several manure application equipment calibration methods are accurate when practiced correctly. Unfortunately, many of the methods are inconvenient because of the physical and labor resources required. Therefore, few farmers actually conduct routine calibrations. Although a farmer should utilize the most comfortable calibration method(s) with which he/she is most comfortable, the following is a method requiring only a matter of minutes using equipment available on every farm. No method provides perfect accuracy, but calibration can reduce application rate errors from as high as 100 to 200 percent down to 10 to 20 percent.

The ground speed of the application equipment is often the ultimate determinate of application rate. In fact, the transmission ratio of the tractor is commonly the limiting factor in accurately matching desired application rates. Utilizing a *Ground Speed - Application Rate Chart* based on actual available ground speeds for a particular tractor or truck is often the most practical option for managing application rates. The following simple formula can be used to easily develop a user-friendly chart like the example provided in Table 1.

$$\text{Rate/acre} = C \div W \div T \div S \times 29,700$$

C = capacity of spreader (tons or gallons minus unused volume)\*

W = width of a pass with applicator (feet - consider overlap)

T = time required to empty spreader at the selected PTO RPM (seconds)\*

S = ground speed of equipment in a particular gear and the selected PTO RPM (mph)

**Table 1. Example: Ground Speed - Application Rate Chart.**

JD 8300 Tractor with 6500 Splash Plate Tanker at Full Overlap.

| Gear @   | MPH | Application Rate (gallons/acre) |
|----------|-----|---------------------------------|
| 1700 RPM |     |                                 |
| 1        | 1.1 | 13,600                          |
| 2        | 1.4 | 10,700                          |
| 3        | 1.8 | 8,300                           |
| 4        | 2.3 | 6,500                           |
| 5        | 2.7 | 5,500                           |
| 6        | 3.1 | 4,800                           |
| 7        | 3.5 | 4,300                           |
| 8        | 4.1 | 3,700                           |

\* If using a drag hose, enter gallons per minute pumped for C, and enter 60 for T.

**Example**

6200-gallon tanker (6,500 gallons minus unused volume)  
 30 ft application width (60 ft splash plate with full overlap)  
 410 sec to empty at 1700 RPM  
 JD 8300 tractor @ 1700 RPM: Gear #1 = 1.1 mph; Gear #2 = 1.4 mph; Gear #3 = 1.8 mph; etc.

**What is the application rate when in each gear at 1700 RPM?**

Gear #1 Rate/Acre =  $6,200 \div 30 \div 410 \div 1.1 \times 29,700 = 13,600$  gal/acre  
 Gear #2 Rate/Acre =  $6,200 \div 30 \div 410 \div 1.4 \times 29,700 = 10,700$  gal/acre  
 Gear #3 Rate/Acre =  $6,200 \div 30 \div 410 \div 1.8 \times 29,700 = 8,300$  gal/acre

A completed chart can easily be developed and used by the equipment operator to achieve a desired application rate with reasonable accuracy (Table 1, page 4 is an example).

**Verify Actual Application Rate**

Routinely measuring actual application rates to verify the accuracy of the predicted rate is equally important. Variables such as manure consistency, wind, and operator differences make this essential. The following formula can be used to quickly calculate the actual rate in field:

**Rate/acre =  $C \div W \div L \times 43,560$**

C = capacity of spreader (tons or gallons minus unused volume)  
 W = width of a pass with applicator (feet - consider overlap)  
 L = length of pass to empty spreader (feet)

Alternatively, the number of gallons applied to a known number of acres also would serve as a check of calibration accuracy. For instance, if it took 25 loads of 6,800 gallons each (170,000 gallons total) to completely cover a 20-acre field, the application rate was 8,500 gallons per acre (170,000 gal  $\div$  20 acres).

**Determining Spreader Capacity**

Knowing the actual capacity of manure application equipment in gallons or tons is critical to accurately calibrate and record field application rates. The following are some relatively simple methods for determining spreader capacity for calibration purposes.

**Liquid Tankers**

The gallon capacity of liquid manure tankers is

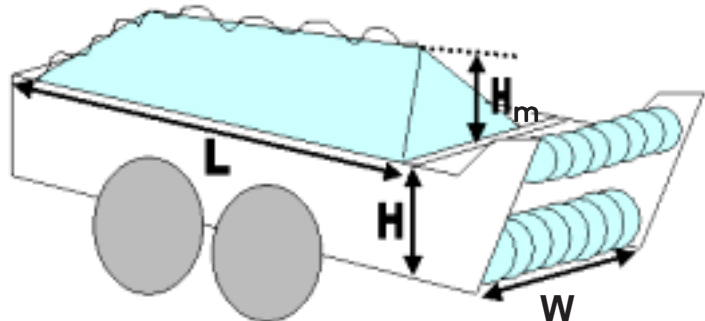
generally known; however, it is important to recognize that there will be unused capacity. Filling a tanker all the way to the very top greatly increases the risk of manure splashing out during transport and spilling onto roads and driveways.

**Open Liquid Spreaders**

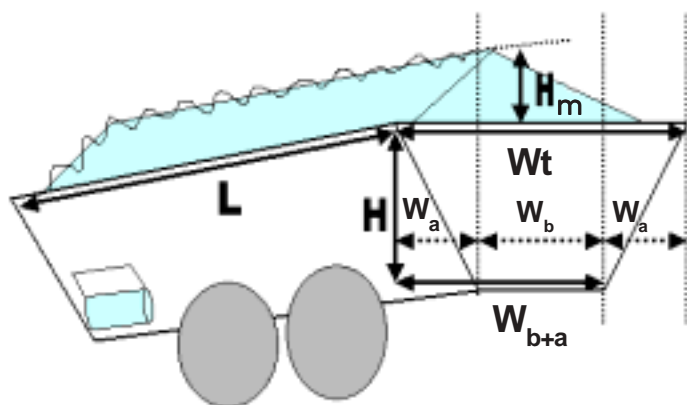
The gallon capacity of open spreaders such as box or V-bottom spreaders may be listed in the operator’s manual; however, most must be calculated. Capacity in gallons can be determined with a simple tape measure and the conversion factor of 7.48 gallons per cubic foot. Refer to Figures 1 and 2 for the spreader measurements needed to complete the calculations.

For box spreaders with liquid manure (see Figure 1):  
**Volume (gallons) =  $L \times W \times H \times 7.48$**

For V-bottom spreaders with liquid manure (see Figure 2):  
**Volume (gallons) =  $L \times W_{b+a} \times H \times 7.48$**



**Figure 1. Box spreader measurements needed to calculate capacity; W=width, L=length, H=height, and H<sub>m</sub>= height of mound.**



**Figure 2. V-bottom spreader measurements needed to calculate capacity; W<sub>a</sub> = width of angled portion; L=length, W<sub>b</sub> = width of bottom; H = height, W<sub>b+a</sub> = W<sub>b</sub> + W<sub>a</sub>; W<sub>t</sub> = width of top; and, H<sub>m</sub> = height of mound.**

### Solid Manure

For solid manure, capacity is expressed in tons. Ideally, a scale, fixed or portable, can be used to measure the actual weight of the spreader with and without its load for each specific type of manure. The difference would be the capacity. If a scale is not conveniently available, an alternative method, based on the volume of the spreader and the manure's density can be used. The same formula as listed on page 5 for a level-full liquid spreader can be used with an additional volume added for mounding.

For box spreaders with solid manure (see Figure 1):

$$\text{Volume (gallons)} = [(L \times W \times H) + (\frac{1}{2} \times L \times W \times H_m)] \times 7.48$$

For V-bottom spreaders with solid manure (see Figure 2):

$$\text{Volume (gallons)} = [(L \times W_{b+a} \times H) + (\frac{1}{2} \times L \times W_t \times H_m)] \times 7.48$$

The density (pounds per gallon) of the manure being measured can be used to convert gallons into tons. A small scale such as a spring scale can be used to measure the net weight in pounds of a five gallon bucket of manure. When weighing a bucket of manure, attempt to duplicate the density

(packing) of the manure in the actual spreader. Divide net weight of the bucket of manure by the volume (*i.e.*, 5 gal) to get density (lb/gal). The solid capacity of the spreader in tons can then be calculated.

$$\text{Weight (tons)} = \text{Volume (gallons as determined above)} \times \text{Density (lb/gal as determined with 5 gal bucket)} \div 2,000.$$

### Summary

Manure application equipment calibration has become so important to properly manage manure nutrients that it should be routine for every dairy and livestock farm. The small investment in developing simple tools such as Ground Speed – Application Rate Charts will be recovered readily in improved accuracy of nutrient crediting in the cropping system and reduced environmental risk. As with any tool, calibration is only valuable when put into practice. If you would like further guidance or assistance in manure application equipment calibration and the implementation of the results, contact your respective Michigan State University Extension Agent, Comprehensive Nutrient Management Plan (CNMP) provider, or other qualified professional.

## On-Farm Mortality Management

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Michigan's Bodies of Dead Animals Act (Act 239 of 1982, as amended) regulates the disposal of dead animals and provides for composting of dead poultry and livestock in Michigan. The intent of this law is to:

- protect human and animal health;
- reduce risk of disease transmission;
- control problems with flies, vermin, and scavenging animals; and,
- protect ground and surface water and air quality.

Conscientious management, as described in this act and accompanying regulations, is necessary for compliance with the Michigan Right-to-Farm Act and the 2002 Michigan/USEPA Regulatory Innovation Agreement (Option 1- NPDES General Permit or Option 2 – MAEAP). In addition, common sense and sound discretion are necessary as it may not be possible to abide by every specific practice, as stated, all of the time. In a time of increasing citizen complaints, it is critical to manage mortality disposal carefully, using art and science.

Under this act, there currently are five alternatives for disposal of dead animals in Michigan: burial; incineration; rendering; land-fill; or, composting.

Regardless of which method of disposal is used, all mortalities must be disposed of within 24 hours after death, unless stored secure at less than 40° F for no more than 7 days or at less than 0° F for no more than 30 days. Mortalities

disposed of must only be those animals “intrinsic to an operation under common ownership or management.” Carcasses may originate from multiple farm sites and be a mixture of livestock species, if all are owned by the same person or firm. Lastly, all disposal methods described in the act are for “normal or natural” rates of mortality for a given farm or system of farms. Any sudden and unexpected increases in mortality rates should be reported immediately to the Director of the Michigan Department of Agriculture, with discussion to include appropriate disposal methods for this unusual mortality.

### Burial

Burial sites must have no contact with bodies of water, either surface or ground water, and must be at least 200 feet from wells. Frozen ground makes burial difficult in winter.

#### Individual graves must be:

1. at least 2 feet beneath the natural surface;
2. limited to 100 graves/acre or 5 tons of tissue/acre;
3. separated by a minimum of 2.5 feet; and,
4. closed within 24 hours of opening.

#### Common graves must:

1. be limited to 2.5 tons of tissue per acre;
2. be separated by a minimum of 100 feet;
3. have each day's mortality covered with a minimum of 1 foot of soil;