Choosing and Calibrating Manure Application Equipment

Nutrient Management Factsheet – No. 8 in Series

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If manure is being used as a primary nutrient source for crop production, choosing the right manure application equipment and properly calibrating that equipment is a key component of optimizing nutrient use. This factsheet provides guidance on both of these processes.

Tables 1 and 2 describe the advantages and disadvantages of the major kinds of manure application equipment currently being used.

Table 1. Solid manure application methods by order of decreasing preference.

Method	Advantages	Disadvantages
Spinning Disks	• easy calibration • accurate placement • fast application	• need dry manure • high dust production
Flail Broadcast	• can spread variable moisture content	• inaccurate placement • non-uniform application
Dump and Grade Not recommended for use due to poor uniformity	• low cost	• cannot be calibrated • non-uniform application • difficult to control rate

Desirable Traits in Application Equipment

Overall, the most desired methods are those that apply manure as uniformly as possible, have low emissions and spray drift, and are cost effective. Methods that have accurate placement on the soil surface or within the crop canopy require less buffer distance to sensitive areas.

Incorporating manure, solid or liquid, soon (i.e. within 2 hours) after application will significantly reduce odour and nitrogen losses into the air.

Damage to crops will be reduced by methods that use high floatation tires, place manure under the canopy, deliver dilute slurry or have low soil disturbance.

Methods that reduce the risk of preferential flow of manure or nutrients to drains include using solid manure or tilling before or after application of liquid manure.

Table 2. Liquid manure application methods by order of decreasing preference.

Method	Advantages	Disadvantages
Sleighfoot or Aerator with Dribble Bar (attached to vacuum tanker)	• easy calibration • uniform application • accurate placement • low ammonia loss • fertilizer value maximization • wider spreading window • minimal nitrous oxide (N_2O) release	• higher cost • slow application • crop damage from wheels if applied when crop is tall • soil compaction from tanker
Low Trajectory Boom (attached to hose reel or vacuum tanker)	• low soil compaction • low crop damage • low N_2O release	• higher risk of run-off • shorter application window • soil compaction (with a tanker) • slow application (with a tanker)
Injector (attached to hose reel or vacuum tanker)	• easy calibration • uniform application • accurate placement • fertilizer value maximization • ammonia and odour reduction • fast application (with hose reel)	• potentially high N_2O release, particularly when soils become saturated after application • only suitable for some soil and crop conditions and short application window • higher cost • low application rate difficult to achieve • soil compaction (with tanker) • slow application (with tanker)
Splash Plate (on vacuum tanker)	• easy calibration • lower cost • low nitrous oxide release	• soil and crop compaction • short application window • high ammonia loss • non-uniform application
Irrigation Gun (attached to hose reel) Not recommended for use due to odour, calibration, uniformity and placement problems	• low cost • rapid application rate • low N_2O release	• difficult to calibrate • non-uniform application • inaccurate placement • high risk of runoff • short application window • high ammonia loss • high risk of pathogen, aerosol and odour drift

Calibrating Application Equipment

Calibration techniques are used to determine the amount of solid or liquid applied per unit area or unit of time for a specific manure applicator.

Calibration is also used to evaluate the uniformity of application. Applying manure uniformly has increased forage crop yield increases up to 15% compared to non-uniform applications.

Figure 1 shows a graphical representation of ideal uniformity over the width of a manure application pattern (splash plate, gun or solid spreader). Note that effective width is less than the spreader width. However, the correct overlapping of runs can result in a uniform application over the field.

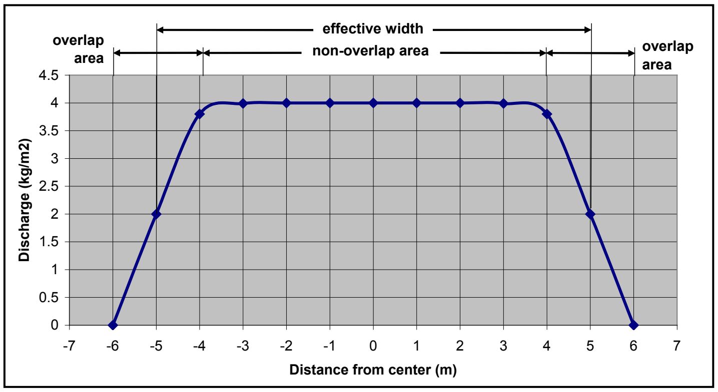

Figure 1. An ideal manure distribution pattern

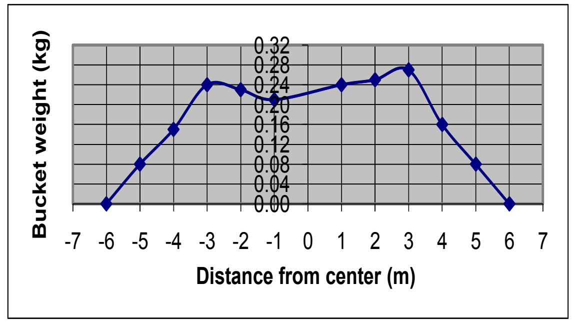

Figure 2. Uniformity of an Actual Manure Application

Assessing Application Uniformity

1. Place a number of containers (of uniform size and shape) in a line perpendicular to the path the spreader will travel. If possible, use 10 or more containers in order to see how the uniformity changes over the spreader width. Measure the distance the containers are from the centre line of the proposed spreader path.
2. Apply manure, starting far enough back form the row of containers so that the spreader is operating at the desired working speed when it passes the containers.
3. Record the weight of manure in each container (see **Example 1** and **Table 3**), and plot the results **(Figure 2)**.

Table 3. Example of Bucket Sample Weights for Manure Application Uniformity Test.

Bucket number	Distance from centre (m)	Amount of manure collected (kg)
1	+6	0.0
2	+5	0.08
3	+4	0.16
4	+3	0.27
5	+2	0.25
6	+1	0.24
7	-1	0.21
8	-2	0.23
9	-3	0.24
10	-4	0.15
11	-5	0.08
12	-6	0.0

4. Using the container weights from the non-overlap area (**Figure 1**), calculate the deviation in weights from the average (see **Example 1** and **Table 4**). If the weight of manure in any container from the non-overlap area is more than 15% above or below the average, adjust the spreader (splash plate angle, beater bars etc.) to improve uniformity and repeat the previous steps.

Table 4. Calculation of deviation from average manure application rate (average = 0.24 kg in this example).

Bucket number	Amount of manure collected (kg)	Percent difference (%)
4	0.27	0.27 / 0.24 = 113%
5	0.25	0.25 / 0.24 = 104%
6	0.24	0.24 / 0.24 = 100%
7	0.21	0.21 / 0.24 = 88%
8	0.23	0.23 / 0.24 = 96%
9	0.24	0.24 / 0.24 = 100%

Example 1: Assessing Uniformity

A manure applicator calibration test was done following the steps above. Bucket weights are shown in **Table 3**. The results were plotted on a graph (**Figure 2**).

From the graph, the non-overlap area was determined to be between -3 m to +3 m or buckets 4 to 9.

Calculating the average weight of manure in buckets 4 to 9 gives 0.24 kg. The calculation showing deviation from the average for buckets 4 to 9 is shown in **Table 4**. This is acceptable uniformity since all buckets in the non-overlap area are within 15% of the average.

As manure nutrients become available over time, varying the application pattern will tend to average out any minor uniformity problems – see **Figure 3** for an example.

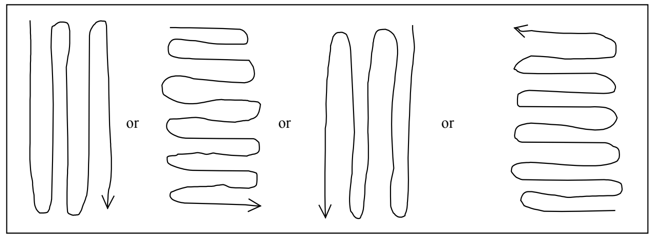

Figure 3. Ways to vary manure application patterns.

Determining Tractor Speed for Target Manure Application Rate

Once a satisfactory uniformity has been achieved, then calibrate by following these steps to obtain the desired loads per hectare:

1. Determine the effective width (m) from the graphical representation (**Figure 1**) of the uniformity test. The effective width is when the overlap area is at half the average of the non-overlap area. In Example 1 half the average is 0.12 kg, and this occurs at -4.5 m and +4.5 m, therefore the effective width is 9.0 m.
2. Fill the spreader with manure and spread the load, recording the speed driven (km/h) and measure the length covered (m).
3. Determine the area covered in hectares (ha) by multiplying the length covered by the effective width and dividing by 10,000.
4. Determine the correct speed (km/h) to drive to achieve a desired application rate by dividing the speed used in the test (km/h) by the product of multiplying area covered (ha) by desired rate (tankers/ha).

   Speed (km/h) = speed used in test (km/h) / [area covered (ha) x desired rate (tankers/ha)]

Example 2: Determining Tractor Speed to Achieve Desired Loads per Hectare

A 9.4 m^3 manure spreader covers 357 m length when driving at 3.0 km/h.

Effective width from **Example 1** is 9.0 m.

The area covered in the calibration test was,
9.0 m x 357 m = 3200 m^2 or 0.32 ha

The calculation for desired speed is shown in Table 5.

If the calculated speed is too fast for your equipment apply at half the speed and space the centre line of each application at twice the distance apart.

Table 5. Calculation of tractor speed to achieve desired loads per hectare (3.0 km/h speed and 0.32 ha used in test).

Desired application rates (tankers/ha)	Speed required (km/h)
5 ½	3.0 ÷ (0.32 x 5 ½) = 3.0 ÷ 1.77 = **1.7**
5 ¼	3.0 ÷ (0.32 x 5 ¼) = 3.0 ÷ 1.69 = **1.8**
4	3.0 ÷ (0.32 x 4) = 3.0 ÷ 1.29 = **2.3**
3 ¾	3.0 ÷ (0.32 x 3 ¾) = 3.0 ÷ 1.20 = **2.5**
3 ¼	3.0 ÷ (0.32 x 3 ¼) = 3.0 ÷ 1.04 = **2.9**
2 ¼	3.0 ÷ (0.32 x 2 ¼) = 3.0 ÷ 0.72 = **4.1**
1 ¼	3.0 ÷ (0.32 x 1 ¼) = 3.0 ÷ 0.40 = **7.5**

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