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Maryland Department of Agriculture

Soil Fertility Guide

Mo Ca Cu P S Fe K Zn Co N Mg B Cl Mn

EC-1

CALIBRATION OF MANURE SPREADERS

UNIFORMITY, SPREAD PATTERNS AND EFFECTIVE SWATH WIDTH

Introduction

Application uniformity is essential for ensuring that crops have adequate access to nutrients in all areas of a field. Unfortunately, application of manure by many spreaders (especially older models) is often non-uniform. For most spreaders the rate of application is higher directly behind the spreader than off to the side of the spreader.

Dealing with Non-uniformity

Application is often non-uniform, even directly behind the spreader. Figure 1 shows the variation in application of a composted manure by a single-beater, rear-discharge box spreader.

Three sets of two equally-sized collection surfaces were placed in the path of the spreader. The tractor and spreader were driven directly over each of the two pairs of collection surfaces at the producer's usual speed and equipment settings. Notice how directly behind the spreader, where the application rate is the most uniform, actual application rates vary from a low of 15 tons per acre to a high of 26 tons per acre.

The most effective way to calculate a reliable average of any measurements with high variability is to collect multiple measurements. University of Maryland Extension (UME) recommends a minimum of three measurements for load-area methods and five measurements for the weight-area method.

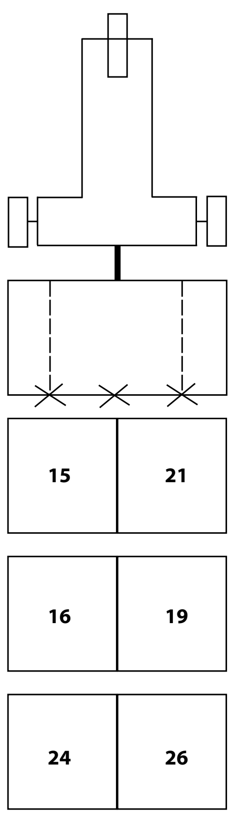

Figure 1. Non-uniformity of application behind a single-beater, rear-discharge box spreader

Swath and Spread Patterns

Swath is the width of the strip of land upon which manure is spread by one pass of a spreader. Some spreaders, like many box spreaders, have swaths that mirror the width of the spreader itself (see Figure 2a below). Other spreaders, like spinner spreaders, deposit material on both sides of the spreader as well as directly behind the spreader (see Figure 2b below). This type of spreader has a *wide swath*.

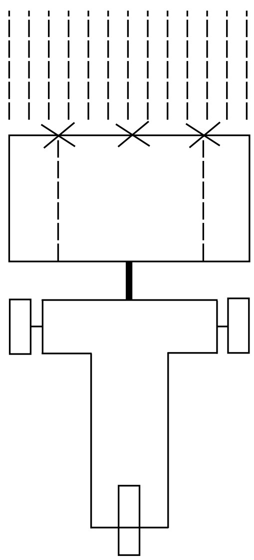

Figure 2a. Bird's eye view of a box spreader swath

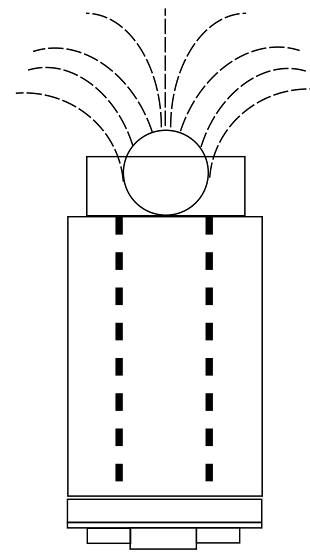

Figure 2b. Bird's eye view of a spinner spreader swath

If one investigates the application rate across a swath, also known as the *spread pattern*, the application rate for all types of spreaders is highest directly behind the spreader and decreases with distance from the spreader. Figure 3 below shows a spread pattern from one pass of a rear-discharge box spreader. The swath is 18 feet and the highest application rate (about 15 tons per acre) is directly behind the spreader. Application rates drop quickly with distance from the spreader.

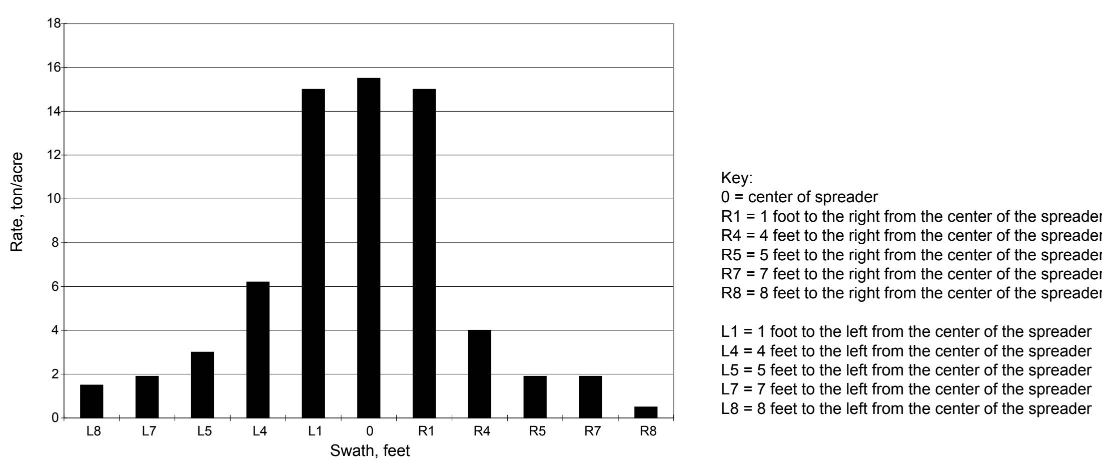

Figure 3. Spread pattern from a rear-discharge box spreader after one pass (© 2000 Iowa State University; *Manure Application with Dry Spreaders*; J. Lorimor)

Figure 4 below shows a spread pattern for three passes of the same rear-discharge, box spreader. The swath width (i.e., the distance from the center of one pass to the center of the next pass) was 12 feet. While swaths were overlapped, the application rate across the field was extremely non-uniform.

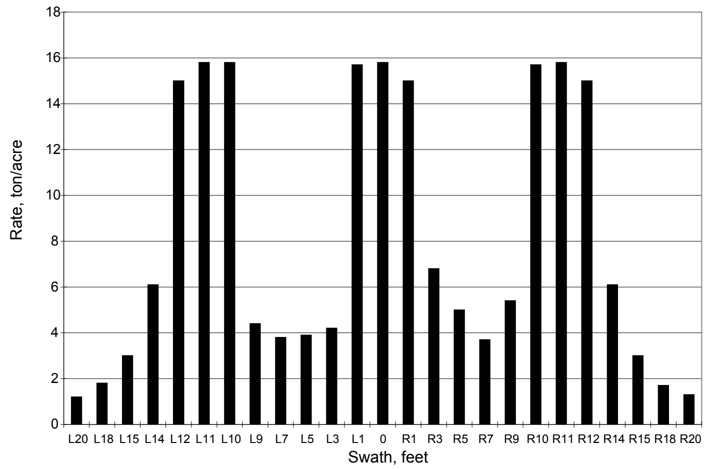

Figure 4. Spread pattern from a rear-discharge, box spreader using a 12-foot swath width (© 2000 Iowa State University; *Manure Application with Dry Spreaders*; J. Lorimor)

If one uses a 6-foot swath width for the same set of circumstances, the application rate across the field would be much more uniform (see Figure 5 below).

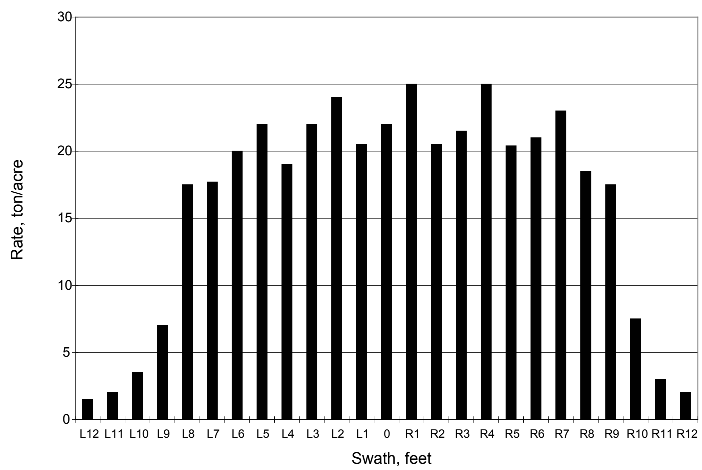

Figure 5. Spread pattern from a rear-discharge, box spreader using a 6-foot swath width (© 2000 Iowa State University; *Manure Application with Dry Spreaders*; J. Lorimor)

One can analyze the initial spread pattern of one swath and calculate the effective swath width required to maximize uniformity across swaths.

Effective Swath Width: What is It?

Effective swath width can be thought of in several ways.

- It is the distance between the center point of one pass of a spreader and the center point of the next pass. This overlap of manure application will lead to a more uniform nutrient application.

- It is the sum of the distance on each side of the center of the spreader where the application rate is 50% of the maximum application rate (typically directly behind the spreader).

Figure 6 below illustrates the concept of effective swath width.

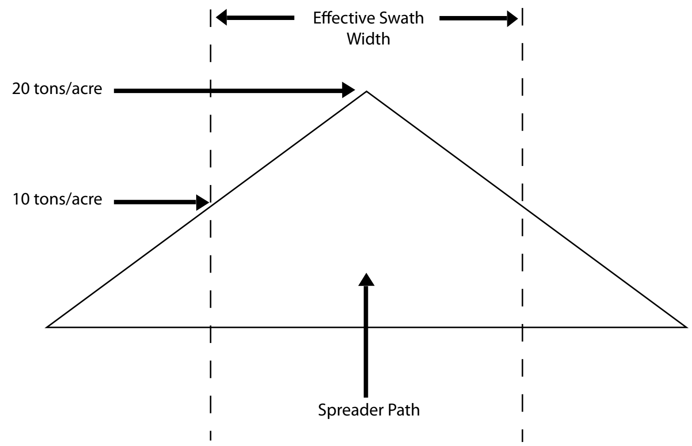

Figure 6. Effective swath width (© 2008 University of Georgia Cooperative Extension; modified from *Calibration of Manure Spreaders*; J. Worley et al.)

Effective Swath Width: How is It Determined?

Effective swath width can be calculated by locating the point on each side of the center of the spreader where the application rate is half as much as the maximum rate.

The type (pan or plastic sheet), size and placement of collection surfaces will depend upon the maximum application rate, the condition of the manure (i.e, solid, liquid) and the distance the manure is spread laterally from the spreader. The number of collection surfaces will vary depending upon the distance the manure is being thrown laterally from the spreader; however, 5-13 collection surfaces are typical.

The following equipment is needed to determine the effective swath width:

- collection surfaces (plastic sheets, tarps, or large pans for liquid manures)
- stakes or pins
- weighing containers (bucket or tub)
- scales (capacity and accuracy depends upon size of collection surface and application rate)

The steps for determining effective swath width are as follows:

Step 1. Set down a line of collection surfaces, at precisely determined intervals, perpendicular to the spreader line of travel. Secure the collection surfaces to the ground using stakes or pins to prevent them from moving during application of the manure.

PTO or Hydraulically-driven Spreaders

Figure 7a below shows an example of where to place collection surfaces when using a box spreader where lateral distribution of manure is minimal. Figure 7b below shows an example of where to place collection surfaces when using a spinner spreader where lateral distribution of manure is extensive.

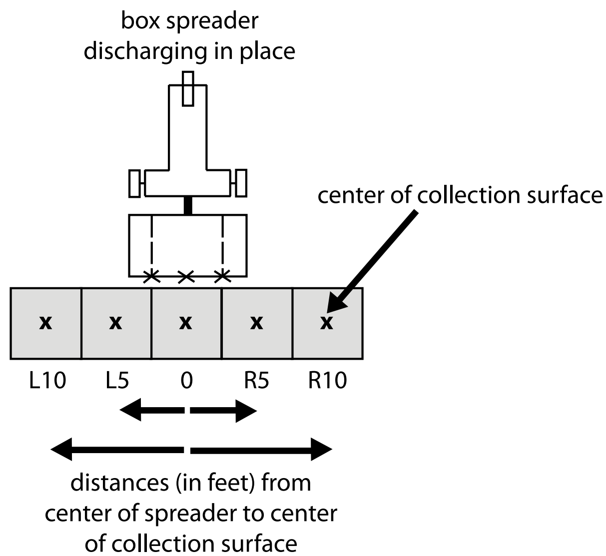

Figure 7a. Placement of collection surfaces when using a PTO or hydraulically-driven box spreader

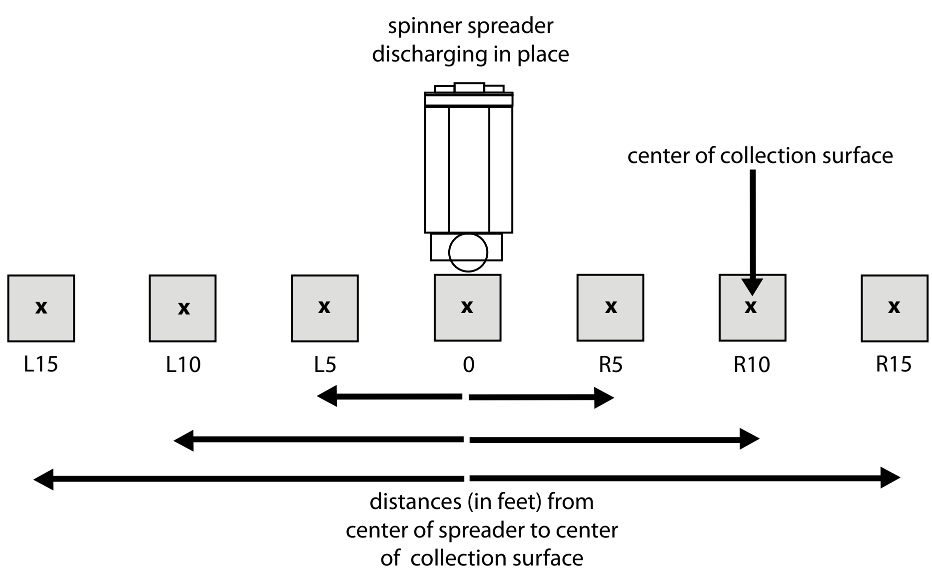

Figure 7b. Placement of collection surfaces when using a spinner spreader

Ground-driven Spreaders

Figure 7c below shows an example of where to place collection surfaces when using a ground-driven box spreader where lateral distribution of manure is minimal. Place the collection surfaces in a location so that the tractor and spreader will be driven at the typical speed when you pass over them.

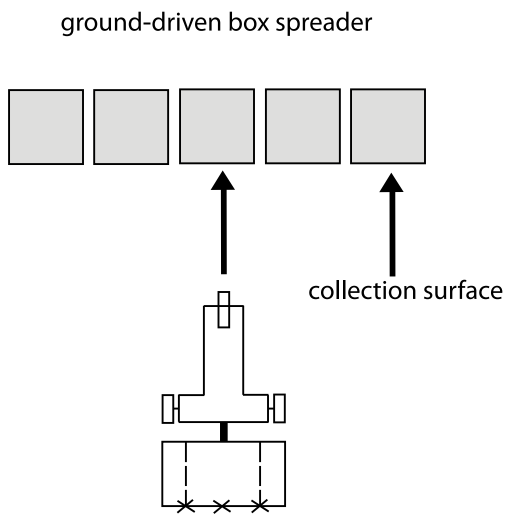

Figure 7c. Placement of collection surfaces when using a ground-driven box spreader

Carefully note the location of each collection surface in reference to the center of the spreader (center = 0 feet). Record each location in feet on **line 1** of **Worksheet 1**.

Step 2. Weigh each empty collection surface. Record the weight in pounds on **line 2** of **Worksheet 1**.

> **Note:** Individual collection surfaces may not be heavy enough to register on a scale. You may need to weigh all of the empty collection surfaces together and then divide by the number of collection surfaces to determine the average weight.

Step 3. For PTO and hydraulically-driven spreaders, engage the spreader (in place) for 20-30 seconds or until a distribution pattern of manure is observed.

For ground-driven spreaders, be sure that the tractor and spreader are being driven at the typical speed when you pass over the collection surfaces.

Step 4. Weigh each collection surface. Record the total weight of each collection surface with manure in pounds on **line 3** of **Worksheet 1**.

Step 5. Calculate the weight of the manure. Subtract the weight of each collection surface (**line 2**) from the weight of the collection surface and manure (**line 3**). Record the weight of manure in pounds on **line 4** of **Worksheet 1**.

Step 6. Determine the location where the application rate was maximum. Use **Worksheet 2** to graph the application rate in pounds per collection surface on the vertical axis (y-axis) and the distance in feet from the center of the spreader to the center of each collection surface on the horizontal axis (x-axis).

Step 7. Determine the distance in feet to the left of center where 50% of the maximum rate was spread. Determine the distance in feet to the right of center where 50% of the maximum rate was spread. Add the two distances to get the effective swath width.

Effective Swath Width: An Example

Scenario: A spinner spreader discharged poultry litter for 20 seconds onto 3 feet by 3 feet collection surfaces while in a stationary location. The following typical settings were used by the producer:

- PTO was set at 540 RPMs
- discharge gate was set at 8 inches
- drag chain speed was set at low range

The arrangement of collection surfaces is shown in Figure 8 below. Table 1 on page 8 shows the location and pounds of litter on each collection surface.

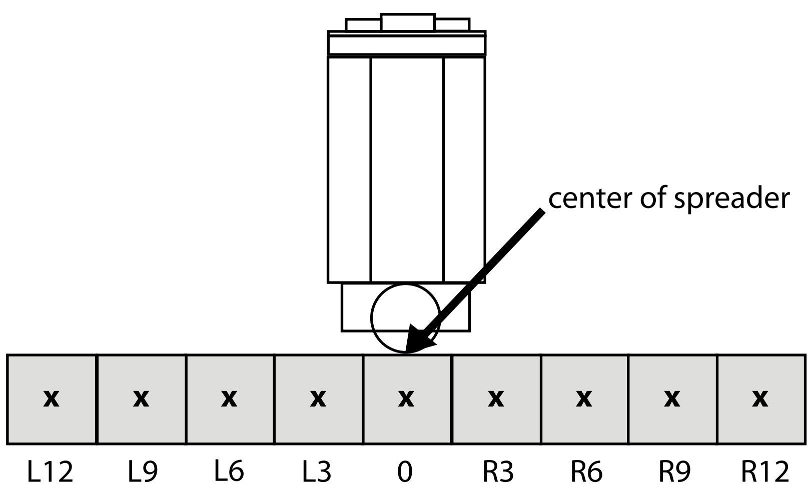

Figure 8. Location of collection surfaces relative to the center of the spreader in feet

Table 1. Weight of poultry litter on each collection surface

Location of collection surfaces in feet relative to center of spreader	Weight of litter in pounds per collection surface
L12	6
L9	15
L6	30
L3	36.8
0	40.8
R3	37
R6	28
R9	14.5
R12	5.6

Interpretation: The highest rate of litter application was observed directly behind the center of the spreader at zero (0) feet. Therefore the maximum application rate of litter on the collection surface directly behind the spreader is:

40.8 pounds

Half of the maximum application rate is 20.4 pounds:

40.8 pounds / 2 = 20.4 pounds

To interpret the graph of the data (Figure 9 on page 9), find where 20.4 (approximately) lies on the left-hand side and draw a line over to where it intersects the curve on the graph. Follow that point down to the horizontal axis (x-axis) (feet from center of spreader) and determine the distance to the left of center. In this case, the distance is approximately 7.5 feet. Repeat to find the distance to the right of center. In this example, the distance to the right of center is approximately 7.5 feet. To calculate the effective swath width, add the two distances together:

7.5 feet + 7.5 feet = 15 feet

Therefore, the effective swath width for this scenario is 15 feet.

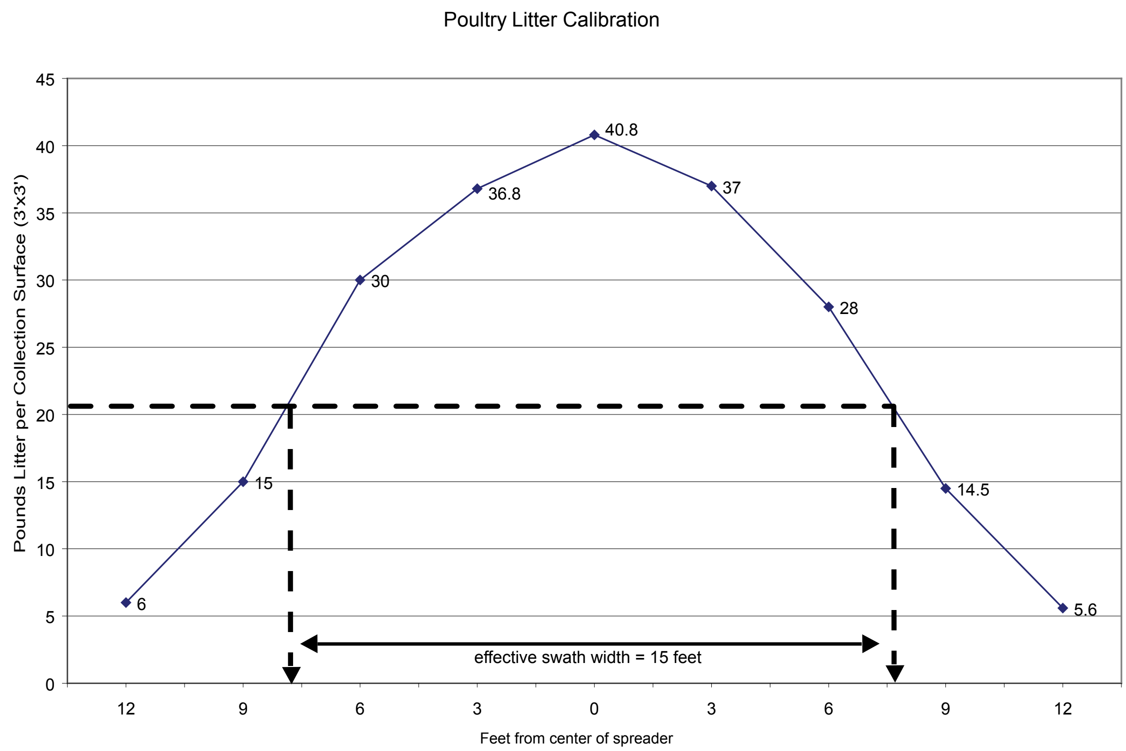

Figure 9. Graph of data for effective swath width scenario

How Frequently Should Effective Swath Width Be Determined?

Variation in spread patterns between manure spreaders is great. However, spread patterns are relatively constant for a particular spreader if the following manure and equipment conditions are similar:

- consistency of manure (moisture content and flow characteristics)
- rate of delivery of material (chain speed, valve or gate setting, PTO speed)
- point of delivery of material (spinner speed, balance between spinners, gate setting)
- cleanliness and upkeep of equipment

If any of these conditions change, the effective swath width should be recalculated.

References

Lorimor, J. 2000. *Manure Application with Dry Spreaders*. Odor and Nutrient Management Newsletter. Iowa State University, Ames, IA, 50111.

Worley, J., P. E. Sumner and T. M. Bass. 2008. *Calibration of Manure Spreaders*. Circular 285. University of Georgia Cooperative Extension, Athens, GA, 30602.

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Worksheet 1

EC-1, “Calibration of Manure Spreaders: Uniformity, Spread Patterns and Effective Swath Width”

line 4													
line 3													
line 2													
line 1							0 (center)						

line 1 - location of each collection surface relative to the center of the spreader (ft)
line 2 - weight of each collection surface (lbs)
line 3 - weight of each collection surface and manure (lbs)
line 4 - weight of manure on each collection surface (lbs)

Worksheet 2

EC-1, “Calibration of Manure Spreaders: Uniformity, Spread Patterns and Effective Swath Width”