NM1418 (Revised)

Manure Spreader Calibration

For Nutrient Management Planning

Revised by

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Purpose for Calibration

Livestock manures contain many beneficial and valuable plant nutrients, mainly nitrogen (N), phosphorus (P), potassium (K), sulfur (S) and micronutrients. However, if the manure application equipment is not properly calibrated, these valuable nutrients may be wasted by overapplication or crop yield goals may not be met due to underapplication.

Misapplication of manure also leads to a higher risk of environmental pollution. Environmental issues with manure pollution pertain mainly to bacterial pathogens, P in runoff entering surface waters, and N leaching through the soil to groundwater. These factors can cause health and environmental issues (Freitas and Burr, 1996).

NDSU EXTENSION SERVICE

October 2015

Nutrient Properties

Manure has many inorganic (mineralized) and many organic (immobilized) nutrients. The immobilized nutrients are not plant available until microbes break the manure down, releasing the nutrients to the soil (mineralization). Roughly 60 percent of the N, 80 percent of the P and 90 percent of the K found in manure is plant available during the first growing season after manure application. Most of the remaining immobilized nutrients will be mineralized during the following growing season.

The added organic matter from manure promotes sustained fertility due to a slow release of nutrients and increase in soil cation exchange capacity (CEC), which is the soil's capacity to hold onto positively charged ions.

Soil characteristics such as water-holding capacity, water infiltration, bulk density and soil buffering can be improved by using manure with a properly planned and practiced nutrient management plan. Economic benefits arise from increased soil health, crop production and money saved from reduced fertilizer costs.

Testing Manure

Manure composition can vary greatly due to differences that include animal species, bedding, diet, climate and storage facilities. Book values **(Table 1)** can help develop a nutrient management plan, but we highly recommend you have a manure sample analyzed by a specialized lab before application so you can better manage nutrients from manure, ensuring safe environmental practices and meeting crop yield goals.

Refer to NDSU Extension publication "Manure Sampling for Nutrient Management Planning" (NM-1259) for sampling methods.

For corn manure fertilization, use the "NDSU Manure Application Calculator for Corn," available for download at *www.ag.ndsu.edu/lem/manure-corn-n-p-calculator*. It calculates manure application rates, among other variables, for corn based on a manure analysis report, soil analysis and crop target yield information.

Calibration Methods

Sheet Method

This method works well for solid manure applications.

Materials:

- Tarps/sheets (at least three) of known area (length [feet] x width [feet] = area [feet^2]). Landscaping fabric works well because applied manure will not slide off as easily as it will on a plastic sheet.
- 5-gallon bucket
- Scale

Procedure:

- Weigh the bucket and a sheet to tare the weight off the manure.
- Lay out the sheets in a row and anchor them down with a few rocks or stakes. **Photo 1.**
- Start the tractor and turn the spreader on. Allow time for the spreader to start spreading. **Photo 2.**
- Record your tractor gear, engine's revolutions per minute (RPM) and spreader settings.
- Drive over the sheets, applying manure over them. **Photo 3.**
- Retrieve the manure covered sheets and weigh them in the bucket. **Photos 4 and 5.**

If a sheet measuring 21.8 feet^2 (3 feet by 7 feet 4 inches or 4 feet by 5 feet 6 inches) is used, then the weight in pounds of manure on the sheet is equal to tons/acre **(Table 2, Example 1)**. Example 2 shows how to determine the application when a different size sheet is used (see **Table 3** for some examples of tarp sizes, manure weight and correspondent application rate).

The application rate is given by the following expression:
Rate (tons/acre) = (pounds of manure on sheet x 21.8) ÷ sheet area (feet^2).







Photos taken at the
Carrington Research Extension Center
by Mary Berg





Table 1. Manure book values for various livestock species and categories.

Animal	N	P_2O_5	K_2O
	Pounds Per Ton		
Beef	13	6	12
Sheep	20	10	20
Poultry			
Layer	34	51	26
Tom turkey	40	50	30
Equine, sedentary	7	2	2
	Pounds Per 1,000 Gallons		
Dairy, lactating	54	28	30
Swine			
Gestating	55	36	45
Finishing	93	37	47

Sources:
Midwest Plan Service, 2004
Berg et al., 2015

Table 2. Sheet method worksheet.

	Manure on Sheet (lbs)	Multiply	Correction Factor (21.8)	Divide	Square Feet of Sheet (Length x Width)	Equals	Tons of Manure Per Acre
Example 1	*21.25*	x	*21.8*	÷	*21.8*	=	*21.25*
Example 2	*21.25*	x	*21.8*	÷	*24*	=	*19.3*
Sheet 1		x		÷		=	
Sheet 2		x		÷		=	
Sheet 3		x		÷		=	

This procedure also should be replicated three or more times and averaged to help account for variability (Jokela, 2008).

What is the magic 21.8 number?

To convert the weight of manure applied to the area of the calibration strip or tarp (pounds/square feet) to tons/acre, we need to multiply the weight in pounds by 43,560 square feet (= 1 acre) and divide it by 2,000 pounds (= 1 ton).

Instead of doing a two-step calculation, we calculate a factor that will convert at the same time the weight from pounds to tons and the area from square feet to acre.

The factor 21.8 is the rounded value for the division of 43,560 square feet/acre by 2,000 pounds/ton (= 21.78).

Table 3. Tarp sizes, manure weight and corresponding manure application rate.

Manure Weight	Tarp Size, feet			
	5x7	6x8	6x4, 8x3[a]	4x10, 8x5[b]
lbs.	Manure Application Rate[c], ton/acre			
2	1.2	0.9	1.8	1.1
4	2.5	1.8	3.6	2.2
6	3.7	2.7	5.4	3.3
8	5.0	3.6	7.3	4.4
10	6.2	4.5	9.1	5.4
12	7.5	5.4	10.9	6.5
14	8.7	6.4	12.7	7.6
16	10.0	7.3	14.5	8.7
18	11.2	8.2	16.3	9.8
20	12.4	9.1	18.2	10.9
22	13.7	10.0	20.0	12.0
24	14.9	10.9	21.8	13.1
26	16.2	11.8	23.6	14.2
28	17.4	12.7	25.4	15.2
30	18.7	13.6	27.2	16.3
32	19.9	14.5	29.0	17.4
34	21.2	15.4	30.9	18.5
36	22.4	16.3	32.7	19.6
38	23.6	17.2	34.5	20.7
40	24.9	18.2	36.3	21.8
42	26.1	19.1	38.1	22.9
44	27.4	20.0	39.9	24.0
46	28.6	20.9	41.7	25.0
48	29.9	21.8	43.6	26.1
50	31.1	22.7	45.4	27.2

[a] Halves of a 6- by 8-foot tarp.
[b] Halves of a 10- by 8-foot tarp.
[c] Manure Application Rate = (Manure Weight [lbs.] x 21.8)/Tarp Area [feet^2]

Axle Weight Method

This method works for solid and liquid manure applications.

Materials:

- 100-foot measuring tape or a measuring wheel.
- Scale capable of weighing the manure spreader (truck scales or portable axle scales work well).

Procedure:

- Weigh the manure spreader loaded. In the event the spreader is a tandem axle and the scale is unable to weigh both axles at the same time, each axle may be weighed individually and their weights can be added. (If using a tractor-pulled spreader and parking the tractor and spreader on the scale is not possible, be sure to lower the manure spreader jack onto the scale to take weight off the tractor tongue.).
- Record tractor gear, engine RPM and spreader settings.
- Apply manure to a desired area or measure the area after manure application (length [feet] x width [feet] = area [feet^2]).
- Weigh the spreader after application.

The application rate can be calculated by the following expression:

Rate (tons /acre) = (loaded spreader weight [pounds] – empty spreader weight [pounds]) x 21.8 ÷ application area [feet^2] **(Table 4)**.

Table 4. Axle weight method worksheet.

	Loaded Spreader Weight (lbs.)	Minus	Spreader Weight After Application (lbs.)	Divide	Manure Weight (lbs.)	Times	Correction Times	Divided	Application Area (feet^2)	Equals	Manure Application Rate (tons/acre)
Example	*37,188*	–	*19,321*	÷	*17,867*	*x*	*21.8*	÷	*16,438*	=	*23.7*
Application 1		–		÷		x	21.8	÷		=	
Application 2		–		÷		x	21.8	÷		=	
Application 3		–		÷		x	21.8	÷		=	
Application 4		–		÷		x	21.8	÷			

This procedure might be the most time consuming, but it is the most accurate because it can account for variability within the application procedure.

Notes

Notes

References

Freitas, R.J., and M.D. Burr. 1996. Animal Wastes. In Pollution Science. I.L. Pepper, C.P Gerba and M.L. Brusseau (ed). Academic Press. San Diego, Calif.

Jokela, B. Verified April 7, 2008. Manure Spreader Calibration. The University of Vermont Extension. *http://pss.uvm.edu/vtcrops/articles/ManureCalibration.pdf*

Midwest Plan Service. 2004. Manure Characteristics Manure Management Systems Series. Section 1, Second edition.

Refer to NDSU Extension publication "Manure Sampling for Nutrient Management Planning" (NM1259) for sampling methods.

This publication was authored by Chris Augustin, Ron Wiederholt and Teresa Dvorak, former area livestock nutrient management specialist, NDSU, 2009.

For more information on this and other topics, see www.ag.ndsu.edu

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