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Fertilizing with Manure

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Farming West of the Cascades

This publication is designed for the small to mid-sized crop producer (organic and conventional) to assist the producer in more efficiently managing nutrients from solid animal manures. The purpose of this publication is to (1) describe how to determine the appropriate manure application rate based on the type of manure and crops, and (2) describe how to apply the manure at that rate.

Manure is a good source of plant nutrients and organic matter. Properly managed manure applications recycle nutrients to crops, improve soil quality, and protect water quality. Manure is highly variable source to source, and growers must be able to understand and reduce that variability to make best agronomic and environmental use of manure.

The three main sources of variability and uncertainty when using manure are:

- Nutrient content of the manure
- Availability of manure nutrients to crops
- Application variability

If you do not account for this variability, you may apply too much or too little manure. Applying too little manure can lead to inadequate crop growth because of lack of nutrients, while applying too much manure may reduce crop quality or increase risk of plant diseases. Over-applying nutrients also may increase the risk of contaminating surface or groundwater. For more information on livestock water quality issues see *Manure Management in Small Farm Livestock Operations, Protecting Surface and Groundwater*, EM8649, available from the Oregon State University Extension Service.

Fertilizing with Manure outlines a systematic method to help you manage nutrients from manures. Even with the best methods, there is still some degree of uncertainty when using manures as nutrient sources. This publication describes how to:

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- Decide if manure is a good choice for your farm.
- Determine the nutrient content of manure.
- Estimate manure nutrient availability based on manure type, handling, and nutrient content.
- Calculate the application rate.
- Calibrate manure spreaders and apply manure at the target rate.
- Store manure.
- Test soil and monitor crops to adjust manure application rates.
- Evaluate long-term effects of manure applications on soil quality.

Three worksheets in this publication (Worksheets A, B, and C) will help you calibrate your manure spreader.

Is Manure a Good Choice for Your Farm?

Consider the following questions before applying animal manure on your farm:

- What is the local availability of manure?
- What is the quality of local manure sources?
- Where does manure fit in your crop rotation?
- Will your crops respond to added nutrients?

Local Availability of Manure

If you raise livestock, or if you have neighbors who do, you will likely have plenty of manure available nearby. If you have to import manure from more distant sources, transportation can greatly increase costs. If you are considering importing manure, you will need to decide if it makes economic sense.

Quality of Manure Sources

Manure quality varies considerably, as discussed later in this bulletin. You will need to compare the quality of available manure sources (nutrient supply, ease of handling, odor, and risk of weed seeds or pathogens) with your farming needs. See below for a comparison of composted and uncomposted manure sources.

Crop Rotations

Manure use is compatible with most crops and crop rotations. Remember that crop nutrient needs vary and manure applications should be consistent with the nutrient needs of your crops. Soil test results and

Composted Vs. Uncomposted Manure

When you are looking for organic forms of nutrients for crop production, manure and manure composts are two of the logical choices. Composting is more than just piling the material and letting it sit. Composting is the active management of manure and bedding to aid the decomposition of organic materials by microorganisms under controlled conditions.

What are the benefits or detriments of using uncomposted or composted manure? In some cases they have comparable properties and in other ways they are quite different. The table below compares the two materials.

Compost	Manure
• slow release form of nutrients	• usually higher nutrient content
• easier to spread	• sometimes difficult to spread
• lower potential to degrade water quality	• higher potential to degrade water quality
• less likely to contain weed seeds	• more likely to contain weed seeds
• higher investment of time or money	• lower investment of time or money
• reduced pathogen levels (e.g., salmonella, *E. coli*)	• potential for higher pathogen levels
• more expensive to purchase	• less expensive to purchase
• fewer odors (although poor composting conditions can create foul odors)	• odors sometimes a problem
• improves soil tilth	• improves soil tilth

extension bulletins are good sources of information on crop nutrient needs. Fresh manure is not a good choice for most salad and root crops because of food safety concerns. For more information see the section titled "Using Manure Safely."

Soil Fertility

Manure provides the most benefits on soils with deficient to adequate levels of nutrients. Soils with high to excessive levels of nutrients are not a good choice for manure use, because the nutrients in manure are less likely to benefit crops and more likely to leach into groundwater or run off into surface water. If you have excessive levels of nutrients in your soil, limit applications of those nutrients to recommended starter levels, and use an alternative source of organic matter input, such as growing cover crops.

How To Determine the Nutrient Content of Manure

Not knowing the nutrient content of manure can lead to large errors in nutrient application rate. We strongly advise you test the manure you plan to use. If you buy manure from a commercial source, they should be able to provide you with nutrient test values; you would not need to do further testing. In the absence of test values, use the published values in Table 1 as a starting point.

Laboratory Analysis

Laboratory analysis measures the nutrients in manure instead of just estimating them based on table values. Testing laboratories will charge from $30 to $60. (See the section "Deciding What To Test" for specifics on nutrient analysis of manure.) Using testing laboratories requires proper sampling techniques and timely delivery of the sample to the laboratory.

Choosing a Laboratory

It is important to use a laboratory that routinely tests animal manure as they will know the correct type of analysis to use when testing animal manures. Extension offices can provide you publications that list manure testing laboratories in the Pacific

Using Manure Safely

Fresh manure sometimes contains pathogens that can cause diseases in humans. Salmonella bacteria are among the most serious pathogens found in animal manure. Pathogenic strains of *E. coli* bacteria can be present in cattle manure. Manure from swine and carnivores can contain helminths, which are parasitic worms.

These pathogens are not taken up into plant tissue, but they can adhere to soil on plant roots, or on the leaves or fruit of low-growing crops. Cooking destroys pathogens, but raw food carries a risk of pathogen exposure. Washing and peeling raw produce removes most pathogens, but some may remain. The risk from pathogens is greatest for root crops (e.g., carrots and radishes) or leaf crops (e.g., lettuce or spinach), where the edible part touches the soil. The risk is negligible for crops such as sweet corn, which does not come in contact with the soil, or for any crop that is cooked thoroughly.

Consider any raw manure to be a potential source of pathogens, and avoid using fresh manure where you grow high-risk crops. Bacterial pathogens die off naturally during extended storage or after field application. Complete die-off of bacterial pathogens occurs in days to months depending on the pathogen and environmental conditions. Helminths in swine manure can persist in soil for years, however.

Composting manure at high temperatures will kill pathogens, including helminths, but you need careful quality control to make sure that all of the manure reaches conditions for pathogen kill. If you plan to compost manure, refer to the *On-Farm Composting Handbook* (listed in "Additional Resources") for procedures to compost manure under conditions to destroy pathogens.

If you grow certified organic crops you must follow the manure and compost practices in the National Organic Standards. These practices specify waiting periods between the application of fresh manure and the harvest of different types of crops, and time and temperature requirements for killing pathogens in manure compost.

Northwest (see the “Additional Resources” section for references).

Questions to ask when choosing a lab:

- Does the lab routinely analyze manure?
- How many manure samples do they analyze in a year?
- Can they perform the tests you need?
- Are the results reported in the form you need?
- How are the samples handled before analysis? Do they thoroughly mix the samples? Do they dry the samples before analysis? Drying samples prior to analyzing for ammonium nitrogen results in loss of most of the ammonium nitrogen from the sample.
- Can the laboratory supply quality control information to you? Do they participate in a regional, national, or university sample exchange program? Participation in a sample exchange program is a good indicator of a commitment to accurate results.
- How much does analysis cost? ($30–$60)

Laboratories report results on an as-received or a *dry-weight* basis. As-received results usually are reported in units of lb/ton, while dry weight results usually are reported in percent or mg/kg. The as-received results are most helpful when determining application rates. The dry-weight results can be used to compare analyses over time and from different manure sources. If you are not sure what reporting basis the lab is using, contact them for clarification. It is a good idea to ask for a sample reporting sheet before you choose a lab, to make sure you can interpret their results.

To convert manure analyses reported on a dry-weight basis (in percent) to an as-received basis (in lb/wet ton), multiply by 20 to convert the dry weight percent to lb/ton; then multiply by the decimal equivalent of the solids content.

Example:

For beef manure at 23% solids and 2.4% nitrogen (N) on a dry weight basis:

Step 1. 2.4% x 20 = 48 lb N/ton dry weight

Step 2. 48 lb N/ton dry weight x .23 = 11 lb N/ton as-is.

Deciding What To Test

The main components you should have measured are total nitrogen, ammonium nitrogen, total phosphorus, total potassium, electrical conductivity, and solids. If the manure is old or has been composted you may also want to test for nitrate-N. Total carbon (C) and pH sometimes are useful measurements. Total C can be useful for manure with bedding, so you can determine the C:N ratio. Manure with a C:N ratio greater than 25 is likely to tie up nitrogen when you apply it to the soil.

Sampling Manure

A nutrient analysis is only as good as the sample you take. Samples must be fresh and representative of the manure. Follow these steps carefully:

1. Ask the laboratory what type of containers they prefer. Also, make sure the laboratory knows when your sample is coming. Laboratories should receive samples within 48 hours of collection. Plan to collect and send your sample early in the week so the sample does not arrive at the lab on a Friday or a weekend.

2. If you have a bucket loader and a large amount of manure, use the loader to mix the manure before sampling.

3. Take 10 to 20 small samples from different parts and depths of the manure pile to form a composite sample. The composite sample should be about 5 gallons. The more heterogeneous your pile, the more samples you should take.

4. With a shovel or your hands thoroughly mix the composite sample. You may need to use your hands to ensure complete mixing. Wear rubber gloves when mixing manure samples with your hands.

5. Collect about one quart of manure from the composite sample and place in an appropriate container.

6. Freeze the sample if you are mailing it. Use rapid delivery to ensure that it arrives at the laboratory within 24 to 48 hours. You can refrigerate the sample if you are delivering it directly to the lab.

Published Values

Table 1 shows typical published values for livestock manure. These values may not accurately represent your situation. The nutrient content of manure varies widely with amount and type of bedding used, storage conditions, age of manure, manure handling, and animal diet. Nutrient values can vary by a factor of two or more from the values listed in Table 1.

For example, leaving manure piles uncovered in western Washington will reduce manure nutrient content by leaching. The use of bedding reduces manure nutrient by dilution. The amount of reduction from either of these factors is difficult to determine without laboratory testing.

Nitrogen Availability for Crop Growth

Manure application rates are usually N based, because N is usually the nutrient needed in the largest quantity for crop growth. Manure is not like commercial fertilizer in that it does not come with a guaranteed N availability. Nitrogen availability from manure varies greatly, depending on the type of animal, type and amount of bedding, and age and storage of manure.

Manure contains nitrogen in the organic and ammonium forms. The organic form releases N slowly, while ammonium-N is immediately available for crop growth. Ammonium-N can be lost to the atmosphere as ammonia gas when manure is applied to the soil surface. Most solid manures contain most of their nitrogen in the organic form, but poultry manure contains substantial ammonium-N. Poultry and other manures that contain a large proportion of ammonium-N may lose substantial N to the atmosphere if they are not tilled into the soil the same day they are spread. Ammonia loss is greater in warm, dry, and breezy conditions; less in cool, wet weather.

There is no simple test to determine N availability for an individual manure sample. Use Table 2 or Figure 1 to estimate N availability from manure.

The N availability numbers in Table 2 are approximate ranges for each type of manure. Use the lower part of the ranges if manure contains a large proportion of ammonium-N (such as poultry manure), and it is not tilled into the soil soon after application. Also, use the lower part of the ranges if the manure contains large amounts of bedding, or if the measured N content is lower than typical values. Use the higher part of the ranges if the manure contains less bedding or if the measured N content is higher than typical values.

Thorough composting generally reduces the rate of release of manure N by incorporating the N into more biologically resistant forms. Composting can reduce the amount of first-year N release by 50% or more,

Table 1. Typical nutrient content, solids content, and bulk density of uncomposted animal manures at the time of application.[1]

Type	N	P[2]	K	Solids	Bulk density
		lb per ton as-is[3]		*percent*	*lb/cu yard*
Broiler with litter	73	28	55	70	900
Laying hen	37	25	39	40	1400
Sheep	18	4.0	29	28	1400
Rabbit	15	4.2	12	25	1400
Beef	12	2.6	14	23	1400
Dry stack dairy	9	1.8	16	35	1400
Separated dairy solids	5	0.9	2.4	19	1100
Horse	9	2.6	13	37	1400

[1] Dairy manure data and some horse manure data were collected in the Pacific Northwest. Other data sources are listed in *Additional Resources*.
[2] Manure analyses are usually reported in terms of P and K, while fertilizer labels use P_2O_5 and K_20. To convert from P to P_2O_5, multiply P by 2.3. To convert from K to K_2O, multiply K by 1.2.
[3] *As-is* is typical moisture content for manure stored under cover.

Table 2. Typical nitrogen availability for uncomposted animal manures.

Type	Typical Nitrogen Content	Nitrogen Availability[1]
	percent dry weight	*percent*
Broiler with litter	4–6	40–70
Laying hen	4–6	40–70
Sheep	2.5–4	25–50
Rabbit	2.5–3.5	20–40
Beef	2–3	20–40
Dry stack dairy	1.2–2.5	20–40
Separated dairy solids	1–2	0–20
Horse	0.8–1.6	0–20

[1] Nitrogen available in the first growing season after application.

and Table 2 will usually overestimate available N from manure composts.

This may not be the case for material sold as composted poultry litter, however. Poultry litter (from broiler production) is a mixture of manure and wood shavings. Dry stacked poultry litter will heat to high temperatures, but the composting process is often limited by insufficient moisture in the pile. Materials sold as "composted poultry litter" are frequently incompletely composted, and have similar N availability as fresh poultry litter. Incompletely composted poultry litter will have a strong ammonia odor and will have ammonium-N analyses above 2000 ppm (0.2 % ammonium-N on a dry weight basis).

Horse manure or other manures with lots of woody bedding may temporarily tie up nitrogen rather than supply nitrogen for crop growth, because the wood is still decaying, and bacteria that break down the carbon in the wood consume nitrogen. Expect first-year N tie-up from manures containing less than 1% N.

Figure 1 is an alternative way to estimate manure N availability, based on laboratory measurements of manure N content. In general, the higher the N content of manure, the higher the proportion of N that will become available to crops.

If you have been applying manure to the same field for several years, residual organic nitrogen from past applications will contribute to the supply of N available to crops. You will need to reduce the manure application rate for fields that receive repeated manure applications.

Calculating the Application Rate

Now that you have determined the nutrient content and estimated the N availability of the manure you will be using, you are ready to determine the application rate. Application rates of manure are usually based on providing adequate nitrogen for crop growth. In most cases supplying sufficient nitrogen will also provide adequate phosphorus and potassium for crop growth.

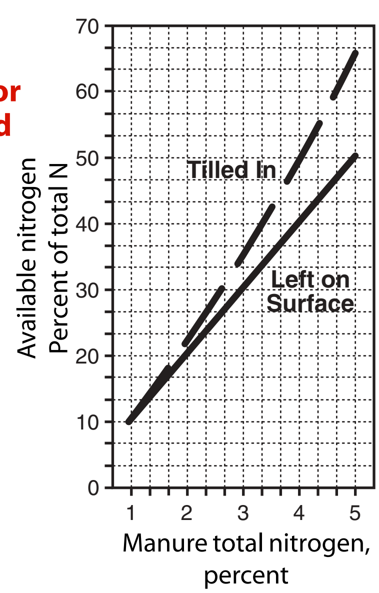
First, you will need to know the amount of nutrients your crop requires. Nutrient requirements for specific crops can be found in Cooperative Extension production guides or from soil test recommendations.

If you have your manure and soil tested at the same time at the same laboratory, the lab can provide a recommendation for the amount of manure to apply.

Once you know the amount of nitrogen needed for your crop, and the nutrient content of your manure, you can estimate the amount of manure to apply using a few simple calculations.

Observe the performance of your crops to help fine-tune your application rate. If you have a complicated

Figure 1. Nitrogen availability for uncomposted manure based on total N content.



nutrient management program, you may need to consult with a professional agronomist. See the "Additional Resources" section for publications listing laboratories and professional agronomists, or contact your local Extension office.

Applying Manure

Manure Spreaders

The best of manure application estimates will not be useful if you don't know how much you're applying once you get to the field. You will need a spreader appropriate to the size of your farm, and you will need to calibrate it so you have confidence in your application rates.

Equipment

There are several ways to spread manure. For small amounts, you can use buckets or apply it from the back of a pickup truck. Using a mechanical manure spreader is easier and more effective for spreading large amounts of manure.

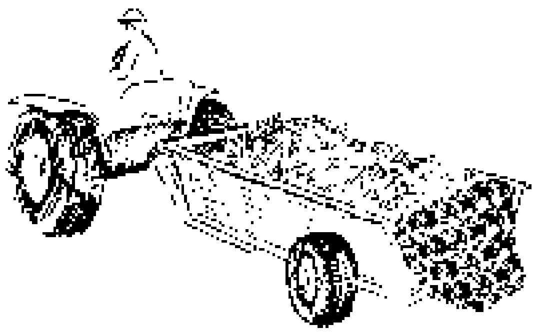
There are three general types of solid manure spreaders: rear delivery, side-delivery, and specialty spreaders. Rear delivery spreaders work best with drier materials. Side delivery spreaders handle both wet and dry

Table 3. Worksheet for calculating manure application rates.

Example: I am growing sweet corn and the nitrogen recommendation is 100 pounds N per acre. I have beef manure that has been tested by a laboratory and contains 11 pounds of N, 2.2 pounds of P, and 8.3 pounds of K per wet ton of manure.

Note: Unshaded cells in table are information about manure and crop. Shaded cells are calculations you make.

Step	Units	Example	Your Value
A. Type of manure		beef	
B. Crop		sweet corn	
C. Desired N application rate	lb N/acre	100	
D. Manure N concentration, from laboratory analysis or Table 1.	lb N/ton as-is	11	
E. Phosphorus concentration, from laboratory analysis or Table 1.	lb P/ton as-is	2.2	
F. Potassium concentration, from laboratory analysis or Table 1.	lb K/ton as-is	8.3	
G. Plant availability of N in manure from Table 2 or Figure 1.	percent	25	
H. Calculate manure available nitrogen **Line D x (line G / 100)**	lb N/ton as-is	2.75	
I. Calculate application rate **Line C / line H**	tons manure/acre as-is	36	
J. Calculate amount of phosphorus applied **Line I x line E x 2.3**	lb P_2O_5/acre	184	
K. Calculate amount of potassium applied **Line I x line F x 1.2**	lb K_2O/acre	362	



Manure Spreader

materials. Specialty spreaders have the capability of spreading material onto narrow beds found in perennial crop production. They are designed for drier materials. Prices for new equipment vary from $1,600 to $8,000. A good used spreader costs about 50–60% of a new spreader. Used spreaders are sometimes difficult to find because farmers usually wear them out before replacing them.

Calibrating Manure Applications

Calibrating your spreader will allow you to determine the actual application rate and adjust it to meet your target rate. You can calibrate your spreader by measuring a small part of the manure applied using pans or tarps. Or, you can weigh an entire spreader load and measure how much area the load covers. If you know the bulk density of the manure you can calculate the volume of a spreader load rather than the weight. These three methods are described in Worksheets A, B, and C beginning on page 10.

Calibrating your spreader will allow you to convert loads of manure applied to tons per acre. The spreader load calibration is the most accurate method, but it requires truck scales to complete. Calibration improves accuracy of the overall application rate, but there will still be variability in the actual application across your field.

If you apply manure to a small area and use buckets or a pickup truck, it is still important to know how much you are applying. You can do this by weighing the buckets or determining the weight or volume of the pickup load.

Regardless of which method you use, recheck your measurements periodically to make sure you stay on target.

Timing Manure Applications

The best time to apply manure to row crops is in the spring before planting. You also can apply manure in the fall, but some of the nutrients will be lost over the winter if you apply manure to bare ground. Environmental risks of leaching and runoff also increase. If you do apply manure in the fall, apply it early, and plant a cover crop to help capture nutrients and prevent runoff. You can apply manure to pastures from late February through mid-October in most places west of the Cascades, as long as the applications are at moderate rates.

Manure Storage

If you raise animals on your farm or import manure for crop production you may need to store manure on your farm prior to application. Proper manure storage conserves nutrients and protects surface and groundwater. Storing manure can be as elaborate as keeping it under cover in a building or as simple as covering the manure pile with a tarp. The important point is keeping the pile covered and away from drainage areas and standing water. The storage location should also be convenient to your animals and crop production. If you decide to build a manure storage structure, refer to extension bulletins that cover this subject (see "Additional Resources"), or see your nearest Natural Resources Conservation Service office.

Using Soil Testing To Adjust Application Rates

Taking soil test samples and observing your crops can help you determine if manure application rates are adequate or if they need adjusting. The report card soil test helps determine if you are applying too much manure. The report card test measures nitrate-N remaining in the soil in the fall. If you apply too much manure, nitrate N will accumulate in the soil, unused by the crop. When the fall and winter rains come, the nitrate will leach from the soil and become a potential contaminant in groundwater or surface water. Excess N can also harm some crops, delaying fruiting and increasing the risk of disease damage, freeze damage, and wind damage.

To do a report card test, sample the soil (0 to 12-inch depth) between August 15 and October 1. Timing is critical. You want to sample after most crop uptake of N has occurred, but before the fall rains leach nitrate from the soil. Take a report card sample as you would any other soil sample, collecting soil cores at multiple spots in the field, and combining the cores together into a composite sample. For details on soil sampling procedures, refer to *Soil Sampling*, Bulletin 704, available from the University of Idaho Cooperative Extension System.

If your report card nitrate-N results are greater than 15–20 mg/kg, this suggests you are supplying more N than your crop needs, and you can reduce manure application rates. Report-card nitrate-N levels greater than 30 mg/kg are excessive.

When interpreting report card results, consider the performance of your crop, too. If crop growth was poor because of drought, pests, or poor growing conditions, crop N uptake may have been less than expected, resulting in excess N remaining in the soil profile even if manure applications were on target for a normal crop.

You can use basic soil tests to evaluate the soil for sufficiency or excess of other nutrients. A basic soil test includes P, K, calcium (Ca), magnesium (Mg), boron (B), pH, and a lime recommendation. If you have consistently low levels of P and K and reduced crop growth, you can probably increase your manure application rates. If you have consistently excessive levels of P and K, you may need to decrease or eliminate manure applications, as described below.

Long-Term Effects of Manure Applications

Repeated applications of manure can increase soil organic matter content and the soil nutrient pool. Because the pool of slow-release nutrients increases in the soil with repeated manure applications, the amount of manure needed to meet crop needs will decline over time.

When manure applications are based on nitrogen need, manure usually supplies P and K in excess of crop needs. As a result, P and K can accumulate in soils with a history of manure applications, and may eventually reach excessive levels. Excess levels of soil P can increase the amount of P in runoff, increasing the risk of surface water degradation. Many crops can handle high levels of K, but livestock can be harmed by nutrient imbalances if they consume a diet of forages with high K levels.

If you apply manure repeatedly to the same fields, it is important to have a regular soil testing program to track nutrient levels. If P and K reach excessive levels, you may need to switch to a commercial fertilizer to supply N. If you are an organic farmer and do not use synthetic fertilizers, consider replacing some or all of your manure with legume cover crops. Legumes will fix N from the atmosphere, but they do not supply P or K. Reserve manure for fields that have lower P and K levels.

Summary

To reduce variability and uncertainty in manure applications, follow these four steps:

1. Determine the nutrient content of the manure you are using. Laboratory testing will give you the most reliable estimate.
2. Estimate manure N availability based on the type of manure, handling, and nitrogen content.
3. Calibrate your manure spreader so that you have confidence in the rate applied.
4. Do soil testing (report card and basic tests) and observe plant growth to evaluate the effect of manure applications on crop production and soil nutrient levels. Adjust manure rates as necessary based on your evaluations.

Worksheet A

Application Calibration Using a Tarp

You will need some tarps and a scale on which to weigh the manure. Hanging scales work well. Then follow these steps:

1. Weigh the tarp and record the weight and size of the tarp on Worksheet A.
2. Place tarps in application area.
3. Spread manure over the application area using the spreading pattern typically used in the field. Make sure the spreader is traveling at the speed it would typically travel. On Worksheet A, record tractor speed and gear, and note spreader settings.
4. Collect and weigh the manure. Record the weight on Worksheet A.
5. Calculate an average application by completing Worksheet A.
6. Repeat steps 1–4 five to nine times. Replication gives you more accurate results.
7. Adjust the application rate by changing tractor speed or gearing, or making an adjustment on the manure spreader. After adjustment, you will need to repeat the calibration procedure until you have arrived at the desired application rate.
8. Keep the calibration records for future use.

Worksheet A

Date ____________________ **Field** ____________________ **Spreader ID** ____________________

Speed ____________________ **Gear** ____________________ **Operator** ____________________

	Tarp ID						
	Example	A	B	C	D	E	F
1. Weight of tarp with manure (lb)	*9.2*						
2. Weight of empty tarp (lb)	*6.5*						
3. Weight of manure **(line 2 minus line 1)**	*2.7*						
4. Tarp area (sq ft)	*9.0*						
5. Manure applied (lb/ sq ft) **(line 3 / line 4)**	*0.3*						
6. Convert to tons/acre **(line 5 x 21.78)**	*6.5*						
7. Average application rate (Ave. over all locations) tons/acre							

Worksheet B

Spreader Calibration Using a Full Spreader Load and Scales

Use this method to monitor the manure application rate on the entire field. After the initial weighing to determine the capacity of the application vehicle, the only tool you need is a field-measuring wheel or long tape.

1. Determine the weight of manure the spreader will hold using a truck scale to weigh the spreader when empty and full. Record the weights on Worksheet B.

2. Spread a load on the field, using constant, even tractor speed and settings to cover field uniformly. Spread in a rectangular pattern so the area calculation will be simple. Record tractor speed and gear settings used on Worksheet B.

3. Measure the length and width covered by one full load and compute the application rate in tons per acre using Worksheet B below.

4. Adjust the application rate by changing tractor speed or gearing, or making an adjustment on the manure spreader. After adjustment, you will need to repeat the calibration procedure until you have arrived at the desired application rate.

5. Keep the calibration records for future use.

Worksheet B

Date ____________________ **Field** ____________________ **Spreader ID** ____________________

Speed ____________________ **Gear** ____________________ **Operator** ____________________

	Replicates				
	Example	A	B	C	D
1. Weight of loaded spreader (lb)	*12,000*				
2. Weight of empty spreader (lb)	*2,000*				
3. Weight of manure in spreader (lb) **(line 2 - line 1)**	*10,000*				
4. Length of area spread (ft)	*1,300*				
5. Width of area spread (ft)	*25*				
6. Area spread (sq ft) **(line 4 x line 5)**	*32,500*				
7. Manure applied (lb/sq ft) **(line 3 / line 6)**	*0.308*				
8. Convert to tons/acre **(line 7 x 21.78)**	*6.7*				

Worksheet C

Spreader Calibration Using Manure Bulk Density

This method can be used if you know or estimate the manure bulk density, but is not as accurate as one of the other methods. You will need a tape measure, calculator and a measurement or estimate of the manure bulk density.

1. Determine the length, width, depth, and stacking height of the manure spreader and enter values in Worksheet C. Measure or estimate manure bulk density from Table 1 and enter in the worksheet.
2. Calculate the volume and weight of manure in a spreader load using Worksheet C.
3. Spread a load on the field, using constant, even tractor speed and settings to cover field uniformly. Spread in a rectangular pattern so the area calculation will be simple. Record tractors speed and gear settings used on Worksheet C.
4. Measure the length and width covered by one full load and compute the application rate in tons per acre using Worksheet C.
5. Adjust the application rate by changing tractor speed or gearing, or making an adjustment on the manure spreader. After adjustment, you will need to repeat the calibration procedure until you have arrived at the desired application rate.

Worksheet C

Date ____________________ **Field** ____________________ **Spreader ID** ____________________

Speed ____________________ **Gear** ____________________ **Operator** ____________________

	Replicates			
	Example	A	B	C
1. Manure bulk density from table (lb/yd)	*1,100*			
2. Length of manure spreader (ft)	*7.0*			
3. Width of manure spreader (ft)	*3.0*			
4. Depth of manure to top of spreader side boards (ft)	*1.4*			
5. Stacking height from the top of the side boards to top of pile (ft)	*1.1*			
6. Volume of manure in spreader (ft^3) **(line 2 x line 3 x (line 4 + (line 5 x 0.8))**	*48*			
7. Weight of manure in the spreader (lb) **(line 1 x line 6) / 27**	*1,951*			
8. Length of area spread (ft)	*245*			
9. Width of area spread (ft)	*4*			
10. Area spread (sq ft) **(line 8 x line 9)**	*980*			
11. Manure applied (lb/sq ft) **(line 7 / line 10)**	*1.99*			
12. Convert to tons/acre **(line 11 x 21.78)**	*43*			

Additional Resources

Typical Nutrient Analyses of Manure

Camberato, J. J. *Land application of animal manure*. EC 673 (Clemson University Cooperative Extension, 1996).

Web site http://virtual.clemson.edu

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Web site http://ctr.uvm.edu.

Sullivan, D., C. Cogger and A. Bary. *Which test is best? Customizing dairy manure nutrient testing*. PNW 505 (Oregon State University, 1997).

Web site http://eesc.orst.edu

Manure Handling on the Farm

Godwin, D. and J, A. Moore. *Manure Management in Small Farm Livestock Operations, Protecting Surface and Groundwater*. EM8649 (Oregon State University, Cooperative Extension Service, 1997).

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Koelsch, R. *Manure applicator calibration*. G95-1267-A (University of Nebraska Cooperative Extension, 1995).

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Midwest Plan Service. *Livestock Waste Facilities Handbook*. MWPS-18 (Iowa State University, Ames Iowa, 2001).

Rynk, R. *On-Farm Composting Handbook*. NRAES-54 (Northeast Regional Agricultural Engineering Service, 1992).

Lists of Laboratories and Consultants

Daniels, C. H. *Analytical Laboratories and Consultants Serving Agriculture in the Pacific Northwest*. EB1578E (Washington State University Extension, 2002).

Hart, J. *A list of analytical laboratories serving Oregon*. EM8677 (Oregon State University Extension Service, 2002).

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Cogger, C.G. *Soil Management for Small Farms*. EB1895 (Washington State University Extension, 2000).

Mahler. R.L. and T.A. Tindall. *Soil Sampling*. Bulletin 704 (University of Idaho Cooperative Extension System, 1997).

Notes

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