Guidelines *for* Applying Manure *to* Cropland *and* Pasture *in* Wisconsin

Guidelines for Applying Manure to Cropland and Pasture in Wisconsin

Fred Madison, Keith Kelling,
Leonard Massie and Laura Ward Good

Land application of manure is the only practical management alternative for most Wisconsin farmers. When manure is applied to cropland and broken down by soil microorganisms, nutrients are released and recycled for crop production. Care must be taken, however, to ensure that manure is applied where it can decompose and the nutrients be used by plants without contaminating surface water or groundwater.

Proper manure management and handling is complicated. This publication describes how to maximize manure's benefits to plants and soils and to minimize the possibility of surface or groundwater pollution from manure applications.

Benefits and Hazards of Applying Manure

Manure is a resource. It provides essential nutrients for crop growth and adds organic matter to soils. Manure improves soil structure, or tilth, and increases the soil's ability to hold water and nutrients and to resist compaction and crusting. Well-structured soils trap rainwater and allow it to infiltrate, thus reducing the potential for runoff and erosion.

Manure's value as a fertilizer has been overlooked for many years. Recently, however, increased commercial fertilizer costs and smaller farm profit margins have enhanced the value of manure for crop production. Farmers today are finding that planning for manure management makes good economic sense.

Environmental concerns also dictate the need for careful manure management planning. The phosphorus (P) contained in manure can affect lake and stream water quality by stimulating weed and algae growth. The nitrogen (N) in manure may be converted through the action of soil bacteria to the nitrate form which, if unused by plants, can move through the soil and into the groundwater. High nitrate levels in drinking water (greater than 10 parts per million) can cause health problems for babies; pregnant women; and, in combination with nitrates from food sources, livestock. Movement of nitrate to groundwater is more likely to be a problem in areas with sandy soils and a water table near the land surface, or where shallow soils cover fractured limestone or sandstone bedrock.

In addition, odors can be a problem when manure is applied to the land surface or when stored manure is agitated before hauling and spreading. These problems can be minimized if manure is injected when there are calm winds, cool temperatures and low humidity.

Manure's Value as Fertilizer

Typical amounts of the three major plant nutrients contained in fresh manure from livestock and poultry operations are shown in Table 1. In addition to N, P, and potassium (K), manure contains other elements essential to plant growth such as calcium, magnesium, sulfur, boron, manganese, copper and zinc. The exact amounts of crop nutrients contained in various animal manures depend on the method of manure collection and storage, the kind and amount of bedding or litter used, and the amount and type of feed. Having a manure sample analyzed at a laboratory to determine its nutrient content will provide farm-specific information.

Much of the *total* nutrient content of manure is not immediately usable by plants. Decomposition must first release the nutrients held in organic compounds before they become *available* for plant uptake and use. Other nutrients in manure may be transformed to unavailable forms or lost as gases to the air (volatilized). For example, about one-half of the N in manure is in a form which is released slowly as the manure decays; this process may take several years. Manure also contains ammonia-N which may be lost to the air if manure is surface-applied without incorporation.

As much as 50 percent of the total N and P and 40 percent of the K may be lost from manure on an open lot through volatilization, runoff or leaching. Up to 40 percent of the N and from 5 to 15 percent of the P and K may be lost during daily hauling and spreading. Taking into account decomposition rate and nutrient losses, the approximate first year *available* nutrient content portion of Table 1 shows how much of a particular nutrient is expected to be available in the first crop season after spreading.

Table 1: Manure Nutrient Contents

Approximate Total Nutrient Content[1]

	Animal Type			
	Dairy	**Beef**	**Poultry**	**Swine[2]**
Nitrogen				
(lb/ton)	10	14	25	10
(lb/1000 gal)	28	39	69	55
Phosphate (P_2O_5)				
(lb/ton)	5	9	25	6
(lb/1000 gal)	14	25	69	27
Potash (K_2O)				
(lb/ton)	10	11	12	9
(lb/1000 gal)	28	31	33	34

Approximate First-Year Available Nutrient Content (Fertilizer Value)[1]

	Animal Type			
	Dairy	**Beef**	**Poultry**	**Swine[2]**
Nitrogen				
Manure not incorporated				
(lb/ton)	**3**	**4**	**13**	**4**
(lb/1000 gal)	**8**	**10**	**35**	**22**
Manure incorporated within 3 days				
(lb/ton)	**4**	**4**	**15**	**5**
(lb/1000 gal)	**10**	**12**	**41**	**28**
Phosphate (P_2O_5)				
(lb/ton)	**3**	**5**	**14**	**3**
(lb/1000 gal)	**8**	**14**	**38**	**15**
Potash (K_2O)				
(lb/ton)	**8**	**8**	**9**	**7**
(lb/1000 gal)	**21**	**23**	**25**	**26**

[1] These values have been rounded to the nearest whole pound.

[2] Assumes finishing unit.

Incorporate Manure Whenever Possible

Reduce nutrient losses and runoff pollution by incorporating manure

Whenever possible, manure should be injected or worked into the soil within 3 days after application to reduce volatilization and runoff losses. Note that incorporated manure has a higher first year available N content than unincorporated manure (Table 1).

Inject or work into the soil within 3 days of application.

To reduce the chances of surface water pollution from manure washing into waterways, do not apply more than 25 tons per acre of solid dairy manure (or its equivalent on a P-content basis as shown in Table 2) in any year unless it is incorporated. In no-till row crop production or on established hay fields and pastures, manure can not be worked into the soil. Avoid possible runoff pollution from areas that can not be tilled by limiting applications to 25 tons or less per acre of solid dairy manure (or its equivalent on a P-content basis) in any 5 year period.

If not incorporated through injection or tillage, do not apply more than 25 tons/a of solid dairy manure (or an amount of manure with the same amount of available phosphorus—75 lbs P_2O_5/a) in any 1 year period.

On no-till fields and other areas that are not tilled, do not apply more than 25 tons/a of solid dairy manure (or an amount of manure with the same amount of available phosphorus—75 lbs P_2O_5/a) in any 5 year period.

Table 2: Manure Amounts with Phosphorous Levels Equivalent to 25 Tons of Solid Dairy Manure*

	Solid (tons)	Liquid (gallons)
Dairy	25	9,000
Beef	14	5,000
Swine		
Finishing unit	25	5,000
Farrow-nursery	25	13,000
Poultry	5	2,000

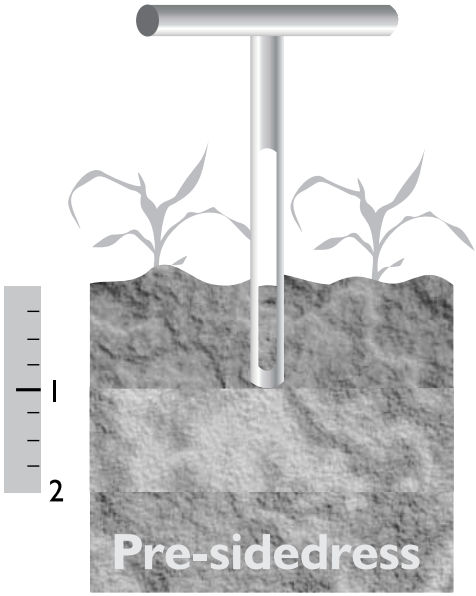
* Amounts are rounded to nearest whole ton or 1,000 gallons.

Know Crop Nutrient Requirements

Soil test fields every 3 to 4 years.

Effective use of the nutrients in manure requires a knowledge of the crop's nutrient requirements and the amounts of nutrients present in the soil as well as in the applied manure. Most soils should be tested every 3 to 4 years. The goal is to apply manure at rates equivalent to crop nutrient needs; nutrients completely re-used by crops cannot run off to surface waters or percolate through the soil to the groundwater.

For information on soil testing and on crop nutrient requirements consult the University of Wisconsin-Extension publications: *Sampling Soils for Testing* (A2100), *Soil Test Recommendations for Field, Vegetable, and Fruit Crops* (A2809), *Corn Fertilization* (A3340), and *Nutrient Management: Practices for Wisconsin Corn Production and Water Quality Protection* (A3557). If you need additional assistance, contact your county Extension office.



Growers can confirm that the expected amount of manure-nitrogen is available to the crop during the growing season by using the pre-sidedress soil nitrate test.

Credit Manure-Nitrogen to Avoid Over-Application of Nitrogen

Apply manure at rates sufficient to meet crop nitrogen requirements.

Take all N sources into account, including legume-N, when planning applications to avoid exceeding crop needs.

In Wisconsin, our guidelines allow manure applications at rates sufficient to meet, but not to exceed the N needs of agronomic crops. N supplied by manure should be taken into account before commercial N fertilizer is applied to a field to avoid over-application of N. If the manure you spread has not been analyzed, use the average first-year available N values shown in Table 1. For example, you may take an N credit of 3 pounds per ton of solid dairy manure for the application year. If solid dairy manure is worked into the soil within 3 days of spreading (incorporated), the credit is 4 pounds of N per ton. This credit can be increased to 5 pounds of N per ton when manure is applied annually to the same field at about the same rate for 3 or more years because manure continues to breakdown and provide N in the soil over a number of years. These credit recommendations assume average management and include some handling losses.

For example, on a silt loam soil in southern Wisconsin, the University of Wisconsin recommendation for corn is 160 pounds N per acre. Solid dairy manure spread at a rate of 25 tons per acre will provide 75 pounds of N per acre, and commercial fertilizer applications should be reduced by that amount to 85 pounds per acre. An application of 25 tons per acre of dairy manure that is incorporated will provide about 100 pounds of N per acre, and only 60 pounds of fertilizer N are recommended. If manure has already been applied to this field at this same 25 ton per acre rate for 3 years or more, there should be about 125 pounds of available N per acre, leaving only a 35 pound per acre N requirement to be supplied by fertilizer.

Manure N can be lost or released more slowly than expected, so growers may wish to confirm that the expected amount of manure N is available to the crop by using the pre-sidedress soil nitrate test. This test is especially valuable when most or all of the crop's N needs are expected to come from manure N. It is performed when the corn is 6-12 inches tall, and will show whether there is an adequate reservoir to meet crop needs for the rest of the growing season. For more information on the pre-sidedress nitrate test see University of Wisconsin-Extension publication *Soil Nitrate Tests for Wisconsin Cropping Systems* (A3624).

Crop rotation options

Manure may be applied prior to planting most crops, although some crops will be harmed by heavy applications. For example, only modest (10-15 tons per acre) manure applications should be made prior to a small grain crop to avoid lodging of the crop if it is to be harvested for grain rather than silage.

Where alfalfa, soybeans, or other legumes are being rotated into corn, calculate the amount of N available from decomposition of the residues (the legume N credit) before making a manure application. In many cases, the additional N in manure will not be needed for a corn crop following alfalfa, and the manure might be more profitably used on an N-deficient field. Refer to Table 3 or the University of Wisconsin-Extension publication *Using Legumes as a Nitrogen Source* (A3517) for more information.

Manure applications preceding legumes do not constitute an added risk of excess nitrates leaching to groundwater, because legumes will take up available N (from manure or other sources) in the soil before expending energy to fix atmospheric N. However, topdress applications of manure to legume forages may cause some stand deterioration, unless the applications are light. Some growers have had success with 5 to 6 tons per acre topdress applications using a slinger-type manure spreader which breaks up the manure into fine particles and sprays it out uniformly.

Table 3: Nitrogen Credits for Alfalfa and Soybeans in Wisconsin

	Medium and Fine Textured Soils		Sandy Soils	
	last cut before Sept. 10	*last cut after Sept. 10*	*last cut before Sept. 10*	*last cut after Sept. 10*
	lb N/acre			
Alfalfa				
Stand density				
Good *(70-100% alfalfa, more than 4 plants/ft²)*	190	150	140	100
Fair *(30-70% alfalfa, 1.5 to 4 plants/ft²)*	160	120	110	70
Poor *(0-30% alfalfa, less than 1.5 plants/ft²)*	130	90	80	40

Second year credit: In the second cropping year following fair and good stands on medium and fine textured soils, you can take a credit of 50 lb N/acre.

Soybeans
1 lb N/acre for each bu/acre of beans harvested up to a maximum credit of 40 lb N/acre. (Note: No credit on sandy soils)

Avoid Fields With High Phosphorus Levels

If soil-test phosphorus levels reach 75 ppm (150 lbs/a) — plant phosphorus-demanding crops such as alfalfa, use appropriate runoff reduction practices, and reduce manure application rates. On muck and sandy soils, soil-test phosphorus levels may reach 120 ppm (240 lbs/a) before phosphorus-reduction practices are warranted.

If soil test phosphorus levels reach 150 ppm (300 lbs/a) — stop applying manure if possible and use additional runoff reduction practices. On muck and sandy soils, soil-test phosphorus levels may reach 240 ppm (480 lbs/a) before manure applications should be stopped.

Applying manure to meet grain crop N needs will usually result in over-applications of P and/or K and, over time, the levels of these nutrients in the soil will increase. Most of the P reaching surface waters is attached to eroded soil particles. Erosion and runoff from soils with high levels of P can pollute surface waters. For most crops (potatoes are an exception) when soil-test P levels reach 75 ppm (150 pounds per acre) on a particular field, there will be no benefit to the crop from additional P, with the possible exception of a minimal amount in starter fertilizer. Plant P-demanding crops such as alfalfa, use appropriate runoff reduction practices, and reduce manure application rates. If soil-test P levels reach 150 ppm (300 pounds per acre), discontinue manure applications on that field, if possible, until soil-test P levels drop. On muck and sandy soils (sands and loamy sands) P removal practices should be started at soil test levels of 120 ppm and manure applications should be stopped at 240 ppm.*

Soil Test Report

IDENTIFICATION	
Field	3
Acres	15
Soil Name (or subsoil group)	Sisson
Plow Depth	8.0

LABORATORY ANALYSIS						
Sam. No.	Text code	Est. CEC	Soil pH	O.M. %	P ppm	K ppm
1	2		7.6	3.2	105	205
2	2		7.4	2.9	98	195
3	2		7.5	2.7	102	210

OPTION 1

Crop Year	Crop to be Grown	Crop Yield Goal	Soil Test Interpretation		Nutrient Needs N	P_2O_5	K_2O
1	Corn	131-150	EH	EH	160	0	0
2	Alfalfa	3.6-4.5	EH	EH	0	0	0
3	Alfalfa	3.6-4.5	EH	EH	0	0	0

OPTION 2

Crop Year	Crop to be Grown	Crop Yield Goal	Soil Test Interpretation		Nutrient Needs N	P_2O_5	K_2O
1	Corn	131-150	EH	EH	160	0	0
2	Oats	61-90	EH	EH	40	0	0
3	Alfalfa	3.6-4.5	EH	EH	0	0	0

Soil-test phosphorus levels on Field 3 are higher than 75 ppm. Adding phosphorus as manure or as phosphorus fertilizer will not benefit the corn crop.

* The extraction process used in testing soil P levels is more efficient for muck and sandy soils than for other soils. Soil P levels of 120 ppm and 240 ppm in muck and sandy soils represent approximately the same amount of plant-available P as levels of 75 ppm and 150 ppm in other soils.

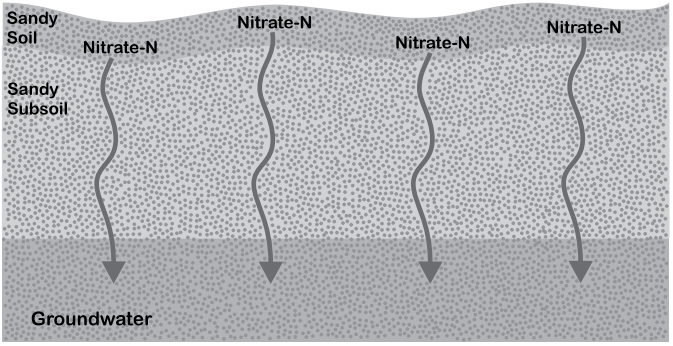
Avoid Applications that Will Lead to Nitrate-Nitrogen Leaching to Groundwater

Sandy soils

Unique soil conditions in some areas of Wisconsin require special attention. Mobile nutrients such as N in the nitrate form and K may leach out of excessively drained, coarse-textured soils. If you apply manure to sands or loamy sands in the early fall at soil temperatures greater than 50 degrees F, N in manure will be converted to nitrate-N at a time when crops are not growing. The nitrate-N may be leached to groundwater during heavy rains in the fall or early spring.

In the autumn, do not apply manure to sands or loamy sands until after October 31 unless a cover crop will be established. If a nitrification inhibitor is used, manure can be applied after mid-September.

On these soils, apply manure only where a cover crop will be established or after October 31 when soil temperatures are probably less than 50 degrees F. If a nitrification inhibitor is used, manure can be applied to these soils after mid-September. However, due to the high application rate required for a nitrification inhibitor to work with manure, this practice may not be cost-effective. Spring applications at temperatures over 50 degrees F are not a problem if crops are planted after the manure application.



Nitrate-nitrogen can rapidly leach from excessively drained, coarse-textured soils.

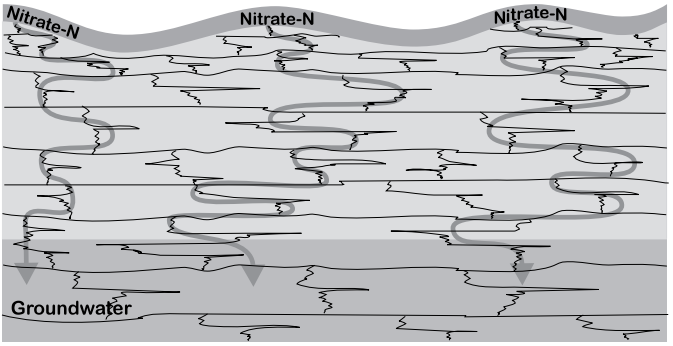
Thin soils over fractured bedrock

If there are less than 10 inches of soil over bedrock, do not apply manure.

If there are only 10 to 20 inches of soil over bedrock, do not apply manure unless it can be incorporated within 3 days, do not apply more than 25 tons/a dairy manure (or other manure with more than 100 lbs of available N/a), and, in the autumn, do not apply until after October 31 unless a nitrification inhibitor is used.

Manure applications in areas with thin soils over fractured limestone or poorly-cemented or fractured sandstone bedrock can cause significant groundwater problems. Nitrate that leaches through the soil can be carried comparatively rapidly to groundwater by water flowing down through the cracks in the bedrock.

Do not apply manure where there is less than 10 inches of soil over bedrock. Where the soil is only 10 inches to 20 inches thick over bedrock, do not apply more than 25 tons of dairy manure or its equivalent on an N-content basis and incorporate the manure within 3 days. Do not apply manure to these soils when they are frozen. Fall-applied manure should be spread after October 31 or with a nitrification inhibitor.



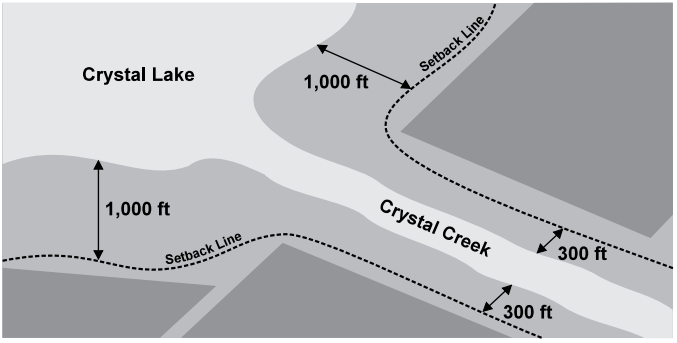
Nitrate-nitrogen leaching through the soil can be carried rapidly to groundwater by water flowing down through cracks in fractured bedrock.

Avoid Applications Where Manure Can Be Washed Directly to Surface Waters

Areas subject to periodic flooding or close to lakes and streams also pose problems. Heavy rainfall or snow melt can carry unincorporated manure from these lands directly to surface waters. The goal is to make applications where and when the risk of major runoff events is lowest. Do not apply manure within the 10-year flood plain (wet soils and other areas that are periodically flooded) or within 300 feet of streams and 1000 feet of lakes unless you incorporate it within 3 days.* Do not apply manure to these lands when the ground is frozen. Never apply manure in grassed waterways, terrace channels, open surface drains or other areas where water flow concentrates.

Do not apply manure to grassed waterways, terrace channels, open surface drains, or anywhere else that water flow concentrates.

Do not apply manure to land with wet soils that are periodically flooded (areas within the 10-year flood plain), within 300 feet of streams, or within 1000 feet of lakes unless you can incorporate it within 3 days.



Manure should not be applied to land within setback areas unless it can be worked into the soil within 3 days.

* At present, the US Department of Agriculture-Natural Resource Conservation Service's Nutrient Management Standard 590 requires a setback of 200 feet from a stream or lake for spreading manure without incorporation. The setback distances recommended here are greater and coincide with the shoreland management areas ordinance boundaries established by the Wisconsin Shoreland Management Program as defined in NR 115.03 Wisconsin Administrative Rules.

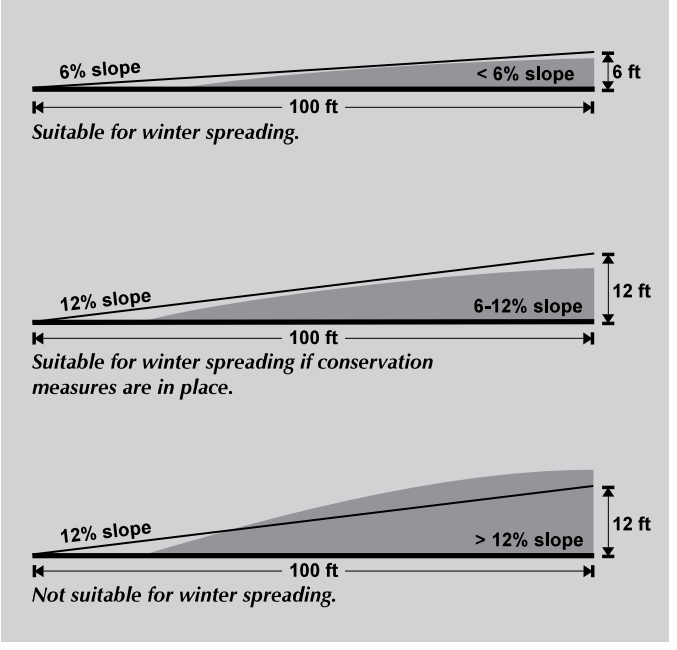
The requirements for setbacks from lakes and streams often raise questions about applications in certain areas, particularly headlands, where manure is especially valuable because it reduces the compaction effects of heavy machinery traffic. You can spread manure on these areas immediately before tillage in the spring. The setbacks provide valuable buffer strips which protect surface water from manure-laden runoff, since water moving over them tends to lose its pollutant load. This recommendation is not intended to prevent manure applications on these critical land areas, but rather to reduce the environmental risks associated with such applications.

Restrict winter applications to the most level fields

Manure applied to frozen soil may be carried off to lakes and streams during thaws or during winter or early spring rains. To minimize this risk when soils are frozen, apply manure only to relatively flat fields (those with slopes of 6 percent or less). If these fields get washed by runoff from up-slope areas, protect them with diversions, terraces, grassed waterways or other appropriate conservation practices.

When soils are frozen, do not apply manure to fields with greater than 12% slope. If manure is applied to frozen fields with 6-12% slopes, conservation measures must be in place.

If you apply manure to frozen soils with slopes of 6 to 12 percent, contour strips (row cropping with alternate strips in forage), terraces, reduced tillage, or other conservation measures must be in place.* Grassed waterways must be well-established and maintained. Build terraces if appropriate, or contour and strip-crop the fields with alternate strips in sod. Row crops should be planted on the contour, and they should be protected with at least 30-percent ground cover from the previous year's crop.



* Currently, the US Department of Agriculture-Natural Resource Conservation Service's Nutrient Management Standard 590 requires the existence of conservation measures when manure is applied to frozen soils with slopes greater than 9%. We recommend that conservation practices be in place on fields with greater than 6% slope.

Plan Manure Applications to Make Sure Suitable Land Is Available

As long as they plan ahead, most livestock farmers in Wisconsin have enough suitable cropland available to apply manure even in the winter months. In planning manure applications, you need to be sure that the fields you plan to use meet the guidelines for slope, soil, tillage and site conditions summarized on page 20. If you haul during the winter, you should identify land areas which meet the requirements for winter application, and estimate the acreage you will need for the winter months.

For an example, we will determine acreage needed for manure from a 50-cow herd over the winter. One 1400-pound dairy cow produces about 115 to 125 pounds of manure daily.* During the 5 months (November to March) when the ground may be frozen, a 50-cow herd will produce about 500 tons of manure. At a maximum application rate of 25 tons per acre per year without incorporation, you'll need 20 acres of cropland. You will need additional lands if you plan to spread manure from calves, heifers, steers or other livestock during the winter. If suitable cropland is not available, you may need a short or long-term manure storage facility.

If you pasture your cows in summer months, you will haul and spread less manure, but you will still need suitable land. Follow the same procedure to determine acreage needs for summertime spreading. Storage may also be needed during the summer when cropland is not available for spreading.

An understanding of daily manure production, spreader capacity and application rates at various tractor speeds will help you to apply manure at desired rates. For solid manure handling systems, we recommend that manure spreaders be calibrated with scales to determine how many tons of manure are actually spread per load. If you need help, county Land Conservation Department, University of Wisconsin-Extension, and Natural Resource Conservation Service (NRCS) staff can put you in touch with trained nutrient management specialists in your area.

* These numbers may be conservative. Per cow manure production rates can vary greatly from herd to herd and should be measured to assure accuracy. Actual herd manure production rates for daily haul systems can be measured by finding the weight of a spreader load (one day's worth) of manure with portable axle scales.

Summary

The guidelines described provide the basis for developing an economically and environmentally-sound manure-management plan. Some farmers may need long-term or short-term manure storage facilities because their land is not suitable for winter manure applications. However, many farmers will be able to follow these guidelines without changing manure storage and handling practices. Proper manure management benefits both the farmer and the environment.

Basic Guidelines for Land Application of Manure in Wisconsin

Incorporate Manure Whenever Possible

- Inject or work into the soil within 3 days of application.
- If not incorporated through injection or tillage, do not apply more than 25 tons/a of solid dairy manure (or an amount of manure with the same amount of available phosphorus—75 lbs P_2O_5/a) in any 1 year period.
- On no-till fields and other areas that are not tilled, do not apply more than 25 tons/a of solid dairy manure (or an amount of manure with the same amount of available phosphorus—75 lbs P_2O_5/a) in any 5 year period.

Know Crop Nutrient Requirements

- Soil test fields every 3 to 4 years.

Credit Manure-Nitrogen to Avoid Over-Application of Nitrogen

- Apply manure at rates sufficient to meet crop nitrogen requirements.
- Take all N sources into account, including legume-N, when planning applications to avoid exceeding crop needs.

Avoid Fields With High Phosphorus Levels

- If soil-test phosphorus levels reach 75 ppm (150 lbs/a) — plant phosphorus-demanding crops such as alfalfa, use appropriate runoff reduction practices, and reduce manure application rates. On muck and sandy soils, soil-test phosphorus levels may reach 120 ppm (240 lbs/a) before phosphorus-reduction practices are warranted.

- If soil test phosphorus levels reach 150 ppm (300 lbs/a) — stop applying manure if possible and use additional runoff reduction practices. On muck and sandy soils, soil-test phosphorus levels may reach 240 ppm (480 lbs/a) before manure applications should be stopped.

Avoid Applications that Will Lead to Nitrate-Nitrogen Leaching to Groundwater

- In the autumn, do not apply manure to sands or loamy sands until after October 31 unless a cover crop will be established. If a nitrification inhibitor is used, manure can be applied after mid-September.
- If there are less than 10 inches of soil over bedrock, do not apply manure.
- If there are only 10 to 20 inches of soil over bedrock, do not apply manure unless it can be incorporated within 3 days, do not apply more than 25 tons/a dairy manure (or other manure with more than 100 lbs of available N/a), and, in the autumn, do not apply until after October 31 unless a nitrification inhibitor is used.

Avoid Applications Where Manure Can Be Washed Directly to Surface Waters

- Do not apply manure to land with wet soils that are periodically flooded (areas within the 10-year flood plain), within 300 feet of streams, or within 1000 feet of lakes unless you can incorporate it within 3 days.
- Do not apply manure to grassed waterways, terrace channels, open surface drains, or anywhere else that water flow concentrates.
- When soils are frozen, do not apply manure to fields with greater than 12% slope. If manure is applied to frozen fields with 6-12% slopes, conservation measures must be in place.

Plan Manure Applications to Make Sure Suitable Land Is Available

Areas suitable for spreading in winter (when the ground is frozen):

- Fields greater than 300 feet from streams or 1000 feet from lakes.
- Fields with more than 20 inches of soil over bedrock.
- Fields with less than 6 % slopes.
- Fields with 6-12 % slopes if conservation practices are in place.

Areas suitable for spreading in the fall (before October 31):

- Fields with medium to fine-textured soils (not sands or loamy sands).
- Fields with more than 20 inches of soil over bedrock.

Areas that are not suitable for spreading unless the manure will be worked into the soil within 3 days:

- Fields within 300 feet of streams or 1000 feet of lakes.
- Fields with soil that is only 10 inches to 20 inches thick over bedrock.

Areas that are never suitable for spreading manure:

- Land that is wet or frequently flooded (within the 10-year flood plain).
- Grassed waterways, terrace channels, open surface drains or other areas where water flow may concentrate.
- Land with less than 10 inches of soil over bedrock.

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