Management Considerations For Nitrogen

Groundwater Concerns

The groundwater concern comes primarily from nitrogen. If not captured by plant roots, it can move down below the root zone and may enter the groundwater. The speed at which nitrate moves depends on the amount of precipitation and soil texture. Water moves through sandy soil much more rapidly than a clay soil.

Because nitrate moves through soil with water, it is extremely important that the rate applied, either as manure or fertilizer, does not exceed that which can be used by crops. Any nitrate remaining in the soil profile at the end of the season is subject to leaching.

Water Quality Risk Assessment Maps will be labeled with the symbol "L" on fields that are Vulnerable to N leaching.

If a field is determined highly vulnerable for nitrate leaching to an aquifer, all of the following management activities will be implemented.

1. Prior to the application of nitrogen above starter application rates, a nitrate nitrogen test **(zero to two foot and two to four foot sample)** will be taken and analyzed. **Or** An acceptable alterative to the zero to four feet sampling method would be to take a **zero to two foot sample every year within four weeks after crop harvest** prior to nitrogen applications above starter rates as recommended by SDSU.
2. Soil samples (zero to six inches) should also be included and analyzed for P and K. Soil samples will be taken as per land grant university recommendations found on the back of the SDSU Soil Testing Laboratory Soil Sample Information Sheet, or SDSU-FS935, "Recommended Soil Sampling Methods for South Dakota."

Nitrogen Best Management Practices

- Match manure nutrient applications to crop needs.
- Apply manure as close to the time of crop utilization as possible. Apply commercial fertilizer nitrogen in a sidedress or split application when fields are located over shallow aquifers or on soils that have a high leaching potential.
- Delay fall manure applications until soil temperatures drop below 50°F to minimize nitrate leaching and ammonia volatilization.
- Avoid applying manure on wet soils to minimize soil compaction, runoff, nitrate leaching and denitrification.
- Inject or incorporate the manure into the soil preferably within 24 hours for maximum nutrient-use efficiency and to reduce odor and runoff problems. Significant volatilization losses will occur when manure is left on the surface for several days.

Nitrogen Recommendations Using Manure

Crops can contain large amounts of nitrogen (Table 4-1). In most cases only the grain is removed and the straw is returned to the soil, supplying nitrogen through mineralization in subsequent years. Because of this and the other sources of N such as nitrate N already in soil, soil organic matter, precipitation and legumes, crop removal alone is not a good estimate of the amount of N to apply.

Table 4-1 Nitrogen Contained in Crops

Crop	Plant Part		
	Grain	Straw	Total
	----------pounds N----------		
Corn (bu)	0.9	0.5	1.4
Soybeans (bu)	3.7	0.8	4.5
Wheat (bu)	1.6	0.8	2.6
Oats (bu)	0.9	0.4	1.3
Barley (bu)	1.1	0.4	1.5
Sunflowers (cwt)	2.8	2.4	5.2
Alfalfa (ton)	----	----	55
Grass (ton)	----	----	30

Table 4-2 Nitrogen Requirements of Crops

Crop	Unit	Nitrogen Required[1/]
Wheat	bu	2.5 x yield[2/]
Oats	bu	1.3 x yield
Barley		
malting	bu	1.5 x yield
feed	bu	1.7 x yield
Rye	bu	2.5 x yield
Flax	bu	3.0 x yield
Corn (grain)	bu	1.2 x yield
Corn (silage)	ton	10.4 x yield
Sorghum (grain)	bu	1.1 x yield
Sorghum, sudan (hay)	ton	25 x yield
Grass hay	ton	25 x yield
Sunflowers	lb	0.05 x yield
Edible beans	lb	0.05 x yield
Millet	lb	0.035 x yield
Rape	cwt	6.5 x yield
Mustard	cwt	6.5 x yield
Safflower	lb	0.05 x yield
Buckwheat	bu	2.2 x yield
Potatoes	cwt	0.4 x yield

1/ Available manure nitrogen or fertilizer nitrogen to apply is equal to the nitrogen requirement minus soil NO_3 – N to a 2-ft depth minus any legume credits.
2/ Yield goal

Management Considerations For Phosphorus

Surface Water Concerns

Surface water concerns focus primarily on Phosphorus. Phosphorus acts very differently in soils than nitrogen. It attaches tightly to soils and does not generally move down through the soil profile. This lack of movement through soils results in accumulations of phosphorus in soil if phosphorus rates, either from manure or fertilizer, are greater than crop removal.

Increases in phosphorus concentrations in soil can result in more phosphorus moving off the field either attached to soil particles lost by erosion or dissolved in the runoff water. In some situations phosphorus could move into surface waters with manure itself if the manure is applied in such a manner that it moves directly into waterways.

Water Quality Risk Assessment Maps will be labeled with the symbol "R" on fields that are Vulnerable to Phosphorus runoff.

1. In no case shall manure or organic by product applications (broadcast or incorporated/injected) be made within 100 feet of a surface water or conveyance; 35 feet if a perennial grass filter strip is established and maintained.

2. A minimum of a 35-foot wide perennial grass filter strip is required in all cases on the edges of fields that border a lake, river, or intermittent/perennial stream.

3. In selected cases based on Table 1, depending on soil test phosphorus and estimated soil loss in a field, a perennial grass filter strip maybe required within 100 feet of a surface water or conveyance if manure is applied based on nitrogen needs of a crop and not crop removal of phosphorus (see Table 1).

Phosphorus Based Manure Application

If the manure application is required to be based on phosphorus crop removal, the application rate shall be based on phosphorus removed in the harvested portion of the crop.

Application can be based on multi-year phosphorus crop removal but cannot exceed the one year nitrogen crop need, and no manure may be applied to that field again until the applied phosphorus has been removed from the field via harvest and crop removal.

(See Table 1 for additional information)

Usually fields with High soil test P and/or high runoff potential.

Phosphorus Best Management Practices

- Establish and maintain grass filter strips at the point where water leaves the field to trap sediment and nutrients
- Control sheet and rill erosion by installing conservation practices including conservation tillage, contour farming, strip cropping, terraces and cover crops
- Control ephemeral erosion by installing grassed waterways, diversions and sediment retention structures.
- Incorporate or inject manure and commercial fertilizer where possible while maintaining sufficient crop residue levels for erosion control
- Grow high yielding, high phosphorus removing crops on fields with already high soil test phosphorus to reduce test levels

How Phosphorus affects Soils Tests

Phosphorus rate recommendations are based on the phosphorus soil test. This test is an index of availability of phosphorus to plants. It is not a measure of total available phosphorus or total phosphorus in soil. However, as total phosphorus levels increase in soils, the soil test index usually increases also.

These categories represent a decreasing probability of a yield response to broadcast fertilizer or manure. The probability of response is from about 80 percent at the very low soil test level to less than a 20 percent chance when soil tests are in the very high range.

Table 4-3 Soil Test Calibration Levels Used for Phosphorus and Potassium in SD

Nutrient	Name of Soil Test	Categories				
		Very Low	Low	Medium	High	Very High
		----------ppm extractable (0-6 inch sample)----------				
Phosphorus	Bray P-1	0 – 5	6 – 10	11 – 15	16 – 20	21+
Phosphorus	Olsen	0 – 3	4 – 7	8 – 11	12 – 15	16+
Potassium	NH_4Ac	0 – 40	41 - 80	81 - 120	121 - 160	161+

If phosphorus is applied at rates greater than crop removal (Table 4-4), phosphorus soil test levels will increase. As a very general rule of thumb, for **every 20 pounds of phosphorus (P_2O_5) applied and not removed by crops, the soil test index will increase by 1 part per million (ppm).**
Following a good nitrogen application plan with manure in South Dakota can often result in a one to three ppm increase per year in the phosphorus soil test.

Table 4-4 Phosphorus Content of the Harvested Portion of Crops

Crop	P_2O_5 (lbs)
Alfalfa (per ton)	12
Buckwheat (per bu)	0.53
Canola (per cwt)	1.5
Corn Grain (per bu)	0.35
Corn Silage (per ton)	4.3
Edible Beans (per cwt)	1.25
Feed Barley (per bu)	0.41
Flax (per bu)	0.7
Forage Sorghum (per ton)	5.8
Grass (per ton)	10
Malting Barley (per bu)	0.41
Millet (per cwt)	0.83
Mustard (per cwt)	1.5
Oats (per bu)	0.25
Potatoes (per cwt)	0.09
Rapeseed (per cwt)	1.5
Rye (per bu)	0.48
Safflower (per cwt)	1.14
Sorghum (per bu)	0.27
Soybean (per bu)	0.77
Sudan Grass (per ton)	5.8
Sunflowers (per cwt)	1.14
Wheat (per bu)	0.56

As the phosphorus soil test index increases, the possibility of moving significant amounts of phosphorus off the field to surface water usually increases. The movement is both phosphorus attached to soil particles lost with erosion and phosphorus dissolved in the runoff water.

From 60 to 80 percent of the phosphorus in most manure is available to plants within the first year of application. After several years of application, the amount of phosphorus available to plants from manure is equal to that applied with the manure each year.

1/ Source:

Jim Gerwing, Extension Soil Specialist
Ron Gelderman, Director, Soil Testing Lab
South Dakota State University

Nitrogen need/Phosphorus Crop Removal Manure Application Determination

Three factors are considered when recommending a nitrogen based or phosphorus based manure application:

(1) Current level of phosphorus in the soil,

(2) Potential soil loss

(3) Presence or absence of a 100 foot vegetated buffer in fields having certain soil phosphorus test levels. See Table 1 below.

Table 1

Soil Test Phosphorus ppm		Potential Soil Loss – Sheet and Rill Erosion (Tons per Acre per Year)[1/]				
		Less than 4		**4 to 6**		**Greater than 6**
		Min. 100 Foot Vegetated Buffer[2/ 4/]		Min. 100 Foot Vegetated Buffer[2/ 4/]		
Olsen	Bray-1	Yes	No	Yes	No	
0-25	0-35	Nitrogen based	Nitrogen based	Nitrogen based	Nitrogen based	**No application**
26-50	36-75	Nitrogen based	Nitrogen based	Nitrogen based	Phosphorus based (crop removal[3/])	**No application**
51-75	76-110	Nitrogen based	Phosphorus based (crop removal)	Phosphorus based (crop removal)	Phosphorus based (crop removal)	**No application**
76-100	111-150	Phosphorus based (crop removal)	Phosphorus based (crop removal)	Phosphorus based (crop removal)	Phosphorus based (crop removal)	**No application**
Greater than 100	Greater than 150	**No application**	**No application**	**No application**	**No application**	**No application**

1/ Refers to a calculated soil loss estimate using the Revised Universal Soil Loss Equation (RUSLE).
2/ Refers to the vegetated area width between manure or wastewater land application and a natural/manmade drainage, tile inlet or other conduit.
3/ Crop removal is the amount of phosphorus a planned crop removes in one crop year.
4/ If no conveyances, lakes, rivers, streams, etc… exist in application field then 100 foot vegetated buffer is not applicable.

Note: A single application of phosphorus applied as manure may be made at a rate equal to the recommended phosphorus application for the entire crop rotation or multiple years in the crop sequence. When such applications are made, however, the application rate should not exceed the recommended nitrogen application rate for the planned crop.

Manure Application On Frozen Ground

Manure shall not be applied to frozen, snow covered, or saturated soil if the potential risk for runoff exists. In South Dakota (SD), this is interpreted to mean no manure application during periods when the soil surface is frozen (approximately November 15 to March 30). However, care and common sense must always be used to make sure manure applications and potential runoff will not cause environmental degradation to surface water regardless of what time of year it is.

Liquid manure applications to frozen or snow-covered (winter) soil will not be allowed. In situations where a catastrophic system failure is imminent; manure may be applied to soils with slopes less than 4 percent provided that a 1,000-foot setback is maintained to a lakes, rivers, streams and a 300-foot setback to non-cropped wetland or conveyances to lakes, rivers, or streams.

Incidental winter application of solid manure, waste feed materials, snow, and ice will be allowed to facilitate the proper operation of open feedlots by allowing producers to clean along feed bunks, watering areas, and allow removal of snow and ice from open lots.

1. **Frozen ground manure applications will not exceed the rate calculated in the nutrient budget for the application field based on the current fall soil test results and applications will be no more than 10 percent of the annual manure production.**

2. **Frozen ground applications will only be allowed on slopes that are four percent or less and will be prioritized using current soil loss calculations based on the water erosion prediction technology as listed in the SD Technical Guide. Fields with the lowest predicted soil loss will have the highest priority for winter applications.**

3. **No manure application on floodplains (as defined by the Natural Resources Conservation Service (NRCS) in the soil survey as frequently or occasionally flooded).**

4. **No manure application within a 300-foot setback from conveyances or non-cropped wetlands.**

5. **No manure application within 1,000 feet of lakes, rivers, and named perennial streams.**

Review and comply with other specific winter application requirements in the current SD General Livestock Permit regulations or your local county zoning ordinance when dealing with state and locally permitted facilities.

Failure to follow this guidelines could lead to United States Department of Agriculture contract violations and may result in monetary penalties due to breach of contract (see your contract appendix or contact your local NRCS office for further clarification).