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EC98-790 Farm*A*Syst Nebraska's System for Assessing Water Contamination Worksheet 14: Crop Nutrient Application Management

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Farm•A•Syst

WORKSHEET 14

Nebraska's Farm Assessment System for Assessing the Risk of Water Contamination

Crop Nutrient Application Management

Why should I be concerned?

Most Nebraska farmers apply some source of plant nutrients to help improve their crop production each year. Nutrients come from applied chemical fertilizers, manure or sewage sludge, and soil organic matter or legumes. When nutrients move off site or leach out of the root zone, they can pose a threat to the environment and the water we drink.

Two in particular, phosphorus (P) and nitrogen (N), are showing up more often in Nebraska's surface and groundwater, posing a risk to our health and the quality of our surface water. A nitrate-N level in drinking water above federal and state drinking water standards of 10 ppm (mg/l) may pose a risk to infants. Infants under six months of age are particularly susceptible to health problems from high nitrate-N levels which cause nitrite-induced methemoglobinemia (blue baby syndrome). Nitrate may also affect adults, but the evidence is much less certain.

Surface water quality can be harmed with the addition of nutrients. Erosion and runoff from fertile cropland to lakes, ponds, and streams add nutrients to these surface waters. Phosphorus is the most important nutrient to prevent from reaching surface water. It will be attached to eroding sediment and dissolved in runoff water. Soluble phosphorous stimulates excessive growth of aquatic plants and algae that can deplete surface water oxygen levels, resulting in fish kills and reducing the aesthetic and recreational value of lakes.

Managing nutrients is a challenging task. The manager needs to consider the time of year, crop, type of tillage, and the specific nutrients. The goal of nitrogen management is to have sufficient nitrogen available for crop needs, but not to have high residual nitrates after crop harvest. As an example, corn plants have a relatively short period of major nitrogen uptake. Nitrogen fertilizer applied prior to planting is subject to leaching losses if heavy rainfall occurs. Excessive irrigation also can leach nitrate from the root zone. Excessive nitrogen application resulting in root zone residual nitrate is subject to off-season leaching from the root zone. On fine textured (clay) soils, runoff is the most serious problem. On coarse textured (sandy) soils, percolation or leaching is the most serious problem.

The more you know about your soil conditions, the depth of groundwater, and tillage and field management practices, the better prepared you are to help protect the environment and the water in your area. Your drinking water is least likely to be contaminated if you follow appropriate management procedures. Since corn is a major Nebraska crop and has high nutrient requirements, much of this worksheet emphasizes corn nutrient management.

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Elbert C. Dickey, Interim Director of Cooperative Extension, University of Nebraska, Institute of Agriculture and Natural Resources.

The goal of Farm*A*Syst is to help you protect the groundwater that supplies your drinking water and surface waters.

How will this worksheet help me protect my drinking water?

- It will take you step-by-step through your nutrient application practices.
- It will evaluate your activities according to how they might affect groundwater and surface water.
- It will provide you with easy-to-understand "risk level scores" that will help you analyze the relative risk of your nutrient application practices.
- It will help you determine which of your practices are reasonably safe and effective, and which practices might require modification to better protect your drinking water.

How do I complete the worksheet?

Follow the directions at the top of the chart on page 3. It should take you 15 to 30 minutes to complete this worksheet and determine your risk level.

Information derived from Farm*A*Syst worksheets is intended only to provide general information and recommendations to farmers regarding their own farmstead practices. It is not the intent of the educational program to keep records of individual results.

Glossary

These terms may help you make more accurate assessments when completing WORKSHEET 14. They may also help clarify some of the terms used in FACT SHEET 14.

Band application: A technique for applying nutrients in a concentrated area on the surface or in the soil rather than broadcasting over the entire surface. In-soil placement of nutrients with some type of knife injection device is the most common method of band application.

Broadcast application: A method of applying fertilizer in which it is uniformly spread over the surface of fields.

Composite soil sample: A soil sample submitted for testing that is an accurate representative of the sampling area (i.e. cropland field). For surface samples it is acceptable to use 10 to 15 cores per 40 acres, but most desirable to use 15 to 20 cores per 20 acres for a composite sample. For subsurface nitrate samples it is acceptable to use 6 to 8 cores per 40 acres, but most desirable to use 6 to 8 cores per 20 acres.

Cover crops: Densely seeded crops (typically rye, oats, wheat, vetch) planted in the interim period between principle crop production periods for the purpose of protecting soil from erosion and capturing residual nitrogen, thus preventing potential leaching loss. In the case of vetch or other legumes, nitrogen may be produced for subsequent crops.

Expected yield: An expected crop yield used in determining fertilizer recommendations. Expected yield should be realistic and based on records from previous years. Expected yield should not be more than 5% above the previous five-year average. The terms "expected yield" and "yield goal" are sometimes used interchangeably.

Fertigation: The application of a fertilizer nutrient by injecting it into the irrigation water as it is applied to a crop.

Forms of nitrogen fertilizer: Ammonium nitrate, ammonium sulfate, anhydrous ammonia, nitrogen solutions, urea.

Highly erodible land (HEL): Cropland fields with an erosivity index of 8 or greater. Such fields are required to be farmed according to an approved conservation plan as specified in the 1985 farm bill (Food Security Act) and the 1990 farm bill (FACTA).

Irrigation scheduling: A process of planning crop irrigation timing and amounts based on soil, crop, climatic, and management factors.

Legume nitrogen credit: The amount of nitrogen available to a crop following a legume crop (alfalfa, clover, soybean, etc.) in the rotation. This amount of nitrogen should be deducted from the crop's base nitrogen fertilizer recommendation.

Multiple delayed applications: Typically refers to nitrogen applications in which fertilizer is applied in several increments during the growing season with very little of the fertilizer being applied prior to planting.

Nitrification inhibitor: A compound added to ammonium or ammonium-forming nitrogen fertilizers in order to slow the conversion of ammonium to nitrate. The intended effect is to reduce the potential for nitrogen losses that occur in the nitrate form (such as leaching and denitrification).

Nutrient credits: The amount of crop nutrients available from non-commercial fertilizer resources such as manure and organic waste applications to cropland, legumes grown in rotation with grain crops, carryover soil nitrate, and nitrate in applied irrigation water. The amount of the nutrient credit is determined and then deducted from the base fertilizer recommendation. Economic and environmental incentives exist for taking nutrient credits.

Routine soil testing: An analysis of soil samples to estimate the major nutrient (nitrogen, phosphorus, and potassium) supplying capacity of a given soil as well as pH and organic matter. Sampling for non-mobile nutrients (phosphorus and potassium) should be done every three to four years. Deep profile sampling for nitrate should be done every year a grass crop such as corn, grain sorghum, oats, or wheat are grown. Fertilizer and lime recommendations are based on soil test results.

Sidedress application: A method of applying fertilizer, typically nitrogen, in which it is placed next to or between crop rows during the growing season.

Soil sampling: The process of collecting a soil sample that will be analyzed for nutrient supplying capacity which, along with crop history and yield goals, leads to a fertilizer recommendation. The sample must be representative of the field from which it is collected to insure accurate fertilizer recommendations.

Soil test phosphorus: Soil test value for phosphorus determined through routine soil testing of upper 6 to 8 inches; expressed in parts per million and assigned an interpretation of either very low, low, medium, high, or very high. Soil test results reported in pounds per acre are twice the ppm quantity. For example: 5 ppm = 10 lbs / acre.

Soil nitrate tests: Soil tests that measure soil nitrogen and can improve the efficiency of nitrogen fertilizer applications by adjusting nitrogen fertilizer recommendations for field-specific conditions.

Split applications: Typically refers to nitrogen fertilizer applications in which a portion of the fertilizer is applied in pre-plant and the remainder in at least one application during the growing season.

Starter fertilizer: An in-row (banded) application of fertilizer placed with or near the seed **to promote vigorous seedling growth** by providing a high concentration of readily available nutrients. Starter fertilizer has the most benefit on cool, wet soils. Fertilizer applied at planting to correct specific nutrient deficiencies is generally not considered a starter fertilizer.

Tolerable soil loss (T): A defined annual rate of soil erosion that if exceeded would remove soil from the landscape faster than productivity can be maintained with changes in inputs. Long-term effects of exceeding "T" rates include reduced soil productivity. Tolerable soil loss rates vary among soil types; however, the majority of rates are from three to five tons / acre / year.

University of Nebraska fertilizer recommendations: Fertilizer recommendations based on soil test results and university research specific to the soils and cropping conditions found in the state of Nebraska.

Crop Nutrient Application Management: Assessing the Risk of Surface Water and Groundwater Contamination

1. Use a pencil. You may want to make changes.
2. For each category listed on the left that is appropriate to your farm, read across to the right and circle the statement that best describes conditions on your farm. (Skip and leave blank any categories that don't apply to your farm.)
3. Then look above the description you circled to find your "risk number" (1, 2, 3, or 4) and enter that number in the blank under "YOUR RISK."
4. Allow about 15-30 minutes to complete the worksheet and figure out your risk for crop nutrient application management practices.

	HIGH RISK (risk 4)	HIGH-MODERATE (risk 3)	MODERATE-LOW RISK (risk 2)	LOW RISK (risk 1)	YOUR RISK
SOIL TESTING					
Frequency of soil testing (except for nitrogen)	Cropland fields tested more than 10 years ago or no soil testing.	Cropland fields tested every 6 to 9 years.	Cropland fields tested every 4 to 5 years.	Cropland fields tested every 3 years or less.	
Frequency of soil testing for nitrogen	No soil testing on cropland receiving N applications.	Testing fields only after crop losses (hail or drought) or after sustained (2 years or more) or heavy manure application on cropland receiving N applications.	_____	Annual testing of all cropland receiving N applications.	
Depth of soil testing for nitrogen	No soil testing or surface sample only.	Composite soil sample at 0-12 inches.	Surface layer sample at 0-8 inches plus one subsoil sample at 8-24 inches.	Surface layer sample at 0-8 inches plus two subsoil samples, one at 8-24 inches and one at 36-48 inches.	
Sampling density	10 or less surface sample soil cores are collected from fields of 40 or more acres OR a single soil sample is collected from fields of any size.	10 or less surface sample soil cores are collected from fields of 20 to 40 acres to form a composite sample.	At least 10 to 15 surface sample soil cores and 6 to 8 subsurface samples are collected from fields of 20 to 40 acres to form a composite sample.	At least 15 to 20 surface sample soil cores and 6 to 8 subsurface samples are collected from fields of 20 acres or less to form a composite soil sample.	
Nutrient application rates	No nutrient credits* are considered OR nutrient application rates exceed University of Nebraska recommendations by greater than 50%.	No nutrient credits *are considered OR nutrient application rates exceed University of Nebraska recommendations by 25 to 50%.	Some nutrient credits* are not considered OR nutrient application rates exceed University of Nebraska recommendations by 10 to 25%.	All nutrient credits* are considered AND nutrient application rates do not exceed University of Nebraska recommendations.	

*Nutrient credits include residual soil nitrate, nitrogen from legume crops, manure and other organic waste, and irrigation water.

	HIGH RISK (risk 4)	HIGH-MODERATE RISK (risk 3)	MODERATE-LOW RISK (risk 2)	LOW RISK (risk 1)	YOUR RISK
SOIL TESTING (continued)					
Expected yield used for nitrogen (N) rate determinations	All fertilizer recommendations are based on expected yields higher than yields ever obtained on field OR measured yield information is not collected or, if collected, is not used when determining fertilizer recommendations.	All fertilizer recommendations are based on expected yields from a 1 to 2 year field history OR greater than 15% over average yield.	All fertilizer recommendations are based on expected yields from a 3 to 4 year average OR greater than 5 to 15 % over average yield.	All fertilizer recommendations are based on expected yields from a 5 year average plus 5% over average yield.	
NITROGEN (N) FERTILIZER APPLICATIONS **SANDY SOILS AND OTHER GROUNDWATER SENSITIVE AREAS SECTION** **MEDIUM AND FINE TEXTURED SOILS SECTION**					
NITROGEN (N) FERTILIZER APPLICATIONS ON SANDY SOILS AND OTHER GROUNDWATER SENSITIVE AREAS ***The following three categories pertain to nitrogen fertilizer management on sandy soils. If your farm does not have sandy soils, skip to the categories on medium and fine textured soils. If you have sandy soils on your farm, complete the following three categories.***					
Timing of N fertilizer applications	The majority or all of N is applied in the fall OR early preplant and N is applied without the use of a nitrification inhibitor.	Preplant applications of N with the use of a nitrification inhibitor.	Split applications with greater than 60% of the N applied preplant and sidedress application or fertigation.	Less than 60% N applied near planting time and single sidedress or multiple delayed applications of N.	
Source of nitrogen (N)	All urea or solution N applied preplant or fall.	Ammonium nitrate or N solution (28%, 32%) forms of N fertilizer are used.	Ammonium sulfate or urea forms of N fertilizer are used.	Anhydrous ammonia form of N fertilizer is used.	
Cover crops to capture nitrogen (N)*	Cover crops are not used to capture N left after harvest even when in season indicators suggest residual N.	Cover crops are seldom used to capture N left after harvest even when in season indicators suggest residual N.	Cover crops are sometimes used to capture N left after harvest when in season indicators suggest residual N.	Cover crops are frequently used to capture N left after harvest when in season indicators suggest residual N.	

* When timing and rates are chosen carefully, this risk factor will be less important.

	HIGH RISK (risk 4)	HIGH-MODERATE RISK (risk 3)	MODERATE-LOW RISK (risk 2)	LOW RISK (risk 1)	YOUR RISK
NITROGEN (N) FERTILIZER APPLICATIONS ON MEDIUM AND FINE TEXTURED SOILS ***The following two categories pertain to nitrogen fertilizer management on medium and fine textured soils. If your farm does not have medium and fine textured soils, skip this section. If you have medium and fine textured soils on your farm, complete the following two categories.***					
Timing of N applications	The majority or all of N applied in the fall without a nitrification inhibitor and when soil temperatures are greater than 50 degrees F.	Fall applications of N with a nitrification inhibitor and when soil temperatures are greater than 50 degrees F OR no nitrification inhibitor and when soil temperatures are less than 50 degrees F.	Spring preplant applications of N without a nitrification inhibitor.	Spring preplant applications of N with a nitrification inhibitor OR split (preplant and sidedress or fertigation) applications of N.	
Source of N for fall applications *(Note: ignore this category if fertilizer N is NOT applied in the fall.)*	Nitrate, urea or N solutions (28%, 32%) forms of N fertilizers are used in the fall.	Ammonium forms of N fertilizers without a nitrification inhibitor are used in the fall.	Ammonium forms of N fertilizers treated with a nitrification inhibitor are used in the fall and applied after soil temperature is below 55 degrees F.	Anhydrous ammonia with a nitrification inhibitor is used in the fall after soil temperature is below 50 degrees F.	
PHOSPHORUS (P) AND POTASSIUM (K) FERTILIZER APPLICATIONS					
Timing of P and K applications	Broadcast applications to frozen soils on fields with runoff potential.	Broadcast applications with no incorporation or to frozen fields with no runoff potential.	Incorporation within three days of broadcast application.	Immediate incorporation of broadcast applications OR band applications (i.e. starter fertilizer at planting time) OR dual placement with anhydrous ammonia application.	
OTHER FACTORS					
Calibration of fertilizer application equipment	Application equipment has not been adjusted and calibrated in the last five years.	Application equipment is adjusted and calibrated every other year.	Application equipment is adjusted and calibrated once every year.	Application equipment is calibrated at least once a year AND application rates are monitored as applied and calibrations and adjustments are made as needed.	

	HIGH RISK (risk 4)	HIGH-MODERATE RISK (risk 3)	MODERATE-LOW RISK (risk 2)	LOW RISK (risk 1)	YOUR RISK
OTHER FACTORS (continued)					
Uniformity of calibration	Application equipment has not been adjusted and calibrated in the last 5 years.	Application equipment is calibrated every 3 to 5 years and the measured output across the spreader width is adjusted to be within 10% of the average value OR equipment is calibrated annually and the measured output is greater than 15% of the average value.	Application equipment is calibrated at least every other year and the measured output across the spreader width is adjusted to be within 10% of the average value OR equipment is calibrated annually and the measured output is within 10 to 15% of the average value.	Application equipment is calibrated at least once a year and the measured output across the spreader width is within 10% of the average value.	
Record keeping	No records are kept on soil tests, N credits given, N application rates, crop grown, and yield for each field.	Records are kept but not used in decision making.	Records are not complete on soil tests, N credits, N application rates, crop grown, and yield for each field. Information available used in decision making.	Complete records are kept on soil tests, N credits, N application rates, crop grown, and yield for each field and information used in decision making.	
Crop rotation	High intensity row crops (corn) receiving large applications of N are planted every year.	Small grain or legume crops are planted at least 1 of every 5 years.	Small grain or legume crops are planted at least 1 of every 3 or 4 years.	Small grains or forage are planted more years than row crops.	
Soil conservation	No farm conservation plan is being followed. Visible evidence of soil erosion.	A farm conservation plan is being followed, but the plan allows erosion in excess of T (i.e. plan includes alternate conservation systems).	A farm conservation plan is followed only on designated highly erodible land (HEL) acres. These acres are planned not to exceed T.	A farm conservation plan is being followed that does not allow tolerable soil loss (T) to be exceeded for any cropland fields.	
Irrigation scheduling	Irrigation frequency and amount is not based on any measured parameters.	Irrigation performed when judged necessary by land manager. Decision is based on past experience and some soil moisture monitoring.	Irrigations are scheduled using regular soil moisture monitoring or input from crop consultant.	Irrigation frequency and amount determined using estimated crop water use from weather information, regular soil moisture monitoring to 3 feet, and applied water is measured.	

NOTE: If manure is applied to cropland you should also complete WORKSHEET 11, *Land Application of Manure.*

Your groundwater vulnerability score from *Worksheet 2* was _____
Note: If the surface texture, subsurface texture, or depth to groundwater used to calculate this score are not characteristic of the site conditions present for the activities / practices discussed in this worksheet, calculate a new vulnerability score for this site.

If your groundwater vulnerability score is:
- 1 to 1.4: your site has a LOW VULNERABILITY to pollution reaching groundwater.
- 1.5 to 2.4: your site has a MODERATE-LOW VULNERABILITY to pollution reaching groundwater.
- 2.5 to 3.4: your site has a HIGH-MODERATE VULNERABILITY to pollution reaching groundwater.
- 3.5 to 4.0: your site has a HIGH VULNERABILITY to pollution reaching groundwater.

Your surface water vulnerability score from *Worksheet 2* was _____
Note: If the surface texture, slope toward surface water, or distance from surface water used to calculate this score are not characteristic of the site conditions present for the activities / practices discussed in this worksheet, calculate a new vulnerability score for this site.

If your surface water vulnerability score is:
- 1 to 1.4: your site has a LOW VULNERABILITY to pollution reaching surface water.
- 1.5 to 2.4: your site has a MODERATE-LOW VULNERABILITY to pollution reaching surface water.
- 2.5 to 3.4: your site has a HIGH-MODERATE VULNERABILITY to pollution reaching surface water.
- 3.5 to 4.0: your site has a HIGH VULNERABILITY to pollution reaching surface water.

Look over your worksheet scores for individual activities:

- **Low risk** practices (1's): are ideal and should be your goal regardless of your site's vulnerability to pollution reaching ground or surface water. Cost and other factors may make it difficult to achieve a low risk rating for all activities.

- **Moderate-low risk** practices (2's): provide reasonable water quality protection unless your site's vulnerability to pollution reaching ground or surface water is moderate-high or high.

- **High-moderate risk** practices (3's): do not provide adequate protection in many circumstances, especially if your site's vulnerability to pollution reaching ground or surface water is high or high-moderate. They may provide reasonable water quality protection if your site's vulnerability to pollution reaching ground or surface water is low to moderate-low.

- **High risk** practices (4's): pose a serious danger of polluting water, especially if your site's vulnerability to pollution reaching ground or surface water is high, high-moderate, or moderate-low. Some high risk activities may not immediately threaten water quality if your site's vulnerability to pollution reaching ground or surface water is low, but still pose a threat over time if not corrected.

Read ***Fact Sheet 14 Improving Crop Nutrient Application Management*** and consider how you might modify your farm practices to better protect your drinking water supply and other ground and surface water supplies. Some concerns you can take care of right away; others could be major or costly projects requiring planning and prioritizing before you take action.

Summary Evaluation for Crop Nutrient Application Management Worksheet

Summarize your potential high risk activities in the following table and consider the response options you can take to reduce the potential for water quality contamination.

High Risk Activities and Activities Impacted by Site Vulnerability	**Response Options (Check One)**		**Taking Action** For "immediate action possible" items, note practices and when each will occur. For issues "requiring further planning," note estimates, consultations, or other activities necessary and when each will occur. Establish a target date for making necessary changes.
	Immediate Action Possible	**Further Planning Required**	

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