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Lincoln County
Verdi Township
Spring Creek Watershed Survey

For additional information, contact:
Denton Bruening at 612-297-4400
Minnesota Department of Agriculture

General Information:

Water quality in Southwest Minnesota is of significant concern to both private well users and public water suppliers. Aquifers in this region are often shallow and have a high potential of contamination from nitrate leaching. Deeper aquifers in this area may not be suitable for water supplies due to other contaminants such as sulfur or because of slow well recharge. Agricultural practices can be a source of contamination and adoption of environmentally sound practices can be highly beneficial in reducing contamination of the area's aquifers.

In September of 1997 a steering committee was formed to address water quality problems in Southwest Minnesota. Agencies involved in the steering committee included the Department of Health, Department of Natural Resources, Board of Water and Soil Resources, Pollution Control Agency and the Department of Agriculture. The steering committee then brought together a technical committee to determine sources of pollution in ground water, specifically nitrate, and to determine possible solutions or preventive actions.

One of the first actions of the technical committee was to address nitrate problems of a specific public water supplier. Lincoln-Pipestone Rural Water supplies water to over 10,000 individuals in Southwest Minnesota. During the summer of 1997, water supplied to some of its customers exceeded 10 parts per million (the U. S. Environmental Protection Agency recommended allowable limit for nitrate in drinking water). Lincoln-Pipestone Rural Water pumps water from three major well fields. The Holland well field is located between Lake Benton and Pipestone, the Verdi well field is located west of Verdi, and the Burr well field is located west of Canby. Some customers receiving water from the Holland well field were notified this past summer that the water they received exceeded the limit for nitrate and could be dangerous to infants under six months of age. Nitrate levels in both the Holland and the Verdi well fields have been over 5 parts per million during the past year.

One of the first actions taken by the technical committee was to interview farmers in the potential recharge area of the well fields. Farmer interviews took place in September for the Verdi well field and interviews will take place after harvest in December/January for the Holland well field.

Local Soil and Water Conservation District and Natural Resources Conservation Services personnel were contacted in September to inform them of the specifics of the farm surveys and the overall goals. The SWCD and NRCS served as an important link between the farmers and the technical committee. They made personal telephone calls to the farmers after an initial letter was sent from the Department of Agriculture signed by the Commissioner. The letter's intent was to identify: the overall project; the purpose of the nutrient assessment; why they were selected; and what types of information and amount of their time would be necessary to successfully complete the project.

Farmers were interviewed through a technique called FArm Nutrient Management Assessment Program (FANMAP). In the past five years, over 400 farmers have volunteered 2 to 4 hours of their time to share information about their farming operations. Letters were sent to most farmers in the Spring Creek watershed in Verdi township. Figure 1 details the land that was included in the FANMAP process. Twenty two farm operations were involved in the interview process.

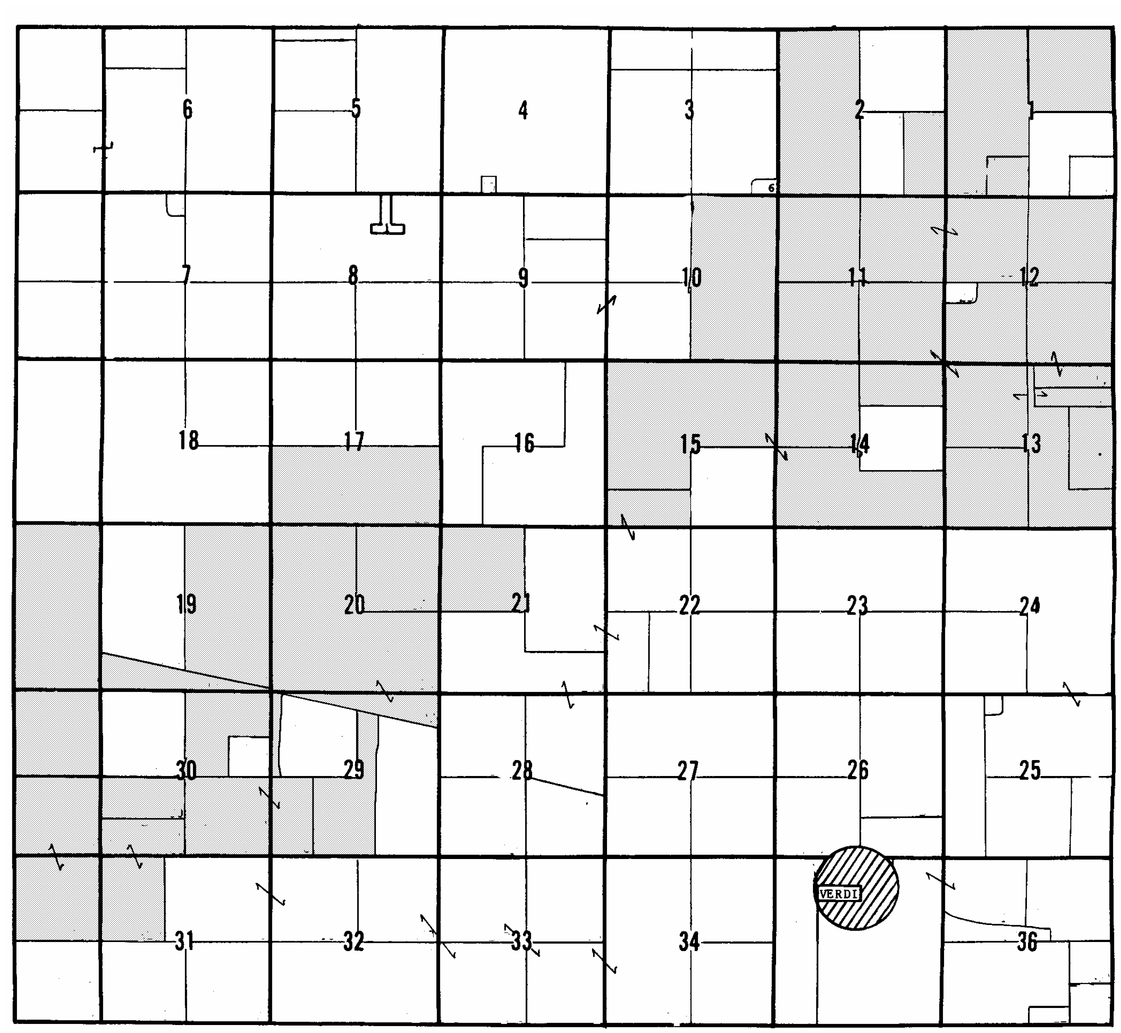

Figure 1. Area of Spring Creek watershed involved in the FANMAP process.

The aquifer supplying water to the Verdi well field may have contributions from surface water due to shallow depth to the aquifer and gravel areas that exist in the Spring Creek watershed.

Nutrient Management Data Collection:

Inventory forms and database design were patterned after a previous successful project[1]. Timing, rates, and method of applications were collected for all nitrogen (N), phosphate (P_2O_5), and potassium (K_2O) inputs (fertilizers, manures, and legumes) on **a field-by-field basis for all acres within the watershed.** Soil and manure testing results were also collected if available. Nutrient inputs and yields were specific for the 1997 cropping season. Crop types and manure applications (starting in the fall of 1996) were also collected from the 1996 season for purposes of 1997 nitrogen crediting. Long term yield data generally reflected the past 3 to 5 years. Livestock census and other specifics for the entire farm (i.e. types of manure storage systems, total farm sizes) were also recorded.

Farm Size, Crop and Livestock Characteristics of the Selected Farms in Spring Creek Watershed:

Twenty-two farmers were interviewed in September of 1997. Some of the "farmers" were actually a combination of farmers such as a father and son who farmed together. Eighteen farmers had crops other than or including Crop Reserve Program (CRP) acres. Four farmers had only CRP acres. These four farmers did not supply any data other than acres of CRP in the watershed. The average age of a farmer interviewed was 47 years. Nine participants were cash farmers, 5 were dairy farmers and 4 were beef farmers. Sixteen of the farmers received water from the rural water system while two did not.

A total of 6,364 acres of farmland were inventoried in the Spring Creek watershed. An additional 600 acres in the lower watershed and an additional 900 acres in the upper watershed were not inventoried. Farm interviews covered over 80% of all agricultural acres in the watershed.

Livestock appears to play a limited role in the Spring Creek watershed. It also appears several farmers have recently quit raising livestock in the last 10 years. Some of the livestock only contributed manure in the form of "daily pasture manure". There was no livestock other than dairy and beef.

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[1]Effective Nitrogen and Water Management for Water Quality Sensitive Regions of Minnesota, LCMR 1991-93

Livestock and Manure Characteristics of the Selected Farms:

Factors directly affecting crop nutrient availability from land applied manure (including manure storage, types, manure amounts being generated, application methods, incorporation factors and rates) were also quantified to complete the "whole farm" nutrient balance. Table 1 includes a complete animal inventory, including estimates of N, P_2O_5 and K_2O produced[2] and collected in various types of manure systems for spreading on acres in the survey (manure collected but not spread on acres specified in the survey are not considered in the collected amounts). Manure not collected from the cattle is usually due to time spent on pastures and large lots where manure is not collected or manure that was spread on land that was not in the Spring Creek watershed. Livestock numbers represent the livestock on hand from the fall of 1996 to the summer of 1997. This would be the livestock that would contribute manure to the 1997 crops.

Table 1. 1997 livestock numbers, and manure N, P_2O_5 and K_20 produced and collected by livestock types in sample population.

Livestock Type	Livestock Number	Manure Nitrogen Produced	Manure Nitrogen Collected	Manure P_2O_5 Produced	Manure P_2O_5 Collected	Manure K_2O Produced	Manure K_2O Collected
			Pounds		Pounds		Pounds
Dairy Bulls	15	2,521	452	1,008	183	2,013	365
Dairy Cows	130	20,150	17,076	8,060	6,830	16,120	13,661
Dairy Calves	51	3,978	2,535	1,683	1,073	3,162	2,015
Replacement Heifers	90	13,950	5,490	5,580	2,196	11,160	4,392
Dairy Steers	41	6,355	5,890	2,542	2,356	5,084	4,712
Beef Bulls	6	942	458	678	330	834	405
Beef Cows	165	21,615	10,644	16,500	8,125	18,810	9,263
Beef Feeders Under a Year	65	4,030	1,679	3,055	1,273	3,575	1,490
Beef Feeders Over a Year	275	34,100	24,025	25,050	17,631	29,000	20,625
TOTAL	**838**	**107,631**	**68,248**	**64,131**	**39,997**	**89,758**	**56,928**

Manure was collected by deep bedding in barns and lots, some daily or weekly hauling, and some stacking. Storage losses of nitrogen accounted for a reduction of approximately 30% in the amount available for spreading. There was no storage losses for phosphorous or potash. Total amount of nitrogen available for spreading was 48,461 lbs.

Nutrient losses from collection and storage were estimated from accepted guidelines[3] for each individual storage system(Table 2)[4].

[2] Livestock Waste Facilities Handbook, Midwest Plan Services, Iowa State University, Ames, Iowa. 1993.

[3] Livestock Waste Facilities Handbook, Midwest Plan Services, Iowa State University, Ames, Iowa. 1993.

Table 2. Distribution of first year available farm generated manure to cropland in 1997[5].			
Crop	Manured Acres	Total Acres	% of Acres
Corn	400	2,350	17%
Soybeans	274	2,323	12%
Small Grains	14	167	8%
Pasture	72	350	21%
Other	7	1,174	1%
Crop Total	**767**	**6,364**	**12%**

Losses as a function of application methods and timing factors were calculated on a field-by-field basis. All manure was broadcast with very little incorporation. Manure generated a total of 12,000 lbs of "first year available" N. Table 3 details the amount of “first year available” nitrogen added to crop acres from manure.

Table 3. Distribution of first year available farm generated manure to cropland in 1997[6].			
Crop	Manured Acres	Total lbs Manure N	Average lbs Manure N Per Acre
Corn	400	7,053	18
Soybeans	274	2,505	9
Small Grains	14	1,243	89
Pasture	72	438	6
Other	7	876	125
Crop Total	**767**	**12,115**	**16**

Commercial Fertilizer Use Characteristics on Selected Farms:

[4] M. Schmitt, and G. Rehm. Fertilizing Cropland with Dairy Manure. FO-5880-C. M. Schmitt, and G. Rehm. Fertilizing Cropland with Swine Manure. FO-5880-C. M. Schmitt, and G. Rehm. Fertilizing Cropland with Beef Manure. FO-5880-C.

[5] M. Schmitt, and G. Rehm. Fertilizing Cropland with Dairy Manure. FO-5880-C. M. Schmitt, and G. Rehm. Fertilizing Cropland with Swine Manure. FO-5880-C. M. Schmitt, and G. Rehm. Fertilizing Cropland with Beef Manure. FO-5880-C.

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Most acres of cropland were in a corn/soybean rotation (Table 4).

Table 4. Type and Acres of Crops in the Watershed	
Crop	Acres
Corn	2,350
Soybean	2,323
Alfalfa	198
Small Grains	167
Pasture	350
Grasses	54
CRP	910
Red Clover	12
Total Acres	6,364

A total of 264,000 lbs of nitrogen were applied were applied to the crops in the form of commercial fertilizer for the 1997 crop season. Corn acres received 255,000 lbs of commercial fertilizer or 96% of all fertilizer nitrogen. An additional 7,000 lbs of nitrogen were contributed though manure for a total of 262,000 lbs of nitrogen applied to all corn acres. All acres received nitrogen either in the form of commercial nitrogen or manure. Most corn acres, 2,020 (87%), were corn following soybeans.

The following analysis is based on an average per acre. An average of 112 lbs of nitrogen were applied to each acre of corn. Average yields on corn acres from past history were 130 bushels to the acre and this year's yield goals averaged 133 bushels to the acre. On overall acres of corn, the average recommended amount of nitrogen to apply is approximately 92 lbs an acre .
These soils are very low in organic matter averaging only 3.8% of organic matter.

Timing of N fertilizer applications is an important consideration in maximizing fertilizer use efficiency and minimizing environmental effects. Spring preplant applications of nitrogen in the form of anhydrous ammonia or urea are recommended for Southwest Minnesota[7]. The following table (Table 5) lists when the nitrogen was applied and the amount applied.

Table 5. Time of Year and the Amount of Nitrogen Applied.		
Time of Year	Amount	Percentage

[7] M.A. Schmitt and G.W. Randall 1993. Best Management Practices for Nitrogen Use in Southwest MN. AG-FO-6128-C.

Fall	62,020	24%
Spring PrePlant	107,110	42%
At Planting	12,109	05%
Sidedress	73,950	29%
Totals	255,190	100%
Totals	255,189	100%

Fall application of nitrogen for corn in Southwest Minnesota is recommended if the proper source (anhydrous ammonia or urea) is selected and the proper soil temperature is reached. Research indicates anhydrous ammonia is the most efficient source of nitrogen when used for fall fertilization in Southwest Minnesota[8]. Producers applied 24% of the total nitrogen for corn during fall applications of 1996 for the 1997 growing season. In this survey, all fall-applied nitrogen for corn was in the form of urea and none of it was applied with a nitrification inhibitor. The average fall application date of urea was October 15.

Fall applications of anhydrous ammonia should be delayed until the soil temperature is below 50 F at the 6-inch depth. Long-term climatic data from the Lamberton Experiment Station indicate that soil temperatures will generally remain below 50 F after October 30. Delaying fall application of urea fertilizer until after October 30 may reduce leaching of nitrogen.

Only 864 acres(15%) of the 5,891 acres planted with crops other than corn were applied with N fertilizer. Soybeans accounted for 46% of "non-corn" commercial N while alfalfa and small grains accounted for 25% and 26%, respectively.

Anhydrous ammonia supplied 5% of the total amount of commercial N applied to corn. All of the of anhydrous ammonia was applied as a spring preplant. Urea accounted for 52% of all nitrogen while UAN solutions (39%) and ammonium based fertilizers (4%) accounted for the rest.

Relative Importance of Nitrogen Sources on the Selected Farms:

University of Minnesota (UM) recommendations for nitrogen provide N credits from legumes. Alfalfa was assumed to have 2-3 plants per square foot when tilled for the following corn crop. First year alfalfa provided a 75 lb/A credit, and

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[8] M.A. Schmitt and G.W. Randall 1993. Best Management Practices for Nitrogen Use in Southwest MN. AG-FO-6128-c.

second year alfalfa provided a 50 lb/A credit. Soybeans provided a 40 lb/A credit. These N credits will later be compared to the reductions in nitrogen on corn acres with no legume N credits to those corn acres with legume N credits. In the Spring Creek watershed survey, soybeans were by far the most important source of legume N, supplying approximately 95% of all legume N to corn acres. Alfalfa (first and second year credits) supplied the balance (5%). A total of 80,000 lbs of N was contributed to the corn acres through legumes.

Commercial fertilizer (74%), manure (3%), and legumes (23%) contributed a total of 347,000 lb. of "first year available N" to **corn acres** (Figure 2). This is an average N rate of 148 lb/A across all corn acres. Proper crediting for these sources is critical in maintaining economic and environmental balances.

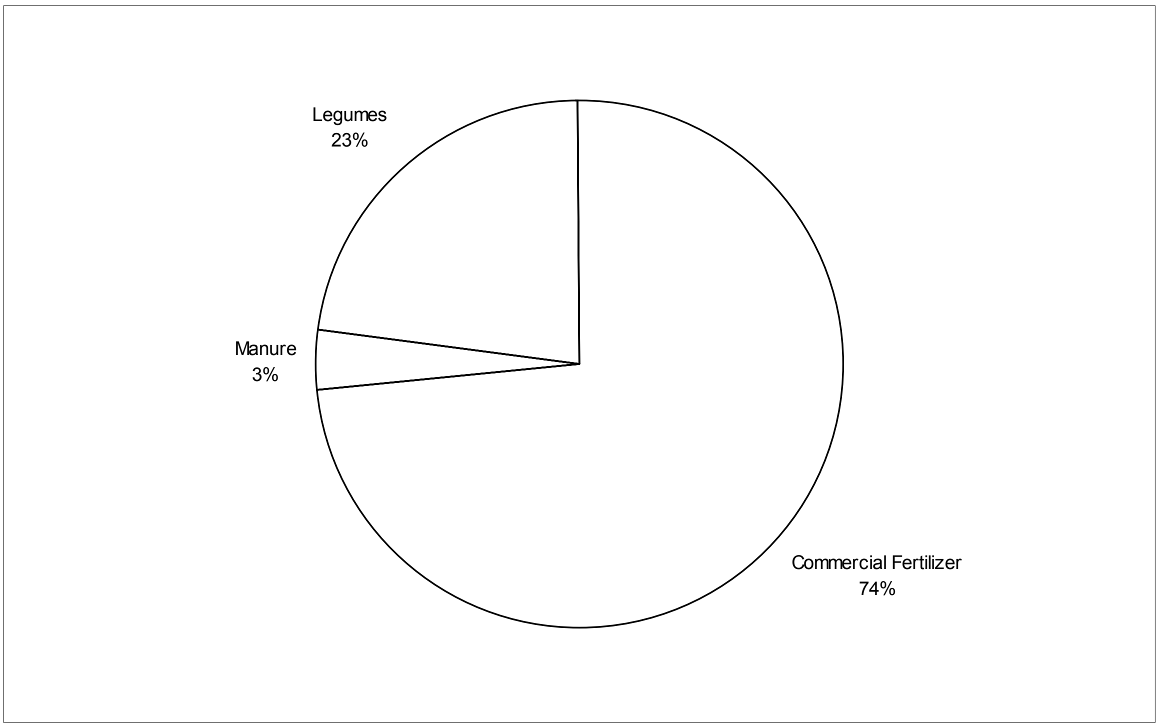

Figure 2. Relative N contributions from fertilizers, manures and legumes across all corn acres. N inputs totaled 347,000 for all sources. N contributions averaged 148 lb/A across all corn acres.

Nitrogen Balances and Economic Considerations:

The corn yield goal across all farms was 133 bushels per acre on an average field. University of Minnesota N recommendations (based on yield goal, crop history, and soil organic matter level) were compared to actual amounts of fertilizer and manure applied to each field. Approximately 1,350 acres had soil tests with soil organic matter data. The average field had 3.8% organic matter and 88% of all fields were in the medium to high range (greater than 3%) in regard to organic matter. University of Minnesota N recommendations to fulfill this goal averaged 92 lb/N/A (Figure 3). Actual amounts of N applied from commercial fertilizer and manure averaged 109 lb N/A and 3 lb/A respectively across all corn acres. Factoring in all appropriate credits from fertilizer, legumes and manures, there was an over-application rate of 19 lb/N/A.

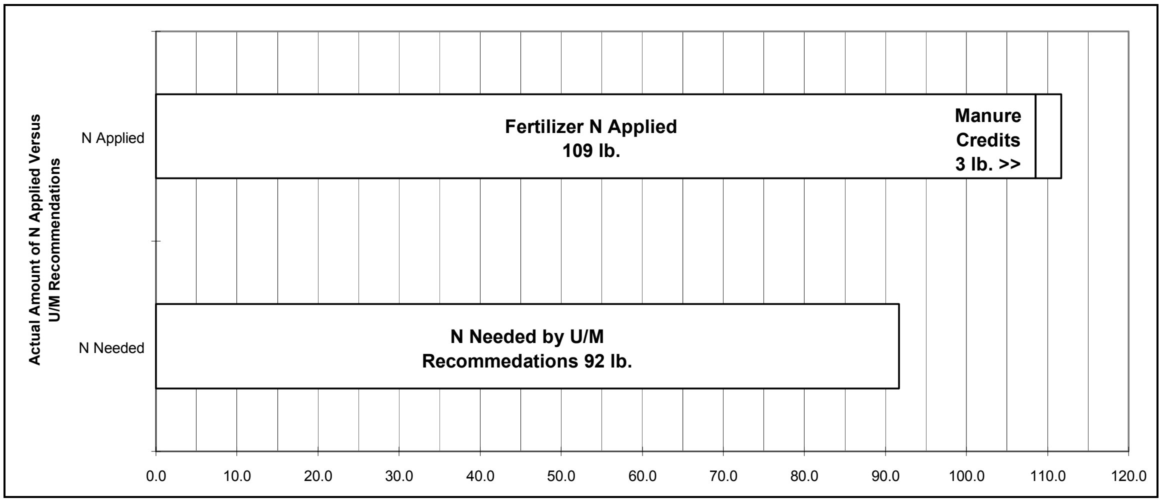

Figure 3. Crop N requirements based on UM recommendations in comparison to actual N inputs (fertilizer, and manure) across all corn acres. Total corn area in this analysis was 3,250 acres. Legumes also provided 34 lb/A N across all acres and is already reflected in the UM recommendations.

Acres with soil tests averaged 3.8% organic matter. However, when farmers without soil test data were asked to estimate organic matter, over 50% of acres were estimated to be in the low category or less than 3% organic matter. If farmers are under-estimating organic matter, additional reductions could be made in nitrogen inputs due to the contributions of nitrogen from soils with higher organic matter.

Over 85% of the corn acres were a corn/soybean rotation in the Spring Creek watershed. Figure 4 details the rotation of corn acres.

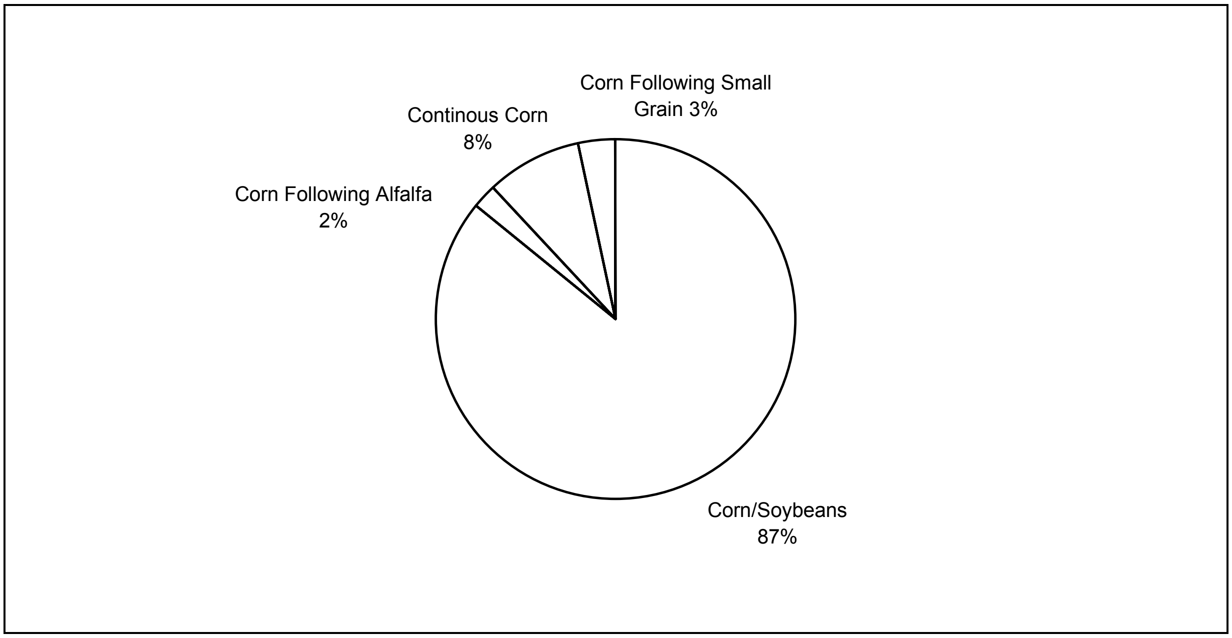

Figure 4. Corn acres in the Spring Creek watershed.

Factoring in legume N credits and manure N inputs into the process on a field-by-field basis, the amounts in excess of 1997 UM recommendations are illustrated in Table 6. One of the huge advantages of the technique developed through the nutrient assessment process is the ability to examine in great detail the nutrient balances and make some inferences on where the biggest gains in water quality can be obtained through focused educational programs.

Table 6. Excess Nitrogen on Corn Acres

Crop Rotation	Total Acres	Excess Acres	Excess N Average lb/A	Excess N Total lb
Corn/Soybeans	1,990	1,984	20	40,219
Other	320	241	47	10,078
Totals	2,350	2,225	23	50,297

Ninety-five (95%) of the total corn acres were classified into the Excess category. Over-application of N averaged 23 lb/A across all acres in this category. However, only 518 (22%) acres of corn were applied with N in excess of 30 lbs/A of the UM recommendations. Reduction of nitrogen on all acres to the maximum recommended by the UM would reduce 50,000 of lbs nitrogen from the farmers interviewed and including 650 acres of corn not in the survey process, an additional 13,000 lbs of nitrogen could be reduced for a total of 63,000 lb reduction of nitrogen for Spring Creek watershed. UM recommendations are based on economic factors, so the reductions in N should lead to substantial savings with little or no yield loss to many of the farmers in the Spring Creek watershed.

Conclusions and Summary of the Current Nutrient Management Practices for the Spring Creek Watershed

Twenty-two farms, covering over 6,000 acres, participated in the FArm Nutrient Management Assessment Program (FANMAP) with staff from the Minnesota Department of Agriculture. Producers volunteered 2-4 hours of their time to share information about their farming operation. The overall purpose of the program was to develop a clear understanding of current farm practices regarding agricultural nutrients and utilize this knowledge for future water quality educational programs.

Over 40% of commercial N used on corn was applied as a spring preplant and urea was the dominant source of N for all applications (52%). Manure (first year available) accounted for only 3% of the N while legumes and commercial N accounted for 23% and 74%, respectively. Soybeans was the dominate source of legume N credits. Seventeen percent (17%) of corn acres received applications of manure leaving ample land available for manure application, if based on N inputs.

Producers appeared to be applying approximately 20 lbs/A of nitrogen above recommendations that were made by UM. Corn following soybean acres accounted for most of the excess N in this survey. Reducing the average amount of N applied and accounting for soybean credits could save farmers approximately $4 an acre.

There were some very positive findings from this study. There is strong evidence that producers are voluntarily adopting the educational materials and strategies developed by the UM. It is also evident that promotional activities need to continue and be specifically targeted to deliver the most recent technology and recommendations. Soybeans crediting is an area where there is a strong need for more education in this study area. Strong similarities exist in all existing FANMAP projects: producers are generally managing commercial N inputs successfully (although frequently using outdated recommendations) but continually under-estimate the N credits associated with manure and legume inputs.