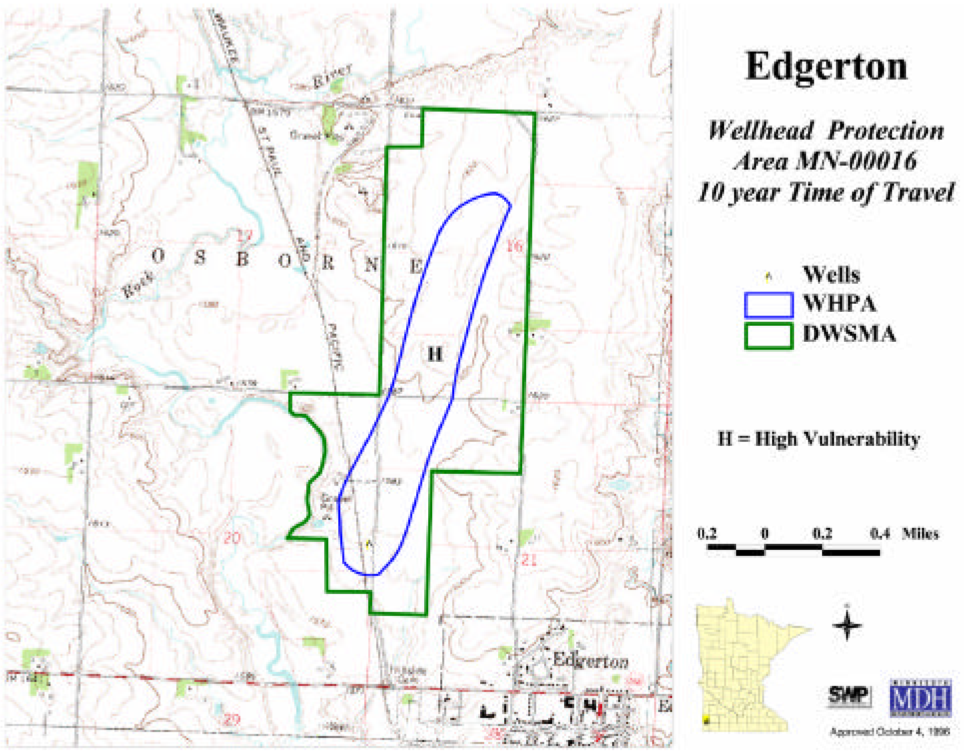
Southwest Minnesota

Survey of Farmers Located in

Wellhead Study Areas 1998



Edgerton Wellhead Protection Area
One of Four Study Areas

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General information: Selected Farms in the Rock, Red Rock, Edgerton and Balaton Wellhead Study Areas.

Several public water suppliers in southwest Minnesota have had to address contamination of public drinking water sources with nitrate. Good drinking water sources can often be scarce in areas of southwest Minnesota and therefore it is important to protect current supplies. Understanding agricultural practices that can affect the ground water near drinking water supplies is critical to determine the affects of agriculture on groundwater. The Southwest Minnesota Wellhead Study Areas (SMWSA) includes the Rock (wells located south of Laverne) and Red Rock Rural Water Suppliers (wells located by Windom), and the cities of Balaton and Edgerton.

A list of farmers located in southwest Minnesota SMWSA's was obtained from the local County Farm Service Agencies. Local Soil and Water Conservation District (SWCD) personnel, Extension Educators, and Natural Resources Conservation Services (NRCS) personnel were contacted in January 1999 informing them of the specifics of the farm surveys and the overall goals. The SWCD, NRCS and MES served as an important link between the farmers and the MDA staff. Local agency staff made personal telephone calls to the farmers after an initial letter, signed by the commissioner, was sent from the Department of Agriculture. The letter's intent was to identify: 1) the overall project, 2) the purpose of the nutrient assessment; why they were selected, 3) and what types of information and amount of time would be necessary to successfully complete the project. Letters were sent to 57 farmers and a total of 35 farmers were interviewed

The Minnesota Department of Agriculture has developed the Farm Nutrient Management Assessment Program (FANMAP) to obtain a thorough understanding of current farm practices regarding agricultural inputs. This information will be used to design effective water quality educational programs and serve as baseline data to determine program effectiveness over time. In the past six years, over 500 farmers have volunteered two to four hours of their time to share information about their farming operations. This previous information was collected as a result of funding through the Legislative Commission on Minnesota Resources or from Clean Water Partnership Programs.

Nutrient Information of the Selected Farms in the Rock, Red Rock, Edgerton and Balaton Wellhead Study Areas

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 each watershed.** Soil and manure testing results were also collected if available. Nutrient inputs, and yields, were specific for the 1998 cropping season. Crop types and manure applications (starting in the fall of 1997) were also collected from the 1997 season for purposes of 1998 nitrogen crediting. Long-term yield data generally reflected the past three to five years. Livestock census and other specifics for the entire farm (i.e. types of manure storage systems, total farm sizes) were also recorded. Information was gathered from the farmer or the fertilizer dealer if the dealer kept the farmer's records.

Farm Size, Crop and Livestock Characteristics of the Selected Farms in the Rock, Red Rock, Edgerton and Balaton Wellhead Study Areas

Thirty-five farmers were interviewed from January through March of 1999. Some of the "farmers" were actually a combination of farmers such as a father and son who farmed together. Thirteen of the 35 farmers applied some type of manure to crop acres for the 1998 growing season.

A total of 7,543 acres of farmland were inventoried across all four SMWSA's. Farm interviews covered approximately 25% of all agricultural acres across all SMWSA's. Livestock appears to play a prominent role in the four SMWSA's with 19% of all available N coming from manure.

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

Figure 1 lists each type of crop grown and the corresponding percentage of acres inventoried in the four SMWSA's.

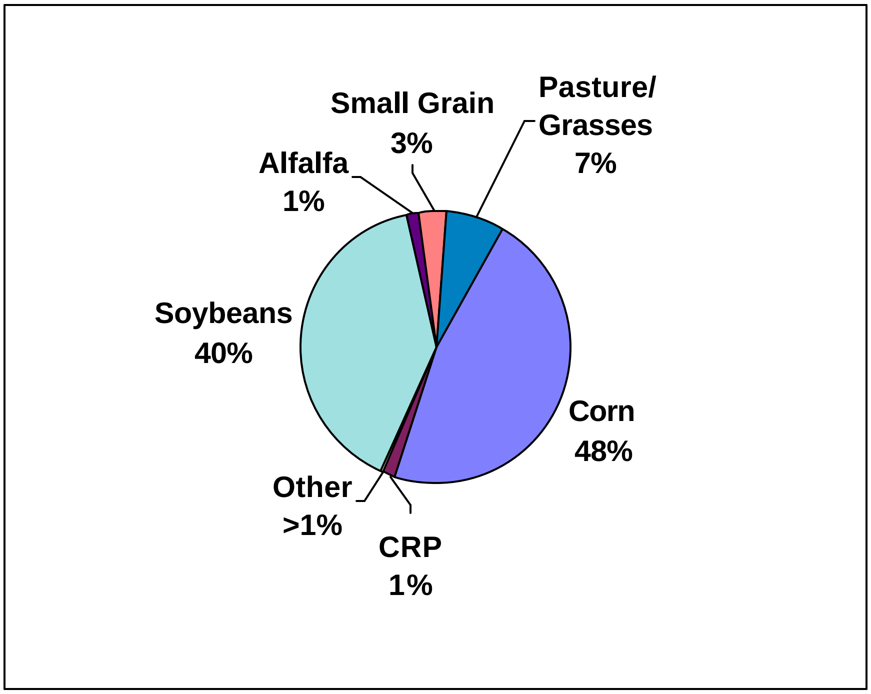

Figure 1. Distribution of crops across all 7,543 inventoried acres dominated by 3,521 corn acres and 3,021 soybean acres.

Commercial Fertilizer Use Characteristics on Selected Farms: Selected Farms in the Rock, Red Rock, Edgerton and Balaton Wellhead Study Areas

Field corn accounted for 97% of the 362,000 pounds of N commercial fertilizer applied by surveyed farmers. All corn acreage received either commercial N fertilizer or manure (Table 1). Ninety-six percent of all corn fields received commercial fertilizer. Average fertilizer N rate on corn acres with commercial fertilizer was 104 lb N/A. This rate is calculated as the means across all corn acres regardless of past manure or legume N credits. Average commercial fertilizer N rate across all corn acres was 100 lb N/A. Total N inputs will be discussed later in the "Nitrogen Balances and Economic Considerations" section.

Table 1. Distribution Of Commercial Nitrogen Applications On Cropland - 1998.			
Crop	**Acres Receiving N Fertilizer**	**Total N Applied**	**Average Rate of N on Fertilized Acres**
Corn	3,381	352,413	104
Alfalfa	15	150	10
Small Grains	164	7,792	48
Soybeans	159	1,670	11
TOTALS	**3,719**	**362,024**	**---**

The timing of N fertilizer applications on corn acres 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[2]. 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[3]. Research indicates anhydrous ammonia is the most efficient source of nitrogen when used for fall fertilization in Southwest Minnesota[4]. Producers applied 29% of the total nitrogen for corn during fall applications of 1997 for the 1998 growing season. In this survey, all fall-applied nitrogen for corn was in the form of anhydrous ammonia and a nitrification inhibitor was not used with any applications.

Fall applications of anhydrous ammonia should be delayed until the soil temperature is below 50 F at the 6-inch depth to reduce the potential of nitrate leaching. 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 anhydrous ammonia fertilizer until after October 30 may reduce leaching of nitrogen. Farmers generally delayed fall applications of N until after November 1.

Approximately 69% of commercial nitrogen fertilizer used on surveyed corn acres was spring-applied as a preplant application (Figure 2).

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

[3] According to the University of Minnesota, a consistent temperature of 50º or below in the soil should be reached before fall applications of nitrogen.

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

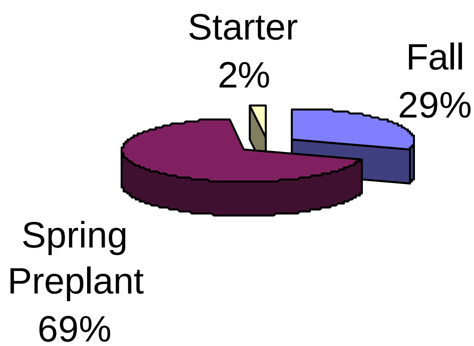

Figure 2. Timing of N fertilizer applications across all corn acres.

Anhydrous ammonia supplied 65% of all N in the Southwest surveys (Figure 3). No nitrogen inhibitor was used by farmers.

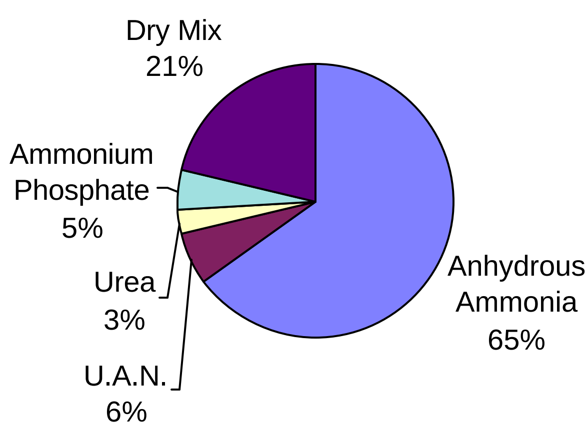

Figure 3. Sources of N used on all inventoried corn acres.

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 2 includes a complete animal inventory, including estimates of N, P_2O_5 and K_2O produced[5] 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 within the Southwest MN Wellhead Study Areas. Livestock numbers represent the livestock on hand from the fall of 1997 to the summer of 1998. This is the livestock that would contribute manure to the 1998 crops. Thirteen of the thirty-five farmers raised livestock within a wellhead study area.

Table 2. 1998 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	
Sows/Boars	184	4,812	4,812	3,332	3,332	3,332	3,332
Feeder Pigs	950	912	912	551	551	551	551
Slaughter Hogs	26,700	219,864	219,864	156,516	156,516	168,850	168,850
Beef Cows/Bulls	155	20,409	9,058	15,552	6,907	17,770	7,886
Beef Feeders Under a Year	111	6,193	3,097	4,695	2,348	5,494	2,747
Beef Feeders Over a Year	1,502	187,533	187,533	137,307	137,307	166,670	166,670
TOTALS	**29,602**	**439,724**	**425,276**	**317,953**	**306,960**	**362,667**	**350,036**

Manure collection varied by type of livestock in the Southwest MN SMWSA's. Hog manure supplied 53% and beef manure supplied 47% of the total amount of N collected from all livestock raised on the farm (Figure 4). Some additional dairy manure was imported and will be accounted for later in the report.

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

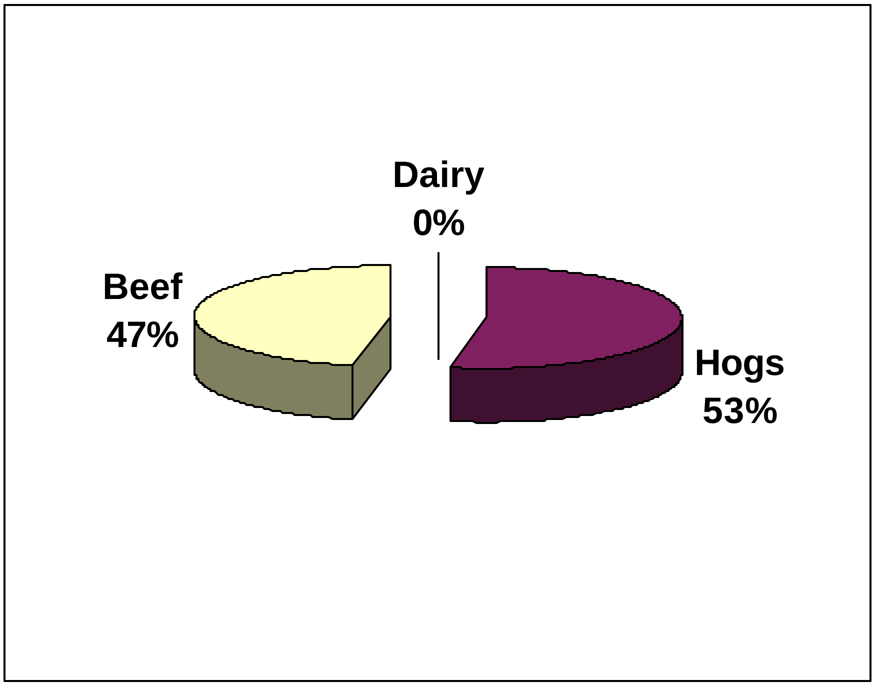

Figure 4. Percentages of total nitrogen collected by animal types across all selected farms.

The type of storage system available for producers is an important consideration in efficiently retaining nutrients and allowing enough storage to field apply the manure in an environmentally safe manner. Thirteen farms produced manure and an additional farmer imported diary manure. Of these, seven applied some liquid manure while the other seven applied only solid manure.

Nutrient losses from collection and storage were estimated from accepted guidelines[6] for each individual storage system. Losses as a function of application methods and timing factors were calculated on a field-by-field basis. Solid manure systems were most often cleaned on a "as needed" basis, both in the barns and lots. Liquid systems were generally cleaned in the fall. One farm could have several systems for collecting manure, such as, a pit for finishing hogs and a deep bed barn for gestation sows.

Nitrogen collected from each system is summarized by the type of system for solid manure in Figure 5 and liquid manure in Figure 6.

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

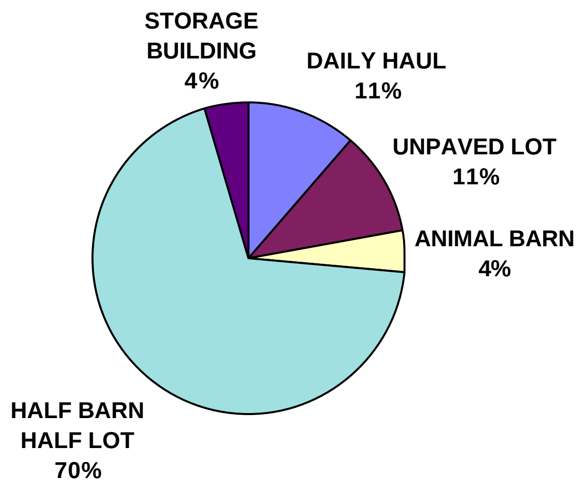

Figure 5. Percentage of solid manure collected by type of system. A total of 232,000 pounds of N was collected in the solid manure systems. System losses totaled 90,000 pounds N leaving 142,000 pounds N available to spread.

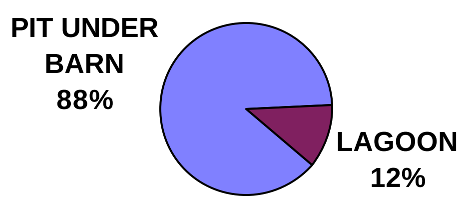

Figure 6. Percentage of liquid manure collected by type of system. A total of 194,000 pounds of N was collected in the liquid manure systems. System losses totaled 48,000 leaving 146,000 pounds N available to spread.

Storage losses of N and P_2O_5 varied by type of system. Table 3 lists the system type and associated losses for each system type.

Table 3. Manure N, P_2O_5 and K_2O collected and storage losses by all livestock on all farms in 1998.

System Type	Number of Systems	Manure Nitrogen Collected	Retained N After System Losses	Manure P_2O_5 Collected	Retained P After System Losses	Manure K_2O Collected	Retained K After System Losses
		Pounds		Pounds		Pounds	
DAILY HAUL	3	26,077	18,905	18,571	18,571	19,977	19,977
UNPAVED LOT	1	25,460	12,730	18,640	10,252	22,580	14,677
ANIMAL BARN	2	9,808	6,865	7,261	7,261	9,017	9,017
HALF BARN HALF LOT	3	160,003	96,001	117,301	93,841	141,840	127,656
STORAGE BUILDING	1	10,080	7,056	7,200	7,200	7,776	7,776
PIT UNDER BARN	6	171,384	132,822	122,147	122,147	131,805	131,805
LAGOON	1	22,464	13,478	15,840	7,920	17,040	8,520
TOTALS	**17**	**425,276**	**287,861**	**306,960**	**267,192**	**350,035**	**319,429**

The fate of manure-N is summarized in a simple flow diagram (Figure 7). This diagram simplifies the complexities associated with N from excretion to "plant available". Due to the large amount of pasture and small amount of incorporation of solid manure (the majority of manure is produced by beef cattle), only 25% of the total amount of N produced was available for the first year credit to the crop.

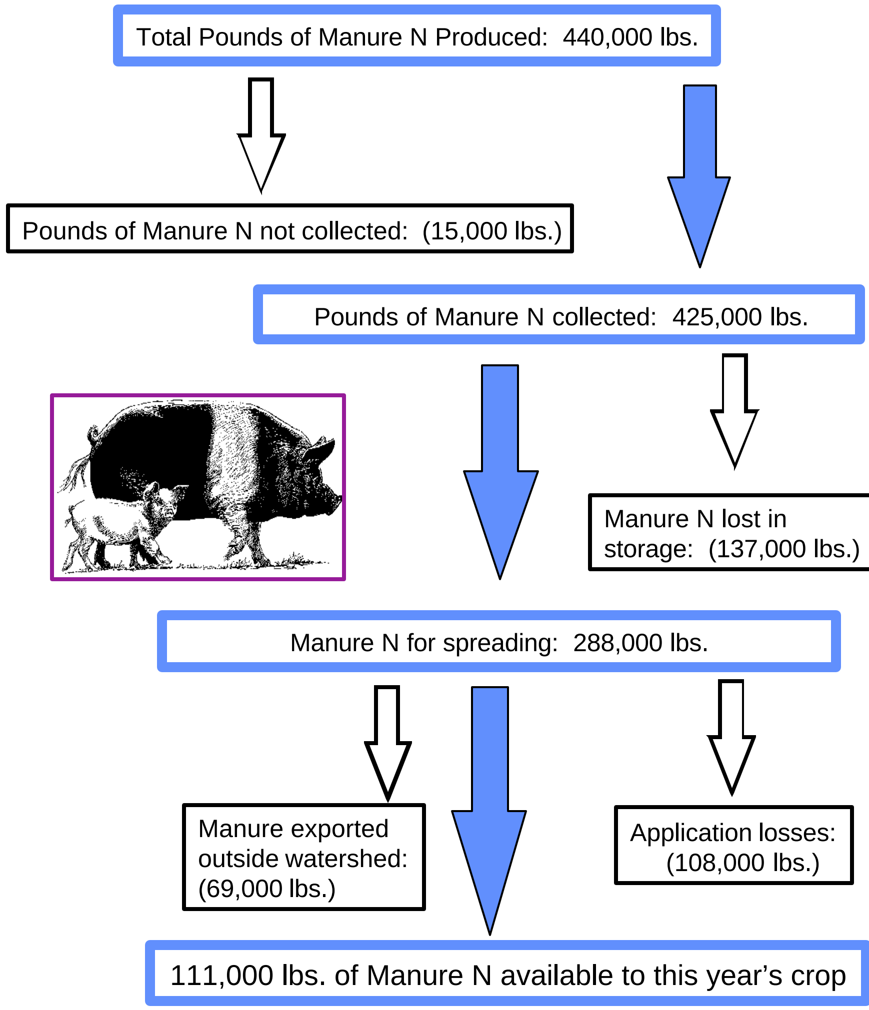

Figure 7. Fate of farm generated and imported manure-N across all storage and management factors. First year available N accounted for 25% 0f the manure-N produced. An additional 2,750 of N imported from a neighbor's dairy operation is included in the total amount available for spreading.

Manure supplied 70,000 lb. of N to the 1998 corn crop. An additional 41,000 lbs. of nitrogen from manure was supplied to crops other than corn. Figure 8 details the percentage of first year available N applied to each crop.

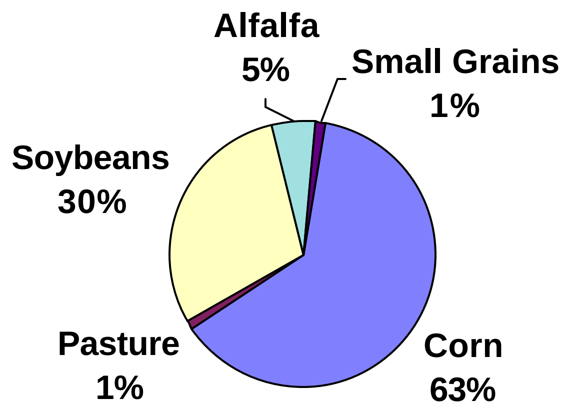

Figure 8. Final destination of first year available N.

Hog manure was generally knife injected and cattle manure was generally broadcast and not incorporated in 4 days. Figure 9 details the amount of each type of manure retained and the amount of manure N available for crop use.

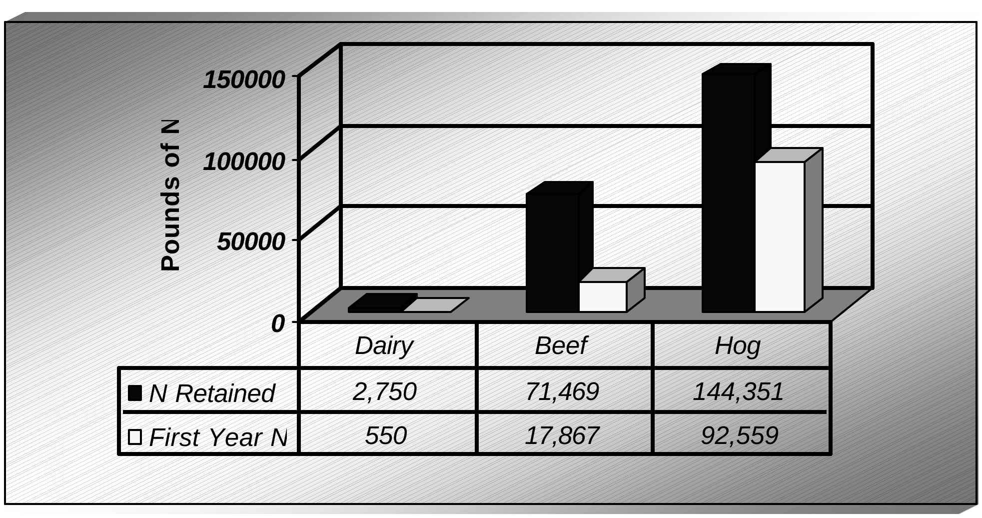

Figure 9. Comparison of the type of manure and manure availability for the 1998 crops.

Application losses and system losses were greater for cattle than for hogs. Hogs generated 53% of the manure N collected from the barns and other manure systems. Due to higher application and system losses associated with cattle manure, hog manure generated N now accounts for 84% of first year available N (Figure 10).

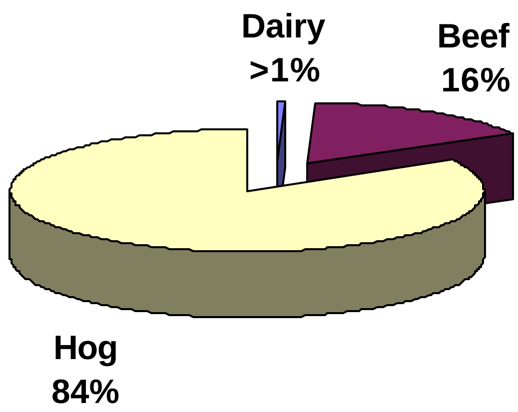

Figure 10. Source and percent of manure applied to all crop acres.

Forty-three percent (43%) of the farm-generated manure on all acres was applied as a broadcast with no incorporation within 4 days (Figure 11). Incorporation of broadcast manure within 4 days or less would generally double the amount of retained N available for crop use. Fifty-seven percent (57%) of the manure was knife injected.

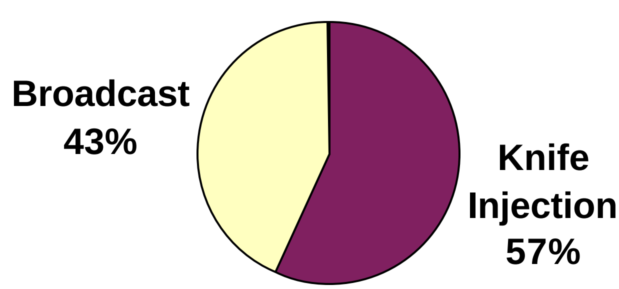

Figure 11. Type and percentage of manure application for all acres.

Eighty-nine percent (89%) of the first year available N was applied in the fall. The balance was generally applied though out the year.

Relative Importance of N Sources on the Selected Farms: Southwest Wellhead Study Areas:

University of Minnesota 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 N/A credit, and second year alfalfa provided a 50 lb N/A credit. Soybeans supplied a 40 lb N/A credit. In the Southwest Minnesota survey, soybeans were by far the most important source of legume N, supplying approximately 99% of all legume N.

Commercial fertilizer (59%), manure (19%), and legumes (22%) contributed a total of 594,000 pounds of "first year available N" to all corn acres (Figure 12). Proper crediting of these sources is critical in maintaining economic and environmental balances.

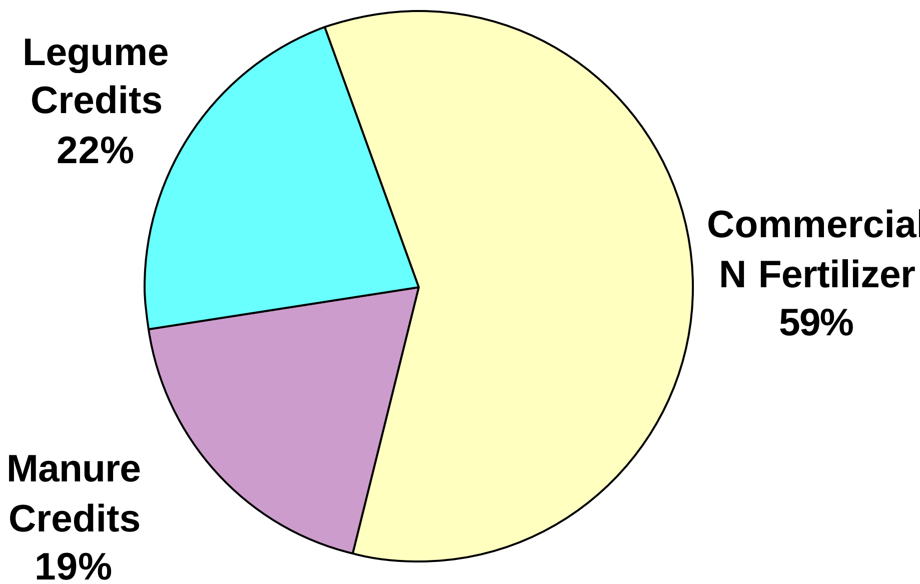

Figure 12. Relative N contributions from fertilizers, manures and legumes across all corn acres. N inputs totaled 594,000 for all sources.

Nitrogen Balances and Economic Considerations: Southwest Wellhead Study Areas

Contributions of Commercial N to corn acres totaled 352,000 pounds and manure supplied 70,000 pounds of N. Historic yields for corn averaged 130 bushel per acre. Yield goals for corn were slightly greater than historic yields (137 bushels per acre). It appears farmers are using realistic yield goals for corn acres. 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.

University of Minnesota (UM) N recommendations for corn averaged 107 lb N/A (Figure 13). Actual amounts of N applied from fertilizer and manure averaged 120 lb N/A across all surveyed corn acres. Factoring in all appropriate credits from fertilizer, legumes and manures, there was an over-application rate of 13 lb N/A across all surveyed acres.

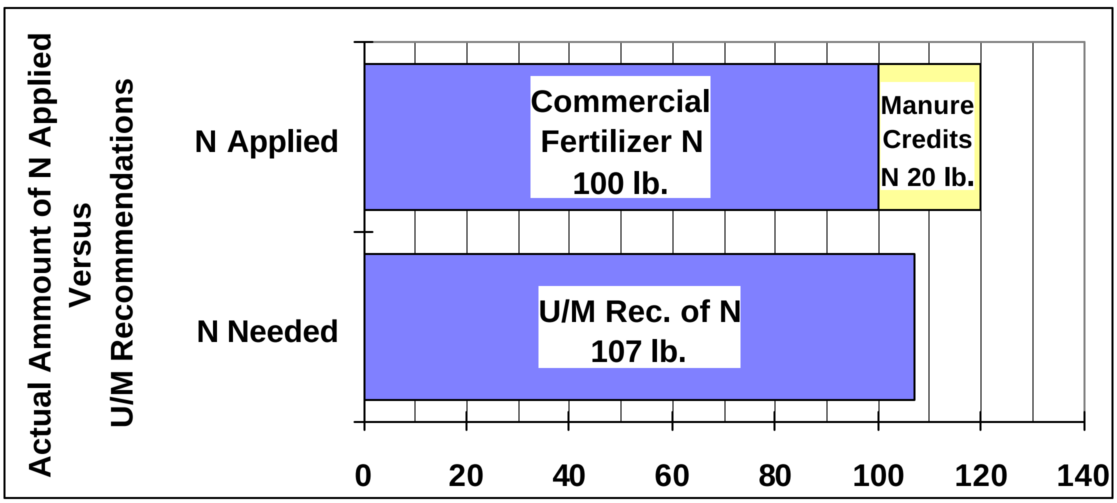

Figure 13. Crop N requirements based on University of MN recommendations in comparison to actual N inputs (fertilizer, and manure) across all corn acres. Total corn area in this analysis was 3,521 acres.

Factoring in legume N credits and manure N credits into the process on a field-by-field basis, the amounts in excess of 1998 UM recommendations are illustrated in Figure 14. 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.

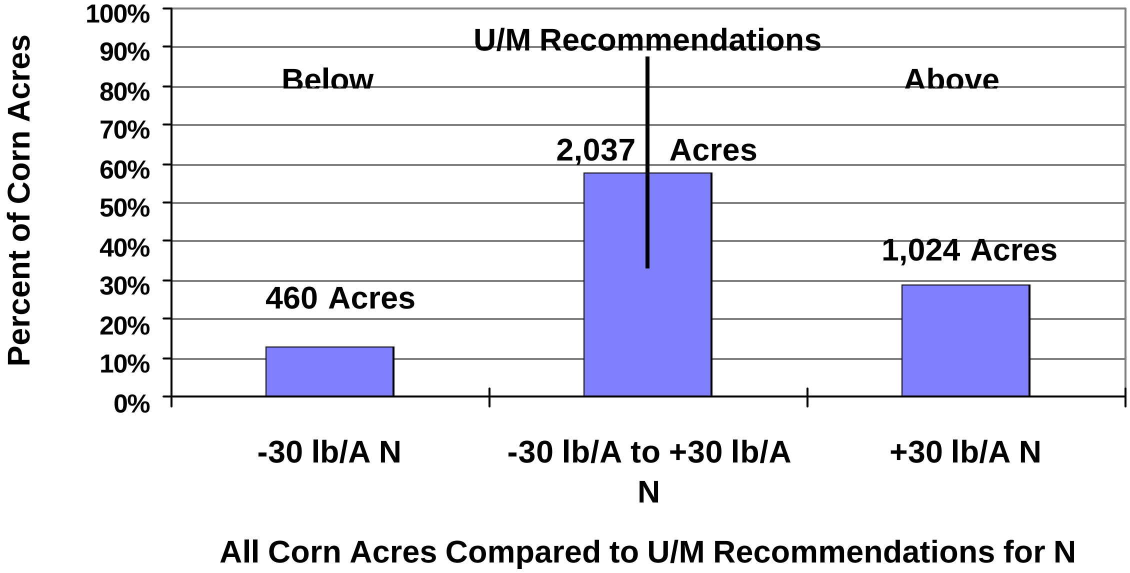

Figure 14. Corn acres that fall within plus and minus 30 pounds of the UM recommendations for N.

Twenty-nine percent (29%) of the corn acres were classified in the excess category and 13% of the acres were in the below UM recs. category. By adjusting both of these categories to within 30 lbs of the UM recommendations, N applied to corn acres would actually decrease by 45,000 lbs. It appears a majority of farmers are very close to UM recommendations for N in regard to corn.

Corn acres receiving N credits from liquid manure accounted for 30% of all corn acres. However, when looking specifically at those corn fields with excess N greater than 30 lbs/A, a total excess N of 52,000 was applied to 1,024 acres. Of those fields, 613 acres and 33,000 lbs of N, or 64% of all excess N, was contributed through cornfields that received liquid hog manure (Figure 14).

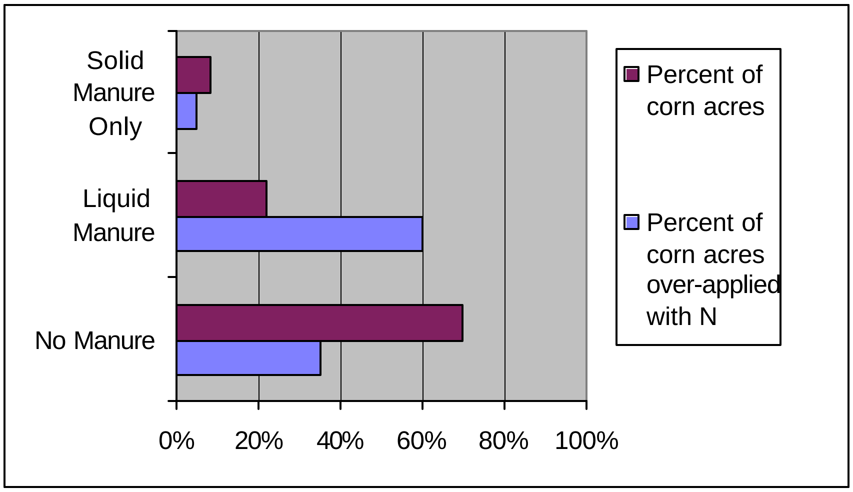

Figure 14. Percent of corn acres and manure applications compared to percent of corn acres over-applied with nitrogen. There was a total of 3,521 corn acres and a total of 1,024 corn acres over-applied by more than 30 lbs/A over the UM recommendations.

Seventy-seven percent (77%) of all corn fields receiving liquid manure were over-applied by more than 30 lbs of N per acre. Table 4 details where over-application is occurring across all corn acres.

Table 4. Distribution Of Over-application of Nitrogen On Corn Cropland - 1998.

Nitrogen Source	**Acres**	**Acres Excess N by Over 30 lbs/N/A**	**Percent of Acres Over-applied**	**Average N Over-application lbs/N/A**	**Total N Over-Applied**
No Manure	2,473	356	14%	3	8,376
Solid Manure Only	253	55	21%	-2	-455
Liquid Manure	795	613	77%	47	37,421
TOTALS/Average	**3,521**	**1,024**	**29%**	**13**	**45,342**

Conclusions and Summary of the Current Nutrient Management Practices for the Southwest MN SMWSA's.

Thirty-five farms, covering 7,543 acres, participated in the FArm Nutrient Management Assessment Program (FANMAP) with staff from the Minnesota Department of Agriculture. Producers volunteered two to four 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 utilizes this knowledge for future water quality educational programs.

Over 362,000 pounds of commercial N was applied to the crops for the 1998 growing year. Ninety-seven percent of the commercial N was applied to corn acres. Anhydrous ammonia was the source of N in 65% of all N applied. Nitrogen applications in spring accounted for 71% of all N applied. Fall applications of N contributed 29% of all commercial N applied to corn acres. All fall applications of N were in the form of anhydrous ammonia and applications were generally applied after November 1 when the soil temperature was below 50º. Nitrogen inhibitors were not used with any N applications.

Manure (first year available) accounted for 19% of the N applied to corn while legumes and commercial N accounted for 22% and 59%, respectively. Soybeans were the dominant source of legume N credits.

University of Minnesota (UM) N recommendations for corn averaged 107 lb N/A (Figure 13). Actual amounts of N applied from fertilizer and manure averaged 120 lb N/A across all surveyed corn acres. Factoring in all appropriate credits from fertilizer, legumes and manures, there was an over-application rate of 13 lb N/A across all surveyed acres.

Approximately 30% (1,024 acres) of all corn acres were over-applied with N by more than 30 lb/A, and 64% of those acres received liquid hog manure.

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 specific practices.