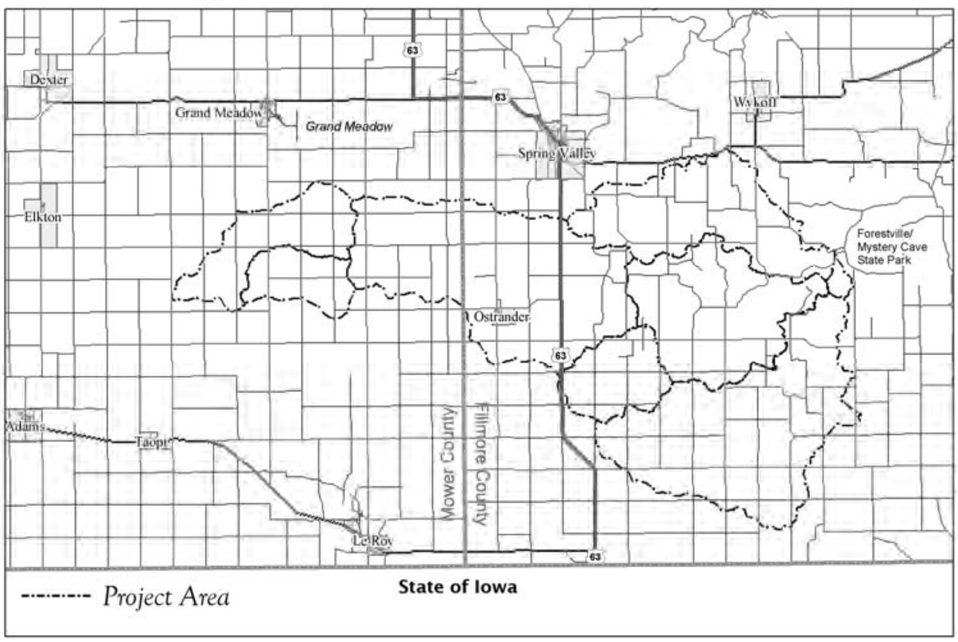
MINNESOTA DEPARTMENT OF AGRICULTURE

2007 Nutrient
Management Assessment of Producers
South Branch of the Root River

South Branch of the Root River Watershed Project



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General Information:
The South Branch Root River

The South Branch Root River (SBRR) Watershed Project is a collaborative effort to help protect and enhance the water quality of the South Branch of the Root River. The project area begins in the headwaters of the South Branch of the Root River, west of Forestville/Mystery Cave State Park in southeastern Minnesota. The 74,330-acre project area lies in western Fillmore County and eastern Mower County. The Mower County portion comprises about 15,700 acres (21 percent) of the project area.

This, and many projects like it, originated from an effort of the Environmental Protection Agency (EPA) to provide standards for water pollution prevention and control. Congress amended the Clean Water Act (CWA) in 1987 to establish section 319 and the Nonpoint Source Management Program because it recognized the need for greater federal leadership to help focus on state and local nonpoint source efforts. Under section 319, States, Territories, and Indian Tribes receive grant money which support a wide variety of activities including technical and financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific nonpoint source implementation projects. A diagnostic study was first conducted from 1998 to 2002 in this watershed to assess water quality by gathering information on land use, watershed characteristics, and water quality monitoring data of the streams and groundwater. Monitoring data revealed that pollutants in this segment of the Root River had exceeded water quality standards. Many wells in the watershed were also contaminated with bacteria due to the many sinkholes that allow surface water to easily enter groundwater. Sediment levels in the streams frequently exceed standards putting fish and other aquatic organisms at risk. Sediments in the streams indicate a corresponding loss of soil productivity and nutrients from the watershed's cropland.

To advance these efforts, in 2003, Governor Tim Pawlenty announced the Clean Water Initiative (Initiative) in effect for 10 years. Efforts to prevent nonpoint source pollution were focused on southeastern Minnesota to reduce fecal coliform bacteria in streams by 65 percent and turbidity by 30 percent. The Root River was chosen as the pilot watershed for the Initiative; in particular, the SBRR area was designated as a special focus for the first three years. By 2004, grant money of $299,420 launched this study forward.

In addition, the Water Pollution Control Revolving Loan Fund provides federal funds to local units of government, specifically the Minnesota Pollution Control Agency (MPCA), for Clean Water Partnership (CWP) loans. These CWP loans are available for projects that implement 'best management practices' and other activities that target the restoration of a water resource (i.e. lake, stream, or groundwater aquifers) such as cost-sharing a low-cost feedlot improvement, manure management plans, buffer strips of hay or grass planted for production, and vegetative buffers that are deliberately managed with conservation tillage, cover crops, and nutrient management. Other incentives were offered for developing forest stewardship plans and voluntary conservation easements. In 2004, the South Branch Root River Watershed Fecal Coliform Bacteria Reduction Project was also awarded CWP loans equal to $300,000 for implementation of a management program.

Farm Nutrient Management Assessment Program (FANMAP) survey is one tool used to ultimately evaluate water pollution prevention by documenting farming practices. In early 2004, the first FANMAP for this project was conducted to gather information about the 2003 crop season in effort to determine the adoption of the 1993 version of Nitrogen Best Management Practices (NBMP) and the 2003 University of Minnesota recommendations for nitrogen (N) on corn according to "Fertilizing Corn in Minnesota"[1]. The electronic results from the 2003 FANMAP are located at http://www.mda.state.mn.us/news/publications/protecting/soilprotection/fanmaprootriver.pdf.

In early 2008, the second FANMAP for this project was conducted after the section 319 and the Nonpoint Source Management Program grant funds were received. Those funds provided education and loans to implement various best management practices mentioned above. Efforts were made to continue to evaluate the adoption of both the 1993 version of Nitrogen Best Management Practices (NBMP) and the 2006 University of Minnesota revised recommendations for nitrogen (N) on corn. For more information on current BMPs for nitrogen use in southeastern Minnesota and rates of nitrogen application, visit http://www.extension.umn.edu/distribution/cropsystems/DC8557.pdf

Comparison of the 1993 to the 2006 U of M N recommendations can be found in Appendix 1 along with sample comparisons of different N scenarios in the South Branch of the Root River.

Farm Nutrient Management Assessment Program for the South Branch of the Root River

Controlling runoff from open feedlots and proper manure management when the manure is land applied is the key to protecting water quality. Potential water contaminants from manure include the nutrients nitrogen and phosphorus, ammonia, fecal coliform bacteria and disease-causing organisms, antibiotics and antibiotic-resistant bacteria, and organic materials which add to Biological Oxygen Demand (BOD). When properly managed and land-applied, the nutrients from manure can be a valuable resource for crop production.

To analyze farm nutrient management, four areas of focus were determined at a SBRR Watershed Project meeting by farmers, local residents and other persons attending. The analysis was completed using information compiled from the SBRR Watershed Project. Analysis of the 2003 and 2007 FANMAPS are in similar format for easy comparison.

Cooperators

[1]Fertilizing Corn in Minnesota, G.Rehm, G.Randall, J.Lamb, R.Eliason, University of Minnesota, 2006.

The South Branch Root River Project is by mutual effort of watershed farmers, landowners, citizens, county, state, and federal groups. The coalition that was interested in improving this watershed includes traditional water resource agencies: Soil and Water Conservation District (SWCD), Natural Resource Conservation District (NRCS), Environmental Services, Farm Service Agency (FSA), Minnesota Department of Agriculture (MDA), Minnesota Pollution Control Agency (MPCA) and Minnesota Department of Natural Resources (DNR).

The coalition agreed to focus this study on agricultural inputs (nutrients and pesticides) and management practices associated with the SBRR and then summarize results of farm assessments conducted for the 2007 cropping season. Several 'manure application' field days were sponsored through the watershed project to educate cooperators on research study results and BMPs for nitrogen application.

A list of farmers/operators in the SBRR was obtained from the Fillmore and Mower SWCD and NRCS. Farm operations to be interviewed were chosen by random selection across each section. Introduction letters describing the project were mailed to the farmers in January of 2008. The letter's intent was to explain: 1) the overall project; 2) the purpose of the nutrient assessment; 3) the selection process; 4) types of information; and 5) the amount of time necessary to successfully complete the project.

The Minnesota Department of Agriculture (MDA) used a data-gathering tool and analysis system called FANMAP to conduct the study. FANMAP was developed 15 years ago to provide an understanding of current farm practices regarding agricultural inputs. This information is used to design effective water quality educational programs and provides baseline data to determine program effectiveness over time. In the past decade, more than 800 farmers throughout Minnesota have volunteered one to three hours of their time to share information about their farming operations. Previous FANMAP studies have been funded, in part, by programs such as the Legislative Citizen Commission on Minnesota Resources, Clean Water Partnership, USDA programs, and supplemental funding from the fertilizer tonnage fee account at the MDA. Previous reports can be found on the MDA website at http://www.mda.state.mn.us/protecting/soilprotection/fanmap.htm.

Nutrient Information of the Selected Farms in the South Branch Root River

Inventory forms and database design have been designed and perfected over the past years. The following types of information were collected on a field-by-field basis for all inventoried acres within the South Branch Root River (SBRR) through Farm Nutrient Management Assessment Program (FANMAP) interviews:

- Timing, rates and method of applications were collected for all nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O) inputs[2] (fertilizers, manures and legumes);
- Pesticide information (product, rate, timing, etc);
- Soil and manure test results (if available);
- Tillage practices;
- Sink holes and streams.

Livestock types, manure storage, application rates, and application timing information were also recorded.

Nutrient inputs and yields were collected for the 2007 cropping season. Crop types and manure applications (starting in the fall of 2006) were also collected for the 2007 season for purposes of nitrogen credit for crops grown during the 2007 season. 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, etc.) were also recorded. Information was gathered from the farmer or from the fertilizer dealer, if the dealer kept the farmer's records.

Farm Size, Crop, and Livestock Characteristics of the Selected Farms in the South Branch Root River

Sixty farm interviews were conducted between February and May of 2007. FANMAP survey was conducted when all operations connected with the 2007 growing season were completed. A total of 25,216 acres of farmland was inventoried in the SBRR study for the 2007 crop season. Fillmore County Farm Service Agency provided farm and tract information for the cropping year 2007 that indicated there were approximately 74,000 acres in the SBRR. Farm interviews covered approximately 32 percent of all acres in the SBRR and 42 percent of all crop acres. The SBRR cropland was dominated by a corn/soybean rotation accounting for 85 percent of all acres. Each crop grown and the percentage of acres it represents in the SBRR are shown below (Figure 1).

[2] The analysis grade of phosphorus (P) and potassium (K) in fertilizers are expressed in the oxide form, hence, P_2O_5 and K_2O. Once the fertilizer is added to the soil, the amount of these nutrients analyzed in the soil is expressed as pounds of P and K per acre.

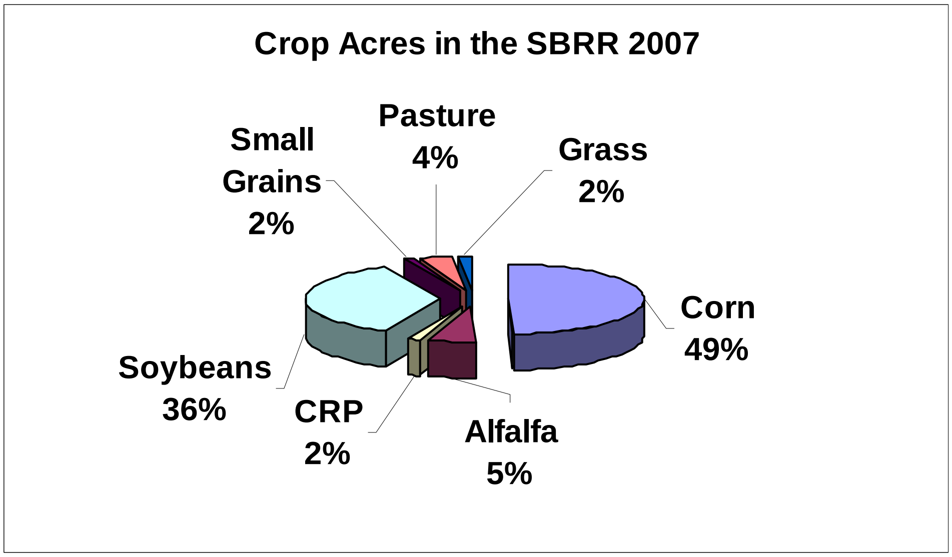

Figure 1. Crop acres for 2007 representing 60 farms within the SBRR.

Commercial Fertilizer Use Characteristics on Selected Farms: South Branch Root River

Commercial Nitrogen Fertilizer

Field corn accounted for 99 percent (1,570,511) of the 1,587,069 pounds of commercial nitrogen (N) fertilizer applied across all farms. All field corn acres received commercial N fertilizer. Commercial N rates across all field corn acres averaged 126 pounds per acre (lb/A). Total N inputs will be discussed later in the "Nutrient Balances and Economic Considerations" section of this report.

"Best Management Practices for Nitrogen Use in Southeastern Minnesota"[3] have been developed by the University of Minnesota. Applications of nitrogen before spring planting of field corn are highly recommended in the South Branch Root River (SBRR). Fifty-five percent of the N applied to field corn was applied as a spring pre-plant application (Figure 2).

[3] Best Management Practices for Nitrogen Use in Southeastern Minnesota. M.A. Schmitt, G.W. Randall, University of Minnesota. 1993.

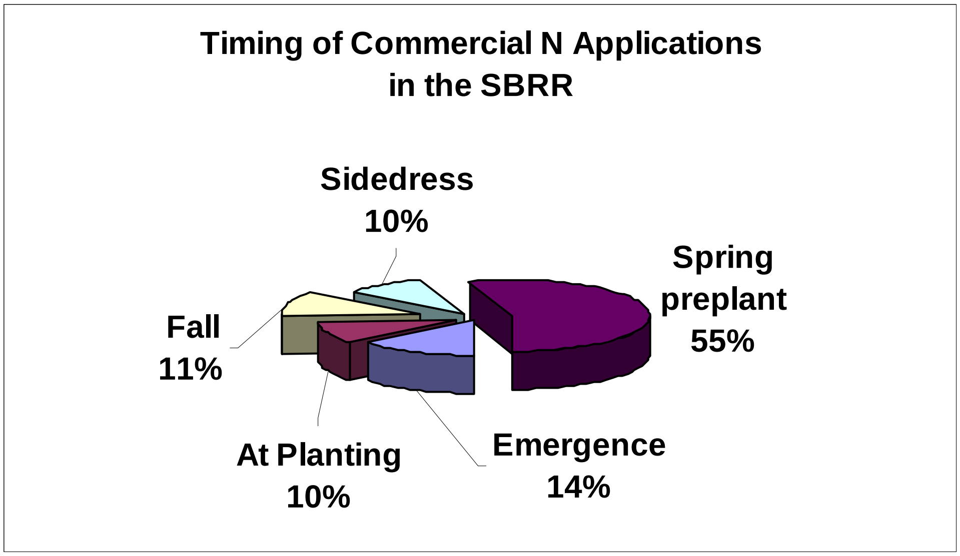

Figure 2. Timing of commercial N applications across all 12,613 inventoried corn acres.

Liquid N sources supplied 36 percent of all commercial N on corn acres (Figure 3). Many farmers who reduced their tillage increased the use of liquid N sources. This may have been because farmers have the capability of applying nitrogen without the need for tillage or incorporation.

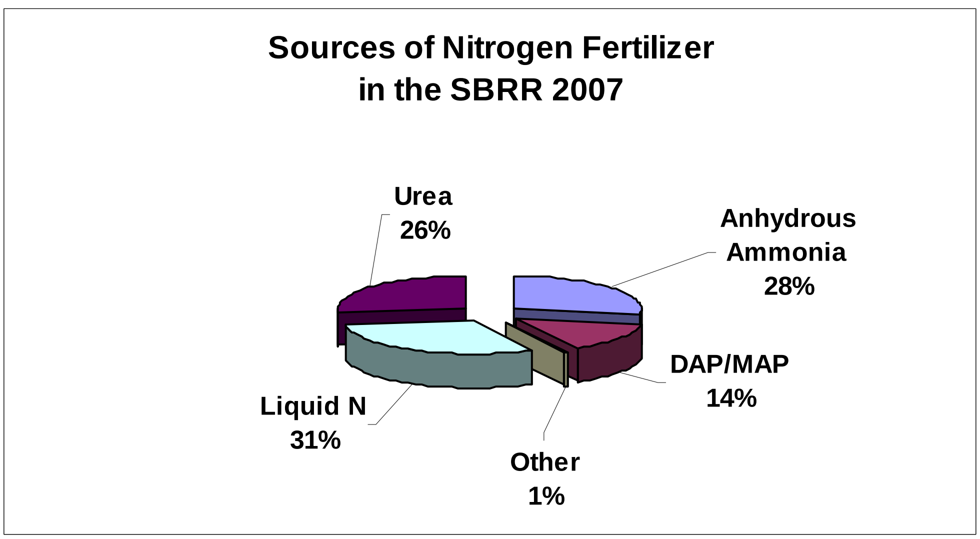

Figure 3. Sources of commercial N used on corn acres [4].

A very small percentage (<1 percent) of the commercial N was applied to crops other than corn. Because of the small sample size, analysis is not performed in regards to N on crops other than corn.

[4] Diammonium Phosphate is represented as DAP; Monoammonium Phosphate is represented as MAP.

Commercial Phosphate Fertilizer

There was 672,878 pounds of commercial phosphate fertilizer (P_2O_5) applied in 2007 of which 96 percent was applied to field corn. All field corn acres received commercial P_2O_5 fertilizer. Average commercial fertilizer rate of P_2O_5 was 52 lb/A. Total P_2O_5 inputs will be discussed later in the "Nutrient Balances and Economic Considerations" section of this report. Thirty-nine percent of the commercial P_2O_5 was applied at planting on inventoried corn acres. Figure 4 shows the application timing of commercial P_2O_5 on field corn acres.

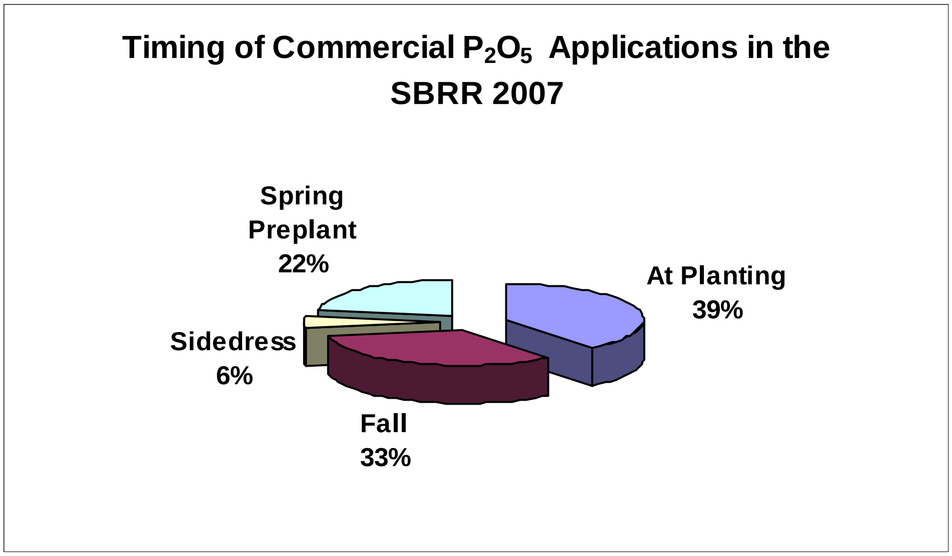

Figure 4. Timing of commercial P_2O_5 applications across corn acres.

Livestock and Manure Characteristics of the Selected Farms

Factors directly affecting crop nutrient availability from land-applied manure (including manure storage, types, manure generated, application methods, incorporation factors, and rates) were quantified to complete the "whole farm" nutrient balance. Livestock numbers in Table 1 represent the livestock inventory present ("on hand") or raised from the fall of 2006 to the summer of 2007. It is assumed that the livestock manure generated during this time was applied sometime to the 2007 crops. Seventeen of the 60 farmers interviewed had livestock in the South Branch Root River (SBRR). The major animal production on these farms consisted of hog, dairy, and beef operations, with smaller numbers of sheep, goats, and horses.

Table 1. 2007 Distribution of Livestock Across Inventoried Farms.	
Livestock Type	**Livestock Number**
Dairy Cows/bulls	500
Dairy Calves	380
Hog Finishers[5]	32,800
Beef Cows/bulls	609
Beef Calves/finishers	964
Sheep/Goats/Horses	685
TOTALS	**35,948**

Nutrients from manure production totaled 659,636 pounds of nitrogen (N), 423,650 pounds of phosphate (P_2O_5) and 529,072 pounds of potassium (K_2O)[6]. However, all manure was not collected in part because some of these animals "over-winter" on pastures. Manure production by type of livestock is listed in Table 2. Currently there are no recommendations for crediting N from manure applied to fields from over-wintering animals.

Table 2. Manure N P_2O_5 and K produced in the South Branch of the Root River by livestock type for the 2007 season.

	Nitrogen	**P_2O_5**	**Potash**
Livestock Type			
Beef	155,381	114,125	121,837
Dairy	161,870	65,540	130,450
Hogs	328,000	229,600	262,400
Sheep/Horses	14,385	14,385	14,385
TOTALS	**659,636**	**423,650**	**529,072**

All beef manure was collected as a solid from barns or lots. Manure produced by hogs was collected as a liquid from manure pits. Dairy manure was collected from both liquid manure pits and solid systems of barns and lots. Manure collected from sheep, goats and horses was collected as a solid. Overall, 71 percent of the manure produced was collected and available, based on N content[7]. Table 3 gives details regarding the manure collected in the SBRR. Some of the manure collected was applied outside the watershed.

[5] Hog finishers are the number sold per year. All other categories are average on hand per year.

[6] Based on calculations from the Midwest Plan service, MWPS-18 Section 2, Manure Storages.

[7] Manure available was the manure that would have been produced and available for spreading in the fall 2006 and spring 2007 (preceding planting).

Table 3. Manure N, P_2O_5, and K_2O collected to be spread on inventoried acres for the 2007 crop season.						
	Nitrogen		**P_2O_5**		**K_2O**	
	Produced	**Collected**	**Produced**	**Collected**	**Produced**	**Collected**
Livestock Type						
Beef	155,381	53,923	114,125	39,763	121,837	42,970
Dairy	161,870	118,858	65,540	48,155	130,450	95,763
Hogs	328,000	328,000	229,600	229,600	262,400	262,400
Sheep/Horses	14,385	9,590	14,385	9,590	14,385	9,590
TOTALS	**659,636**	**510,371**	**423,650**	**327,108**	**529,072**	**410,723**

Nutrient losses from manure, especially N, can occur within a manure handling system through volatilization, leaching, and runoff[8]. Table 4 details the manure handling system losses for manure N. Except for minor losses of P_2O_5 and K_2O on open lots, most of the P_2O_5 and K_2O were retained in manure systems and were available to be spread on inventoried acres.

Table 4. Manure N collected and retained after manure handling system loses for the 2007 crop season in the SBRR.		
	Nitrogen	
	Collected	**Retained**
Livestock Type		
Beef	53,923	35,341
Dairy	118,858	87,757
Hogs	328,000	262,400
Sheep/Horses	9,590	6,713
Totals	**510,371**	**392,302**

[8] Based on calculations from the Midwest Plans Service, MWPS-18 Section 2, Manure Storages.

Hog manure accounted for 71 percent of the "first year available nitrogen" or from manure that was applied and available the first year to inventoried acres. Table 5 further details the source of the nutrients, amounts of nutrients applied, and nutrients available after application losses[9]. Manure from sheep, horses, and goats were spread on pasture or other non-crop areas.

Table 5. Manure N, P_2O_5, and K_2O spread on inventoried acres before and after application losses for the 2007 crop season.

	Nitrogen		**P_2O_5**		**K_2O**	
Livestock Type	**Applied**	**Available**	**Applied**	**Available**	**Applied**	**Available**
Beef	35,341	14,631	11,903	10,712	11,648	10,483
Dairy	87,757	36,863	26,377	23,739	30,699	27,629
Hog[10]	202,400	140,597	125,398	112,858	137,162	123,446
Totals	**325,498**	**192,091**	**163,678**	**147,310**	**179,509**	**161,558**

Manure was applied on 1,680 inventoried acres within the watershed. Corn accounted for all but 95 acres which were planted to alfalfa. Table 6 details the manure applications on inventoried crop acres.

Table 6. Manure N, P_2O_5, and K_2O applied in the South Branch of the Root River by crop for the 2007 season.

	Acres	**Nitrogen**	**P_2O_5**	**K_2O**
Crop Type				
Corn	1,585	187,905	145,565	158,189
Alfalfa	95	4,186	1,745	3,369
TOTALS	**1,680**	**192,091**	**147,310**	**161,558**

Sixty one percent of the first year available N was applied in the fall on inventoried acres in the SBRR (Figure 5).

[9] In most instances, liquid manure was tested and applied knowing its nutrient value. Sometimes, enough nutrients are applied for more than one year (in April the first year and in March the following year). Manure analysis' do not always reflect actual manure nutrients applied, thus the nutrients are not actually available or applied upon spreading as listed in Tables 5, 6, and 7.

[10] Some hog manure was applied outside the watershed.

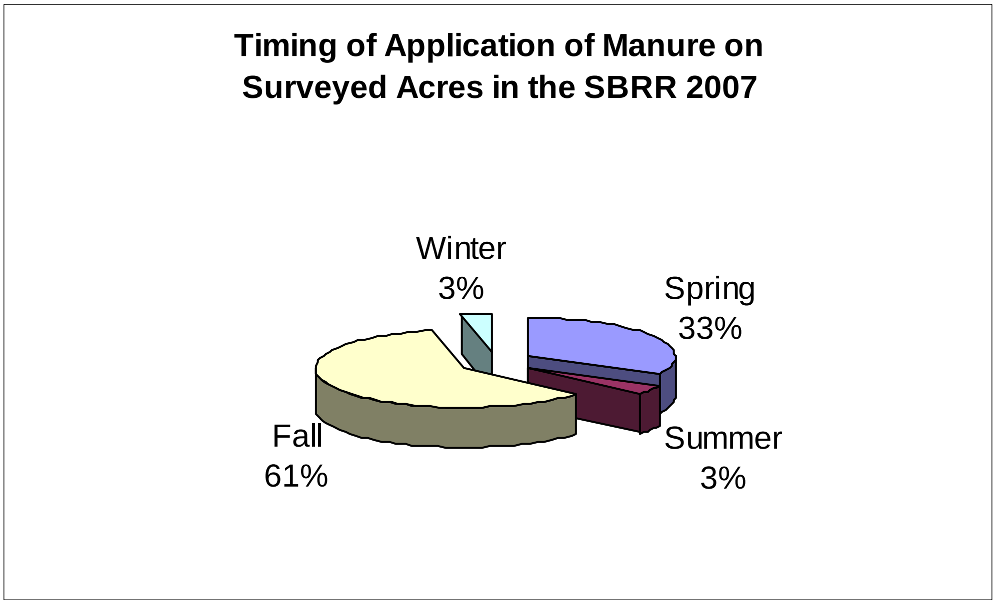

Figure 5. Timing[11] of "first year available" manure N on inventoried acres in the SBRR.

Manure applications on inventoried corn acres consisted of injection, broadcast with no incorporation, and broadcast with incorporation (Figure 6).

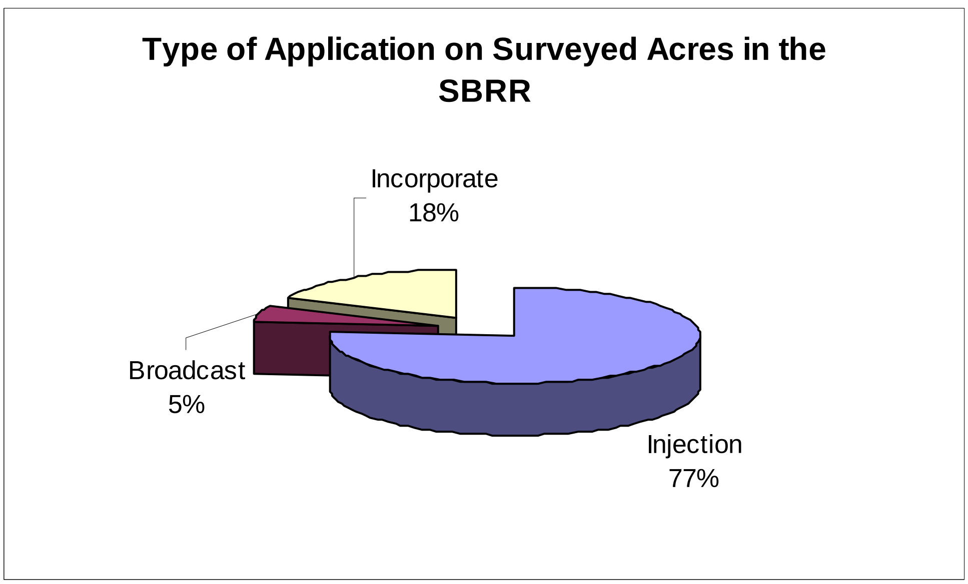

Figure 6. Application methods of manure applications on inventoried corn acres in the SBRR.

Livestock in the SBRR produce manure in different quantities by type and size. Nutrient values also differ across livestock type and size. On surveyed farms, hog manure contributed the largest percentage of N (Figure 7).

[11] Timing based on pounds of N available to the 2007 crop.

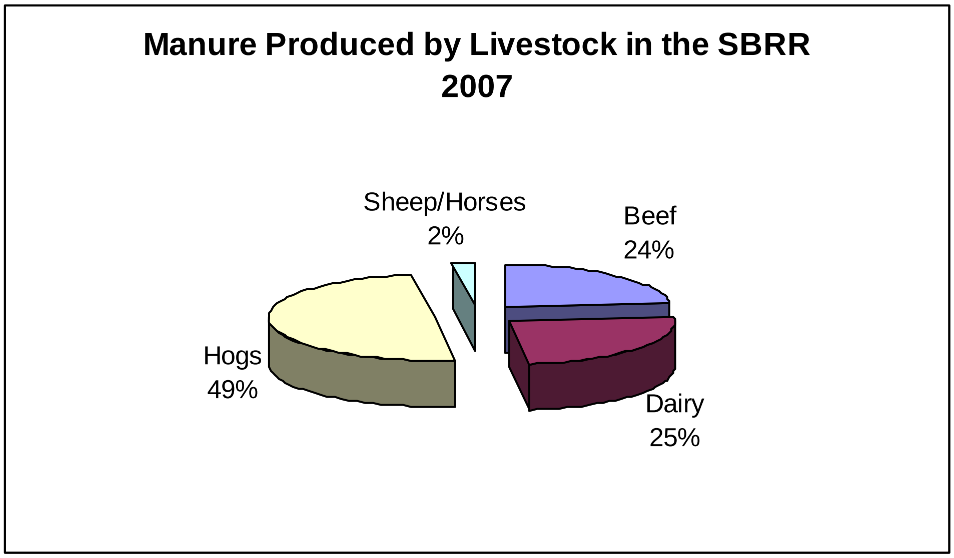

Figure 7. Manure N production of livestock by type within the SBRR.

Figure 8 is the actual portion of N from manure that is applied to fields in the SBRR and available for the crop by livestock type.

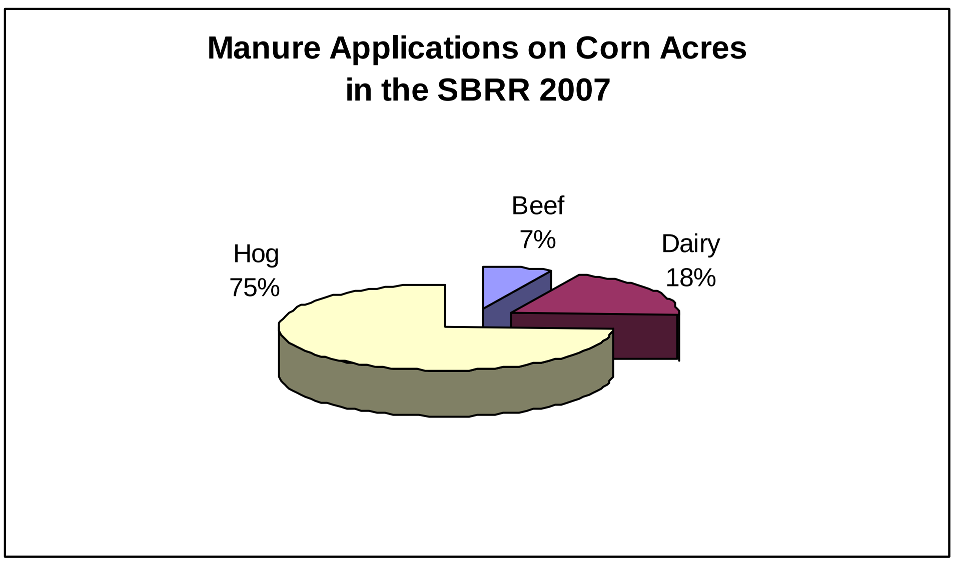

Figure 8. "First year available" manure N for surveyed acres by livestock type.

Relative Importance of Nutrient Sources on the Selected Farms: South Branch Root River

Commercial nitrogen[12] applications accounted for 89 percent of the total nitrogen (N) applied on inventoried corn acres with the balance of N from manure. A total of 1,779,160 pounds of N were applied on inventoried fields. Corn acres received 1,758,416 pounds and the remaining balance was applied to acres other than corn. Table 7 details the contributions of N, phosphorus (P_2O_5) and potassium (K_2O) from both manure and commercial fertilizer applied to the various inventoried crops.

Table 7. Total N, P_2O_5, and K_2O applied in the South Branch of the Root River by crop for the 2007 season.

	Acres	**Nitrogen**	**P_2O_5**	**K_2O**
Crop Type		**Pounds**	**Pounds**	**Pounds**
Corn	12,457	1,758,416	794,551	947,428
Other	12,603	37,302	36,239	76,155
Totals	**25,216**	**1,795,718**	**830,790**	**1,023,583**

It is important that producers recognize and take the appropriate N credit for past legume crops. The University of Minnesota nitrogen recommendations for corn are reduced anywhere from 75 to 100 pounds per acre (lb/Ac) for alfalfa dependent on the alfalfa stand. Alfalfa was the previous crop to corn on 190 acres. For this survey, the first year alfalfa nitrogen credit equaled 75 lb/Ac. Alfalfa nitrogen credits for the second year were available on 370 acres and given 50 lb/Ac. U of M recommendations for soybean nitrogen credits range from 30 to 40 lb/Ac for corn following soybeans. In this study, soybeans are assumed to have a 40 lb/Ac N credit.

Nitrogen inputs totaled 1,758,416 pounds for all sources applied to all inventoried corn acres. Legume credits (399,510 pounds) are reflected in U of M recommendations and are not considered an input. Commercial fertilizers (72 percent), manures (9 percent), and legumes (19 percent) contributed a total of 2,264,000 pounds of "first year available N" to all inventoried corn acres in 2007 (Figure 9).

[12] Commercial nitrogen is any fertilizer sold with an analysis and is not manure.

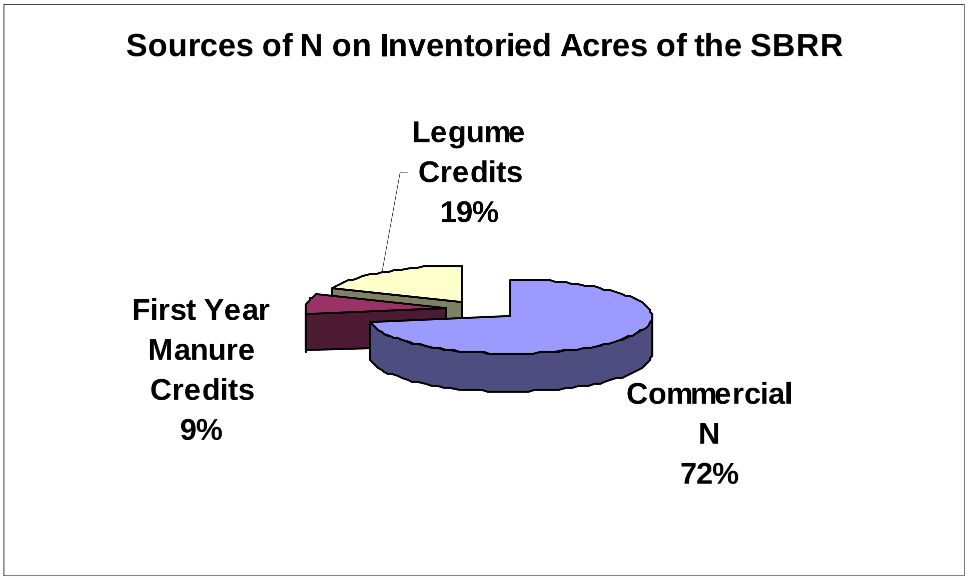

Figure 9. Relative N contributions from fertilizers, manures, and legumes for all corn acres inventoried in 2007.

Nutrient Balances and Economic Considerations: South Branch Root River

Nitrogen Contributions

Total nitrogen (N) from commercial fertilizer and manure applied to inventoried acres totaled 1,795,718 pounds. Field corn received most of the N with 98 percent (1,758,416 pounds) of the total applied. Field corn yield goal for these farms averaged 201 bushels per acre (Bu/Ac) and were consistent with the 5-year historical averages of 182 Bu/Ac. It appears farmers used realistic yield goals for field corn acres and that farmers have been growing excellent crops to reach their yield goals consistently in the past five years.

Current nitrogen recommendations are based on economic and environmental factors. Research at the Southern Minnesota Research & Outreach Center in Waseca, MN has shown that these recommendations, in the long term, generally optimize profit.
The next table compares current U of M N recommendations to actual amounts of N (fertilizer and manure) applied to each field. According to Gyles Randall, Soil Scientist and Professor at the U of M, the current N recommendations or the "maximum return to nitrogen" (MRTN) will provide the greatest net return to the farmer and is the recommended rate. The MRTN for field corn across all inventoried acres averaged 113 lb/Ac. Actual amounts of N averaged 141 lb/Ac (Figure 10). After factoring in all appropriate credits from fertilizer, legumes and manures, 28 lb/A of nitrogen was applied in excess of the current U of M recommendations.

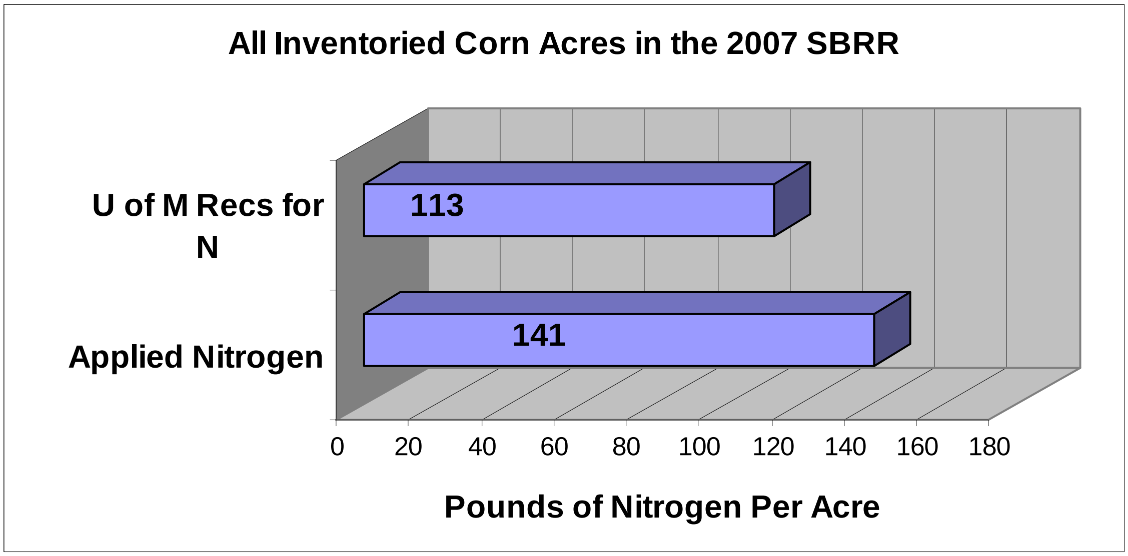

Figure 10. Difference shown between MRTN and actual N inputs.

Table 8 details the MRTN and the rate range for various corn rotations and corn produced with or without manure in the SBRR 2007 survey.

Table 8. Actual Nitrogen Applied Compared to U of M range of recommendations in the 2007 SBRR.

Crop rotation	Average N applied	Low Range	MRTN	High Range
All Corn Acres	141	93	113	130
Corn Following Soybeans	137	91	111	127
Corn Following Corn	185	121	142	167
Corn Following Alfalfa	125	61	82	106
Corn with Manure	156	100	121	142
Corn without Manure	139	91	111	128

One major advantage of the technique developed through the nutrient assessment process is the ability to examine in detail the nutrient balances or lack thereof. Important gains in water quality can be obtained, provided that farmers receive education in these areas.

Figure 11 details the percentage of corn acres that were applied at or below the lower recommended range, equal to the MRTN, and higher than the recommended range in regard to nitrogen applications.

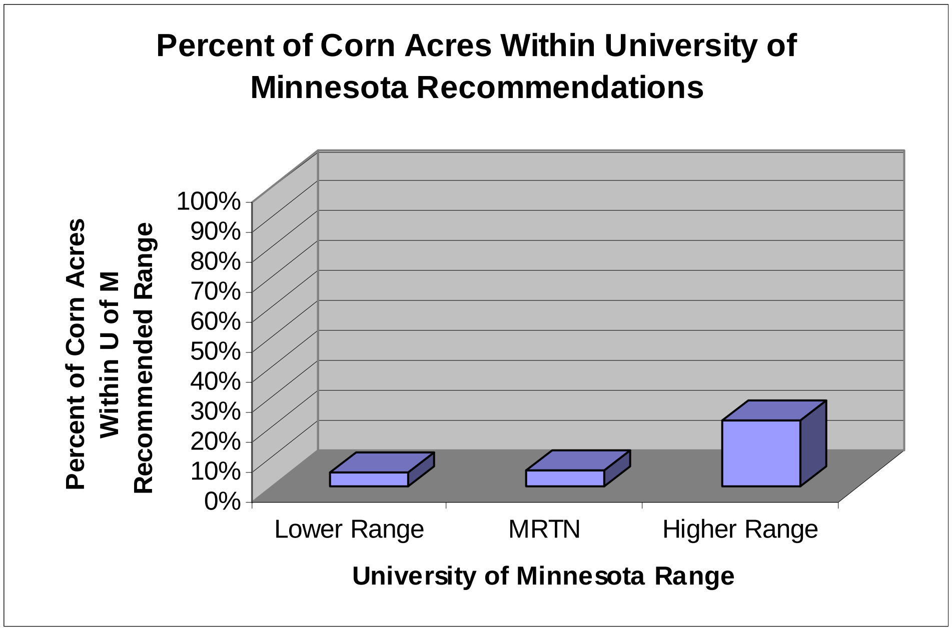

Figure 11. Distribution of corn fields within the University of Minnesota recommended range for N.

Statewide BMPs :
South Branch Root River

Nitrogen (N) Best Management Practices (BMPs) were developed for Minnesota growers, which includes the South Branch Root River (SBRR) in 1993. These practices are listed in the following Table 9 because they were still current in 2007 and they were used for comparison.[13]

Table 9. Statewide BMPs
1. Set realistic yield goals.
2. Develop and use a comprehensive record-keeping system for field specific information.
3. Adjust nitrogen rate according to soil organic matter content, previous crop and manure applications.
4. Use a soil nitrate test where appropriate.
5. Use prudent manure management to optimize nitrogen credit.
6. Credit second year nitrogen contribution from alfalfa and manure.
7. Do not apply nitrogen above recommended rates.
8. Plan nitrogen application timing to achieve high efficiency of nitrogen use.

Statewide BMP Adoption

1. Set realistic yield goals.

Farmers in the SBRR were setting an average yield goal of 201 bushels per acre and the historical average yield was 182 bushels per acre. County yields averaged 173 and 191 for the past two years in Fillmore County, where most of the watershed is located. It appeared that farmer's yield goals were within an acceptable standard that was 10 percent of historic yields.

2. Develop and use a comprehensive record-keeping system for field specific information.

Controlling excessive nitrogen rates is the key to protecting water quality and can be achieved in part by comprehensive record-keeping. Computer software programs are available and used for comprehensive record-keeping by growers and farm chemical dealers serving growers in the SBRR. Variable-rate technology (VRT) and Global Positioning Systems (GPS) are complementary tools that are widely used in the southeast to provide additional detail in records. Because growers know that when manure is properly managed and land-applied, the nutrients from manure can be a valuable resource

[13] In 2008, the University of Minnesota revised the 1993 version of Nitrogen Best Management Practices by recommending several specific sets of practices based on your location, crop, and farm management. For information specific to southeastern Minnesota, visit the University of Minnesota Extension's website at: http://www.extension.umn.edu/distribution/cropsystems/DC8557.pdf

for crop production. Manure management is a priority in the watershed and most livestock farmers had a manure management plan which also requires recording nitrogen applications.

3. Adjust nitrogen rate according to soil organic matter content, previous crop and manure applications.

The third BMP was based on the University of Minnesota recommendations for fertilizing corn in Minnesota.[14] The U of M revised these recommendations in 2006, that is, to adjust the nitrogen rate according to soil organic matter content, previous crop, and manure no longer applies.[15] The U of M instead adopted a uniform maximum return to nitrogen rate (MRTN) formula for Minnesota applications on highly productive soils. Thus, farmers should not be using soil organic matter content, previous crop, manure applications, or even yield goals to calculate varying rates of nitrogen in Minnesota. As a result, rates of nitrogen used by growers were not compared to this statewide BMP #3.

Ideally, growers will adopt the latest U of M recommendations or MRTN for fertilizing corn in Minnesota in an effort to achieve the maximum return for nitrogen. In this process, farmers determine their nitrogen rate by using the price of corn, the price of fertilizer, and the previous crop in the MRTN formula. Upon consideration of the calculated rate, "Fertilizing Corn in Minnesota" (see footnote 13) cautions the grower:

> "A producer who is risk adverse and cannot tolerate risk associated with less-than-maximum yields in some years even though economic return to N may not always be the greatest may want to use the N rates near the high end of the acceptable range. On the other hand, if water quality concerns are an issue and/or localized N response data support lower N rates, producers may choose N rates near the low end of the acceptable range, if they are willing to accept the possibility of less-than-maximum yield in some years without sacrificing profit."

Comparative analysis for rates of nitrogen used by growers and MRTN formulated rates may be conducted in future Farm Nutrient Management Assessment Program (FANMAP) surveys.

4. Use a soil nitrate test where appropriate.

The U of M has a flow chart showing when it is appropriate to use a soil nitrate test in southeast Minnesota. Some acres spread with manure could have utilized a soil nitrate test. However, no farmers in the SBRR used it. The test is listed as an option.

5. Use prudent manure management to optimize nitrogen credits.

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[14] Fertilizing Corn in Minnesota, G. Rehm, J. Lamb, R. Eliason, M. Schmitt, G. Randall, University of Minnesota, 2000.
[15] Fertilizing Corn in Minnesota, G.Rehm, G.Randall, J.Lamb, R.Eliason, University of Minnesota, 2006.

Prudent manure management includes:

- *Testing for manure analysis*. All farmers that applied liquid manure tested the manure. Solid manure was generally not tested.
- *Calibrating manure spreaders.* Farmers were not asked if calibration was done on the manure spreaders.
- *Apply manure uniformly.* Farmers were not asked about uniformity of manure application. However; we conclude that fields did have a uniform application because of their use of spreaders with advanced technology.
- *Injection is preferable.* Injection is only possible with liquid manure. All liquid manure was injected totaling 77 percent based on N content.
- *If not injected, incorporate.* Eighteen percent of the manure was incorporated, leaving only 5 percent broadcast without incorporation, based on N content.
- *Avoid manure on frozen sloping soils*. Only 3 percent of the manure based on N content was winter applied.

6. Credit second year nitrogen contribution from alfalfa and manure.

Information on crediting second year nitrogen from manure was not gathered in this FANMAP process. Second year crediting of manure on corn generally requires two years of corn following the manure application. A small number of corn acres following corn received credit for second year nitrogen, as most acres were corn following soybean. Second year crediting was limited in regards to alfalfa as only one corn field had second year nitrogen credits. Reporting is not done on a single field basis.

The majority of the manure type applied was hog manure. The U of M does not suggest taking a second year nitrogen credit for hog manure.

Southeast Minnesota BMP Adoption

1. Do not apply nitrogen fertilizer in the fall.

Eleven percent of all commercial N and 61 percent of N from manure was applied to corn in the fall.

2. Spring preplant application of anhydrous ammonia or urea is encouraged. Broadcast urea should be incorporated within three days of application.

Fifty-five percent of all N was spring preplant. Fifty-four percent of all N was in the form of urea or anhydrous ammonia. One hundred percent of all urea was incorporated.

3. Apply sidedress applications to corn before it is 12 inches high.

All sidedress applications were before corn was 12 inches.

4. Inject or incorporate sidedress applications of urea and UAN to a minimum depth of four inches.

No sidedress applications were incorporated to a depth of four inches.

5. Use a nitrification inhibitor with preplant nitrogen applications if soils are poorly drained and soil moisture levels are high near the surface.

According to the local Soil Water Conservation District (SWCD) and Natural Resource Conservation Service (NRCS), there were no poorly drained soils and no nitrification inhibitor used by the farmers surveyed.

6. Minimize direct movement of surface-water runoff to sinkholes.

Sixty-eight percent of the sinkholes had some type of buffer or setback.

Phosphorus Contributions

Contributions of phosphorus (P_2O_5) from commercial fertilizer and manure totaled 830,790 pounds in the South Branch Root River (SBRR) on inventoried acres. Field corn received the most calculating at 96 percent or 794,551 pounds of the total P_2O_5 applied.

Twenty-seven percent of the acres inventoried had soil tests available at the time of the interview to predict available phosphorus and crop response to P_2O_5 application. All soil tests were performed within the last three years. The relative index of phosphorus availability, according to the Bray-1 soil test, was interpreted using University of Minnesota categories listed in Figure 12 ranging from low to very high. There were no soils that were very low in P_2O_5. Although many more farmers may have had soil tests, their availability at the time of the survey was limited. Farmers were not required to look extensively or even submit a former soil test. Soil tests are valid for four years and are not always located with other farmer records. In 2007, tests that included grid or zone sampling represented 52 percent of the acres tested. In these cases, phosphorus test results are an average of the field.

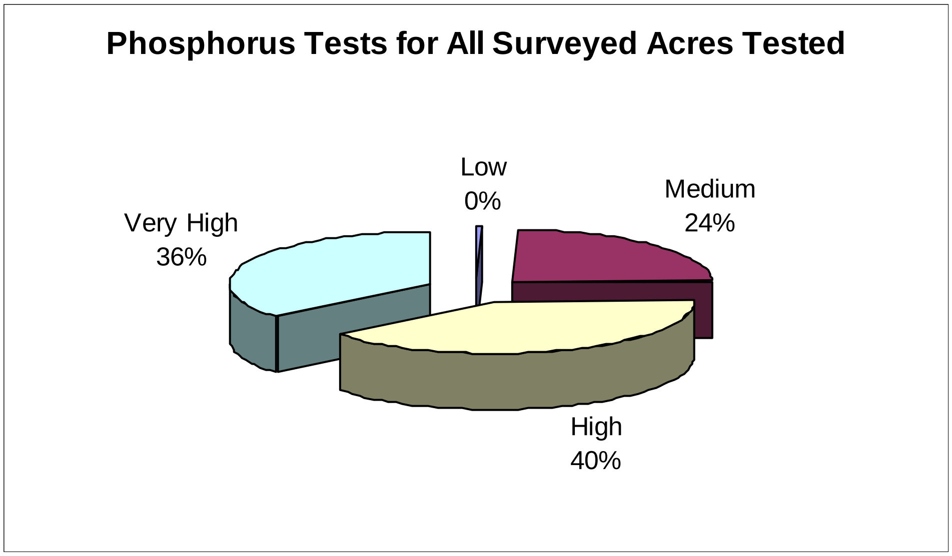

Figure 12. Percentage of inventoried acres and corresponding P_2O_5 availability.

According to the Potash & Phosphate Institute[16], the percentage of soils testing at 'medium' or below for phosphorus (P) within a state ranges from 15 to 86 percent. In 2001, the Minnesota soil P tests that ranged from medium or below was 46 percent. On inventoried acres, 24 percent of the soil tests were medium or below. The U of M recommendations for P_2O_5 vary widely by crop, soil test, tillage, and placement. In addition, the U of M recognizes and provides special considerations for applications of P[17]. Manure management plans are based on N in the manure. Sometimes P in manure meets or exceeds the crop's needs, thus more P_2O_5 is applied incidentally than the U of M would recommend. Because of all of these factors, comparisons of actual amounts of P_2O_5 applied cannot be compared to U of M recommendations as was done with N. However, it does appear that rates for P could be reduced in many instances, especially when the P soil tests are in the high and very high ranges.

Inventoried field corn averaged 64 pounds per acre (lb/A), that is 52 lb/A from commercial P_2O_5 and 12 lb/A from manure applications. Crop removal of P_2O_5 can also be determined according to U of M calculations. Corn grown on inventoried acres averaged 182 bushels per acre (Bu/Ac). Crop removal would be calculated at 60 lb/A per year for corn[18]. Soybeans grown on inventoried acres averaged 45 Bu/Ac over the last five years. Crop removal would be calculated at 41 lb/A per year for soybeans. Eighty-five percent of the acres were planted to either corn or soybeans. Over a two year rotation of corn following soybeans, 64 lb/A of P_2O_5 would be applied and 101 lb/A would be removed. If this practice continues, the soil P may drop, on average of .4 to .8 parts per

16 Nutrient Budgets in North America, P. E. Fixen, A. M. Johnston.

17 Fertilizing Corn in Minnesota, G. Rehm, J. Lamb, R. Eliason, M. Schmitt, G. Randall, University of Minnesota, 2000.

18 Nutrient Removal by Major Minnesota Crops, G. Rehm, University of Minnesota.

million per year (ppm/yr)[19]. These farmers could reduce P_2O_5 applications in many cases, but overall, are still applying less than crop removal in this survey. On average, P_2O_5 buildup is occurring on some acres applied with manure.

Table 10 details the P_2O_5 applications.

Table 10. Corn Acres and P_2O_5 Applied to the SBRR in 2007.			
Manure Applied	**Acres**	**P_2O_5 Applied**	**P_2O_5 Average per Acre**
Corn Acres Manure	1,641	202,299	123
Corn Acres No Manure	10,816	592,252	55
Totals/Averages	**12,457**	**794,551**	**64**

Corn acres received an average of 92 lb/A of P_2O_5 from manure applications.

[19] Soil Test P: How Fast Does it Change?, G. Randall, T Iragavarapu, University of Minnesota.

Buffered Acres:
South Branch Root River

Little to no information was gathered on tiled acres within the South Branch of the Root River (SBRR). Highlights include:

1. There were 50 sink holes located on the farms of those interviewed. These sink hole locations included pasture and areas other than fields. Sixteen sink holes or 32 percent had no buffer.
2. Within the SBRR, 28 fields had streams and 14 of those had some buffer. Eight of the buffers were less than 100 feet wide.
3. There were a total of 43 surface inlets and none had a buffer or setback. There were no side inlets in the survey.

Tillage Practices:
South Branch Root River

Tillage practices were documented on all surveyed acres in the SBRR. Fall tillage was the most common time for primary tillage on field corn acres (Figure 13). Fields planted to corn were most often worked using chisels and field cultivators (Figure 14).

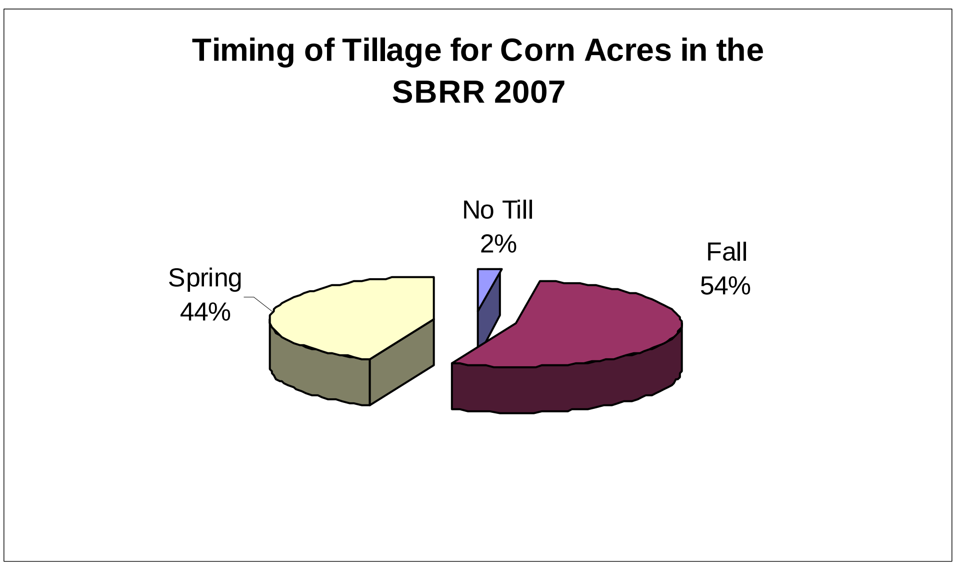

Figure 13. Percentage of corn tilled at different times.

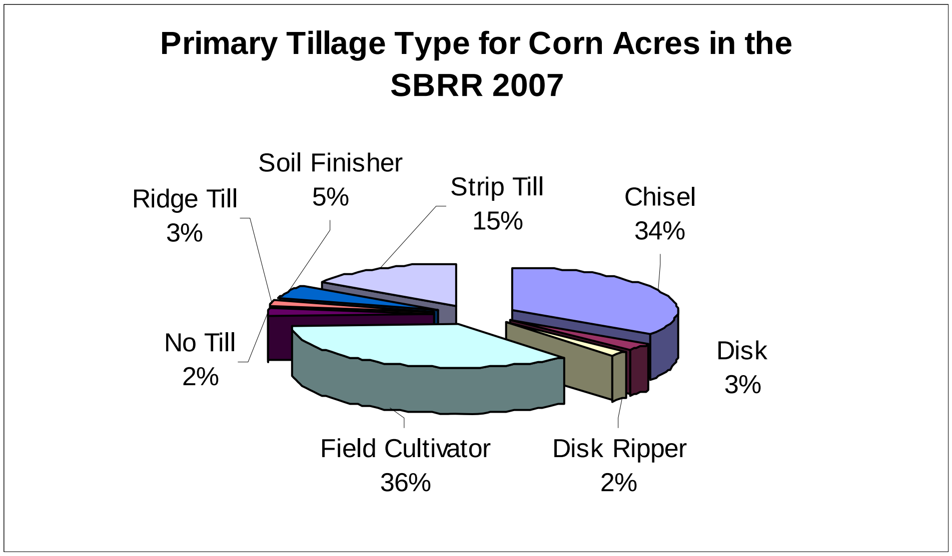

Figure 14. Percentage of corn in each tillage category.

Fields planted to soybeans were most often not tilled - also known as 'no till' (Figure 15 and 16).

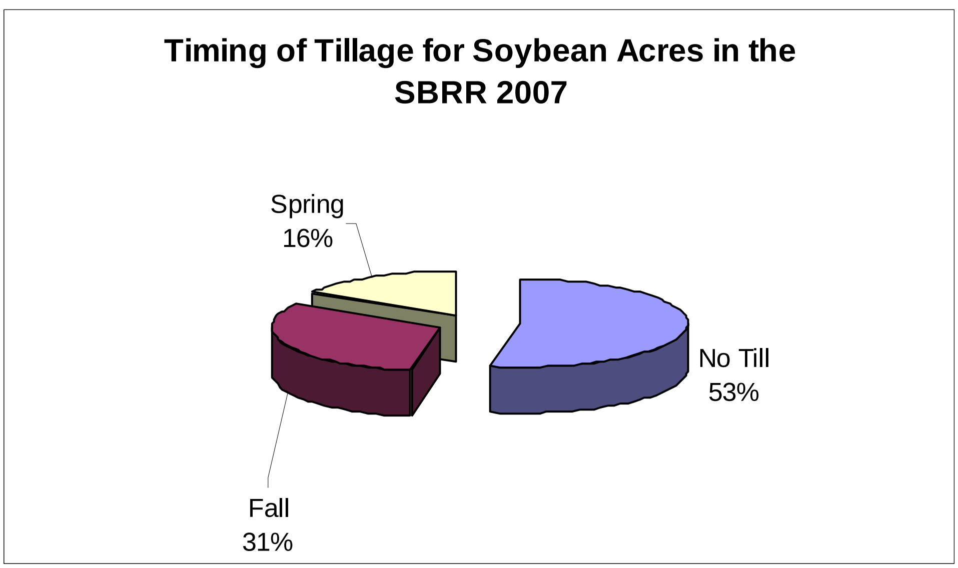

Figure 15. Percentage of soybeans tilled at different times.

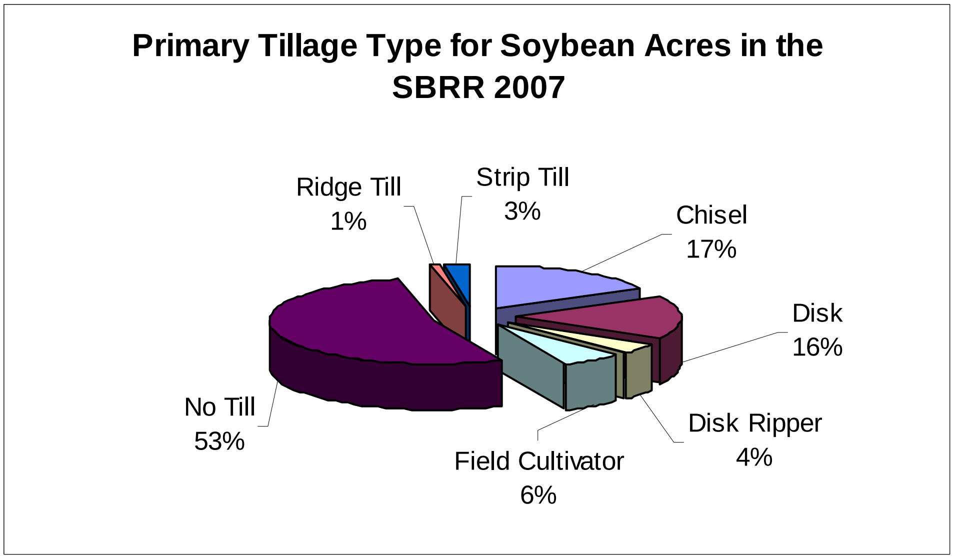

Figure 16. Percentage of soybeans in each tillage category.

Pesticide Applications:
South Branch Root River

Pesticide use data was gathered on all inventoried crop acres in the South Branch of the Root River (SBRR). Pesticides were used on 85 percent of all inventoried crop acres (Table 11) and included only herbicides and insecticides.

Table 11. Inventoried Crop Acreage and Percentage Treated With Pesticides.

	Total	Pesticides	
Crop Grown	Acres	Acres Treated	Percent of Total
Corn	12,457	12,457	100%
Soybeans	9,169	8,969	98%
Other	3,590	206	6%
Total Acres			
	25,216	**24,772**	**85%**

Pesticide use on all acres consisted of 34 different formulas (different EPA numbers, or products). Table 12 describes the pesticide, product used, and the corresponding active ingredients (AI) of each pesticide product used.

Table 12. Product Name and Description of Pesticide Use in SBRR.					
Name Of Product	**EPA Number**	**Herbicide Insecticide**	**Active Ingredients (AI)**	**AI in Product**	**AI Expressed as**
2,4-D	5905-542	Herbicide	2,4-D	1.74	Pounds per Gallon
Aatrex 4L	100-497	Herbicide	Atrazine	4.00	Pounds per Gallon
Aatrex 9O	100-585	Herbicide	Atrazine	0.90	Percent by Weight
Accent	352-560	Herbicide	Nicosulfuron	0.75	Percent by Weight
Asana XL	352-515	Insecticide	Esfenvalerate	0.66	Pounds Per Gallon
Atrazine 90 WDG	34704-622	Herbicide	Atrazine	0.90	Percent by Weight
Buccaneer	54467-10	Herbicide	Glyphosate	4.00	Pounds per Gallon
Buctril	264-437	Herbicide	Bromoxynil	2.00	Pounds per Gallon
Callisto	100-1131	Herbicide	Mesotrione	4.00	Pounds per Gallon
Counter 15G	5481-545	Insecticide	Terbufos	0.15	Percent by Weight
Domain	264-771	Herbicide	Metribuzin Flufenacet	0.36 0.24	Percent by Weight
Dual II	100-711	Herbicide	S-Metolachlor	0.84	Percent by Weight
Dual II Magnum	100-818	Herbicide	S-Metolachlor	7.64	Pounds Per Gallon
First Rate	62719-275	Herbicide	Cloransulam-Methyl	0.84	Percent by Weight
Force 3G	100-1075	Insecticide	Tefluthrin	0.03	Percent by Weight
Glyphosate	352-607	Herbicide	Glyphosate	4.00	Pounds per Gallon
Gmax Lite	7969-200	Herbicide	Dimethenamid-P Atrazine	2.25 2.75	Pounds per Gallon
Harness	524-473	Herbicide	Acetochlor	7.00	Pounds per Gallon
Harness 20G	524-487	Herbicide	Acetochlor	0.20	Percent by Weight

Harness Extra	524-480	Herbicide	Acetochlor Atrazine	4.30 1.70	Pounds per Gallon
Keystone	62719-368	Herbicide	Acetochlor Atrazine	3.00 2.25	Pounds per Gallon
Keystone LA	26719-479	Herbicide	Acetochlor Atrazine	4.00 1.50	Pounds per Gallon
Liberty	45639-199	Herbicide	Glufosinate-Ammonium	1.67	Pounds per Gallon
Lorsban-4e	62719-220	Insecticide	Chlorpyrifos	4.00	Pounds per Gallon
Lumax	100-1152	Herbicide	Atrazine Mesotrione S-Metolachlor	1.00 0.27 2.68	Pounds per Gallon
Outlook	7969-156	Herbicide	Dimethenamid	6.00	Pounds per Gallon
Pursuit	241-310	Herbicide	Imazethapyr	2.00	Pounds per Gallon
Roundup Ultra	524-475	Herbicide	Glyphosate	3.00	Pounds per Gallon
Roundup Ultra Max	524-512	Herbicide	Glyphosate	4.00	Pounds per Gallon
Roundup Weathermax	524-537	Herbicide	Glyphosate	5.50	Pounds per Gallon
Status	7969-242	Herbicide	Diflufenzopyr Dicamba	0.17 0.44	Percent by Weight
Select 2ec	59639-3	Herbicide	Clethodim	2.00	Pounds per Gallon
Steadfast	352-608	Herbicide	Nicosulfuron Rimsulfuron	0.50 0.25	Percent by Weight
Touchdown	10182-449	Herbicide	Glyphosate	3.00	Pounds per Gallon
Warrior	10182-96	Insecticide	Lambda-Cyhalothrin	1.00	Pounds per Gallon

There was 42,859 pounds of active ingredients (AI) from all pesticides used on all crops. Herbicide AI totaled 41,556 pounds and insecticide AI totaled 1,303 pounds. There were no fungicides applied on inventoried acres. Field corn accounted for 61 percent of the total AI used (by pounds represented in Figure 17).

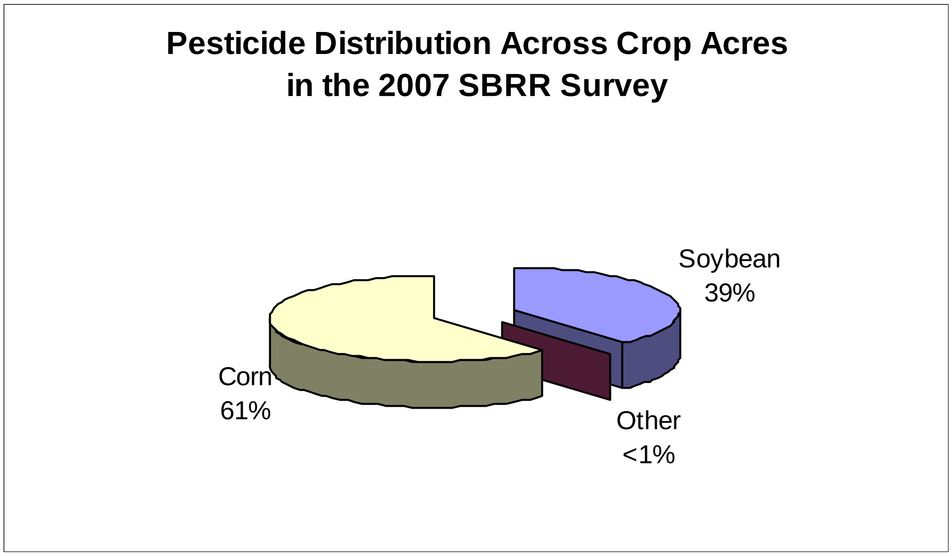

Figure 17. Percentage of total pounds applied to crops.

Table 13 lists AI, acreage, and total pounds applied to inventoried acres. Each separate application is recorded. In the case of a 100-acre field that receives two applications of glyphosate, it would be recorded as 200 acres treated. Glyphosate was the only AI that was applied in more than one application on the same field. The “acres treated” category includes 8,473 acres applied initially with glyphosate.

Table 13. Pesticide Use And Acres Treated by Active Ingredient.

Name Of Compound	Acres Treated	Total Pounds Applied
2,4-D	750	534
Acetochlor	3,886	5,309
Atrazine	8,509	6,259
Bromoxynil	2,000	688
Chlorpyrifos	382	191
Clethodim	21	2
Cloransulam-methyl	109	3
Dicamba	2,624	159
Diflufenzopyr	2,624	52
Dimethenamid	2,223	2,062
Dimethenamid P	1,858	784
Esfenvalerate	1,115	23
Flufenacet	44	8
Glufosinate-ammonium	388	162
Glyphosate	24,285	23,420
Imazethapyr	21	1
Lambda-cyhalothrin	5,996	242
Mesotrione	2,053	425
Metribuzin	44	12
Nicosulfuron	510	11
Rimsulfuron	460	5
S-metolachlor	1,743	2,204
Tefluthrin	3,324	400
Terbufos	864	778

Pesticide use on corn consisted of 15 herbicide AIs. Table 14 details each compound used and the percentage of acres treated with each compound.

Table 14. Pesticide Use on Corn Acres

Name Of Active Ingredient	Percent Of All Surveyed Corn Acres	Number of Applications	Rate Applied Pounds per Acre Per Application	Rate Applied Pounds per Acre Per Year	Total Pounds Applied
Acetochlor	31%	1.0	1.37	1.37	5,309
Atrazine	68%	1.0	0.74	0.74	6,259
Bromoxynil	16%	1.0	0.34	0.34	688
Dicamba	21%	1.0	.06	.06	159
Diflufenzopyr	21%	1.0	.02	.02	52
Dimethenamid	18%	1.0	0.93	0.93	2,062
Dimethenamid P	15%	1.0	0.42	0.42	784
Glufosinate-Ammonium	3%	1.0	0.42	0.42	162
Glyphosate	58%	1.1	1.08	1.14	7,764
Mesotrione	16%	1.0	0.21	0.21	425
Nicosulfuron	4%	1.0	0.02	0.02	11
Rimsulfuron	4%	1.0	0.01	0.01	5
S-Metolachlor	14%	1.0	1.26	1.26	2,204
Tefluthrin	27%	1.0	0.12	0.12	400
Terbufos	7%	1.0	0.90	0.90	778

Soybean acres received pesticide applications from 10 compounds (Table 15).

Table 15. Pesticide Use on Soybean Acres.

Name Of Active Ingredient	Percent Of All Surveyed Soybean Acres	Number of Applications	Rate Applied Pounds per Acre Per Application	Rate Applied Pounds per Acre Per Year	Total Pounds Applied
2,4-D	8%	1.0	0.71	0.71	534
Chlorpyrifos	4%	1.0	0.50	0.50	191
Clethodim	0%	1.0	0.08	0.08	2
Cloransulam-methyl	1%	1.0	0.03	0.03	3
Esfenvalerate	12%	1.0	0.02	0.02	23
Flufenacet	0%	1.0	0.18	0.18	8
Glyphosate	99%	1.8	0.96	1.73	15,655
Imazethapyr	0%	1.0	0.06	0.06	1
Lambda-cyhalothrin	63%	1.0	0.04	0.04	239
Metribuzin	0%	1.0	0.27	0.27	12

The only other application of pesticides on other crops was two pounds of lambda-cyhalothrin on 206 acres of alfalfa.

Over 6,600 pounds of AI were applied with impregnated fertilizer on 5,265 acres of corn. That equates to 42 percent of all inventoried acres. Table 16 details each AI, amount, and the number of acres treated.

Table 16. Pesticide Use and Acres Treated by Active Ingredient for Impregnated Pesticides[20].

Name Of Compound	Acres Treated	Total Pounds Applied
Acetochlor	2,104	2,973
Atrazine	1,725	896
Dicamba	390	24
Diflufenzopyr	390	8
Dimethenamid	2,000	1,842
Mesotrione	261	44
Nicosulfuron	390	8
Rimsulfuron	390	4
S-metolachlor	771	839

[20] Includes all pesticide applied with solid and liquid fertilizer applications.

Based on treated acres, pesticides were most often applied postemergence (Figure 18).

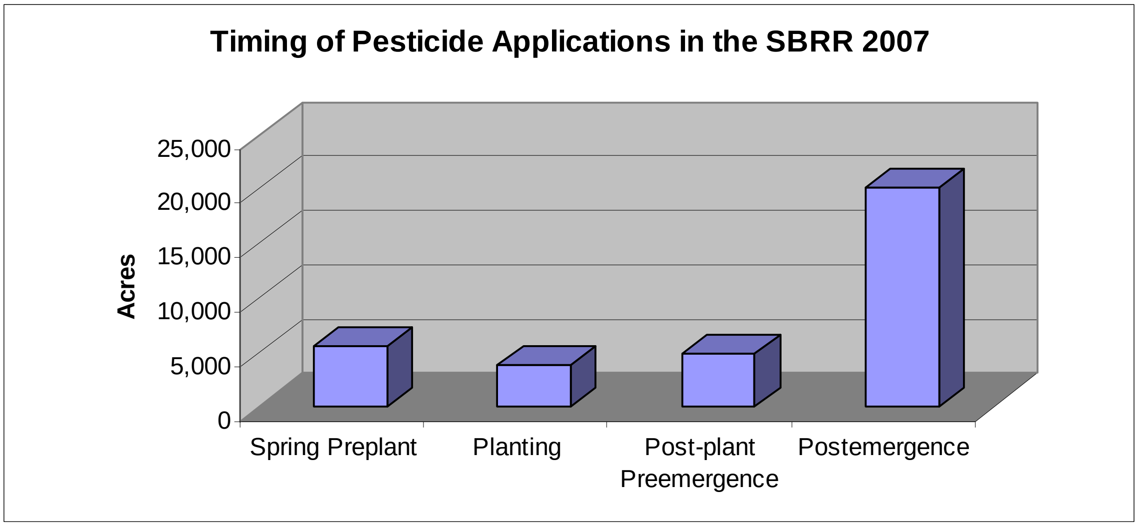

Figure 18. Number of acres applied with pesticides at different times in the SBRR.

Postemergence pesticide application was the most popular timing for both corn (Figure 19) and soybeans (Figure 20).

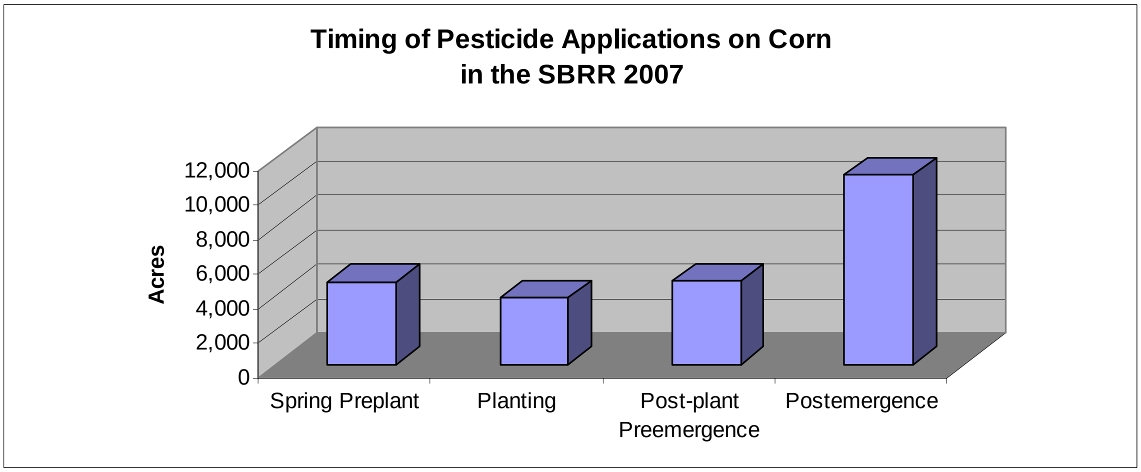

Figure 19. Number of corn acres applied with pesticides at different times in the SBRR.

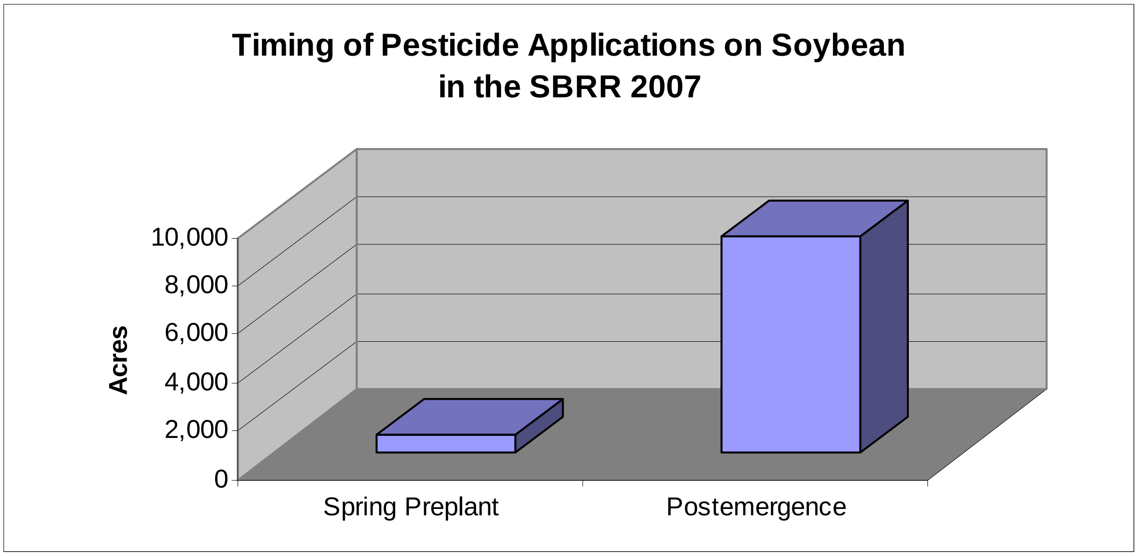

Figure 20. Number of soybean acres applied with pesticides two different times in the SBRR.

Pesticides impregnated on dry or liquid fertilizer is detailed in Figure 21. Only spring preplant applied pesticides that were impregnated were incorporated[21]. Only one farmer in the SBRR currently cultivates. Incorporation would require the use of a cultivator or special equipment for sidedress application.

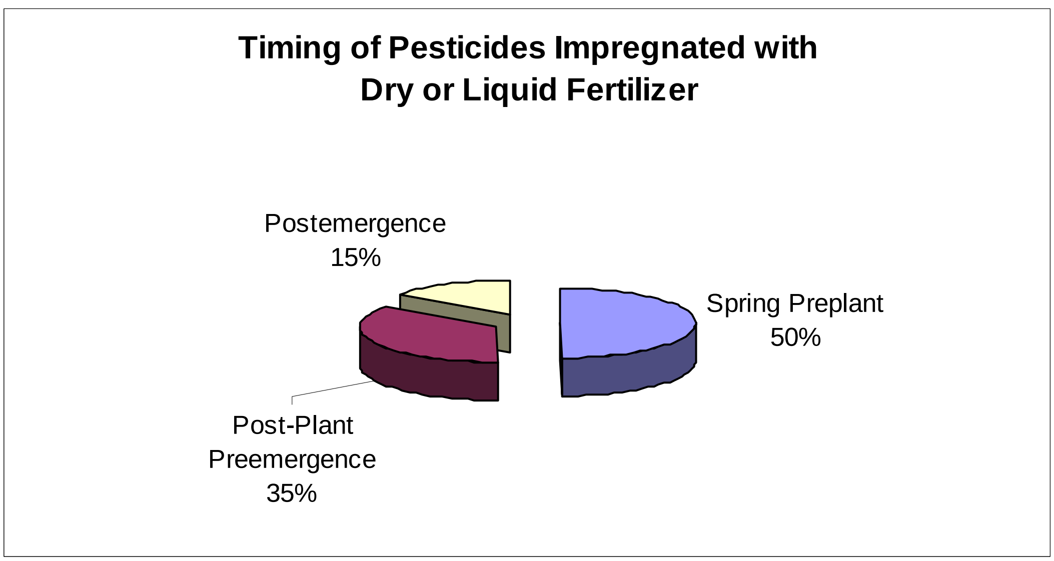

Figure 21. Timing of pesticide applications on corn acres applied with impregnated pesticides.

[21] Current BMPs for Nitrogen use in Southeast Minnesota state that N should be incorporated 3-4 inches. Current BMPs for Pesticides suggest following the label. Labels state that incorporation should be less than three inches. Therefore, farmers who impregnate can either follow the N BMP or the Pesticide BMP but not both because of conflicting language.

Corn herbicide totaled 25,884 pounds and is detailed by the number of applications and scheduled timing in Figure 22. Two pass application includes a preemergence application followed by a postemergence application.

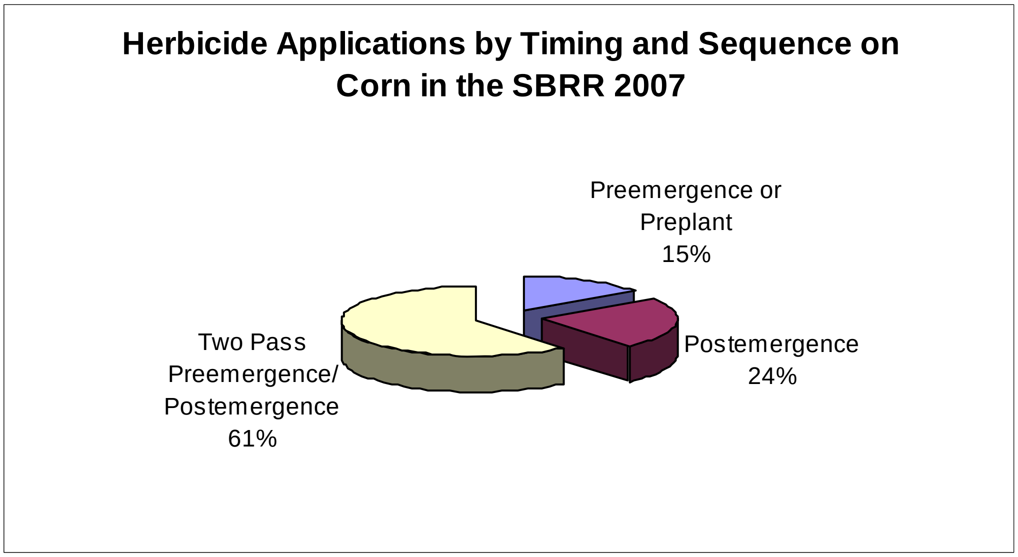

Figure 22. Herbicide applied to all surveyed corn acres by number of applications and timing.

All pesticides were broadcast except for 4,000 acres of insecticide on surveyed corn acres. Corn insecticides consisted of two AIs, tefluthrin and terbufos. Atrazine, glyphosate, and acetochlor have been the most commonly used herbicides on corn for the past five years. In 2007, these herbicides were applied to more than 30 percent of all corn acres and together they account for 75 percent of all herbicides applied to corn in terms of pounds of AI applied.

Atrazine Use

Atrazine was applied at various rates by the surveyed farmers in the South Branch of the Root River (SBRR). Atrazine was the most used pesticide as a function of acres treated. Although Atrazine was the most prevalent pesticide in streams in southeast Minnesota and the SBRR[22], Atrazine rates per acre were applied below the maximum rates recommended by the manufacturer and are specified on the label.

Water Quality Best Management Practices for Atrazine[23], as developed by the Minnesota Department of Agriculture (MDA) and other cooperators, states "For Southeast: Limit total atrazine use per year to 0.8 lbs of active ingredient per acre on all soils except on medium and fine textured soils, where a total of 1 lb of active ingredient per acre per year

[22] "2007 Annual Monitoring Report". August 2008. Minnesota Department of Agriculture. 2 Dec 2008. <http://www.mda.state.mn.us/news/publications/chemfert/2007watqualmonrpt.pdf>
[23] Water Quality Best Management Practices for Atrazine can be found at http://www.mda.state.mn.us/news/publications/protecting/bmps/bmpsforatrazine.pdf

can be used for preemergence control.” In fact, 58 percent of the acres were applied with less than 0.6 pounds active ingredient per acre of Atrazine (Figure 23).

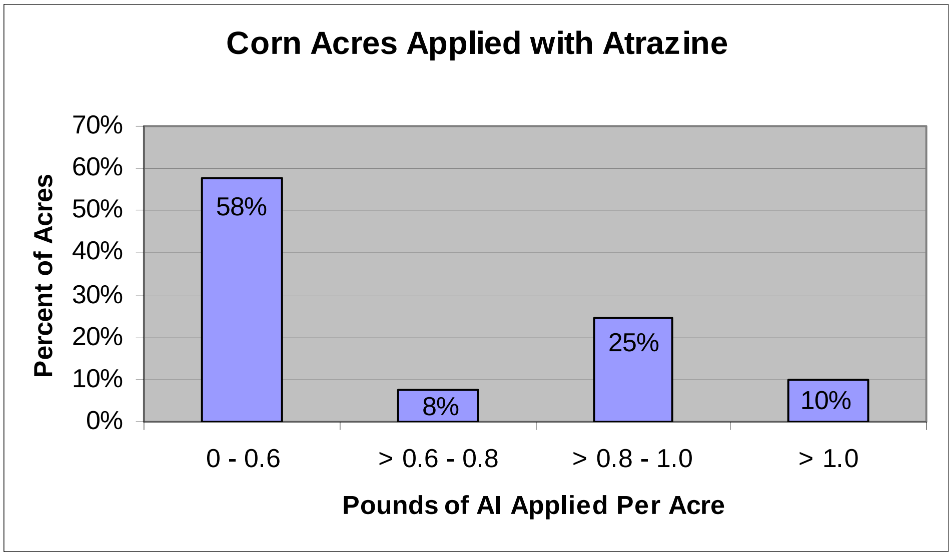

Figure 23. Atrazine applied on surveyed corn acres by rate of AI.

The largest amount of Atrazine was applied postemergence. (Figure 24).

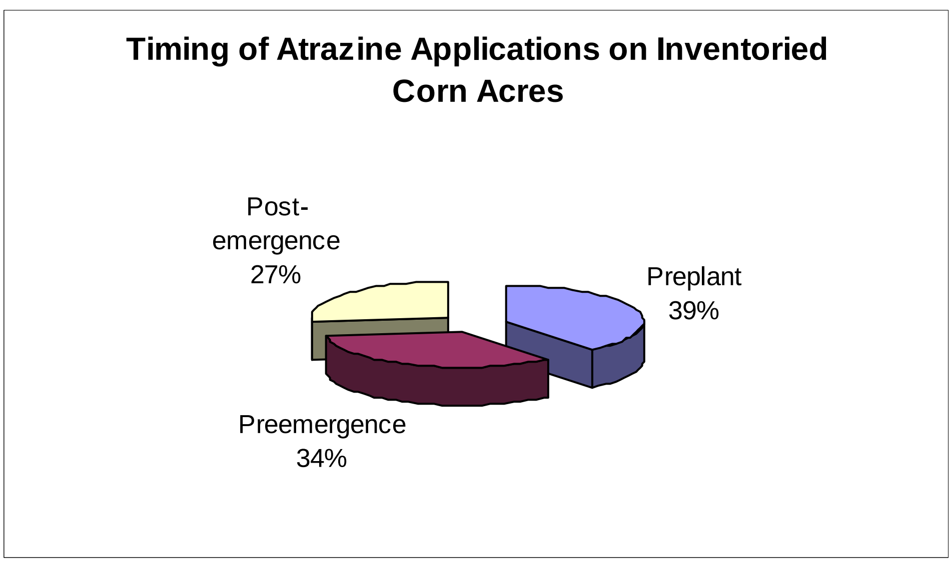

Figure 234. Timing of Atrazine applications on surveyed corn acres.

Acetochlor Use

Acetochlor was applied by the surveyed farmers in the SBRR. Recommended rates for application vary dependent on the product used. All surveyed farmers applied Acetochlor within labeled rates. The most popular rate, between 1.5 and two pounds active ingredient per acre, was used on 39 percent of the surveyed acres (Figure 25).

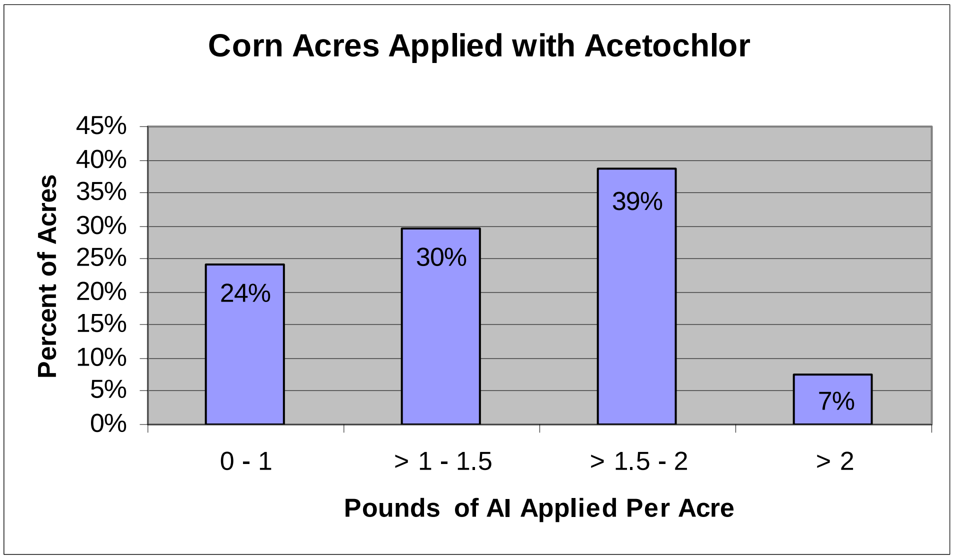

Figure 25. Acetochlor applied on surveyed corn acres by rate.

Most Acetochlor was applied as a spring preplant. (Figure 26).

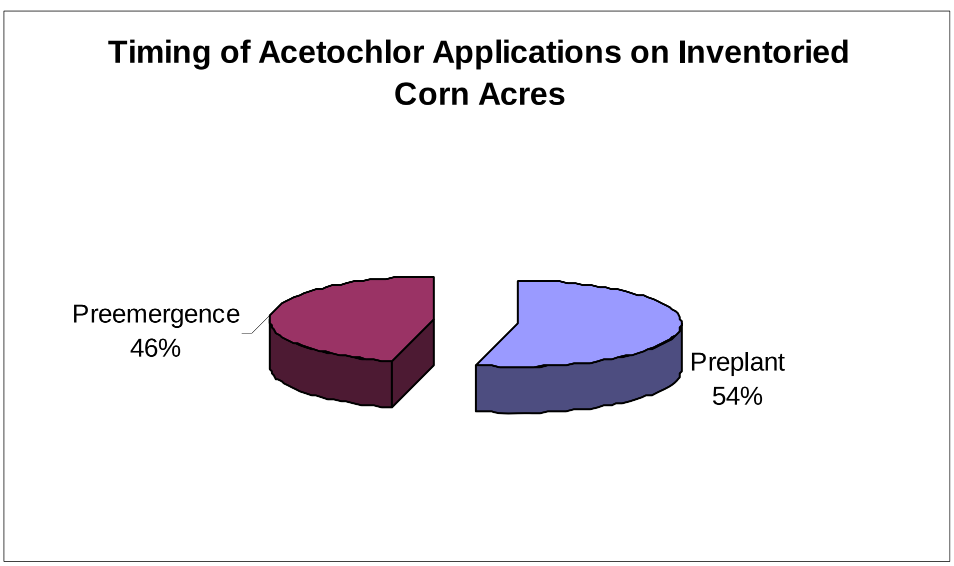

Figure 26. Timing of Acetochlor applications on surveyed corn acres.

S-Metolachlor

S-Metolachlor was applied at various rates by the surveyed farmers. Thirty-seven (37%) of the acres were applied with rates of between 1.5 and 2 pounds per acre (Figure 27).

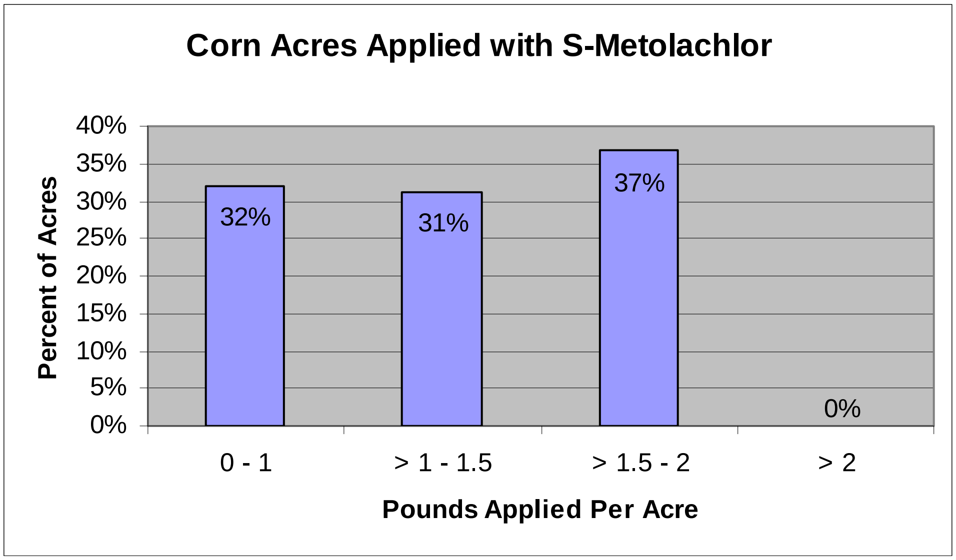

Figure 27. S-Metolachlor applied on surveyed corn acres by rate.

The largest amount of S-Metolachlor was applied as a post-plant preemergence. (Figure 28).

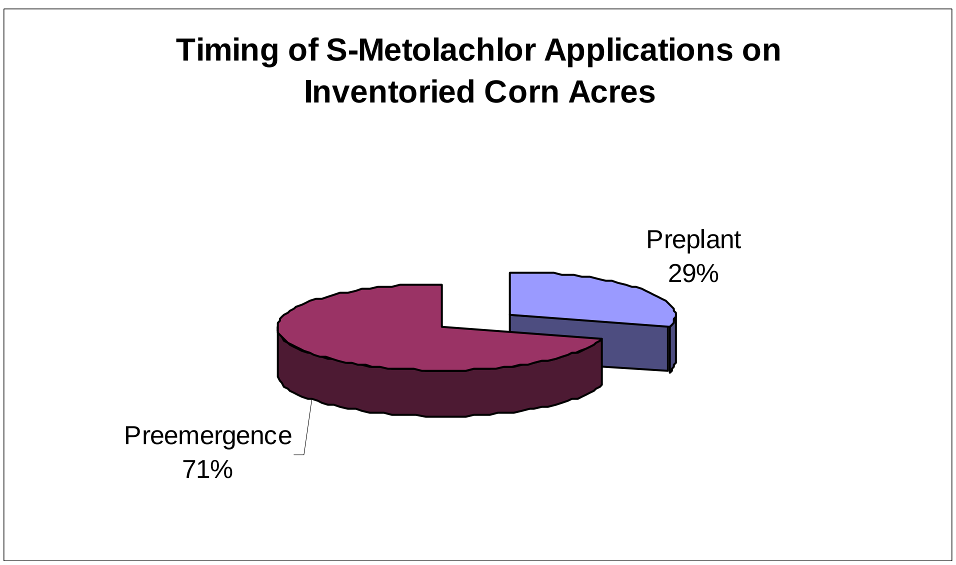

Figure 28. Timing of S-Metolachlor applied on surveyed corn acres.

Best Management Practices for Herbicides used on Corn Acres: South Branch of the Root River

The Best Management Practices (BMPs) as developed by the Minnesota Department of Agriculture (MDA) and other cooperators are provided as a series of options. The MDA encourages producers, crop consultants, and educators to select from these options the ones most appropriate for a given farming operation, considering soil types and geography, tillage and cultivation practices, and irrigation and runoff management. The MDA also encourages development of Integrated Weed Management Plans for every Minnesota farm.

A few questions directly related to these options or ‘core practices’ listed in the Water Quality Best Management Practices for All Agricultural Herbicides[24] were asked of farmers in the South Branch of the Root River (SBRR) to focus on scouting, product incorporation, and precision agriculture. MDA conducted its surveys using available program funds within the time allotted. These answers were based on farmer response and are not weighted by acres. Farm operators could give more than one answer in the scouting and product incorporation sections. The following BMPs may be evaluated further and presented in future documents.

Scouting:
“Scout fields for weeds and match the management approach to the weed problem.”

Scouting is an important tool used to match the correct herbicide, rate, and timing with the current weed problems. Herbicide choices and BMP options most appropriate for a given farming operation will vary based on weed type and density. Figure 29 provides details about the person(s) responsible to scout corn fields of each farming operation. Results in this section are based on 50 operations.

[24] Water Quality Best Management Practices for All Agricultural Herbicides can be found at: http://www.mda.state.mn.us/news/publications/protecting/bmps/bmpsforagherbicides.pdf

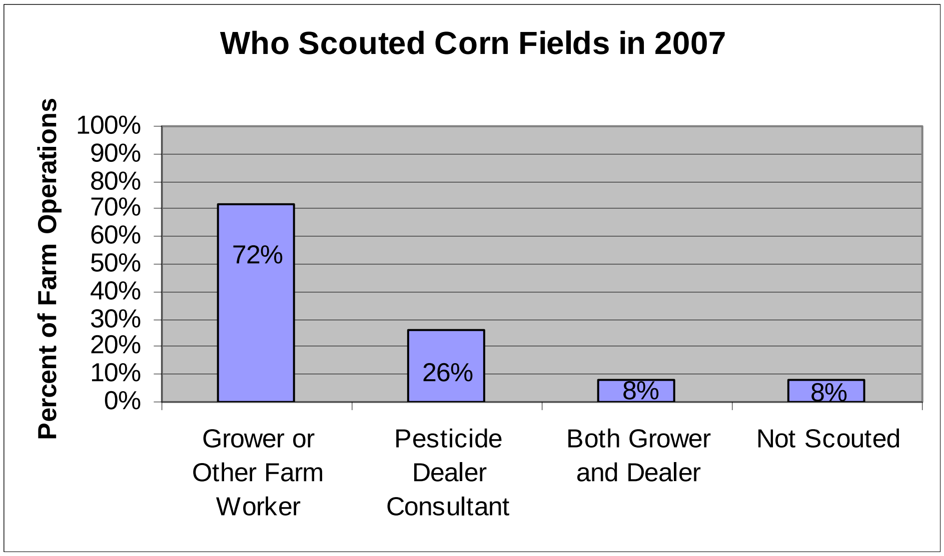

Figure 29. Responses of farm operators when asked, "Who scouted your corn fields for weeds in 2007?"

Study results depicted in Figure 29 show 84 percent of the growers in the SBRR adhered to this BMP.

Figure 30 provides details describing reasons why fields were scouted.

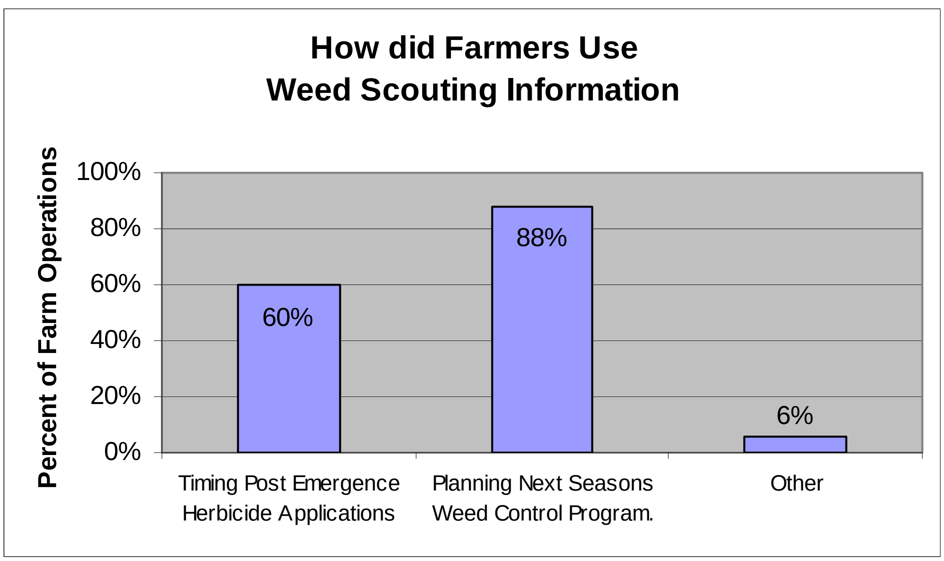

Figure 30. Responses of farm operators when asked, "How is the weed scouting information used?"

Table 18. lists the most problematic weeds in corn.

Table 18. "What are your most problematic weeds in corn?"	
Weed	**Number of Responses**
Giant Ragweed	29
Wooly Cupgrass	17
Lambsquarters	8
Foxtail	6
Waterhemp	5
Quackgrass	2
Dandelions	2
Pigweed	1
Velvetleaf	1

Table 18. Responses of farm operators when asked, "What are your most problematic weeds in corn?"

Product Incorporation:
"*For Surface Water protection*: Soil incorporate herbicides."

Incorporation can lower herbicide runoff by placing the product below the soil surface where it can bind to soil. Survey questions were asked to explore the reasons that farmers incorporate herbicides. Figure 31 contains reasons why 11 farm operators incorporated herbicides. Future surveys are needed to determine whether farmers are using products that recommend incorporation and to what depth to show the number of farmers that could adopt this BMP and what proportion of farmers adhere to this BMP.

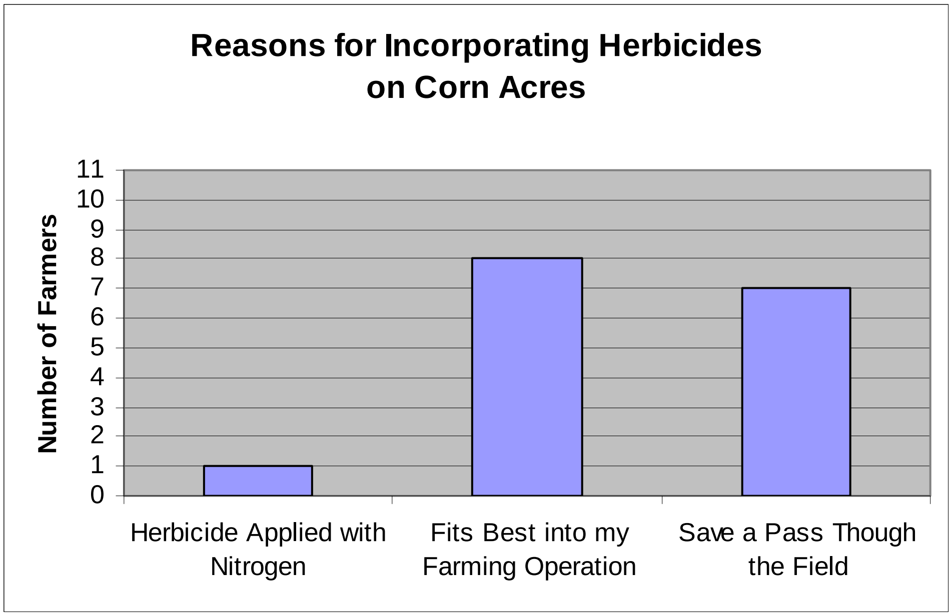

Figure 31. Responses of farm operators when asked, “What were the reasons for soil incorporating herbicides?”

Precision Agriculture:
“Consider precision application of herbicides.”

Precision technologies include field mapping of weed distribution and application methods to apply an herbicide only on selected areas. Precision applications using controlled applicator devices such as Global Positioning System auto-steer systems for tractors (GPS auto-steer or auto-steer), reduces herbicide overlap and overspray which decreases the total amount of herbicide used.

In this survey, “auto-steer” was described as any tool that assisted in precision herbicide application using GPS technology. Responses from 50 farm operators were compiled into Figure 32 that shows how widely auto-steer was used to apply herbicide on corn acres in the SBRR during 2007. Unfortunately**,** some farm operators were not aware of the equipment used by their custom herbicide applicators, so they were not able to answer this question.

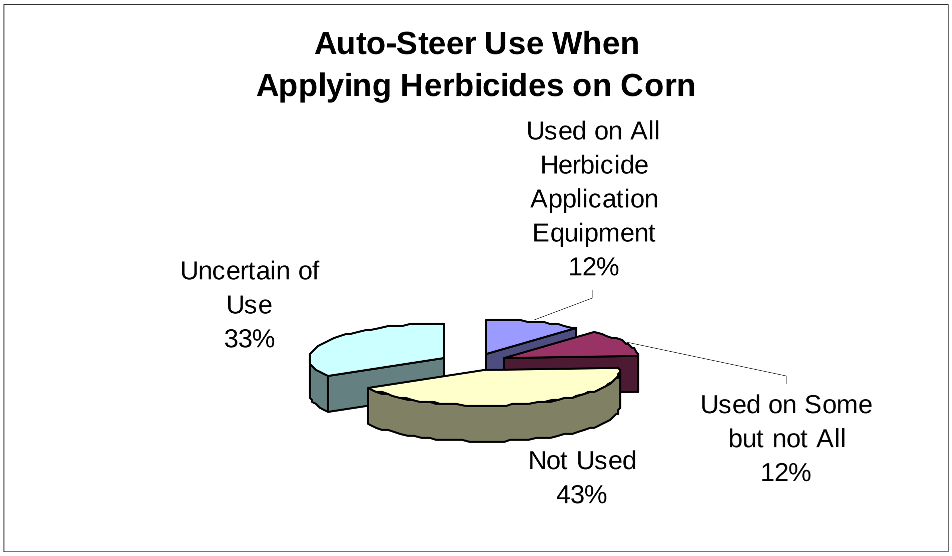

Figure 32. Responses of farm operators when asked, "How widely are auto-steer equipped sprayers used to apply herbicides on your corn?"

Herbicide Resistant Corn Use:

One question was asked which is not listed as an option or 'core practice' in the Water Quality Best Management Practices for All Agricultural Herbicides. Because herbicide choices and BMP options will vary based on the use of herbicide resistant crop technology and the use of preemergence herbicides in conjunction with glyphosate and glufosinate products (contact herbicides), information was gathered regarding the use of herbicide resistant corn. Based on responses from 41 farm operators, two figures have been generated. Figure 33 represents Roundup Ready® (resistant to glyphosate products) or LibertyLink® (resistant to glufosinate) corn planted in the SBRR. Figure 34 breaks out the use of preemergence herbicide on Roundup Ready® or Liberty Link® corn.

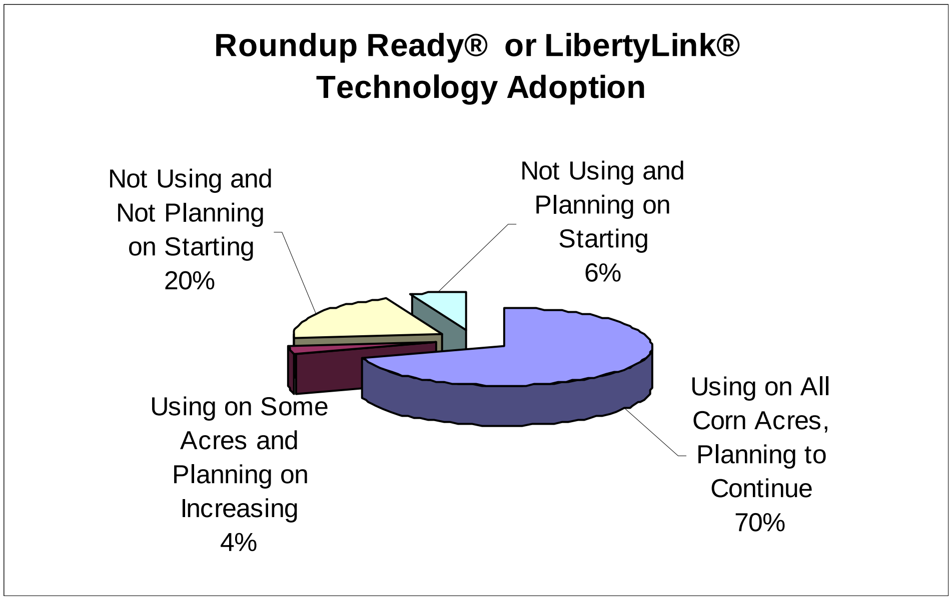

Figure 33. Responses of farm operators when asked, "Which best describes your use of Roundup Ready® or LibertyLink® technologies on corn?"

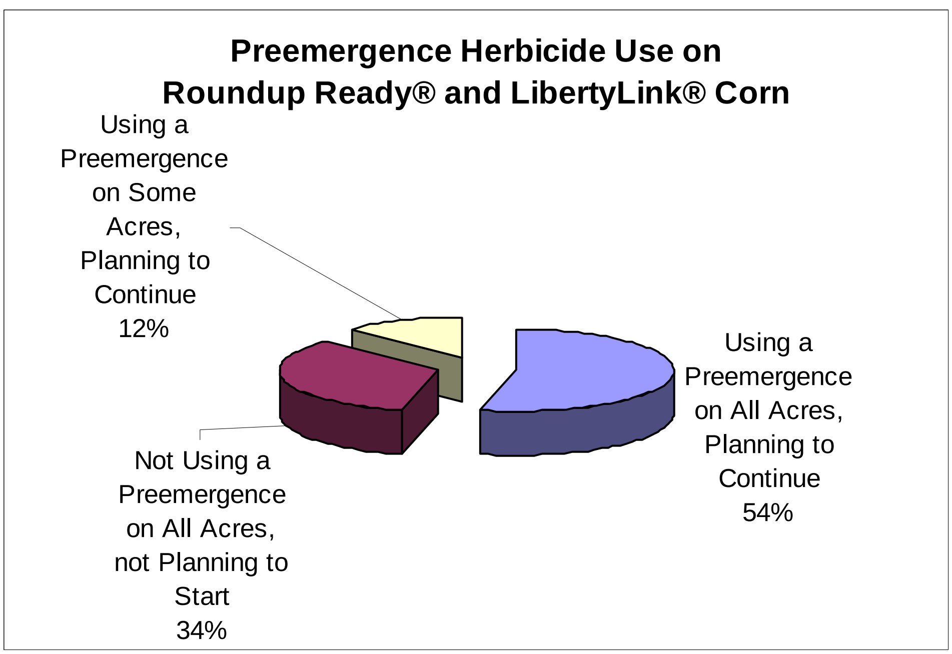

Figure 34. Responses of farm operators when asked, "What best describes your use of preemergence herbicide in combination with Roundup Ready® or LibertyLink® technologies on corn?"

Conclusions and Summary of the Current Nutrient, Tillage, and Pesticide Management Practices for the South Branch Root River

The South Branch of the Root River is a 74,000 acre watershed that lies across Fillmore and Mower counties. Sixty farmers, operating 25,000 acres in the SBRR, were interviewed by the Minnesota Department of Agriculture using the Farm Nutrient Management Assessment Program (FANMAP) tool. Producers volunteered one to three hours of their time to share information about their farming operations. This FANMAP was the second FANMAP performed in the SBRR; the first was completed specific to the 2003 crop year.

Approximately 42 percent of all crop acres within the SBRR were inventoried. Field corn and soybeans were the dominant crops representing 85 percent of all acres planted. Forty-nine percent of the crop acres were planted with field corn and 99 percent of the total 1,587,069 pounds of commercial N was applied to those field corn acres. Fifty-five percent of all N applied was during spring preplant applications. Liquid N accounted for 31 percent of N applied to field corn. Fall applications of N are not recommended in Fillmore County, but are allowed in Mower County if applications of N are delayed until soil temperature reaches a consistent 50°. Only 11 percent of the commercial N was applied as a fall application.

Field corn accounted for 96 percent of the commercial P fertilizer applied to inventoried acres. Applications of commercial P applied at planting accounted for 39 percent.

Livestock raised in the SBRR was dominated by hog operations, with 49 percent of the manure N produced. However, due to the lack of collecting beef manure from pasturing and over wintering on cropland, and also due to non-incorporation of beef manure and hog manure being brought into the watershed, 75 percent of the first year available N was from hog manure. Manure was applied on 1,585 acres of corn and 95 acres of alfalfa. Fall applications of manure accounted for 61 percent of the manure N applied.

Commercial fertilizers (72 percent), manures (9 percent), and legumes (19 percent) contributed a total of 2,264,000 lb of first year available N to all inventoried corn acres in 2007.

On average, inventoried farmers were over-applying N by 28 lb/A on corn. Less than 10 percent of the farmers were applying below the lower range of the N recommendations and/or the MRTN. Less than 20 percent of the farmers were below the higher range of the N recommendations.

Pesticide use was prevalent in the SBRR, as 85 percent of all crop acres were treated with herbicides or insecticides. Pesticide use consisted of 34 different formulas or products. There were 24 separate active ingredients used in these pesticide applications, totaling 42,859 pounds. Field corn and soybeans accounted for 61 percent and 39 percent of all active ingredients applied, respectively. Postemergence applications dominated both corn and soybean acres.

Herbicide use on corn acres was dominated by atrazine, glyphosate, and acetochlor. Glyphosate was also the dominate herbicide used on soybeans.

Inventoried farmers in the SBRR appear to practice a broad range of farming methods that have been documented throughout this watershed in this FANMAP. Decisions regarding methods of tillage, pesticide use, and nutrient applications are dependent on each other, so changes to one method may influence the others. This survey is an effort in part to summarize these influences by way of documenting the current practices.

Current University of Minnesota recommendations for nitrogen applications to corn compared to the previous 2005 recommendations can be found in Appendix 1 along with sample comparisons of different N source and rate scenarios in the South Branch of the Root River.

Appendix 1:

University of Minnesota's brochure "Fertilizing Corn in Minnesota" provides the reasons for the change in the recommendations. It states the following:

> "Because of technology improvements in corn production practices such as weed and pest control, expected yield is not as important a factor in determining N rate as it has been in the past. Soil productivity has become a better indicator of N needs. A majority of Minnesota soils are highly productive and have generally produced maximum economic corn yield with similar N rates over the last 15 years. Some soils have a reduced potential attributed to erosion, reduced water holding capacity caused by lower organic matter content, sandy soil texture, poor drainage, and any restriction to root growth."

With the current volatility in energy costs, fertilizer N cost has risen dramatically in the past three years. This increase does affect the economic optimum N rate. To account for this change, the ratio of the price of N per pound to the value of a bushel of corn has been added to the N rate decision. An example calculation of the price/value ratio: if N fertilizer costs $0.30 per lb N or $492 per ton of anhydrous ammonia, and corn is valued at $2.00 per bushel, the ratio would be 0.30/2.00 = 0.15".

The differences in the recommendations are detailed in Figure 35. Prices for corn and nitrogen were the current Minnesota prices on September 9, 2008. Numbers attached to the bars represent the current recommendations for farmers using UAN priced at $0.98 per pound.

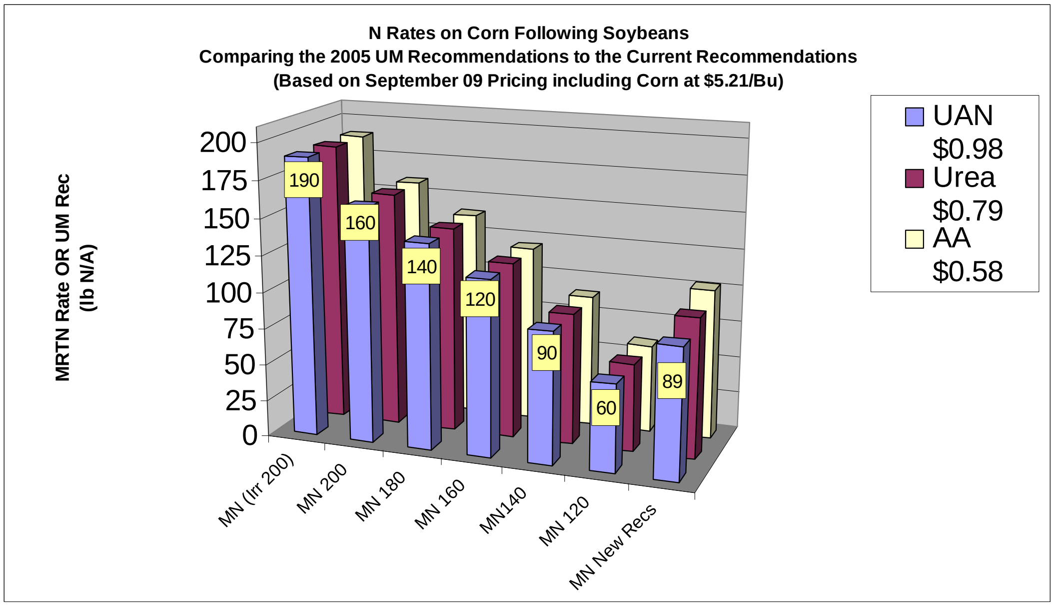

Figure 35. Current University of Minnesota recommendations for nitrogen applications to corn compared to the previous recommendations.

Soil fertility specialists in Wisconsin, Minnesota, Iowa, Indiana, and Illinois agreed to use the same philosophy to develop N rate guidelines for corn (grain). The philosophy used is based on maximizing return to N (MRTN) fertilizer. The new N rate guidelines were developed as a means to provide growers guidance on how much they might adjust their N application rates and maintain or enhance profitability depending upon their individual farm situation. Research data collected in these states over a period of 20 years was used to develop the guidelines. Figure 36 details the differences in the recommendations for the states involved based on September 9, 2008 prices.

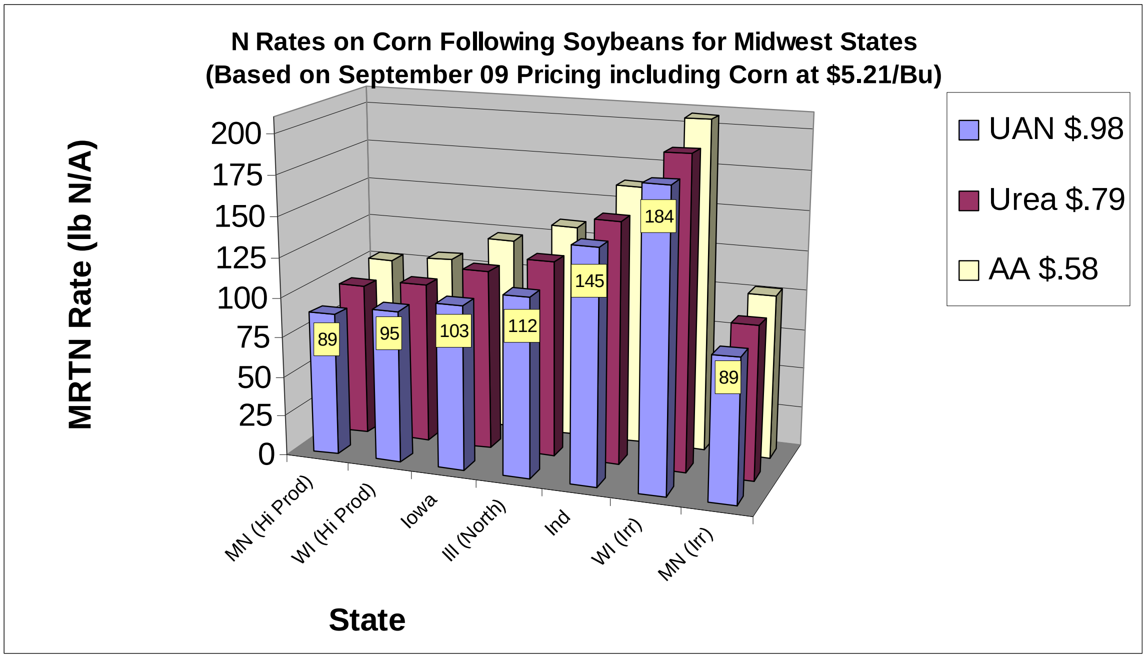

Figure 36. Current University of Minnesota recommendations for nitrogen applications to corn compared to other participating states.

Previous University of Minnesota recommendations which are based on yield goals are detailed in Table 19 for a previous Root River FANMAP. It appears that famers with higher yield goals will have to make substantial reductions in N rates in effort to follow the University of Minnesota guidelines for N fertilization.

Table 19. Corn Acres and N Applied by Yield on the South Branch of the Root River for the 2003 Season.

Yield Goal	Acres	N Applied	N Recommended	Over Application
100 – 149	1,032	89	83	7
150 – 174	8,842	145	130	15
175 or Higher	2,711	178	145	33
Totals/ Average	**12,585**	**147**	**130**	**17**