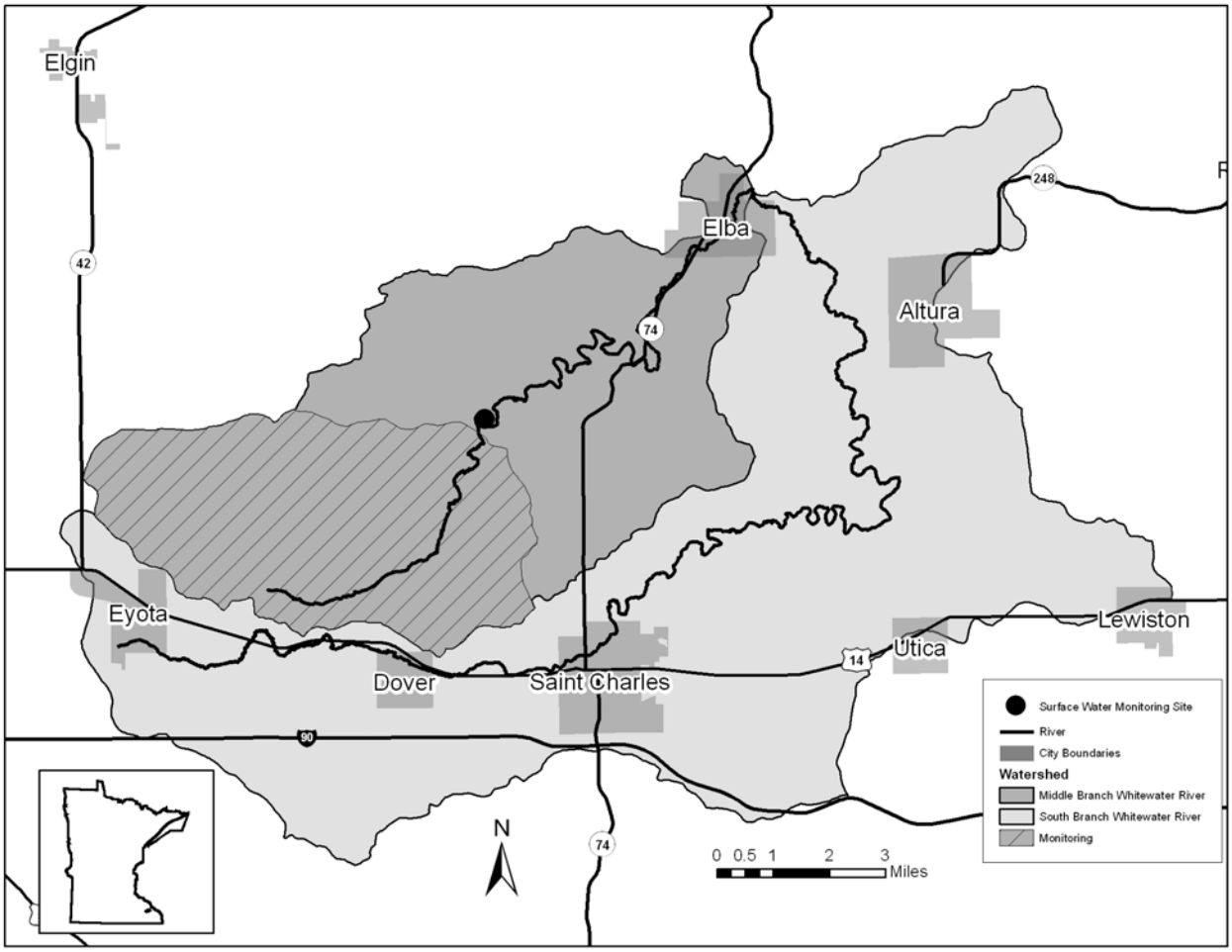
MINNESOTA DEPARTMENT OF AGRICULTURE
FROM THE FARM TO YOUR FAMILY

2005 Nutrient and Pesticide Management Assessment of Producers in the Middle Branch and South Branch Watersheds of the Whitewater River



For additional information, contact:
Denton Bruening at 651-201-6399
Minnesota Department of Agriculture
Date of printing: 6/4/2008

General information:
The Whitewater River Watershed (WRW)
(Information Provided by Whitewater River Watershed)

Water quality in the Whitewater River is a concern to the citizens of the surrounding area and the many citizens of Minnesota who visit the area each year. Due to the Karst topography of steep hills and fractured bedrock, both ground water and surface water are susceptible to contamination. This study focuses on the agriculture land use of the Middle Branch Watershed and South Branch Watershed of the Whitewater River. It also compares the results of the 2005 survey of farmers in the Middle Branch and South Branch watersheds with the result of a previous study conducted in 1997 on the area of the Middle Branch Watershed that provides drainage to the Minnesota Department of Agriculture's monitoring station.

The Minnesota Department of Agriculture has developed the Farm Nutrient/Pesticide Management Assessment Program (FANMAP) to obtain a thorough understanding of current farm practices regarding agricultural inputs and management practices. 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 ten years, over 600 farmers have volunteered two to four hours of their time to share information about their farming operations through the FANMAP process. Previous reports can be found on the MDA website at http://www.mda.state.mn.us/protecting/soilprotection/fanmap.htm.

The focus of this study was to gather information on nutrient, tillage and pesticide use. The Middle Branch was chosen as a priority area for a follow-up survey for multiple reasons. There is a large amount of water quality monitoring data available from the Middle Branch, the size of the watershed is manageable, and the MDA has historical data from 1996 for comparison. The South Branch was selected because of historically high bacteria levels. A better understanding of farm management and input trends, along with monitoring data will aid in better understanding water quality trends in these streams, both over time and in neighboring watersheds.

South Branch Whitewater Watershed

INTRODUCTION

The South Branch of the Whitewater River is located in Winona and Olmsted counties, in the Driftless Area of Southeast Minnesota. The western portion of the South Branch is part of the Rochester Plateau with gently rolling land that is heavily row cropped. The eastern portion of the watershed is more rolling and dissected by steep valleys with forested slopes. The crop fields in the Eastern portion are smaller with more hay and pasture present. Dairy and beef are the major livestock types in the watershed. Land use is 64% cropland, 10% pasture, 10% wildlife, 7% forest, and 9% other/urban/suburban.

The South Branch of the Whitewater River begins just west of Eyota. The River runs east through Dover and dissects the northwest side of St. Charles before running northwest and joining the main branch of the Whitewater River near Elba. The drainage area of the South Branch is about 93 square miles.

The lower third of the South Branch of the Whitewater River supports a healthy brown trout population. It flows through the Whitewater Wildlife Management area and sustains Crystal Springs Fish Hatchery. After joining with the main stem of the Whitewater River near the town of Elba, the river flows northeast through the 27,000 acre Whitewater Wildlife Management Area. It discharges to the Mississippi River at Weaver Bottoms, an important waterfowl staging area.

The population of the South Branch Watershed is approximately 7,300. The South Branch contains 70% of the urban population of the Whitewater Watershed, and includes the rapidly growing cities of St. Charles, Dover and Eyota, as well as the smaller communities of Utica and Altura.

GEOLOGY

The South Branch is in a geologically sensitive Karst area including fractured limestone bedrock, sinkholes and disappearing streams. These features are typical of Karst regions and can be direct routes for contaminants to reach groundwater and drinking water supplies. Special emphasis needs to be placed on protecting the water supply from surface pollution which can easily infiltrate groundwater.

A predominant geological feature running through the South Branch watershed, including the southern city limits of the city of St. Charles, is the Decorah Edge. The Decorah shale creates an impermeable layer, causing water to run laterally across it. This flow of water over the shale sustains a biologically diverse ecosystem that naturally filters the groundwater. Development along the edge of the Decorah shale formation can disturb the groundwater flow, jeopardizing the ability of the Decorah shale to filter groundwater. Wetness and flooding problems can be a costly result of development on these geologically sensitive areas.

WATER RESOURCES

The surface and groundwater in the Whitewater Watershed are intricately connected through fractured bedrock, springs and sinkholes. Any action affecting surface waters will ultimately affect ground water.

BACTERIA

The South Branch is listed in the Clean Water Act Section 303(d) list of impaired waters as impaired for aquatic life and recreation from fecal coliform. Monitoring data show the Whitewater River Watershed as having some of the highest fecal coliform bacteria levels in the Lower Mississippi River Basin. Impairments from fecal coliform bacteria limit the river's uses; posing a threat to human health from pathogen exposure, decreasing the river's suitability for livestock and wildlife drinking water, and reducing the recreational suitability of this important trout stream.

TURBIDITY

The South Branch is also listed as impaired for aquatic life from turbidity. Sediment becomes a problem in the streams when concentrations are excessive, when the elevated levels occur for prolonged periods of time, or when instream habitats are damaged by sediment deposition. Sediments are delivered to the stream from upland and riparian sources, especially during runoff events. Sediments transport pollutants such as phosphorus and certain pesticides via adsorption onto the sediment surface.

PESTICIDES

The MDA began monitoring water quantity and water quality, including pesticides on the South Branch of the Whitewater River in 1991. Monitoring has continued on and off since then and the South Branch and it is currently a Tier 2 surface water indicating it is sampled four to eight times per year for pesticides. Atrazine concentrations have been detected at levels of concern in the South Branch of the Whitewater River.

The delivery of pesticide residues to the streams of the Whitewater River system can vary with weather conditions. During very wet years with high volumes of storm runoff, most of annual pesticide loads in the streams are storm-runoff related. However, during normal to dry years, the majority of the annual pesticide load is a result of the base flows. This is another indication of the link between surface water, recharge, ground water, and stream flow.

Middle Branch Whitewater Watershed

INTRODUCTION

The Middle Branch of the Whitewater River is located in Olmsted and Winona counties, in the Driftless Area of Southeast Minnesota. The western portion is part of the Rochester Plateau, with gently rolling, heavily row cropped land. The eastern portion of the watershed is more rolling and dissected by steep valleys and forested slopes. Crop fields in the eastern portion are smaller, and include more hay and pasture than the western portion. Dairy and beef are the major livestock types in the watershed. Middle Branch land use is 73% cropland, 8% pasture, 6% wildlife, 5% forest, and 8% other/urban/suburban.

The Middle Branch begins just North of Eyota, and then runs northeast through Whitewater State Park, joining the main branch of the Whitewater River near Elba. The drainage area of the Middle Branch is about 53 square miles. After joining with the main branch of the Whitewater River near the town of Elba, the river flows northeast through the 27,000 acre Whitewater Wildlife Management Area. The Whitewater River discharges to the Mississippi River at Weaver Bottoms, an important waterfowl staging area.

GEOLOGY

The Middle Branch of the Whitewater Watershed is in a geologically sensitive Karst area including fractured limestone bedrock, sinkholes and disappearing streams. These features are typical of Karst regions and can be direct routes for contaminants to reach groundwater and drinking water supplies. Special emphasis needs to be placed on protecting the water supply from surface pollution which can easily infiltrate groundwater.

A predominant geological feature in the Middle Branch watershed is the Decorah Edge. The Decorah shale creates an impermeable layer, causing water to run laterally across it. This flow of water over the shale sustains a biologically diverse ecosystem that naturally filters the groundwater. Development along the edge of the Decorah shale formation can disturb groundwater flow, jeopardizing the ability of the Decorah shale to filter groundwater. Wetness and flooding problems can be a costly result of development on these geologically sensitive areas.

WATER RESOURCES

The Middle Branch is a cold, spring fed stream. It's a designated trout stream that supports a healthy population of brown trout, as well as supporting a wild brook trout population. The Middle Branch has been designated as Protected Waters by the Minnesota Department of Natural Resources. A DNR protected waters permit is required prior to any disturbance of the river. The surface and groundwater in the Whitewater Watershed are intricately connected through fractured bedrock, springs and sinkholes. Any action affecting surface waters will ultimately affect ground water.

BACTERIA

The Middle Branch is listed in the Clean Water Act Section 303(d) list of impaired waters as impaired for aquatic life and recreation from fecal coliform. The presence of this group of bacteria indicates contamination of water from human and/or animal (both domestic and wild) sources. Monitoring data show the Whitewater River

Watershed as having some of the highest fecal coliform bacteria levels in the Lower Mississippi River Basin. Impairments from fecal coliform bacteria limit the river's uses; posing a threat to human health from pathogen exposure, decreasing the river's suitability for livestock and wildlife drinking water, and reducing the recreational suitability of this important trout stream.

TURBIDITY

The Middle Branch is listed in the Clean Water Act Section 303(d) list of impaired waters as impaired for aquatic life from turbidity. Sediment becomes a problem in the streams when concentrations are excessive, when the elevated levels occur for prolonged periods of time, or when in stream habitats are damaged by sediment deposition. Sediments are delivered to the stream from upland and riparian sources, especially during runoff events. Sediments transport pollutants such as phosphorus and certain pesticides via adsorption onto the sediment surface.

PESTICIDES

The Minnesota Department of Agriculture (MDA) has conducted pesticide monitoring in the Middle Branch of the Whitewater River since 1992, monitoring water quantity and pesticide concentrations year round during most years. Monitoring results indicate that atrazine and acetochlor are present at concentrations of concern in post application runoff events. In addition, the degradates of these pesticides are present throughout the year.

The delivery of pesticide residues to the streams of the Whitewater River system can vary with weather conditions. During very wet years with high volumes of storm runoff, most of the annual pesticide load in the streams are storm-runoff related. However, during normal to dry years, the majority of the annual pesticide load is a result of the baseflow contribution. This is another indication of the link between surface water, recharge, ground water, and stream flow.

General information:
Farmers in the Middle Branch Watershed (MBW) and South Branch Watershed (SBW) of the Whitewater River.

The Middle Branch and South Branch Watersheds were surveyed in 2005. A previous survey was completed in 1997 on the watershed area of the Middle Branch Watershed upstream of the MDA's water monitoring location. This area will be referred to as the Monitoring Watershed (MW).

Local Soil and Water Conservation District personnel, Extension Educators, and Natural Resources Conservation Services personnel were contacted in January 2006 informing them of the specifics of the farm surveys and the overall goals. The Soil and Water Conservation District, National Resources Conservation Service and Minnesota Extension Service 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.

One forty acre plot was randomly chosen from each section within the each watershed. The name of the operator on each of these plots were pooled and then randomly drawn for selection of the interview process. The goal was to randomly draw 30 farm operations from each watershed to be surveyed. Introduction letters signed by the Commissioner of Agriculture were mailed out to each of the farmers who managed those 40 acres. All of the farmer's land within the Middle Branch and South Branch watershed boundaries was inventoried. Letters were sent in February of 2006. The local SWCD contacted farmers to inform them of the local involvement in the surveys. Next, the MDA contacted the farmers to inquire if they would be involved in the survey process. Once a farmer agreed to be interviewed, information was gathered on all acres operated within both watersheds. Several of these farmers operated as one operation sharing a variety of equipment and land. Interviews of the farmers in the MW in 1997 included more distinct farm operations than the 2005 survey.

Nutrient Information of the Selected Farms in the Middle Branch Watershed and the South Branch Watershed of the Whitewater River.

Inventory forms and database design were patterned after a previous successful project[1]. The following types of information were collected on a field-by-field basis for all inventoried acres within the Whitewater River through FANMAP interviews:

- 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);
- Pesticide information (product, rate, timing, etc);
- Soil and manure testing results if available;
- Tillage practices;
- Sinkholes and streams;
- Livestock types;
- Manure storage, application rates and application timing;

Nutrient and pesticide inputs, and crop yields, were specific for the 2005 cropping season. Crop types and manure applications (starting in the fall of 2004) were also collected to quantify nutrient crediting for the 2005 season. Long-term yield data generally reflected the past 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 dealer if the dealer kept the farmer's records. Tillage practices were also included in the survey.

Characteristics of the Selected Farms in the Middle Branch Watershed and the South Branch Watershed of the Whitewater River.

Sixty-six farmers were interviewed in February of 2006. Thirty-seven farmers were interviewed in the SBW and 29 farmers were interviewed in the MBW. In the previous 1997 survey, 22 farmers were surveyed in the MW.

Farmland in the MBW and the SBW was 29,053 acres and 45,143 acres, respectively. Farmland included all land classified as cultivated crops, grassland and pasture[2]. Farmland surveyed in the MBW totaled 12,338 acres (42% of farmland available) and farmland surveyed in the SBW totaled 15,186 acres (34% of farmland available). In 1997 the FANMAP survey covered 6,527 or approximately 40% of the farmland available for farming operations in the MW. A total of 27,524 acres of farmland across both watersheds was included in the 2005 survey results.

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

[2] Information on land cover was gathered from the USGS 2001 National Land Cover Database.

Table 1 lists crop type, acres, and percentage of total surveyed acres for the SBW, MBW, and MW of the Whitewater River.

Table 1. Crop Type, Acres, and the Percentage of Total Crop Acres in the Middle Branch Watershed, South Branch Watershed and the Monitoring Watershed of the Whitewater River[3].

	SBW	SBW	MBW	MBW	1997 MW	1997 MW
Crop	**Acres**	**Percentage**	**Acres**	**Percentage**	**Acres**	**Percentage**
Corn	8,055	53%	6,693	54%	3,069	47%
Soybean	3,822	25%	3,067	25%	1,532	23%
Sweet Corn	194	1%	258	2%	254	4%
Alfalfa	1,903	13%	1,747	14%	747	11%
Small Grains	90	1%	10	0%	185	3%
Pasture	623	4%	171	1%	467	7%
Peas	354	2%	317	3%	*[4]	*
Other[5]	145	1%	75	1%	273	2%
Totals	15,186	100%	12,338	100%	6,527	100%

Commercial Fertilizer Use

Commercial Nitrogen (N)

Field corn accounted for 96% of all commercial nitrogen (N) fertilizer applied on the 66 farms within the survey. A total of 2,024,080 pounds of N was applied on the surveyed acres. The MBW surveyed acres received 1,036,468 pounds of N and the SBW received 987,612. Field corn accounted for 96% of N in both the MBW the SBW. In 1997 study, MW farmers applied a total of 458,322 pounds (89%) of the N to field corn.

Ninety-eight percent (98%) of all field corn acres received commercial N fertilizer. All field corn acreage received either commercial N fertilizer or manure N. Commercial N rates across all fertilized field corn acres averaged 149 lb/A in the MBW and 121 lb/A in the SBW (Table 2). In the MW survey, 99% of inventoried corn acres were fertilized at an average rate of 133 lb/A. Total N inputs will be discussed later in the "Nutrient Balances and Economic Considerations" section of this report.

[3] The Middle Branch Watershed and the South Branch Watershed were surveyed in 2005 and the Monitoring watershed was surveyed in 1997.

[4] Pea acres were not recorded separately in 1997. They were included in the Other category.

[5] Other includes CRP, Buckwheat and grasses

Table 2. Crop Type, N Fertilized Acres, Percentage of Crop Acres Applied With N, and the N Rate per Fertilized Acre in the Middle Branch Watershed and South Branch Watershed of the Whitewater River.

	SBW	SBW	SBW	MBW	MBW	MBW
Crop	**Acres Fertilized**	**Percent Applied with N**	**Rate per Acre Fertilized[6]**	**Acres Fertilized**	**Percent Applied with N**	**Rate per Acre Fertilized**
Corn	7,812	97%	121	6,651	99%	149
Soybean	362	9%	9	441	14%	2
Sweet Corn	194	100%	124	233	90%	132
Alfalfa	450	24%	9	135	8%	6
Peas	269	76%	27	317	100%	39
All Other Crops	180	21%	9		0%	0
Totals/averages	9,267	61%	107	7,777	63%	133

Eighty-six percent (86%) of the commercial N applied to inventoried acres was as a spring pre-plant application in the SBW (Figure 1) and 84% in the MBW (Figure 2).

Ninety-three percent (93%) of the N was spring applied (either pre-plant or starter) and the other 7% was applied sidedress to **corn** acres, which accounted for 89% of all commercial N, in the 1997 MW.

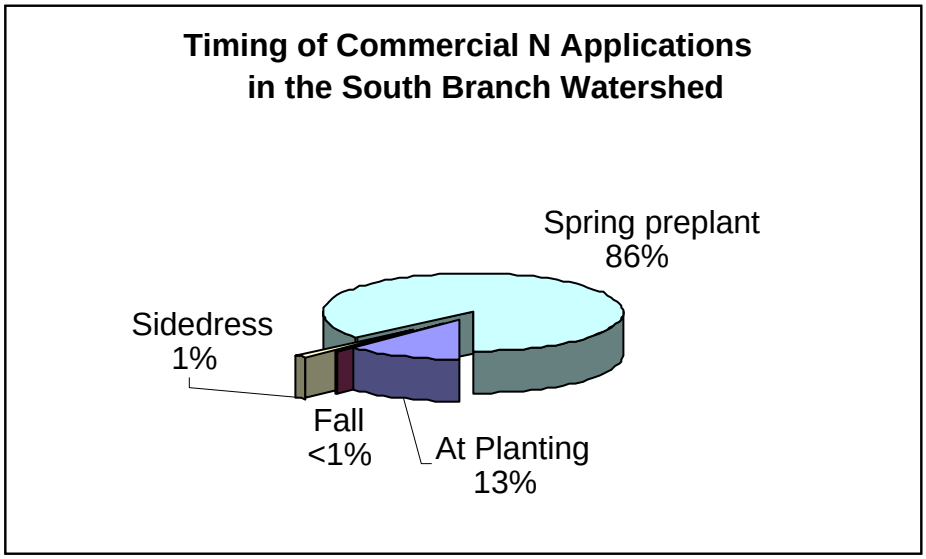


Figure 1. Timing of commercial N applications across all 9,267 fertilized acres in the South Branch Watershed.

[6] Rate per Acre Fertilized is determined by N applied across all fertilized acres.

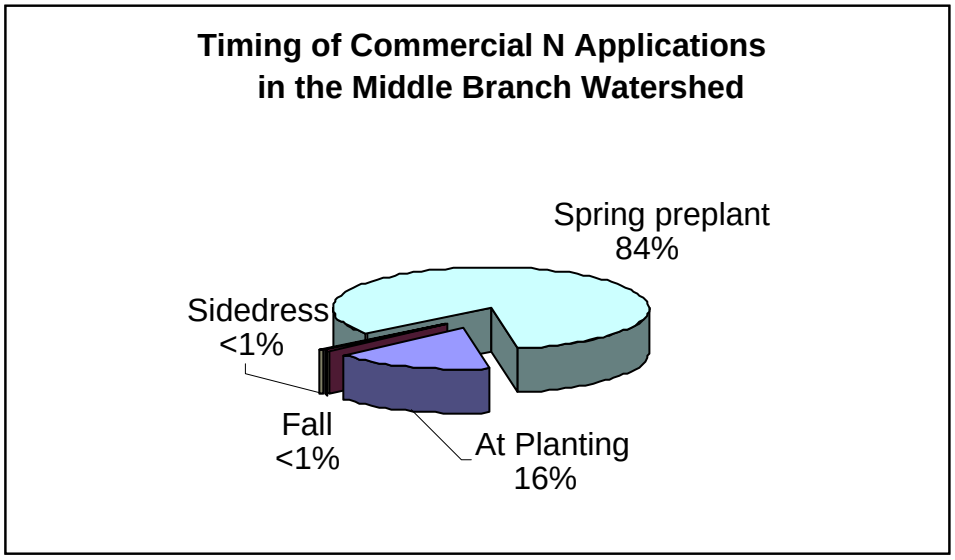


Figure 2. Timing of commercial N applications across all 7,777 fertilized acres in the Middle Branch Watershed.

Anhydrous ammonia supplied 51% of all commercial N on inventoried acres in the SBW (Figure 3) and 73% of all commercial N in the MBW (Figure 4).

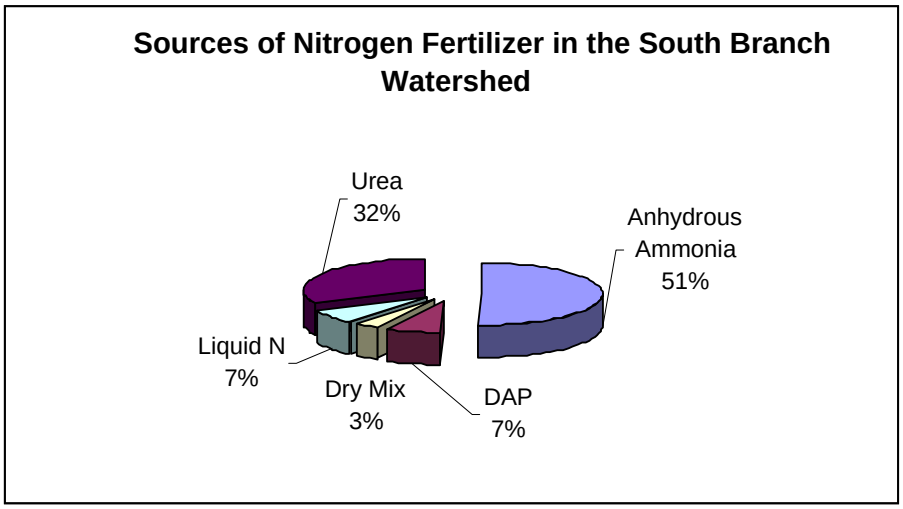


Figure 3. Sources of commercial N used on inventoried acres[7].

[7] Diamonium Phosphate is represented as DAP.

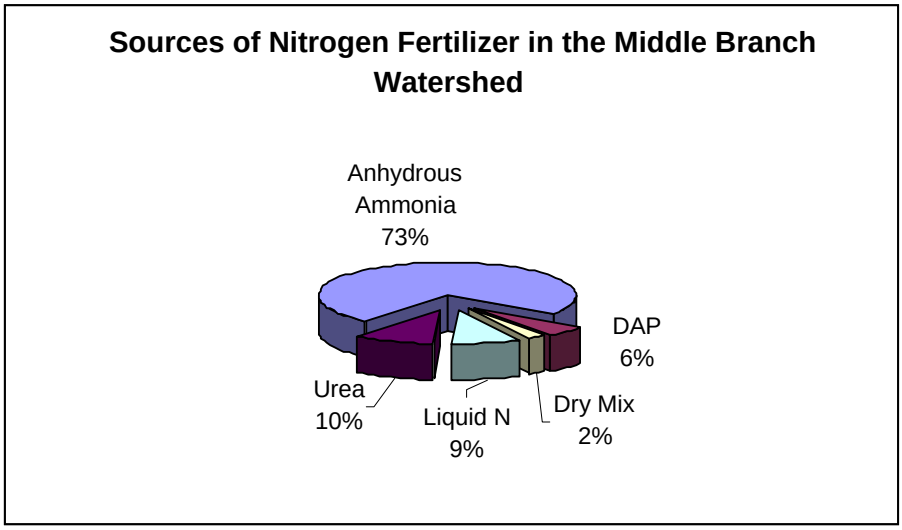


Figure 4. Sources of commercial N used on inventoried acres[8].

Commercial N Applications on Field Corn

Specific Best Management Practices for nitrogen use have been developed for southeast Minnesota[9]. Applications of nitrogen before spring planting of field corn are highly recommended in the Whitewater watershed.

Eighty-six percent (86%) of the commercial N applied to inventoried corn acres was as a spring pre-plant application in the SBW (Figure 5) and 83% of the commercial N applied to inventoried corn acres was as a spring pre-plant application in the MBW (Figure 6). Fall application of commercial N is not recommended and less that 1% of corn acres received any commercial N in the fall. As stated earlier, 93% of the N was spring applied (either pre-plant or starter) and the other 7% was applied sidedress to **corn** acres, which accounted for 89% of all commercial N, in the 1997 MW.

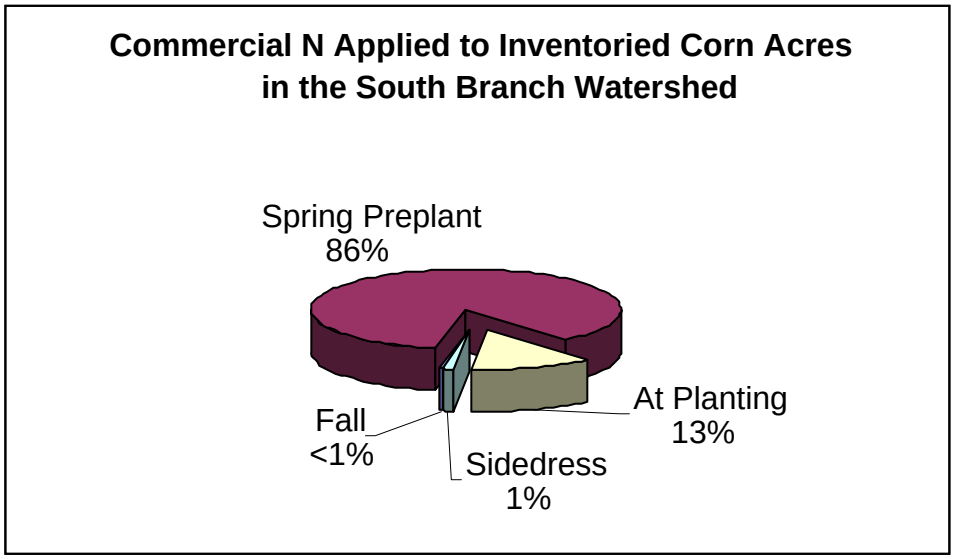


Figure 5. Timing of commercial N applications across all 8,055 corn acres in the South Branch Watershed.

[8] Diamonium Phosphate is represented as DAP.

[9] Best Management Practices for Nitrogen Use in South-East Minnesota. M.A. Schmitt, G.W. Randall, University of Minnesota.

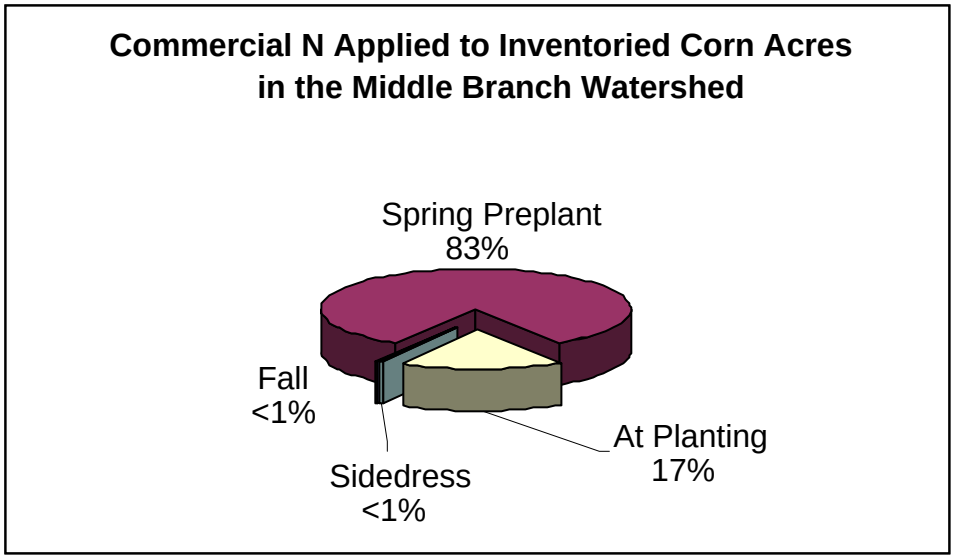


Figure 6. Timing of commercial N applications across all 6,693 corn acres in the Middle Branch Watershed.

Fall applications of N were only in the form of DAP as farmers were generally fall applying fertilizer for the phosphorus source. Anhydrous ammonia supplied 53% of all commercial N on inventoried corn acres in the SBW (Figure 7) and 76% in the MBW (Figure 8). In the 1997 MW, anhydrous ammonia supplied 59% and urea supplied 29% of the commercial N to inventoried corn acres.

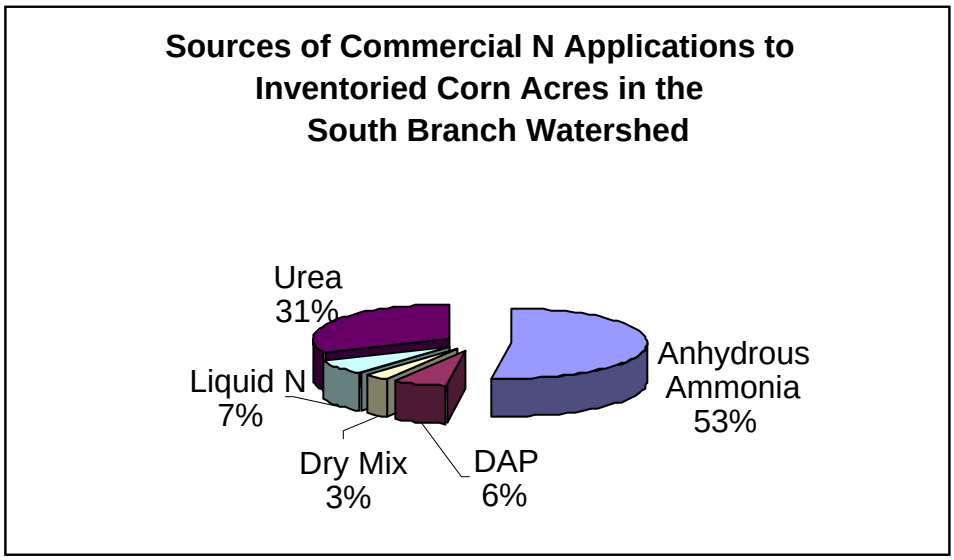


Figure 7. Sources of commercial N used on inventoried corn acres[10].

[10] Diamonium Phosphate is represented as DAP.

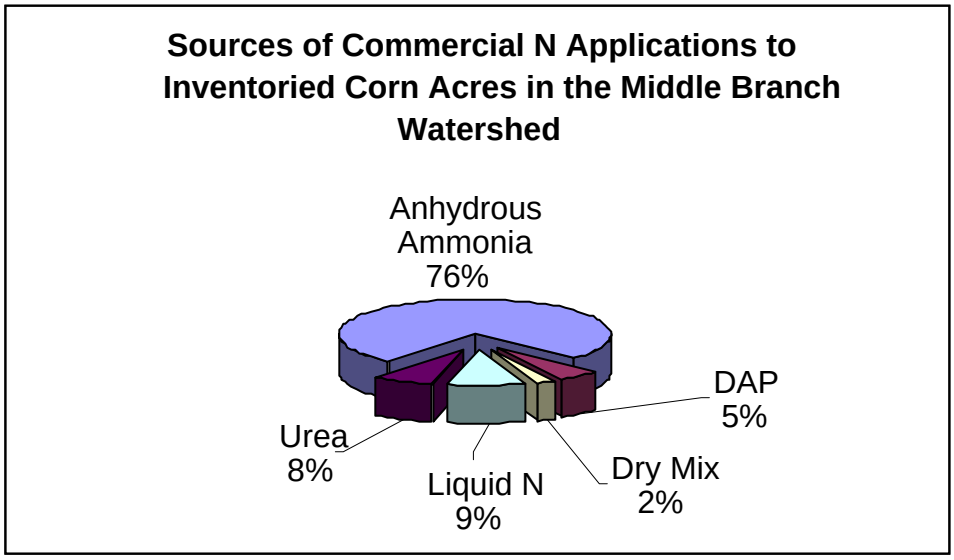


Figure 8. Sources of commercial N used on inventoried corn acres[11].

There was no use of nitrogen inhibitors for any N sources on any crop acres in the survey.

Commercial N Applications on Other Crops

A small percentage (4%) of the commercial N was applied to crops other than corn. Sweet corn accounted for 3% of all commercial N applications across both watersheds. A total of 54,654 pounds of commercial N was applied on 427 inventoried sweet corn acres resulting in a 128 lb/A N average across all sweet corn acres. Anhydrous ammonia accounted for 76% of all commercial N applied to inventoried sweet corn acres (Figure 9).

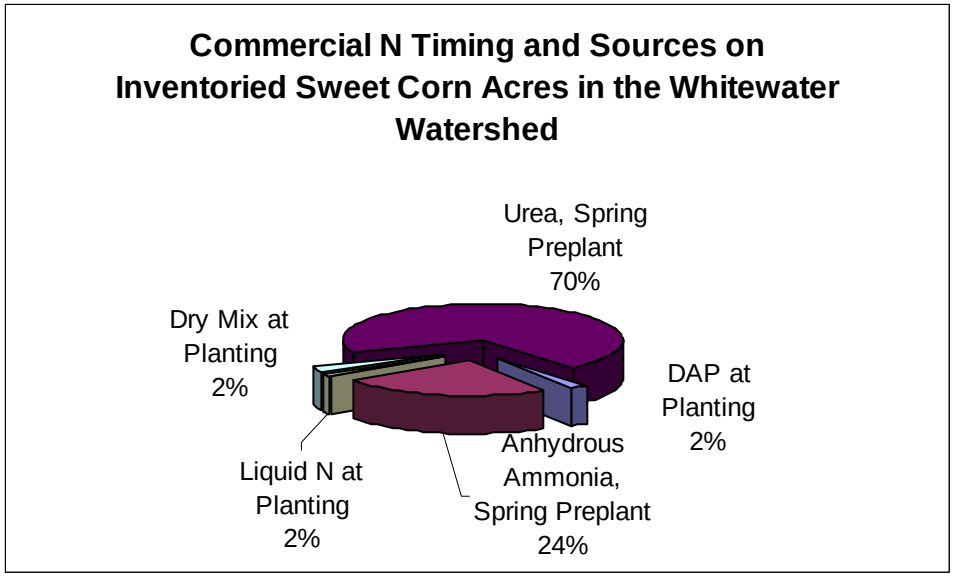


Figure 9. Sources of commercial N used on inventoried sweet corn acres[12].

[11] Diamonium Phosphate is represented as DAP.
[12] Diamonium Phosphate is represented as DAP.

Pea acres accounted for less than 1 percent of all commercial N applied on the inventoried acres of the Whitewater watershed. A total of 19,267 pounds of commercial N was applied in the form of urea or DAP as a spring preplant on 586 inventoried pea acres.

Less than 1 percent of the N went on a variety of other crops and was generally in the form of DAP.

Commercial Phosphorus

A total of 559,416 pounds of commercial P_2O_5 was applied in 2005. Field corn accounted for more than 88% of the 292,582 pounds of commercial P_2O_5 fertilizer applied in the SBW (Figure 10) and 92% of the 266,835 pounds in the MBW (Figure 11). Commercial P_2O_5 data was not analyzed for the 1997 MW.

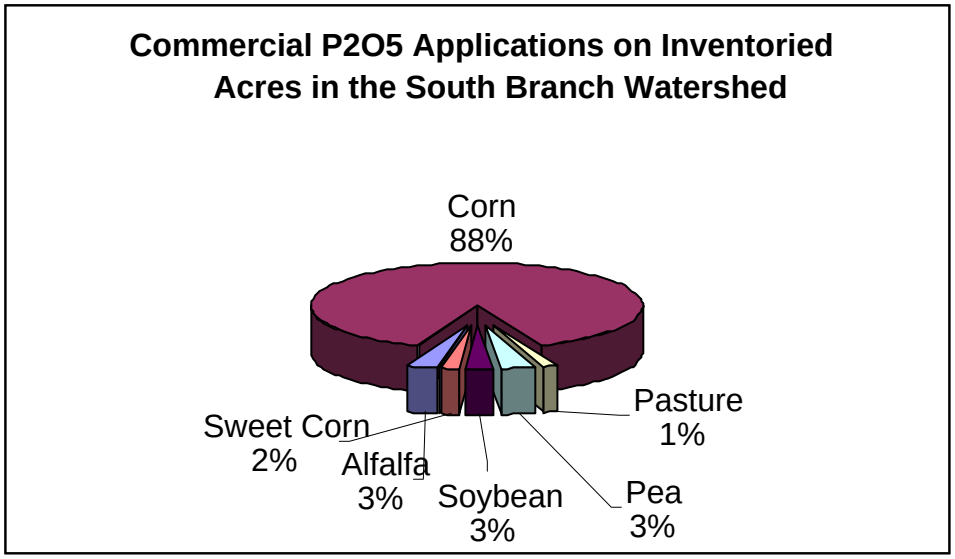


Figure 10. Commercial P_2O_5 applications on inventoried crop acres in the South Branch Watershed.

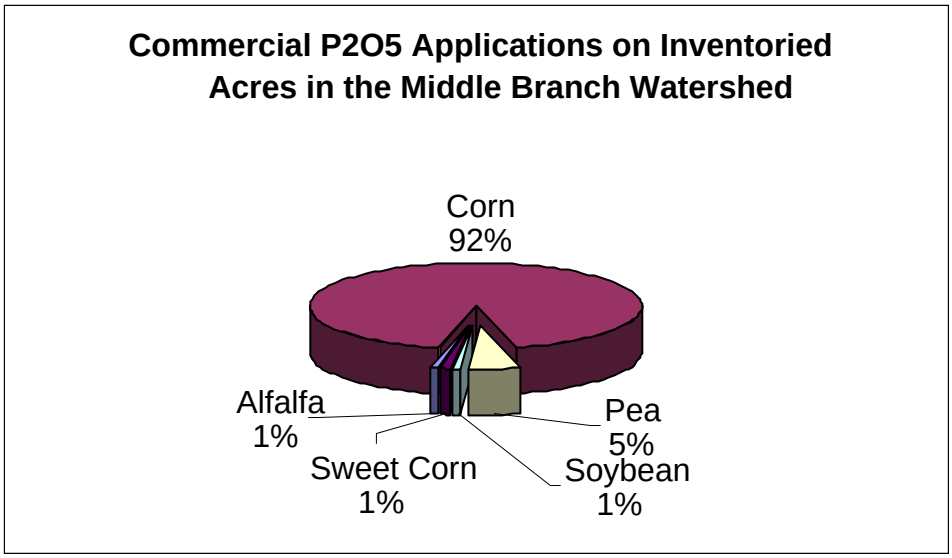


Figure 11. Commercial P_2O_5 applications on inventoried crop acres in the Middle Branch Watershed.

DAP or other dry mixes accounted for 83% of commercial P_2O_5 applied across the inventoried acres in the Whitewater watershed. Liquid fertilizers accounted for the other 27%.

Eighty-five percent (85%) of the commercial P was applied at planting on inventoried acres (Figure 12).

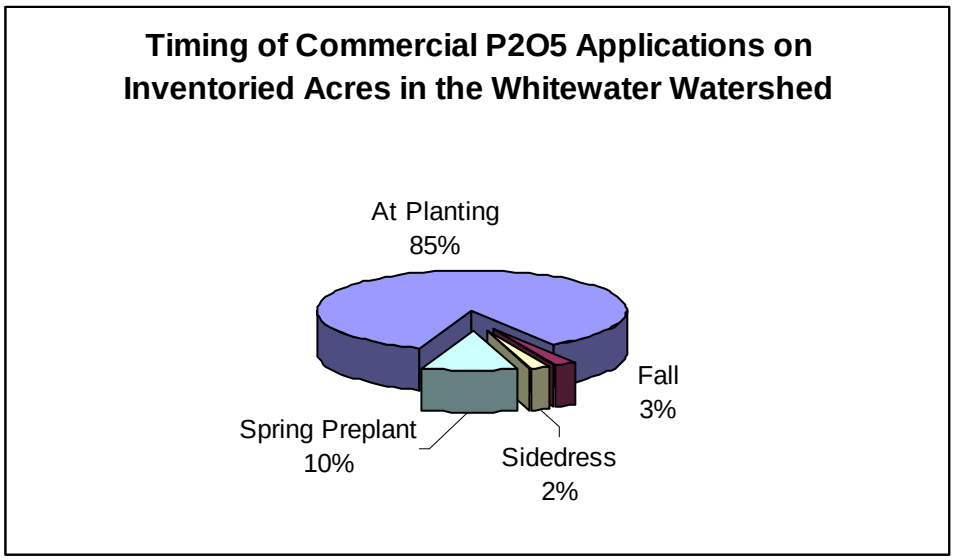


Figure 12. Timing of commercial P_2O_5 applications across all inventoried acres.

Commercial P_2O_5 Applications on Field Corn

A total of 257,105 pounds of P_2O_5 was applied to inventoried corn acres in the SBW. Sixty-two percent (62%) of the commercial P_2O_5 was applied as a dry fertilizer at planting (Figure 13). The vast majority of the dry fertilizer was in the DAP form.

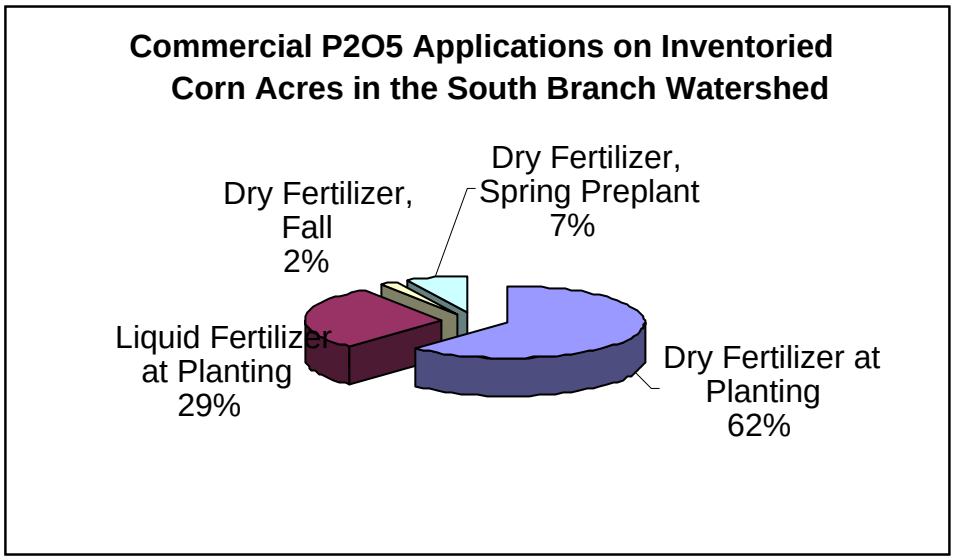


Figure 13. Timing of commercial P_2O_5 applications across all inventoried corn acres in the South Branch Watershed.

A total of 247,003 pounds of P_2O_5 was applied to inventoried corn acres in the MBW. Sixty-six percent (66%) of the commercial P_2O_5 was applied as a dry fertilizer at planting (Figure 14). The vast majority of the dry fertilizer was in the DAP form.

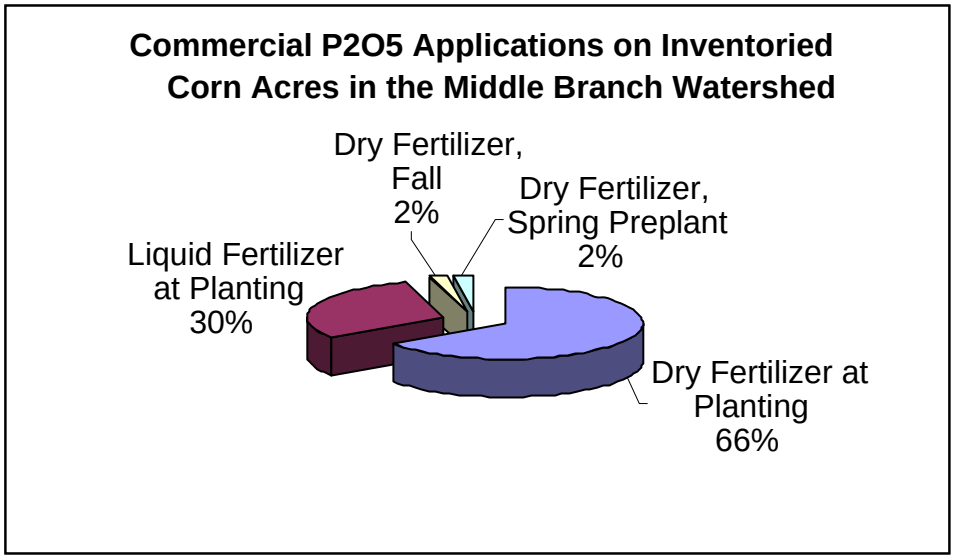


Figure 14. Timing of commercial P_2O_5 applications across all inventoried corn acres in the Middle Branch Watershed.

Commercial P_2O_5 Applications on Other Crops.

Pea acres accounted for 4% of the P_2O_5 applied the Whitewater Watershed. All P_2O_5 was applied as a DAP spring preplant application. Applications on other crops were limited and did not allow for analysis.

Livestock and Manure Characteristics on Selected Farms in the Whitewater Watershed:

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 quantified to complete the "whole farm" nutrient balance. Livestock numbers in Table 3 represent the livestock inventory on hand from the fall of 2004 to the summer of 2005. It is assumed that the livestock manure generated during this time period was applied at some point in time to the 2005 crops. Twenty-three of the 37 farmers in the SBW had livestock and 19 of the 29 farmers in MBW had livestock.

Animal production on these farms consisted of dairy, beef, sheep, hog and buffalo operations. Livestock was more dominant in the SBW than in the MBW. Table 3 details the variety of animals raised in the Whitewater Watershed.

Table 3. 2005 Distribution of Livestock Across Inventoried Farms		
Livestock Type	**Livestock Number**	
	SBW	MBW
Dairy Cows/Bulls	3,210	691
Dairy Calves/Heifers/Steers	2,590	1375
Boars/Sows	710	99
Hog Feeders	0	180
Hog Finishers[13]	15,040	1,500
Beef Cows/Bulls	492	285
Beef Calves/Finishers	1,348	268
Sheep	67	0
Buffalo	32	0
TOTALS	**23,489**	**4,398**

Nutrients supplied through manure production totaled 1,742,887 pounds of N and 872,824 pounds of P. However, all manure was not collected due to such scenarios as over-wintering on fields or use of pasture where manure is not collected. Manure production by type of livestock is listed in Table 4. A total of 1,329,928 pounds of N was produced in the SBW and a total of 404,279 pounds of N was produced in the MBW[14].

Table 4. Manure Nitrogen and P_2O_5 Produced in the Middle Branch and South Branch Watersheds by Livestock Type for the 2005 Season.

	Nitrogen	**P_2O_5**	**Nitrogen**	**P_2O_5**
Livestock Type	**SBW**	**SBW**	**MBW**	**MBW**
Dairy Cows/Bulls	696,570	320,964	149,947	69,004
Dairy Calves/Heifers/Steers	320,061	129,927	191,334	77,043
Boars/Sows	18,530	12,830	2,609	1,807
Hog Feeders	0	0	180	180
Hog Finishers[15]	138,960	93,840	14,600	10,100
Beef Cows/Bulls	64,946	49,447	37,673	28,669
Beef Calves/Finishers	83,576	63,356	7,936	12,596
Sheep	725	309	0	0
Buffalo	6560	2752	0	0
TOTALS	1,329,928	673,425	404,279	199,399

Dairy livestock produced the most nutrients through manure. Dairy manure produced 76% of the manure nutrients in the SBW and 66% of the manure nutrients in the MBW.

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

[14] Manure Storages, MWPS-18 Section 2.

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

Dairy manure was collected through both liquid manure pits and solid systems of barns and lots. Of the beef cattle manure that was collected, all was collected as a solid through barns or lots. The majority of manure produced by hogs was collected as a liquid through manure pits. No manure was collected for spreading on crop acres from sheep and buffalo as these animals were on pasture and manure applications were on pasture. Sixty percent (60%) of the dairy manure N was retained in the SBW (Table 5) and 84% of the dairy manure N was retained in the MBW (Table 6).

Table 5. Manure N and P Produced and Collected to be Spread on Inventoried Acres of the South Branch Watershed for the 2005 Crop Season.

	Nitrogen			P_2O_5		
Livestock Type	**Nitrogen Produced**	**Nitrogen Collected**	**Percent Collected**	**P_2O_5 Produced**	**P_2O_5 Collected**	**Percent Collected**
Dairy	1,016,631	613,203	60%	450,891	277,580	61%
Beef	148,522	64,337	43%	112,803	48,821	43%
Hogs	157,490	157,490	100%	106,670	106,670	100%
Sheep/Buffalo	7,285	0	0%	3,061	0	0%
TOTALS	1,329,928	835,030		673,425	433,071	

Table 6. Manure N and P_2O_5 Produced and Collected to be Spread on Inventoried Acres of the Middle Branch Watershed for the 2005 Crop Season.

	Nitrogen			P_2O_5		
Livestock Type	**Nitrogen Produced**	**Nitrogen Collected**	**Percent Collected**	**P_2O_5 Produced**	**P_2O_5 Collected**	**Percent Collected**
Dairy	341,281	286,986	84%	146,047	123,173	84%
Beef	45,609	18,789	41%	41,265	14,281	35%
Hogs	17,389	16,585	95%	12,087	11,475	95%
Sheep/Buffalo	0	0	0	0	0	0
TOTALS	404,279	322,360		199,399	148,929	

Manure nutrient losses, especially manure N, occur within a manure handling system through volatilization, leaching and runoff[16]. Table 7 details the manure handling system losses for manure N by type of livestock. Except for minor losses of P_2O_5 and K on open lots, most of the P_2O_5 and K were retained in manure systems and was available to be spread on inventoried acres. Some of the manure was eventually applied outside the watershed.

[16] Manure Storages, MWPS-18 Section 2.

Table 7. Manure N losses From the Manure Handling System by Type of Livestock Within the Whitewater Watershed for the 2005 Crop Season.

	South Branch Watershed			Middle Branch Watershed		
	Nitrogen Collected	Nitrogen Retained	Percent Retained	Nitrogen Collected	Nitrogen Retained	Percent Retained
Livestock Type						
Dairy	613,203	411,428	67%	286,986	188,008	66%
Beef	64,337	40,995	64%	18,789	11,460	61%
Hogs	157,490	122,055	78%	16,585	11,970	72%
TOTALS	**835,030**	**574,478**		**322,360**	**211,438**	

Manure imported from outside the watershed was applied to 730 acres within the watershed. Imported manure was applied on 500 acres of corn and 230 acres of other crops including sweet corn, hay, peas and soybeans.. A total of 139,864 pounds of manure N and 117,799 pounds of P_2O_5 was applied from imported manure on watershed acres. Seventy-one percent (71%) of the imported manure was turkey manure with the balance cattle and hog manure. Generally 80% of the P_2O_5 was available for the following crop. Application losses are addressed in the in the application analysis.

Many farms, including several large dairies, were located on the edges of the watershed. Some of these farms applied manure outside the watershed that was produced inside the watershed. Likewise, some farms located just outside the watershed applied manure inside the watershed.

Large dairies in the watershed have satellite farms that raise heifers in different stages. For example, some farmers raised dairy heifers from 6 months to one year and then they went to another satellite farm. This practice allows farmers to have specific practices for a specific age of heifer, such as a consistent feed program.

Manure was applied on a total of 5,711 inventoried acres within the Whitewater watershed. Manure was applied on 3,686 acres within the SBW and 2,025 acres in the MBW. Eighty-four percent (84%) of the manure applied acres were planted to corn within the SBW and 88% of the manure applied acres were planted corn within the MBW.

Manure N application losses vary by animal type and also by type of application and incorporation. Manure P_2O_5 available to the crop following application is consistently 80% of P_2O_5 applied through manure. A percentage of the applied manure nutrients is available the second and third years after application. A total of 969,063 pounds of N was applied before application losses and a total of 687,409 pounds of P_2O_5 was applied before applications losses. Table 8 details the application losses. Because of the addition of the imported manure and the application of some manure applied outside the watersheds, the amounts of manure applied is different than the amount retained from the manure handling systems table.

A total of 415,531 pounds of N and 584,299 pounds of P_2O_5 was available for the 2005 season across all surveyed acres.

Table 8. Manure N and P_2O_5 spread on inventoried acres before and after application losses[17] for the 2005 crop season.

	SBW				MBW			
	Nitrogen		P_2O_5		Nitrogen		P_2O_5	
Livestock Type	Applied	Available	Applied	Available	Applied	Available	Applied	Available
Beef	62,220	21,516	60,832	51,707	49,371	22,703	38,487	32,714
Dairy	460,067	181,427	267,196	227,117	205,228	75,345	119,700	101,745
Hog	86,991	65,243	84,935	72,195	5,890	2,814	3,660	3,111
Turkey	42,096	18,943	57,600	48,960	57,200	27,540	55,000	46,750
Totals	651,374	287,129	470,563	399,979	317,689	128,402	216,847	184,320

Fifty-three percent (53%) of the first year available N was applied in the spring on inventoried acres in the SBW (Figure 15).

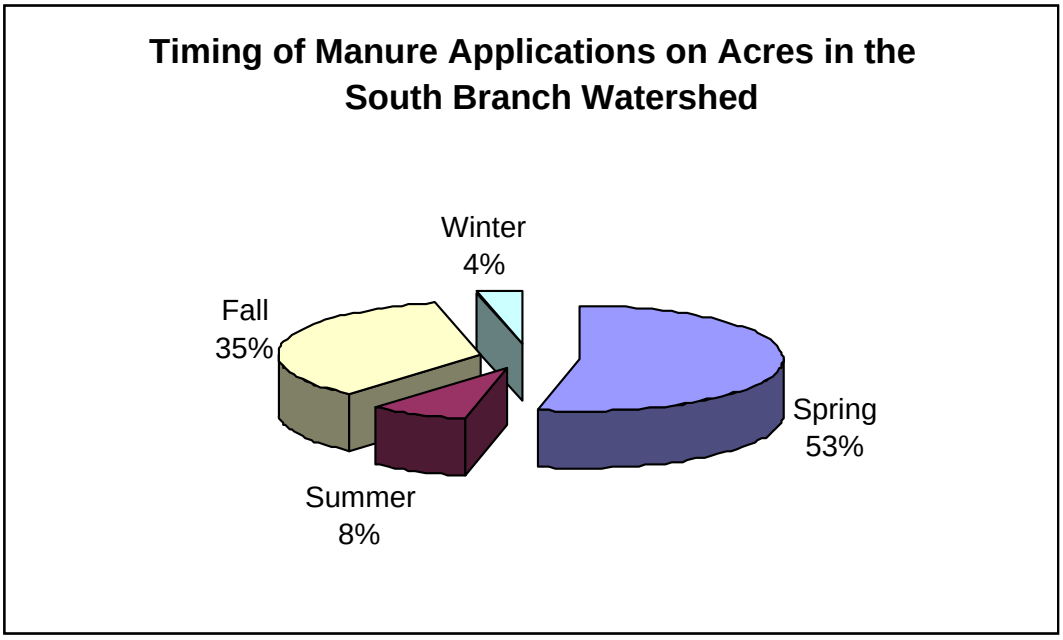


Figure 15. Timing[18] of first year available manure N on inventoried acres in the SBW.

[17] Application losses based on Manure Storages MWPS-18 Section 2.
[18] Timing based on pounds of N available to the 2005 crop.

Sixty-two percent (62%) of the first year available N was applied in the spring on inventoried acres in the SBW (Figure 16).

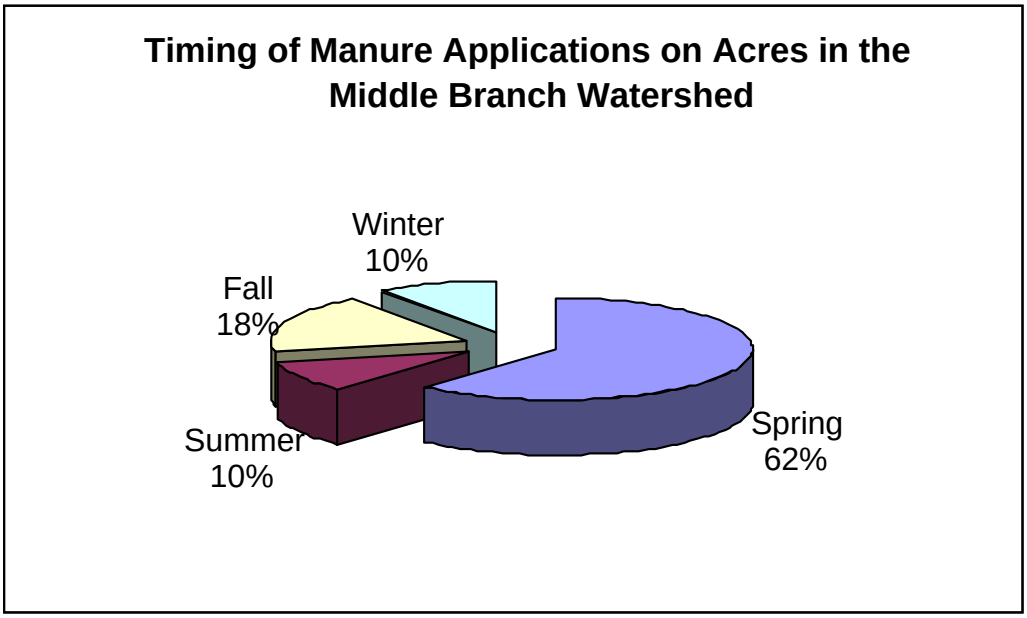


Figure 16. Timing[19] of first year available manure N on inventoried acres in the MBW.

In the 1997 survey of farmers in the MW, only 29% of the manure was applied during a spring application as shown in Figure17. Increases in spring applications are due to less tillage used and better manure handling systems that allow collection rather than the need to spread on a frequent basis.

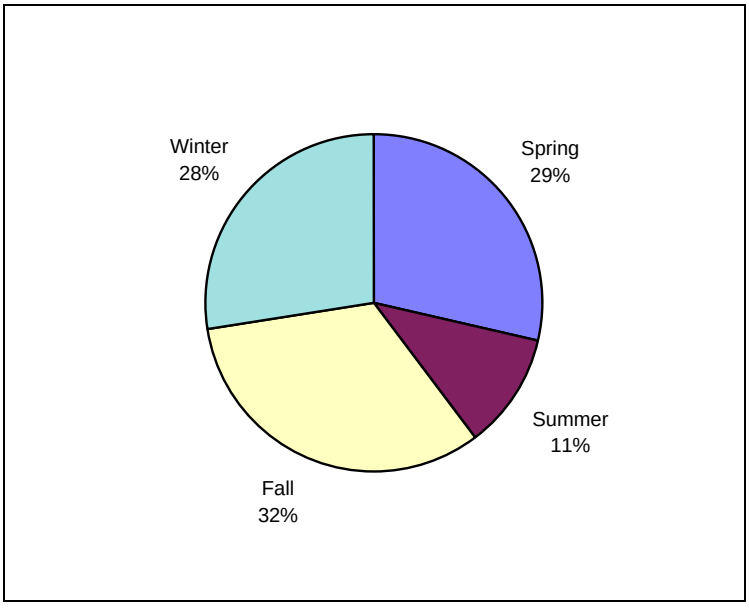


Figure 17. Timing[20] of first year available manure N on inventoried acres in the 1997 survey of farmers in the MW.

[19] Timing based on pounds of N available to the 2005 crop.

[20] Timing based on pounds of N available to the 2005 crop.

Manure applications on inventoried corn acres consisted of injection, broadcast with no incorporation and broadcast with incorporation. Incorporation of broadcast applications accounted for 69% of all manure based on N in the SBW (Figure 18) but only 36% of the manure in the MBW (Figure 19).

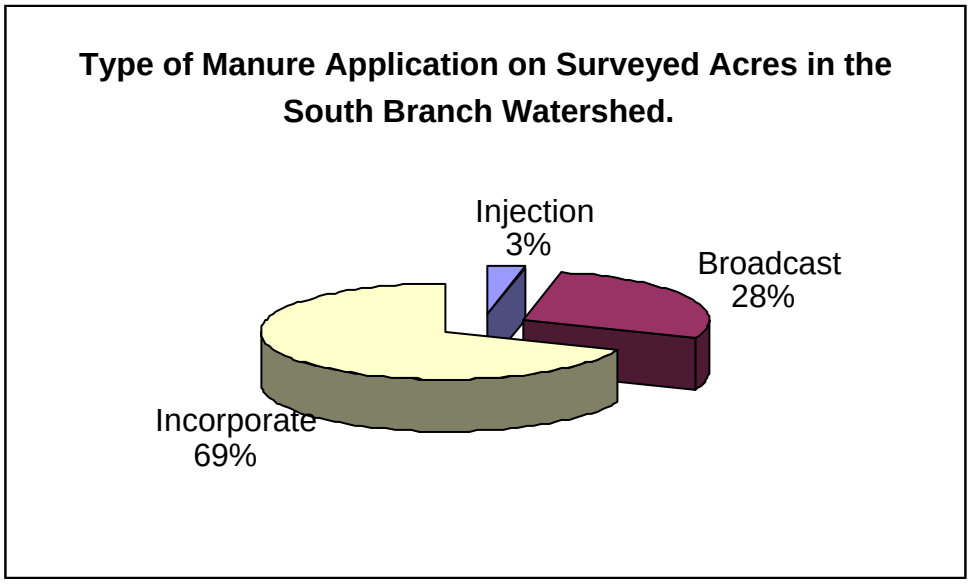


Figure 18. Application methods of manure applications on inventoried corn acres in the SBW.

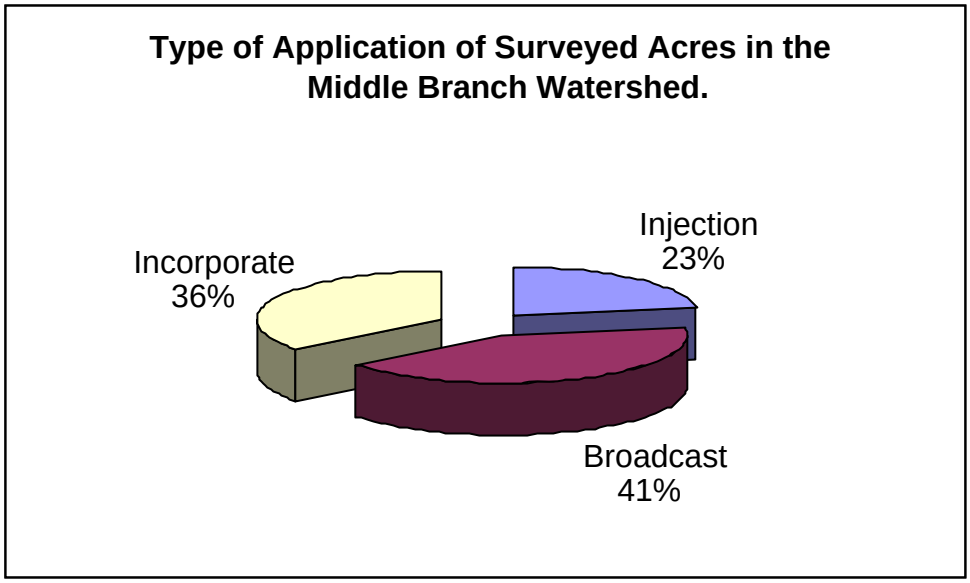


Figure 19. Application methods of manure applications on inventoried corn acres in the MBW.

Nutrients supplied by livestock varied by the type and quantity livestock. On surveyed farms, dairy manure contributed the largest percentage of N contributed by livestock type for the SBW (Figure 20) and the MBW (Figure 21). Dairy livestock also provided over 60% of the manure based on N content in the 1997 survey of farmers in the monitoring watershed.

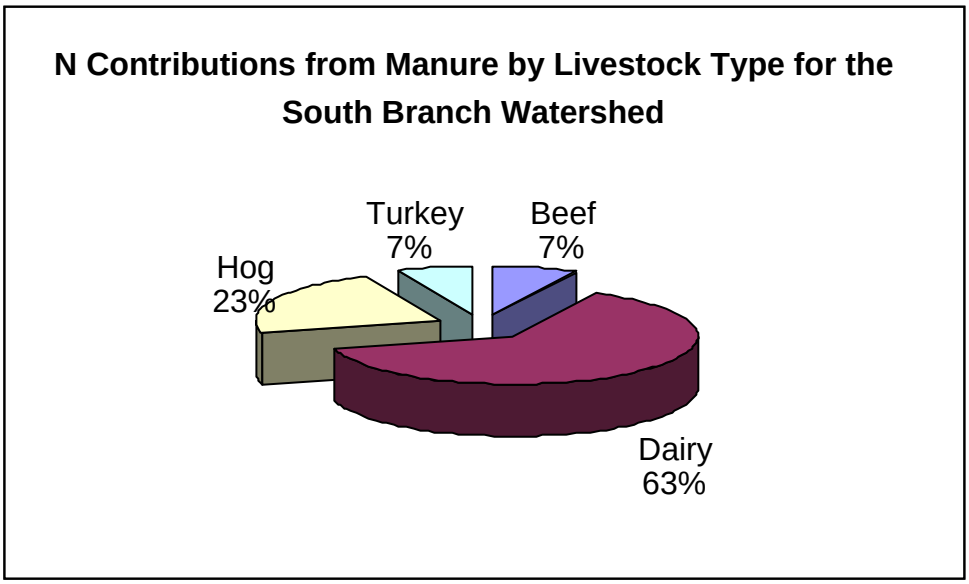


Figure 20. Manure 1st year available N for surveyed acres by livestock type for the SBW.

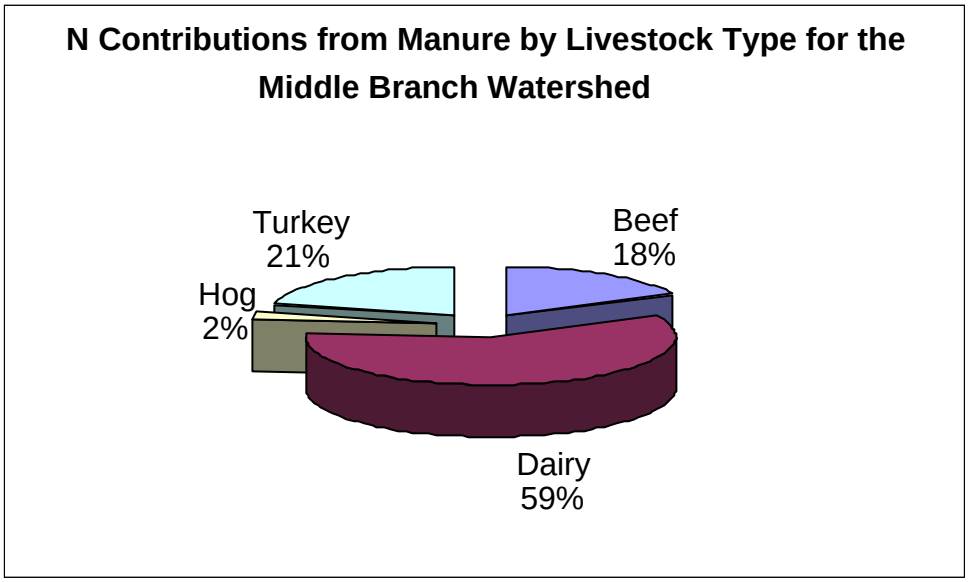


Figure 21. Manure 1st year available N for surveyed acres by livestock type for the MBW.

A total of 415,531 pounds of N and 584,299 pounds of P_2O_5 was available for the 2005 season from manure applied across 5,711 surveyed acres.

Relative Importance of Nutrient Sources on the Selected Farms: Whitewater Watershed

Commercial N applications accounted for 83% of the total N applied on inventoried corn acres with the balance of N contributed from manure across both watersheds. A total of 2,439,610 pounds of N were applied on inventoried fields. Table 9 details the contributions of N from both manure and commercial N applied on acres in each watershed.

Table 9. Nitrogen Use on Surveyed Acres Across Both Watersheds.

Watershed	Commercial N	Percent	Manure N	Percent	Total N
SBW	987,612	77%	287,129	23%	1,274,741
MBW	1,036,468	89%	128,402	11%	1,164,869
Both	2,024,080	83%	415,531	17%	2,439,610
MW (1997)	410,850	94%	24,750	6%	435,600

Commercial P_2O_5 applications accounted for 49% of the total P_2O_5 applied on inventoried corn acres with the balance of P_2O_5 contributed from manure across both watersheds. A total of 1,143,715 pounds of P_2O_5 were applied on inventoried fields. Table 10 details the contributions of P_2O_5 from both manure and commercial P_2O_5 applied to the various inventoried crops by watershed. There was no P_2O_5 analysis on the 1997 MW.

Table 10. P_2O_5 Use on Surveyed Acres Across Both Watersheds.

Watershed	Commercial P_2O_5	Percent	Manure P_2O_5	Percent	Total P_2O_5
SBW	292,582	42%	399,979	58%	692,561
MBW	266,835	59%	184,320	41%	451,154
Both	559,417	49%	584,298	51%	1,143,715

Table 11 details the contributions of N and P_2O_5 from both manure and commercial sources applied to the various inventoried crops by watershed. In both watersheds, 95% of the N was applied to corn acres. However in regards to P_2O_5, 86% was applied to corn in the SBW and 92% was applied to corn in the MBW.

Table 11. Total N and P_2O_5 Applied in Each Watershed by Crop for the 2005 Season.

	SBW			MBW		
Crop Type	**Acres**	**Nitrogen**	**P_2O_5**	**Acres**	**Nitrogen**	**P_2O_5**
Alfalfa	1,903	13,747	34,902	1,747	12,866	16,850
Corn	8,055	1,200,096	595,401	6,693	1,105,589	413,317
Other	145	5,655	9,121	75	0	0
Oats	90	1,024	2,097	10	0	0
Pasture	623	1,620	4,140	171	63	205
Peas	354	12,454	18,652	317	12,381	13,528
Soybean	3,822	16,176	23,651	3,067	1,479	4,226
Sweet Corn	194	23,969	4,597	258	32,491	3,029
TOTALS	**15,186**	**1,274,741**	**692,561**	**12,338**	**1,164,869**	**451,154**

It is important that producers recognize and take the appropriate N credit for past legume crops. The UM recommendations for corn are reduced 75 to 100 pounds N per acre for alfalfa depending on the density of the alfalfa stand and 40 pounds N per acre or more for soybeans, dependent on yield. In this study alfalfa was the previous crop to corn on 3,650 acres. Based on the stand density the first-year alfalfa credit given was 75 pounds N per acre. Alfalfa credits for second year were available on 492 acres at 50 pounds N per acre.
Soybeans, the most important source of legume N in this study, supplied 40 pounds of N per acre to all 6,784 inventoried corn acres previously in soybeans in 2004.

Commercial fertilizers (67%), manures (14%), and legumes (19%) contributed a total of 3,009,321 lb of "first year available N" to all inventoried acres in 2005 (Figure 22). Figure 23 and Figure 24 detail the first year available N in both the SBW and the MBW. In the 1997 survey of farmers, 83% of the N was from commercial fertilizers.

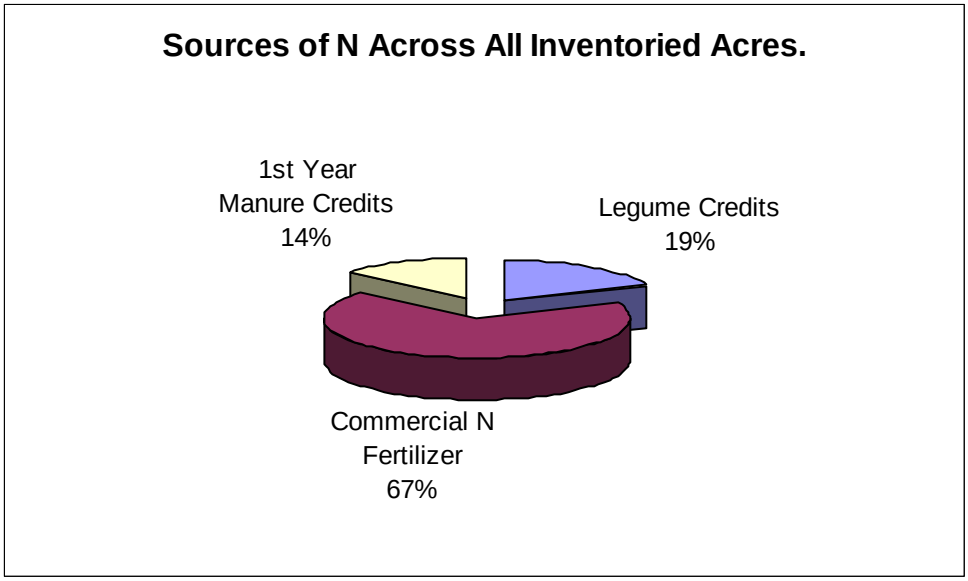


Figure 22. Relative N contributions from fertilizers, manures and legumes across all acres inventoried in 2005. Nitrogen inputs totaled 3,009,321 lb for all sources applied across all inventoried acres. Legume credits (569,710 pounds) are reflected in the UM recommendations.

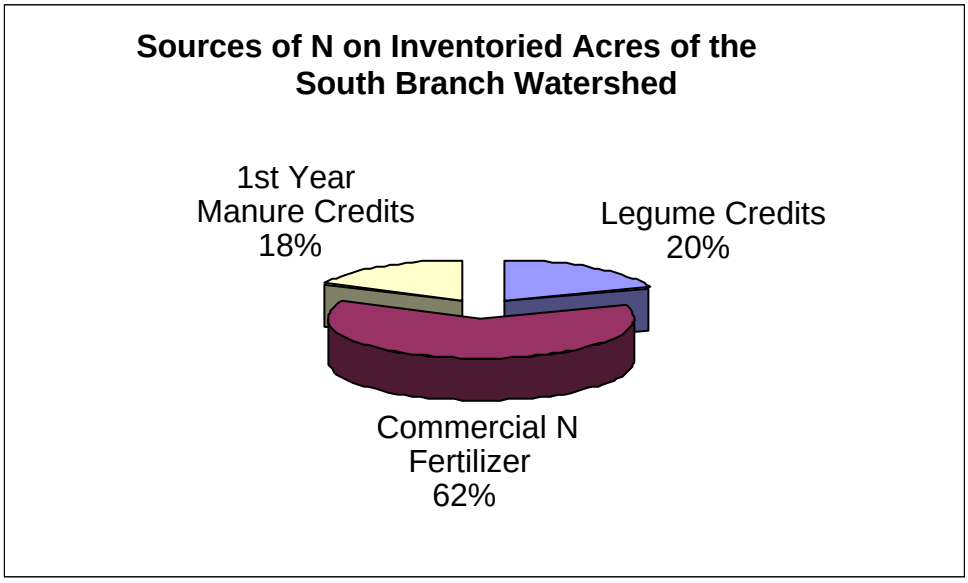


Figure 23. Relative N contributions from fertilizers, manures and legumes across all SBW acres inventoried in 2005. Nitrogen inputs totaled 1,585,896 lbs for all sources applied across all inventoried acres.

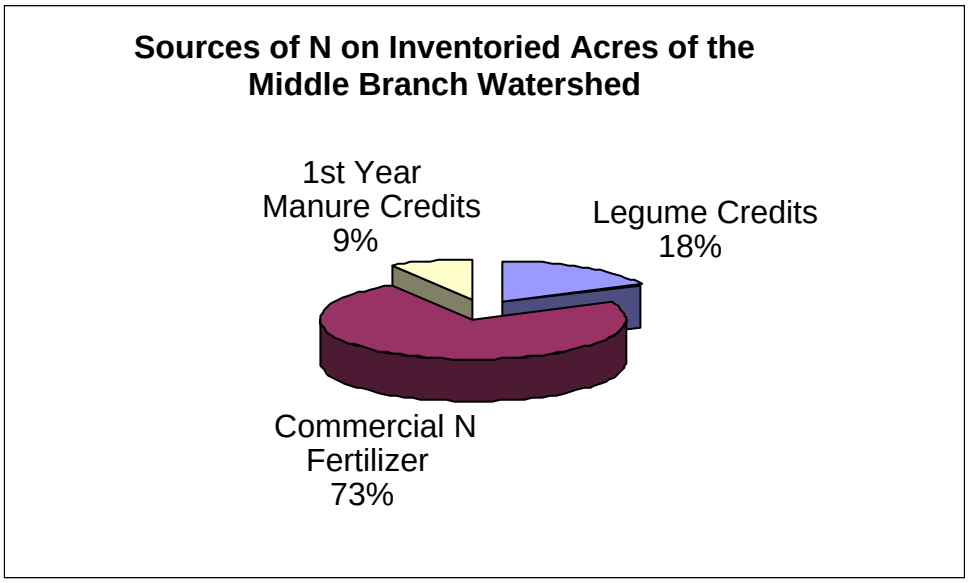


Figure 24. Relative N contributions from fertilizers, manures and legumes across all MBW acres inventoried in 2005. Nitrogen inputs totaled 1,423,424 lbs for all sources applied across all inventoried acres.

Nutrient Balances and Economic Considerations: Whitewater Watershed

Nitrogen Contributions

Contributions of N from commercial fertilizer and manure to inventoried acres totaled 2,439,610 pounds. Field corn received most of the N with 95% (2,305,685 pounds of N) of the total N applied. Field corn yield goal across these farms averaged 185 Bu/A and were highly consistent with historic yield averages of 180 Bu/A for the past five years. The corn yield for 2005 averaged 197 Bu/A across all inventoried acres. Yields for corn were similar across both watersheds as shown in Table 12. The county average for Olmsted County was 187 Bu/A and the county average for Winona county was 185 Bu/A for the 2005 growing season.

Table 12. Yields for Corn Acres Across the Middle Branch and South Branch Watersheds for the 2005 Season.

	Average Yield	Yield Goal	Actual Yields
	Bushels per Acre		
South Branch Watershed	178	182	194
Middle Branch Watershed	182	185	200
Both Watersheds	180	183	197

It appears farmers are using realistic yield goals for field corn acres and it also appears that farmers have been growing excellent crops to reach their yield goals consistently in the past five years. In the 1997 MW survey, the yield goal farmers were using was 154 Bu/A. Yield goals have increased by 29 Bu/A since 1997.

University of Minnesota recommendations are based on economic and environmental factors. Research at the Southern Minnesota Research & Outreach Center (Waseca) has shown that the recommendations are based on sound economic decisions and, in the long term, generally optimize profit.

University of Minnesota (UM) 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[21]. This analysis compares actual amounts of N with the current recommendations.
In the 2006 corn season farmers will have new recommendations from the UM in regard to N. These new recommendations will be discussed later. Current UM N recommendations for field corn across all inventoried acres averaged 155 lb N/A. Actual amounts of N applied from fertilizer (131 lb N/A) and manure (25 lb N/A) averaged 156 lb N/A across all corn acres (Figure 25). Factoring in all appropriate credits from fertilizer, legumes and manures, there was an over-application rate of 1 lb/N/A according to current UM recommendations.

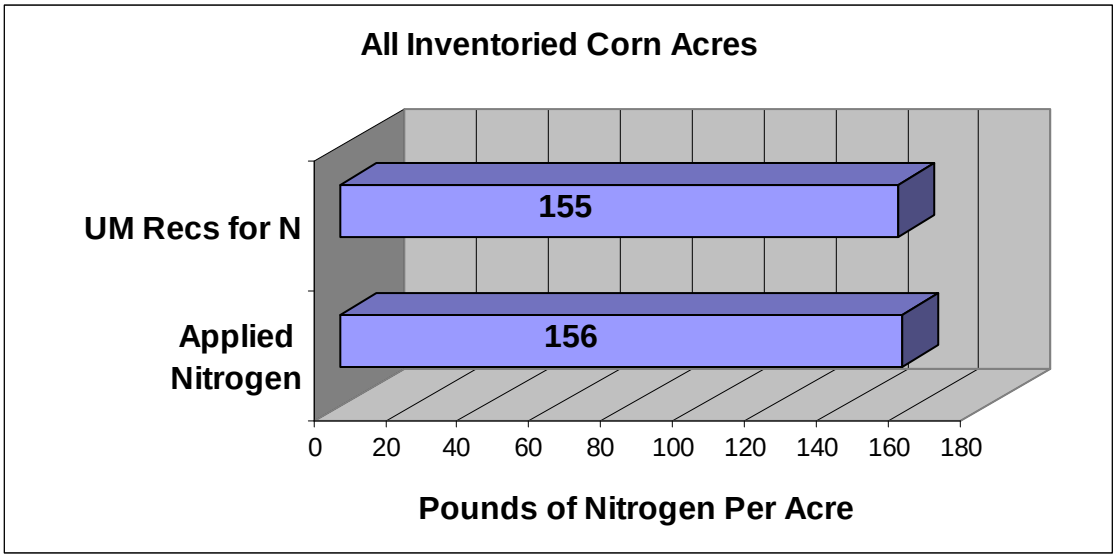


Figure 25. 2005 crop N requirements based on University of Minnesota nitrogen recommendations in comparison to actual N inputs (fertilizer and manure) for field corn acres in the inventoried area.

[21] Guidelines for use of nitrogen fertilizer for corn is taken from Table 1 in the Fertilizing Corn in Minnesota brochure FO-3790-C Revised 2002.

Figure 26 compares UM N recommendations for corn to actual N applied to corn for the SBW and Figure 27 compares the same for the MBW.

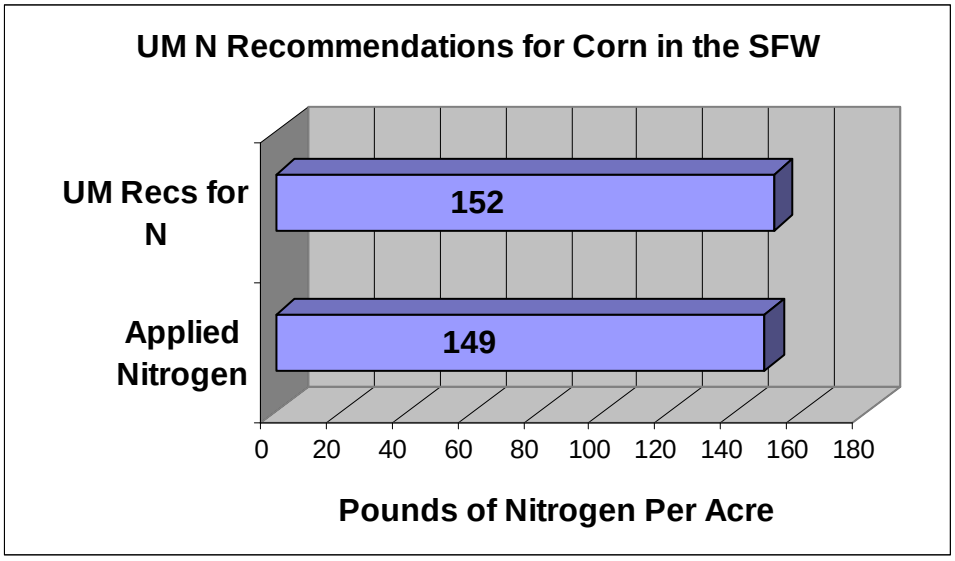


Figure 26. 2005 crop N requirements based on University of Minnesota nitrogen recommendations in comparison to actual N inputs (fertilizer and manure) for field corn acres in the SBW. Thirty-one pounds of N was in the form of manure and 118 pounds of N was in the form of commercial N in regards to applied N.

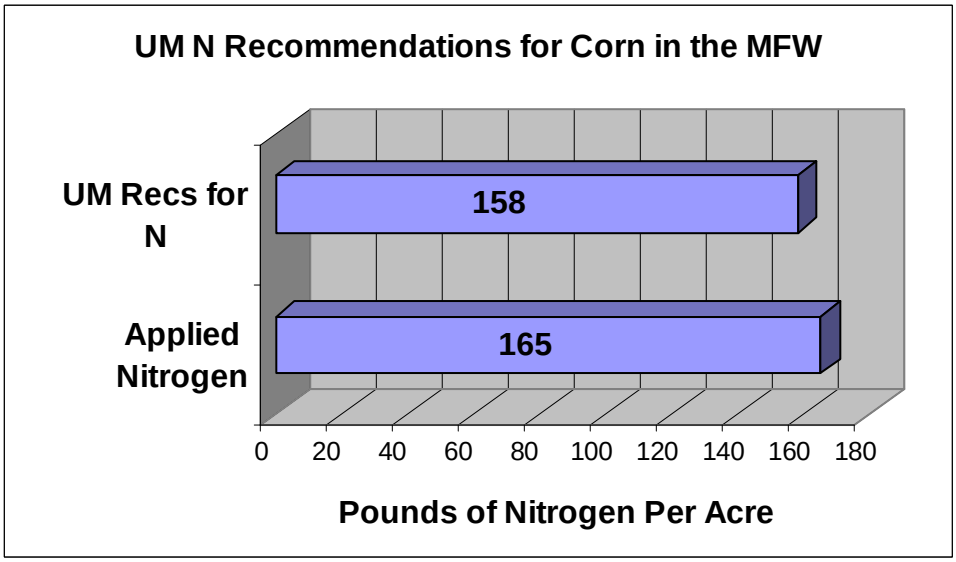


Figure 27. 2005 crop N requirements based on University of Minnesota nitrogen recommendations in comparison to actual N inputs (fertilizer and manure) for field corn acres in the MBW. Seventeen pounds of N was in the form of manure and 148 pounds of N was in the form of commercial N in regards to applied N.

Figure 28 details corn fields from the 1997 MW.

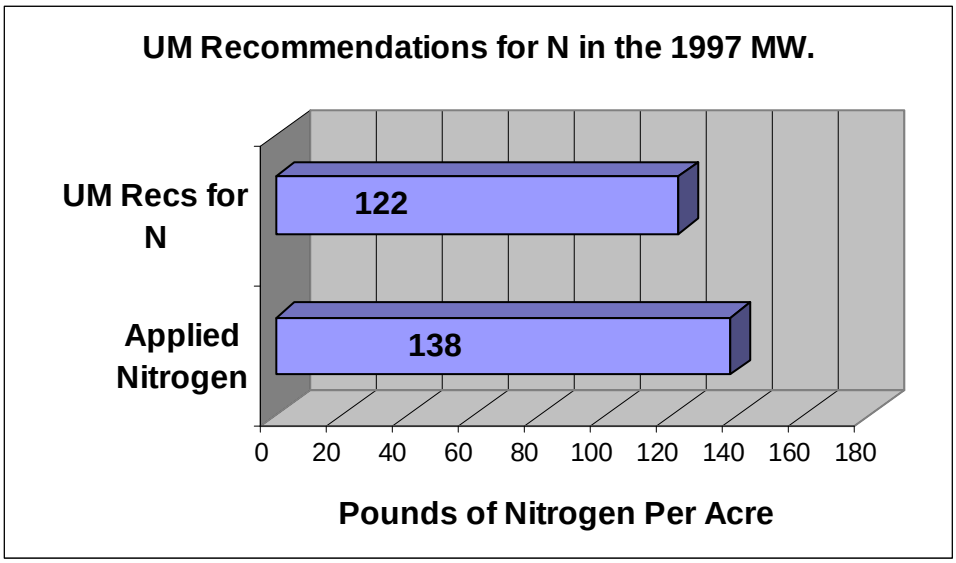


Figure 28. 1997 crop N requirements based on University of Minnesota nitrogen recommendations in comparison to actual N inputs (fertilizer and manure) for field corn acres. Five pounds of N was in the form of manure and 133 pounds of N was in the form of commercial N in regards to applied N.

One major advantage 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. Manure contributed 16% of the available N to the corn crop in the 2005 survey. In the 1997 MW, manure contributed 4% of the available N to the corn crop. Table 13 compares corn acres applied with manure to corn acres without manure in regards to N.

Table 13. Comparison Of N Applied With Manure and Without Manure on Corn Acres By Watershed.

Watershed	Manure	N Applied	N Recommended	Over Application
SBW	Yes	157	162	-5
SBW	No	145	144	1
MBW	Yes	179	155	24
MBW	No	160	159	-1
All Inventoried Acres	**All**	**156**	**155**	**1**
1997 MW	Yes	--	--	26
1997 MW	No	--	--	14
1997 MW	**All**	**138**	**122**	**16**

University of Minnesota recommendations for N are based on previous crop history. Table 14 details the crop history for all inventoried acres, the SBW and the MBW.

Table 14. Corn Acres and N Applied by Previous Crop, Compared to the UM N Recommendations for the 2005 season.

Watershed	Crop Rotation (crop/preceding crop)	Acres	N Applied	N Recommended	Over Application
All Acres	Corn /Alfalfa	519	100	28	72
All Acres	Corn /Soybeans	6,784	149	140	9
All Acres	Corn/Corn	6,953	172	180	-8
All Acres	Corn/Corn/ Alfalfa	492	109	134	-25
All Acres	**All Corn Acres**	**14,748**	**156**	**155**	**1**
SBW	Corn/Alfalfa	296	66	27	39
SBW	Corn/Soybeans	3,707	148	139	9
SBW	Corn/Corn	3,649	163	177	-14
SBW	Corn /Corn/Alfalfa	403	95	134	-39
SBW	**All Corn Acres**	**8,055**	**149**	**152**	**-3**
MBW	Corn/Alfalfa	223	144	30	114
MBW	Corn/Soybeans	3,077	150	141	9
MBW	Corn/Corn	3,304	181	184	-3
MBW	Corn /Corn/Alfalfa	89	169	130	39
MBW	**All Corn Acres**	**6,693**	**165**	**158**	**7**
1997 MW	Corn/Soybeans	1,241	---	---	26
1997 MW	Corn/Corn	1,645	---	---	9
1997 MW	Corn/Other	183	---	---	13
1997 MW	**All Corn Acres**	**3,069**	**138**	**122**	**16**

Figures 29 and 30 details how close farmers were to the University of Minnesota recommendations in regard to nitrogen applications on corn acres.

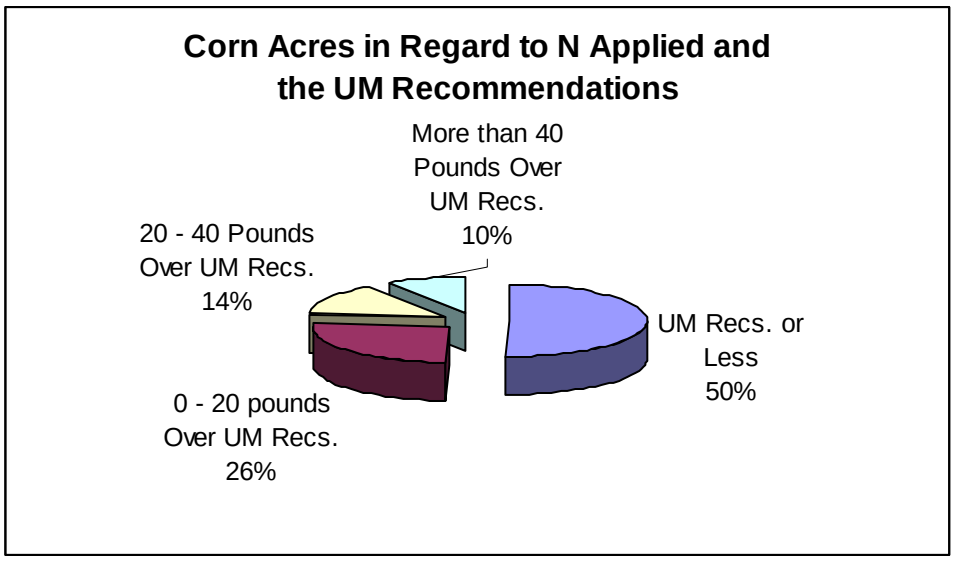


Figure 29. Distribution of corn fields within and above the University of Minnesota recommendations for N.

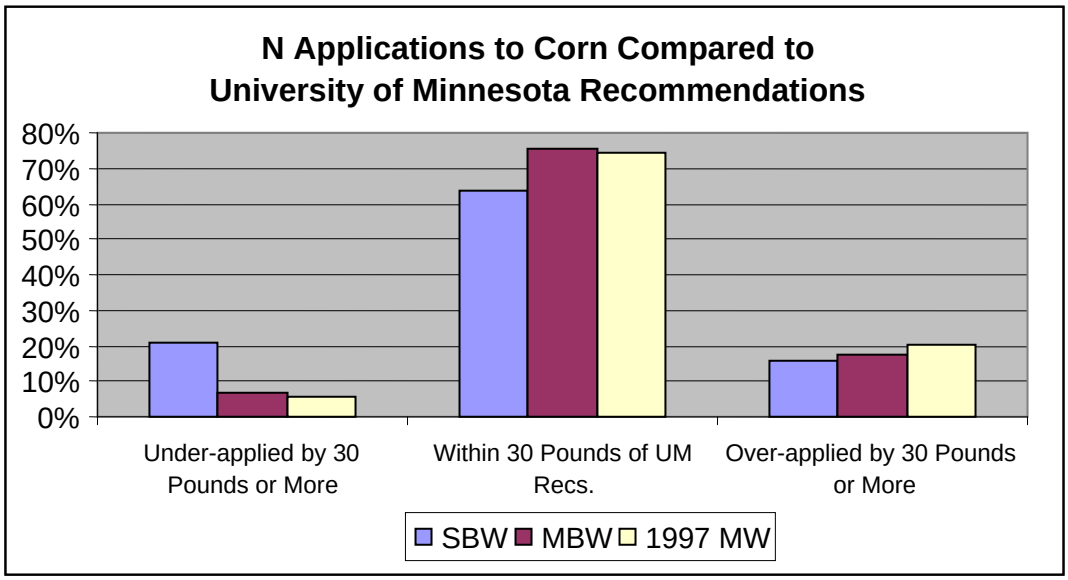


Figure 30. Acres of corn within and above the University of Minnesota recommendations for N.

The University of Minnesota revised the recommendations for N applications on corn in 2006. Yield is no longer a major factor in calculating the correct rate for N applications on corn acres as shown in the guidelines for use of N on corn[22]. The price of N compared to the crop value and previous crop are now the criteria used in the guidelines for determining N rate on corn acres. For further analysis on the UM recommendations for corn see appendix A and for further information see the University of Minnesota, Fertilizing Corn In Minnesota brochure, FO-3790-C.

[22] Guidelines for use of nitrogen fertilizer for corn is taken from Table 1 in the Fertilizing Corn in Minnesota brochure FO-3790-C Revised 2006.

Phosphorus Contributions

Contributions of P_2O_5 from commercial fertilizer (559,417) and manure (584,298) to inventoried acres totaled 1,143,715 pounds. Field corn received most of the P_2O_5 with 88% (1,008,718 pounds) of the total P applied.

Forty-three percent (43%) of the acres inventoried had soil tests available at the time of the interview. Soil tests were from the previous three years. Soil tests were all Bray and were converted to categories listed in Figure 32 of low through very high[23]. There were no soils that were very low in P_2O_5. Although many more farmers may have had soil tests, availability at the time of the survey was limited. Farmers were not required to due extensive looking for a soil test. Soil tests are valid for 4 years and were not always located with current farmer records.

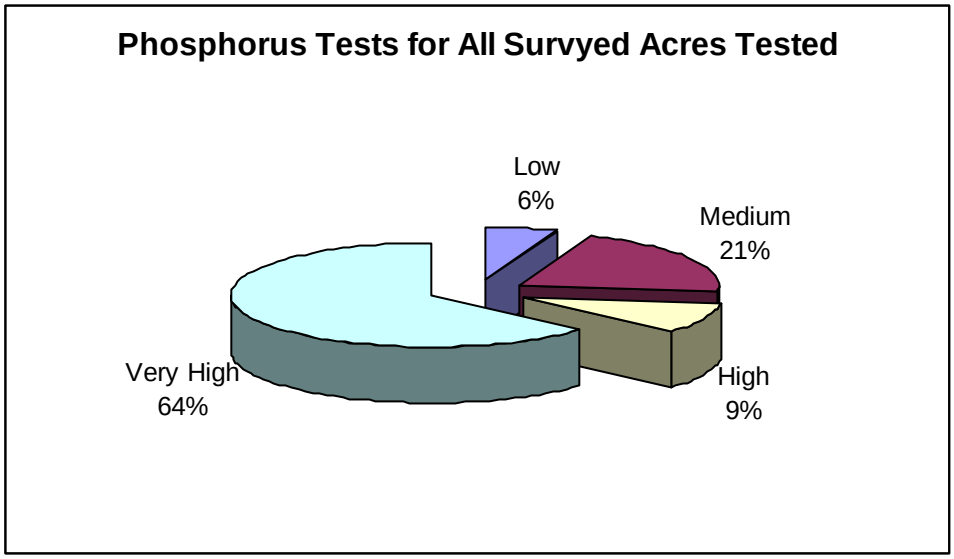


Figure 31. Percentage of acres in each soil testing P_2O_5 category across inventoried acres.

Another factor is individual manure management plans may be based on N in the manure. These plans may require applications of P_2O_5 greater than the amount of P_2O_5 the UM would recommend without manure applications. Because of all of these factors, comparisons of actual amounts of P_2O_5 applied cannot be compared to UM recommendations as was done with N. However it does appear that rates for P_2O_5 could be reduced in many instances, especially when the P soil tests are in the high and very high ranges.

Phosphorus P_2O_5 applications to inventoried field corn averaged 68 lb/A (34 lb/A from commercial P_2O_5 and 34 lb/A from manure applications). Crop removal of P_2O_5 can also be determined according to UM calculations. Corn grown on inventoried acres averaged 197 bushels per acre. Crop removal would be calculated at 67 lb/A per year for corn[24]. Soybeans grown on inventoried acres averaged 45 bushes per acre over the last 5 years. Crop removal would be calculated at 41 lb/A per year for soybeans. Over a two year rotation, 68 lb of P_2O_5 would be applied and 108 lb P_2O_5 would be removed for corn on soybeans and 134 would be removed for corn on corn rotation. If this practice continues, the soil P_2O_5 tests may drop, on average, by .4 to .8 ppm P/yr[25]. Inventoried farmers could reduce P_2O_5 applications in many cases, but overall, are still applying less than crop removal in this survey. In the case of acres applied with manure, P_2O_5 tests are increasing and on acres not applied with manure P_2O_5 tests are decreasing.

[23] Categories of soil tests defined in

[24] Nutrient Removal by Major Minnesota Crops, G. Rehm, University of Minnesota.

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

Table 15 details the P_2O_5 applications by manure applications.

Table 15. Corn Acres and P_2O_5 Applied by Manure Applications for the 2005 Season.				
Watershed	**Manure Applied**	**Acres**	**P_2O_5 Applied**	**P_2O_5 Average per Acre**
All Acres	No	9,847	371,303	38
All Acres	Yes	4,901	637,415	130
SBW	No	4,946	194,403	39
SBW	Yes	3,109	400,998	129
MBW	No	4,901	176,900	36
MBW	Yes	1,792	236,417	132

Tillage Practices:
Whitewater Watershed

Tillage practices were documented on all surveyed acres. Figure 32 details the timing of tillage operations for acres planted to corn[26] in the SBW and Figure 33 details the timing of tillage operations for acres planted to corn in the MBW.

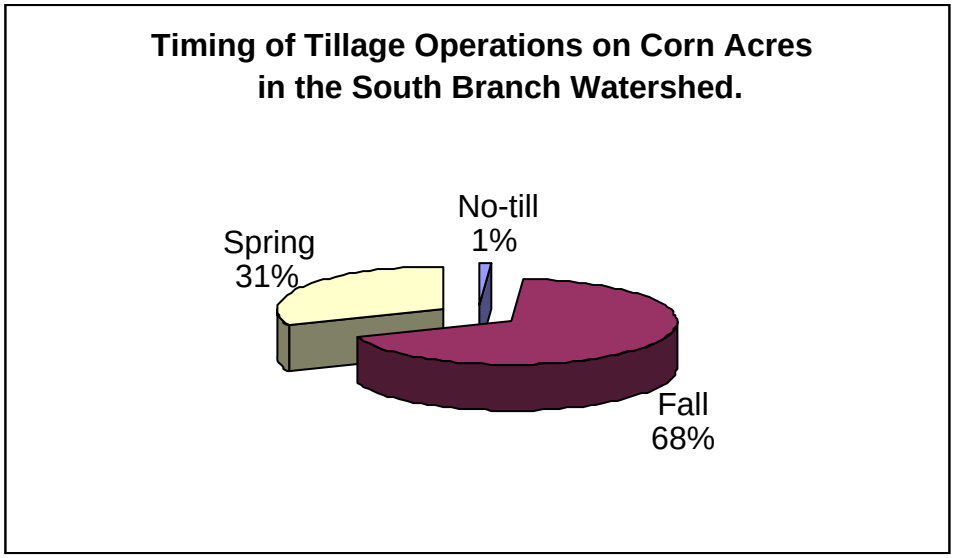


Figure 32. Timing of tillage operations for corn acres in the SBW.

[26] Tillage operations would be defined as all tillage operations used to till the 2004 crop before planting the 2005 corn crop.

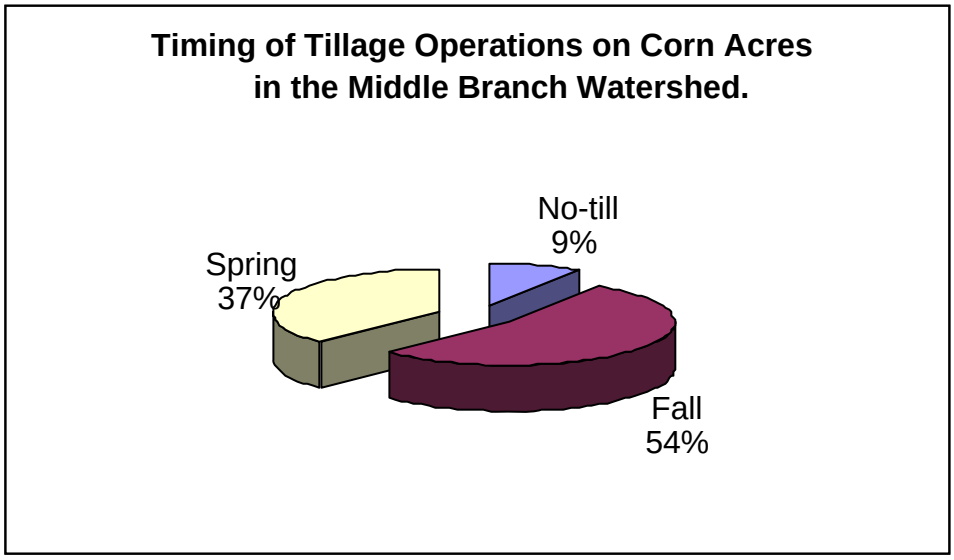


Figure 33. Timing of tillage operations for corn acres in the MBW.

Figure 34 details the timing of tillage operations for acres planted to soybeans in the SBW and Figure 35 details the timing of tillage operations in the MBW.

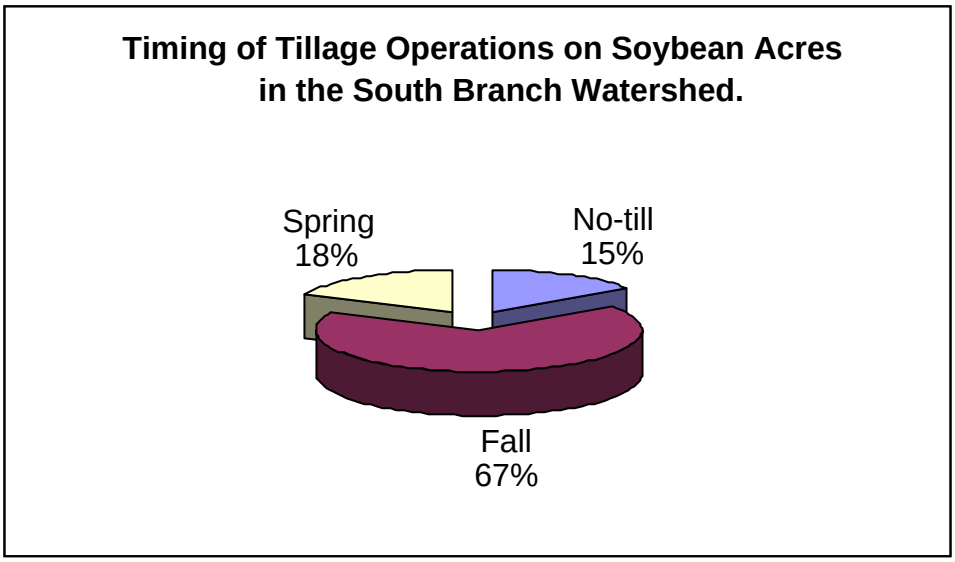


Figure 34. Timing of tillage operations for soybean acres in the SBW.

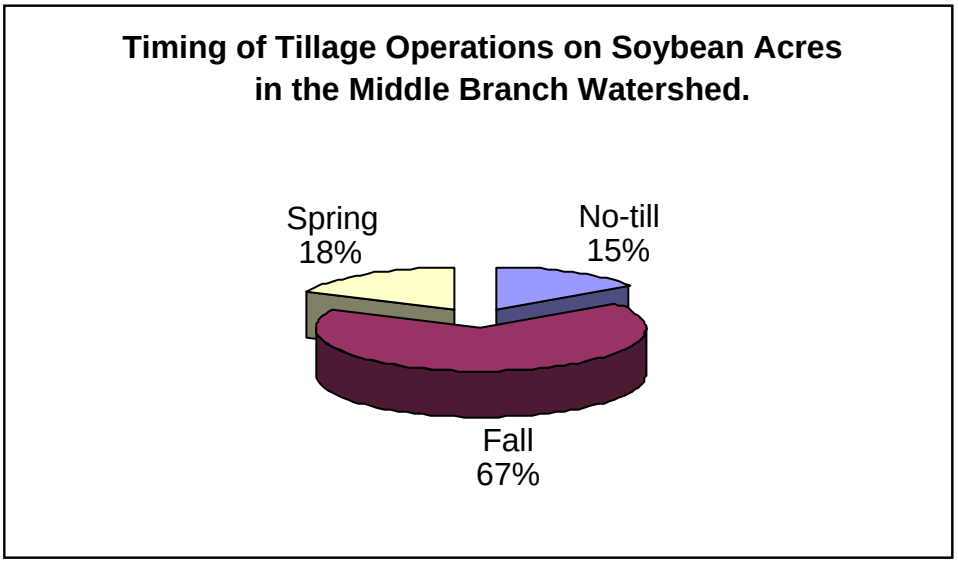


Figure 35. Timing of tillage operations for soybean acres in the MBW.

Field corn acres were tilled by a variety of tillage equipment. Figure 36 details the variety of tillage equipment used for primary tillage in the SBW and Figure 37 details the variety of tillage equipment used for primary tillage in the MBW.

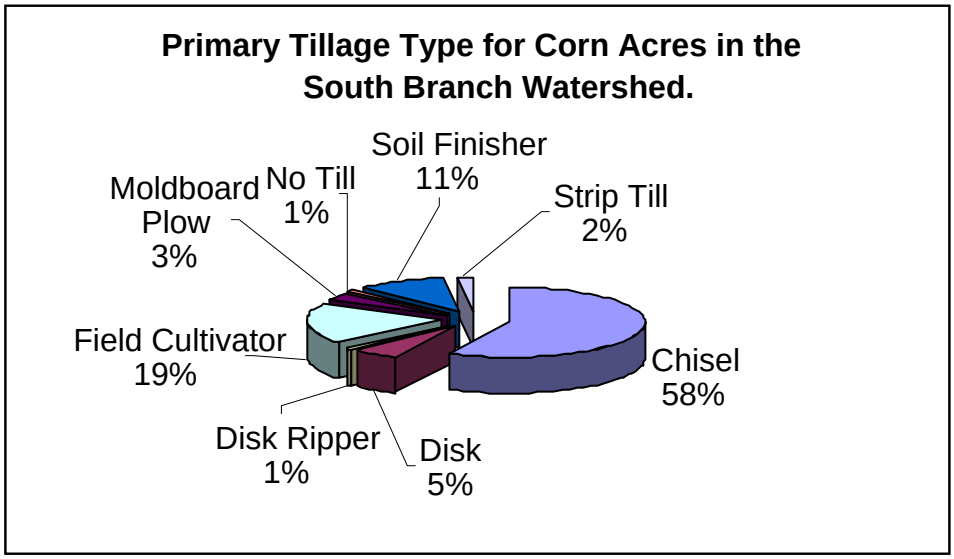


Figure 36. Percentage of acres in each tillage category across inventoried corn acres in the SBW.

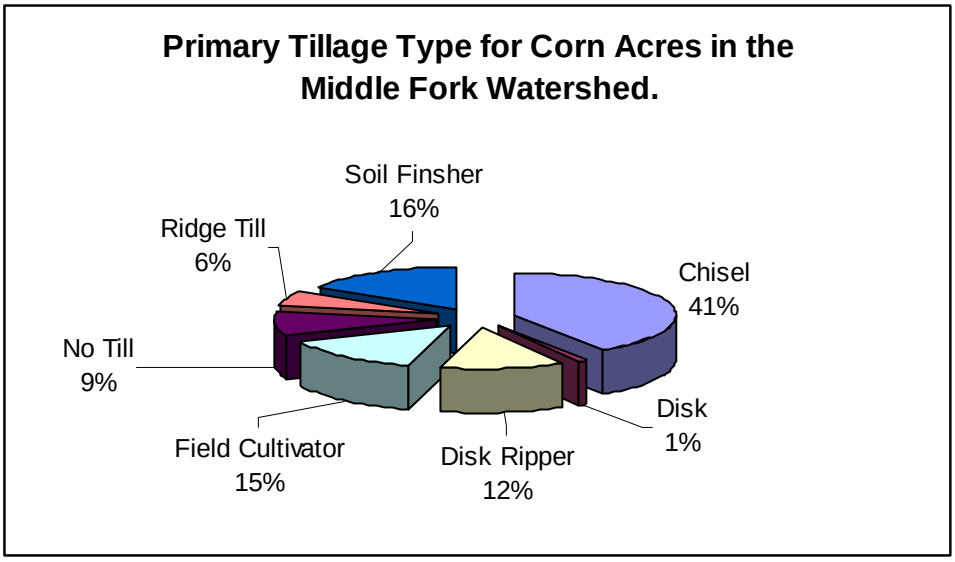


Figure 37. Percentage of acres in each tillage category across inventoried corn acres in the MBW.

Soybean acres were tilled by a variety of tillage equipment. Figure 38 details the variety of tillage equipment used for primary tillage in the SBW and Figure 39 details the variety of tillage equipment used for primary tillage in the MBW.

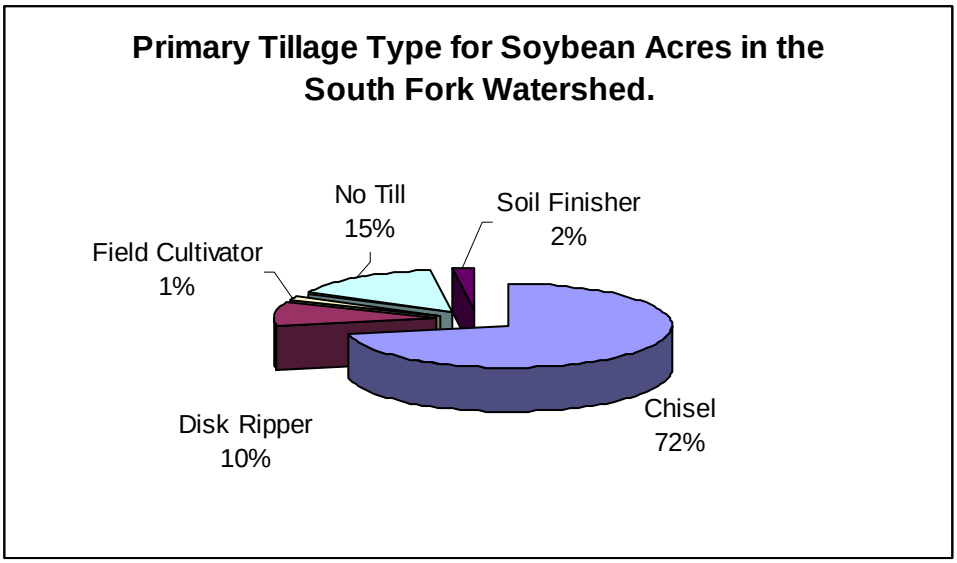


Figure 38. Percentage of acres in each tillage category across inventoried soybean acres in the SBW.

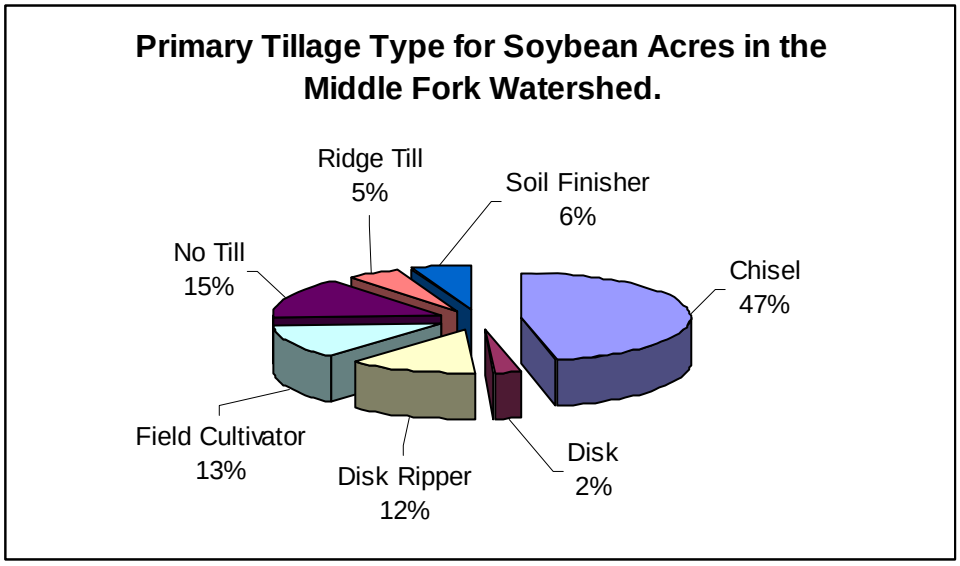


Figure 39. Percentage of acres in each tillage category across inventoried soybean acres in the MBW.

There was no tillage data for the 1997 MW survey.

Pesticide Applications:
Whitewater Watershed

Pesticide use data was gathered on all inventoried crop acres. Pesticides were used on 87% of all inventoried crop acres (Table 16). Pesticide use in the Whitewater watershed included only herbicides and insecticides.

Table 16. Inventoried Crop Acreage and Percentage Treated With Pesticides in the Middle Branch Watershed, South Branch Watershed and the Monitoring Watershed of the Whitewater River.

	SBW	SBW	SBW	MBW	MBW	MBW
Crop	**Total Acres**	**Acres Treated**	**Percent**	**Total Acres**	**Acres Treated**	**Percent**
Corn	8,055	7,960.00	99%	6,693	6,676	100%
Soybean	3,822	3,822.00	100%	3,067	2,992	98%
Sweet Corn	194	194	100%	258	258	100%
Alfalfa	1,903	525	28%	1,747	488	28%
Small Grains	90	0	0%	10	0	0%
Pasture	623	231	37%	171	50	29%
Peas	354	354	100%	317	317	100%
Other	145	145	100%	75	0	0%
Totals	**15,186**	**13,231.00**	**87%**	**12,338**	**1,0781**	**87%**

Pesticide use by crop and acres covered for the 1997 MW is detailed in Table 17.

Table 17. Pesticide Applications by Crop and Percent Applied for the 1997 Monitoring Watershed.

Crop Grown	Total Acres	Pesticides	
		Acres Treated	Percent of Total Acres
Corn	3,069	3,060	99%
Soybeans	1,532	1,523	99%
Other	1,926	409	21%
Total Acres	**6,527**	**4,992**	**76%**

Pesticide use on all acres consisted of 54 different formulas (different EPA numbers, or products). Table 18 describes the pesticide, product used and the corresponding Active Ingredients (AI) of each pesticide product used.

Table 18. Product Name and Description of Pesticide Use in Whitewater watershed.					
Name Of Product	**EPA Number**	**Herbicide Insecticide**	**Active Ingredients (AI)**	**AI in Product**	**AI Expressed as**
2,4-D	5905-72	Herbicide	2,4-D	5.70	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
Accent Gold	352-593	Herbicide	Clopyralid Flumetsulam Nicosulfuron Rimsulfuron	0.52 0.19 0.07 0.07	Percent by Weight
Aim	279-3194	Herbicide	Carfentrazone Ethyl	0.40	Percent by Weight
Atrazine 90 WDG	34704-622	Herbicide	Atrazine	0.90	Percent by Weight
Aztec 2	3125-412	Insecticide	Cyfluthrin Tebupirimphos	0.00 0.02	Percent by Weight
Basagran	7969-45	Herbicide	Bentazon	4.00	Pounds Per Gallon
Bathroid 2	3125-351	Insecticide	Cyfluthrin	2.00	Pounds Per Gallon
Boundary	100-958	Herbicide	Metribuzin S-Metolachlor	1.50 6.30	Pounds Per Gallon
Callisto	100-1131	Herbicide	Mesotrione	4.00	Pounds Per Gallon
Celebrity Plus	7969-175	Herbicide	Dicamba Diflufenzopyr Nicosulfuron	0.47 0.18 0.11	Percent by Weight
Clarity	7969-137	Herbicide	Dicamba	4.00	Pounds Per Gallon
Define	264-189	Herbicide	Flufenacet	4.00	Pounds Per Gallon
Distinct	7969-150	Herbicide	Dicamba Dichloro O Anisic Acid	0.21 0.55	Percent by Weight
Dual II Magnum	100-818	Herbicide	S-Metolachlor	7.64	Pounds Per Gallon
Dual II Magnum SI	100-829	Herbicide	S-Metolachlor	6.30	Pounds Per Gallon
Dual Magnum	100-816	Herbicide	S-Metolachlor	7.62	Pounds Per Gallon
Extreme	241-405	Herbicide	Glyphosate Imazethapyr	2.00 0.17	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
Fusilade DX	10182-367	Herbicide	Fluazifop-p-butyl	2.00	Pounds Per Gallon
Glyphosate	352-607	Herbicide	Glyphosate	4.00	Pounds Per Gallon
Harmony GT	352-446	Herbicide	Thifensulfuron	0.75	Percent by Weight
Harness	524-473	Herbicide	Acetochlor	7.00	Pounds Per Gallon
Harness Extra	524-480	Herbicide	Acetochlor Atrazine	4.30 1.70	Pounds Per Gallon
Hornet	62719-253	Herbicide	Clopyralid Flumetsulam	0.63 0.23	Percent by Weight
Laddok S-12	7969-100	Herbicide	Bentazon Atrazine	2.50 2.50	Pounds Per Gallon
Lasso	524-314	Herbicide	Alachlor	5.40	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
Marksman	7969-136	Herbicide	Dicamba Atrazine	1.10 2.10	Pounds Per Gallon
Outlook	7969-156	Herbicide	Dimethenamid	6.00	Pounds Per Gallon
Pounce	279-3014	Herbicide	Permethrin	3.20	Pounds Per Gallon
Prowl 3.3 EC	241-337	Herbicide	Pendimethalin	3.30	Pounds Per Gallon
Prowl H2O	241-418	Herbicide	Pendimethalin	3.80	Pounds Per Gallon
Pursuit	241-310	Herbicide	Imazethapyr	2.00	Pounds Per Gallon
Pursuit Plus EC	241-331	Herbicide	Imazethapyr Pendimethalin	0.20 2.70	Pounds Per Gallon
Regent	7969-207	Insecticide	Fipronil	4.00	Pounds Per Gallon
Resource	59639-82	Herbicide	Flumiclorac pentyl ester	0.86	Pounds Per Gallon
Roundup Ultra	524-475	Herbicide	Glyphosate	3.00	Pounds Per Gallon
Roundup Weathermax	524-537	Herbicide	Glyphosate	5.50	Pounds Per Gallon
Select 2EC	59639-3	Herbicide	Clethodim	2.00	Pounds Per Gallon
Steadfast	352-608	Herbicide	Nicosulfuron Rimsulfuron	0.50 0.25	Percent by Weight
Sterling Plus	51036-307-9779	Herbicide	Atrazine Dicamba	2.10 1.10	Pounds Per Gallon
Surpass EC	10182-325	Herbicide	Acetochlor	6.40	Pounds Per Gallon
Thistrol	71368-5	Herbicide	MCPB	2.00	Pounds Per Gallon
Touchdown	10182-449	Herbicide	Glyphosate	3.00	Pounds Per Gallon
Treflan HFP	62719-250	Herbicide	Trifluralin	4.00	Pounds Per Gallon
Tri-4 HF	241-343	Herbicide	Trifluralin	4.00	Pounds Per Gallon
Warrior	10182-96	Insecticide	Lambda-Cyhalothrin	1.00	Pounds Per Gallon
Weedmaster	7969-133	Herbicide	Dicama 2,4-D	1.00 2.87	Pounds Per Gallon

There were a total of 32,151 pounds of active ingredients (AI) from all pesticides used on all crops. Herbicide AI totaled 31,800 pounds and insecticide AI totaled 351 pounds. There were no fungicides applied on inventoried acres. Field corn acres accounted for 71% of all pesticide AI use by pounds (Figure 40).

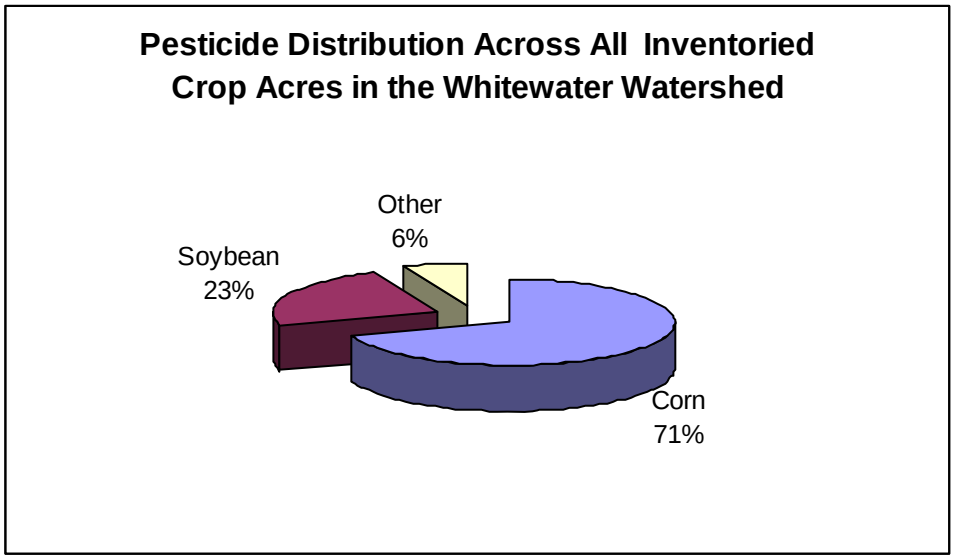


Figure 40. Application of pesticide AI's applied to inventoried acres by crop type and percentage of pounds applied.

Pesticide use in the 1997 MW is shown in Figure 41.

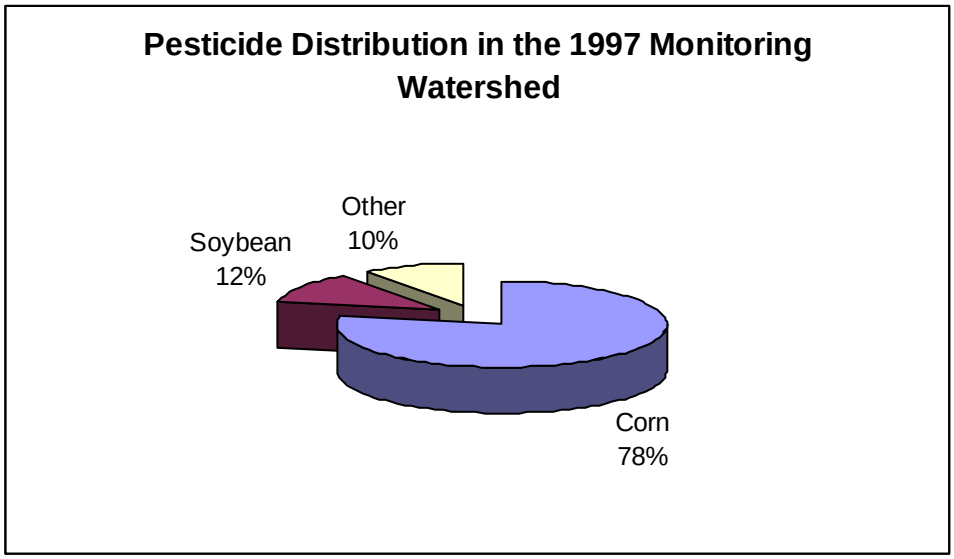


Figure 41. Application of pesticide AI's applied to inventoried acres by crop type and percentage of pounds applied for the 1997 MW.

Table 19 lists each AI, coverage and total pounds for the 37 different AI's applied to inventoried acres.

Table 19. Pesticide Use And Acres Treated by Active Ingredient Across All Inventoried Acres in the Whitewater Watershed.

Name Of Compound	Acres Treated	Total Pounds Applied
2,4-D	1,124	716
Acetochlor	3,721	4,257
Alachlor	80	160
Atrazine	11,556	6,060
Bentazon	160	104
Carfentrazone Ethyl	289	3
Chlorpyrifos	331	147
Clethodim	691	54
Clopyralid	1,879	199
Cloransulam-Methyl	345	4
Cyfluthrin	983	7
Dicamba	2,940	443
Dicamba, dimet. Salt	77	5
Dichloro o anisic acid	90	6
Diflufenzopyr	90	5
Dimethenamid	846	551
Fipronil	136	17
Fluazifop-p-butyl	112	14
Flufenacet	323	110
Flumetsulam	1,879	74
Flumiclorac pentyl ester	80	3
Glufosinate-ammonium	2,864	977
Glyphosate	11,830	12,276
Imazethapyr	1,508	64
Lambda-cyhalothrin	1,992	35
MCBD	168	70
Mesotrione	3,534	430
Metribuzin	255	63
Nicosulfuron	3,231	72
Pendimethalin	996	518
Permethrin	112	11
Rimsulfuron	2,584	29
S-metolachlor	2,676	4,295
Tebupirimphos	960	118
Tefluthrin	1,774	173
Thifensulfuron	293	1
Trifluralin	180	78

Pesticide use on corn acres consisted of 22 separate herbicide AI's totaling 22,555 pounds. Table 20 details each compound used and the number of acres treated by each compound.

Table 20. Pesticide Use on All Inventoried Corn Acres.

Name Of Active Ingredient	Percent Of All Surveyed Corn Acres	Rate Applied Pounds per Acre Per Year	Total Acres Treated	Total Pounds Applied
2,4-D	5%	0.53	698	368
Acetochlor	25%	1.14	3,721	4,257
Atrazine	77%	0.52	11,287	5,914
Carfentrazone ethyl	2%	0.01	264	3
Clopyralid	13%	0.11	1,879	199
Cyfluthrin	7%	0.01	960	6
Dicamba	17%	0.13	2,514	321
Dicamba, dimet. Salt	1%	0.07	77	5
Dichloro o anisic acid	1%	0.07	90	6
Diflufenzopyr	1%	0.05	90	5
Dimethenamid	4%	0.52	613	317
Fipronil	1%	0.13	136	17
Flufenacet	2%	0.34	323	110
Flumetsulam	13%	0.04	1,879	74
Glufosinate-ammonium	19%	0.34	2,864	977
Glyphosate	35%	1.03	5,211	5,350
Mesotrione	24%	0.12	3,484	427
Nicosulfuron	22%	0.02	3,174	70
Rimsulfuron	18%	0.01	2,584	29
S-metolachlor	16%	1.66	2,299	3,810
Tebupirimphos	7%	0.12	960	118
Tefluthrin	12%	0.10	1,774	173

Pesticide use on corn acres in the SBW consisted of 17 separate herbicide AI's totaling 11,771 pounds and pesticide use on corn acres in the MBW consisted of 18 separate herbicide AI's totaling 9,967 pounds. Table 21 details each compound used and the number of acres treated by each compound for each watershed.

Table 21. Pesticide Use on Corn Acres Within the South Branch Watershed and the Middle Branch Watershed.

Name Of Active Ingredient	Percent Of All Surveyed Corn Acres	Rate Applied Pounds per Acre Per Year	Total Acres Treated	Total Pounds Applied
South Branch Watershed				
Acetochlor	20%	1.21	1,596	1,925
Atrazine	78%	0.54	6,262	3,273
Clopyralid	13%	0.11	1,012	109
Cyfluthrin	12%	0.01	960	6
Dicamba	13%	0.13	1,066	144
Dimethenamid	7%	0.53	592	315
Fipronil	2%	0.13	136	17
Flufenacet	4%	0.34	323	110
Flumetsulam	13%	0.04	1,012	40
Glufosinate-ammonium	17%	0.35	1,382	482
Glyphosate	35%	1.04	2,835	2,461
Mesotrione	28%	0.11	2,248	256
Nicosulfuron	17%	0.02	1,387	30
Rimsulfuron	13%	0.01	1,007	10
S-metolachlor	18%	1.66	1,472	2,439
Tebupirimphos	12%	0.12	960	118
Tefluthrin	4%	0.13	282	35
Middle Branch Watershed				
2,4-D	10%	0.53	698	368
Acetochlor	32%	1.10	2,125	2,185
Atrazine	75%	0.51	5,025	2,562
Carfentrazone ethyl	4%	0.01	264	3
Clopyralid	13%	0.10	867	90
Dicamba	22%	0.12	1,448	177
Dicamba, dimet. Salt	1%	0.07	77	5
Dichloro o anisic acid	1%	0.07	90	6
Diflufenzopyr	1%	0.05	90	5
Dimethenamid	0%	0.09	21	2
Flumetsulam	13%	0.04	867	33
Glufosinate-ammonium	22%	0.33	1,482	495
Glyphosate	35%	1.01	2,376	2,298
Mesotrione	18%	0.14	1,236	171
Nicosulfuron	27%	0.02	1,787	40
Rimsulfuron	24%	0.01	1,577	19
S-metolachlor	12%	1.66	827	1,370
Tefluthrin	22%	0.09	1,492	138

Pesticide use on corn acres in the 1997 MW is detailed in Table 22.

Table 22. Pesticide Use on All Inventoried Corn Acres in the 1997 Monitoring watershed.

Name Of Active Ingredient	Percent Of All Surveyed Corn Acres	Rate Applied Pounds per Acre Per Year	Total Acres Treated	Total Pounds Applied
2,4-D	4%	0.21	111	23
Acetochlor	71%	2.35	2,185	5,128
Alachlor	3%	1.68	81	136
Atrazine	59%	0.61	1,810	1,099
Bromoxynil	8%	0.24	246	58
Carbofuran	2%	1.00	57	57
Chlorpyrifos	1%	0.92	24	22
Clopyralid	7%	1.08	204	221
Cyanazine	3%	1.35	105	142
Cyfluthrin	18%	0.01	560	3
Dicamba	70%	0.29	2,142	613
Dimethenamid	3%	1.05	85	89
Flumetsulam	7%	0.04	204	9
Halosulfuron-methyl	16%	0.02	505	11
Imazapyr	8%	0.02	247	4
Imazethapyr	8%	0.04	247	10
Metolachlor	10%	2.34	300	701
Nicosulfuron	16%	0.02	483	12
Phorate	1%	1.21	33	40
Primisulfuron	7%	0.02	217	4
Prosulfuron	7%	0.02	217	4
Tebupirimphos	18%	0.13	560	73
Tefluthrin	24%	0.08	726	59
Terbufos	4%	0.67	132	89

Soybean acres received pesticide applications from 14 different active ingredients. (Table 23).

Table 23. Pesticide Use on Soybean Acres.

Name Of Active Ingredient	Percent Of All Surveyed Corn Acres	Rate Applied Pounds per Acre Per Year	Total Acres Treated	Total Pounds Applied
Alachlor	1%	2.00	40	80
Chlorpyrifos	3%	0.45	241	107
Clethodim	10%	0.08	691	54
Cloransulam-methyl	5%	0.01	345	4
Fluazifop-p-butyl	1%	0.16	82	13
Flumiclorac pentyl ester	1%	0.04	80	3
Glyphosate	96%	1.01	6,589	6,657
Imazethapyr	14%	0.04	977	43
Lambda-cyhalothrin	17%	0.02	1,157	20
Metribuzin	3%	0.25	225	56
Pendimethalin	7%	0.65	465	301
S-metolachlor	3%	1.04	225	235
Thifensulfuron	4%	0.00	293	1
Trifluralin	1%	0.50	70	35

Pesticide use on soybean acres in the SBW consisted of 11 herbicide AI's totaling 4,238 pounds and pesticide use on soybean acres in the MBW consisted of 9 separate herbicide AI's totaling 3,371 pounds. Table 24 details each compound used and the number of acres treated by each compound for each watershed.

Table 24. Pesticide Use on Soybean Acres Within the South Branch Watershed and the Middle Branch Watershed.

Name Of Active Ingredient	Percent Of All Surveyed Corn Acres	Rate Applied Pounds per Acre Per Year	Total Acres Treated	Total Pounds Applied
South Branch Watershed				
Chlorpyrifos	6%	0.44	211	92
Clethodim	9%	0.08	345	27
Cloransulam-methyl	9%	0.01	345	4
Fluazifop-p-butyl	2%	0.16	82	13
Flumiclorac pentyl ester	2%	0.04	80	3
Glyphosate	94%	1.08	3,597	3,876
Imazethapyr	11%	0.04	405	14
Lambda-cyhalothrin	22%	0.02	824	14
Pendimethalin	10%	0.44	365	159
Thifensulfuron	8%	0.00	293	1
Trifluralin	2%	0.50	70	35
Middle Branch Watershed				
Alachlor	1%	2.00	40	80
Chlorpyrifos	1%	0.50	30	15
Clethodim	11%	0.08	346	27
Glyphosate	98%	0.93	2,992	2,781
Imazethapyr	19%	0.05	572	29
Lambda-cyhalothrin	11%	0.02	333	6
Metribuzin	7%	0.25	225	56
Pendimethalin	3%	1.43	100	143
S-metolachlor	7%	1.04	225	235

Pesticide use on soybean acres in the 1997 MW is detailed in Table 25.

Table 25. Pesticide Use on Soybean Acres in the 1997 Monitoring Watershed.

Name Of Active Ingredient	Percent Of All Surveyed Corn Acres	Rate Applied Pounds per Acre Per Year	Total Acres Treated	Total Pounds Applied
Acetochlor	4%	2.40	62	149
Acifluorfen	10%	0.16	146	24
Bentazon	17%	0.75	263	197
Clethodim	19%	0.08	292	24
Clomazone	17%	0.76	255	195
Dicamba	4%	0.03	62	2
Fenozaprop-P-Ethyl	8%	0.04	123	5
Fluazifop-P-Butyl	8%	0.15	123	19
Flumiclorac Pentyl Ester	4%	0.03	64	2
Glyphosate	5%	1.00	80	80
Halosulfuron-Methyl	4%	0.02	62	1
Imazethapyr	74%	0.06	1,135	63
Metribuzin	1%	0.13	15	2
Pendimethalin	19%	1.20	287	343
Sethozydim	36%	0.25	545	136
Sodium Salt of Fomesafen	12%	0.38	182	70
Tefluthrin	4%	0.06	62	4
Thifensulfuron	35%	0.00	529	1
Trifluralin	1%	0.76	21	16

Table 26 lists all pesticide applications to crops other than field corn or soybeans.

Table 26. Pesticide Use on Acres Other Than Corn or Soybean Acres Across All Inventoried Acres.

Name Of Active Ingredient	Percent Of All Surveyed Corn Acres	Rate Applied Pounds per Acre Per Year	Total Acres Treated	Total Pounds Applied
Alfalfa				
Chlorpyrifos	2%	0.44	90	40
Cyfluthrin	1%	0.03	23	1
Lambda-cyhalothrin	22%	0.02	805	15
Permethrin	3%	0.10	112	11
Other				
2,4-d	38%	0.82	426	349
Dicamba	38%	0.29	426	122
Pea				
Bentazon	6%	0.75	38	29
Fluazifop-p-butyl	4%	0.05	30	1
Glyphosate	4%	9.00	30	270
Imazethapyr	79%	0.04	531	21
Lambda-cyhalothrin	4%	0.02	30	1
Mcpb	25%	0.41	168	70
Metribuzin	4%	0.23	30	7
Pendimethalin	79%	0.41	531	217
S-metolachlor	4%	0.98	30	30
Trifluralin	16%	0.39	110	43
Sweet Corn				
Alachlor	9%	2.00	40	80
Atrazine	60%	0.54	269	146
Bentazon	27%	0.62	122	76
Carfentrazone ethyl	6%	0.01	25	0
Dimethenamid	52%	1.00	233	234
Mesotrione	11%	0.08	50	4
Nicosulfuron	13%	0.03	57	2

Table 27 details pesticide information on crops other than corn and soybeans for the 1997 MW.

Table 27. Pesticide Use on Acres Other Than Corn or Soybean Acres Across All Inventoried Acres for the 1997 MW.

Name Of Active Ingredient	Percent Of All Surveyed Corn Acres	Rate Applied Pounds per Acre Per Year	Total Acres Treated	Total Pounds Applied
Alfalfa				
Malathion	5%	1.11	35	39
Permethrin	14%	0.14	106	15
Other				
2,4-D	1%	0.29	14	4
Deithanolamin	0%	0.25	4	1
Dimethylamine	0%	0.25	4	1
Sweet Corn				
Alachlor	24%	3.00	60	180
Atrazine	60%	0.86	153	132
Bentazon	48%	0.59	123	72
Dimethinamid	12%	1.50	30	45
EPTC	40%	5.02	101	507
Metolachlor	25%	3.00	63	189
Nicosulfuron	12%	0.03	30	1
Cyfluthrin	25%	0.02	63	1
Tebupirimphos	25%	0.13	63	8

Pesticides were impregnated and applied on 2,713 acres of cropland. All impregnated pesticides were applied on corn except for 408 acres of peas and 253 acres of sweet corn. In the SBW 1,499 pounds of AI were applied on 2,351 acres of cropland and in the MBW 1,037 pounds of AI were applied on 1,578 acres of cropland through impregnation. Table 28 details the amount of active ingredient applied and acres treated. Fourteen percent (14%) of all corn acres received pesticides through impregnation on fertilizer. Impregnation information was not gathered for the 1997 MW.

Table 28. Pesticide Use and Acres Treated by Active Ingredient for Impregnated Pesticides.

Name Of Compound	Crop Planted	Acres Treated	Total Pounds Applied
Acetochlor	Corn	803	782
Atrazine	Corn	476	229
Clopyralid	Corn	41	6
Dicamba	Corn	41	1
Dimethenamid	Corn	572	295
Flufenacet	Corn	323	110
Flumetsulam	Corn	41	2
Mesotrione	Corn	227	39
S-metolachlor	Corn	374	564
Imazethapyr	Pea	370	12
Pendimethalin	Pea	370	162
Trifluralin	Pea	38	19
Dimethenamid	Sweet corn	208	207
S-metolachlor	Sweet corn	45	107

In the SBW 1,232 pounds of AI were incorporated on 3,262 acres of cropland and in the MBW 965 pounds of AI were incorporated on 1,465 acres of cropland.

Only 152 acres of pasture received spot treatments of herbicides. All corn acres and soybean acres received complete field coverage of any herbicides applied. All herbicides were broadcast with the exception of 730 acres in the SBW and those were banded in correlation with strip tillage or row cultivation.

Pesticides were most often applied post-emergence in regard to acres treated or pounds applied (Figure 42).

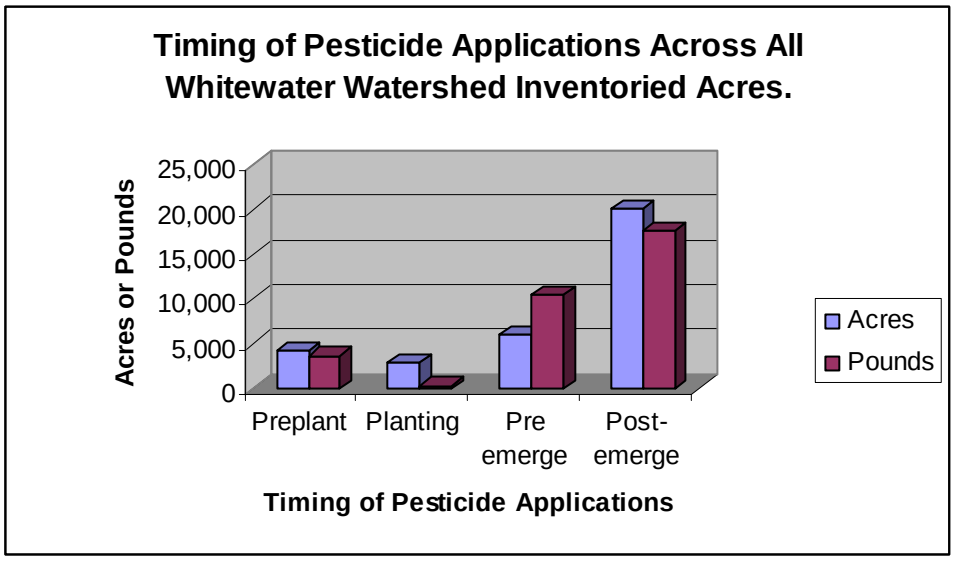


Figure 42. Pesticide applied by acres and pounds on all surveyed acres applied with pesticides.

Post-emergence dominated pesticide application timing for both corn (Figure 43) and soybeans (Figure 44).

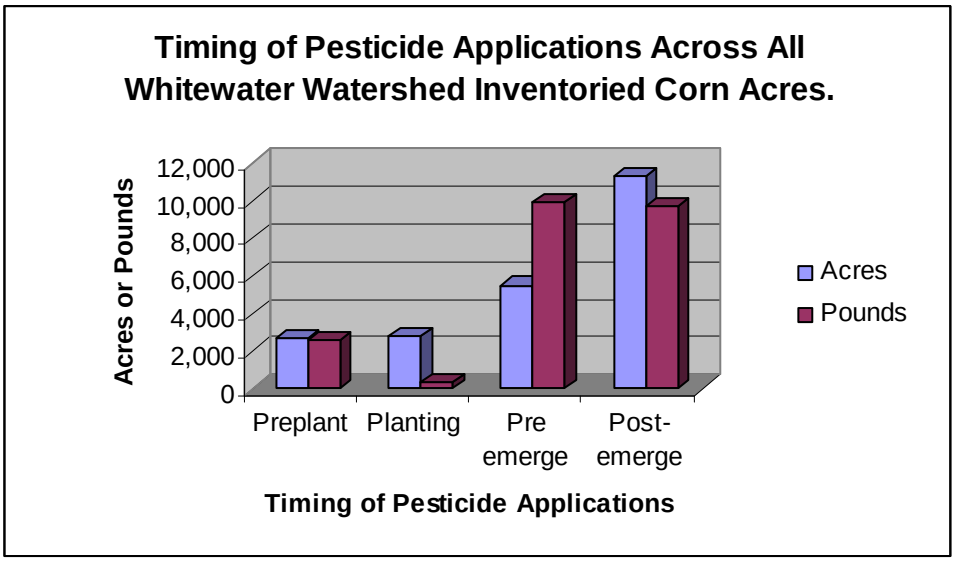


Figure 43. Pesticides applied to all surveyed corn acres by acres and timing.

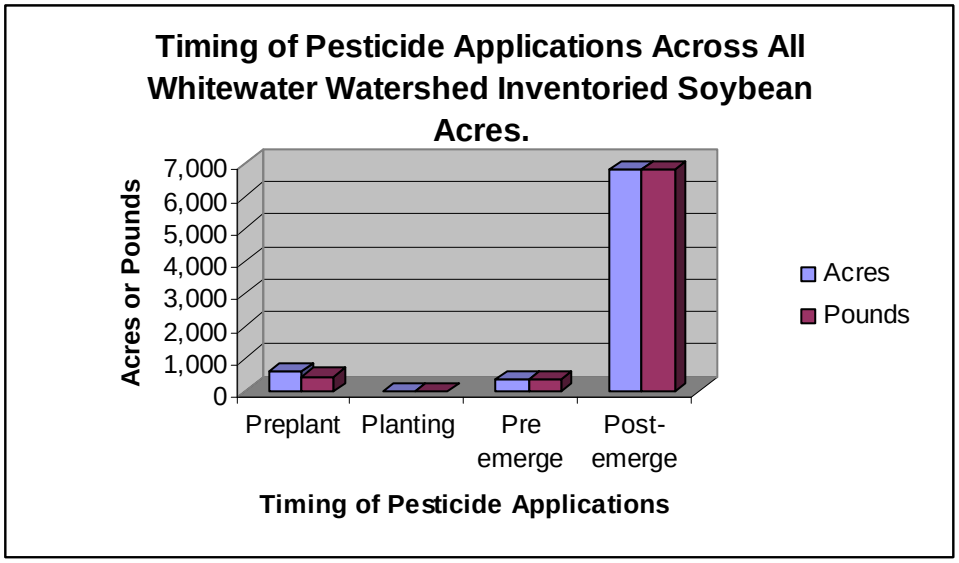


Figure 44. Timing of pesticides applied to all surveyed soybeans by acres and timing.

Special BMP's have been developed for atrazine, acetochlor and metolachlor that include rate reduction or rate limitations.

Atrazine was applied in various amounts by the surveyed farmers. Sixty-eight percent (68%) of the acres that received atrazine were applied with less than 0.6 pounds AI (Figure 45).

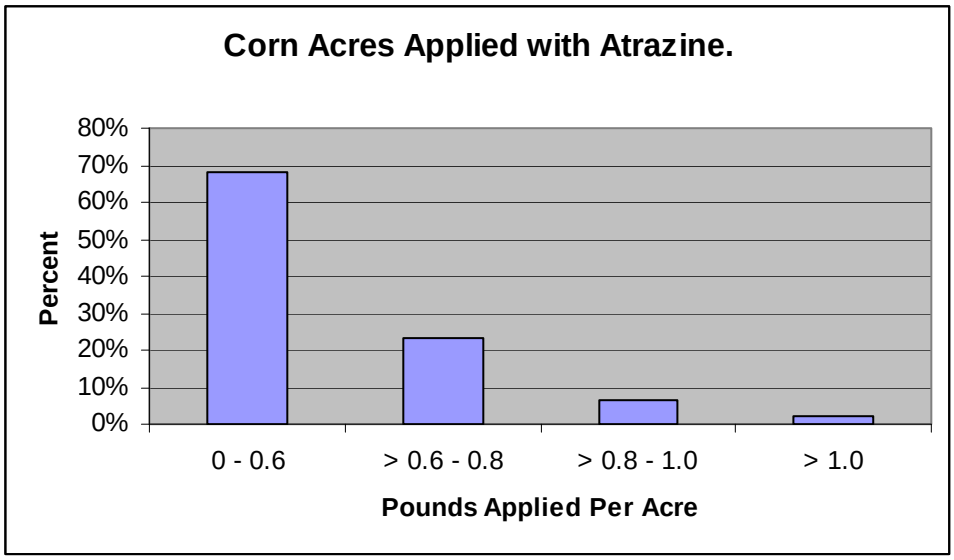


Figure 45. Percent of atrazine applied to corn acres by rate. This percent is the percentage of each category for those acres applied with atrazine.

The largest amount of atrazine was applied post-emergence (Figure 46).

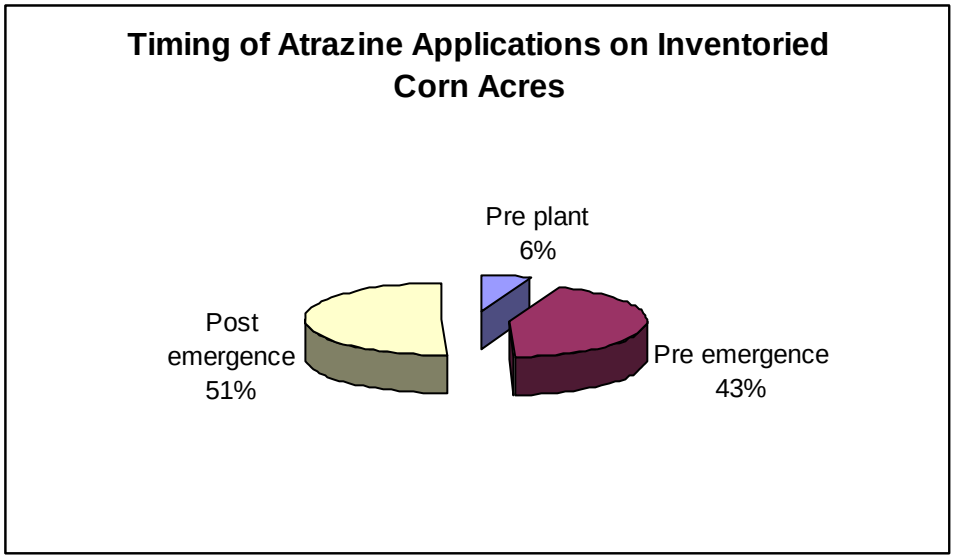


Figure 46. Percent of atrazine applied to inventoried corn acres by timing and pounds applied.

Atrazine was the most used pesticide as a function of acres treated. Atrazine application amounts per acre were generally below maximum recommended amounts according to the label. However, atrazine is the most prevalent pesticide in streams in southeast Minnesota, and the Whitewater River.

Best Management Practices for Atrazine, as developed by the MDA, states for Southeast Minnesota: Limit total Atrazine use per year to 0.8 lbs of active ingredient per area on all soils, except on medium and fine textured soil, where a total of 1 lb of active ingredient per year can be used for pre-emergence control. In the Whitewater watershed, 91% of all acres treated with atrazine adhered to the BMP.

Acetochlor was applied in various amounts by the surveyed farmers. Forty percent (40%) of the acres were applied with rates of acetochlor of 1 pound per acre or less (Figure 47).

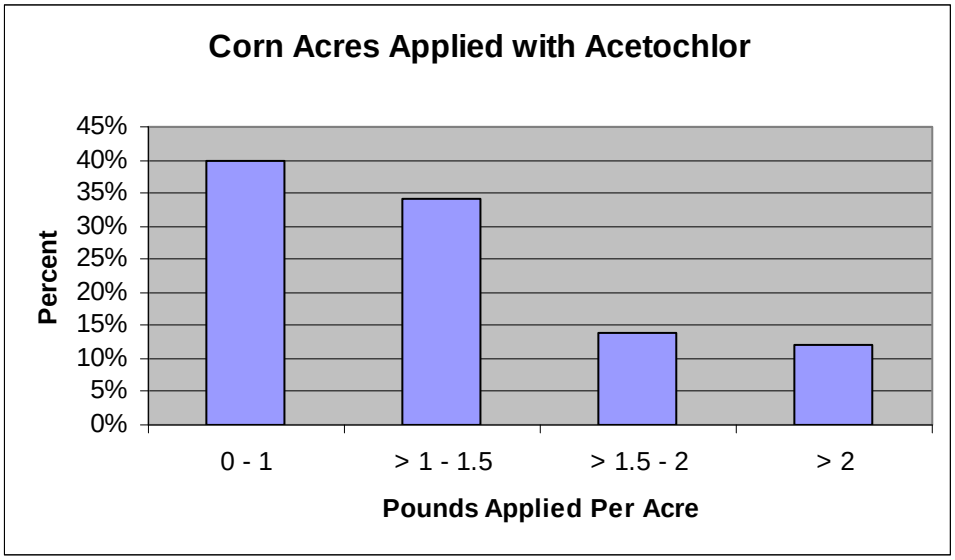


Figure 47. Percent of acetochlor applied on surveyed corn acres by rate.

The largest amount of acetochlor was applied as a spring pre-emergence. (Figure 48).

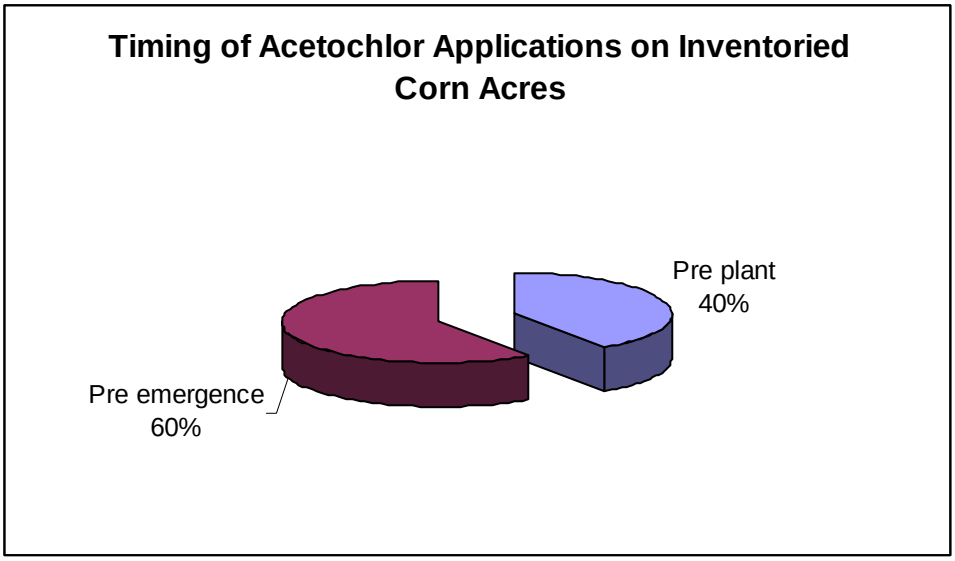


Figure 48. Percent of acetochlor applied to surveyed corn acres by timing and pounds of AI applied.

Using a reduced rate of acetochlor is a BMP and 88% of acres applied with acetochlor received a reduced rate of 2 pounds or less per acre.

When using a metolachlor product, the BMP suggests using S-metolachlor. All metolachlor use was in the S-metolachlor form. S-metolachlor was applied in various amounts by the surveyed farmers. Eighty-two percent (82%) of the S-metolachlor applied acres were applied with rates of S-metolachlor between 1.5 and 2 pounds per acre (Figure 49).

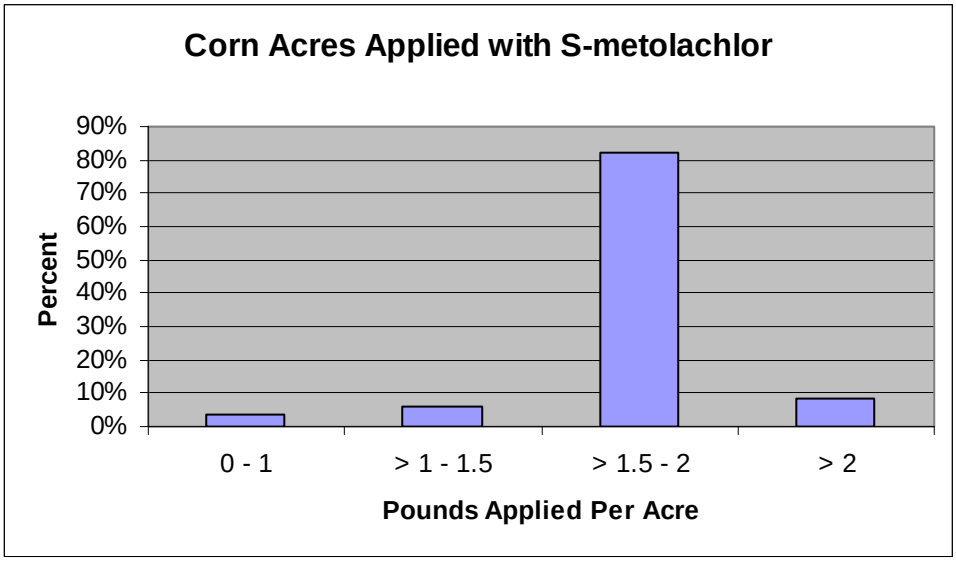


Figure 49. Percent of S-Metolachlor applied on surveyed corn acres by rate.

The largest amount of S-Metolachlor was applied as a spring pre-plant. (Figure 50).

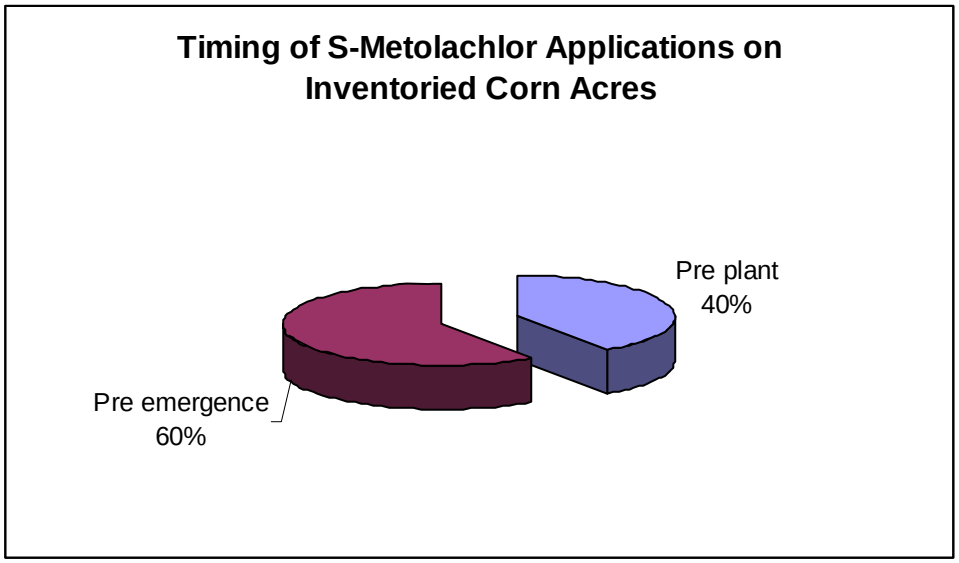


Figure 50. Percent of S-Metolachlor applied to surveyed corn acres by timing and pounds of AI applied. Only S-Metolachlor was applied in the Whitewater Watershed.

Acres of corn applied with S-Metolachlor were generally applied with the recommended rate.

Over 95% of all soybean acres received glyphosate. On corn acres, 35% of all corn acres received glyphosate. Forty-six percent (46%) of all glyphosate applied corn acres included a pre-emergence application of a soil applied herbicide followed by a single post emergence application of glyphosate. Figure 52 details the different packages of glyphosate use on inventoried corn acres.

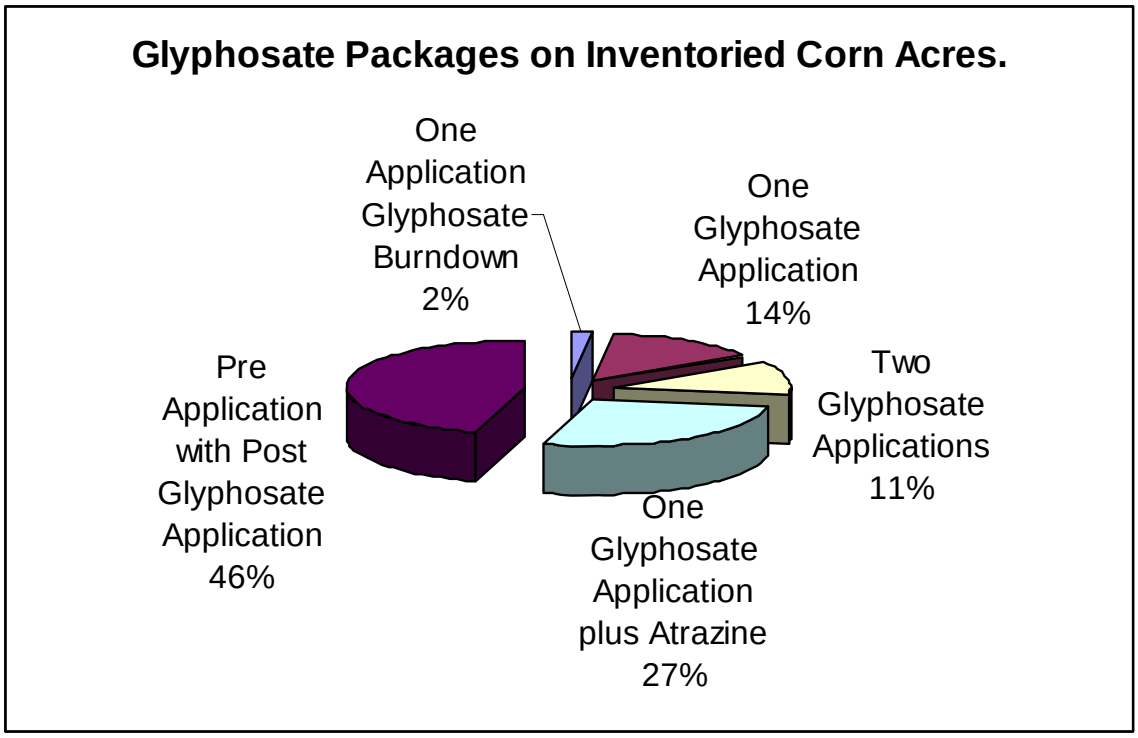


Figure 51. Glyphosate applied on inventoried corn acres by number of applications.

For acres with a pre emergence application followed by a post emergence application of glyphosate, 81% of the acres were applied with acetochlor, 14% with dimethenamid P, and 5% with 2,4-D.

Conclusions and Summary of the Current Nutrient, Tillage and Pesticide Management Practices for the Whitewater Watershed.

This study focuses on the agriculture land use of the Middle Branch Watershed and South Branch Watershed of the Whitewater River. It also compares the results of the 2005 survey of farmers in the Middle Branch and South Branch watersheds with the result of a previous 1997 survey of farmers in the upper Middle Branch Watershed above the Minnesota Department of Agriculture's monitoring station.

A total of 66 farmers were interviewed, 29 from the Middle Branch Watershed and 37 from the South Branch Watershed. Total land available for farming operations in the MBW was 29,053 acres and the total land available for farming in the SBW was 45,143 acres. Land available for farming included all land classified as cultivated crops, grassland and pasture[27]. Land surveyed in the MBW totaled 12,338 acres (42% of land available) and land surveyed in the SBW totaled 15,186 acres (34% of land available). A total of 27,524 acres of farmland across both watersheds was included in the 2005 survey results. In 1997 the FANMAP survey covered 6,527 or approximately 40% of the land available for farming operations in the MW.

[27] Information on land cover was gathered from the USGS 2001 National Land Cover Database.

Corn and soybeans accounted for 78% of the farmland in the SBW and 79% of the farmland in the MBW. In the 1997 MW corn and soybeans accounted for 70% of the farmland. Corn yields have increased by 29 BU/A since the 1997 MW survey. Anhydrous ammonia was the source of nitrogen on 53% of the SBW corn acres and 76% of the MBW. Spring preplant applications account for 86% of the N applied on corn acres in the SBW and 83% of the N applied on corn acres in the MBW.

Livestock in the SBW and the MBW were dominated by dairy. Dairy operations were larger in the 2005 survey than in the 1997 MW survey. Manure N (first year available) from dairy accounted for 63% of manure N applied in the SBW and 59% of the manure N applied in the MBW.

Manure accounted for 23% of the total N applied to corn acres in the SBW and 11% of the total N applied to corn acres in the MBW.

On average, inventoried farmers were in excellent agreement with the UM recommendations for N on corn acres in the SBW and were over-applying by 7 lb/A in the MBW. In the 1997 MW inventoried farmers were over-applying by 16 lb/A. It appears that farmers are currently managing N applications better in the 2005 survey than the farmers in the 1997 MW survey.

The most used type of tillage equipment used on corn acres and soybean acres was a chisel plow. The chisel plow was used on 58% of the corn acres in the SBW and 41% of the corn acres in the MBW. The chisel plow was used on 72% of the soybean acres in the SBW and 47% of the soybean acres in the MBW.

Pesticide use was prevalent in the SMCW, as 87% of all crop acres were treated with herbicides or insecticides including over 98% of corn and soybean acres. Pesticide use consisted of 54 different formulas or products. There were 37 separate active ingredients used in these pesticide applications, totaling 32,151 pounds of active ingredients. Field corn and soybeans accounted for 71% and 23% of all AI applied, respectively.

Atrazine and glyphosate were the two active ingredients most often used to treat field corn with 77% and 35% of all inventoried acres applied respectively. Glyphosate was the most commonly used pesticide on soybeans with 96% of all soybean acres treated.

Inventoried farmers in SBW and the MBW appear to be comparable with many of the practices consistent across the watershed. It also appears that tillage, pesticides and nutrients are closely tied together in this watershed. Therefore, any changes in one area may affect changes in the other two, thus some educational efforts would need to take into consideration the current “package” of practices that farmers are currently using.

Some very positive results were discovered through this study. There is strong evidence that producers are voluntarily adopting the educational materials and recommended N management strategies developed by the UM for the SMCW, especially in regard to manure crediting. However, overall reductions in N can still be achieved with little chance of economic loss in the long term. It is also evident that promotional activities need to continue and be specifically targeted to deliver the most recent advances in technology and revised N management as new research is available.

Appendix A

The University of Minnesota revised the recommendations for N applications on corn in 2006. Yield is no longer a major factor in calculating the correct rate for N applications on corn acres as shown in the guidelines for use of N on corn[28]. The price of N compared to the crop value and previous crop are now the criteria used in the guidelines for determining N rate on corn acres. For further information on the UM recommendations for corn see the University of Minnesota, Fertilizing Corn In Minnesota brochure, FO-3790-C.

An N Price/Crop Value ratio of 0.10 was determined by using the calculations described in the UM Fertilizing Corn in Minnesota brochure. An average price of N at $0.25 per pound and a crop value of $2.52 was used to determine the N Price/Crop Value ratio of 0.10[29]. A 0.10 ratio would then determine the respected Maximum Return To N (MRTN) for each crop rotation. An acceptable range of N applied to corn is also included in the UM recommendations. A farmer who is risk adverse may use the higher rate of N. If water concerns are a factor farmers may use the lower rate of N. All corn acres are considered highly productive in this survey. Only the MRTN will be compared to the rate of N on corn acres.

Table 29 compares the N applied to the 2006 revised N recommendations.

Table 29. Corn Acres and N Applied by Previous Crop, Compared to the 2006 Revised UM N Recommendations for the 2005 season.

Watershed	Crop Rotation (crop/proceeding crop)	Acres	N Applied	Maximum Return To N	Over Application
All Acres	Corn /Alfalfa	519	100	40	60
All Acres	Corn /Soybeans	6,784	149	110	39
All Acres	Corn/Corn	6,953	172	140	32
All Acres	Corn/Corn/ Alfalfa	492	109	90	19
All Acres	**All Corn Acres**	**14,748**	**156**	**121**	**35**
SBW	Corn/Alfalfa	296	66	40	26
SBW	Corn/Soybeans	3,707	148	110	38
SBW	Corn/Corn	3,649	163	140	23
SBW	Corn /Corn/Alfalfa	403	95	90	5
SBW	**All Corn Acres**	**8,055**	**149**	**120**	**29**
MBW	Corn/Alfalfa	223	144	40	104
MBW	Corn/Soybeans	3,077	150	110	40
MBW	Corn/Corn	3,304	181	140	41
MBW	Corn /Corn/Alfalfa	89	169	90	79
MBW	**All Corn Acres**	**6,693**	**165**	**122**	**43**

[28] Guidelines for use of nitrogen fertilizer for corn is taken from Table 1 in the Fertilizing Corn in Minnesota brochure FO-3790-C Revised 2006.

[29] Average county prices for the year 2005.

Comparing N applied on corn acres to the lower of the range of N applied (to protect water quality) would mean an average over application per acre of 55 pounds per acre across all corn acres. Using the higher range of N applied (for farmers adverse to risk) would mean an average over application of 15 pounds per acres across all corn acres.

Nitrogen applied on corn acres averaged 156 pounds per acre and the University of MN recommends on average 155 pounds per acre for a 1 pound per acre over application, based on the 2005 recommendations.

Fifty percent (50%) of the corn acres were over the UM recommendations and 50% of the corn acres were under the UM recommendation for N on all surveyed acres for 2005. Using the 2006 revised UM recommendations for Maximum Return To Nitrogen, 82% of the corn acres were over the UM recommendations, 91% of the corn acres were over the lower range for water quality, and 68% were over the higher range for farmers adverse to risk.

According to the revised UM recommendations additional reductions in N applications may be possible.