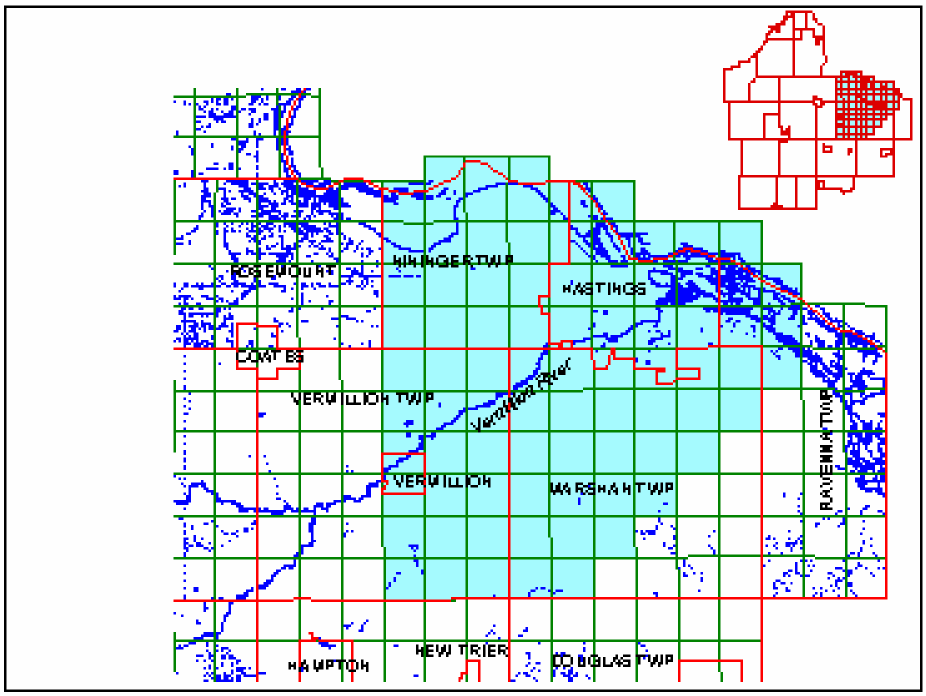
2000 Nutrient Management Assessment of Producers



Hastings Nitrate Study Area

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Errata 10/28/2002

References to Metolachlor, Atrazine and Glyphosate have been changed to reflect errors discovered after the 12/05/01 publication of this report.

Related changes affect tables, text and graphs on pages 20 though 34.

References to "Acetamide" in the 12/05/01 report have been changed to "Metolachlor" and as a result affect the total amount of Metolachlor use in the study area.

Corrections to Atrazine and Glyphosate resulted in only minor changes to graphs, text, and tables.

General information:
Farmers in the Hastings Nitrate Study Area.

Since 1964, water quality sampling indicates an apparent upward trend in nitrates in private and public wells in the city of Hastings, with nitrates appearing in the deeper Prairie du Chien and Jordan aquifers, in addition to shallower wells. In May 1999, samples from Hastings city well #6 had an average value of 10.5 mg/L, exceeding federal drinking water standards, which are 10.0 mg/L. This prompted city officials to shut down that particular well for several weeks.

In September 2000, 146 private wells and five Hastings city wells were tested for nitrates. The median level was 3.7 mg/L; 26% of the samples exceeded the federal drinking water standard and an additional 26% were considered “elevated” (between 3.0 and 10.0 mg/L). The median nitrate result within the city of Hastings was 5.7 mg/L.

For the past several years, water managers and resource specialists in Dakota County have been concerned about these increasing levels. In response to these concerns, Dakota County is conducting a “Hastings Clean Water Partnership” study that is designed to identify the sources and extent of nitrate contamination in the Hastings area and to develop educational programs to minimize future nitrate contamination of the groundwater. Dakota County’s efforts in this study are being assisted by the Minnesota Departments of Agriculture, Health and Natural Resources, the city of Hastings, the County Soil and Water Conservation District and the Metropolitan Council.

This study focuses on the farming activities associated with the Hastings Nitrate Study Area (HNSA) and reports the results of farm assessments conducted for the 2000 cropping season. A list of farmers/operators in the HNSA was obtained from the Dakota County Farm Service Agency. Minnesota Extension Service Educators, the city of Hastings, the Dakota County Environmental Service Office, Natural Resources Conservation Service (NRCS) personnel and Soil and Water Conservation District (SWCD) personnel were contacted to inform them of the specifics of the project and its objectives.

Introduction letters describing the project were mailed to the farmers in July of 2000. The letter’s intent was to identify: 1) the overall project; 2) the purpose of the nutrient assessment; 3) why individual farmers were selected; and 4) what types of information and amount of time would be necessary to successfully complete the project. Letters were sent to 68 farm operations. A total of 42 operators participated in the study.

To conduct its research, the Minnesota Department of Agriculture (MDA) used a data-gathering tool and analysis system called the Farm Nutrient Management Assessment Program (FANMAP). FANMAP was developed seven years ago to provide an understanding of current farm practices regarding agricultural inputs. This information is used to design effective water quality educational programs and provides baseline data to determine program effectiveness over time. In the past seven years, more than 500 farmers throughout Minnesota have volunteered one to three hours of their time to share information about their farming operations. Previous FANMAP studies have been conducted as a result of funding through the Legislative Commission on Minnesota Resources or Clean Water Partnership programs and from the fertilizer tonnage fee account at the MDA.

Nutrient Information of the Selected Farms in the Hastings Nitrate Study Area

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 HNSA 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; and
- Soil and manure testing results were also collected if available.

Nutrient inputs and yields were specific for the 2000 cropping season. Crop types and manure applications (starting in the fall of 1999) were also collected for the 1999 season for purposes of 2000 nitrogen crediting. Long-term yield data generally reflected the past three to five years. Livestock census and other specifics for the entire farm (i.e. types of manure storage systems, total farm sizes) were also recorded. Information was gathered from the farmer or from the fertilizer dealer if the dealer kept the farmer's records.

Farm Size, Crop and Livestock Characteristics of the Selected Farms in the Hastings Nitrate Study Area

Forty-two farmers were interviewed for the study in July & August of 2000. A total of 16,135 acres of farmland was inventoried in the HNSA study for the 2000 crop season. Hastings county offices estimate there are 78,000 crop acres in the HNSA. Farm interviews covered approximately 25% of all agricultural acres in the HNSA. The HNSA cropland was dominated by a field corn/soybean rotation with field corn and soybeans accounting for 69% of all acres. Sixty-three percent (63%) of all inventoried crop acres were irrigated. Figure 1 lists each type of crop grown and the corresponding percentage of acres.

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

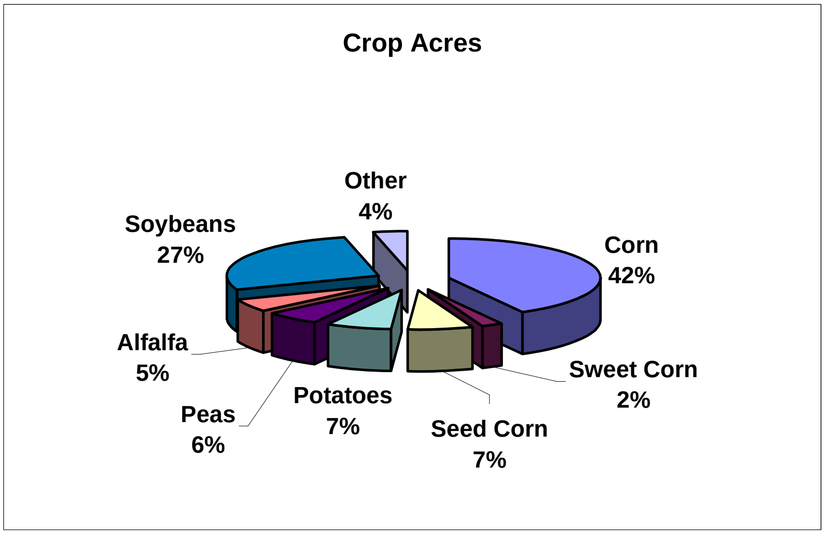


Figure 1. Crop acres inventoried in the HNSA. Cropland totaled 16,135 acres.

Commercial Fertilizer Use Characteristics on Selected Farms: Hastings Nitrate Study Area

Field corn accounted for more than 68% (1,114,442) of the 1,627,043 pounds of commercial N fertilizer used (Figure 2). All field corn acreage received either commercial N fertilizer or manure. Ninety-eight percent (98%) of all field corn acres received commercial N fertilizer. Average fertilizer N rate across all field corn acres was 165 lb/A. Total N inputs will be discussed later in the "Nutrient Balances and Economic Considerations" section of this report.

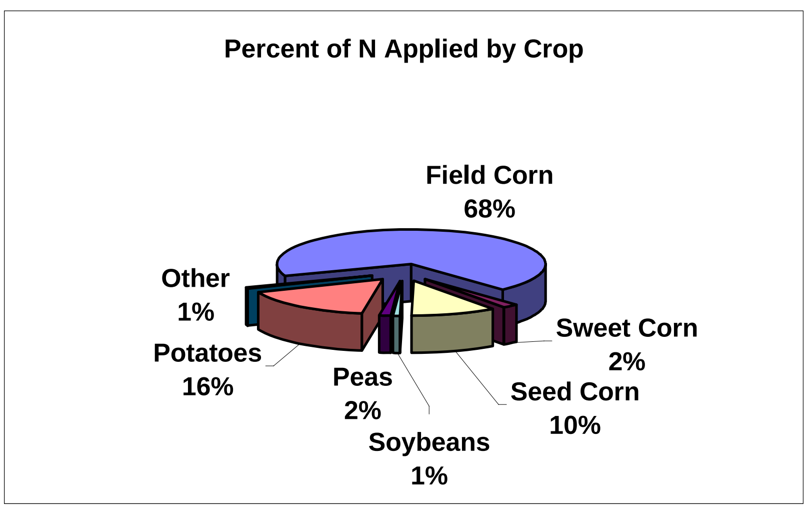


Figure 2. Commercial fertilizer N use on all inventoried acres. Commercial fertilizer N totaled 1,627,043 pounds.

Timing of N fertilizer applications for all crops is an important consideration on the course-textured soils in east-central Minnesota. Fifty-seven percent (57%) of commercial N applied to all crops was as a preplant application (Figure 3).

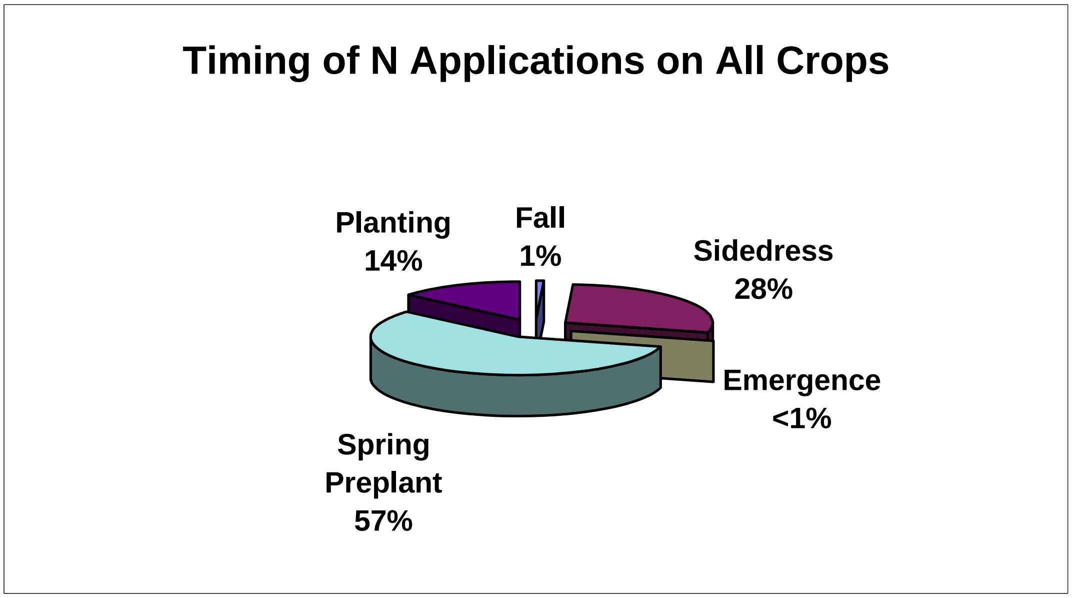


Figure 3.Timing of 2000 commercial N fertilizer applications across **all** inventoried acres.

Each crop has specific Best Management Practices in regard to timing of N applications. Best Management Practices (BMPs) for nitrogen use have been developed for east-central Minnesota. Applications of nitrogen before spring planting of field corn are highly recommended in the HNSA. Seventy percent (70%) of the N applied to field corn was as a spring preplant application (Figure 4).

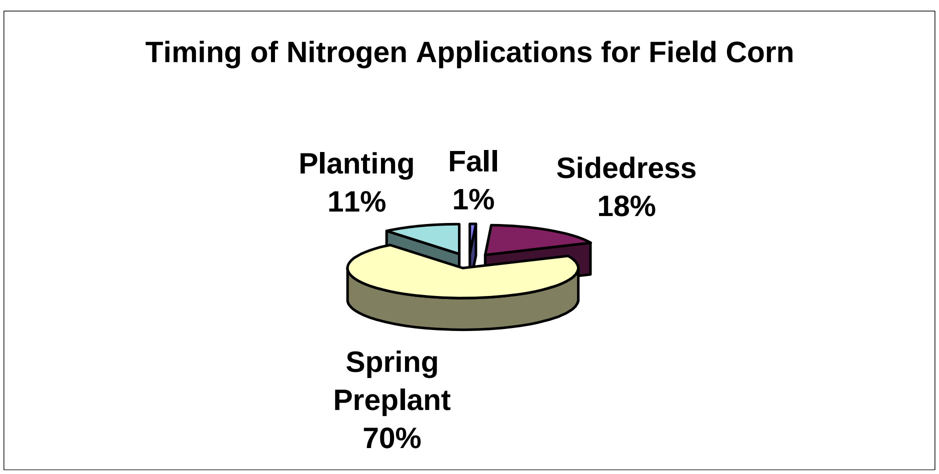


Figure 4. Timing of commercial N applications across all **field corn** acres.

Anhydrous ammonia supplied 63% of the commercial N applied to all inventoried acres (Figure 5).

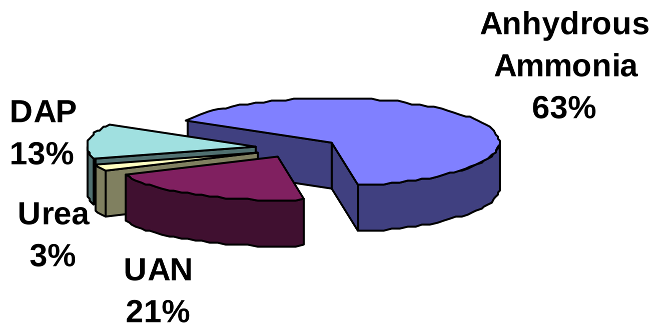


Figure 5. Sources of commercial N used on **all** inventoried crop acres.

Anhydrous ammonia accounted for 80% of all commercial N applied to inventoried field corn acres (Figure 6).

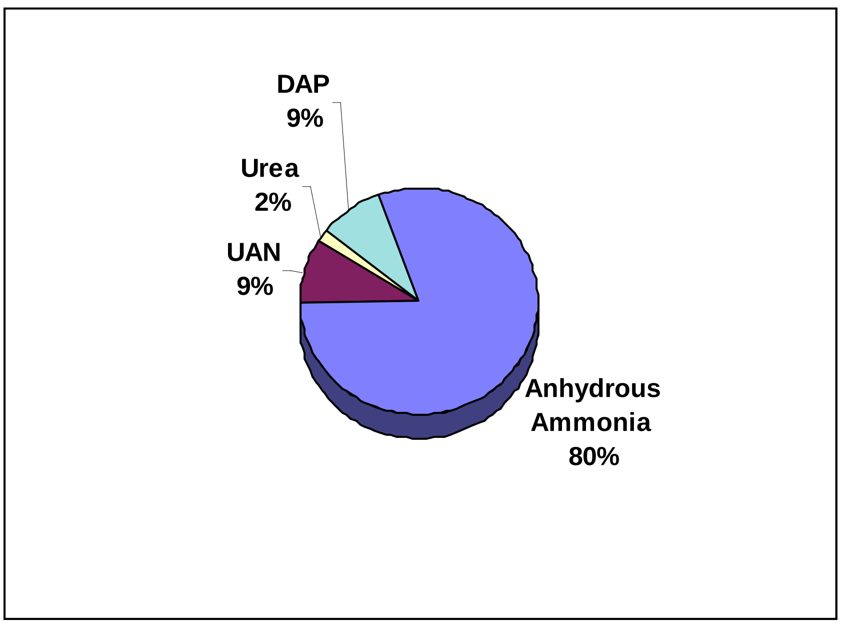


Figure 6. Sources of commercial N used on all inventoried **field corn** acres.

Commercial N Applications on Field Corn

Field corn totaled 6,770 acres, of which 4,492 acres were irrigated. Fall applications of N on field corn acres totaled 7,840 pounds and all N was in the form of diammonium phosphate (DAP). Spring preplant applications for field corn acres totaled 790,687 pounds of commercial N. Ninety-eight percent (98%) of spring preplant N was in the form of anhydrous ammonia with the remaining 2% in the form of urea or DAP. Nitrogen inhibitor was used with 349,943 pounds, or 44%, of the anhydrous ammonia during the spring preplant applications. Applications of N at planting totaled 120,768 pounds. Sixty-three percent (63%) of the N applied to field corn at planting was in the form of DAP, 30% of N was in the form of UAN, and 7% in the form of urea. Sidedress applications of N totaled 195,146 pounds. Farmers were generally applying the majority of sidedress N as anhydrous ammonia (62%), with the balance as UAN (36%) and urea (1%).

Commercial N Applications on Sweet Corn

Acres planted to sweet corn totaled 342, of which 202 were irrigated. There was no fall application or sidedress application of commercial N on sweet corn acres. Nitrogen applications of commercial N totaled 34,650 pounds with 31,116 pounds (90%) of N applied as a preplant application and the balance, 3,534 pounds (10%) applied as a starter. Anhydrous ammonia was the dominant form of commercial N used on sweet corn acres with applications totaling 25,310 pounds, all applied during spring applications. UAN applications of N totaled 6,094 pounds with 5,080 pounds (83%) applied as spring preplant and the balance as a starter. DAP applications of N totaled 3,246 pounds with 78% applied at planting and the balance as a preplant.

Commercial N Applications on Seed Corn

Seed corn acres totaled 1,126. All seed corn acres were irrigated and there was no fall application of commercial N on seed corn acres. Nitrogen applications of commercial N totaled 167,947 pounds with 83,353 pounds (51%) of N applied as a preplant application (Figure 7).

Anhydrous ammonia was the dominant form of commercial N used on seed corn acres, with applications totaling 126,021 pounds or 75% of all commercial N (Figure 8). Ninety-seven percent (97%) of all spring preplant commercial N applications was in the form of anhydrous ammonia with the balance applied as urea. Twenty-two percent (22%) of the spring preplant anhydrous ammonia was applied with a nitrogen inhibitor. Urea, UAN and DAP were all used as an N source for applications at planting. Ninety-four percent (94%) of the sidedress N was applied as anhydrous ammonia, with the balance applied as urea. Six percent (6%) of all commercial nitrogen was applied though the irrigation system in the UAN form.

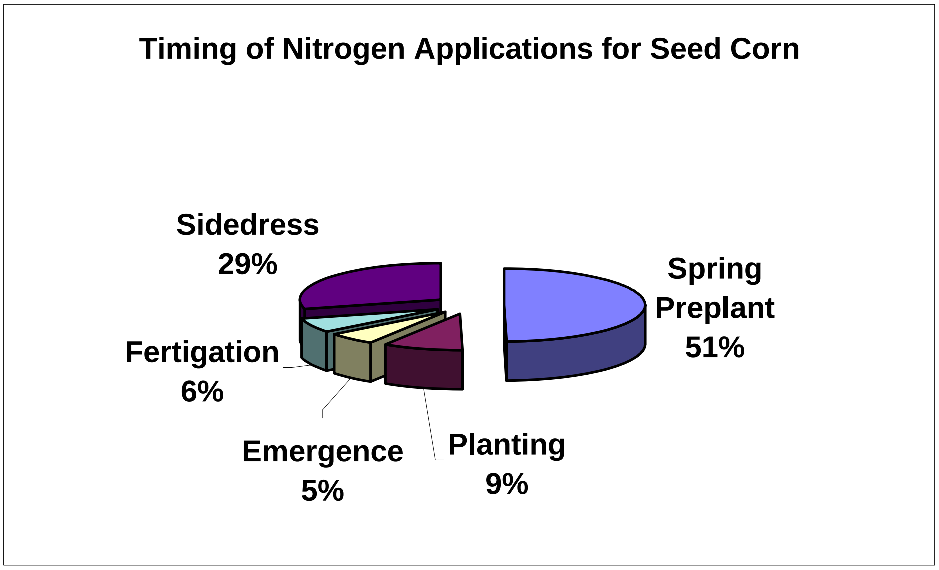


Figure 7. Timing of Commercial N applications for seed corn.

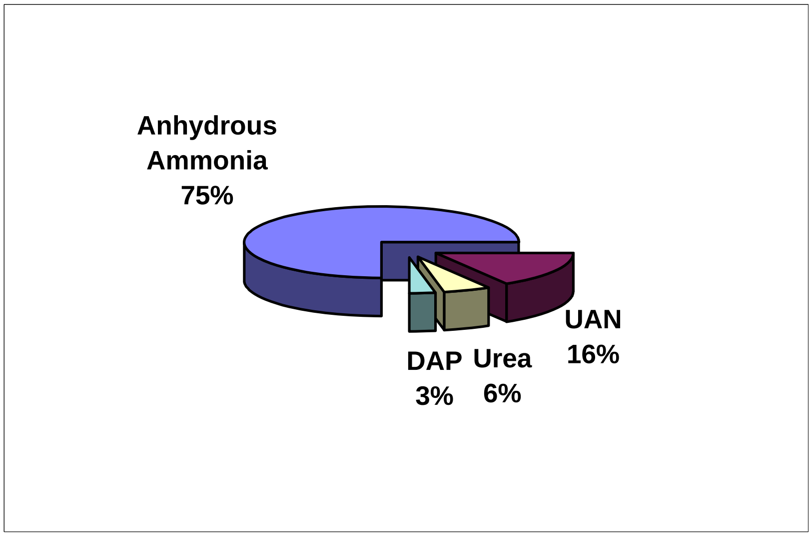


Figure 8. Forms of N used on seed corn acres compared by percentage.

Commercial N Applications on Peas

Pea acres totaled 938, of which 864 were irrigated. Commercial N applications totaled 25,055. Commercial N was only applied in the DAP form and 93% of N was applied as a preplant with the balance applied at planting. All pea acres were double cropped, and soybeans were planted to all acres after the pea harvest.

Commercial N Applications on Potatoes

Potato acres totaled 1,150. All potato acres were irrigated. There was no fall application of commercial N on potato acres. Nitrogen applications of commercial N totaled 263,350 pounds with 67,850 pounds (26%) of N applied in the form of DAP at planting, 92,000 pounds (34%) applied as a hilling application and the balance, 103,500 pounds (40%) applied as a fertigation application.

Commercial N Applications on Other Crops

Soybean acres totaled 4,400 with 2,147 acres irrigated. Nitrogen applications on soybeans consisted of 10,730 pounds of commercial N applied on 901 acres of soybeans. An additional 10,870 pounds of commercial N was spread across 618 acres of a variety of crops including pasture, alfalfa, grass and small grains. An additional 228 acres of alfalfa were irrigated, while no other crops not previously mentioned were irrigated.

Factors directly affecting crop nutrient availability from land-applied manure (including manure storage, types, manure amounts being generated, application methods, incorporation factors and rates) were also quantified to complete the "whole farm" nutrient balance. Livestock numbers represent the livestock on hand from the fall of 1999 to the summer of 2000. This is the livestock that would contribute manure to the 2000 crops. Twelve farm operations had livestock within the HNSA.

Livestock and Manure Characteristics of the Selected Farms:

Animal production in the H-NSA consists of dairy, beef and hog operations. Table 1 details the variety of animals produced in the HNSA.

Table 1. 2000 Distribution of Livestock Across Inventoried Farms

Livestock Type	Livestock Number
Dairy Cows and Bulls	369
Dairy Calves	243
Replacement Heifers	227
Dairy Steers	570
Beef Cows and Bulls	80
Beef Calves	31
Beef Feeders	1,793
Sows and Boars	79
Slaughter Hogs[2]	900
TOTALS	**4,292**

[2] Slaughter Hogs are the number of animals sold/raised per year. All other numbers are average number of animals on hand per year.

Manure production varied by type of livestock in the HNSA. Beef manure supplied 51% of the total amount of N produced from all livestock raised on the farm (Figure 9).

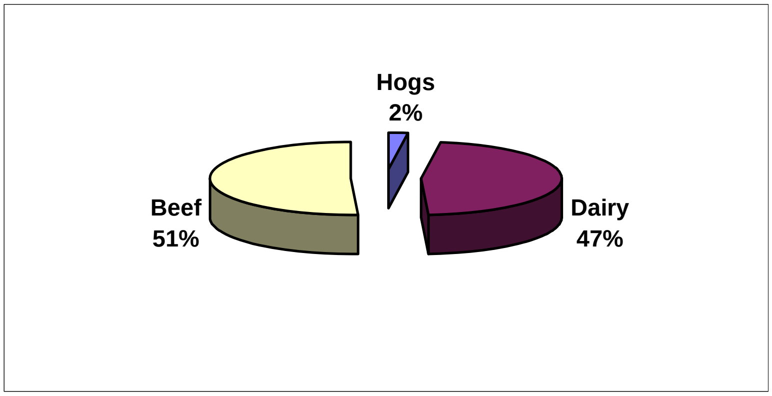


Figure 9. Amounts of nitrogen (total) generated by animal types across all selected farms. A total of 461,565 pounds of manure was produced by 4,292 animals.

Sixty-five percent (65%) of the manure produced in the survey was collected. Manure not collected was due to pasturing of cattle or holding cattle in wintering areas too large to collect manure. A total of 298,209 pounds of manure N was collected. Table 2 further details the specific type of livestock and their respective manure nutrient contributions on the inventoried farms. Nutrient losses from collection and storage were estimated from accepted guidelines[3] for each individual storage system. A total of 205,233 pounds of N was available from livestock raised on the farms.

Table 2. 2000 livestock numbers and fate of manure N produced and available to spread after system losses by livestock types in sample population.

Livestock Type	Livestock Number	Manure Nitrogen Produced	Manure Nitrogen Collected	Manure Nitrogen Available
		Pounds		
Dairy Cattle	1,409	216,787	186,411	127,356
Beef Cattle	1,904	234,272	101,292	69,997
Hogs[4]	979	10,506	10,506	7,880
TOTALS	**4,292**	**461,565**	**298,209**	**205,233**

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

[4] Slaughter Hogs are the number of animals sold/raised per year. All other numbers are average number of animals on hand per year.

Three of the 12 farmers with livestock had some type of liquid manure system for the majority of their manure. The remaining nine farmers had only solid manure. Liquid manure systems were all under-barn pits and contributed a total of 70,918 pounds (35%) of manure N.

Manured acres totaled 2,772. Manure N available for spreading totaled 210,003 pounds. This included acres from one farmer who imported manure. Eighty-six percent (86%) of all manure, based on manure N, was spread with no incorporation. Fourteen percent (14%) of the manure was incorporated within 12 hours and there was no injection of manure. A total of 59,028 pounds (28% of manure N applied) of N was available for first year N credits to the crop.

Approximately 31% of the manure was fall applied (Figure 10). Many of the farmers spread manure throughout the year as land became available for application.

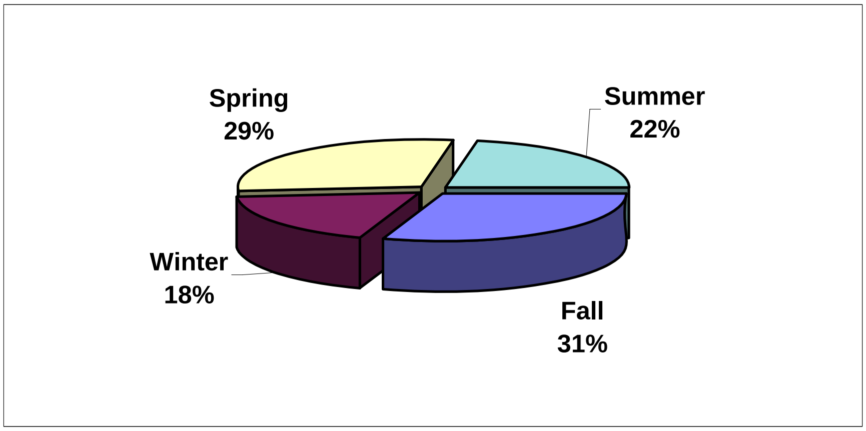


Figure 10. Timing of manure applications on all acres based on manure N availability.

Corn was the major crop that received manure. Seventy-nine percent (79%) of the cropland covered with manure was planted to field corn (Figure 11).

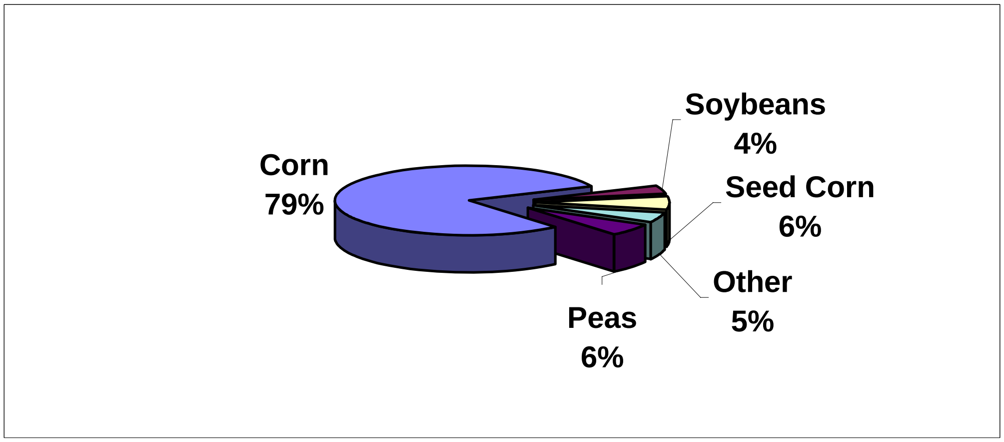


Figure 11. Distribution of manure based on crop acres covered. A total of 2,772 acres of cropland were covered with manure.

Relative Importance of Nutrient Sources on the Selected Farms: Hastings Nitrate Study Area

The University of Minnesota recommends legume crops be credited for their N contributions to subsequent crops. Alfalfa credits were available on only 39 acres of field corn and 33 acres of sweet corn. Field corn acres (39 acres) following alfalfa were given 75 lb N/A. Sweet corn acres (33 acres) received alfalfa legume credits and were second year alfalfa credits of 50 lb N/A. Soybean acres were given a 40 lb N/A credit. Soybeans were the most important source of legume N, supplying approximately 97% of all legume N. Figure 12 details legume credits on the inventoried acres.

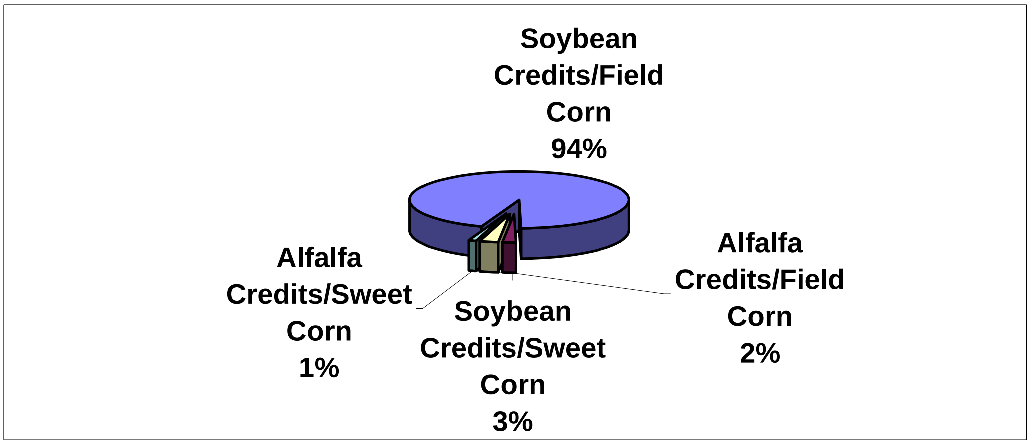


Figure 12. Legume credits on inventoried acres.

Commercial fertilizers (89%), manures (3%), and legumes (8%) contributed a total of 1,826,817 lb of "first year available N" to all inventoried acres in 2000 (Figure 13).

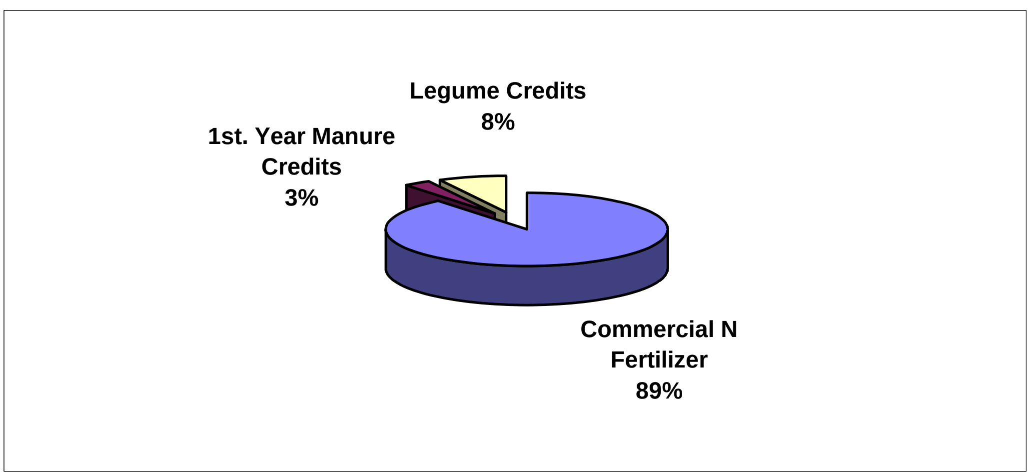


Figure 13. Relative N contributions from fertilizers, manures and legumes across all crop acres inventoried in 2000. Nitrogen inputs totaled 1,826,817 lb for all sources across all inventoried acres.

Nutrient Balances and Economic Considerations: Hastings Nitrate Study Area

Contributions of N from commercial fertilizer and manure to inventoried acres totaled 1,686,071 pounds. Field corn received most of the N with 69% (1,1580,138 pounds of N) applied to field corn (Figure 14). The field corn yield goal across all farms averaged 170 Bu/A while historic yields averaged 165 Bu/A. Yield goals for corn were approximately 5 Bu/A greater than average yields for the past five years. It appears farmers are using realistic yield goals for field corn acres.

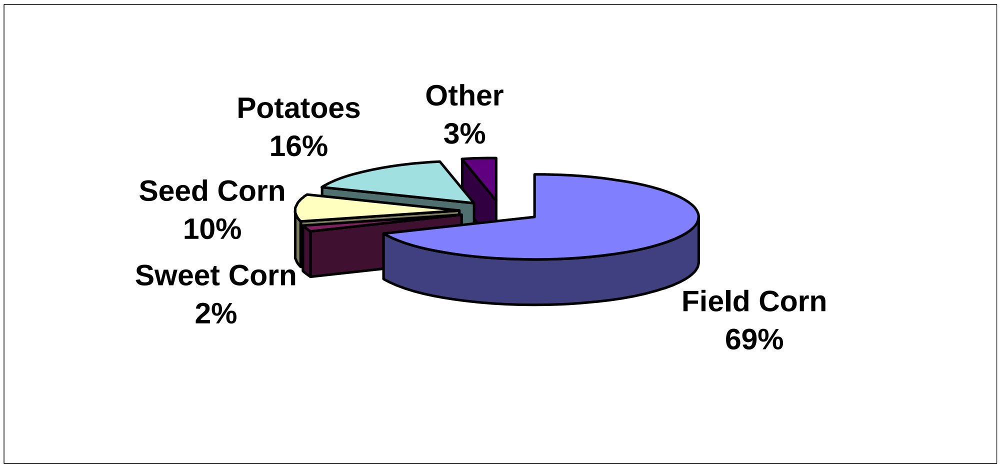


Figure 14. Destination of all N including 1,627,044 pounds of commercial N and 59,028 of manure N.

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 result in the most economic profit.

University of Minnesota (UofM) 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. In the fall of 2000 the UofM released new fertilizer recommendations for field corn. This analysis will compare actual amounts of N to both the old and new UofM recommendations. In this survey, all soils in the HNSA are considered low in organic matter, based on soil surveys and actual soil tests. Irrigated soils also receive the UofM recommendations for soils low in organic matter. Irrigation was prevalent on surveyed field corn acres with 4,492 acres (66%) irrigated.

Old University of Minnesota N recommendations for field corn averaged 167 lb N/A (Figure 15). New UofM N recommendations for corn averaged 182 lb N/A. Actual amounts of N applied from fertilizer and manure averaged 171 lb N/A across all corn acres. Factoring in all appropriate credits from fertilizer, legumes and manures, there was an over-application rate of 4 lb/N/A according to the old UofM recommendations and an **under**-application rate of 11 lb/N/A according to the new UofM recommendations.

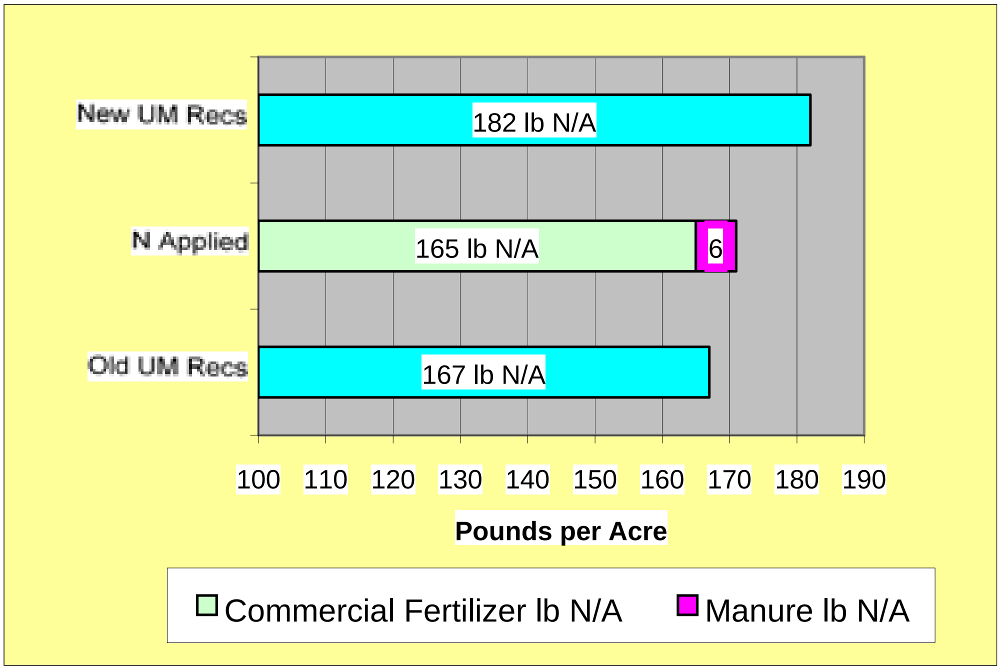
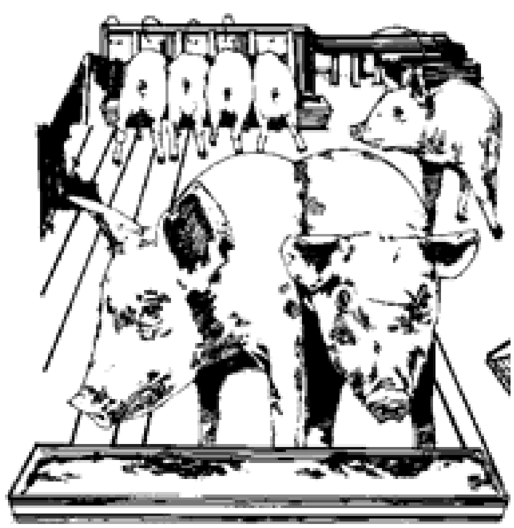


Figure 15. 2000 crop N requirements based on University of Minnesota N recommendations in comparison to actual N inputs (fertilizer and manure) for field corn acres in the inventoried area. Average N application was 171 lb N/A.

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. Factoring in legume N credits and manure N credits into the process on a field-by-field basis, the amounts in excess of 2000 UofM recommendations are illustrated in Figure 16.



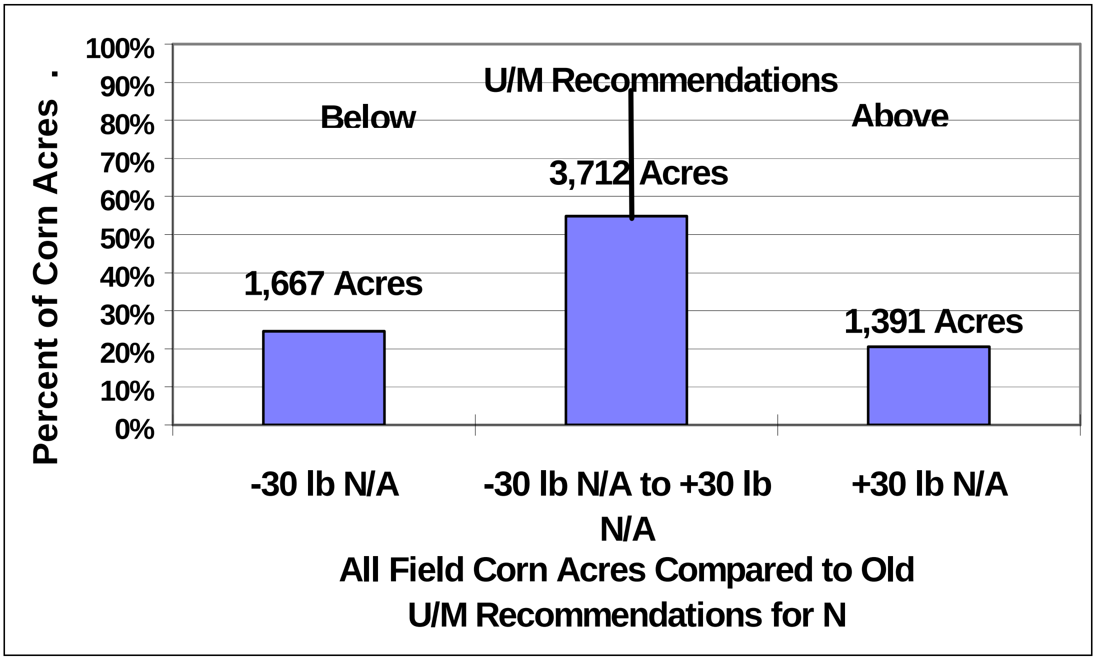
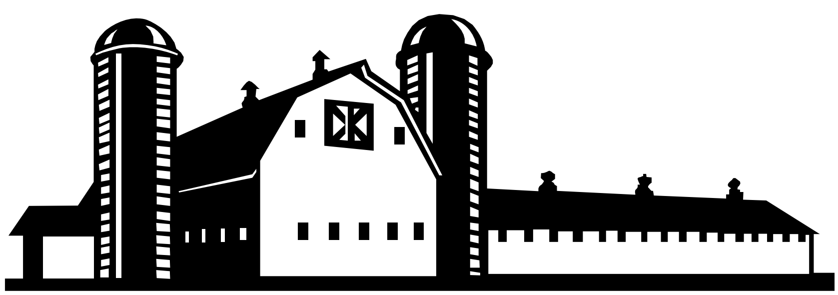


Figure 16. Field corn acres that fall within plus and minus 30 pounds of the 2000 UM recommendations for N.

Twenty-one percent (21%) of the field corn acres were classified in the excess UofM category according to the old (2000) recommendations. By applying the N according to old UofM recommendations, N applied to corn acres would actually decrease by 28,267 lbs.

New UofM recommendations (2001) have slight increases in the amount of N required for corn. When comparing what the farmers are currently applying for N to the new recommendations, there are less acres over-applied with N (Figure 17).



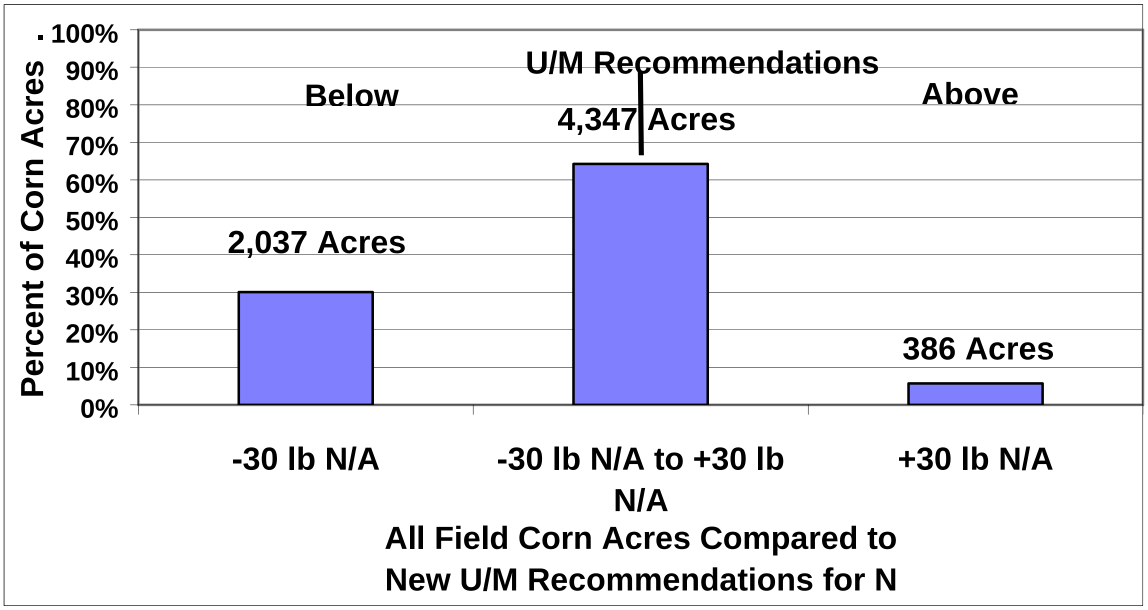


Figure 17. Corn acres that fall within plus and minus 30 pounds of the new (2001) UofM recommendations for N.

Five percent (5%) of the field corn acres were classified in the excess UofM category according to the new (2000) recommendations. By applying the N according to UofM recommendations, N applied to corn acres would actually **increase** by 73,513 lbs. When looking only at those 386 acres that were over-applied by more than 30 lb N/A above UofM recommendations, 341 acres had legume credits, 130 acres had manure N applied, and 123 acres were irrigated.

Contributions of N from commercial fertilizer and manure applied to the 342 inventoried **sweet corn** acres totaled 34,800 pounds of which 99% came from commercial N. Typical yield goals and yields are between 6 and 8 tons per acre. University of Minnesota N recommendations for sweet corn at these yields are to apply 130 lb N/A. Actual amounts of N applied from fertilizer and manure averaged 102 lb N/A across all sweet corn acres. Factoring in all appropriate credits from fertilizer, legumes and manures, there was an **under**-application rate of 28 lb N/A according to the UofM recommendations.

Contributions of N from commercial fertilizer and manure to the 1,126 inventoried **seed corn** acres totaled 175,210 pounds of which 96% came from commercial N. Actual amounts of N applied from fertilizer and manure averaged 156 lb N/A across all seed corn acres. The UofM does not have recommendations for seed corn at this time. Yields for inbred lines planted for seed corn can average between 70 and 110 bushels per acre. It is also thought that the inbred lines may have very week root systems and therefore may need additional N when compared to field corn with similar yields.

Contributions of N from commercial fertilizer and manure to the 938 inventoried **pea** acres totaled 30,182 pounds of which 83% came from commercial N. Typical yield goals and yields are between 2,000 and 4,000 pounds per acre. University of Minnesota N recommendations for peas at these yields are to apply 20 lb N/A. Actual amounts of N applied from fertilizer and manure averaged 32 lb N/A across all pea acres. Factoring in all appropriate credits from fertilizer, legumes and manures, there was an over-application rate of 12 lb/N/A according to the UofM recommendations. However, it should be noted all pea acres were second cropped with soybeans and some of the fertilizer applied as DAP (all N on peas was in the form of DAP) could also be for the soybean crop.

There were 600 acres of potatoes planted after corn and 550 acres of potatoes planted after soybeans. Potatoes were given a 20 lb N/A credit for soybeans as a previous crop according to the UofM recommendations. Potato growers applied 59 lb N/A as a starter application across all 1,150 inventoried acres of potatoes. Diammonium phosphate was the source of N in starter applications.

All potato acres received N at hilling, with potato acres having a single hilling operation. Rate of N at hilling was 80 lb N/A and UAN solutions were used for all hilling operations.

For potatoes, N not applied as starter or at hilling was applied through the irrigation system. Rates of N through the irrigator averaged 15 lb/A per application with each field averaging 6 applications of N through the irrigation pivots. Approximately 40% of the N was applied through irrigation (Figure 18).

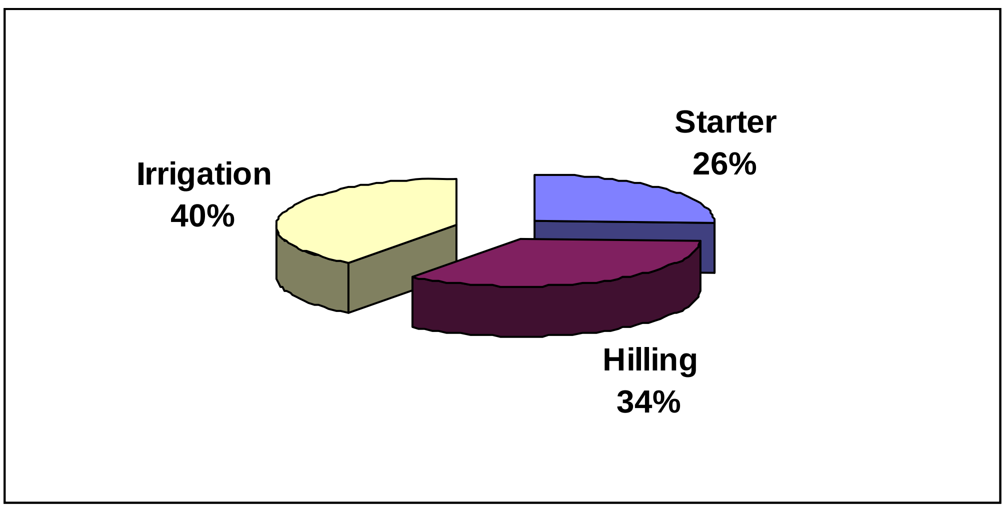


Figure 18. N applied on inventoried potato acres.

The potato yield goal across all farms averaged 550 cwt./A. All potato acres were irrigated. Historic yields averaged 500 cwt./A. University of Minnesota N recommendations (based on yield goal, crop history, and soil organic matter level) were compared to actual amounts of fertilizer N applied to each field. University of Minnesota N recommendations for potatoes averaged 242 lb N/A based on yield goals selected by the producers (Figure 19). However, the actual amounts of fertilizer N applied averaged 229 lb/A across all potato acres. Thus, there was an under-application rate, on average, of 13 lb/N/A.

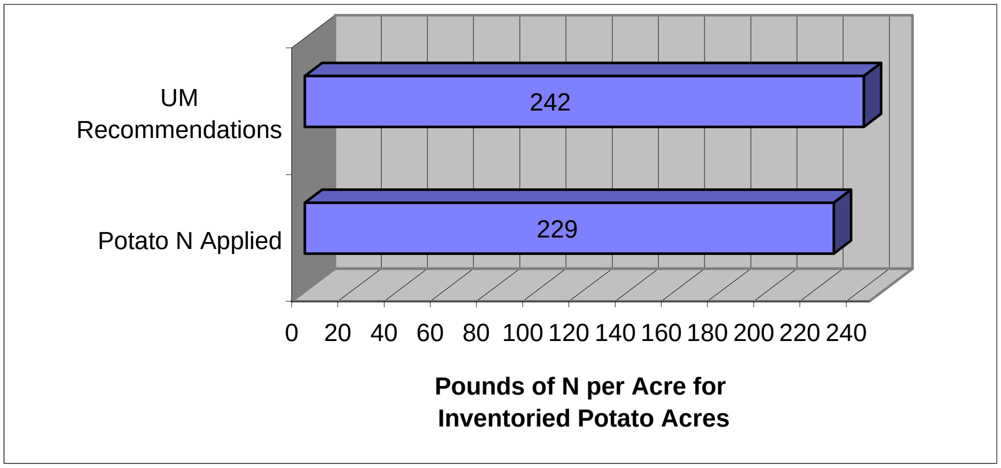


Figure 19. Crop N requirements based on University of Minnesota N recommendations in comparison to actual N inputs across all potato acres. Total area planted to potatoes in this analysis was 1,150 acres.

Assessment results indicate that potato fertilization and production practices on inventoried acres do not typically follow practices anticipated in the published potato BMPs. For example, the UofM recommends 20 to 40 lb/N/A starter fertilizer for potato production. Current practices, according to this assessment, are to apply an average of 59 lb/N/A. Additionally, the UofM recommendations anticipate two hilling operations, with a portion of post-emergence fertilizer needs split between the two hilling events and applied as an injected or incorporated sidedress. Production practices documented during the assessment confirm the elimination of a hilling event. Applications of N normally linked to the second hilling event (up to 40 lb/N/A) must therefore shift to the first hilling event or to applications elsewhere in the growing season.

Potato BMPs recommend testing irrigation well water to account for the nitrogen contribution from nitrate-contaminated groundwater. For example, groundwater contaminated with 10 parts per million nitrate and applied through irrigation pivots (one inch per week for six weeks) could provide up to 14 lb/N/A. Failure to account for nitrogen in irrigation water can lead to over-application of N. Well water concentrations are not known, so any crediting at this time is not possible.

Carl Rosen, UofM specialist, has planned upcoming research focusing on fertilizing potatoes and includes researching starter application amounts of N, and timing and amounts of N applied at hilling.

Pesticide Applications:
Hastings Nitrate Study Area:

Data on pesticide use were gathered on all crop acres. Pesticides were used on 90% of all crop acres (Table 3). Pesticide use on the HNSA included herbicides, insecticides and fungicides.

Table 3. Crop Acreage and Percentage Treated With Pesticides.

Crop Grown	Total Acres	Type of Pesticide					
		Herbicide		Insecticide		Fungicide	
		Acres	Percent	Acres	Percent	Acres	Percent
Corn	6,770	6,761	99%	1,520	22%	0	0%
Sweet Corn	342	342	100%	33	9%	0	0%
Seed Corn	1,126	1,126	100%	0	0%	0	0%
Potatoes	1,150	1,150	100%	1,150	100%	1,150	100%
Peas	938	938	100%	0	0%	0	0%
Alfalfa	834	78	9%	353	42%	0	0%
Soybeans	4400	4,017	91%	0	0%	0	0%
Other	575	59	10%	5	1%	5	1%
Total Acres	**16,135**	**14,471**	**90%**	**3,061**	**19%**	**1,155**	**7%**

Pesticide use on all acres consisted of 63 different formulas (different EPA numbers) of which 46 were herbicide formulas, 10 were insecticides and seven were fungicides. Tables 4, 5 and 6 describe the active ingredients (AI) of each pesticide product used.

Table 4. Product Name and Description of Herbicide Use in H-NSA.				
Name Of Product	EPA Number	Active Ingredients (AI)	Amount of AI in Product	AI Expressed as
Accent	352-560	Nicosulfuron	0.750	Percent By Weight
Accent Gold	352-593	Clopyralid Flumetsulam Nicosulfuron Rimsulfuron	0.517 0.190 0.070 0.070	Percent By Weight
Amine 4	34704-120	Diamethylamine Salt Of 2,4-D	3.740	Pounds Per Gallon
Atrazine 4L	34704-69	Atrazine	4.000	Pounds Per Gallon
Atrazine 90 WDG	34704-622	Atrazine	0.900	Percent By Weight
Atrex	100-585	Atrazine	0.855	Percent By Weight
Basis Gold	352-585	Nicosulfuron Rimsulfuron Atrazine	0.013 0.010 0.820	Percent By Weight
Bladex 4L	352-470	Cyanazine	4.000	Pounds Per Gallon
Bladex 90DF	352-495	Cyanazine	0.900	Percent By Weight
Broadstrike+Dual	62719-239	Flumetsulam Metalachlor	0.200 7.470	Pounds Per Gallon
Buctril	264-437	Bromoxynil	2.000	Pounds Per Gallon
Clarity	7969-137	Dicamba Diglycolamine Salt	4.000	Pounds Per Gallon
Dacthal W-75	50534-1	Dcpa	0.750	Percent By Weight
Diquat	10182-353	Diquat Dibromide	2.000	Pounds Per Gallon
Dual II Magnum	100-818	Metolachlor	7.640	Pounds Per Gallon
Dual II Magnum SI	100-829	Metolachlor	7.640	Pounds Per Gallon
Extrazine II DF	352-577	Cyanazine Atrazine	0.675 0.210	Percent By Weight
Extreme	241-405	Imazethapyr Gllyphosate	0.170 2.000	Pounds Per Gallon
First Rate	62719-275	Cloransulam-Methyl	0.840	Percent By Weight
Flexstar	10182-418	Sodium Salt Of Fomesafen	0.221	Pounds Per Gallon
Fusion	10182-343	Fluazifop-P-Butyl Fenoxaprop-p-ethyl	2.000 0.560	Pounds Per Gallon
Harness	524-473	Acetochlor	7.000	Pounds Per Gallon
Harness 20G	524-487	Acetochlor	0.200	Percent By Weight
Harness Extra	524-480	Acetochlor Atrazine	4.300 1.700	Pounds Per Gallon
Hornet	62719-253	Flumetsulam Clopyralid	0.231 0.630	Percent By Weight
Laddok S-12	7969-100	Bentazon Sodium Salt Atrazine	0.270 .25	Pounds Per Gallon
Lasso	524-314	Alachlor	0.451	Pounds Per Gallon
Liberty	45639-199	Glufosinate-Ammonium	1.670	Pounds Per Gallon
Lightning	241-377	Imazethapyr imazapyr	0.525 0.180	Percent By Weight
Marksman	7969-136	Dicamba Potassium Salt Atrazine	0.134 0.220	Pounds Per Gallon
Northstar	100-923	Primisulfuron Sodium Salt of Dicamba	 0.075	 Percent By Weight
Poast	7969-58	Sethozydim	1.500	Pounds Per Gallon
Poast Plus	7969-88	Sethozydim	1.000	Pounds Per Gallon
Princep 4l	100-526	Simazine	4.000	Pounds Per Gallon
Prowl 3.3 EC	241-337	Pendimethalin	3.300	Pounds Per Gallon
Pursuit Plus EC	241-331	Pendimethalin Imazethapyr	2.700 0.200	Pounds Per Gallon
Raptor	241-379	Ammonium Salt Of Imazamox	1.000	Pounds Per Gallon
Resource	59639-82	Flumiclorac Pentyl Ester	0.860	Pounds Per Gallon
Rezult B	7969-112	Bentazon	5.000	Pounds Per Gallon
Rezult G	7969-88	Sethozydim	1.000	Pounds Per Gallon
Roundup Ultra	524-475	Glyphosate	3.000	Pounds Per Gallon
Sencor DF	3125-325	Metrabuzin	0.750	Percent By Weight
Stinger	62719-73	Clopyralid	3.000	Pounds Per Gallon
Surpass 100	10182-363	Acetochlor Atrazine	3.000 2.000	Pounds Per Gallon
Treflan	62719-250	Trifluralin	4.000	Pounds Per Gallon
Tri-4 HF	241-343	Trifluralin	4.000	Pounds Per Gallon

Table 5. Product Name and Description of Insecticide Use in H-NSA.				
Name Of Product	**EPA Number**	**Active Ingredients (AI)**	**Amount of AI in Product**	**AI Expressed as**
Aztec 2	3125-412	Tebupirimphos Cyfluthrin	0.020 0.001	Percent By Weight
Baythroid	3125-351	Cyfluthrin	2.000	Pounds Per Gallon
Counter	241-314	Terbufos	0.200	Percent By Weight
Dimethoate 400	34704-207	Dimethoate	4.000	Pounds Per Gallon
Force 3g	10182-373	Tefluthrin	0.030	Percent By Weight
Lorsban 15g	62719-34	Chlorpyrifos	0.150	Percent By Weight
Sevin 4f	264-349	Carbaryl	4.000	Pounds Per Gallon
Thimet 20-G	241-257	Phorate	0.200	Percent By Weight
Thiodan 3 Ec	279-2924	Endosulfan	3.000	Pounds Per Gallon
Warrior	10182-96	Lambda-Cyhalothrin	1.000	Pounds Per Gallon

Table 6. Product Name and Description of Fungicide Use in H-NSA.				
Name Of Product	**EPA Number**	**Active Ingredients (AI)**	**Amount of AI in Product**	**AI Expressed as**
Benlate	352-354	Benomyl	0.500	Percent By Weight
Bravo Zn	50534-204	Chlorothalonil	4.170	Pounds Per Gallon
Captan 50-Wp	10182-145-51036	Captan	0.489	Percent By Weight
Maxim	100-821	Fludioxonil	0.005	Percent By Weight
Quadris	10182-415	Azoxystrobin	2.080	Pounds Per Gallon
Ridomil Gold Bravo	100-801	Metalaxyl	4.000	Pounds Per Gallon
Topsin M 70w	4581-322	Thiophanate-Methyl	0.700	Percent By Weight

There were a total of 36,874 pounds of active ingredients from all pesticides used on all crops. Herbicide active ingredients totaled 18,171 pounds and fungicide and insecticide active ingredients totaled 14,658 and 4,045 pounds respectively (Figure 20).

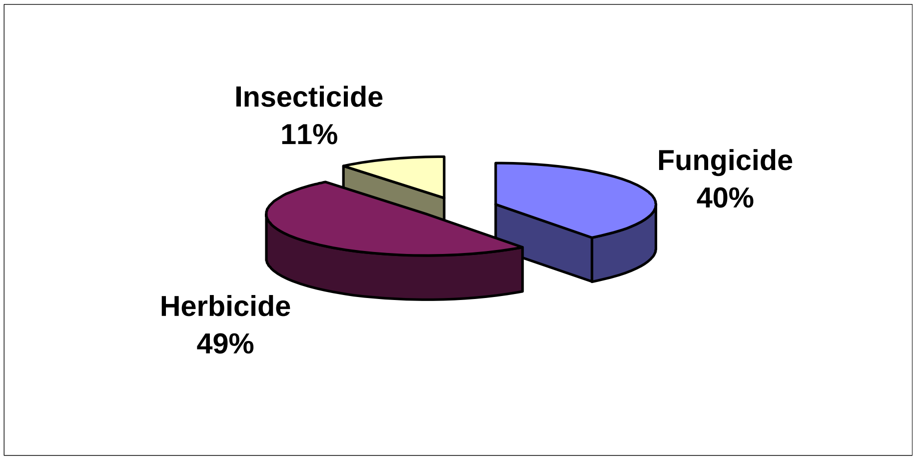


Figure 20. Contributions of active ingredients of pesticides. A total of 36,874 pounds of AI were applied to all surveyed acres.

Potato acres accounted for 49% of all pesticide AI (Figure 12).

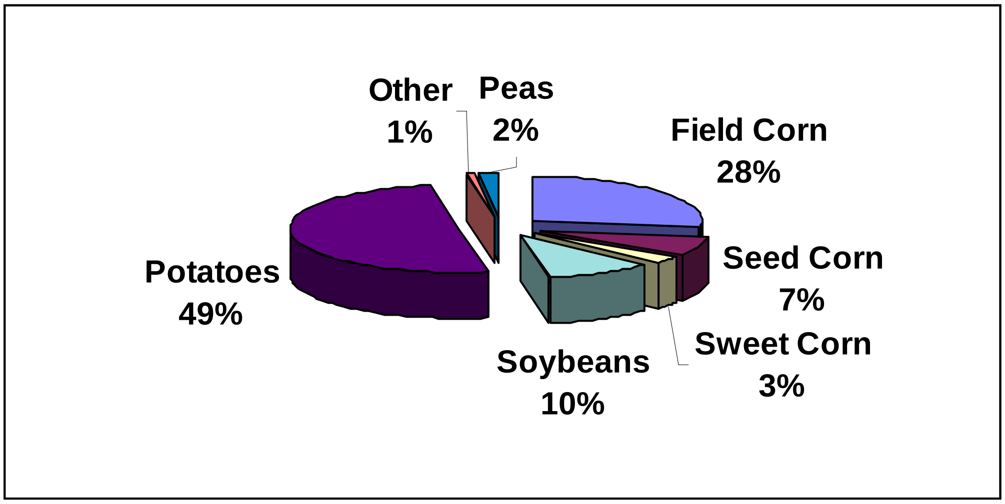


Figure 21. Application of pesticides applied to inventoried acres by crop type.

Field corn applications of herbicides totaled 8,761 pounds of AI and accounted for 47% of all AI applied (Figure 22).

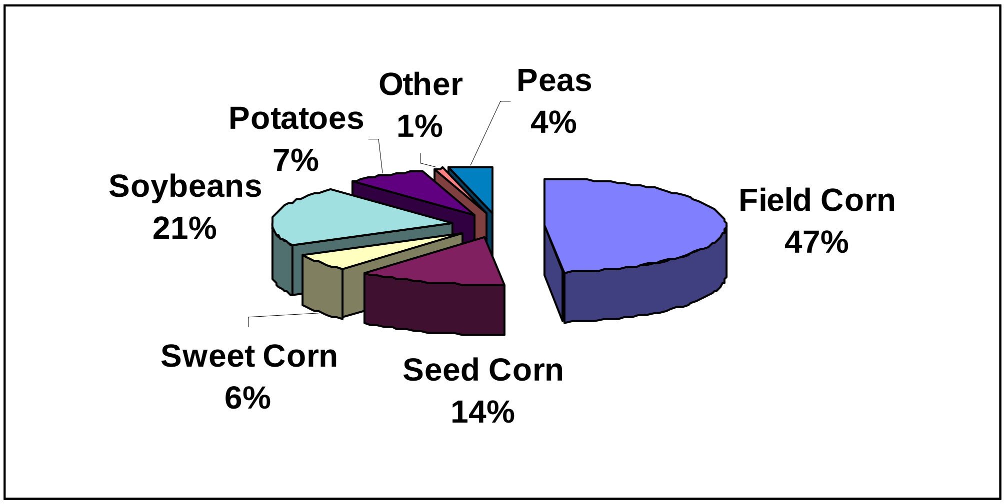


Figure 22 . Herbicide use by crop type vs. percentage of AI.

Fungicide use was dominated by potatoes with more than 99% of all AI applied to potatoes.

Insecticide use was also dominated by potatoes with 62% of all AI applied to potatoes (Figure 23).

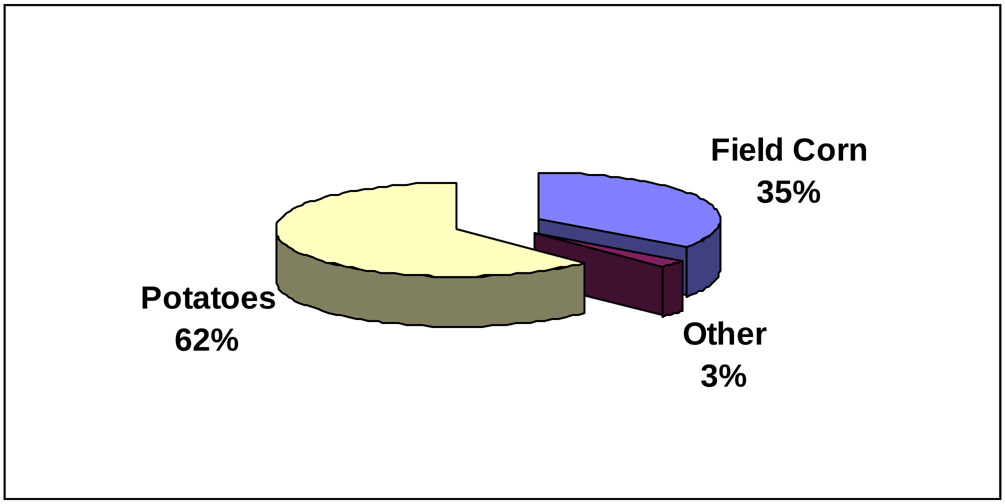


Figure 23. Insecticide applications by crop type on inventoried acres.

Herbicide use was dominated by the compound atrazine. A total of 5,460 pounds of atrazine was used on 4,166 inventoried acres (Table 7). Fungicide use was dominated by chlorothalonil. A total of 13,779 pounds of chlorothalonil was used on 1,150 inventoried acres (Table 8). Insecticide use was dominated by the compound phorate. A total of 2,530 pounds of phorate was used on 1,150 inventoried acres Table 9).

Table 7. Herbicide Use And Acres Covered by Compound.

Name Of Compound	Acres Covered	Total Pounds
Acetochlor	1,668	1,430
Alachlor	8	2
Ammonium Salt Of Imazamox	1034	33
Atrazine	5,460	4,166
Bentazon	370	370
Bentazon Sodium Salt	342	18
Bromoxynil	20	2
Clopyralid	3,467	300
Cloransulam-Methyl	155	2
Cyanazine	388	228
Dcpa	5	45
Diamethylamine Salt Of 2,4-D	353	165
Dicamba Diglycolamine Salt	300	19
Dicamba Potassium Salt	620	29
Diquat Dibromide	1,150	288
Fenoxaprop-P-Ethyl	45	2
Fluazifop-P-Butyl	45	6
Flumetsulam	3,630	120
Flumiclorac Pentyl Ester	6	0
Glufosinate-Ammonium	300	94
Glyphosate	3,488	3,300
Imazapyr	711	10
Imazethapyr	1,097	48
Metalachlor	1,851	1,772
Metrabuzin	1,388	574
Nicosulfuron	2,848	45
Pendimethalin	3,299	2,623
Primisulfuron	496	12
Rimsulfuron	1,867	24
Sethozydim	970	209
Simazine	1	2
Sodium Salt Of Dicamba	496	68
Sodium Salt Of Fomesafen	250	5
Trifluralin	66	45

Table 8. Fungicide Use And Acres Covered by Compound.

Name Of Compound	Acres Covered	Total Pounds
Azoxystrobin	1,150	232
Benomyl	5	4
Captan	5	24
Chlorothalonil	1,150	13,779
Fludioxonil	550	19
Metalaxyl	1,150	173
Thiophanate-Methyl	605	427

Table 9. Insecticide Use And Acres Covered by Compound.

Name Of Compound	Acres Covered	Total Pounds
Carbaryl	5	10
Chlorpyrifos	33	35
Cyfluthrin	411	8
Dimethoate	75	56
Endosulfan	5	8
Lambda-Cyhalothrin	78	2
Phorate	1,150	2,530
Tebupirimphos	211	31
Tefluthrin	202	38
Terbufos	1,107	1,328

Herbicide use on corn acres consisted of 19 separate compounds. Table 10 details each compound used and the number of acres covered by each compound.

Table 10. Herbicide Use on Corn Acres.

Name Of Compound	Acres Covered	Pounds of Compound Applied
Acetochlor	1,230	1,070
Alachlor	8	2
Atrazine	4,600	3,298
Bromoxynil	20	2
Clopyralid	2,695	238
Cyanazine	264	177
Dicamba Diglycolamine Salt	300	19
Dicamba Potassium Salt	620	29
Flumetsulam	2,675	88
Glufosinate-Ammonium	300	94
Glyphosate	558	419
Imazapyr	711	10
Imazethapyr	711	30
Metolachlor	1,229	2,084
Nicosulfuron	2,504	37
Pendimethalin	1,200	1,062
Primisulfuron	496	12
Rimsulfuron	1,867	24
Sodium Salt Of Dicamba	496	68

Figure 24 compares the top 8 herbicides used on field corn, based on acres.

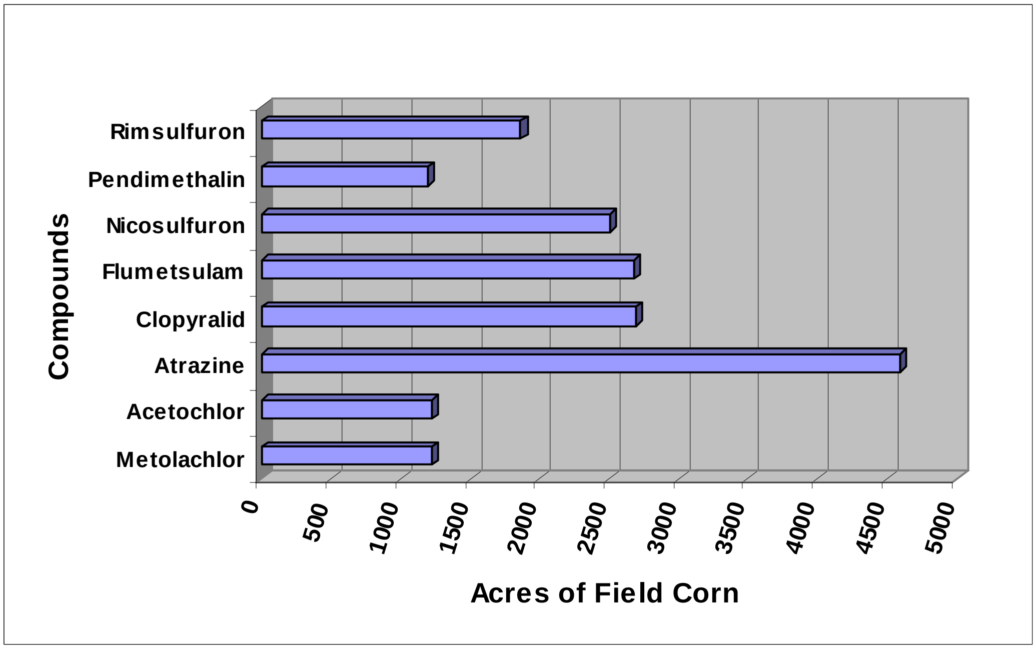


Figure 24. The top 8 active ingredients from herbicides applied to field corn acres, based on acres covered.

Figure 25 compares active ingredients from herbicides applied to field corn, based on pounds of active ingredients.

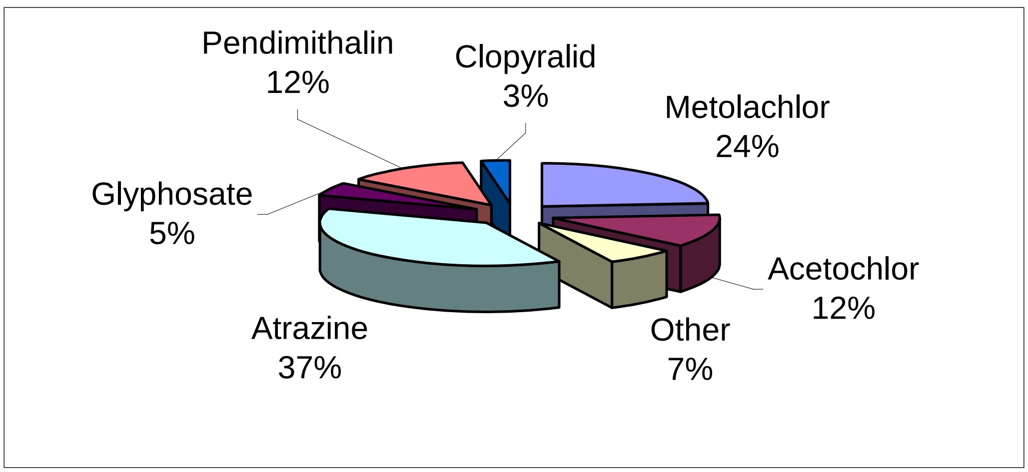


Figure 25. Active ingredients applied to field corn acres, based on pounds of AI applied.

Insecticide use on field corn acres consisted of four separate compounds. Table 11 details each compound used and the number of acres covered by each compound. Figure 26 compares insecticides by acres covered and Figure 27 compares insecticides by pounds of AI applied.

Table 11. Insecticide Use on Field Corn Acres.

Name Of Compound	Acres Covered	Pounds of Compound Applied
Cyfluthrin	211	2
Tebupirimphos	211	31
Tefluthrin	202	38
Terbufos	1,107	1,328

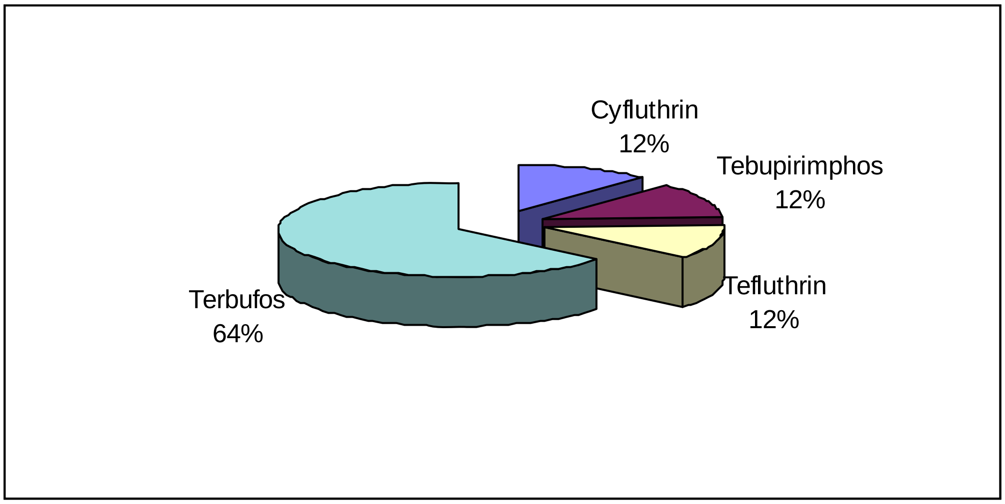


Figure 26. Insecticides applied to field corn acres based on acres applied.

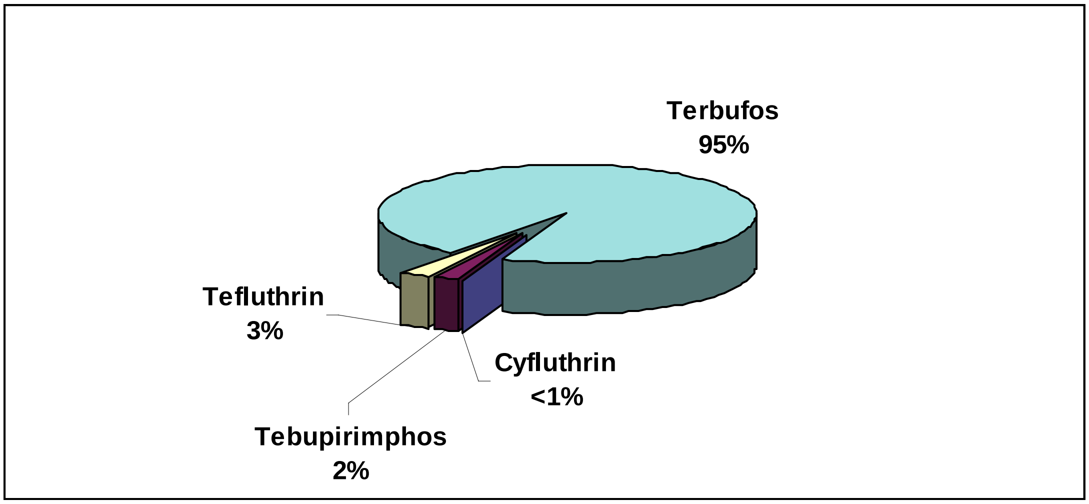


Figure 27. Insecticide applications to field corn based on pounds of AI applied.

Seed corn received herbicide applications from 9 different compounds (Table 12).

Table 12. Insecticide Use on Seed Corn Acres.

Name Of Compound	Acres Covered	Pounds of Compound Applied
Metolachlor	528	708
Acetochlor	438	360
Atrazine	518	620
Clopyralid	772	62
Cyanazine	124	51
Flumetsulam	772	23
Glyphosate	460	345
Nicosulfuron	344	8
Pendimethalin	300	278

Figure 28 compares herbicides use on seed corn by acres covered and Figure 29 compares herbicides by pounds of AI applied.

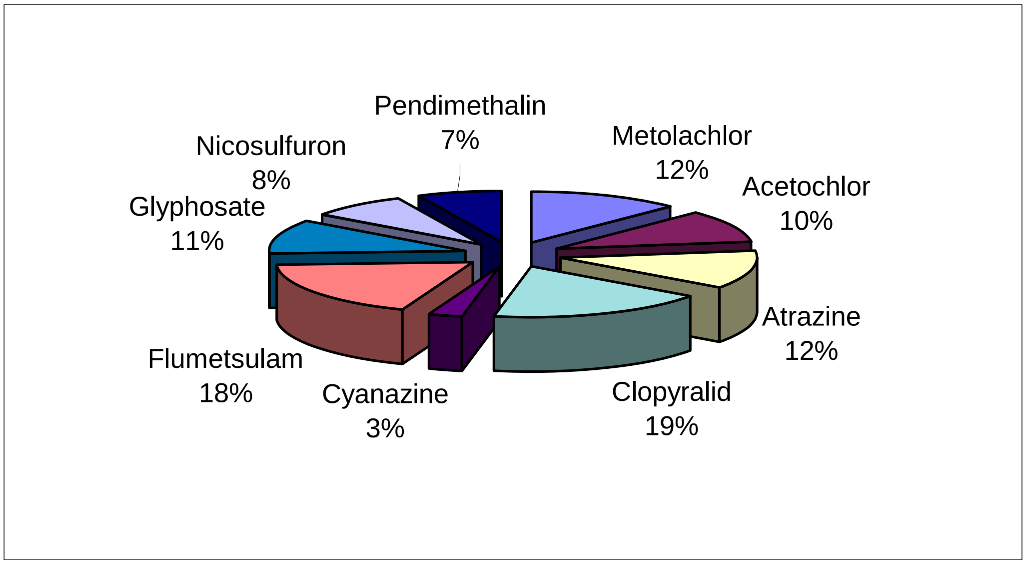


Figure 28. Herbicide applications to seed corn based on acres of seed corn covered.

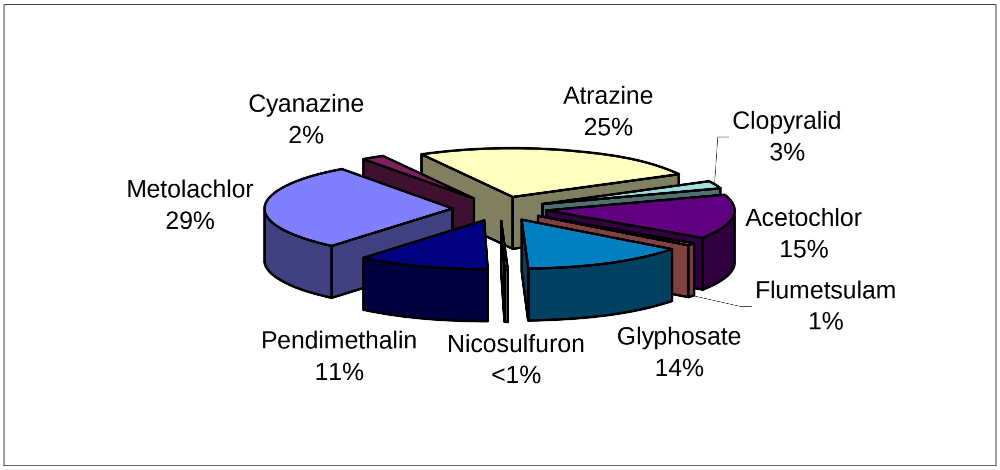


Figure 29. Herbicide applications to seed corn based on pounds of AI applied.

Herbicide use on sweet corn acres consisted of three separate compounds. Table 13 details each compound used, the number of acres covered by each compound and the total pounds of AI applied. In regard to insecticides, 33 acres of sweet corn received a total of 35 pounds of Chlorpyrifos.

Table 13. Herbicide Use on Sweet Corn Acres.		
Name Of Compound	Acres Covered	Pounds of Compound Applied
Metolachlor	342	754
Atrazine	342	249
Bentazon Sodium Salt	342	18

Herbicide use on soybean acres consisted of 16 separate compounds. Table 14 details each compound used and the number of acres covered by each compound. Figure 30 compares herbicide by acres covered and figure 31 compares herbicides by pounds of AI applied.

Table 14. Herbicide Use on Soybean Acres.		
Name Of Compound	Acres of Soybeans Covered	Pounds of Compound Applied
Ammonium Salt Of Imazamox	1,034	33
Bentazon	370	370
Cloransulam-Methyl	155	2
Diamethylamine Salt Of 2,4-D	300	140
Fenoxaprop-P-Ethyl	45	2
Fluazifop-P-Butyl	45	6
Flumetsulam	183	9
Flumiclorac Pentyl Ester	6	0
Glyphosate[5]	2,207	2,507
Imazethapyr	386	18
Metalachlor	183	342
Metrabuzin	160	38
Pendimethalin	261	189
Sethozydim[6]	370	97
Sodium Salt Of Fomesafen	250	5
Trifluralin	13	5

[5] 1,554 acres of soybeans were covered with 2 applications of Glyphosate.
[6] 120 acres of soybeans was covered with 2 applications of Sethozydim.

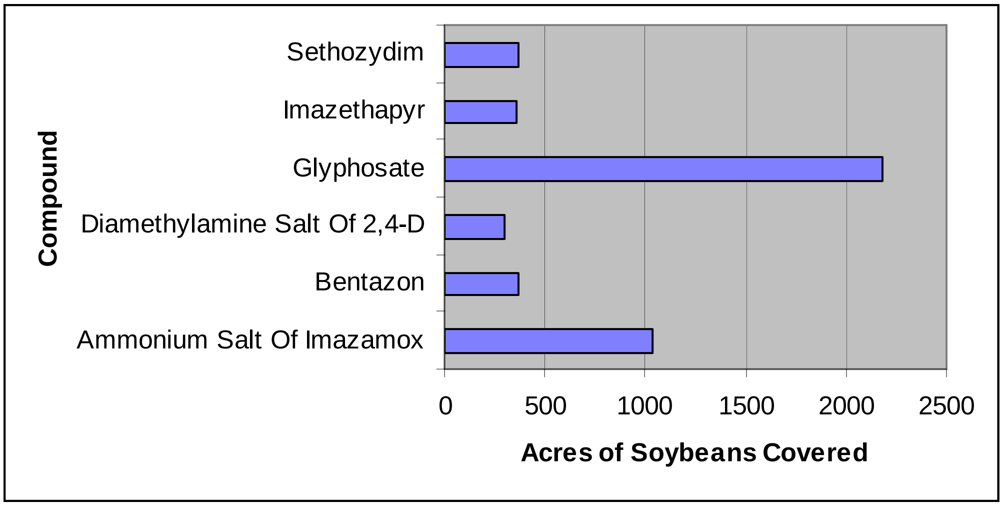


Figure 30 Herbicide use on soybeans acres of top six compounds by acres covered.

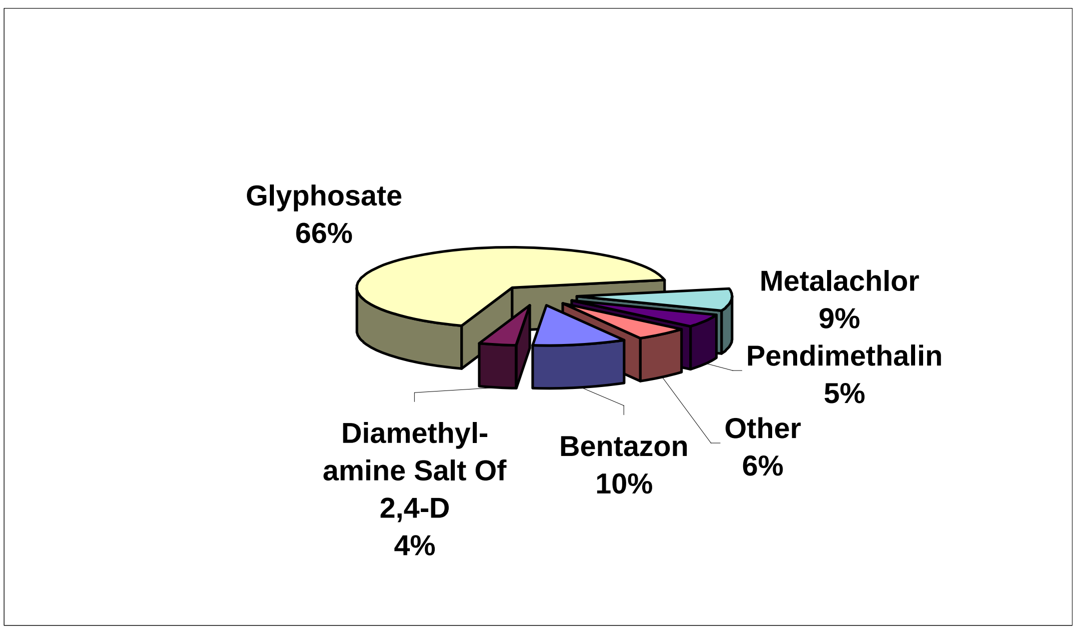


Figure 31. Herbicide applied to soybeans versus percentage of AI.

There were four separate compounds of herbicides used on potato acres. Table 15 details each compound used and the number of acres covered.

Table 15. Herbicide Use on Potato Acres.		
Name Of Compound	Acres Covered	Pounds of Compound Applied
Diquat Dibromide	1,150	288
Metrabuzin	1,150	518
Pendimethalin	600	371
Sethozydim	600	113

There was one compound of insecticide used on potatoes. A total of 2,530 pounds of phorate was applied to 1,150 acres of potatoes. Fungicide use on potatoes was dominated by chlorothalonil with 13,779 pounds of AI applied to 1,150 acres (Table 16).

Table 16. Fungicide Use on Potatoes.		
Name Of Compound	Acres Covered	Pounds of Compound Applied
Azoxystrobin[7]	1,150	232
Chlorothalonil[8]	1,150	13,779
Fludioxonil	550	19
Metalaxyl	1,150	173
Thiophanate-Methyl	600	420

[7] Azoxystrobin was applied as more than one application.
[8] Chlorothalonil was applied as more than one application.

Peas, wheat, alfalfa and other crops received pesticides. All other pesticide use, acres covered and pounds of AI are listed in table 18.

Table 18. Herbicide, Fungicide and Insecticide Use on Other Crops.

Crop	Compound	Pesticide	Acres Covered	Pounds of Compound Applied
Peas	Herbicide	Pendimethalin	938	722
Alfalfa	Herbicide	Metrabuzin	78	19
Alfalfa	Insecticide	Lambda-Cyhalothrin	78	1
Alfalfa	Insecticide	Cyfluthrin	200	6
Alfalfa	Insecticide	Dimethoate	150	56
Wheat	Herbicide	Diamethylamine Salt Of 2,4-D	53	24
Wheat	Herbicide	Glyphosate	53	29
Wheat	Herbicide	Trifluralin	53	39
Other	Herbicide	Simazine	1	2
Other	Fungicide	Benomyl	5	3
Other	Fungicide	Captan	5	24
Other	Fungicide	Thiophanate-Methyl	5	7
Other	Herbicide	Dcpa	5	45
Other	Insecticide	Carbaryl	5	10
Other	Insecticide	Endosulfan	5	7

It appears all applications of pesticides are at or below recommended rates for both application rates per application and total AI allowed per year.

Conclusions and Summary of the Current Nutrient Management Practices for the Hastings Nitrate Study Area.

The Hastings Nitrate Study Area consists of course-textured soils in east-central Minnesota. Forty-two farmers, farming 16,000 acres in the HNSA, were interviewed by the Minnesota Department of Agriculture using the Farm Nutrient Management Assessment Program (FANMAP) tool. Producers volunteered one to two hours of their time to share information about their farming operations. The overall purpose of the program was to develop a clear understanding of current farm practices regarding agricultural nutrients and pesticides and use this knowledge for future water quality educational programs.

Approximately 25% of the crop acres within the HNSA were inventoried. Field corn and soybeans were the dominant crops with 69% of all acres planted to these crops. Irrigation was prevalent as 63% of all acres were irrigated. Forty-two percent (42%) of the crop acres were planted with field corn and 68% of the 1,100,000 pounds commercial N was applied to those field corn acres. Most of the N applied to crops in the HNSA was applied as a spring preplant. Fifty-seven percent (57%) of all N applied was during spring preplant applications. Less than 1% of N was fall applied. Anhydrous ammonia, U.A.N. solutions, DAP and urea accounted for 63%, 21%, 13% and 3% of the N respectively. Nitrogen inhibitors were applied with spring preplant applications of N, and 44% of field corn acres applied with anhydrous ammonia used nitrogen inhibitors.

Manure N (first year available) accounted for 3% of all relative N contributions with legumes and commercial N accounting for 8% and 89% respectively. Soybeans were the dominant source of legume N credits accounting for more than 97% of all legume N credits.

In the fall of 2000, the University of Minnesota came out with new recommendations for field corn. According to the new recommendations only 5% of the field corn acres were over-applied with N by more than 30 pounds/A or more. There was also no over-application on sweet corn acres. Seed corn acres did not have a UofM recommendation for N and it appears some research in this area would be helpful at this time.

Potato acres were also applied with N below the UofM recommendations for total N applied. According to BMPs for potatoes, starter rates could be reduced from 59 lb N/A to 40 or less. However, due to farmers not following N application patterns anticipated in the BMPs, UofM staff are currently planning research that focuses on timing of N applications.

Pesticide use was prevalent in the HNSA, as 90% of all crop acres were applied with herbicides, pesticides or fungicides. Pesticide use consisted of 63 different formulas consisting of 46 herbicides, 10 insecticides and 7 fungicides. There were 52 separate compounds used in these pesticide applications, totaling 37,000 pounds of active ingredients. Herbicides, fungicides and insecticides totaled 18,000, 15,000 and 4,000 pounds of active ingredients (AI) respectively.

Herbicide use was dominated by field corn with 47% of all AI applied to field corn. Atrazine was the most used compound. Fungicide use was dominated by potatoes with 99% of all AI applied to potatoes. Chlorothalonil was the prevalent compound used. Insecticide use was dominated by potatoes with 62% of all AI applied to potatoes. Phorate was the prevalent compound used as an insecticide. It also appears all applications of pesticides are at or below recommended rates for both rates per application and total AI allowed per year.

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 UofM for the HNSA. 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 and new UofM recommendations for the area.