

2015 Pesticide Usage on Corn and Hay Grown in Minnesota

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Introduction

Acknowledgements

This survey was a cooperative effort between the Minnesota Department of Agriculture (MDA) and the United States Department of Agriculture: National Agricultural Statistics Service (NASS), Minnesota field office. The detailed pesticide use information could not have been collected without the cooperation of thousands of farmers who voluntarily responded to the survey in the midst of their normally busy lives, and for this we are extremely grateful. Similarly, the assistance of agricultural chemical dealers and co-operatives is much appreciated. Special thanks goes to Dan Lofthus, State Statistician within the USDA at the Minnesota field office and his respective staff, for assistance with sample design and data collection. The MDA is ultimately responsible for the representations of data provided in this report, and for the design of the survey mechanism used to collect that data.

2015 Pesticide Use Summary and Highlights

This report summarizes herbicide, insecticide and fungicide use information reported by approximately 2,800 farmers for the 2015 crop year. Excellent participation and good record keeping by Minnesota farmers and agricultural chemical dealerships played a vital part in providing complete and detailed pesticide information. This survey targeted two crops in Minnesota: corn and hay. Collectively these two crops accounted for approximately 47% of Minnesota's cropland in 2015. This survey collected pesticide information from 700,000 acres of hay and corn cropland across the state in all counties except for Lake of the Woods, Lake, Cook, and Ramsey Counties. The survey covered nearly 7% of the state's corn acres and 11% of the hay acres¹¹.

The report represents the seventh survey conducted on pesticide use in Minnesota by the MDA. The previous surveys collected information for the 2003, 2005, 2007, 2009, 2011, and 2013 crop years and included corn, soybeans, wheat, and hay. The MDA does not collect pesticide use data in the same year for the same crops as USDA NASS. Because USDA NASS collected data for soybeans and wheat for the 2015 crop year, the MDA did not survey farmers with those specific crops. The MDA surveys can be found at:

<http://www.mda.state.mn.us/chemicals/pesticides/pesticideuse.aspx>

The USDA NASS surveys can be found at:

https://www.nass.usda.gov/Statistics_by_State/Minnesota/Publications/Other_Press_Releases/index.php

Corn Highlights: Herbicides, insecticides, and fungicides were applied to 99%, 11%, and 8%, respectively, of the surveyed corn acres. For the 1,800 farms that reported corn information on approximately 544,000 acres, the top four herbicide products (based on percent acres covered) were glyphosateⁱⁱ (84%), acetochlor (43%), flumetsulam (32%) and clopyralid (32%). Bifenthrin (6%), tefluthrin (3%), lambda-cyhalothrin (3%), and chlorpyrifos (1%) were the major corn insecticides used in the survey. The major fungicide products were pyraclostrobin and propiconazole, which were applied on 4% and 3% of all corn acres, respectively.

Hay Highlights: Herbicides, insecticides, and fungicides were applied to 2%, 5%, and <1%, respectively, on 156,000 acres of hay. Approximately 1,700 farms provided information on this crop. The three major pesticides applied were the herbicide glyphosate, on 1% of all hay acres, and the insecticides lambda-cyhalothrin and chlorpyrifos, which were applied on 3% and 1% of all hay acres, respectively.

Survey Design and Implementation

Figure 1 outlines the ten Pesticide Management Regions (PMRs) as defined by the MDA. Counties are clustered based on similarities in geology, soils and crops. The regions also define the boundaries of the monitoring areas used by the MDA water resource monitoring program. Pesticide management region pesticide use information is used to help design and implement specific water quality monitoring and pesticide educational programs.

Due to the low intensity of row crop agriculture in portions of northern Minnesota and the Minneapolis/St. Paul Metro Area, Lake of the Woods (PMR 2), Lake (PMR 3), Cook (PMR 3), and Ramsey (PMR 10) counties were not included in the survey. Not all the participating counties were included for corn acres and not all the participating counties were included for hay acres, also due to the low intensity of the crops within the county.

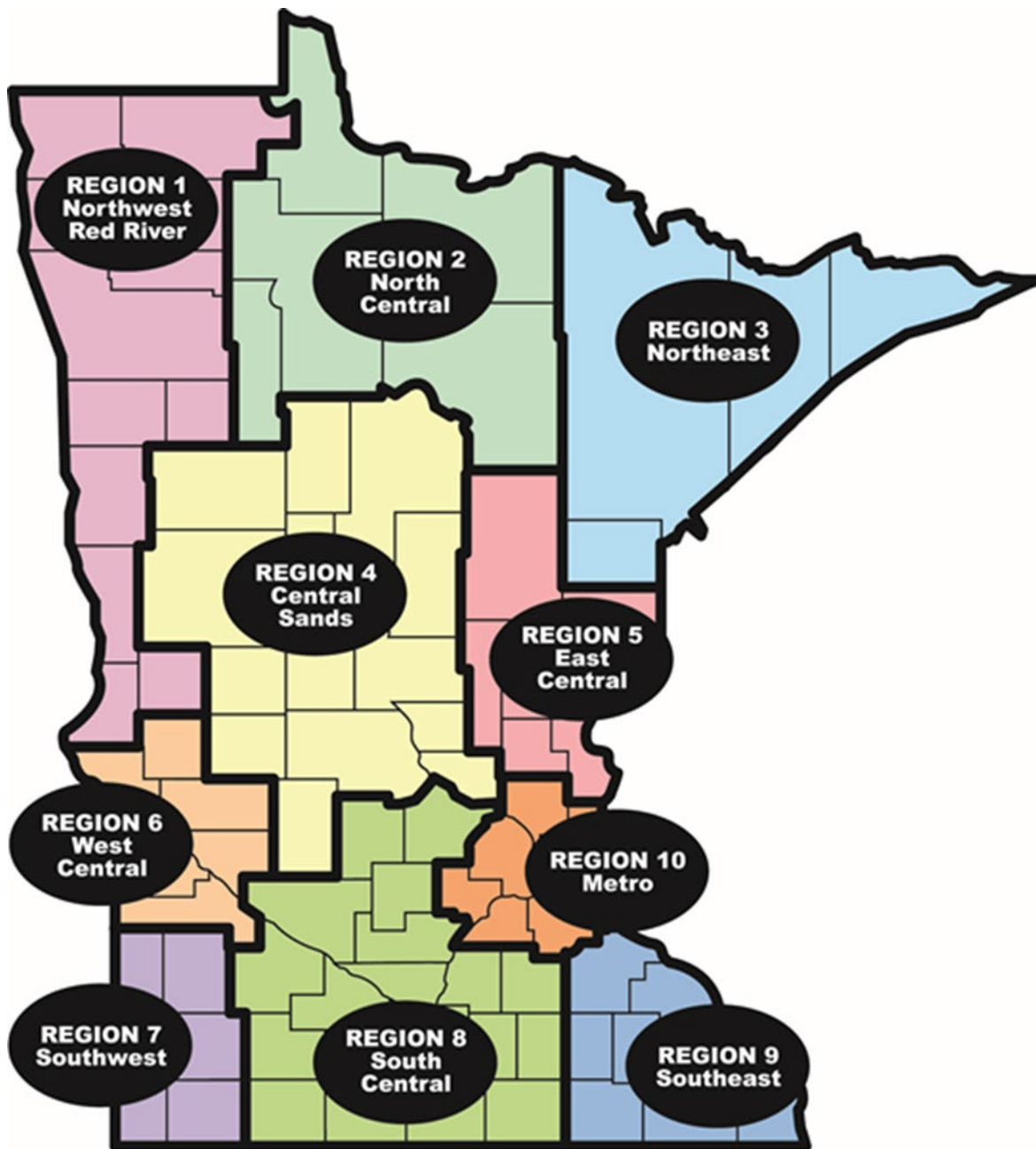


Figure 1. MDA Pesticide Management Regions (PMRs)

NASS developed the survey sample of 7,600 farms. This was done by selecting approximately 90 farms from each of 83 agricultural counties. All farmers from each county who grew one or both of the target crops (corn and hay) were eligible to be selected. This number provided a large enough pool to reach the desired goal of obtaining approximately 34 farms per county with complete records.

Approximately 2,800 interviews were completed. Respondents were required to have all pesticide applications and rates for a specific crop to be considered for inclusion in the survey. For example, an individual grower may have had good records for corn acres, but could not find the records for the insecticides applied to the hay crop. In this scenario, the corn field would be used and the hay field would be dropped from the data set. Table 1 summarizes the number of participating farms in each county along with the total acres of each crop. The average number of participating farms per county was 34. Table 2 summarizes the crop acres surveyed for each crop and corresponding acreage receiving herbicide, insecticide or fungicide.

In summarizing the county data (Table 1), some farmers were re-categorized into 'Unknown Counties'. These farmers grew corn, hay, or both, but there was not enough data to ensure anonymity for these participating farmers in certain PMRs. Assigning these farmers to 'Unknown Counties' prevents the possibility of any one field or farmer being singled out in the county summary. The data summarized for each PMR still includes those farmers surveyed and assigned in the 'Combined Counties' classification within those regions.

Table 1. Farms and crop acreage by county and PMR

County	PMA	# of Sureveyed Farmers	Corn Acres	Hay Acres	Total Acres
Clay	1	35	7,608	1,681	9,289
Grant	1	25	14,455	0	14,455
Kittson	1	33	3,662	5,343	9,005
Mahnomen	1	27	6,780	1,001	7,781
Marshall	1	28	3,773	3,638	7,411
Norman	1	30	11,065	965	12,030
Pennington	1	23	*	3,056	*
Polk	1	14	*	1,338	*
Red Lake	1	40	3,076	3,123	6,199
Roseau	1	30	488	3,497	3,985
Traverse	1	28	28,641	0	28,641
Wilkin	1	33	18,359	894	19,253
Combined Counties	1	14	5,154	687	5,955
Totals	1	360	103,175	25,223	128,398
Beltrami	2	45	340	6,167	6,507
Clearwater	2	35	302	5,890	6,192
Itasca	2	47	*	7,009	*

County	PMA	# of Sureveyed Farmers	Corn Acres	Hay Acres	Total Acres
Koochiching	2	45	*	7,542	*
Combined Counties	2	12	923	0	923
Totals	2	184	2,360	26,608	28,968
Carlton	3	36	*	6,030	*
St. Louis	3	43	*	9,487	*
Combined Counties	3	*	*	0	*
Totals	3	80	451	15,517	15,968
Becker	4	44	9,186	3,239	12,425
Benton	4	44	3,678	907	4,585
Cass	4	38	523	7,274	7,797
Crow Wing	4	37	2,050	3,749	5,799
Douglas	4	30	2,975	898	3,873
Hubbard	4	29	4,063	3,968	8,031
Kandiyohi	4	32	4,613	624	5,237
Morrison	4	43	3,465	2,906	6,371
Otter Tail	4	36	3,730	2,211	5,941
Pope	4	34	5,580	1,019	6,599
Sherburne	4	43	3,845	864	4,709
Stearns	4	36	3,559	1,497	5,056
Todd	4	29	2,656	1,546	4,202
Wadena	4	37	2,173	3,373	5,546
Combined Counties	4	9	1,831	0	1,831
Totals	4	521	53,927	34,075	88,002
Aitkin	5	45	310	7,496	7,806
Chisago	5	44	1,836	1,033	2,869
Isanti	5	32	3,306	949	4,255

County	PMA	# of Sureveyed Farmers	Corn Acres	Hay Acres	Total Acres
Kanabec	5	31	1,388	2,897	4,285
Mille Lacs	5	36	2,472	2,226	4,698
Pine	5	38	1,413	3,583	4,996
Totals	5	226	10,725	18,184	28,909
Big Stone	6	19	7,703	*	*
Chippewa	6	29	17,774	470	18,244
Lac qui Parle	6	25	5,459	469	5,928
Stevens	6	30	17,946	2,397	20,343
Swift	6	27	16,885	*	*
Yellow	6	24	10,268	320	10,588
Combined Counties	6	10	0	562	562
Totals	6	164	76,035	4,616	80,651
Lincoln	7	29	6,454	773	7,227
Lyon	7	26	9,139	321	9,460
Murray	7	27	9,561	316	9,877
Nobles	7	29	10,816	409	11,225
Pipestone	7	28	7851	787	8,638
Rock	7	32	5,581	581	6,162
Totals	7	171	49,402	3,187	52,589
Blue Earth	8	26	11,342	0	11,342
Brown	8	30	5,970	257	6,227
Cottonwood	8	27	11,216	0	11,216
Faribault	8	28	10,924	0	10,924
Freeborn	8	26	8,204	159	8,363
Jackson	8	31	10,856	471	11,327
Le Sueur	8	36	7,600	392	7,992
Martin	8	20	7,303	0	7,303

County	PMA	# of Sureveyed Farmers	Corn Acres	Hay Acres	Total Acres
McLeod	8	41	7,542	504	8,046
Meeker	8	26	6,227	1,066	7,293
Nicollet	8	36	11,125	966	12,091
Redwood	8	26	8,802	0	8,802
Renville	8	30	14,991	0	14,991
Rice	8	33	7,363	753	8,116
Sibley	8	35	9,350	332	9,682
Steele	8	32	6,883	360	7,243
Waseca	8	30	7,441	249	7,690
Watonwan	8	32	17,944	0	17,944
Wright	8	33	4,370	1,179	5,549
Combined Counties	8	16	0	2,828	2,828
Totals	8	594	175,453	9,516	184,969
Dodge	9	32	6,574	959	7,533
Fillmore	9	37	4,670	1,657	6,327
Goodhue	9	39	12,544	922	13,466
Houston	9	32	3,908	2,777	6,685
Mower	9	30	9,379	453	9,832
Olmsted	9	37	5,419	964	6,383
Wabasha	9	31	4,264	2,018	6,282
Winona	9	41	3,363	2,767	6,130
Totals	9	279	50,121	12,517	62,638
Anoka	10	45	3,830	2,061	5,891
Carver	10	40	3,464	1,605	5,069
Dakota	10	35	7,739	564	8,303
Hennepin	10	31	1,779	764	2,543
Scott	10	36	2,606	630	3,236

County	PMA	# of Sureveyed Farmers	Corn Acres	Hay Acres	Total Acres
Washington	10	36	3,393	1,365	4,758
Totals	10	223	22,811	6,989	29,800
State	State	2,802	544,460	156,432	700,892

An "*" denotes data is not publishable due to use by less than 5 respondents.

Table 2. Summary of acres and corresponding percentage of each major crop receiving pesticide applications for the 2015 crop year.

Crop	Number of Respondents	Total Surveyed Acres	Herbicide Applied		Insecticide Applied		Fungicide Applied	
			Acres	(%)	Acres	(%)	Acres	(%)
Corn	1,796	544,460	537,084	(99%)	60,615	(11%)	40,847	(8%)
Hay	1,734	156,432	3,784	(2%)	7,892	(5%)	585	(<1%)
Totals	2,802ⁱⁱⁱ	700,892	540,868	(77%)	68,507	(10%)	41,432	(6%)

Data Collection Process

Farmers were interviewed over the phone in February 2016. These were “cold calls,” meaning the farmers did not get any type of notification about the survey prior to the contact. The interviews typically would last 5 to 10 minutes.

1. Farmers were first asked to identify the number of acres of corn and hay grown in the 2015 cropping season.
2. They were then asked to identify how many acres of each crop type received fungicide, herbicide and/or insecticide.
3. Lastly, they were asked to identify each specific pesticide product used, the acres treated, the number of applications of that specific product, and the application rate.

Calls were also made directly to local cooperatives (co-ops), private pesticide dealers, or custom pesticide applicators to complete any missing information not provided by the respondent. Surveys requiring such a follow-up call were first sorted by co-op/dealer name. Then, the co-ops/dealers were called to obtain information for all the incomplete farms associated with that crop. This streamlined the number of calls made to the co-ops/dealers.

Some of the challenges of collecting pesticide use data are:

Unlike fertilizer formulations, which remain constant, new pesticide products and formulations are released every year;

- Currently, there are approximately 700 different pesticide products available for use in Minnesota for corn and hay;
- There are multiple product names that use the same active ingredients but frequently have different label rates and use restrictions. For example, Monsanto marketed glyphosate for many years under numerous trade names. Currently popular Monsanto glyphosate products are Roundup Power Max and Roundup Weather Max. There are also several popular glyphosate products manufactured by companies other than Monsanto such as Cornerstone, Buccaneer, and Durango. It is critical that the exact product be correctly identified in any type of use survey;
- Occasionally generic pesticide products are legally sold once a patent expires. For example, Glyphosate 4 plus, Glypro Plus, Gly Star5 Extra and Glyphos X-tra are various glyphosate based products. Minor complications may arise from these similar formulations; and
- Pesticides can come in liquid or solid formulas. Rates must be recorded in the correct unit during the survey process. For example, Harness, Harness Xtra and Harness Xtra 5.6L are sold as a liquid. The maximum legal application rate of Harness is 2.75 pints/acre, while Harness Xtra and Harness Xtra 5.6L is 2.3 and 3.0 quarts/acre, respectively. Further confusing data collection, Harness 20G is a granular with a maximum application rate of 14 pounds/acre.

Data Reporting and Limitations

Due to the simplified method used to collect what is typically considered complex data, it is helpful for the reader to understand the limitations of the datasets.

Potential for bias

As previously mentioned, approximately 34 farms per county participated in the survey. Farmers that grew corn or hay were randomly selected from county lists of producers accessed by NASS. Because respondents in each county were not selected in proportion to the actual number of producers of a given crop, over-selection, or under-selection of those producing one or more of the four crops might result in unintentional bias in the results for specific crops and their related pesticide use. This bias could lead to problems in extrapolation of results, e.g., an over or under-representation of product use and rates within a county area, or statewide.

Traditional surveys employ advanced sampling strategies and are designed to statistically represent a non-homogenous population, thus data is “weighted” to account for sample size, county size, crop acreage, and nonresponse, etc. Such strategies can be very expensive and are not without their own limitations.^{iv} The data in this study were not weighted to adjust for those factors.

Attempts to extrapolate data for purposes of estimating total pounds of a product or active ingredient used in a county, area, or statewide must consider an appropriate statistical analysis of the dataset for the estimations to be valid. Failure to do so may provide over- or under-representation of the data. The MDA can be contacted to further discuss interpretation of the survey data.

Areas receiving multiple products

Due to the method that was used for pesticide data collection, it is not possible to report on the number of crop acres receiving two or more products, though the individual applications and rates are captured. For example, some producers in south central Minnesota (Area 8) use a pre-emergence, soil-applied herbicide for grass control and follow up post-emergence for broadleaves. Following this general pesticide strategy, Surpass or Harness may be selected for pre-emergence weed control and Roundup as the post-emergence product on corn acres. Acetochlor products, such as Surpass or Harness, were reported in this area on 54% of the corn acres and glyphosate (such as Roundup Weather Max or Power Max) was reported on 84% of acres. Because the acres are not identical, it is not possible to capture acres with both products applied on a total number of acres.

Similarly, products containing the same active ingredient, but not the same brand name, and applied to the same acres, would not be totaled and recorded as applications to the same field. For example, Aatrex 4L might be applied to an 80 acre field, with Lumax EZ applied to a 60-acre subset of the same field. Both products contain atrazine but because two different products were used, the additive total of the atrazine (active ingredient) on the entire cropland may not be captured.

On individual fields, this survey indicates that the use of different brand name products containing the same active ingredients is infrequent. The average number of applications for most products was 1.0 application per year. Glyphosate is one of the exceptions for corn. In this survey, there were 1.1 applications of glyphosate per year on corn (84%) of all surveyed corn acres at a rate of 0.97 pounds/acre for each application.

Statewide Pesticide Applications – Corn

Many pesticide active ingredients can be used in the production of corn. Corn producers responding to the survey associated with this report may have used one or more of the active ingredients listed in Table 3; however, data is only published for pesticides applied by five or more respondents. This is consistent with standard reporting protocol used by NASS in other agricultural chemical use reports.

To obtain a list of products (brand names) registered in Minnesota and containing the active ingredients listed below, visit http://npirspublic.ceris.purdue.edu/state/state_menu.aspx?state=MN, enter the database, submit “active ingredient” as the search option, enter the name of the active ingredient, click “submit,” Then click on Display Companies to show companies with that specific active ingredient. This will display all companies that have products with that active ingredient. Next click on “Display Products” to obtain a list of all registered products containing the active ingredient for a specific company.

Table 3. Publication status for corn pesticide active ingredients

Active Ingredient	Published	Active Ingredient	Published
Herbicide		Insecticide	
2,4-D	P	Bifenthrin	P
Acetochlor	P	Chlorethoxyfos	P
Atrazine	P	Chlorpyrifos	P
Bicyclopyrone	*	Cyfluthrin	P
Bromoxynil	P	Gamma-cyhalothrin	P
Carfentrazone	*	Lambda-cyhalothrin	P
Clopyralid	P	Permethrin	*
Cloransulam	P	Tebupirimphos ^v	P
Dicamba	P	Tefluthrin	P
Diflufenzopyr	P	Terbufos	*
Diglycolamine	*	Thiamethoxam	*
Dimethenamid-P	P		
Flumetsulam	P	Fungicide	
Flumioxazin	*	Azoxystrobin	P
Fluthiacet-methyl	P	Cyproconazole	*
Glufosinate-ammonium	P	Fluoxastrobin	P
Glyphosate	P	Flutriafol	*

Active Ingredient	Published	Active Ingredient	Published
Herbicide		Fungicide	
Halosulfuron-methyl	*	Fluxapyroxad	P
Mesotrione	P	Metconazole	P
Metolachlor	*	Picoxystrobin	*
Metribuzin	*	Propiconazole	P
Nicosulfuron	P	Prothioconazole	*
Pendimethalin	P	Pyraclostrobin	P
Primisulfuron	P	Trifloxystrobin	P
Rimsulfuron	P		
S-metolachlor	P		
Saflufenacil	P		
Sulfentrazone	*		
Tembotrione	P		
Thifensulfuron	*		
Topramezone	P		
Triencarbazone-methyl	P		

An "*" denotes data is not publishable due to use by less than 5 respondents.

A statewide summary of corn pesticide applications is provided in Table 4. Seven percent (7%) of all Minnesota corn acres were surveyed for the 2015 season. Herbicides were applied to 99% of all surveyed corn acres. Insecticides were applied to 11% of all acres and 8% of surveyed acres received fungicides.

Table 4. Pesticide applications and rates by active ingredient (a.i.) for corn statewide.^{vi}

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Herbicide					
2,4-D	<1	1.0	0.64	0.64	223
Acetochlor	43	1.0	1.10	1.12	263,568
Atrazine	10	1.0	0.56	0.56	29,436
Bromoxynil	<1	1.0	0.33	0.33	226
Clopyralid	32	1.0	0.07	0.08	13,035
Cloransulam	<1	1.0	0.02	0.02	9
Dicamba	10	1.0	0.17	0.17	9,299
Diflufenzopyr	7	1.0	0.05	0.05	2,113
Dimethenamid-p	8	1.0	0.52	0.53	24,273
Flumetsulam	32	1.0	0.03	0.03	5,191
Fluthiacet-methyl	<1	1.0	0.00	0.00	8
Glufosinate-ammonium	1	1.0	0.52	0.52	2,259
Glyphosate	84	1.1	0.97	1.14	522,565
Mesotrione	24	1.0	0.09	0.09	11,701
Nicosulfuron	<1	1.0	0.04	0.04	37
Pendimethalin	<1	1.0	1.20	1.20	304
Primisulfuron	1	1.0	0.02	0.02	76
Rimsulfuron	<1	1.0	0.02	0.02	37
S-metolachlor	15	1.1	0.97	1.07	85,740
Saflufenacil	8	1.0	0.06	0.06	2,431
Tembotrione	9	1.0	0.07	0.07	3,841

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Topramezone	1	1.0	0.02	0.02	134
Triencarbazone-methyl	1	1.0	0.01	0.01	93
Insecticide					
Bifenthrin	6	1.0	0.07	0.07	2,410
Chlorethoxyfos	<1	1.0	0.03	0.03	76
Chlorpyrifos	1	1.0	0.34	0.34	1,106
Cyfluthrin	<1	1.0	0.01	0.01	14
Gamma-cyhalothrin	<1	1.0	0.00	0.00	3
Lambda-cyhalothrin	3	1.0	0.02	0.02	353
Tebupirimphos	<1	1.0	0.12	0.12	262
Tefluthrin	3	1.0	0.10	0.10	1,858
Fungicide					
Azoxystrobin	2	1.0	0.08	0.08	921
Fluoxastrobin	1	1.0	0.10	0.10	436
Fluxapyroxad	1	1.1	0.06	0.06	200
Metconazole	2	1.1	0.03	0.03	339
Propiconazole	3	1.0	0.06	0.06	896
Pyraclostrobin	4	1.1	0.10	0.10	2,078
Trifloxystrobin	1	1.0	0.08	0.08	355

Herbicides applied but not published included the following: Bicyclopyrone, Carfentrazone, Diglycolamine, Flumioxazin, Halosulfuron-methyl, Metolachlor, Metribuzin, Sulfentrazone, and Thifensulfuron.

Insecticides applied but not published included the following: Permethrin, Terbufos, and Thiamethoxam.

Fungicides applied but not published included the following: Cyproconazole, Flutriafol, Picoxystrobin, and Prothioconazole.

Acetochlor, atrazine and S-metolachlor are three commonly used herbicides for which the Minnesota Department of Agriculture has developed specific voluntary Best Management Practices to protect groundwater and surface water resources. Because of the additional concerns regarding the use of these products, their use frequencies are compared below. Figure 2 illustrates the range of rates reported for atrazine use on corn for 2003, 2005, 2007, 2009, 2011, 2013, and 2015.

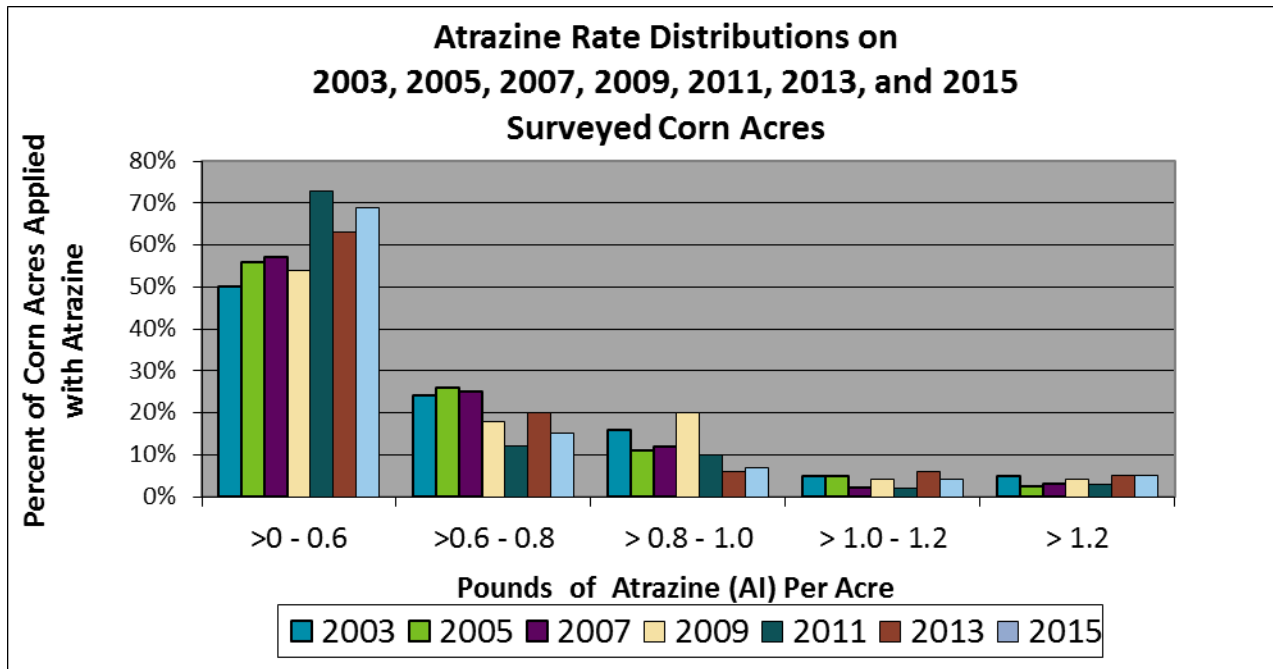


Figure 2. Atrazine (active ingredient) rate per acre distribution across surveyed corn acres for the 2003, 2005, 2007, 2009, 2011, 2013, and 2015 crop years.

Atrazine use by surveyed respondents has fallen from 30% in 2003 to 10% in 2015. The application rate has fallen from 0.67 pounds a.i. per acre in 2003 to 0.56 pounds a.i. per acre in 2015.

Acetochlor use by surveyed respondents is detailed in Figure 3, which illustrates the range of acetochlor rates reported for use in the 2003, 2005, 2007, 2009, 2011, 2013, and 2015 crop years.

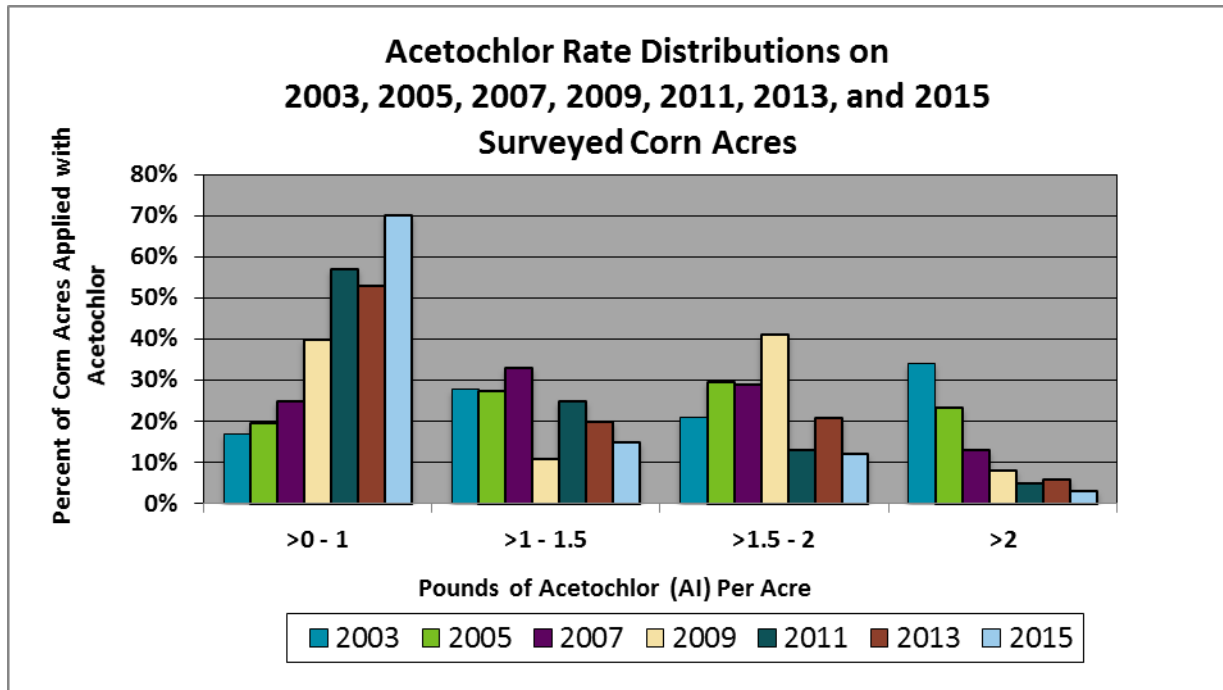


Figure 3. Acetochlor (active ingredient) rate per acre distribution across surveyed corn acres for the 2003, 2005, 2007, 2009, 2011, 2013, and 2015 crop years.

Acetochlor use by surveyed respondents has risen from 25% in 2003 to 43% in 2015. The application rate of acetochlor dropped from 1.61 pounds a.i. per acre in 2003 to 1.12 pounds a.i. per acre in 2015.

S-metolachlor use by surveyed respondents is detailed in Figure 4, which illustrates the range of rates reported for use of S-metolachlor in the 2003, 2005, 2007, 2009, 2011, 2013, and 2015 crop years.

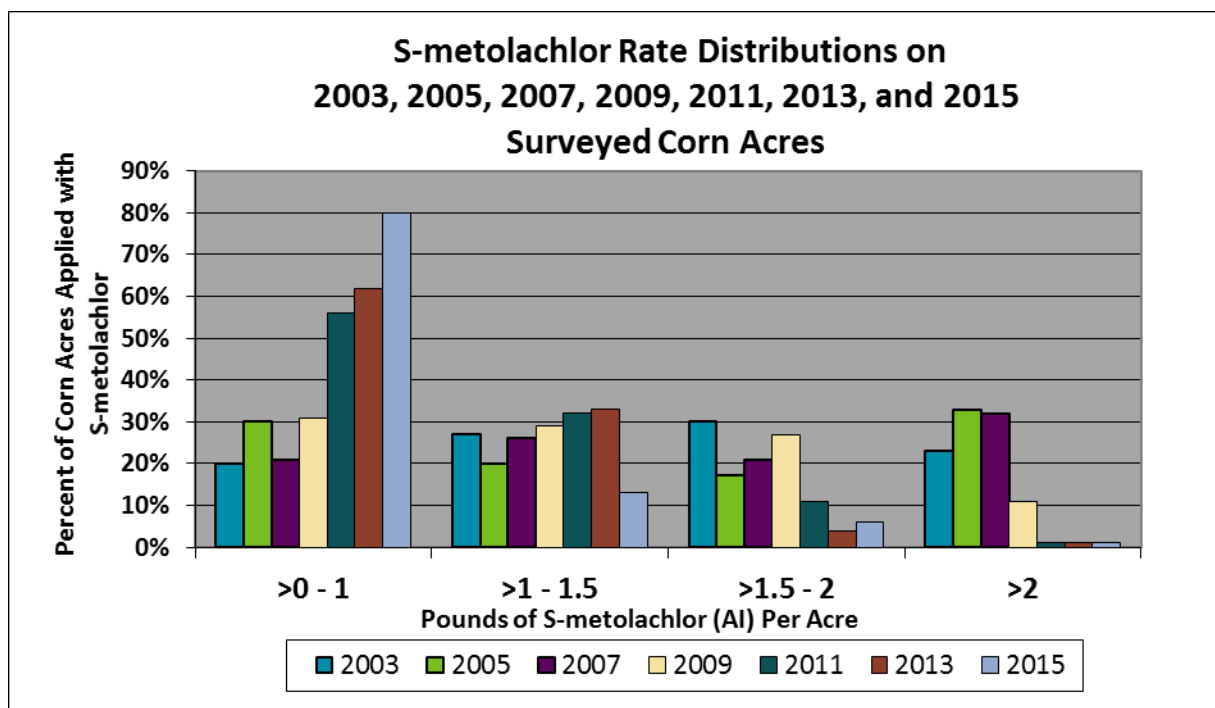


Figure 4. S-metolachlor (active ingredient) rate distribution across surveyed corn acres for the 2003, 2005, 2007, 2009, 2011, 2013, and 2015 crop years.

S-metolachlor use by surveyed respondents has risen slightly from 12% in 2003 to 15% in 2015. The application rate fell significantly from 1.67 pounds a.i. per acre in 2003 to 1.07 pounds a.i. per acre in 2015.

Corn Herbicide County-level Estimated Use Map

Atrazine use in Minnesota varies across the state. Some reasons for the variation in use include different weed species, soils, crop rotations and the pesticide packages that individual pesticide dealers promote in geographic areas of the state. As the vast majority of this herbicide is used in corn production, corn acres within each county will also have a direct influence on any county-based comparisons. Maps of the estimated land area in each county receiving atrazine can be constructed using data from the 2015 MDA survey.

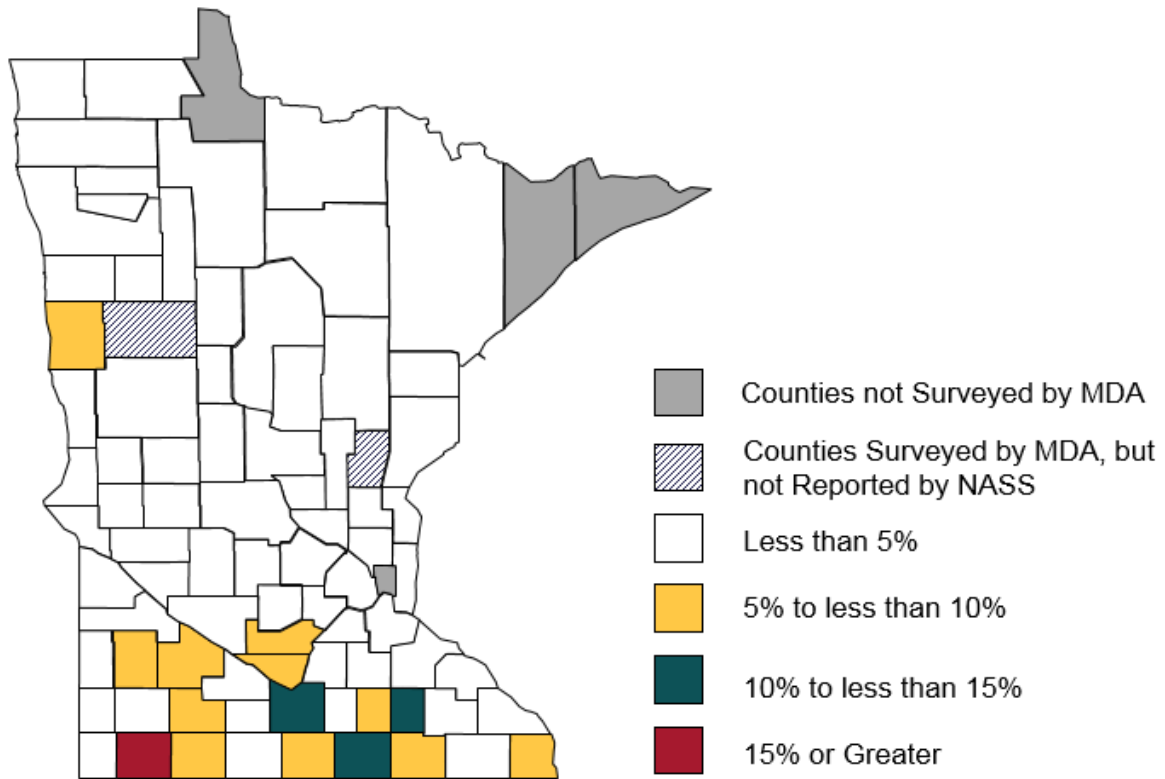
Figure 5 was constructed as follows: The percentage of surveyed crop acres receiving atrazine was multiplied by the number of crop acres in each county (a summation of corn and hay acres) as reported by NASS. This value was then divided by the county’s total land area (excluding lakes) expressed in acres and as reported by the U.S. Census.

Tables of statewide and regional MDA survey results are reported strictly as percentages of survey respondents. By multiplying the percentage of surveyed county crop acres receiving a specific pesticide by the number of NASS acres for those crops assumes that all crop acres in a county receive herbicide applications at the same rate as those acres included in the survey. Although this assumption results in an extrapolation whose accuracy cannot be verified statistically, the exercise provides a helpful means of utilizing available data to compare the

ways in which counties use certain herbicides relative to the amount of land in the county farmed for corn and hay. If a county is highlighted in blue, then no acres were reported by NASS for a particular crop, but MDA survey results did report crops grown in that county. Therefore, these counties are excluded from the mapping results.

Additionally, the map helps to correct a potential misinterpretation of statewide use data. Because the survey draws nearly equally from each county (approximately 34 farms per county), when an active ingredient's use data is presented as a statewide average of all counties, it is not adjusted for differing farm sizes or the amount of county land in corn or hay production. Instead, statewide averages are simply a reporting of data collected from all survey respondents. This averaging process can lead to inappropriate conclusions and may under-represent or over represent an active ingredient's use in smaller geographical areas. Similarly, the county-level data tables are only a report of data from survey respondents, and provide no means of identifying a county's relative use of an active ingredient. The extrapolation conducted to create the county-level estimated use map is an attempt to adjust the survey's raw data using the assumption that the approximately 34 producers surveyed in a county are representative of county-level farm sizes and practices associated with corn and hay production. This produces a potentially more realistic, regional estimate of active ingredient use based on factors that statewide averaging or simple county-level survey results can't approximate.

Percent of All Land Within Each County Applied with Atrazine



Percent of atrazine acres applied by county was calculated by:

MDA Survey: Percent of crop acres applied with atrazine, multiplied by total cropland acres (NASS official estimates), divided by total county size (US Census).

Figure 5. Estimated percent of land acres applied with atrazine on a county basis for the 2015 crop year.

Pesticide Applications on Corn by Pesticide Management Areas

Table 5 details the number of 2015 respondents with usable reports in each Pesticide Management Region (PMR), the number of corn acres reported in each area, and the number of corn acres receiving herbicides, insecticides and fungicides. Tables 6 – 14 provide corn pesticide applications and rates for individual PMRs. Corn acres were limited in PMRs 2 and 3; therefore, they are listed as ‘Combined PMRs’ this report. All responses in the following tables were published data five or more responses were collected from producers.

Table 5. Summary (by PMR) of surveyed corn acreage to which pesticides were applied.

PMR	Number of Respondents	Corn Acres	Herbicide Acres	Insecticide Acres	Fungicide Acres
1	216	103,175	101,868	9,590	4,145
4	298	53,927	52,914	1,296	752
5	105	10,725	10,458	*	*
6	147	76,035	75,786	2,635	2,555
7	146	49,402	48,685	5,625	*
8	511	175,453	173,551	28,914	22,609
9	208	50,121	48,908	10,503	9,056
10	131	22,811	22,381	2,008	200
Combined PMRs	34	2,811	2,533	*	*
Totals	1,796	544,460	537,084	60,615	40,847

* Data is not publishable due to use by less than 5 respondents.

Table 6. Pesticide applications and rates for corn – PMR 1

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Herbicides					
Acetochlor	33	1.0	1.32	1.34	46,072
Atrazine	8	1.0	0.61	0.62	5,261
Clopyralid	19	1.0	0.07	0.08	1,444
Dicamba	9	1.0	0.15	0.15	1,353
Diflufenzopyr	7	1.0	0.05	0.05	383

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Dimethenamid-p	3	1.0	0.51	0.51	1,849
Flumetsulam	18	1.0	0.03	0.03	565
Glyphosate	84	1.3	0.97	1.28	111,455
Mesotrione	10	1.0	0.10	0.10	1,009
S-metolachlor	5	1.0	1.13	1.13	5,458
Saflufenacil	3	1.0	0.06	0.06	211
Tembotrione	13	1.0	0.08	0.08	1,008
Triencarbazone-methyl	3	1.0	0.01	0.01	36
Insecticide					
Lambda-cyhalothrin	9	1.0	0.03	0.03	245
Fungicide					
Propiconazole	1	1.0	0.03	0.03	33
Pyraclostrobin	3	1.0	0.12	0.13	355
Trifloxystrobin	1	1.0	0.08	0.08	94
Triencarbazone-methyl	3	1.0	0.01	0.01	36

Data in this column is calculated from "raw" data and represents the total pounds of active ingredient applied to the indicated crop(s) in 2015 by survey participants in this area. Data in this table and the selection of survey participants was not statistically "weighted" in any fashion. Thus, inappropriate extrapolation of the data may over- or under-estimate the total pounds of a.i. used at the state, area or sub-area levels.

Herbicides applied but not published included the following: Fluthiacet-methyl, Glufosinate-ammonium, and Topramezone.

Insecticides applied but not published included the following: Bifenthrin and Tefluthrin.

Fungicides applied but not published included the following: Azoxystrobin, Fluxapyroxad, Metconazole, and Prothioconazole.

Table 7. Pesticide applications and rates for corn – PMR 4

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Herbicides					
Acetochlor	34	1.0	0.95	0.96	17,580
Atrazine	4	1.0	0.59	0.59	1,253
Clopyralid	32	1.1	0.07	0.08	1,306
Dicamba	19	1.0	0.19	0.19	1,888
Diflufenzopyr	15	1.0	0.08	0.08	612
Dimethenamid-p	3	1.0	0.56	0.56	917
Flumetsulam	32	1.1	0.03	0.03	523
Glyphosate	83	1.2	0.97	1.15	51,706
Mesotrione	8	1.0	0.10	0.10	454
Nicosulfuron	1	1.0	0.03	0.03	10
S-metolachlor	6	1.0	1.03	1.03	3,520
Saflufenacil	3	1.0	0.06	0.06	105
Tembotrione	9	1.0	0.08	0.08	366
Triencarbazone-methyl	1	1.0	0.01	0.01	8

Data in this column is calculated from “raw” data and represents the total pounds of active ingredient applied to the indicated crop(s) in 2015 by survey participants in this area. Data in this table and the selection of survey participants was not statistically “weighted” in any fashion. Thus, inappropriate extrapolation of the data may over- or under-estimate the total pounds of a.i. used at the state, area or sub-area levels.

Herbicides applied but not published included the following: 2,4-D, Bromoxynil, Fluthiacet-methyl, Glufosinate-ammonium, Halosulfuron-methyl, Pendimethalin, Rimsulfuron, Thifensulfuron, and Topramezone.
Insecticides applied but not published included the following: Bifenthrin, Lambda-cyhalothrin, and Tefluthrin.
Fungicides applied but not published included the following: Azoxystrobin, Fluoxastrobin, Flutriafol, Fluxapyroxad, Propiconazole, Pyraclostrobin, and Trifloxystrobin.

Table 8. Pesticide applications and rates for corn – PMR 5

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Herbicides					
Acetochlor	16	1.0	1.05	1.05	1,754
Atrazine	14	1.0	0.77	0.77	1,194
Glyphosate	77	1.0	0.91	0.95	7,859
Mesotrione	19	1.0	0.09	0.09	174
S-metolachlor	14	1.0	0.83	0.83	1,223
Tembotrione	9	1.0	0.06	0.06	58
Triencarbazone-methyl	7	1.0	0.01	0.01	8

Data in this column is calculated from “raw” data and represents the total pounds of active ingredient applied to the indicated crop(s) in 2015 by survey participants in this area. Data in this table and the selection of survey participants was not statistically “weighted” in any fashion. Thus, inappropriate extrapolation of the data may over- or under-estimate the total pounds of a.i. used at the state, area or sub-area levels.

Herbicides applied but not published included the following: Bromoxynil, Clopyralid, Dicamba, Diflufenzopyr, Flumetsulam, Glufosinate-Ammonium, Nicosulfuron, Pendimethalin, Rimsulfuron, and Topramezone.

Table 9. Pesticide applications and rates for corn – PMR 6

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Herbicides					
Acetochlor	58	1.0	1.08	1.09	47,824
Clopyralid	46	1.0	0.07	0.07	2,519
Dicamba	11	1.0	0.20	0.20	1,703
Diflufenzopyr	6	1.0	0.05	0.05	242
Dimethenamid-p	9	1.0	0.51	0.51	3,650
Flumetsulam	46	1.0	0.03	0.03	1,019
Glyphosate	92	1.2	0.98	1.14	79,429

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Mesotrione	22	1.0	0.09	0.09	1,465
S-metolachlor	6	1.0	0.89	0.90	4,362
Saflufenacil	9	1.0	0.06	0.06	416
Tembotrione	7	1.0	0.07	0.07	376
Insecticides					
Bifenthrin	3	1.0	0.08	0.08	25

Data in this column is calculated from “raw” data and represents the total pounds of active ingredient applied to the indicated crop(s) in 2015 by survey participants in this area. Data in this table and the selection of survey participants was not statistically “weighted” in any fashion. Thus, inappropriate extrapolation of the data may over- or under-estimate the total pounds of a.i. used at the state, area or sub-area levels.

Herbicides applied but not published included the following: 2,4-D, Atrazine, Bromoxynil, and Triencarbazone-methyl.

Insecticides applied but not published included the following: Chlorethoxyfos, Chlorpyrifos, Gamma-cyhalothrin, Lambda-cyhalothrin, and Tefluthrin.

Fungicides applied but not published included the following: Fluoxastrobin, Metconazole, Propiconazole, Pyraclostrobin, and Trifloxystrobin.

Table 10. Pesticide applications and rates for corn – PMR 7

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Herbicides					
Acetochlor	54	1.0	1.04	1.04	28,084
Atrazine	12	1.0	0.48	0.48	2,904
Clopyralid	39	1.0	0.07	0.07	1,392
Dicamba	7	1.0	0.20	0.20	709
Diflufenzopyr	4	1.0	0.07	0.07	122
Dimethenamid-p	6	1.2	0.59	0.69	1,958
Flumetsulam	39	1.0	0.03	0.03	561
Glyphosate	86	1.2	0.99	1.18	50,188

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Mesotrione	36	1.0	0.09	0.09	1,671
S-metolachlor	16	1.1	0.92	1.04	8,263
Saflufenacil	5	1.0	0.06	0.06	164
Tembotrione	6	1.0	0.09	0.09	244
Insecticides					
Bifenthrin	1	1.0	0.07	0.07	44
Chlorpyrifos	2	1.0	0.24	0.24	239
Tefluthrin	7	1.0	0.12	0.12	404

Data in this column is calculated from “raw” data and represents the total pounds of active ingredient applied to the indicated crop(s) in 2015 by survey participants in this area. Data in this table and the selection of survey participants was not statistically “weighted” in any fashion. Thus, inappropriate extrapolation of the data may over- or under-estimate the total pounds of a.i. used at the state, area or sub-area levels.

Herbicides applied but not published included the following: Bromoxynil, Glufosinate-ammonium, Metolachlor, Rimsulfuron, and Triencarbazone-methyl.

Insecticides applied but not published included the following: Cyfluthrin, Lambda-cyhalothrin, and Tebupirimphos.

Fungicides applied but not published included the following: Azoxystrobin, Metconazole, Propiconazole, and Pyraclostrobin.

Table 11. Pesticide applications and rates for corn – PMR 8

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Herbicides					
Acetochlor	54	1.0	1.07	1.10	103,791
Atrazine	12	1.0	0.52	0.53	10,951
Clopyralid	39	1.0	0.07	0.08	5,214
Dicamba	7	1.0	0.14	0.14	1,867
Diflufenzopyr	4	1.0	0.04	0.04	326
Dimethenamid-p	9	1.0	0.53	0.53	8,155

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Flumetsulam	39	1.0	0.03	0.03	2,069
Glufosinate-ammonium	1	1.0	0.51	0.51	1,207
Glyphosate	81	1.1	0.97	1.08	153,870
Mesotrione	35	1.0	0.09	0.09	5,561
S-Metolachlor	24	1.1	0.97	1.12	47,682
Saflufenacil	8	1.0	0.06	0.06	819
Tembotrione	12	1.0	0.07	0.07	1,546
Topramezone	2	1.0	0.02	0.02	61
Triencarbazone-methyl	1	1.0	0.01	0.01	34
Insecticides					
Bifenthrin	11	1.0	0.07	0.07	1,338
Chlorpyrifos	1	1.0	0.36	0.36	423
Cyfluthrin	1	1.0	0.01	0.01	10
Lambda-cyhalothrin	1	1.0	0.02	0.02	34
Tebupirimphos	1	1.0	0.12	0.12	191
Tefluthrin	2	1.0	0.09	0.09	359
Fungicides					
Azoxystrobin	6	1.0	0.08	0.08	821
Propiconazole	6	1.0	0.07	0.07	776
Pyraclostrobin	4	1.0	0.11	0.11	818
Trifloxystrobin	1	1.0	0.09	0.09	158

Data in this column is calculated from "raw" data and represents the total pounds of active ingredient applied to the indicated crop(s) in 2015 by survey participants in this area. Data in this table and the selection of survey participants was not statistically "weighted" in any fashion. Thus, inappropriate extrapolation of the data may over- or under-estimate the total pounds of a.i. used at the state, area or sub-area levels.

Herbicides applied but not published included the following: 2,4-D, Bromoxynil, Cloransulam, Flumioxazin, Fluthiacet-Methyl, Pendimethalin, Primisulfuron, Rimsulfuron, and Sulfentrazone.

Insecticides applied but not published included the following: Chlorethoxyfos, Gamma-cyhalothrin, Permethrin, and Thiamethoxam.

Fungicides applied but not published included the following: Cyproconazole, Fluoxastrobin, Fluxapyroxad, Metconazole, and Picoxystrobin.

Table 12. Pesticide applications and rates for corn – PMR 9

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Herbicides					
Acetochlor	24	1.1	1.12	1.20	14,629
Atrazine	14	1.0	0.67	0.67	4,799
Clopyralid	19	1.0	0.08	0.08	773
Dicamba	15	1.0	0.14	0.14	1,109
Diflufenzopyr	14	1.0	0.05	0.05	324
Dimethenamid-p	26	1.0	0.50	0.52	6,703
Flumetsulam	19	1.0	0.03	0.03	305
Glyphosate	86	1.1	0.97	1.06	45,333
Mesotrione	19	1.0	0.09	0.09	812
S-metolachlor	16	1.1	0.96	1.10	9,002
Saflufenacil	23	1.0	0.06	0.06	659
Tembotrione	5	1.0	0.08	0.08	186
Insecticides					
Bifenthrin	9	1.0	0.06	0.06	244
Chlorpyrifos	1	1.0	0.38	0.38	272
Tefluthrin	7	1.0	0.12	0.12	416
Fungicides					
Metconazole	14	1.0	0.03	0.03	216
Pyraclostrobin	16	1.0	0.08	0.08	656

Data in this column is calculated from “raw” data and represents the total pounds of active ingredient applied to the indicated crop(s) in 2015 by survey participants in this area. Data in this table and the selection of survey participants was not statistically “weighted” in any fashion. Thus, inappropriate extrapolation of the data may over- or under-estimate the total pounds of a.i. used at the state, area or sub-area levels.

Herbicides applied but not published included the following: 2,4-D, Bicyclopyrone, Cloransulam, Diglycolamine, Glufosinate-ammonium, Metribuzin, Nicosulfuron, Primisulfuron, Rimsulfuron, Sulfentrazone, and Topramezone.

Insecticides applied but not published included the following: Chlorethoxyfos, Cyfluthrin, Gamma-cyhalothrin, Lambda-cyhalothrin, Tebupirimphos, and Terbufos.

Fungicides applied but not published included the following: Fluoxastrobin, Fluxapyroxad, Propiconazole, and Trifloxystrobin.

Table 13. Pesticide applications and rates for corn – PMR 10

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Herbicides					
Acetochlor	18	1.0	0.94	0.94	3,835
Atrazine	20	1.0	0.59	0.59	2,694
Clopyralid	16	1.0	0.08	0.08	281
Dicamba	13	1.0	0.16	0.16	483
Diflufenzopyr	3	1.0	0.05	0.05	30
Dimethenamid-p	8	1.0	0.57	0.57	1,040
Flumetsulam	16	1.0	0.03	0.03	105
Glyphosate	83	1.1	0.94	1.09	20,600
Mesotrione	28	1.0	0.09	0.09	554
S-metolachlor	27	1.0	0.91	0.92	5,663
Saflufenacil	4	1.0	0.06	0.06	58
Tembotrione	3	1.0	0.08	0.08	58
Insecticides					
Tefluthrin	1	1.0	0.12	0.12	39

Data in this column is calculated from “raw” data and represents the total pounds of active ingredient applied to the indicated crop(s) in 2015 by survey participants in this area. Data in this table and the selection of survey participants was

not statistically "weighted" in any fashion. Thus, inappropriate extrapolation of the data may over- or under-estimate the total pounds of a.i. used at the state, area or sub-area levels.

Herbicides applied but not published included the following: Carfentrazone, Diglycolamine, Fluthiacet-methyl, Glufosinate-ammonium, Pendimethalin, Primisulfuron, Rimsulfuron, Topramezone, and Triencarbazone-methyl.

Insecticides applied but not published included the following: Bifenthrin, Chlorpyrifos, and Lambda-cyhalothrin.

Fungicides applied but not published included the following: Azoxystrobin, Propiconazole, Pyraclostrobin, and Trifloxystrobin.

Table 14. Pesticide applications and rates for corn – Combined PMRs

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Herbicides					
Glyphosate	73	1.1	0.98	1.03	2,125

Data in this column is calculated from "raw" data and represents the total pounds of active ingredient applied to the indicated crop(s) in 2015 by survey participants in this area. Data in this table and the selection of survey participants was not statistically "weighted" in any fashion. Thus, inappropriate extrapolation of the data may over- or under-estimate the total pounds of a.i. used at the state, area or sub-area levels.

Herbicides applied but not published included the following: Atrazine, Nicosulfuron, and S-Metochlor.

Insecticides applied but not published included the following: Cyfluthrin and Tebupirimphos.

Statewide Pesticide Applications – Hay

Many pesticide active ingredients can be used in the production of hay. Hay producers responding to the survey associated with this report may have used one or more of the active ingredients listed in Table 15; however, data is only published for pesticides applied by 5 or more respondents. This is consistent with standard reporting protocol used by NASS in other agricultural chemical use reports.

To obtain a list of products (brand names) registered in Minnesota and containing the active ingredients listed below, visit:

http://npirspublic.ceris.purdue.edu/state/state_menu.aspx?state=MN

enter the database, submit “active ingredient” as the search option, enter the name of the active ingredient, click “submit,” check the appropriate boxes, and “submit” to obtain a list of all registered products containing the active ingredient.

Table 15. Publication status for hay pesticide active ingredients

Active Ingredient	Published	Active Ingredient	Published
Herbicide		Insecticides	
2,4-D	P	Cyfluthrin	*
Clethodim	*	Gamma-cyhalothrin	*
Glyphosate	P	Lambda-cyhalothrin	P
Imazamox	*	Permethrin	*
Trifluralin	*	Zeta-cypermethrin	*
Insecticides		Fungicides	
Alpha-cypermethrin	*	Azoxystrobin	*
Bifenthrin	*	Propiconazole	*
Chlorpyrifos	P	Pyraclostrobin	P
Fungicides			
Trifloxystrobin	*		

An “*” denotes data is not publishable due to use by less than 5 respondents.

A statewide summary of hay pesticide applications is provided in Table 15. Eleven percent (11%) of all Minnesota hay acres were surveyed for the 2015 season. Herbicides were applied to 2% of all surveyed hay acres. Insecticides were applied to 5% of all acres and <1% surveyed acres were recorded as being applied with fungicides.

Table 16. Pesticide applications and rates by active ingredient (a.i.) for hay statewide.

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Herbicides					
2,4-D	<1	1.0	0.20	0.20	153
Glyphosate	1	1.0	1.06	1.09	2,070
Insecticides					
Chlorpyrifos	1	1.0	0.27	0.27	610
Lambda-cyhalothrin	3	1.4	0.02	0.03	144
Fungicides					
Pyraclostrobin	<1	1.0	0.10	0.11	53

Data in this column is calculated from “raw” data and represents the total pounds of active ingredient applied to the indicated crop(s) in 2015 by survey participants in this area. Data in this table and the selection of survey participants was not statistically “weighted” in any fashion. Thus, inappropriate extrapolation of the data may over- or under-estimate the total pounds of a.i. used at the state, area or sub-area levels.

Herbicides applied but not published included the following: Clethodim, Imazamox, and Trifluralin.

Insecticides applied but not published included the following: Alpha-cypermethrin, Bifenthrin, Cyfluthrin, Gamma-cyhalothrin, Permethrin, and Zeta-cypermethrin.

Fungicides applied but not published included the following: Azoxystrobin, Propiconazole, and Trifloxystrobin.

Pesticide Applications on Hay by Pesticide Management Areas

Table 17 details the number of 2015 respondents with usable reports in each Pesticide Management Region (PMR), the number of hay acres in each area, and the number of hay acres receiving herbicides, insecticides and fungicides. Tables 18 – 27 provide corn pesticide applications and rates by individual PMRs. All responses in the following tables were published data if five or more responses were collected from producers.

Table 17. Summary (by PMR) of surveyed hay acreage to which pesticides were applied.

PMR	Number of Respondents	Corn Acres	Herbicide Acres	Insecticide Acres	Fungicide Acres
1	208	25,223	397	528	*
2	172	26,608	*	*	*
3	79	15,517	*	*	*
4	385	34,075	380	1,116	*
5	185	18,184	*	*	*
6	46	4,616	*	2,610	*
7	85	3,187	*	374	*
8	239	9,516	728	1,175	*
9	181	12,517	267	1,276	335
10	154	6,989	*	713	*
Totals	1,734	156,432	3,784	7,882	585

An “*” denotes data is not publishable due to use by less than 5 respondents.

Table 18. Pesticide applications and rates for hay – PMR 1

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Herbicides					
Glyphosate	2	1.1	0.98	1.06	401

Data in this column is calculated from “raw” data and represents the total pounds of active ingredient applied to the indicated crop(s) in 2015 by survey participants in this area. Data in this table and the selection of survey participants was not statistically “weighted” in any fashion. Thus, inappropriate extrapolation of the data may over- or under-estimate the total pounds of a.i. used at the state, area or sub-area levels.

Herbicides applied but not published included the following: Pyraclostrobin.

Insecticides applied but not published included the following: Chlorpyrifos, Lambda-cyhalothrin, and Zeta-cypermethrin.

Table 19. Pesticide applications and rates for hay – PMR 2

No data is publishable for hay in Area 2.

Herbicides applied but not published included the following: Pyraclostrobin.

Table 20. Pesticide applications and rates for hay – PMR 3

No data is publishable for hay in Area 3.

Herbicides applied but not published included the following: 2,4-D and Glyphosate.

Table 21. Pesticide applications and rates for hay – PMR 4

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Herbicides					
Glyphosate	2	1.1	0.98	1.06	401
Insecticide					
Lambda-cyhalothrin	2	1.1	0.02	0.02	18

Data in this column is calculated from “raw” data and represents the total pounds of active ingredient applied to the indicated crop(s) in 2015 by survey participants in this area. Data in this table and the selection of survey participants was not statistically “weighted” in any fashion. Thus, inappropriate extrapolation of the data may over- or under-estimate the total pounds of a.i. used at the state, area or sub-area levels.

Herbicides applied but not published included the following: Clethodim.

Insecticides applied but not published included the following: Bifenthrin, Chlorpyrifos, and Gamma-Cyhalothrin.

Table 22. Pesticide applications and rates for hay – PMR 5

No data is publishable for hay in Area 5.

Herbicides applied but not published included the following: Glyphosate.

Insecticides applied but not published included the following: Permethrin.

Table 23. Pesticide applications and rates for hay – PMR 6

No data is publishable for hay in Area 6.

Herbicides applied but not published included the following: Imazamox.

Insecticides applied but not published included the following: Chlorpyrifos, Lambda-cyhalothrin, and Lambda-cyhalothrin.

Fungicides applied but not published included the following: Pyraclostrobin.

Table 24. Pesticide applications and rates for hay – PMR 7

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Insecticide					
Chlorpyrifos	9	1.2	0.49	0.58	160

Data in this column is calculated from “raw” data and represents the total pounds of active ingredient applied to the indicated crop(s) in 2015 by survey participants in this area. Data in this table and the selection of survey participants was not statistically “weighted” in any fashion. Thus, inappropriate extrapolation of the data may over- or under-estimate the total pounds of a.i. used at the state, area or sub-area levels.

Herbicides applied but not published included the following: 2,4-D, Glyphosate, and Trifluralin.

Insecticides applied but not published included the following: Lambda-cyhalothrin.

Table 25. Pesticide applications and rates for hay – PMR 8

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Insecticide					
Chlorpyrifos	7	1.0	0.47	0.47	307
Lambda-cyhalothrin	3	1.2	0.02	0.03	7

Data in this column is calculated from “raw” data and represents the total pounds of active ingredient applied to the indicated crop(s) in 2015 by survey participants in this area. Data in this table and the selection of survey participants was not statistically “weighted” in any fashion. Thus, inappropriate extrapolation of the data may over- or under-estimate the total pounds of a.i. used at the state, area or sub-area levels.

Herbicides applied but not published included the following: 2,4-D, Clethodim, and Imazethapyr.

Insecticides applied but not published included the following: Cyfluthrin and Permethrin.

Fungicides applied but not published included the following: Azoxystrobin.

Table 26. Pesticide applications and rates for hay – PMR 9

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Herbicide					

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Glyphosate	1	1.0	0.77	0.77	129
Insecticide					
Lambda-cyhalothrin	4	1.1	0.02	0.02	12

Data in this column is calculated from “raw” data and represents the total pounds of active ingredient applied to the indicated crop(s) in 2015 by survey participants in this area. Data in this table and the selection of survey participants was not statistically “weighted” in any fashion. Thus, inappropriate extrapolation of the data may over- or under-estimate the total pounds of a.i. used at the state, area or sub-area levels.

Herbicides applied but not published included the following: Clethodim.

Insecticides applied but not published included the following: Alpha-cypermethrin, Bifenthrin, and Chlorpyrifos.

Fungicides applied but not published included the following: Propiconazole, Pyraclostrobin and Trifloxystrobin.

Table 27. Pesticide applications and rates for hay – PMR 10

Agricultural Chemical (a.i.)	Surveyed Area Applied Percent	Average Applications Number	Average Rate Per Application Pounds per Acre (a.i.)	Average Rate Per Crop Year Pounds per Acre (a.i.)	Total Applied Per Crop Year Total Pounds (a.i.)
Insecticide					
Lambda-cyhalothrin	8	1.3	0.02	0.03	16

Data in this column is calculated from “raw” data and represents the total pounds of active ingredient applied to the indicated crop(s) in 2015 by survey participants in this area. Data in this table and the selection of survey participants was not statistically “weighted” in any fashion. Thus, inappropriate extrapolation of the data may over- or under-estimate the total pounds of a.i. used at the state, area or sub-area levels.

Herbicides applied but not published included the following: 2, 4-D and Glyphosate.

Appendix 1. MASS Data Sheet



**Minnesota
Agricultural
Statistics Service**

U.S. Department of Agriculture - National Agricultural Statistics Service

P.O. Box 7068, St. Paul, MN 55107-7068
Telephone: 651-296-2230 FAX: 651-296-3192
E-mail: nass-mn@nass.usda.gov
Project 487

Minnesota Pesticide Use Survey Instrument For 2015 Cropping Year

1. ACREAGE

REPORT FOR THE FARM YOU OPERATE (Include Land Rented From Others, Exclude Land Rented Out)				
2015 Crop	Total Acres Planted	Total Acres Treated With Fungicide	Total Acres Treated With Herbicide	Total Acres Treated With Insecticide
CORN	201	202	203	204
ALL HAY	216	217	218	219

2. USAGE OF INDIVIDUAL PESTICIDES ON 2015 CROPS - Include applications after September 1, 2014 on crops for 2015 harvest. (Please report below the acres treated with each individual chemical during 2015 by crop and/or land use. If pesticides were applied in combination, report each separately. Exclude seed treatment and inoculants.)

NAME OF PESTICIDE USED (Please list chemicals used. If necessary, refer to the enclosed list)	Office Use	Acres Treated	No. of Applications	Rate	Unit Code :
					1 Pounds 13 Quarts 15 Ounces
CORN					
	301	302	303	304	305
	306	307	308	309	310
	311	312	313	314	315
	316	317	318	319	320
	321	322	323	324	325
	326	327	328	329	330
	331	332	333	334	335
	336	337	338	339	340
	341	342	343	344	345
	346	347	348	349	350
	351	352	353	354	355
	356	357	358	359	360

	361	362	363	364	365
	366	367	368	369	370
NAME OF PESTICIDE USED <i>(Please list chemicals used. If necessary, refer to the enclosed list)</i>	Office Use	Acres Treated	No. of Applications	Rate	Unit Code: 1 Pounds 12 Gallons 13 Quarts 14 Pints 15 Ounces 30 Grams
ALL HAY					
	601	602	603	604	605
	606	607	608	609	610
	611	612	613	614	615
	616	617	618	619	620

If rates are not known, may we call your pesticide applicator? Yes _____ No _____

If yes, Company _____ Contact _____ City _____ Phone # _____ - _____ - _____

	Response Code	Enum.	Eval.	Julian Date
1-Op/Mgr 2-Spouse 3-Acct/Bkpr 4-Oth 5-Eat R 6-Eat NR 8-Office Hold 9-Partner	101	2-Tel 3-Int 7-TR 8-IR 9-Inac	910	098 100 987

Appendix 2. Additional Project Background Information

The Minnesota Department of Agriculture (MDA) is required by state law to monitor pesticide use. In pursuit of fulfilling that responsibility, the MDA began exploring the possibility of using the existing framework of the USDA National Agricultural Statistics Service (NASS) to enhance and broaden pesticide use monitoring efforts. NASS has a long history of providing statewide crop and production statistics. Over the last decade NASS has also become an important information source for pesticide and fertilizer use. Several joint pilot projects evolved with the financial assistance from Environmental Protection Agency (EPA) and were conducted from 2001-2003. These pilots were essential to the final methodology used in this report.

The first pilot was conducted in 2001 by expanding the existing Agricultural Resource Management Study (ARMS) developed by NASS. The normal number of participating farms in an ARMS survey is about 150. The pilot increased the number of personal interviews to approximately 600 and most of the enhancements were focused on the southern third of the state. The pilot provided reliable, regionally-enhanced data on pesticide product choices and application rates. Additionally, useful information on primary sources of pesticide management information, scouting, timing, and other pesticide management related information was obtained.

In neighboring North Dakota, the USDA North Dakota Field Office and North Dakota State University Extension had already established a strong tradition in collecting statewide pesticide use by using NASS telephone enumerators. *“Pesticide Use and Pest Management Practices for Major Crops in North Dakota”* is published on a four-year cycle. With the goal of expanding to a statewide scale while reducing costs, a second pilot was developed. MDA and NASS used many techniques from the North Dakota program but decided to expand the level of detail by including pesticide application rates. Historically, most mail out or telephone style surveys have been unsuccessful at quantifying pesticide rates. Due to the numerous formulations, different application rates and units of measure (i.e., active ingredient (a.i.) can be expressed in pounds, ounces, pints or quarts), complications can quickly develop. Another major complicating factor may result from the farmer using the services of a commercial pesticide applicator. If the farmer did not apply the product, the likelihood that the farmer would be familiar with the product and rate decreases significantly.

In recognition of some of the obstacles in collecting pesticide rate information, two methods for collecting pesticide rates were tested in the second pilot. “Method One” was conducted in Douglas County with 150 randomly selected farm operators. Operators were interviewed over the phone by the NASS enumerators. If the operator did not know the pesticides and/or rates, no additional follow-up work was conducted and the data was limited to any information that was provided. In neighboring Grant County, another 150 farm operators were contacted. In this county using “Method Two”, if the farm records were incomplete, follow-up calls were made the pesticide dealer to complete the survey with the operator’s permission. The number of surveys with complete data sets was significantly increased with the additional assistance from the dealerships. Eighty-three (83) percent of the surveys were complete in Grant County compared to forty-six (46%) in Douglas County. Equally impressive was the overall support by the local dealerships.

ⁱ Statewide crop totals are from the USDA NASS survey data for 2015.

ⁱⁱ Including all forms of glyphosate.

ⁱⁱⁱ The total sum of respondents across all crops was 3,530. However, since some farmers surveyed grew both corn and hay, the actual number of participating farms was 2,802.

^{iv} For an example survey methods and data quality, visit the NASS website at https://www.nass.usda.gov/Education_and_Outreach/Understanding_Statistics/index.php “Statistical Aspects of Surveys” for more specific facts about agricultural chemical use surveys. Click on “Survey and Estimation Procedures” section of NASS “Agricultural Chemical Usage - Field Crops” reports available at <http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1560>

^v Active ingredients can be known by several different synonyms. In order to be consistent in reporting within the MDA, Phostebupirim is now reported as Tebupirimphos.

^{vi} Excludes any active ingredients with less than five responses.