LR 309

Examine Means to Minimize Conflicts Resulting from Phenoxy Herbicides and Sensitive Crops

Interim Draft Report

Staff prepared draft for consideration and further editing by the LR309 Task Force

December 31, 2014

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Report prepared by Rick Leonard, Agriculture Committee Research Analyst

LEGISLATIVE RESOLUTION 309 Introduced by Wallman

PURPOSE: The purpose of this resolution is to examine and make recommendations on how to improve the protection of sensitive commercial crops from losses due to the damaging effects of phenoxy herbicide drift (2, 4-D, Dicamba, etc.) and how to minimize the occurrences of drift damage. This study shall identify sensitive crops grown in Nebraska, including grapes, and their direct and value-added economic importance. This study shall examine the present awareness and policies of commercial and private licensed applicators, utilities, and governmental and public entities and review their training requirements, training effectiveness, and record-keeping requirements. The study shall also examine existing programs of public sprayer education, general awareness of DriftWatch, and potential liabilities of which all applicators should be aware in an effort to lessen the necessity of and extreme difficulties involved in state drift episode investigations.

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Introduction

Nebraska's agricultural landscape has diversified with a growth in grape and winery production, a growing number of acres under organic management, and investment in other high value and specialty agricultural and horticultural crops. While this diversification is welcome, such crops are often particularly sensitive to herbicides and other pest management products widely utilized in the husbandry of the state's predominant commodity crops and in weed and pest management on range lands, turf and landscaping in residential, commercial and recreational settings, rights-of-way, and other areas under active vegetation management. Certain crops themselves may have a high degree of biological susceptibility to damage, or growers may suffer loss of economic value, or both, resulting from uncontrolled exposure to herbicides and other pesticides. Thus, the potential for drift or other manner of off-site movement of chemicals applied in the vicinity of sensitive crops presents investment risk and husbandry difficulties for growers of such crops. It also introduces potential new liabilities and management complications for growers of conventional crops and those responsible for management of other types of landscapes.

Losses experienced by grape producers during the 2011 and 2012 growing seasons prompted the introduction of LB 636 during the 2012 legislative session proposing a series of restrictive setbacks, notification and application practice standards governing applications of volatile phenoxy herbicides. LB 636 was held by the Agriculture Committee in order to investigate further the conflicts that occur with 2,4-D applications and to review the existing regulatory environment governing its use, the products containing 2,4-D and their utilization in Nebraska, and the economic benefits and tradeoffs associated with 2,4-D utilization and its restriction. Interim study resolution LR 309 introduced by Senator Wallman provides the forum for that inquiry.

In order to carry out the purposes of LR 309, Senator Schilz formed an informal advisory committee to examine these issues in greater detail and report findings and recommendations to the Agriculture Committee. Its ultimate task is to compile useful reference information and prepare recommendations to the Agriculture Committee regarding means to minimize conflicts between agricultural and non-agricultural uses of 2,4-D herbicide products and properties devoted to sensitive crop management. The group was specifically charged with examining and returning its findings and recommendations in the following areas:

- Fostering increased communication and cooperation between landowners, between various segments of the agricultural community, and between the agricultural community and non-agricultural sectors, including but not necessarily limited to improvements in the functionality and utilization of the Driftwatch system.

- Public education and outreach projects and critical audiences for such outreach efforts.

- Means of supporting crop and land management and application best practices to reduce the likelihood of off treatment area damage and economic impacts of weed and pest management applications. These may include, but not necessarily limited to, physical barriers to drift, buffer area separations, application timing, selection of product formulations and drift retardants, and other similar concepts.

- Applicator certification training and improvements in such training that would improve applicator awareness of issues presented by sensitive crops in the vicinity of treatment sites and best management practices to avoid off target impacts.

While it is preferred that the group emphasize recommendations that can be implemented without the need for additional legislation or regulatory changes, the group is not precluded from identifying statutory or regulatory revisions, or funding needs that would be necessary or helpful in implementing its recommendations. Also, although the catalyst and primary focus for this project is the vulnerability of grapes to phenoxy herbicides, the findings and recommendations need not be limited to reducing conflict in this crop-herbicide combination.

There is a careful balancing of interests at stake. Continued investment in specialty crops requires a degree of certainty that the grower can proceed free of unreasonable risks from drift or other manner of movement of chemicals from application sites in the area. Yet, herbicides, including 2,4-D and other pesticides remain important, if not essential, to the productivity of conventional crops and are often the most practical and economical means for managing invasive and other vegetation that conflict with uses and management objectives of other lands.

Specialty Crop Production in Nebraska

This section is intended to provide an overview of specialty crop production within the state. The data provided below hopefully provide an overall picture of the types of crops that we include within the category of specialty crops that are actively produced and harvested within the state, acreage devoted to this niche of agriculture and measures of value, geographical distribution, and where available trends in production.

Specialty/Sensitive Crops Definition

There is not a uniform definition of what constitutes a specialty crop. In general, the term refers to agricultural and horticultural crops that are not one of the major crops widely grown and marketed as commodity crops. For purposes of eligibility for USDA programs to stimulate specialty crop production, Section 101 of the Specialty Crops Competitiveness Act of 2004 (7 U.S.C. 1621) as amended by the Agricultural Act of 2014 (2014 Farm Bill) defines specialty crops as "fruits and vegetables, tree nuts, dried fruits, and horticulture and nursery crops including floriculture. Specialty crops are limited to those non major crops cultivated as food for human consumption, medicinal purposes, or for aesthetic uses."

Specialty crops are often considered and often referred to as pesticide sensitive crops as their biology may make them particularly susceptible to adverse effects on survival, growth or productivity resulting from untimely and/or uncontrolled exposure to herbicides or other pesticide products utilized on predominant agricultural crops and other types of lands in the area. Although there is considerable overlap, not all specialty crops are sensitive by this definition so the terms are not directly interchangeable. Additionally, specialty growers may themselves utilize pesticide products that contain active ingredients utilized by non-specialty crop growers in the area, and in some cases, specialty crops may be grown by the same grower on the same farm with major crops managed with farm chemicals. Furthermore, for crops grown under organic management, sensitivity may also refer to the impact on commercial value of crops and certification of lands exposed to unwanted chemical spray drift in addition to, but distinct from, implications for the health of the crop affected. Grains such as wheat or corn are not normally considered specialty or sensitive crops, but when grown under organic rules, their potential value or marketability may be severely eroded even if not physically damaged. For that matter, an economically pesticide sensitive crop includes any individual crop, whether organic or not, grown under certification rules or production specifications that reduces value or denies premium market access if exposed to chemical drift.

Nebraska Specialty Crop Information

It is difficult to locate precise measures of specialty crop production. Most sources that might be consulted that examine the prevalence and distribution of specialty crops are largely estimates based on surveys or derived from indirect or incomplete sources. Information regarding specialty crop production in Nebraska presented below is largely obtained from 2012 U.S. Census of Agriculture estimates but supplemented by other sources of information where available. More specifically, Census of Agriculture data underlying many of the tables and graphs presented below is extracted from selected tables from Volume 1 (Geographical Area

Series), Part 27 (Nebraska State and County Data) of the 2012 Census of Agriculture publications series. Part 27, Nebraska State and County Data, was published in May of 2014.

The Census does not present data based on classification of crops as specialty or non-specialty. It does provide data for various categories and subcategories of crops and individual crop types for each state. Some subjectivity is therefore necessary to select crop data for those crops that a Nebraska audience might consider to be specialty crops in this state. Also, census data is not dynamic, it is based on information obtained from surveys at a point in time. Since the latest data collection was completed in 2012, the data is already two years old. Particularly for extremely low acreage or low volume crops, estimates may be interpreted from small sample sizes and information may in some cases be omitted due to confidentiality constraints. In some cases, interpreting changes over census intervals may be difficult since small changes and weather, market or other anomalies during the survey year can greatly skew any apparent trends. The reader should not consider the information as a precise accounting of all specialty crop production in the state. It is intended as a general picture of specialty crop production within Nebraska's agricultural landscape.

Aggregate Specialty Crop Data

Census data relevant to those crops referred to as specialty crops are generally included in the following four broad census crop groupings: Vegetables, melons and potatoes (including sweet potatoes); Fruits, tree nuts and berries, Nursery, greenhouse, floriculture and sod, and woodland crops.

Individual Nebraska Commercial Crops Represented in Selected 2012 Census of Ag Crop Categories

Category	Individual Crops
Vegetables, Potatoes and Melons (table 38)	Asparagus, green beans, snap beans, beets, broccoli, brussel sprouts, cabbage (chines & head), cantelopes & muskmelon, carrots, cauliflower, celery, chicory, collands, cucumbers, dakon, eggplant, garlic, herbs, kale, lettuce, okra, onions, parsley, peas, peppers, potatoes, pumpkins, radishes, rhubarb, spinach, squash, sweet corn, potatoes, tomatoes turnips, watermelon, others (unspecified)
Fruits & Nuts, and Berries (tables 39 & 40)	Apples, apricots, cherries, grapes, nectarines, peaches, pears, persimmons, plums, almonds, chestnuts, hazelnuts, pecans, walnuts, other nuts, blackberries, dewberries, blueferries, currants, raspberries, strawberries, other berries
Nurseries, greenhouse, floriculture and Sod (open air grown) (table 41)	Aquatic plants, bulb/rhizome and tuber varieties, cuttings, bedding/garden plants, cut flowers and florist greens, foliage plants, flowers for seed, nursery stock crops, sod, vegetables for seed, vegetable transplants
Woodland Crops (table 42)	Cut Christmas trees, short rotation woody crops

The number and variety of crops in these categories grown commercially in Nebraska may be somewhat surprising. Readers should refer to the census tables cited in the table above for the number of farms engaging in commercial production and estimated acres of each crop reported

in the 2012 census. It is difficult to discern, but many of the fruit and vegetable and other specialty crops that are detected by the census are likely grown on a relatively small number of farms that raise several types of specialty crops. In addition to these cultivated crops, some commercial harvesting of native seeds, wild food source, and other plants and cuttings can occur on grasslands, woodlands and other uncultivated lands.

Comparing the 2012 census to 2007 data does capture an overall increase in the number of farms reporting specialty crop production, the number of acres, and increasing total value of specialty crops.

Change in Nebraska Specialty Crop Acres and Value -- (2007 to 2012)

		Census Year		% change 2007 to 2012
Crop Category		**2012**	**2007**	
Vegetable, Melons, Potatoes & Sweet Potatoes				
	Farms	478	344	39.0%
	Acres	26,001	23,646	10.0%
	Value	$101.14 mil	$63.84 mil	58.4%
Fruits, Tree Nuts & Berries				
	Farms	316	253	24.9%
	Acres	> 1428	> 1500	-4.8%
	Value	$3.16 mil	$2.59 mil	22.0%
Open Grown Nursery, Greenhouse, Floriculture & Sod				
	Farms	480	371	29.4%
	Acres	4649	5170	-10.1%
	Value	$46.02 mil	$41.22 mil	11.6%
Woodland Crops				
	Farms	77	71	8.5%
	Acres	805	719	12.0%
	Value	$1.03 mil	$.59 mil	74.6%
Total	**Acres**	**32,883**	**31,035**	**6.0%**
	Value	**$151.35 mil**	**$108.24 mil**	**39.8%**

Overall, the 2012 Census suggests total crop acres in crops identified as specialty crops for purpose of this report has increased 6% over the 5-year census interval, and value has grown by just under 40% led by an almost 60% increase in the value of vegetable production and 75% increase in woodland crop value.

This growth appears to be stimulated at least in part by increasing offerings of locally grown selections in retail food stores, and growing sales through farmers markets, food cooperatives, community supported agriculture and other models of direct sales from farm to ultimate consumer. Table 2 of the Nebraska Ag Census for “value of agricultural products sold directly to individuals for human consumption” shows a 42% increase in the value of direct sales from 2007 to 2012, from $5.9 million to just under $8.4 million.

While the variety of commercially grown specialty crops is impressive and of growing importance, the number of acres for most of these crops is typically very small and collectively comprise only a small portion of Nebraska's agricultural products, both in terms of acres and value.

Market Value of Nebraska Agricultural Products

Commodity Group	2012 Value ($ mil)	2007 Value ($ mil)
Corn	7,551.00	4,428.00
Wheat	369.00	407.00
Soybeans	2,516.00	1,487.00
Sorghum	26.10	74.60
Other Grains, Dry beans and Dry Peas	262.00	131.30
Hay and Forage Crops	528.00	207.00
Livestock, Poultry & Their Products	11,691.00	8,663.00
Vegetables, Melons, Potatoes	101.00	63.80
Fruits, Tree Nuts and Berries	3.20	2.59
Nursery, Greenhouse, Floriculture and Sod	46.00	41.20
Woodland Crops	1.03	0.59
Total (all)	**23,094.33**	**15,506.08**
Total (Crops Only)	**11,403.33**	**6,843.08**
Specialty Crops (all)	**151.23**	**108.18**
Specialty Crops % of All	**0.7%**	**0.7%**
Specialty Crops % of Crops Only	**1.3%**	**1.6%**

Land in Farms, Cropland Acres & Specialty Crop Acres

Crop Category	2012	2007
Land in Farms	45,331,783	45,480,358
Total Cropland	21,597,313	21,486,025
All Specialty Crop Acres	32,883	35,035
Specialty Crop Acres as % of All Land in Farms	0.073%	0.077%
Specialty Crop Acres as % of Total Cropland	0.152%	0.163%

It is interesting to note that specialty crop values are typically much higher per acre than the value of products from agricultural land as a whole. As shown in the tables above, specialty crops are estimated to represent less than 1/10th of 1% of all land in farms but 7/10th of 1% of the value of all agricultural production. Specialty crop acres are just 2/10th of 1% of all land in

farms identified as cropland acres, yet they are estimated to contribute approximately 1.5% of the value of cropland production.

Grape/wine production

Although grape production is included in aggregate data above, this portion of the report provides additional detail regarding the grape and wine industry in Nebraska. Grapes are a very small crop in terms of number of growing locations, number of acres, and total raw value of harvested grapes. The grape and wine industry however plays a prominent role in this discussion. Growing and developing grapes are particularly sensitive to 2,4-D and other types of spray drift, and are often grown in small, isolated plots and in many cases in close proximity to treated crops.

An estimate of grape production can be discerned from a promotional excise fee that has been imposed beginning in 2007. An excise tax of 1 cent / lb, or $1 / cwt., sold through commercial channels is charged to growers, collected by first purchasers and remitted to the Department of Agriculture. The following table is derived from this checkoff data.

Grape Checkoff -- Dollars Collected and Lbs Assessed

	FY07-08	FY08-09	FY09-10	FY10-11	FY11-12	FY12-13	FY13-14
checkoff @ $1 / cwt	$2,587	$8,610	$9,696	$8,746	$7,783	$6,271	$9,402
LBs of Grapes Assessed	258,700	861,000	969,600	874,600	778,300	627,100	940,200
Convert to Tons	129.4	430.5	484.8	437.3	389.2	313.6	470.1
Grower Value (@ $1300/ton)	$168,155	$559,650	$630,240	$568,490	$505,895	$407,615	$611,130

Although the chart may provide a rough indication of grapes purchased from other growers and the value they receive, actual grape production in the state may be underestimated by checkoff data as a proportion of the state's production processed into wine will be grown by wineries themselves and thus not marketed and assessed. The Census of Agriculture estimates there were 469 acres of bearing age grapes located on 159 farms at the time of the 2012 survey, and an additional 105 acres of not yet bearing acres on 94 farms (it is uncertain what portion of farms having non-bearing acres represent new locations). According to wine industry sources, yield varies from year-to-year and by grape variety, but a working estimate is 3-4 tons / acre and a ton yields approximately 800 bottles of wine. Multiplying the 2012 Census bearing grape acreage estimate by a yield average 3.5 tons / acre, suggests an average production capacity of 1641 tons and another 367 tons to be added as currently non-bearing grapes come into production.

1641 tons translates into over 1.3 million bottles of wine which appears to be highly inflated. For 2013, excise taxes were collected on 66,919 gallons of wine reported to the Liquor Control Commission by farm wineries. Using a rule of thumb that 1 gallon converts to 5 bottles, results in 330,000 bottles produced in 2013. That figure seems more in line with growth reasonably expected to have occurred since a 2006 wine and grape industry economic impact study by the Bureau of Business Research of UNL which estimated 244,000 bottles produced that year (49,000 gallons) from the Liquor Control Commission data.

Regardless, the economic value of grape production is much more pronounced than the value of raw grapes alone when considering the value added by winemaking. The following table estimates the value added through wine making using the estimate of raw grape production that can be verified with checkoff assessed from growers for FY2013-14. It is estimated this way that each $1 of raw grape value translates to $9.2 of finished product value.

Estimate of Value Added to Grapes by Winemaking

(Grape production estimate from FY13-14 Checkoff Data)

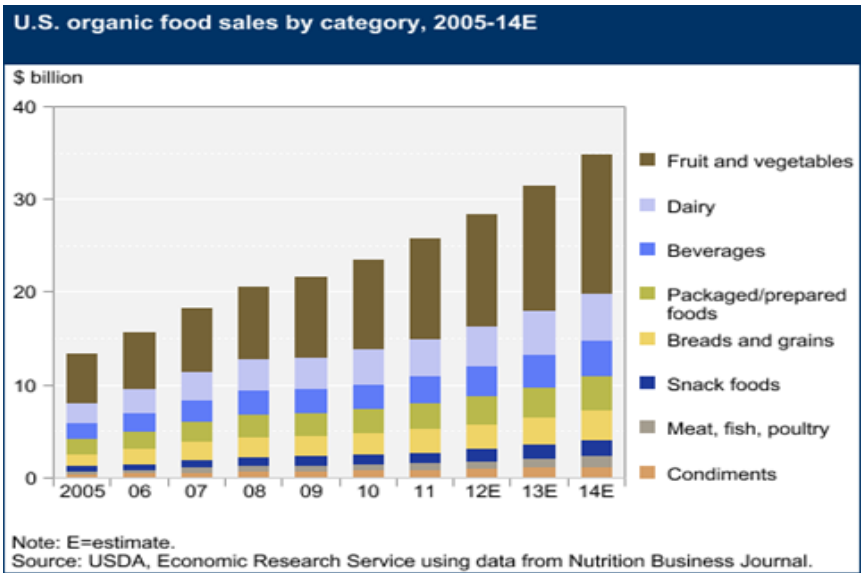
Tons of Grapes	470.1
Grower Value	$611,130
Estimated Wine Production (800 bottles/ton of grapes)	376,080
Wine Value ($15 / bottle avg.)	$5,641,200
Value added (Wine value - grower value)	$5,030,070
Value multiplier (wine value/grower value)	9.2

Additionally, grape production has an economic impact disproportionate to its agricultural footprint in other ways. Wineries supplied by growers add significant value to raw grape commodities grown in the state, but the economic contribution of wineries go beyond just the value of wine sales. Wineries attract tourist and leisure spending dollars to an area, and are quality-of-life assets for a community, a factor in recruiting and retaining young people, other entrepreneurs and other business investment. Thus, compared to other agricultural activities, wineries enjoy a high degree of popularity and visibility with the general public.

Organic Farming

Organic farming is also a growing presence in the state, mirroring national trends. USDA does not have official statistics on U.S. organic retail sales, but information is available from industry sources. U.S. sales of organic products were an estimated $28.4 billion in 2012—over 4 percent of total food sales—and will reach an estimated $35 billion in 2014. Fresh fruits and vegetables have been the top selling category of organically grown food. Produce accounted for 43 percent of U.S. organic food sales in 2012, followed by dairy (15 percent), packaged/prepared foods (11 percent), beverages (11 percent), bread/grains (9 percent), snack foods (5 percent), meat/fish/poultry (3 percent), and condiments (3 percent). This data is shown in graphic form on the following page.

Organic food is sold to consumers through three main venues in the United States—conventional grocery stores, natural food stores, and direct-to-consumer markets. Organic products are now available in nearly 20,000 natural food stores and nearly 3 out of 4 conventional grocery stores.



Source: Organic Market Overview, http://www.ers.usda.gov/topics/natural-resources-environment/organic-agriculture/organic-market-overview.aspx

Nebraska organic production follows, but somewhat lags national trends. Acres certified as organic have increased dramatically in the state over the past decade or more, but as a share of U.S. total have declined.

Change in Certified Organic Cropland and Pasture/Rangeland
Nebraska vs U.S (Years 2000 & 2011)

	2000	2011
Nebraska		
Operations	**104**	**162**
Cropland (acres)	37,465	78,394
Pasture/Rangeland (acres)	10,150	35,848
Total	**47,615**	**114,242**
U. S.		
Operations	**6,592**	**12,880**
Cropland (acres)	1,218,905	3,084,989
Pasture/Rangeland (acres)	557,167	2,298,130
Total (acres)	**1,760,703**	**5,383,119**
Nebraska as % of U. S.		
Operations	**1.6%**	**1.3%**
Cropland (acres)	3.1%	2.5%
Pasture/Rangeland (acres)	1.8%	1.6%
Total (acres)	**2.7%**	**2.1%**

Source: USDA, Economic Research Service, based on information from USDA-accredited State and private organic certifiers.

Table 54 of the 2012 Census of Agriculture, Nebraska Data Series estimates total farm value of organic product sales of just under $40 million in 2012. These sales were reported from 171 farms. Interestingly, the Census indicates that for Nebraska, 78 farms reported $50,000 of

organic product sales accounting for over $38 million, or 96%, of organic sales. If the census data is correct, organic sales by these larger organic farms would average $498,000 apiece.

Pesticide Products and Use

Pests are any organism whose presence and activity conflicts with land use management objectives. Pesticides are any substance used to prevent or mitigate damage resulting from such pests. The term includes herbicides (to control weeds and other plants), insecticides (to control insects), fungicides (to control fungi or other plant pathogens), nematicides (to control parasitic worms), and rodenticides (to control rodents). The term also encompasses soil fumigants, plant growth regulators, defoliants, and desiccants. Pesticides can be synthetic (developed in laboratories and manufactured) or naturally occurring. While some products that can be, and are in fact, utilized for their pesticidal function can be found in nature, and even some commercial manufactured pesticide products are synthetic replicas of chemicals that are produced biologically, the term is popularly associated with manufactured products of man-made chemical composition.

The benefits of pesticide use are accompanied by potential risks to human health and the environment in general, and risks arising from accidents and incidents of misapplication, including the risks of economic externality of unintended chemical drift/migration adversely affecting crop production or other land use activities occurring on other lands in the vicinity. This is not a novel issue. However, the expansion of specialty crop production in Nebraska discussed in Section 1 along with expansion of non agricultural land uses into areas where pesticide use is common is likely to increase the potential for, and the types and value of, economic damage associated with migration of applied pesticide products across property boundaries. Both are likely to simultaneously reduce landowner tolerance of drift incidents.

This section provides an overview of pesticide use in the state and its regulation. Because of the focus of the task force as outlined in LR 309, this section will focus on herbicides with emphasis on 2,4-D and some discussion of other herbicides most commonly implicated in reports of damage to specialty crops. This section will conclude with an overview of best management practices to reduce the potential for off-site pesticide migration or to mitigate resulting impacts.

Economics of Pesticide Use as Pest Management Practice

Farmers have historically had varying degrees of success managing pests through use of inorganic pesticides, through cultural practices, and with manual and mechanical elimination of weeds. These may continue to be utilized today as part of integrated pest management in conventional farming, and are heavily relied upon in organic farming. After World War II, the introduction of synthetic chemicals greatly expanded farmers' pest control options. The availability of relatively inexpensive pesticides made crop production more efficient by providing superior management of weeds, insects, and plant pathogens, while reducing the amount of labor, fuel, and machinery used. These benefits translate into lower production costs, higher crop yields and/or quality, and increased profits for farmers. Pesticides, together with fertilizers and improved seed varieties, have contributed to substantial increases in crop yields over the last 80 years.

A recent USDA publication, *Pesticide Use in U.S. Agriculture: 21 Selected Crops, 1960 – 2008* (Economic Information Bulletin #124, May 2014) provides a useful discussion of economic factors that have driven adoption of herbicides as a weed management practice.
This publication explains that relative price trends for crops, pesticides, and other inputs have enhanced the cost effectiveness of pesticides and the amount used, given the comparative effects of different pesticides, non-pesticide practices, and management systems on pests and damages, which can also change over time. Though the report focuses on agricultural use, many of the same economic considerations in agriculture will apply in other land management situations.

The USDA publication cited above finds that since the late 1990s, the pesticide price per acre has declined relative to the value of crop production per acre, and pesticides have declined relative to the costs of wages, fuels, land, machinery and other inputs. While the NASS index for agricultural input prices rose at an average annual rate of 3.7% from 1990 to 2008, the NASS pesticide price index rose by only 1.7% per year. From 2000 to 2008, the NASS index for agricultural input prices grew at an average rate of 6.8% per year while the pesticide price index rose by only 1.9% per year. At the national level, pesticide costs as a percent of input costs peaked at 4.0% in 1998. Between 1998 and 2008, pesticide cost share declined to about 3.1%. Thus, even when pesticide use is high, pesticides represent a minor cost component. Absent other considerations, substitution of pesticides for labor for manual, and machinery for mechanical, pest control is likely to occur.

Another way to understand the widespread adoption of chemical pest management is the marginal value of the avoided loss of production. This is referred to as the value of the marginal product (VMP) in relation to the marginal cost of deploying pesticides to achieve that avoided loss. The VMP depends on yield potential of the crop, the percentage of yield losses reasonably anticipated, and crop prices. The potential yield losses depend on the extent, intensity, and variability of pest infestations and the effectiveness of pest control inputs. The VMP for pesticides used at agronomic rates is estimated in various studies referenced in the USDA report to range from $1 to $8 (i.e. $1 in the cost of pesticide applications results in a net gain of $1 to $8 in the value of crop yield and quality-related value that would have been lost to weeds and other pests). VMP's tend to be highest in fruits and vegetables and lowest in forage crops. The study also finds that the VMP of herbicide use typically exceeds the VMP of alternatives, such as labor and mechanical methods, (i.e. tillage), although VMP's for different approaches can vary considerably from farm to farm. The marginal value of pest damage prevention has increased as improved genetics, fertilizer and irrigation have greatly increased yields. Pesticides as an input cost have also declined as the relative application costs, efficacy and technical improvements in successive pesticide products have been made. However, the USDA report does suggest that VMP's for herbicides are typically lower than for other types of pesticides and that VMP's for all pesticide use may be trending downward.

While the relative value of pesticide use has led to a bias toward substitution of pesticides for labor and tillage, year-to-year and individual farm variability, as well as long-term trends, in pesticide use are influenced by several factors: levels of pest infestation, technical improvements in pesticide products, market prices, adoption and success of integrated pest management in reducing pest infestations, pesticide regulation, use of herbicide tolerant genetics, use of conservation tillage, changing cropping patterns, pesticide substitutions as resistance arises and availability of labor.

Pesticide/Herbicide Use and Trends

The following series of tables and graphs are provided to present an overall picture of pesticide use in the U.S. The data is largely copied from information at the website of the EPA Office of Pesticide Programs [http://www.epa.gov/opp00001/pestsales/] and documents available from website of the Economic Research Service of USDA under the chemical input topic [http://www.ers.usda.gov/topics/farm-practices-management/chemical-inputs/pesticide-use-markets.aspx]. Neither EPA nor USDA has a program devoted specifically to monitoring the overall pesticide market in terms of dollars spent and quantity of active ingredient used on an annual basis. EPA utilizes available information from the public domain and private marketing research companies (proprietary data sources). USDA derives pesticide use estimates from EPA sources supplemented by other proprietary data and Census of Agriculture and annual ag input cost survey data.

The numbers in the report represent approximate values rather than precise values. There are two other limitations. First, these USDA and EPA estimates are not available by state. While there are likely to be much overlap between Nebraska and national usage patterns, particularly as national usage is heavily influenced by major crops that are also prevalent in Nebraska, there may be differences in crops, pests and other conditions. Also, these agencies have not performed comprehensive estimates since prior to 2010. Some very recent factors that may be influencing pesticide use patterns may not be apparent.

The amount of conventional pesticide used in 2006 and 2007 totaled 821 and 857 million pounds of active ingredient, respectively. The following table breaks out the use of conventional pesticide products use by pesticide type and market sector in 2007. Agriculture accounted for the majority of the total amount used, with non-agricultural sectors cumulatively accounting for approximately one-fifth of the total use in that year.

Amount of Conventional Pesticide Active Ingredient Used in the United States
by Market Sector -- 2007 Estimates

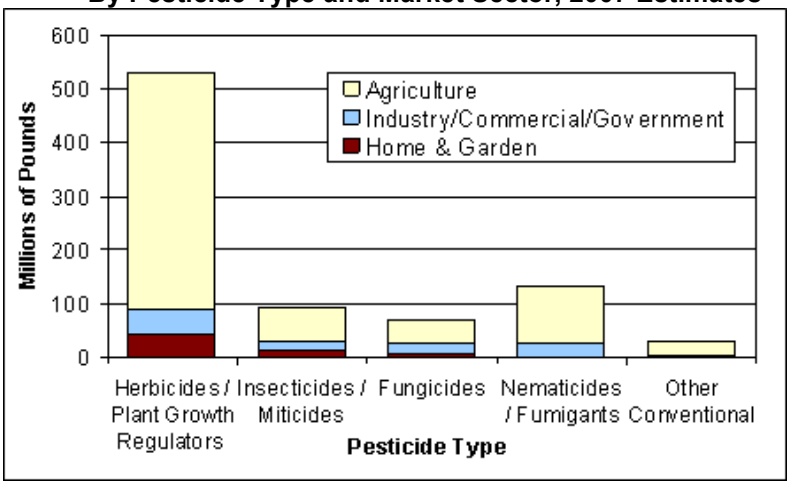
Sector	Mil Lbs	%
Agriculture	684	80%
Ind/Comm/Gov	107	12%
Home & Garden	66	8%
Total	857	100%

Source: EPA estimates based on USDA/NASS and EPA proprietary data

The agriculture sector also accounted for the majority of the total amount used by pesticide type—70% or more of the total amount used of each type, except for fungicides in 2006 (63%) and 2007 (63%). The following graphic shows the breakout of this use by pesticide type and market sector. Pesticide types in this group include herbicides, plant growth regulators, insecticides, miticides, fungicides, nematicides, fumigants, and others.

Amount of Conventional Pesticide Active Ingredient Used in the United States

By Pesticide Type and Market Sector, 2007 Estimates



The next tables shows the 10 most commonly used pesticide active ingredients in the two non-agricultural sectors (home & garden and industry/commercial/government) for 2007 and selected earlier years.

Most Commonly Used Conventional Pesticide Active Ingredient

(Ranked by Range in Millions of Pounds of Active Ingredient)

Home and Garden Market Sector

Active Ingredient	Type	2007 & 2005		2003		2001	
		Rank	**Range**	**Rank**	**Range**	**Rank**	**Range**
2,4-D	H	1	8-11	1	8-11	1	8-11
Glyphosate	H	2	5-8	5	5-8	2	5-8
Carbaryl	I	3	4-6	2	6-9	6	2-4
MCPP	H	4	4-6	3	5-8	5	4-6
Pendimethalin	H	5	3-5	4	5-8	3	3-6
Pyrethroids	I	6	2-4	7	2-4	—	<1
Malathion	I	7	2-4	6	3-6	8	2-4
Dicamba	H	8	1-3	9	1-3	7	2-4
Trifluralin	H	9	1-3	—	<1	—	<1
Pelarganoc Acid	H	10	<1	—	<1	—	<1

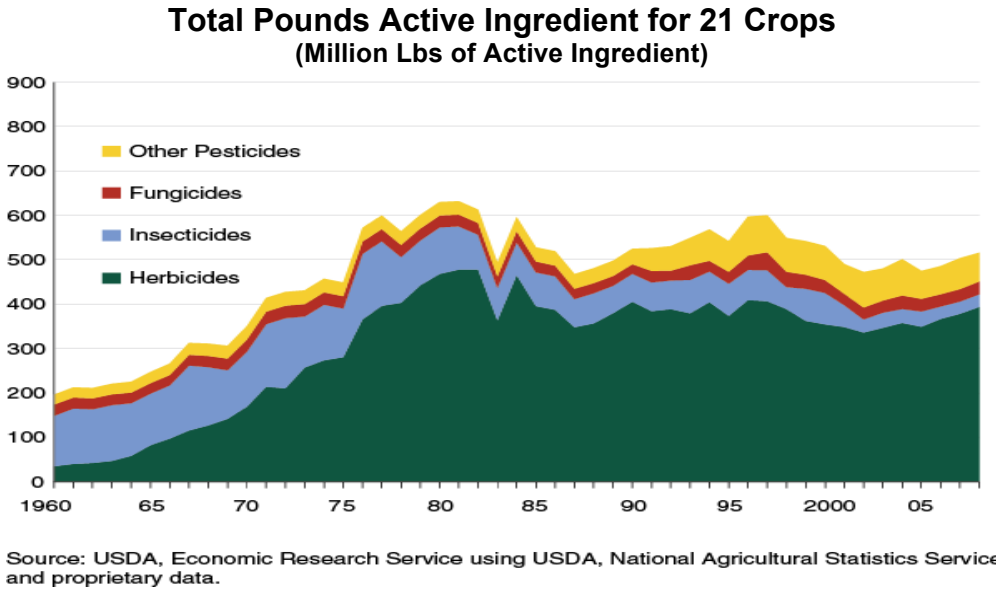
Industry/Commercial/Government Market Sector

Active Ingredient	Type	2007 & 2005		2003		2001	
		Rank	**Range**	**Rank**	**Range**	**Rank**	**Range**
2,4-D	H	1	19-22	1	19-22	1	16-18
Glyphosate	H	2	13-15	2	13-15	2	13-15
Chlorothalanil	F	3	3-5	4	3-5	5	2-4
MSMA	H	4	2-4	5	3-5	8	2-4
Diuron	H	5	2-4	6	2-4	7	2-4
Pendimethalin	H	6	2-4	8	2-4	4	3-5
Triclopyr	H	7	2-4	7	2-4	9	1-3
Copper Sulfate	F	8	2-4	3	4-6	3	4-6
Malathion	I	9	1-3	9	1-3	10	1-3
Sulfuryl fluoride	I	10	1-3	10	1-3	—	—

In both sectors, 2,4-D was the most used active ingredient. Seven of the top 10 active ingredients used in the home and garden sector are herbicides, and three are insecticides. Six of the top 10 active ingredients used in the industry/ commercial/government sector are herbicides, two are fungicides, and two are insecticides.

For agriculture, the specific pesticide use estimates as depicted in graphics below are from the USDA publication, *Pesticide Use in U.S. Agriculture: 21 Selected Crops, 1960 – 2008* (Economic Information Bulletin #124, May 2014) referenced above and summarized in the USDA/ERS monthly magazine *Amber Waves*. (See *Pesticide Use Peaked in 1981, Then Trended Downward, Driven by Technological Innovations and Other Factors*; Amber Waves, June, 2014)

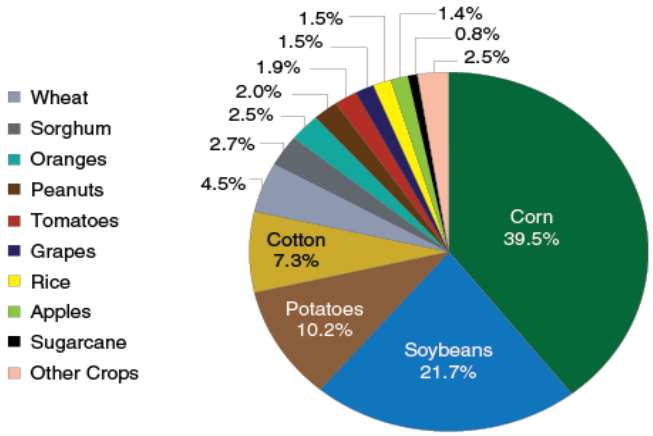
It may be surprising to some, but pesticide use in agriculture has trended slightly downward over the past three decades. Since 1980, most acres planted to major crops have been treated with herbicides, including over 90 percent of corn and soybean acres. USDA attributes the trend toward fewer total pounds of pesticide use to improved active ingredients with new modes of action and lower per-acre application rates. The graph below indicates trends in total pesticide application for the top 21 crops by acreage in the U.S.



As depicted in the graphic on the top of the following page, in 2008, corn, soybeans, cotton, wheat, and potatoes accounted for about 80 percent of the quantity of pesticide (measured in pounds of active ingredient) applied to the 21 crops examined. Corn received the largest share, about 39 percent in 2008; however, this represents a drop from corn's peak share of about 50 percent in the mid-1980s. Soybean production had the next largest share in 2008 at 22 percent, near its all-time high share of 25 percent in 1983. Wheat's share was less than 5 percent in 2008, but it has varied between 2 and 5 percent from 1960 to 2008.

The pesticide types applied by U.S. farmers for the 21 crops analyzed also changed considerably between 1960 and 2008. Insecticides accounted for 58 percent of the quantity of

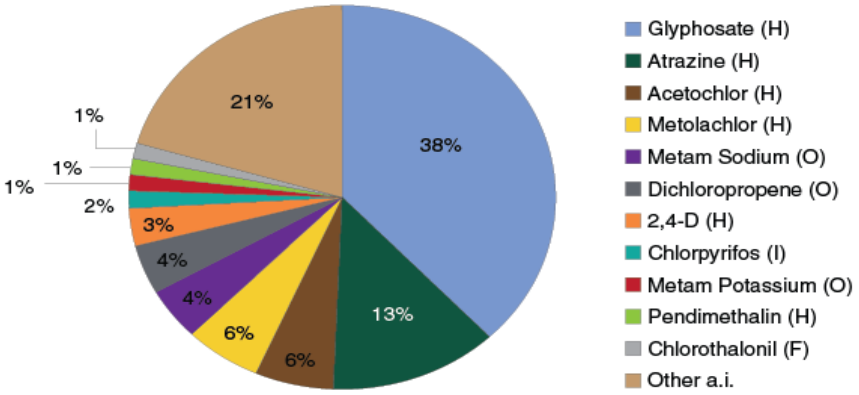
Share of All Pesticide Use for 21 Crops (2008)



Source: USDA, Economic Research Service using USDA, NASS and proprietary data.

pesticides applied in 1960, but only 6 percent in 2008. Herbicide applications increased from 18 percent in 1960 to 76 percent in 2008. Notably, the four most heavily used active ingredients in 2008 were glyphosate, atrazine, acetochlor, and metolachlor, all herbicides.

Percent of Total Active Ingredients Applied to 21 Crops (2008)



Source: USDA, Economic Research Service using USDA, NASS and proprietary data.

Drift Incidents

While a wide selection of herbicide products are available to and utilized by agricultural producers and other land managers in Nebraska, most drift incidents appear to be limited to a handful of active ingredients as suggested drift incident investigation data presented below. However, it should be kept in mind that products being most frequently cited in incident

investigations does not necessarily indicate that these are, compared to alternative products that might be used instead, more lethal to sensitive crops, nor necessarily of higher concern with respect to propensity for drift or other offsite movement, environmental residency, or toxicity to humans, animals or other biota. Aside from the relative potency of the active ingredient, the frequency of certain active ingredients being implicated in drift events may be a factor of much higher overall usage of the product, that the product is more likely to be applied by methods and during times of the year that are more susceptible to drift and when potential for or consequences of damage is highest, and the location of sensitive crops in proximity to where these products are most heavily utilized.

The Nebraska Department of Agriculture was asked to provide a summary of drift incidents reported to and/or investigated by the Department involving damage to sensitive crops for the years 2011 – 2013 and for 2014 to date (10 incidents as of 9/25/14). The Department's response is provided as an appendix item and summarized in the table on the following page. During the period, the Nebraska Department of Department of Agriculture reported investigating 38 drift incidents involving sensitive crops (includes bees).

Over the four years, the annual number of reports of damage has remained fairly constant at about ten per year. However, incidents reported to the Department likely represent only a fraction of drift events. For various reasons, not all incidents will be reported. Some cases of drift damage may not be noticed or deemed by the grower not substantial enough to warrant reporting. Damage observed may be sometimes be attributed to non-pesticide causes or the grower's own chemical applications. In some cases the damaged party may be reluctant to report the incident or the incident is resolved privately. Still, it is thought this data is useful as it is likely to be representative of characteristics of drift actually occurring, although it may represent the more egregious incidents in terms of economic damage.

By far, the heaviest periods of drift incidents reported occur during the months of May and June (33 out of 38 incidents) corresponding to periods of preplanting and early growing season applications before crop canopies are fully established. In fact, very few incidents are reported in July or later in the year. As the following table indicates, incidents of drift reported are most heavily associated with early growing season applications to corn and soybeans. Incidences occurring later in the season are more likely to be related to non agricultural or non-crop applications, or difficult to determine a source.

Correlation of Total Department Investigated Drift Incidents (2011 - 2014) by Month of Year and Source Application Site if Determined

	Corn	Soybeans	R-O-W	Pasture	Unknown
April		1			
May	10	3	1	1	3
June	8	3	3		5
July			1	1	1
August					
September					1

Note – Number of source sites may be more than total incidents due to more than one source site implicated in some incidents.

Characterization of Sensitive Crop Drift Incidents Investigated by the Department of Agriculture

Year	2011	2012	2013	2014(1)	Total
No. of Incidents	10	8	10	10	38
Month of Year					
April		1			1
May	4	6	3	3	16
June	4	1	7	5	17
July	1			2	3
August					0
September	1				1
Active Ingredient*					
2,4-D	8	5	9	6	28
Glyphosate	5	6	6	5	22
Saflufenacil			3		3
Sulfentrazone			2	1	3
Dicamba	1		1		2
Atrazine	1		1		2
Dimethanamid			2		2
Picloram	1			1	2
Glufosinate		1			1
Acetoclor	1				1
Tembotrione		1			1
Diuron			1		1
Fomesafen				1	1
Clethodim				1	1
Imazathapyr				1	1
None(2)				2	2
Application (Source) Site**					
Corn	5	4	5	4	18
Soybeans	1	1	2	3	7
R-O-W	2	1	2	1	6
Pasture	1		1		2
Source Unknown	2	3	3	2	10
On-Site Application(3)	1	3	3		7
Method of Application at Source					
Ground	8	4	6	8	26
Aerial	1	1	1	0	3
Other or Unknown	2	3	3	2	10

* Total active ingredients and total source sites may add to more than number of incidents investigated since more than one active ingredient or source site per drift incident may have be detected

(1) Not a complete year – incidents through 10/25/14; (2) Damage attributed to cause other than pesticides drift; (3) Damage attributed to pesticides applied to property by landowner

The next table examines any correlation between active ingredient detected in drift investigations and the month of year the incident is reported. It is probably not surprising that since the report relates to reports of physical damage due to detected drift herbicide agents incidents are almost exclusively confined to the months of May and June when herbicide use is heaviest.

Correlation of Total Department Investigated Drift Incidents (2011 - 2014) by Month of Year and Active Ingredient Detected

	April	May	June	July	Aug.	Sept.
2,4-D		13	11	3		1
Glyphosate		9	13			
Saflufenacil		1	2			
Sulfentrazone		2	1			
Dicamba			2			
Atrazine		2				
Dimethanamid		1	1			
Picloram				2		
Glufosinate		1				
Acetoclor		1				
Tembotrione		1				
Diuron			1			
Fomesafen			1			
Clethodim			1			
Imazathapyr			1			
Unknown/none	1	2	1			

Note – Number of active ingredients may be more than total incidents due to more than ingredient detected implicated in some incidents.

Perhaps surprisingly, a much higher percentage of incidences investigated are attributed to ground applications compared to aerial spraying. This is perhaps due to the fact that all incidences of physical damage to sensitive crops in the Department's report are herbicides mostly attributed to early growing season applications when ground application is still feasible and price competitive and therefore utilized more heavily as an application method. (Are there possible mechanical reasons for ground application to be more susceptible to drift than aerial?) There are commercial ground application services, but a higher percentage of ground applications are more likely to be performed by private applicators utilizing their own equipment. Aerial applications are more likely to be performed by hired professional commercial applicators, and a higher percentage of late season pesticide applications in crops is performed by aerial applications and more heavily in insecticides, fungicides and other non-herbicide products. It is uncertain from the data available whether there could be any greater association of herbicide drift incidents with private applicators compared to commercial applicators.

It is difficult as well to draw any conclusions regarding whether incidents reported and damage observed is due directly to spray drift or indirectly as volatility. Spray drift is the airborne movement of herbicide particles to non-target sites during application. Volatility is the evaporation of active ingredients during application and from application site surfaces after

application and movement as a gas, or vapor, to the non-target site. Off-site movement can also occur by solution in runoff water and in when bound to soil particles that may be transported by wind. Although vapor and direct spray drift are the most likely source of unintended offsite movement of pesticides, the latter methods of transport, blowing soil and chemicals in solution in runoff, may be a more prominent factor under extreme weather conditions.

Selected Herbicide Information

We conclude this section with additional information with respect to use and properties of four selected herbicide products. The herbicides selected are most commonly associated with drift incidents, either as indicated by the popularity of their use or being most commonly implicated in drift incidents as flowing from the preceding discussion. Unless otherwise indicated, the information presented here is derived from the most recent EPA registration decision or intermediate evaluation documents and from active ingredient fact sheets produced by the National Pesticide Information Center. Agricultural pesticide use intensity maps shown are provided by the USGS National Pesticide Synthesis Use Project. These maps depict the geographic distribution of estimated use on agricultural land in the United States for numerous pesticides (active ingredients). Maps were created by USGS by allocating county-level use estimates based on USDA annual surveys and proprietary data to agricultural land within each county. A graph accompanies each map, which shows annual national use by major crop for the mapped pesticide for each year. See http://water.usgs.gov/nawqa/pnsp/usage/maps/about.php.

USGS estimates for pesticide use in Nebraska for the years 1992 – 2009 as derived from county-level use surveys and proprietary data are provided at the Nebraska Department of Agriculture webpage (see http://www.nda.nebraska.gov/pesticide/trends.html).

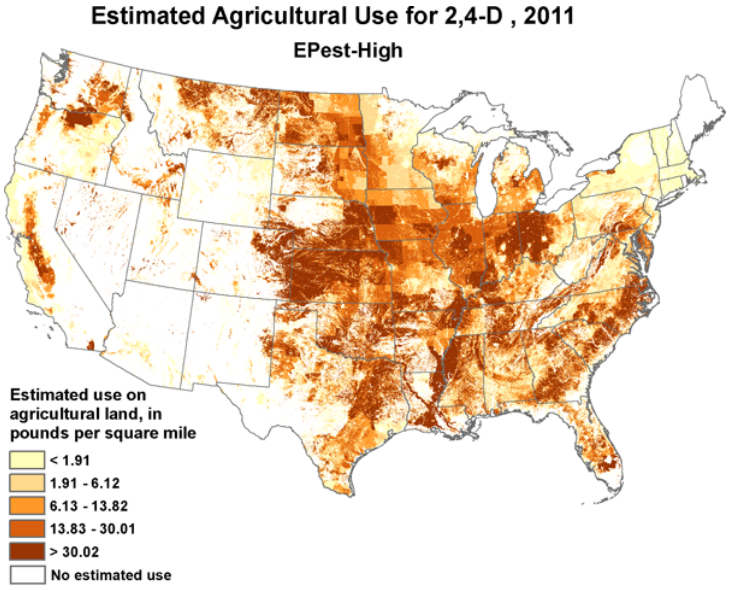
2,4-D

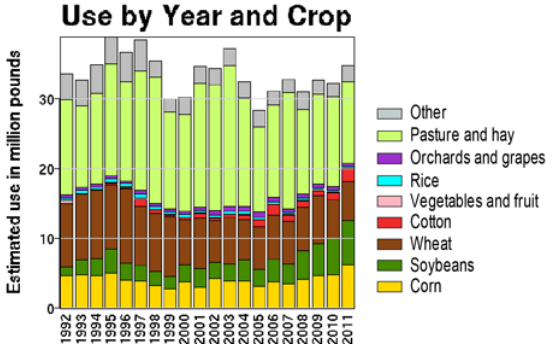
Description: 2,4-D is an herbicide in the phenoxy or phenoxyactic acid family that is used primarily for post-emergence control of broadleaf weeds in agricultural and nonagricultural settings, and it is registered for use in both terrestrial and aquatic environments. It may also be used as a plant growth regulator and as a fungicide. 2,4-D is registered for use on a variety of food/feed sites including field, fruit and vegetable crops. It is also registered for use on turf, lawns, rights-of-way, and forestry applications. Because 2,4-D has little effect on grasses, it can be used with wheat and in corn in early growth stages, is commonly found in household lawn care products, and is popular for use in pasture and rangeland, roadways, and golf courses and other large landscaped areas. 2,4-D is commonly found or used in combination with other herbicides to expand the range of weeds controlled by a single herbicide product. At the time of the latest reregistration of 2,4-D in 2005, there were more than 660 end-use products containing 2,4-D as the primary or contributing active ingredient.

In addition to the acid form, there are numerous salts and esters of 2,4-D which vary in their chemical properties, environmental behavior, and to a lesser extent, toxicity. Formulations of 2,4-D are emulsifiable concentrate, granules, soluble concentrate, water dispersed granules, and wettable powder.

Mode of Action: 2,4-D works by mimicking the effects of auxins, growth regulating hormones existing naturally in plants, causing uncontrolled cell division and growth in certain plant tissues resulting in elongated, distorted and constricted stems and other parts of the plant's vascular system. Abnormal increases in cell wall plasticity, biosynthesis of proteins, and production of ethylene occur in plant tissues following exposure, and these processes are responsible for uncontrolled cell division. It is indicated visually by leaf curling and disfiguration of plant stem and other structures due to abnormal growth.

Agricultural use intensity: 2,4-D use intensity for agriculture estimated for 2011 is depicted in the following graphics found at the Pesticide National Synthesis Project of the U.S. Geological Survey. The accompanying bar graph shows estimated total pounds of 2,4-D usage (lbs. active ingredient / square mile) in agricultural lands for each of years 1992 through 2011 and allocations by major crop categories.





Environmental Fate: 2,4-D amine salts and esters are not persistent under most environmental conditions. The ester forms of 2,4-D penetrate foliage, whereas plant roots absorb the salt forms. Typically, the ester and amine forms degrade rapidly to the acid form. 2,4-D acid is shown to degrade rapidly in soils (half life = 6.2 days), and relatively rapidly in aerobic aquatic environments (half life = 15 days), but is more persistent in anaerobic aquatic environments (half life ranges from 41 to 333 days). 2,4-D has a low affinity to bind in many soils. Thus, it is considered intermediately to highly mobile. Volatility for most

forms of 2,4-D is low. However, the vapor pressure of some ester forms of 2,4-D is very low, indicating that these forms more readily volatilize.

Usage: Total annual domestic usage of 2,4-D was estimated at the time of its reregistration in 2005 at approximately 46 million pounds, with 30 million pounds (66%) used for agriculture and 16 million pounds (34%) used for non-agriculture. In terms of pounds, total 2,4-D usage is allocated mainly to pasture/rangeland (24%), lawn by homeowners with fertilizer (12%), spring wheat (8%), winter wheat (7%), lawn/garden by lawn care operators/landscape maintenance contractors (7%), lawn by homeowners alone (without fertilizer) (6%), field corn (6%), soybeans (4%), summer fallow (3%), hay other than alfalfa (3%) and roadways (3%). Agricultural sites with at least 10% of U.S. acreage treated include spring wheat (51%), filberts (49%), sugarcane (36%), barley (36%), seed crops (29%), apples (20%), rye (16%), winter wheat (15%), cherries (15%), oats (15%), millet (15%), rice (13%), soybeans (12%), and pears (10%). For 2,4-D, rates per application and rates per year are generally less than 1.50 pounds acid equivalent (a.e.) per acre and 2.00 pounds a.e. per acre (lbs ae/A), respectively. 2,4- D is used predominantly in the Midwest, Great Plains, and Northwestern United States.

Glyphosate

Description: Glyphosate is a derivative of glycine used as a non-selective systemic herbicide applied directly to foliage. It can also be used as a plant growth regulator and is a weak chelating agent. Formulations include an acid and a handful of salts. Isopropylamine salt is the most commonly used in product formulas. Glyphosate is the active ingredient in the popular Roundup brand herbicide although patent restrictions for glyphosate have recently expired.

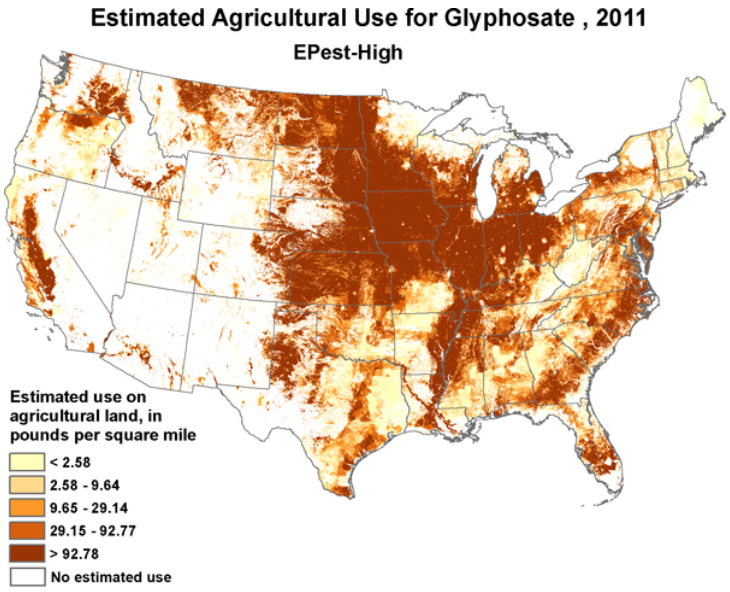
Mode of Action: In plants, glyphosate disrupts the shikimic acid pathway through inhibition of the EPSP enzyme. The resulting deficiency in EPSP production leads to reductions in aromatic amino acids that are vital for protein synthesis and plant growth. Glyphosate is absorbed across the leaves and stems of plants and is translocated throughout the plant, but concentrates in the stem tissue. Plants exposed to glyphosate display stunted growth, loss of green coloration, leaf wrinkling or malformation, and tissue death. Death of the plant may take from 4 to 20 days to occur. Through genetic engineering, crops are endowed with a glyphosate tolerance by substituting a different EPSP enzyme mechanism not disrupted by glyphosate.

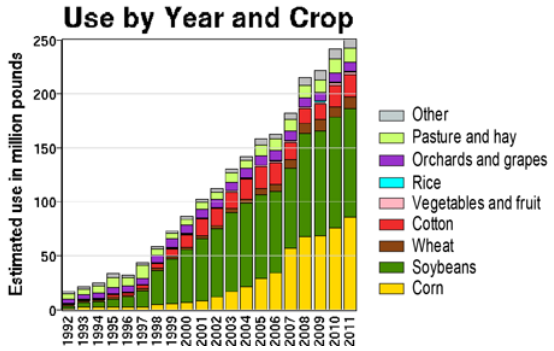
Environmental Fate: The median half-life of glyphosate in soil has been widely studied -- A typical field half-life of 47 days has been suggested. The median half-life of glyphosate in water varies from a few days to 91 days. The primary means of degradation is by soil microbial action. The persistence of glyphosate is affected by soil and climate conditions. Glyphosate binds tightly to minerals in soil and is considered relatively immobile, i.e. having a low propensity to leach. Glyphosate and all its salt formulations are considered very low in volatility.

Usage: Glyphosate is widely used to control weeds in agricultural crops and non-agricultural sites and is registered for use on a variety of fruit, vegetable, and field crops as well as for aquatic and terrestrial uses. Labeled uses of glyphosate include over 100 terrestrial food crops as well as other non-food sites including forestry, greenhouse, non-

crop, and residential. Glyphosate is among the most widely used pesticides by volume. It ranked eleventh among conventional pesticides used in the U.S. during 1990-91. In recent years, approximately 13 to 20 million acres were treated with 18.7 million pounds of glyphosate annually. The largest use sites include hay/pasture, soybeans and field corn. Glyphosate is also registered for use on glyphosate-resistant (transgenic) crop varieties such as canola, corn, cotton, soybeans, sugar beets, and wheat. Glyphosate tolerance enables growing season application to control weeds in growing crops. To some extent, glyphosate has replaced other pesticides utilized for preplanting burndown and soil incorporated preemergent herbicides, and alternative products applied during the growing season. Glyphosate is particularly useful in no-till systems.

Agricultural use intensity:





Atrazine

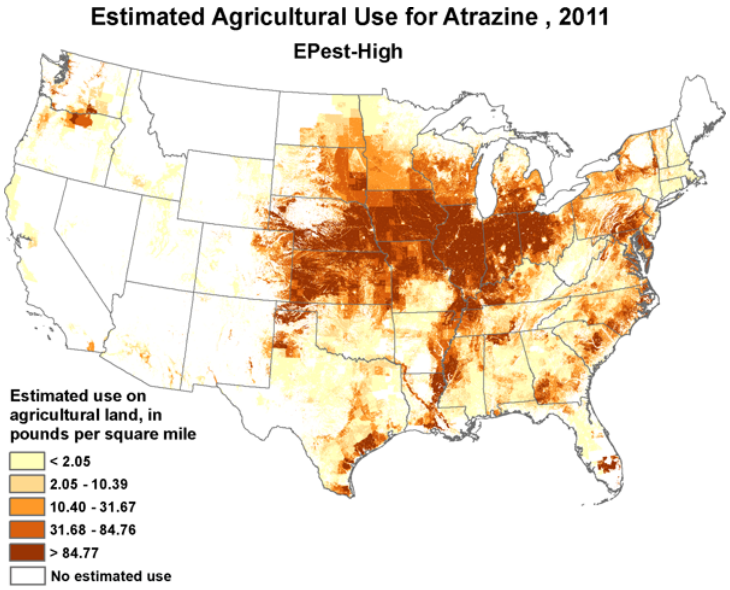
Description: Atrazine is a systemic triazine herbicide first marketed in 1958. Atrazine has four hydroxyatrazine compounds and three chlorinated atrazine compounds as metabolites. The three chlorinated metabolites are desethylated atrazine, desisopropyl atrazine, and diaminochlorotriazine. It is available in many formulations including granular, wettable

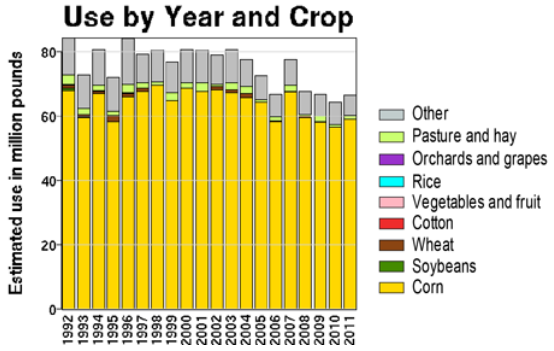
powder, water dispersible granules, emulsifiable concentrate, flowable concentrate, soluble concentrate, readyto-use solution, and water soluble packs.

Mode of Action: Like other triazine herbicides, atrazine functions by binding to certain plant proteins and disrupting normal transfers of nutrients. Plant death results from starvation and oxidative damage caused by breakdown in the electron transport process. Oxidative damage is accelerated at high light intensity

Environmental Fate: Atrazine has a low vapor pressure and is fairly soluable in water. It is relatively persistent in soil, and both atrazine and its degradation products are considered highly mobile. Atrazine is one of the most monitored chemicals due to its propensity to leach into ground and surface water.

Agricultural Use Intensity:





Source: USGS – National Pesticide Synthesis Project

Usage: Atrazine is for use on various agricultural crops with the largest use on corn, sorghum, and sugarcane. Additionally, it is registered for use on wheat, guava, macadamia nuts, and range grasses and for several nonagricultural use sites such as ornamentals, Christmas trees, and sod. There are also registered residential and recreational uses on turf

such as on parks, gold courses, schools, or home lawns and for some commercial and industrial use sites. Atrazine can also be used on roadsides, rights-of-ways, airfields, vacant lots, roadsides, lumber yards, agricultural buildings, industrial sites and storage sites.

Atrazine is most heavily used in corn and sorghum and applied primarily as a preemergent herbicide, although it may be applied postemergence in corn up to mid June during early stages of growth, and as late as August in sorghum. Atrazine is typically applied at a rate of 0.3-2.3 pounds active ingredient per acrs. For the period of 2006-201 0, usage averaged approximately 66 million pounds active ingredient for 67 million acres. Commercial non crop uses of atrazine are estimated to be between 1.5 – 2 million labs a.i. and an additional 400,000 – 500,000 lbs. in homeowner uses.

Dicamba

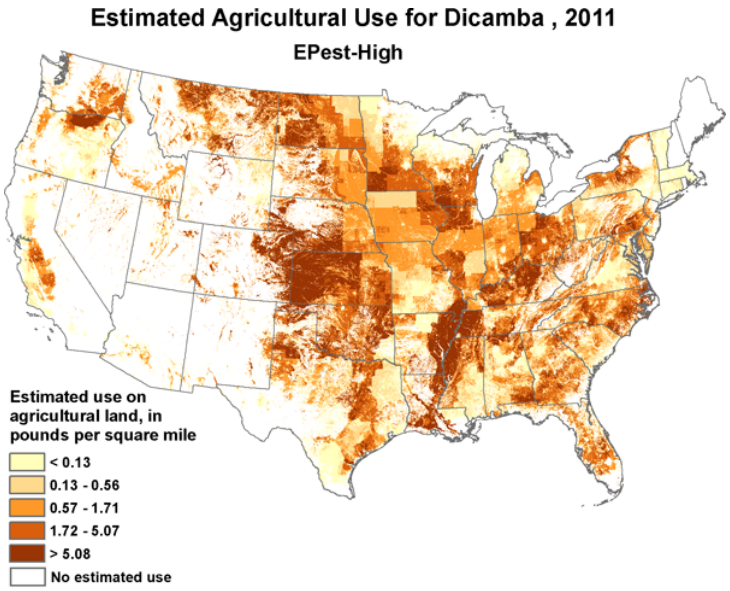
Description: Dicamba is a selective pre- and post-emergent herbicide. It is classified as either a benzoic acid or chlorophenoxy herbicide. Formulations include dicamba acid, dimethylamine salt (DMA), sodium salt, diglycoamine salt (DGA), isopropylamine salts (IPA), and potassium salt. There are 434 dicamba products formulated as liquids, wettable powders, standard granules, and water dispersible granules. Residential products are typically formulated as granular weed-and-feed formulations or as liquids in concentrates or ready-to-use sprays.

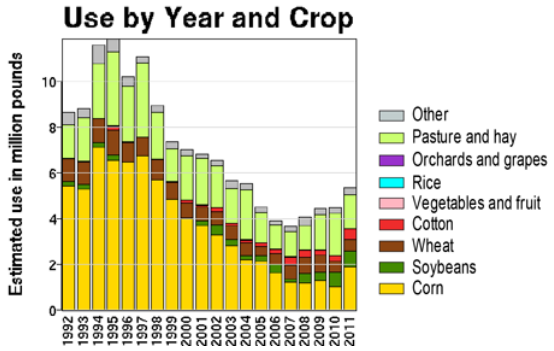
Mode of Action: Similar to 2,4-D, Dicamba is an auxin enzyme simulator and causes rapid and uncontrolled growth of the stems, petioles, and leaves of sensitive plants. This uncontrolled cell division and growth in turn results in the destruction of vascular tissue, leading to plant death. Weeds succumb in 5 to 7 days.

Environmental Fate: Microbial action promotes the degradation of dicamba in soil by a variety of processes. The half-life of in agricultural soils ranges from 30-60 days. Dicamba is considered moderately volatile under field conditions and vapor drift from treated fields is known to occur . Acid forms are the most volatile, and the inorganic salts the least.

Usage: Dicamba was first registered in the United States in 1967 and is widely used in agricultural, industrial and residential settings. Dicamba herbicide is available in aqueous formulations and is commonly mixed in tanks with other herbicides and/or fertilizers before application. In aqueous forms, dicamba is applied as a pre- and post-emergent via aerial or ground spray for control of most annual, biennial and perennial broadleaf weeds in crops. Dicamba is used to control weeds and brush in pasture, rangeland and noncropland areas such as utility, highway right-of-ways and non-irrigation ditchbanks including grazed or hayed areas. Dicamba is also used on residential turf and lawns as well as golf courses for control of weeds and other unwanted plants.

Agricultural Use Intensity:





Pesticide Use Regulation and Risk Mitigation

Pesticide formulations, marketing and use is governed by a complex, interlocking web of state and federal laws and regulations. This section provides an overview of both state and federal laws pertinent to drift prevention and risk mitigation. Civil liabilities that may attach to pesticide drift are also an element of regulation, but this report focuses on administrative and criminal sanctions and enforcement of violations of laws governing pesticide use. The section concludes with an overview of practices that help minimize potential for damaging drift incidents, including the Driftwatch system.

FIFRA and the Nebraska Pesticide Act

The Federal Insecticide, Fungicide, Rodenticide Act (FIFRA) provides for federal regulation of pesticide distribution, sale, and use. FIFRA was first passed in 1947 establishing procedures for registering pesticides with the U.S. Department of Agriculture and established labeling provisions. Originally, the law had a consumer protection focus, primarily concerned with the efficacy of pesticides and did not regulate use. In 1972, FIFRA was substantially rewritten when it was amended by the Federal Environmental Pesticide Control Act (FEPCA) including transferring administration and enforcement to the EPA. In its current form, FIFRA mandates that EPA regulate the use and sale of pesticides to protect human health and preserve the environment. The law has been amended numerous times since 1972, including significant amendments in the form of the Food Quality Protection Act (FQPA) of 1996 which established more stringent criteria for evaluating risks of pesticide residues in dietary and environmental exposures. Since the 1972 amendments, EPA is specifically authorized to strengthen the registration process by shifting the burden of proof to the chemical manufacturer that the product meets registration criteria, enforce compliance against banned and unregistered products, and to establish the necessary regulatory framework to carry out its functions.

While FIFRA provides EPA with the authority to oversee the sale and use of pesticides nationwide, it does not fully preempt state/tribal or local regulation of pesticide use. In most cases, primary enforcement of pesticide regulations is delegated to state and tribal governments under cooperative agreements whereby EPA certifies that the state or tribal government has sufficient authorities and resources to enforce regulations that meet FIFRA standards. The Nebraska Department of Agriculture has jurisdiction and assumes the lead role for most pesticide regulation in the state under the Nebraska Pesticide Act (§§2-2622 – 2-2659) enacted in 1994. The Nebraska Pesticide Act grants substantial authority to the Department to regulate the registration, transportation, storage, sales, use, and disposal of pesticides. Under the Nebraska Pesticide Act (NPA), the Department also provides for certification and licensure of those applying certain pesticides, and licenses pesticide dealers.

Key elements of pesticide regulation carried out separately and concurrently by the Department of Agriculture and EPA are described in more detail below.

Pesticide Registration

Under FIFRA Section 3, a person or company must register all new pesticides or new uses of a previously registered pesticide (with minor exceptions). Pesticides used in the United States must be registered with the EPA before it may be sold or distributed in the United States. Pesticide registration is very specific to the types of uses and target pests a particular chemical may be used for. Each registration specifies the crops or application site on which it may be applied, and each use must be supported by research data. Any proposed new uses of a registered pesticide must also go through the registration process. Ordinarily, the pesticide manufacturer files an application for registration along with extensive information to support the efficacy claims of the product and to evaluate environmental, health and safety issues surrounding the use of the product. Applicants also supply proposed product labeling containing use instructions and restrictions.

To register a pesticide, the Administrator must find the following to be true:

- its composition is such as to warrant the proposed claims for it
- its labeling and other material comply with the requirements of the Act
- when used in accordance with widespread and commonly recognized practice, it will not generally cause unreasonable adverse effects on the environment.

FIFRA defines an "unreasonable adverse effect on the environment" as "(1) any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of the pesticide, or (2) a human dietary risk from residues that result from a use of a pesticide in or on any food inconsistent with the [food pesticide residue] standards under Section 408 of the Federal Food, Drug, and Cosmetic Act."

FIFRA Section 4 provides that all registered pesticides are to be reviewed at least every 15 years and that all products registered prior to 1984 be reregistered according to current registration standards. Product reviews and reregistration takes into account new scientific information developed since the last registration pertinent to evaluating health, environmental or other risks associated with the product. This may include susceptibility of non-target crops or species to exposures and the propensity for the product to drift or volatize. The EPA may update labeling use instructions and restrictions accordingly. Reregistration Eligibility Decisions (RED) that contain the results of EPA's regulatory reviews of pesticides, are available online [http://www.epa.gov/pesticides/reregistration/status.htm].

States are also authorized to register pesticides and inert ingredients that are exempt from the requirements of registration under Section 25b of FIFRA. State registration requirements may be more stringent than EPA. Most states conduct a review of the pesticide label to ensure that it complies with federal labeling requirements and any additional state restrictions of use.

§2-2628, of the Nebraska Pesticide Act provides that no pesticide shall be distributed in this state unless it is registered with the department. The contents of state pesticide registrations are specified in §2-2629, which authorizes the Department of Agriculture to require the submission of the complete formula of a product and information supporting product claims and labeling under the federal act, and may require additional testing and evaluation to assess validity of federal registration and labeling for conditions unique or prevalent in Nebraska. Pursuant to §2-2632, the Department may deny registration, or cancel, suspend or modifiy a product's registration if the Department finds that: "*(a) the composition of the pesticide does not warrant the proposed claims made for it; (b) the pesticide, its labeling, or other materials required to be submitted do not comply with the requirements of the Pesticide Act; or (c) the*

department has reason to believe that any use of a registered pesticide is in violation of a provision of the act or is dangerous or harmful."

Labeling and Prohibited Acts

A critical aspect of registering a pesticide product is the approval of the product label. Label directions and restrictions control when and under what conditions pesticides can be applied, mixed, stored, loaded or used, when fields can be reentered after application, and when treated crops can be harvested. The labeling is designed to enable the product to be used effectively but to minimize adverse environmental externalities including avoiding harmful residues in food and the environment. Each registration specifies the crops/sites on which it may be applied, and each use must be supported by research data. Labeling may include specific outdoor application instructions regarding rate and methods of application, temporal and weather restrictions, setbacks (buffer distance from property line or non-target site) and other application instructions to minimize risks due to drift or other offsite movement of the pesticide or harm to non-target plants, animals or beneficial insects. A sample product labeling excerpt regarding drift management for Amine 400 2,4-D weed killer is attached as an appendix item.

Product labeling is both guidance to minimize unintended off target drift damage and an enforcement mechanism defining prohibited use of pesticides. Under FIFRA §136j(2)(g) it is unlawful to "*use a registered pesticide in a manner inconsistent with its labeling".* Similarly, §2-2646(4) of the Nebraska Pesticide Act defines prohibited acts to include "*to use or cause to be used a pesticide contrary to the act, to the labeling of the pesticide, or to a rule or regulation of the department limiting the use of the pesticide.* §2-2646(7) further prohibits "*to use, cause to be used, dispose, discard, or store a pesticide or pesticide container in a manner that the person knows or should know is: (a) Likely to adversely affect or cause injury to humans, the environment, vegetation, crops, livestock, wildlife, or pollinating insects; . . ."* Finally, it is a prohibited act under §2-2646(18) to "*knowingly or intentionally use, cause to be used, handle, store, or dispose of a pesticide on property without the permission of the owner or lawful tenant."*

In addition to enforcing adherence to federal label use, state pesticide use regulations may be more restrictive than those uses and application methods allowed under the federal labeled uses in other ways pursuant to authorities of the Department under NPA §2-2626. This section authorizes the Department to adopt regulations necessary to the enforcement and administration of the act, including regulations providing for:

- *(c)* l*abeling requirements of all pesticides required to be registered under provisions of the act, except that such regulations shall not impose any requirements for federally registered labels contrary to those required pursuant to the federal act;*

- *(f) Methods to be used in the application of pesticides when the Department of Agriculture finds that such regulations are necessary to carry out the purpose and intent of the Pesticide Act. Such regulations . . may relate to the time, place, manner, methods, materials, amounts, and concentrations in connection with the use of the pesticide, may restrict or prohibit use of the pesticides in designated areas during specified periods of time. . . The regulations shall encompass all reasonable factors which the department deems necessary to prevent damage or injury by drift or misapplication to (i) plants, including forage plants, or adjacent or nearby property, . . . The department may, by*

regulation, require that notice of a proposed use of a pesticide be given to landowners whose property is adjacent to the property to be treated or in the immediate vicinity thereof if the department finds that such notice is necessary to carry out the purpose of the act;

- *(g) State-limited-use pesticides for the state or for designated areas in the state*

State limited use pesticides may be designated by the Department if the director determines that a particular pesticide, "*when used in accordance with its directions for use, warnings, and cautions and for uses for which it is registered, may without additional regulatory restrictions cause unreasonable adverse effects on humans or the environment"* or "*that the pesticide requires additional restrictions to meet the requirements of the Pesticide Act, the federal act, or any plan adopted under the Pesticide Act or the federal act."* For such pesticides, the Department may develop a pesticide management plan to implement strategies to prevent, monitor and mitigate unreasonable adverse impacts from use of the pesticide. While the authority to designate state limited use pesticides and to impose additional restrictions on use via regulation is traditionally associated with concerns regarding water quality, the NPA was amended in 2006 to enable state limited use pesticides to be declared for adverse environmental problems other than water impairment -- for example if use of the pesticide were shown to have a clear relationship to the decline of a species. It is unlikely that state limited-use would be declared for active ingredients or specific commercial products due to economic impacts of drift potential alone. That issue would be more directly amenable through regulations pursuant to subsection (4)(f) of §2-2626 cited above.

Restricted Use Classification

Pesticides, or specific uses of a pesticide, are classified as either unclassified (general use) or for "restricted use". A product, or certain uses of a product, are restricted to application by certified applicators with knowledge and training to apply the pesticide safely if labeling alone is deemed insufficient to mitigate environmental risks and risks to those who apply or handle the product. In some cases, all the uses of a particular formulation may be restricted, in other cases all uses are unclassified, and in some products may have a combination of restricted and general uses. Notification of restricted use classification must be provided on the front panel. In addition to limiting use to certified applicators, products may be restricted with respect to limitations on who may possess, sell or purchase certain products.

Applicator Licensure and Certification

EPA regulations require that applicators of restricted use pesticides be certified by national standards. Certification programs conducted by states or tribal governments must be in accordance with these national standards. Training of certified applicators covers safe pesticide use as well as environmental issues such as endangered species and water quality protection. EPA provides cost sharing through cooperative agreements to assist states and tribes in conducting certification and training programs. EPA provides applicator training workshops and materials, including training materials for improving pesticide drift management and application technology.

§2-2636 prohibits using a restricted-use pesticide unless licensed, as well as requiring licensure for commercial application of certain general use pesticides. The NPA currently provides for three types of applicator licenses:

Commercial applicator – an individual applying restricted-use pesticides on property belonging to another for hire or compensation, or applying lawn care or structural pest control pesticides for hire on property not belonging to the applicator regardless of whether the pestide is restricted-use.

Non-commercial applicator -- An individual who is not a commercial applicator who uses restricted-use pesticides only on property owned by his or her employer, or for a federal or state agency or political subdivision. Any person applying outdoor vector control pesticides on behalf of a political subdivision is also required to be licensed as a non-commercial applicator unless already licensed as commercial applicator .

Private Applicator – An individual applying or supervising application of restricted-use pesticide for agricultural purposes on land owned or rented by the applicator or his/her employer.

Department of Agriculture Regulations at Title 25, Chapter 2 (005) set forth standards for certified applicators. Section 005.01 enumerates general standards applicable to all applicator certifications, and include determination of competency in the following areas pertinent to this discussion:

005.01A Label and Labeling Comprehension

005.01A(2) The understanding of instructions, directions for use, warnings, terms, names, symbols, and other information commonly appearing on pesticide labels;

005.01A(4) Necessity for use consistent with the label. Labels and labeling are legal documents and the directions they contain shall be followed.

005.01C Environmental Risk. The potential environmental consequences of the use and misuse of pesticides that may cause drift and runoff precautions for protection of endangered and threatened species, and methods of spill prevention and control. Such consequences may be influenced by such factors as:

005.01C(1) Weather and other climatic factors that contribute to pesticide drift and run off;

005.01C(3) Recognition of sensitive areas, fish, wildlife and other nontarget organisms affected by pesticide applications, drift and runoff;

005.01G Application techniques. Factors including:

005.01G(1) Methods used to apply various formulations of pesticides, solutions, and gases, together with a knowledge of which technique of application to use in a given situation;

005.01G(2) Relationship of discharge and placement of pesticides to proper use, unnecessary use, and misuse; and

005.01G(3) Prevention of drift and pesticide loss into the environment, including the concept of vapor drift of volatile pesticide formulations.

005.01I Applicator related laws and regulations.

005.01I(2) Applicator responsibility for pesticide use consistent with its label or labeling and supervision of noncertified employees assigned to use a restricted-use pesticide.

005.01I(3) Applicator liability and penalties.

Because risks and efficacy of products may vary according to the purpose and setting of their use, restricted use pesticides products are additionally registered for use in one or more categories with labeling instructions specific to each use category, and limited to application by commercial applicators certified in the corresponding use category or subcategory. These use categories, listed in 40 CRF 171.3, include agricultural, forestry, ornamental and turf, seed treatment, aquatic, right-of-way, industrial, institutional, structural and health related, public health, regulatory, and demonstration/research. Commercial applicators may be certified in one or more category, and certification requires demonstration of knowledge and competence in label comprehension, and understanding pests, risks and risk mitigation for pesticide use generally and as specific to each certification category or subcategory. States may provide for additional subcategories within these ten categories or apply to EPA to add additional major categories. Parallel authority authorizing the Department of Agriculture to define certification categories is found in NPA §2-2537. Currently, there are 13 major categories of commercial applicator certification, with a handful of subcategories. A relevant departure from the certification categories listed in federal regulations is that Nebraska designates aerial pest control as a unique category specific to aerial application of pesticide products.

Certification of applicators is intended to assure that those using pesticides have a fundamental understanding of how to do so safely, and thus pesticide applicator certification is an important foundation for the safe and effective use of pesticides. §2-1637 directs that separate testing requirements for certification and licensing in each category be established and authorizes separate testing requirements in subcategories within a category. UNL's Cooperative Extension Service is designated to conduct training programs for the three types of licensure with such programs "*directed toward a thorough comprehension and knowledge on the safe use of restricted-use pesticides.*"

To become certified as a commercial or non-commercial applicator, an individual must achieve a minimum score on both a general standards exam and at least one specific category exam. The general category exam addresses core principles common to all applicators, while the category exams address information and material specific to that category. For private applicator certification, an individual must complete a private applicator training program or a self-study program supervised by the Cooperative Extension Service, or pass a private applicator exam administered by the Department of Agriculture. Both private and commercial applicators are required to recertify or renew licensure every three years.

As discussed later in this section, pesticide drift management is an area of increased emphasis in both product labeling and certification training, and in voluntary programs by which EPA works with pesticide makers to measure and verify drift parameters, and to develop application technologies and product formulations to reduce drift potential. The reader is encouraged to review the third appendix entry which is a response by Clyde Ogg, Pesticide Safety Extension Educator to an inquiry on behalf of the task force regarding incorporation of drift mitigation in certification training and competency testing. Other educational and outreach activities of the Extension's pesticide education program, including the Herbicide Stewardship and Drift Prevention webpage, may be viewed online: http://pested.unl.edu/psephome.

Drift Incident Enforcement

The Department of Agriculture enforces the act through routine inspections and complaint investigations, including investigations initiated in response to credible anonymous tips. Both EPA under FIFRA and the Department of Agriculture under the NPA have authorities to impose license revocation, suspension or probation, and administrative fines, and when warranted, to seek civil remedies or criminal penalties for violations of FIFRA or the NPA.

The Department relies on public reporting of drift incidents. A formal complaint of a potential violation including a drift incident that may indicate a labeling noncompliance or violations of specific prohibitions pertaining to use of pesticides as described previously, is submitted by contacting the Department by telephone or in writing. The Department assigns an inspector who will visit the site and interview the person submitting the complaint. NDA pesticide inspectors are specifically required to collect evidence in the form of documents, physical samples, and written statements to support inspections or complaint investigations. Examination of damaged plants and analysis of samples to confirm pesticide damage and identify the specific active ingredient or ingredients present may be performed. The inspector may act upon information provided by the complainant or other witnesses to help determine when and where offending applications may have occurred, and interview applicators and review appropriate applicator records in the effort to build evidence linking a particular pesticide application with confirmed drift damages. The inspectors narrative of his/her investigative steps, facts uncovered and supporting documentation is provided as a case report to the pesticide program manager and NDA Case Review Officers. It is at this point that it is determined whether sufficient evidence is available to show that violations of the Nebraska Pesticide Act have occurred and to identify the responsible party.

Civil Liability

The Nebraska Pesticide Act does not provide a mechanism for those damaged by pesticide drift incidents to be compensated. Department of Agriculture inspectors only estimate damage for purposes of calculating fines and other criminal and administrative actions. However, information compiled in the case report and finding of violations may be helpful in pursuing private civil remedies a complainant might pursue.

Drift Management

In its introduction to pesticide drift, EPA estimates up to seventy million pounds of pesticide active ingredients are wasted to drift annually and up to 10% of agricultural pesticide sprays miss or move from the target application site [http://www2.epa.gov/reducing-pesticide-drift/introduction-pesticide-drift]. Substantial government resources are spent investigating and prosecuting drift incidents. Drift incidents disrupt rapport among neighbors, can result in liability for damage to neighboring crops, property and health, and invite new use restrictions and regulations along with associated costs and inconvenience. Thus, there is considerable value and incentive to avoid drift.

As identified previously, there are two primary types of drift, spray drift or vapor drift , i.e. volatilization. Spray drift is the airborne movement of herbicide particles to non-target sites during application. Vapor drift is the evaporation of herbicide particles from plant and other surfaces during and after application and movement as a gas or vapor to the non-target site in sufficient concentration to affect plant processes. Pesticides can volatilize into a gas for some time up to days after application. Vapor drift from a legal pesticide application is sometimes difficult to predict. It depends on factors like what the weather will be even days after the application. Some pesticide products evaporate more easily than others, as do some different formulations of the same pesticide. For example, 2,4-D esters are considered highly volatile, while 2,4-D amines are considerably less volatile although both may drift as droplets or dry particles. Volatized herbicides may drift farther and over a longer time than spray droplets.

Drift management directions are typically an integral component of product labeling. Section 2 beginning on page 5 of the example label for the Amine 400 2,4-D weed killer product included with the appendix items is devoted to application instructions for spray drift management for both particle drift and volatilization

Drift Factors

Drift can occur in all forms of pesticide application, aerial, ground, or irrigation system. The amount and propensity for drift and drift impacts is influenced by factors that can be placed within the following categories:

- Weather
- Product formulation and spray solution characteristics
- Application equipment
- Applicator/landowner decisions

Weather

Wind Speed – Wind speed is the most important factor influencing drift. Measurements of drift have shown that the amount of drift detected 90 feet downwind of a sprayer increases 75% for a doubling of wind speed. Drift potential is lowest at wind speeds of 3 – 10 mph.

Wind Direction – It is an obvious recommendation to avoid spraying when sensitive areas are downwind. Buffer zones may need to be increased and less fine spray size used if unfavorable wind direction cannot be avoided.

Air Temperature and Humidity – Increased rates of volatility occur when high temperatures and low humidity follow application. Hot and dry conditions reduce droplet size through

evaporation and thereby increase drift potential. Small droplet sizes of 50 µm and less may completely evaporate and evaporation of droplet sizes between 50 and 200 µm is significantly affected by temperature and humidity.

Temperature Inversions – A temperature, or thermal, inversion is a condition caused when warmer air above traps cooler air located near the ground, which can be readily observed if dust or smoke appears to hover low to the ground without dissipating. Stagnant or very calm winds limit the mixing of air and allow inversions to persist. Thermal inversions occur naturally and are part of the daily atmospheric cycle, often occurring early in the morning and in the evening. Drift that occurs over long distances is most often the result of applications when air temperatures during application are sufficient to cause evaporation but persistent thermal inversions trap the resulting vapor.

Product Formulation and Spray Characteristics

Droplet Size – Drift is heavily affected by droplet size. Smaller droplet have smaller mass and remain airborne and exposed to air movement longer than larger droplets. The larger the droplet, the faster it will reach its target. The distance that a droplet will travel downwind is a function of the height of release and wind speed and is inversely proportional to its terminal velocity. Larger droplets will fall faster and be less exposed to wind and lose less mass to evaporation. The higher a droplet of any given size is released and the stronger the wind, the greater the chance that a droplet will travel downwind and drift. Droplets that are smaller than 150 µm are considered drift-prone. Adjusting boom height lower for smaller droplet size can partially compensate. There is a tradeoff with droplet size and coverage. The volume of a droplet increases eight fold when its diameter is doubled and larger droplet sizes concentrate application in fewer more dispersed locations. For some types of contact pesticides, insecticides and fungicides for example, maximum coverage is essential. Systemic herbicides can more often work in larger drop sizes since coverage is not as critical. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control.

Product Formulation – Some products are formulated to have higher viscosity. Droplet size and uniformity of droplets produced tends to increase with the viscosity of the spray solution.

A herbicide's potential to volatize, i.e. evaporate, is related to the chemical and physical properties of the herbicide, primarily its vapor pressure. Certain ester formulations of 2,4-D have long been discontinued due to their pronounced susceptibility to volatility. A study of Dicamba volatility in Iowa in 2001 when high impacts to soybeans were observed, found that sodium salt formulations applied to corn resulted in less damage to nearby soybeans due to volatility drift in both greenhouse and field settings while dimethaylamine formulations were associated with higher damage. Also, both volatility and spray drift damage potential varies by commercial product simply due to the concentration of active ingredient applied in the final tank mix. In the 2001 study, it was concluded that the amount of product moving off-site due to volatilization was proportional to the concentration of active ingredient applied.

Application Equipment

Nozzle Selection – Recent advances in nozzle design and technology are intended to reduce drift by eliminating variation in droplet size. The term, volume median diameter

(VMD), is used to indicate the median droplet size of a volume of spray from a nozzle. Thus, A VMD of 400 µm means that half the volume of spray will be droplets that have a diameter of less than 400 µm, and the other half of the volume of spray will be droplets larger than 400 µm. Because smaller droplets have much less volume than larger droplets, most of the droplets will be smaller than the VMD and thus a significant portion of the spray volume will be dispensed in droplet size more susceptible to drift. Several different designs commonly referred to as air-induction or venturi nozzles are currently being marketed. The design reduces pressure at the exit point, allowing larger more uniform droplets to reduce drift significantly.

Spray height - The volume of drift detected from identical amounts of product applied is affect by the boom height. The closer to the target surface, i.e. plant canopy, the less distance the droplets must fall to be intercepted by the canopy, and less opportunity for spray particles to be affected by wind. Lower boom heights take advantage of lower wind speeds closer to the surface. Even relatively small increases in spray height can greatly increase the amount of drift detected downwind.

Spray pressure – In general, higher pressures will produce more fine droplets susceptible to drift. Nozzle tips have been designed to produce more course droplets at a given pressure compared to older nozzle designs. Avoiding additional pressure to achieve greater coverage and penetration or output volume. Coverage should be achieved where possible through larger carrier volumes applied at lower groundspeeds. Lower application speeds also reduce air movements caused by the application equipment itself that can produce drift and reduce fluctuations in boom height caused by jiggling while going over rough ground.

Shielded sprayers – Shield attachments are available for several types of ground applications that have been shown to significantly reduce drift. Shields may also help optimize the proportion of the spray volume directed to and reaching the intended receiving surface, thus potentially reducing the volume of active ingredient and tank mix needed to be sprayed over a given area reducing the amount of spray available for drift.

Applicator/Landowner Decisions

Ultimately, drift prevention relies on the applicator to recognize conditions, to be aware of sensitive areas near application sites, to be up to date with knowledge of products and equipment, and to exercise sound judgment regarding weather and other conditions relative to each application.

Apart from careful and competent application of pesticides, landowner planning and stewardship decisions can be a factor in minimizing potential for drift incidents. Direct communications with neighboring property owners can often lead to understandings and insights that help inform pesticide application decisions. Knowing your neighbor's intentions and they in turn knowing the landowner's application intentions can enable both landowners to adopt strategies such as the location and timing crops, establishment of buffer zones, vegetation plantings etc. that help avoid drift occurring or causing damage. Landowners may also consider incorporating integrated weed management strategies to avoid relying entirely on chemical management of weeds such as disrupt weed cycles with crop rotations and cover cropping and using mixing mechanical and biological controls

EPA Drift Reduction Technologies (DRT) Program

On October 21 of this year, EPA announced a new voluntary Drift Reduction Technology (DRT) program to encourage the development and use of pesticide products and application technologies and equipment to reduce pesticide movement during and after application. Under this program, manufacturers are encouraged to test their technologies (such as nozzles, spray shields and drift reduction chemicals) for drift reduction potential verifiable by standards set by EPA. Spray technology manufacturers interested in participating in EPA's DRT program may now submit data verifying their technology reduces pesticide movement compared to standard practices. EPA will evaluate each data submission and, if appropriate, assign a drift-reduction star rating to the product based on its ability to reduce spray drift.

Additionally, under the DRT initiative, EPA will be encouraging pesticide manufacturers to label their products for use with DRT technologies. The four DRT ratings represented by one, two, three or four stars are awarded for technologies that demonstrate at least 25 percent reduction in potential spray drift compared to the current industry standard. Pesticide registration applicants can choose to label their products for use with both standard application equipment (non-DRT) and DRT-rated equipment or technologies, thus giving the applicator a choice. In this case, labels would have two sets of application restrictions, one set of instructions if the product is applied without DRT, and another set if the product is applied using a DRT rated methodology.

DriftWatch

An important public sector supported but voluntary initiative to promote and facilitate awareness of sensitive crop locations and to promote communication and cooperation between applicators and landowners who utilize pesticides and their neighbors is the Driftwatch system.

DriftWatch is an interactive web portal tool designed at Purdue University. It is now operated by FieldWatch, Inc, a non-profit company created by Purdue in collaboration with interested agricultural stakeholder groups. The DriftWatch tool is designed to enable pesticide applicators and specialty crop growers to communicate more effectively to promote awareness and stewardship activities to prevent and manage drift. DriftWatch provides a central location for sensitive site owners to register those sites and have them depicted geographically with linked owner contact information. The data set is overseen by state-appointed stewards who verify each area submitted to the registry. The Nebraska Department of Agriculture is a subscriber to the service and steward of data by Nebraska users. DriftWatch is free to users. As a non-profit, FieldWatch relies on subscriber revenue, donations and sponsors to maintain the product and web presence.

Driftwatch registry is available only to those raising crops commercially. In Nebraska, the Department of Agriculture supports registration for the following outdoor crops: grapes, fruits, vegetables, beehives, greenhouse, nursery crops, orchards, fish farms, seed crops, cut flowers, woody florals, hops, certain nonherbicide resistant crops. Certified organic crops, including alfalfa, pasture and native prarie are eligible if part of a commercial operation.

Following is a summary provided by the Department of the participation data maintained in DriftWatch for the state, and web site usage data provided by FieldWatch. Since Driftwatch registration is voluntary, not all sensitive locations or acres participate, but this data does

provide an indicator of the numbers and types of sensitive locations, and the importance owners of these sites attach to making their neighbors and applicators aware of them. Readers may consult the Driftwatch Map webpage [https://ne.driftwatch.org/map] to view a map of the state with geographic placement of sensitive site locations. The system allows for layering of geographic data so that individual sensitive crop or sites may be viewed individually.

Sensitive Site Driftwatch Registrations for Nebraska

(acres by crop type as of 8/29/14)

Crop Type	Number of Sites or Fields	Acres
Beehives	71	*
Fish Farm	3	1.6
Fruits	41	186.0
Grapes	140	989.0
Greenhouse - High Tunnel	16	39.0
Nursery Crops	20	190.5
Orchard	34	336.1
Other**	279	39,056.4
Vegetables	74	987.8
Grand Total	**678**	**41,786.3**

*Acres are not tracked for beehives, only the number of locations. **The "Other" category includes certified organic crops that either don't meet any of the other crop type categories, or were not identified as such by the grower.

Table 2. A summary of the types of participants in DriftWatch as of 8/29/14.

Participant	Count
Approved Growers	329 (4)*
Registered Applicators**	156 (9)*

*Numbers in parentheses are registered users who have also become voluntary members of FieldWatch, the parent company of DriftWatch. More information on membership can be found at **www.FieldWatch.com**.
** includes several individuals who may not be pesticide applicators, but who want to stay informed of grower activity in specific areas, including NDA and University Extension personnel (~ 8 people).

A comparison of Nebraska Driftwatch web traffic for 2012, 2013, and 2014.

Note: Prior to March 2013, Driftwatch was maintained by Purdue University. The 2012 data shown here are from March to approximately the end of November; the 2013 data are from April through December; the 2014 data are from the beginning of the year to 8/28/14.

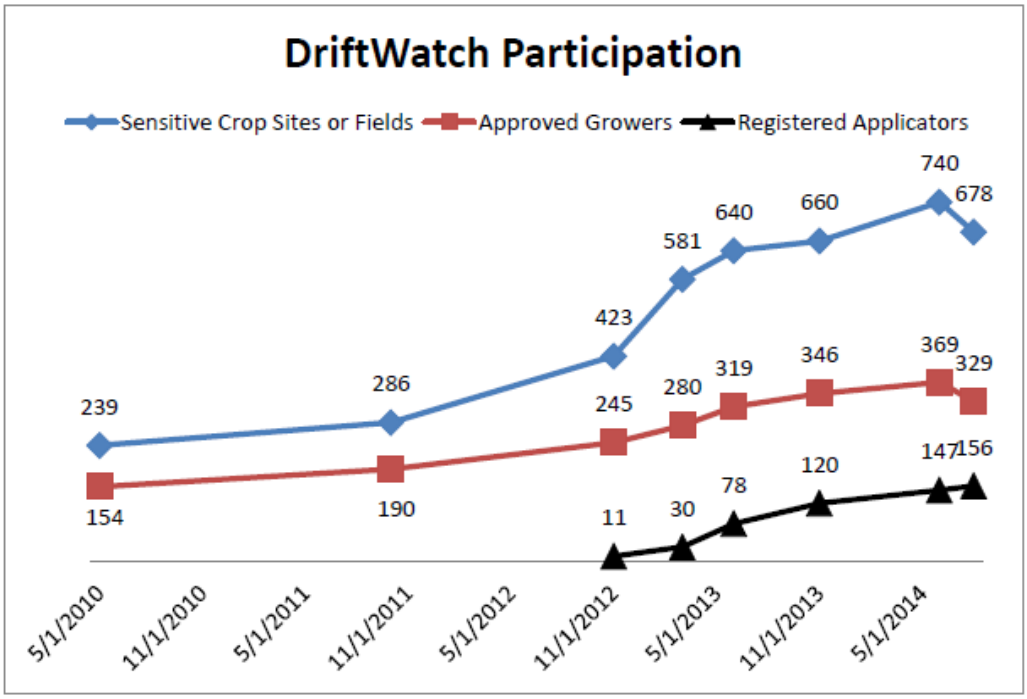


Figure 1. A comparison of DriftWatch participation through time, beginning with the Pesticide Sensitive Crop Locater, Nebraska's version prior to joining DriftWatch.

Note: A dropoff in growers and fields occurred in June 2014 when FieldWatch deleted original members who had not renewed for 2014. Many people have since updated their info and are included in the most recent counts, but there is still an overall decline in 2014.

Task Force Recommendations

- **Fostering increased communication and cooperation between landowners, between various segments of the agricultural community, and between the agricultural community and non-agricultural sectors, including but not necessarily limited to improvements in the functionality and utilization of the Driftwatch system**.

1. Add Driftwatch consultation verification to application recordkeeping requirement for private and commercial/non commercial applicators.

   Nebraska Department of Agriculture regulations at Title 25, Chapter 2, Section 006 of the Nebraska Administrative Code provide for minimal recordkeeping for applications of restricted use pesticide (and in some cases, general use pesticides) by private, commercial and non-commercial applicators. These requirements include a record of the location and size of application site, the date of application, identification of product(s) applied, wind and temperature observations, target pests, and other information. Other than temperature and windspeed, current recordkeeping requirements do not require any notation to be made of other site specific constraints or considerations such as nearby sensitive sites, although such could be included in comment or applicator notes at the discretion of the applicator.

   Driftwatch provides a convenient means for applicators to determine locations of registered sensitive sites within the vicinity of a pesticide application. Regular consultation of Driftwatch by applicators and awareness of sensitive crop locations could be promoted by expanding recordkeeping requirements to include notation of registered sites within a given radius or other defined geographic proximity of the application site (e.g. on the same or adjacent sections). Recording documents could provide for sensitive site information to be entered manually or a printout of the map at the appropriate resolution could be attached. The record could include space for applicator's notes regarding any mitigating actions, e.g. product choice, application method, change of application time, consultation with sensitive site owner, etc., taken by applicator to reduce potential for drift damage.

2. Provide that verified prior Driftwatch consultation by applicators is a mitigating factor in determining fines and penalties imposed by the Department for damages related to drift incidents, or conversely, that failure to consult is an aggravating factor.

   The Department of Agriculture's regulations at Title 25, Chapter 2, Section 007 set forth rules for determining administrative fines for violations of the act, including for damages arising from pesticide drift incidents. The regulations provide for a base fine for first and subsequent violations adjusted by gravity factors that take into account the severity of actual and potential damages, and the degree that violations result from applicator misconduct.

   This recommendation would complement Recommendation 1 under this category regarding applicator recordkeeping to include notation of Driftwatch registered sensitive sites in the vicinity of the application site and notation of applicator mitigations. This recommendation both serves to stimulate regular consultation of

Driftwatch and provide practical value in doing so. Inquiry should be made to Fieldwatch to determine if some method of date stamping of inquiries could be provided to verify consultation of Driftwatch prior to application or printouts of Driftwatch maps attached to application records with printer software that includes a printout date. The task force further recommends that Fieldwatch be consulted as to the feasibility of incorporating a Driftwatch gis map screenshot of sensitive crop/site locations in appropriate resolution in recordkeeping software, e.g. UNL's PeRK mobile app for creating applicator records.

3. Product manufacturers should consider voluntarily adding notification on product labels that Driftwatch is available in participating states with recommendations that it should be consulted and/or subscribed to by applicators. EPA should consider including Driftwatch availability and consultation as a labeling addition.

   The recommendation is offered as a means to enhance the awareness of Driftwatch for users of all labeled pesticide products, not necessarily limited to applicators of restricted use products. It is intended that EPA consider the availability of Driftwatch in applicable states as a mandatory notification printed on the label although EPA may consider Driftwatch consultation, where available, as a labeling instruction.

- **Public education and outreach projects and critical audiences for such outreach efforts.**

1. Pesticide product user trade groups should continue and expand efforts to educate members regarding awareness of specialty/sensitive crops in the landscape.

   The Task Force is aware that trade groups representing product manufacturers, retailers, applicators and end users have engaged in efforts to provide membership training and information regarding the growing presence of specialty/sensitive crops increasingly encountered and the need to employ sound judgment and careful planning to use and apply products responsibly. The Task Force recommends that such groups continue and intensify these efforts through committed efforts to include programming at annual meetings/conventions, and newsletters and other internal communications utilization of educational material developed by the UNL Extension Pesticide Safety Program, the Department of Agriculture and specialty crop sources. The Task Force urges such groups to periodically include programming to update membership on new product formulations, spray equipment and methodologies, integrated pest management strategies, etc. available to minimize drift incident impacts to specialty/sensitive crops. The Task Force further urges that such associations invite specialty/sensitive crop growers to provide input regarding the vulnerabilities of specialty/sensitive crops.

2. Product manufacturers, the Department of Agriculture, and Extension programming should specifically identify preferred product formulations and application methods for use in the vicinity of specialty/sensitive crops.

   The Task Force recognizes that Extension programming and certification training often emphasizes utilization of products less prone to volatization and spray drift and use of application methods and spraying equipment that help prevent off-site

migration of applied pesticide products. The Task Force Recommends that the Department of Agriculture, in cooperation with manufacturers, provide a listing of recommended products and application methods through its website and in industry advisories. The Department should seek to keep regulated applicators informed of Drift Reduction Technology rated products and to recommend their use in the vicinity of specialty/sensitive crops.

- **Means of supporting crop and land management and application best practices to reduce the likelihood of off treatment area damage and economic impacts of weed and pest management applications. These may include, but not necessarily limited to, physical barriers to drift, buffer area separations, application timing, selection of product formulations and drift retardants, integrated pest management and other similar concepts.**

1. The University of Nebraska should explore the feasibility of developing tools for locating new specialty/sensitive crop locations for herbicide drift avoidance and to inform landowner/applicator decisions to minimize drift footprints.

   This recommendation is conceptually based upon the Odor Footprint Tool developed by the University of Nebraska and its applications as a planning resource for use in evaluating the potential odor impact of new and expanded animal production facilities. The tool enables a geographic visualization of odor dispersal based on weather, topography and livestock operation characteristics, as well as enabling evaluation of reduction of odor impacts by incorporating odor suppression technologies and strategies. The tool can help optimize location of CAFO's to minimize potential for off-site odor intrusion, and guide investment in odor mitigation.

   The Task Force would ask the University of Nebraska to explore whether a similar tool could be developed and made available to assist those seeking to establish new, or expand existing, sensitive crop production locations. A drift footprint tool similar to the Odor Footprint Tool would help evaluate potential and potential frequency and severity for herbicide drift impacts to sensitive crops to occur at a given location. An additional utility of such a tool would be to enable existing specialty/sensitive crop producers, conventional agland owners/operators and applicators evaluate the efficacy of alternative drift mitigations such as use of alternative products, timing and methods of application, increased buffers, cropping rotations and other integrated weed management, etc.. The availability of a drift footprint tool could provide a means to facilitate solutions between neighboring landowners.

2. Resistance management should be a more prominent element of pesticide product registration and approval of crops with herbicide tolerant genetics

   The problem of resistant weeds directly and indirectly impacts the environment for specialty/sensitive crop growers. Overreliance on a single herbicide product or single mode of action, as well as reliance on herbicides exclusively for pest management, creates selective pressure that accelerates evolved tolerance of weeds to pesticide products. This can lead to increased rates of application of products that lose efficacy over time and additional applications of older products that can be more challenging to specialty/sensitive crops. The Task Force is

encouraged by federal agency approvals of the Dow Enlist herbicide and companion seed genetics that place additional emphasis on resistance management as an element of pest control stewardship made available by that product. The Task Force encourages product manufacturers and users to utilize alternative products with the goal of extending and restoring where possible use of newer generation herbicides with less volatility, toxicity, environmental residency, and efficacy at lower rates of application and less frequent applications.

3. The Agriculture Committee should explore the value and feasibility of creating a program modeled after the Buffer Strip Program to enlist landowners in the vicinity of specialty/sensitive crops experiencing frequent drift problems in adopting drift/volatility avoidance and integrated management practices.

   The Buffer Strip Program which compensates landowners for the environmental services provided by placing land in adjacent to streams and other waters under vegetative covers and other management practices as a means to filter runoff water entering waterways. The Task Force believes that a similar program, targeted to enlist and compensate landowners in the vicinity of specialty/sensitive crops with repeated damage for adopting integrated pest management, enhanced buffers, and pesticide stewardship practices may achieve similar results.

4. State Agencies and Political Subdivisions should be required to develop and follow spray policies for pesticide applications in the vicinity of specialty/sensitive crops.

   A number of state agencies and local subdivisions utilize pesticide products in the management of rights-of-way and other public lands and spaces. The Task Force recommends that each such agency or political subdivision develop guidelines for its employees or hired applicators for herbicide applications in the vicinity of specialty/sensitive crop locations. Such policy should include elements of identification of sensitive sites, consultation with site owners or managers and notification of upcoming spraying activities, and selection of products and application methods and timing to minimize potential for damage.

- **Applicator certification training and improvements in such training that would improve applicator awareness of issues presented by sensitive crops in the vicinity of treatment sites and best management practices to avoid off target impacts.**

  1.

- **Miscellaneous**

  1. The Agriculture Committee should conduct an interim study to investigate whether alternative models for compensating specialty/sensitive crop growers incurring drift damages, e.g. indemnity fund, are feasible and practical, and whether they would improve upon existing means for compensating specialty/sensitive crop growers for losses due to drift incidents.

The Task Force recognizes that it is not an objective to eliminate or restrict the availability of important pest management products utilized in agriculture and other land stewardship purposes. The first objective is improved protocols and awareness to avoid the occurrence of conflict between use of pest mitigation products and specialty/sensitive crop production. However, the Task Force further recognizes that continued growth in the specialty crop sector requires a degree confidence that considerable investments to establish diversified crops, to meet the expectations of end markets and to acquire certifications depends on entrepreneurs in the specialty crop sector having confidence that their investments will not be lost due to pesticide drift damage. Because is often difficult to identify the source of drift damage that has occurred and that even where a responsible party is known, recovery of damages is time consuming, legally complex and uncertain, the task force have expressed a need to explore alternative models for compensate for pesticide drift damage. The Task Force recommends that the Agriculture Committee investigate the types of indemnity alternatives that may exist, whether such would provide improved protection for specialty crop growers, and evaluation of feasibility and utility.

Appendix

Summary of pesticide drift incidents for calendar year 2011-2014

In calendar year 2011, NDA investigated 10 complaints which involved alleged drift onto a sensitive crop or site. One involved an actual vineyard (another involved a hobby farm), one involved commercial wildflowers, one involved a tree nursery, one involved a commercial tree fruit orchard, four involved organic farming, and one involved commercial vegetables. The commercial vineyard complaint found both 2,4-D and glyphosate in the grape leaves, but no nearby 2,4-D application could be found. The vineyard grower had applied glyphosate over the vines as a pre-bud break treatment.

In calendar year 2012, NDA investigated eight complaints which involved alleged drift onto a sensitive crop or site. Six involved grapes, one involved commercial vegetables and one involved commercial bees. The vineyard complaints all had some impact by either 2,4-D or glyphosate, normally both, with the glyphosate typically being applied by the vineyard grower over the row in the spring.

In calendar year 2013, NDA investigated 10 complaints which involved alleged drift onto a sensitive crop or site. One involved a grower of native forb species for seed production, one involved an organic farming operation, two involved commercial vegetables, and six involved vineyards. The six vineyard complaints all involved drift of 2,4-D and glyphosate, with one of them also involving non-crop herbicides applied to an irrigation canal. Again, at three of the vineyards glyphosate was found applied over the vine row in the spring. Only one of the 10 complaints did not involve 2,4-D in some way.

The current calendar year (2014) as of August 25, has resulted in 10 complaints claiming herbicide or pesticide exposure to a sensitive site or crop. One case was determined to be frivolous in nature and one was found to be due to excessive temperatures causing physiologic leaf roll in tomatoes. Five cases involved grapes, one was a commercial fruit orchard, one was a commercial tree nursery and one involved an organic crop. Most of the cases have been fully investigated, but are still in case review and pending enforcement action.

Table of complaints begins on the following page.

Glossary of acronyms used in the table:

AL = advisory letter, WL = warning letter, R-O-W = right of way

Chemical ingredients referenced: 2,4-D is the active ingredient in hundreds of products with many different trade names. Glyphosate is the active ingredient in herbicides such as Roundup, Glystar and Durango. Atrazine is the active ingredient in herbicides such as Aatrex 4L. Acetochlor is the active ingredient in herbicides such as Harness. Dicamba is the active ingredient in herbicides such as Banvel. Picloram is the active ingredient in herbicides such as Tordon and Grazon. Glufosinate is the active ingredient in herbicides such as Liberty and Ignite. Tembotrione is the active ingredient in Laudis herbicide. Saflufenacil is the active ingredient in herbicides such as Sharpen, and Verdict. Dimethenamid is the active ingredient in herbicides such as Guardsman Max and Verdict. Sulfentrazone is the active ingredient in herbicides such as Authority, Sonic and Spartan. Diuron is the active ingredient in herbicides such as Direx, Karmex and Sahara. Fomesafen is the active ingredient in herbicides such as Flexstar and Reflex. Clethodim is the active ingredient in herbicides such as Poast and Arrow. Imazethapyr is the active ingredient in herbicides such as Pursuit and Optill.

Date	Target Site (Source)	Sensitive Crop	Herbicides	Enforcement Response
5/18/11	Field corn, ground application	Tree nursery	2,4-D, atrazine, acetochlor	WL
5/18/11	Field corn, ground application	Hobby grapes	2,4-D	WL
5/24/11	Field corn, ground application	Commercial vegetables	2,4-D	No action possible
5/26/11	Field corn, ground application	Wildflower seed production	2,4-D, glyphosate	WL
6/14/11	2,4-D source not found	Grapes	2,4-D, glyphosate	No action possible
6/21/11	Soybeans, ground application	Fruit orchard	Glyphosate	WL
6/24/11	R-O-W ground application	Organic crops	Glyphosate	WL
6/29/11	Field corn, ground application	Organic alfalfa	2,4-D, dicamba, glyphosate	WL
7/6/11	Pasture by aircraft and R-O-W by ground application	Organic crops	2,4-D, picloram	Two WLs
9/7/11	Source not found	Organic crops	2,4-D	No action possible

Date	Target Site (Source)	Sensitive Crop	Herbicides	Enforcement Response
4/27/12	Suspected soybeans by aerial application	Hobby bees	No residues found	No action
5/15/12	Field corn and R-O-W, ground applications	Grapes	2,4-D, glyphosate	WL to R-O-W applicator
5/15/12	No source found for 2,4-D	Grapes	2,4-D, glyphosate	No action possible
5/16/12	No source found for 2,4-D	Grapes	2,4-D, glyphosate	No action possible
5/24/12	No source found for 2,4-D	Grapes	2,4-D, glyphosate	No action possible
5/29/12	Field corn, ground application	Grapes	2,4-D	WL
5/30/12	Field corn, ground application	Commercial vegetables	Glyphosate, glufosinate, tembotrione	No residues found, no action taken
6/18/12	Field corn, ground application	Grapes	Glyphosate	WL
5/15/13	Field corn, ground application	Commercial vegetables	Atrazine, saflufenacil, dimethenamid	Penalty action taken
5/15/13	Pasture, aerial application	Heritage forb seed production	2,4-D	Penalty action taken
5/22/13	Field corn and soybeans, ground applications	Commercial vegetables	2,4-D, glyphosate, sulfentrazone	WL
6/3/13	Field corn, soybeans, ground applications	Grapes	2,4-D, glyphosate, sulfentrazone	4 WL's
6/3/13	No source for 2,4-D found	Grapes	2,4-D, glyphosate	No action possible
6/4/13	No source for 2,4-D found	Grapes	2,4-D	No action possible
6/4/13	Irrigation canal application (R-O-W)	Grapes	2,4-D, glyphosate, diuron	Penalty action taken

Date	Target Site (Source)	Sensitive Crop	Herbicides	Enforcement Response
6/6/13	No source for 2,4-D found	Grapes	2,4-D, glyphosate	AL for one neighbor
6/13/13	Field corn, ground application	Organic soybeans	2,4-D, saflufenacil, dimethenamid	WL
6/20/13	Field corn and R-O-W, ground applications	Grapes	2,4-D, glyphosate, dicamba, saflufenacil	WL
5/5/14	Soybeans, ground application	Grapes	2,4-D, glyphosate, sulfentrazone	Pending
5/14/14	Field corn, ground application	Fruit trees	2,4-D, glyphosate	WL
5/21/14	Soybeans, ground application	Organic pasture	Frivolous complaint	No action
6/2/14	No nearby source found	Commercial vegetables	Physiologic leaf roll	No pesticides, no action
6/24/14	Field corn, ground application	Tree nursery	2,4-D	Residues found, case pending
6/10/14	Field corn, ground application	Grapes	Glyphosate	WL
6/27/14	Soybean, ground application	Organic alfalfa	Glyphosate, fomesafen, clethodim	No violation, no action
6/27/14	Field corn, ground application	Grapes	2,4-D, glyphosate, imazethapyr	Residues found, case pending
7/1/14	R-O-W, ground application	Grapes	2,4-D	Residues found, case pending
7/9/14	Source not determined yet	Grapes	2,4-D, picloram	Residues found, case pending

Pesticide-Sensitive Crops Task Force

September 26, 2014

Clyde Ogg, Pesticide Safety Extension Educator
University of Nebraska–Lincoln Extension

Senator Ken Schilz asked that I provide appropriate data, information and comments on each of the following three points:

#1 Programming and Activities of the UNL Extension PSEP to raise awareness of the public and the applicator community regarding sensitivity of certain crops to applications of 2,4-D.

Developed *Herbicide Stewardship and Drift Prevention* Webpage http://nodrift.unl.edu

Promoted DriftWatch (https://ne.driftwatch.org/) to create awareness of sensitive crops and their locations:

- 2012 & 2013 Educator In-service Training; Invited R. Thomas Zumpfe to speak during the 2013 Educator In-service.
- 2012-2014 Private and Commercial Training;
- 2012-2014 Crop Production Clinics;
- March 14, May 9, 17 & 29, August 22, December 18, 2013; June 6, 2014 *CropWatch Newsletter* (http://cropwatch.unl.edu)

Wrote *Protecting Pesticide Sensitive Crops* NebGuide http://www.ianrpubs.unl.edu/epublic/live/g2179/build/g2179.pdf

Developed "No Drift Zone" signs as alternative to those offered by DriftWatch for placement near sensitive crop locations.

Developed video programs to create awareness about drift, drift prevention and protection of sensitive sites:

- Sensitive Sites: Vineyards – 285 views
  http://www.youtube.com/watch?v=EZeYln2skWU&feature=player_embedded&list=UUuCAmiE--vWiWtha51VKbWg
- Sensitive Sites: Pollinators – 301 views
  http://www.youtube.com/watch?feature=player_embedded&v=Msdb7jYYVXI&list=PLhBDhSwbr6JGunTZ6tuG6PLwcyXk3UvFR
- How to use DriftWatch – 95 views
  http://www.youtube.com/watch?feature=player_embedded&list=PLhBDhSwbr6JGunTZ6tuG6PLwcyXk3UvFR&v=s8ElK3HmwxQ
- Managing Pesticide Drift – 177 views
  http://www.youtube.com/watch?v=gdgnxA0wtQQ&list=UUY-S0_KLnrd778-MenarSig
- Reducing the Risk of Herbicide Injury – 143 views
  http://www.youtube.com/watch?v=htMr6hArK-M

Presented information about the UNL Extension Pesticide Safety Education Program (PSEP) and its efforts to create awareness about 2,4-D drift and the damage it can cause to grapes at a program organized by the Nebraska Winery and Grape Growers Association about 2,4-D drift. Lincoln, NE, November 2012.

Provided comments and answered questions about the PSEP as member of a panel at the Nebraska Winery and Grape Growers Association Conference in a 2,4-D drift awareness session. Kearney, NE, March 2013.

Taught approximately 150 Master Gardeners during 2013 & 2014 about drift, drift prevention and 2,4-D sensitive plants.

Used Social Media to promote safe pesticide use, applicator health protection, drift and run-off prevention, and awareness about sensitive sites.

Facebook (https://www.facebook.com/UNLPSEP) – 268 likes

Twitter (https://twitter.com/UNL_PSEP) – 582 tweets; 292 followers

YouTube (http://www.youtube.com/user/UNLExtensionPSEP) – 26 videos with 54,734 total views; 83 Subscribers

#2 Course Training Materials used in Pesticide Applicator Certification that focus on special considerations when applying pesticides in the vicinity of sensitive crops.

(1) Private Applicator PowerPoint Presentations

(2) *Nozzle Selection for Droplet Size*— how to increase pesticide efficacy and manage drift.

(3) *Spray Drift Factors*— equipment selection and set-up to minimize drift potential.

(4) *Recognition of Sensitive Areas*— crops, bees, and water.

(5) *Understanding Vapor and Particle Drift*— recognize how and when drift can occur.

(6) *Climate Factors Contributing to Drift*wind— speed and direction, temperature inversions, and humidity.

(7) *Pesticide Factors Contributing to Drift*— viscosity, droplet size, and additives.

(8) *Applicator Attitude*

(9) Private Applicator Lesson Plan – Hands-on Activities

(10) *Spray Drift Prevention Activities*

(11) Discussion and exploration of print and electronic resources detailing the effects that droplet size, nozzle type, and boom set-up have on drift.

(12) Use of *The Beaufort Scale* to understand wind speed and the effect it has on drift.

(13) Demonstrate the *Driftwatch Website*, using computer or smart phone to encourage applicators to check for sensitive crops near their application sites before spraying.

(14) *Monitoring Wind Direction* and *Using a Compass to Determine Wind Direction in Degrees* teaches applicators how to accurately describe and record wind direction in order to make good decisions regarding drift prevention.

(15) *SpotOn Calibrator* Calibration Activity teaches applicators to identify worn or clogged nozzles that could cause drift and inefficient applications.

(16) *Air Temperature Inversions: Causes, Characteristics and Potential Effects on Pesticide Spray Drift* reference publication teaches Extension Educators about inversions.

(17) Training Manuals and Video Programs for Commercial Pesticide Applicators – Detailed discussions about spray equipment; nozzles; pesticide selections and tank additives; equipment, pesticide, and weather factors contributing to drift; and methods for drift prevention.

(18) General Standards (Core)

(19) Agricultural Pest Control – Plant
(20) Right-of-Way Pest Control
(21) NebGuides and Extension Circulars
(22) *2014 Guide for Weed Management* Extension Circular
http://www.ianrpubs.unl.edu/live/ec130/build/ec130.pdf
(23) *Spray Drift of Pesticides* NebGuide
http://www.ianrpubs.unl.edu/epublic/live/g1773/build/g1773.pdf
(24) *Bee Aware: Protecting Pollinators from Pesticides* Extension Circular
http://www.ianrpubs.unl.edu/epublic/live/ec301/build/ec301.pdf
(25) *Protecting Pesticide Sensitive Crops* NebGuide
http://www.ianrpubs.unl.edu/epublic/live/g2179/build/g2179.pdf
(26) Live, face-to-face training using PowerPoint presentations and handouts.
(27) Crop Production Clinics, 9 locations across Nebraska with 1500-1700 participants each January. Topics vary, but during 2012-2014 detailed information about drift, DriftWatch, and sensitive crops were presented.
(28) Nebraska Turfgrass Conference, large annual conference with 125-200 participants in the Ornamental and Turf recertification session. Drift prevention was taught during 2013-2014.

#2 (Continued) To what extent is demonstration of knowledge of sensitive crops and means to mitigate conflict a competency required for commercial and private applicator applicants?

Nebraska Pesticide Act http://www.nda.nebraska.gov/regulations/plant/actbm.pdf
Nebraska Pesticide Regulations http://www.nda.nebraska.gov/regulations/plant/tilw.pdf

005.01 General Standards for Certified Applicators. All certified applicators shall demonstrate practical knowledge of the principles and practices of pest control and safety in use of pesticides. Determination of competency shall be based on examples of problems and situations appropriate to the particular category or subcategory of the applicator's licensure and knowledge of the following areas:
005.01C Environmental Risk. The potential environmental consequences of the use and misuse of pesticides that may cause drift and runoff, precautions for protection of endangered and threatened species, and methods of spill prevention and control. Such consequences may be influenced by such factors as:
005.01C(1) Weather and other climatic factors that contribute to pesticide drift and run off;
005.01C(3) Recognition of sensitive areas, fish, wildlife and other nontarget organisms affected by pesticide applications, drift and runoff;
005.01G(3) Prevention of drift and pesticide loss into the environment, including the concept of vapor drift of volatile pesticide formulations.

005.03 Private Applicators:
005.03B(4) Recognize local environmental situations that must be considered during application to avoid off-site movement of the pesticide by runoff or drift or contamination of non-target sites.

From NDA Website (http://www.nda.nebraska.gov/pesticide/guide.html) "Nebraska Guidelines for Getting a Training Program Approved for Commercial Recertification Purposes"

Non-Target Risk (suggested time 20-30 minutes)

- Recognition of sensitive indoor areas such as food handling areas, schools, daycares, nursing homes, prisons, etc. Recognition of sensitive outdoor areas such as ponds, creeks, gardens, nearby sensitive crops, etc. Consideration also to be given to pets, wildlife, fish, and endangered species.

- Outdoor product use to include discussion on:
    - Weather and other climatic factors that contribute to pesticide drift and run off.
    - Influence of terrain, soil, and other substrata on surface and ground water contamination.
    - Management practices to prevent pesticides from reaching ground and surface water.

#3 What specific application best management practices are most helpful in mitigating the risk of off-target site migration of pesticides of concern to sensitive crops.

A Mississippi State study analyzed data from over 100 studies involving particle drift from ground sprayers. Of the 16 variables considered, three were most important.

- **Wind Speed.** When the wind speed was doubled, there was almost a 70% increase in drift when the readings were taken 90 feet downwind from the sprayer. Spray when the wind speed is 10 mph wind or less.
- **Boom height.** When the boom height was increased from 18 to 36 inches the amount of drift increased 350% at 90 feet downwind.
- **Distance downwind.** If the distance downwind is doubled, the amount of drift decreases five-fold. If the distance downwind goes from 100 to 200 feet, you have only 20% as much drift at 200 feet as at 100 feet and if the distance goes to 400 feet, you only have 4% of the drift you had at 100 feet. Check wind direction and speed when starting to spray a field. You may want to start spraying one side of the field when the wind is lower. Also it may be necessary to only spray part of a field because of wind speed, wind direction and distance to susceptible vegetation. The rest of the field can be sprayed when conditions change.

Best Management Practices Concerning Pesticide Drift

There are two types of drift, particle drift and vapor drift. **Particle drift** is off-target movement of the spray particles and **Vapor drift** is the volatilization of the pesticide molecules and their movement off target.

All nozzles produce a range of droplet sizes. The small, drift-prone particles cannot be eliminated but can be reduced and kept within reasonable limits. Here are some tips:

- **Select low or nonvolatile pesticides.** Choose an application method and a formulation that is less likely to cause drift. After considering the drift potential of a product/formulation, and application method, it may become necessary to use a different product to reduce the chance of drift.

- **Maintain adequate buffer zones** to ensure that drift does not occur off the target area. Read and follow the pesticide label. Instructions on the pesticide label are given to ensure the safe and effective use of pesticides with minimal risk to the environment. Each pesticide is registered for use on specific sites or locations. Many drift complaints involve application procedures in violation of the label.

- **Know your surroundings!** You must determine the location of sensitive areas near the application site. Some crops are particularly sensitive to herbicides that move off-site. You should know the location of sensitive areas within a one-half mile radius of sites on which you would make, or have someone else make, pesticide applications, and one mile downwind. Make pesticide application decisions with these locations in mind.

- **Use drift control/drift reduction agents** within label guidelines. This will result in better pesticide effectiveness and less potential for drift.

- **Avoid high spray boom pressures**; high spray pressure creates finer droplets. Consider 45 PSI the maximum for conventional broadcast ground spraying.

- **Use drift-reduction nozzles.** They will produce larger droplets when operated at low pressures. When using venturi nozzles, higher pressures will be required to maintain an effective pattern. As the pressure is increased with these nozzles, the drift potential will increase, but not as much as with other types of nozzles.

- **Use wide-angle nozzles, low boom heights, and keep the boom stable.** Drive perpendicular to terraces rather than parallel to avoid having the boom ends high above the target surface or digging into the ground.

- **Know the weather conditions.** Drift is minimal when wind velocity is between 3 and 10 mph. Apply pesticides early in the morning or late evening; the air is often more still than during the day. Do not spray when temperature inversions are likely or when wind is high or blowing towards sensitive crops or gardens.

- **Use shielded booms.** When banding, use shroud covers.

- **Learn more details.** *Drift-Reducing Strategies and Practices for Ground Applications* http://maxpond.ext.vt.edu/ojs2/index.php/jpse/article/view/67

Spray Drift Management Label Directions for Amine 400 2,4-D Weed Killer product

[2.] Spray Drift Management

A variety of factors including weather conditions (e.g., wind direction, wind speed, temperature, relative humidity) and method of application (e.g., ground, aerial, airblast, chemigation) can influence pesticide drift. The applicator must evaluate all factors and make appropriate adjustments when applying this product.

Droplet Size
When applying sprays that contain 2,4-D as the sole active ingredient, or when applying sprays that contain 2,4-D mixed with active ingredients that require a Coarse or coarser spray, apply only as a Coarse or coarser spray (ASAE standard 572) or a volume mean diameter of 385 microns or greater for spinning atomizer nozzles. When applying sprays that contain 2,4-D mixed with other active ingredients that require a Medium or more fine spray, apply only as a Medium or coarser spray (ASAE standard 572) or a volume mean diameter of 300 microns or greater for spinning atomizer nozzles.

Wind Speed
Do not apply at wind speeds greater than 15 mph. Only apply this product if the wind direction favors ontarget deposition and there are not sensitive areas (including, but not limited to, residential areas, bodies of water, known habitat for nontarget species, nontarget crops) within 250 feet downwind. If applying a Medium spray, leave one swath unsprayed at the downwind edge of the treated field.

Temperature Inversions
If applying at wind speeds less than 3 mph, the applicator must determine if: a) conditions of temperature inversion exist, or b) stable atmospheric conditions exist at or below nozzle height. Do not make applications into areas of temperature inversions or stable atmospheric conditions.

Susceptible Plants
Do not apply under circumstances where spray drift may occur to food, forage, or other plantings that might be damaged or crops thereof rendered unfit for sale, use or consumption. Susceptible crops include, but are not limited to, cotton, okra, flowers, grapes (in growing stage), fruit trees (foliage), soybeans (vegetative stage), ornamentals, sunflowers, tomatoes, beans, and other vegetables, or tobacco. Small amounts of spray drift that might not be visible may injure susceptible broadleaf plants.

Other State and Local Requirements
Applicators must follow all state and local pesticide drift requirements regarding application of 2,4-D herbicides. Where states have more stringent regulations, they must be observed.

Equipment
All aerial and ground application equipment must be properly maintained and calibrated using appropriate carriers or surrogates.

Additional requirements for ground boom application
Do not apply with a nozzle height greater than 4 feet above the crop canopy.

Additional requirements for aerial applications
The boom length must not exceed 75% of the wingspan or 90% of the rotor blade diameter. Release spray at the lowest height consistent with efficacy and flight safety. Do not release spray at a height greater than 10 feet above the crop canopy unless a greater height is required for aircraft safety. This requirement does not apply to forestry or rights-of-way applications. When applications are made with a crosswind, the swath will be displaced downwind. The applicator must compensate for this by adjusting the path of the aircraft upwind.