



Farmer Perspectives on Pesticide Resistance

Introduction

Pesticide resistance is on the rise in Iowa and the Midwest. Most corn and soybean farmers in the Corn Belt grow plants that have been genetically modified to express resistance to the herbicide glyphosate. In the case of corn, many hybrids have been genetically modified to express one or more Bt (*Bacillus thuringiensis*) proteins that are toxic to western corn rootworm, a major insect pest. The development of crops that are genetically modified to tolerate glyphosate has been tied to a substantial reduction in tillage, which has led to reduced soil erosion. The advent of Bt corn has been credited with a major reduction in the use of broad-spectrum insecticides. However, widespread and continuous use of these pest management technologies has led to selection pressure, or conditions that are conducive to the evolution of resistances to their modes of pesticide action.¹

As a result, weeds that have evolved resistance to glyphosate and other herbicides² and western corn rootworm that have evolved resistance to Bt³ are becoming increasingly common in Iowa and other Midwestern states, and pose a growing threat to crop production.

The effectiveness of pest management practices depends on maintaining a sufficiently *low level of resistance* to control techniques. Pest susceptibility to management practices can be considered to be a “common pool resource,” or a resource from which all farmers and society can benefit. When pests evolve resistance to chemicals used to manage them, that common benefit is eroded.¹

The 2012 and 2013 Iowa Farm and Rural Life Poll surveys included a number of questions about management for herbicide-resistant weeds and Bt-resistant corn rootworm.⁴ Questions focused on farmer experience with resistant weeds and rootworms, concern about resistance, use of various resistance management practices, and the perceived effectiveness of those practices.

In 2014, the Farm Poll posed two sets of questions about the evolution of pesticide resistance. The questions were developed in consultation with Iowa State University (ISU) agronomists, entomologists, plant pathologists, and weed scientists. One question set measured general perspectives on pest resistance management. A second question evaluated farmer beliefs about the degree to which different stakeholders are

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responsible for resistance management actions. A number of complementary questions on information sources and decision making were also asked. Questions focused on who farmers trust for information on pest management, and to what degree they depend on professional advisors to help them make pest management decisions. This short report presents the results for pesticide resistance management and related questions from the 2012, 2013, and 2014 surveys.

Methods

The Iowa Farm and Rural Life Poll is an annual survey of Iowa farmers. It collects and disseminates information on issues of importance to agricultural stakeholders and rural communities across Iowa and the Midwest. Conducted every year since its establishment in 1982, it is the longest-running survey of its kind in the nation. ISU Extension and Outreach, the Iowa Agriculture and Home Economics Experiment Station, the Iowa Department of Agriculture and Land Stewardship, and the Iowa Agricultural Statistics Service are partners in the Farm Poll.

Most of the data presented in this report are from the 2014 Farm Poll. Questionnaires

were mailed in February 2014 to a statewide panel of 2,218 farmers, and 1,128 surveys were returned, resulting in a response rate of 51 percent. Because herbicide and Bt resistance management issues are most applicable to row crop farmers, the results presented in this report are for a subsample of 889 farmers who planted corn and/or soybean in 2013. Information on response rates and numbers of respondents for the 2012 and 2013 Farm Poll surveys are available on the Farm Poll website (<http://www.soc.iastate.edu/extension/ifrlp/about.html>).

Iowa farmers' experience with resistant pests

The 2013 and 2014 Farm Poll surveys asked farmers who planted corn and/or soybean the previous year if they believed they had herbicide-resistant weeds or Bt-resistant insects in any of the fields they farmed. The 2013 survey listed several types of herbicides and asked farmers if they had weeds that were resistant to them in the 2012 growing season. Thirty-two percent of farmers indicated that they believed they had encountered weeds that were resistant to glyphosate (table 1). Fourteen percent reported that they had weeds that were

Table 1. Percent of farmers reporting herbicide resistant weeds and/or Bt-resistant corn rootworm

	Yes	No	Don't know
	— Percentage —		
In 2012, did you have weeds that were resistant to glyphosate (Roundup) herbicides in any of the fields that you farm?	32	56	12
In 2012, did you have weeds that were resistant to ALS inhibitor herbicides (e.g., Classic, Harmony, Firstrate) in any of the fields that you farm?	14	65	21
In 2012, did you have weeds that were resistant to triazine herbicides in any of the fields that you farm?	5	67	28
In 2012, did you have weeds that were resistant to HPPD inhibitor herbicides (e.g., Callisto, Impact) in any of the fields that you farm?	4	65	31
In 2012, did you have weeds that were resistant to PPO inhibitor herbicides (e.g., Flexstar, Authority, Kixor) in any of the fields that you farm?	3	63	34
In 2013, did you identify Bt-resistant corn rootworm in any of your fields?.....	12	80	9

resistant to ALS inhibitors. Minor percentages (less than 5 percent) believed that they had encountered weeds that were resistant to other types of herbicides.

A single item in the 2014 Farm Poll asked about Bt-resistant corn rootworm. The question was simply, “In 2013, did you identify Bt-resistant corn rootworm in any of your fields?” Twelve percent of farmers who had planted corn reported that they had encountered Bt-resistant corn rootworm.

Attitudes and concerns

Ten items assessed farmers’ perspectives on several aspects of resistance evolution and management. “Pesticide treadmill” is a commonly used phrase that describes a repeating cycle in which pests (weeds, insects, pathogens) evolve resistance to management strategies, necessitating the use of higher rates of pesticides and/or alternative pesticides or management methods. Several items focused on aspects of that phenomenon. Ninety-one

Table 2. Corn/soybean farmer perspectives on pest resistance management

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
— Percentage —					
Pesticide Treadmill					
I feel like pest (weed, disease, and insect) management is a never-ending technology treadmill...	0.8	2.4	6.3	58.6	31.9
When new pest management technologies are introduced, it is only a matter of time before pests evolve resistance	0.8	2.2	15.0	58.8	23.2
Seed and chemical companies should do a better job of keeping up with evolution of resistance in pests	1.6	5.7	26.9	49.2	16.6
Concerns					
I am concerned that herbicide-resistant weeds will become a problem in my area (<i>from the 2012 survey</i>)..	1.1	5.1	11.9	48.8	33.2
I am concerned that Bt-resistant insects will become a problem in my area (<i>from the 2012 survey</i>).....	1.7	7.8	28.2	45.4	16.8
Herbicide-resistant weeds are not a major concern because new technologies will be developed to manage them.....	20.3	43.6	22.1	12.9	1.0
Bt-resistant insect pests are not a major concern because new technologies will be developed to manage them.....	13.2	40.7	31.5	13.0	1.5
I am concerned about the impact of pesticides on beneficial insects, microorganisms, etc.....	1.0	4.6	20.0	51.1	23.3
Management Practices					
Poor management by a few farmers leads to premature evolution of resistant pests.....	1.7	7.7	21.7	45.0	23.8
The way that farmers use pest management technologies does not really impact the rate at which resistance evolves	26.3	40.6	18.3	11.7	3.1
Sometimes I think crop advisors recommend more pesticide use than is necessary	1.8	20.3	37.0	33.9	6.9
Farmers are less likely to use sound resistance management practices on rented land.....	6.5	35.1	29.4	23.2	5.8

percent of farmers agreed that pest management “is a never-ending technology treadmill” (table 2). Eighty-two percent of farmers agreed that when new management technologies are introduced, it is only a matter of time before their effectiveness is reduced by evolution of resistance. About two-thirds agreed that seed and chemical companies should do more to keep pace with resistance development.

Five items evaluated farmers’ concerns about resistance. Two items—from the 2012 Farm Poll—measured general concern about the potential for resistance to become a problem in Iowa. Eighty-two percent of farmers agreed that they were concerned about herbicide-resistant weeds becoming a problem (table 1). Sixty-two percent of farmers were concerned about Bt-resistant insects becoming a problem. A single item from the 2014 survey focused on concern about the impacts of pesticides on beneficial organisms; 74 percent of farmers agreed that they worry that pesticides may harm “beneficial insects, microorganisms, etc.”

Two items examined farmers’ confidence in the potential for new technologies to address resistance problems. Most farmers (64 percent) *disagreed* with the statement, “herbicide-resistant weeds are not a major concern because new technologies will be developed to manage them” (table 2). Fifty-four percent disagreed with an identical statement about Bt-resistant insect pests. Fewer than 15 percent of farmers agreed with those statements. Taken together, the results indicate that farmers are worried about pesticide resistance and are not particularly confident in the potential of new technologies to manage it.

The next set of items examined perspectives on various dimensions of pest management. The item that had the highest level of agreement was, “Poor management by a few farmers leads to premature evolution of resistant pests,” with 69 percent of farmers agreeing (table 2). Similarly, 67 percent of farmers *disagreed* with the statement, “The way that farmers use pest

management technologies does not really impact the rate at which resistance evolves.” About 41 percent agreed that they sometimes think that crop advisors recommend more pesticide use than is necessary. More disagreed than agreed that farmers are less likely to use good resistance management practices on rented land (42 percent compared to 29 percent).

Information sources and decision making

Two question sets collected data on who farmers look to for information to assist with weed and insect pest management decisions. The first set asked respondents to indicate which of a number of entities they go to first for pest management information and who they trust most for such information. The second set asked them to indicate to what degree they depend on professional advisors to help them make decisions.

The first set was asked in two stages. The first stage was preceded by the text, “There are many sources of information available that farmers can use to help them make decisions. Please select the group that you would go to first for information on the following topics.” A range of topics were provided with a list of eight groups from which to choose. The second stage was preceded by the text, “Considering the same topics, which group would you trust the most for information to help you make decisions?” The combined results for weed and insect pest management are presented in table 3.

Most farmers indicated that they would go to a fertilizer or agricultural chemical dealer first for information on weed management (78 percent) or insect pest management (66 percent) (table 3). Small percentages selected ISU Extension, private crop consultants, or seed dealers. The percentages shifted somewhat for the trust question, with 66 percent and 56 percent of farmers indicating that they most trust agricultural chemical dealers

Table 3. Use of information sources to assist with pest management decisions

	Fertilizer or Ag Chemical Dealer	Seed Dealer	USDA/ NRCS/ SWCD Service Center	Private Crop Consultant	Iowa State University Extension	A Commodity Association	A Farmer Organization	Other Farmers	Other or N/A
—Percentage—									
Go to first									
Weed management .	77.6	1.4	0.5	7.3	7.2	0.2	0.6	3.0	2.2
Insect pest management.....	66.1	7.1	1.0	8.0	11.8	0.3	0.6	2.3	2.7
Trust the most									
Weed management .	65.9	2.2	1.0	8.1	17.1	0.1	0.7	3.4	1.5
Insect pest management.....	55.6	6.9	1.0	8.5	22.5	0.1	0.7	2.7	2.0

for information on weed and insect pest management, respectively, and 17 percent and 23 percent trusting ISU Extension most on those topics. It is important to note that the survey asked who farmers “trust the most” as sources of information, not whether they trust them or not. If farmers selected ISU Extension, for example, that does not mean that they trust ISU exclusively. They likely trust other groups and individuals as well, although perhaps not to the same extent.

The 2013 Farm Poll found that 54 percent of farmers do not develop their own herbicide programs, and 65 percent hire custom applicators. One of the objectives of the 2014 Farm Poll was to measure the degree to which farmers rely on professional advisors to assist them with their pest management (and other) decisions. Farmers were provided with a set of decisions and actions and provided the following introductory text:

As agriculture becomes more technology-intensive, many farmers turn to professional advisors such as agricultural product sales representatives, independent crop advisers, Extension agronomists, etc. for advice and information to help them make decisions about what inputs (seeds, fertilizers, pesticides), practices, equipment, etc., to use.

Below is a list of management decisions and actions that are made on many farms. For each of the decisions, please circle the category that best describes how decision making or responsibility for action is distributed between you and professional advisor(s).

The results for weed and insect management are shown in table 4.

Results show that most farmers rely on professional advisors to some degree. For pest management decisions such as which product to use or whether or not to spray, around 80 percent of farmers consult with an advisor (table 4). Between a quarter and one-third rely primarily or wholly on a professional advisor for pest management decisions.

Overall, these results help to validate Iowa State University’s strategic initiatives to increase impact by delivering science-based agricultural information both directly to farmers and to key partner stakeholders who also have contact with farmers. Agribusinesses, crop consultants, commodity groups, state agencies, and other agricultural information providers rely heavily on ISU research and extension information as they formulate their technical assistance recommendations for farmers. For example, research has shown that more than 80 percent

Table 4. Professional advisors' role in pest management decision making

	I do not use an advisor	Primarily me, with advisor input	Equally me and an advisor	Primarily an advisor, with my input	Advisor alone	N/A
—Percentage—						
Weed management						
Which herbicide to use.....	13.6	28.3	24.3	22.6	8.4	2.8
Whether or not to spray	21.7	29.2	21.7	19.5	5.2	2.7
Scouting and identification of weeds ..	21.5	29.0	18.8	21.6	6.8	2.3
Insect pest management						
Which insecticide to use.....	14.1	25.8	21.0	25.7	10.0	3.5
Whether or not to spray	20.3	29.1	21.7	21.0	5.2	2.8
Which insect-resistant variety to use (e.g., Bt-corn).....	15.4	27.9	24.0	21.9	7.5	3.4
Scouting and identification of insects..	18.1	27.0	18.8	24.9	8.5	2.7

of crop advisers identify ISU as their primary source of information.⁵ Through these public and private partnerships, Iowa State University Extension and Outreach helps ensure that agricultural decision support that partners provide to farmers is research-based, current, and widely disseminated.

Who is responsible for resistance management?

Actions that can reduce the potential for resistances to evolve can be pursued by a number of individuals and private and public entities. The survey provided farmers with a list of six key stakeholders: pesticide manufacturers, farmers, pesticide applicators, government,

university scientists, and seed companies. They were asked to rate, on a four-point scale ranging from “no responsibility” to “much responsibility,” what level of responsibility each stakeholder has for resistance management action. A short introduction was provided prior to the question:

Over the past several years, a number of weeds, plant pathogens, and insect pests have evolved resistance to pesticides that were previously effective. Please provide your opinions on the following questions about resistant weeds, pathogens, and insect pests.

Many people and entities can play a role in helping to prevent weeds, pathogens,

Table 5. Who is responsible for resistance management?

	No Responsibility	Little Responsibility	Some Responsibility	Much Responsibility
—Percentage—				
Farmers.....	1.2	4.6	32.4	61.8
Pesticide manufacturers.....	2.4	5.2	38.9	53.4
Seed companies	2.7	8.3	44.4	44.7
University scientists	5.7	15.6	42.5	36.2
Pesticide applicators (commercial)	5.4	16.9	44.7	33.0
Government (e.g., EPA, USDA).....	12.5	24.5	40.8	22.2

and insect pests from becoming resistant to pesticides. In your opinion, how much responsibility do each of the following bear in efforts to reduce the evolution of resistance?

Of the six groups provided, farmers rated themselves as most responsible for resistance management, with 94 percent indicating that farmers bear at least some responsibility for managing resistance (table 5). Farmers ascribed similar levels of responsibility to pesticide manufacturers: 92 percent selected either the “some” or “much” category. Eighty-nine percent of farmers indicated that seed companies bear at least some responsibility for resistance management. University scientists and commercial pesticide applicators were seen as similarly responsible, with 79 and 78 percent of farmers selecting “some” or “much” responsibility. Government agencies such as the EPA and USDA were rated as the least responsible group, with 63 percent of farmers choosing “some” or “much” responsibility. Overall, these results suggest that farmers believe multiple stakeholders share the responsibility for resistance management.

Conclusions

A central finding of this research is that many Iowa farmers believe that they have identified pesticide resistance on the land they farm, and most are concerned that herbicide-resistant weeds and Bt-resistant insects will become a problem in the areas where they farm. They also understand that the way farmers use pest management technologies has a major impact on the rate of resistance evolution. Further, they view resistance management as a community problem involving multiple stakeholders.

However, most Iowa farmers also seem to view pest management as a never-ending treadmill cycle of resistance evolution. This perspective is concerning, because it implies that many farmers feel somewhat powerless to cope with evolution of resistance. In fact, the rate at

which pests evolve resistance can be slowed significantly through *widespread, coordinated pest management* practices and strategies. However, such coordinated action is lacking, especially in the area of weed management.

That said, the results indicate that many Iowa farmers would like to translate their concern about resistance into action. The results showed that farmers see themselves as most responsible for resistance management. This makes sense, because the most effective resistance management strategies are those that can be implemented at the farm-level, such as crop rotation, rotation of pesticide mechanisms of action, and using other integrated pest management practices. However, they also ascribe responsibility to other key stakeholders, such as pesticide manufacturers, university scientists, and commercial pesticide applicators. This suggests that they believe that efforts to manage the evolution of resistance in pests should be a community effort among stakeholders, and that they may be open to working on coordinated, collaborative pest management approaches.

Experts have called for the development of coordinated resistance management strategies involving private sector firms, commodity groups, farmers, farmer associations, universities, and government agencies.^v The increasing prevalence of resistant pests in Iowa suggests that such actions should be pursued. The Iowa Farm and Rural Life Poll results suggest that farmers may be sufficiently concerned to take action. Steps should be taken to bring farmers and other stakeholders together to work toward effective resistance management strategies.

References

¹ National Research Council. 2010. *The Impact of Genetically Engineered Crops on Farm Sustainability in the United States*. Washington, DC: National Academies Press.

² For comprehensive resources on weed management, please visit <http://www.weeds.iastate.edu/>.

³ For more information on western corn rootworm, see <http://www.ent.iastate.edu/dept/faculty/hodgson/files/ul/CRW%20management%202012%20final.pdf>

⁴ <http://www.soc.iastate.edu/extension/ifrlp/PDF/PM3061.pdf>; <http://www.soc.iastate.edu/extension/ifrlp/PDF/PM3036.pdf> .

⁵ Iowa State University Corn and Soybean Initiative. 2005. Survey to Assess Iowa State University Corn and Soybean Production Research and Extension Programs. Ames, IA: Iowa State University College of Agriculture.

⁶ Ervin, David and Ray Jussaume. 2014. "Integrating Social Science into Managing Herbicide-Resistant Weeds and Associated Environmental Impacts." *Weed Science* 62:403-414.

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