



Science
Societies

Community management of herbicide-resistant weeds in the Pacific Northwest

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| March 10, 2021



Community-based management of herbicide-resistant weeds brings neighbors together to reach a threshold where enough farmers are managing herbicide resistance to minimize local spread. Photo by Terry Tindall.

While the threat of herbicide-resistant (HR) weeds continues to grow, many of the known prevention and mitigation practices have not been widely adopted by farmers. Is lack of knowledge the reason? Studies have shown that farmers do in fact know what is needed to control HR weeds but nonetheless do not always use these practices. In talking with producers directly, researchers have found that they have many reasons for not adopting integrated weed management practices.

It is no secret that herbicide-resistant (HR) weeds are a serious threat to agronomic production in the United States and around the world (Beckie et al., 2019; Heap, 2020). It is also no mystery how these weeds came to be or what kind of agronomic practices will be necessary to slow their development and manage their impacts (Beckie et al., 2019; Norsworthy et al., 2012). A significant source of confusion and concern, however, lies in the fact that many of these prevention and mitigation practices have been adopted on a very limited basis (Moss, 2019)—while the threat of HR weeds continues to grow (Heap, 2020). The resulting question is often framed as, “Why don’t farmers know what they should be doing to manage HR weeds?” However, multiple studies have demonstrated that farmers do in fact *know* what is needed to control HR weeds but nonetheless do not always use these practices.

Understanding the “why” involves talking to producers directly, a task undertaken and reported on by Jussaume and Dentzman (2016), Dentzman et al. (2016), Dentzman and Jussaume (2017), and Dentzman (2018a, 2018b). They found that farmers have many reasons for not adopting integrated weed management (IWM) practices. Three of the most frequently cited were:

1. Believing their actions would be in vain since they will still get HR weeds from “bad” or incompetent neighbors
2. Expecting that a new herbicide mode of action will be developed and released to replace those that have become less effective
3. Not having the resources needed to implement IWM, such as a ready supply of cheap labor

These beliefs are not ungrounded. Herbicide-resistant weeds are a mobile pest and controlling them takes coordinated landscape-level management (Bagavathiannan et al., 2019). Neighbors will need to work together, and poor management on the part of one neighbor can lessen the prevention and mitigation actions of others (Ervin et al., 2019; Livingston et al., 2016). Additionally, new herbicide modes of action have, in fact, historically been developed in time to replace those that are becoming ineffective due to weeds developing resistance. There is precedence for this trend, even though it is highly unlikely to persist at the rate necessary to control current herbicide resistance issues (Livingston et al., 2015). Integrated weed management can also be difficult to implement, especially on large-scale industrialized farms (Barman et al., 2014; Moss, 2019).

Community Coordination Is Key

Farmers are not acting irrationally in response to the threat of herbicide resistance. They are, rather, drawing on their experiences, knowledge, and available resources to

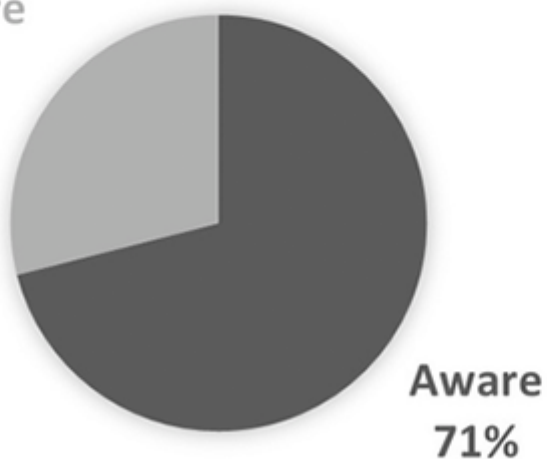
guide their actions. Unfortunately, these are unlikely to be sufficient to actually manage HR weeds. If IWM practices are to be adopted, farmers' current concerns and beliefs must be addressed. We propose that community coordination is key to this effort.

Community-based management addresses the three major reasons farmers do not take action to control HR weeds. First, it brings neighbors together to reach a threshold where enough farmers are managing herbicide resistance to minimize local spread. This addresses farmers' feelings of pointlessness when their actions can be undone by poor management from neighbors. Second, statistical modeling has shown that when farmers see community action as a viable method of HR weed control, they lessen their reliance on the development of a new herbicide mode of action (Dentzman, 2018a). Finally, pooling the resources of a community—not just the farmers, but crop advisers, university extension, and more—creates greater capacity for management.

In order to assess farmers' interest in, and capacity for, community-based management, Ervin et al. (2019) used national-level 2016 survey data of corn and soybean growers ($n = 839$) to look at three fundamental indicators of preparedness for community-based management. They found that 71% of respondents were aware of the mobile nature of herbicide resistance (Figure 1), 56% communicated with their neighbors about herbicide resistance (Figure 2), and 61% agreed that herbicide resistance must be managed cooperatively (Figure 3). In 2018, a similar survey of wheat growers ($n = 104$) in the Pacific Northwest (PNW) found that 80% of respondents were aware of the mobile nature of herbicide resistance, 60% communicated with their neighbors about herbicide resistance, and 67% agreed that herbicide resistance must be managed cooperatively. This may be indicative that the PNW is more prepared to tackle community-based management than the national average although these higher percentages may also be the result of increasing concern in the two years between the surveys.

U.S. AWARENESS OF HR WEED MOBILITY

Unaware
29%



PNW AWARENESS OF HR WEED MOBILITY

Unaware
20%

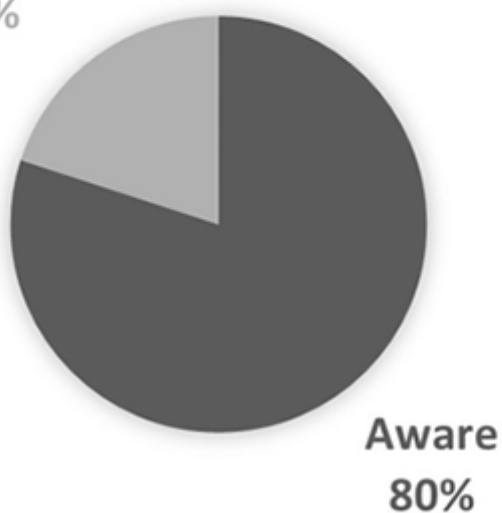


Figure 1, Awareness of mobility.

U.S. COMMUNICATION WITH NEIGHBORS ABOUT HR

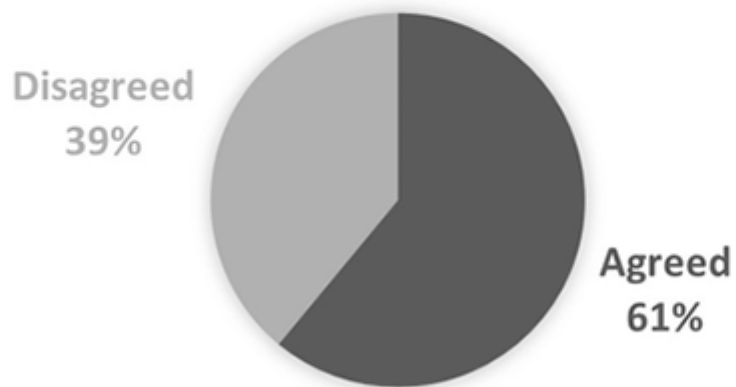


PNW COMMUNICATION WITH NEIGHBORS ABOUT HR



Figure 2, *Communication with neighbors.*

U.S. AGREEMENT THAT HR MUST BE MANAGED COOPERATIVELY



PNW AGREEMENT THAT HR MUST BE MANAGED COOPERATIVELY

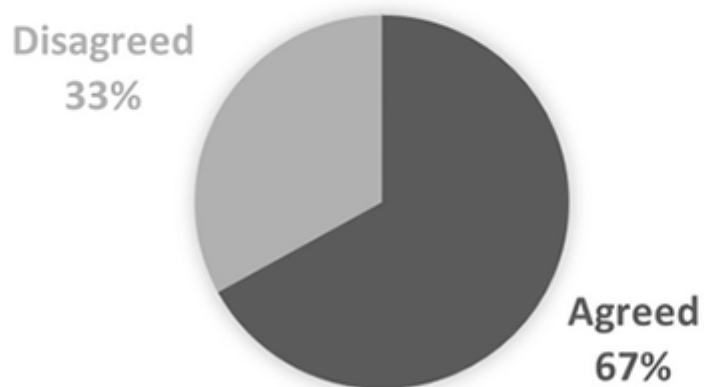


Figure 3, Cooperative management.

There is ongoing research in the PNW to determine the specific community HR weed management strengths, weaknesses, and needs of communities in this area. To this end, listening sessions have been conducted at the Tri-State Grain Growers

Convention (Spokane, WA, Nov. 15, 2019; approximately 60 participants), the Idaho Wheat Commission Meeting (Pocatello, ID, Mar. 10, 2019; approximately 54 participants), and the Washington State County Weed Board Meeting (Chelan, WA, Mar. 12, 2019; approximately 30 participants). Attendees included agricultural producers, researchers, industry representatives, farm supply dealers, county weed board commissioners, and others for a total of approximately 144 participants. Participants were specifically asked to respond to the following questions with approximately 10 minutes of in-group discussion and 5 minutes of out-sharing for each of the four main questions:

1. Is HR a problem in your community?
 1. Why? If not, will it be in the future?
 2. Who is responsible?
2. List strengths of your community for managing HR.
3. List weaknesses of your community for managing HR.
4. Looking towards the future, how would you want to connect as a community?
 1. What ways could our university team support a community initiative?
 2. What would you like to see happen in the next year? The next five years?

Listening Session Responses

Flip charts, notes, and audio recordings were transcribed for each listening session. Responses to each of the four main questions were coded and grouped thematically. While there were some differences between the three listening sessions, there were

also clearly identifiable and consistent themes across listening sessions for all four questions. Results are reported in Table 1; we review the responses to each question category below.

Table 1. Listening session results

Question	Answer categories	Examples	Supporting quotes
1. (Why) is herbicide resistance a problem in your community?	External causes	Spread from others, economic causes, nature, misuse of herbicides by others	“There’s no regulation in those hardware stores teaching those people what to use or how to use it and they don’t attend our meetings and our conferences”
	Internal causes	Misuse of herbicides by self, hard to identify HR, and we said it’s a bad shared responsibility, high awareness	“We’ve said it’s an issue thing”
2. Strengths for Existing networks and community management of herbicide resistance	relationships	Weed boards, networks, programs, outreach, positive relationships	“Long time direct seed experience that we could draw from”

Question	Answer categories	Examples	Supporting quotes
	Caring and cohesive communities	Ethical commitments, knowledge, talents, willingness to help, common goals, proactive and aware	"Willing farmers who understand the issue and are willing to try something different"
	Regional agronomic advantages	Climate, low irrigation, crop type, available herbicides, advantages over other regions	"Lack of low/residual herbs in grain harvested due to dry climate"
3. Weaknesses for community management of herbicide resistance	Personal/community culture	Anti-regulation, unwilling to change, resistant to get involved	"People stuck in their ways probably don't know the whole story"
	Limited resources and options	Commodity prices, cost of management, lack of funding, lack of rotation and chemical options, scarce labor	"Lack of other pre-plant, grassy weed herbicides in a wheat system"; "Have to be able to pencil out the differences in price between products"

Question	Answer categories	Examples	Supporting quotes
	Difficulty networking and information sharing	Physical distance, diverse people and operations, lack of communication, lack of education, no existing networks	"If I know that glyphosate causes cancer, non-Hodgkin's lymphoma, and you know that it's less harmful than table salt, how are we going to have an honest discussion?"
	Misuse of herbicides	By farmers, applicators, general public, landowners. Includes NOT using herbicides or using too little herbicide	"Reaching for herbicide first rather than the IPM approach because I think we all want something that's quick and relatively cheap"
4. Needs going forward	Innovative education and information sharing	Sharing research, social media, sharing between stakeholders, mapping, management plans, certification programs	"Need more resistance management information from universities to producers"

Question	Answer categories	Examples	Supporting quotes
	Diverse, accessible, leader-based networks	Get stakeholders together, partner with local groups, community support, farmer and university leaders	"I'm having a plane fly that field, the plane guy thinks it's resistant—what's our plan for the next year, his guy was already on it, I'm on it"
	Funding	Farmer/stakeholder incentives, funding for research, funding for communities	"Could subsidize products that they do want farmers to use and have a buy-back program for the stuff you don't want them to use"
	Agronomic innovation and monitoring	Research more options for control, start programs for monitoring	"Research studying: How different MOA are developing, mapping—how big is the problem"

When asked whether herbicide resistance was a problem in their community, participants had differing views and levels of awareness. They also agreed that communities in general shared this variation with different people and regions having various difficulties and advantages in understanding and identifying herbicide resistance issues. In general, there were two primary categories of reasons

participants thought herbicide resistance was a problem in their community. The first was external causes. This included spread from outside farmers and regions, larger economic trends, laws of nature, and the misuse of herbicides by others. The second category comprised internal causes. This included internal community failings and personal misuse of herbicides while also emphasizing the responsibility and capability of the community to address these problems through high awareness and shared responsibility. In general, participants thought that herbicide resistance was either a current issue or would soon become one and that community coordination would be necessary to address it.

When asked about their community's strengths for addressing herbicide resistance, participants in the three listening sessions identified factors falling into three main categories: existing networks and relationships, caring and cohesive communities, and regional agronomic advantages. Existing networks and relationships included university programs, such as the Washington State University small-farms program, that could be drawn on for support as well as various existing outreach and networking groups. Positive relationships in their community—and especially across types of stakeholders—was often cited as a strength. This led into the second category of caring and cohesive communities. Participants described their communities as knowledgeable, talented, and willing to help with common goals and strong ethical commitments. Farmers in particular were described as proactive, aware, and educated. Finally, participants saw the PNW as having several agronomic advantages in terms of climate, crop type, and the chemical herbicides available for this region.

While participants easily identified strengths in their communities, they also saw a number of weaknesses that would make it difficult to implement a community-based HR management initiative. These weaknesses fell into four categories:

personal/community culture, limited resources and options, difficulty networking and information sharing, and persistent misuse of herbicides. Although a commonly cited strength was the care and cohesiveness of communities, participants agreed that in every community, there are some people who are unwilling to change, set in their ways, or resistant to getting involved. There was also a noted anti-regulation attitude that the county weed board participants found particularly troubling. Limited resources and options involved economic limitations such as commodity prices and a lack of research funding as well as a lack of agronomic options like profitable crops to rotate with wheat. Limited chemical herbicide options, especially for wheat, and a lack of labor were also concerning. While participants saw networking and information sharing as highly important, they identified several ways in which this was made difficult. Differences in people and farming operations—both agronomically and culturally speaking—were seen as driving a lack of communication. Farm sizes that physically separate farmers by great distances contributed to this concern. Low knowledge and education on herbicide resistance issues, and particularly the unevenness in awareness, was also troubling. Finally, participants described the persistent misuse of herbicides by farmers, applicators, the general public, and non-farmer landowners as all contributing to the difficulty of controlling HR weeds.

When asked what their communities would need going forward to develop herbicide resistance management initiatives, participants were thoughtful and creative. They described four primary needs: innovative education and information sharing; developing diverse, accessible, leader-based networks; increased funding; and agronomic innovation and monitoring. Ideas for education and information were particularly creative with participants suggesting social media outlets, podcasts, map making, certification programs, weed management contests, fair booths, and more. Network building was also emphasized with the need for involvement of community

members from all backgrounds. Many participants mentioned the possibility of drawing on existing groups, meetings, and networks. The necessity of identifying leaders from academia, farming, and other groups was also cited. Funding to help form these networks was a priority, as was funding for research and farmer incentives. Lastly, there was a perceived need for research on additional options for weed management and detailed programs for monitoring the progression of herbicide resistance.

Our research team is currently working on summarizing these findings and providing detailed, tailored reports back to the communities who participated in our listening sessions. Our goal is to identify practical actions these groups can take to move forward with organizing community-based herbicide resistance management efforts. Our envisioned next step is to identify two or three communities in the PNW in which to implement pilot programs and begin building practical community-based management initiatives. We hope to be able to develop a toolkit and standardized process for creating community-based management initiatives across the PNW and the larger United States. To follow our progress, you can keep an eye on the Weed Science Society of America Herbicide Resistance Education webpage (<https://wssa.net/wssa/weed/resistance>) for updates.

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