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Issue

Producers, Weeds, and Society

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Abstract

From a sociological perspective, pest management issues are social issues. What is or is not a pest is defined socially. The management practices and technologies used to control pests are developed and disseminated socially. The positive and negative impacts of those practices and technologies are experienced socially. Thus, pest management can be seen as a social process. In this paper, we highlight weed management as a social process by presenting an analysis of primary data on how farmers responded to herbicide resistance in weeds from a sociological perspective. Our data suggest that farmers are aware of herbicide resistance, that farmers are hopeful that a new 'silver bullet' herbicide will soon be forthcoming, that the growth of large farms has contributed to this hope, and that structural conditions, as well as farmer attitudes, play a role in the selection of weed management practices.

Key words: weed resistance, sociology of agriculture, farmer attitude, weed management

'Pests' can be viewed as life forms that compete with humans for the products of nature. For example, a 'weed' is best thought of as a social construct, because although all plants are inherently valuable, certain plants come to be viewed as troublesome (economically or culturally) at certain periods of time in certain cultures. These are plants that are thought of as 'weeds'. Agriculture is also a social construct and can be viewed as humans' attempt to manage nature—a practice that pests, including weeds, as part of nature, resist. In other words, agriculture is a human system that aims to maximize the production of living things humans deem as useful, a process that involves limiting the destructive potential of other living things humans deem as harmful to that goal.

Since the beginning of the industrial revolution, humans have attempted to modernize agricultural production systems in ways that mimic other industrial production systems (Kautsky 1988). The idea of the industrial formula is to maximize output through the application of technology and routinization, thus leading to lower per unit production costs. The application of this logic to industrial agriculture can be seen in the metaphors of industrial agriculture that express a desire to manipulate nature so that agriculture can be refined as if it were one large machine (Sanford 2011). Following this logic, anything that disrupts that process, including the microbes, insects, and plants we label as pests, are meant to be eliminated in order to maximize production of food and fiber. At the same time, primarily through the use of technology, humans have become a primary force in speeding the evolution of organisms, including many that are viewed as pests, in a way that enables them to resist the technologies that are meant to eliminate them (Palumbi 2001).

Although this is a simplified, sociological conceptualization of pests and agricultural development, it does capture an important idea that we believe is widely accepted by most practitioners of Integrated Pest Management (IPM)—the very concept of a 'pest' has been created by humans and is dependent on our perceptions and behaviors. It is people, both alone and as part of social groups, that determine what is and what is not a pest. It is also people who develop, share, and use practices and technologies to address pest problems. Finally, people are ultimately affected by the positive and negative consequences of these practices and technologies.

In other words, particularly for social scientists, IPM can and should be seen as a social process that involves the interaction of social groups with natural systems. For example, the problem of weed resistance to herbicides can be considered a 'wicked problem' (Jussaume and Ervin 2016) that has no easy solution, in large part because it requires addressing multiple social and natural issues. At its most essential, this means that *the evolution of herbicide resistance*, in addition to being an ecological and economic problem, *is a social problem* that requires a sociological understanding.

Background

Our interest in the sociology of weed management was the result of having participated on a National Academy of Sciences team that was charged with reviewing the science on the impacts of biotechnology on American agriculture. The report included growing evidence that the Genetically Modified Organisms (GMO) technology package had contributed to an evolution of resistance to herbicides in many weeds (Ervin et al. 2010). The two social scientists on this paper (Dentzman and Jussaume) have training and experience working on interdisciplinary teams focused on agriculture and food issues, and soon became involved in a project that examined farmer perceptions and behaviors related to the management of herbicide-resistant (HR) weeds. Specifically, this team aimed to assess changes in weed management practices that resulted from the evolution of HR weeds. One major goal was to isolate the factors, including social, that might be influencing weed management decision-making in this changing agricultural environment.

One early contribution that sociologists often make to research teams is to challenge the basic assumptions that other team members may have about human behavior. Sociologists train students in the '*sociological imagination*', which can be defined as the ability to see one's position in the social world from outside of the social world of which one is a part (Mills 2000). This is a difficult perspective to develop, even for social scientists, because it requires recognition that the observer is part of the world they are investigating. Imagine an intelligent, self-conscious honey bee describing and studying the hive of which they are a part. That bee would develop an interesting perspective, but surely not the same as the beekeeper observing the hive from the 'outside'. It is important for sociologists to take the perspective of beekeepers, while still recognizing that their perceptions are inherently biased because they are a bee inside the hive. When part of an interdisciplinary team, sociologists must encourage other team members to question their own perspectives in a similar manner, as well as encourage recognition of the importance of the perspectives of the bees.

Consequently, sociologists are trained to challenge the received understandings of people with whom they interact, including other sociologists, because they realize that society and the understanding of others can influence their own perceptions. For example, lack of knowledge is often considered to be a factor that can explain poor dietary choices and health outcomes in some populations. Although education is clearly an important factor that needs to be assessed when examining dietary choices, other factors could also be in play, but these alternative explanations are sometimes ignored. Challenging assumptions about the importance of any single factor, such as education and the primacy of the individual as a social actor, can open one up to alternative possibilities. Thus, research has demonstrated that many people who make 'poor' nutritional decisions do so NOT simply because of a lack of knowledge but because of a lack of access, which includes both cost and availability, to healthy food options (Caraher et al. 1998; Hendrickson et al. 2006).

Similarly, as we became part of the HR weed project, we suggested that the assumption that many farmers were unaware of HR weeds' should be treated as an empirical question. We recognized that there may indeed be farmers who were unaware of the problem, but also recognized that the failure to adopt recommended Best Weed Management Practices (BWMPs) was not *necessarily* because farmers lacked knowledge. That is, we questioned and tested an assumption about why farmers might not be using BWMPs. We used this as a jumping off point for investigating how farmers responded to the problem and what factors might influence whether and how they responded.

To do this, we employed a multimethod approach that began with a series of focus group interviews followed by a general survey of farmers. The strength of focus group interviews is that, when conducted properly, researchers develop a deep understanding of participants' perspectives on the issues. To do this effectively, researchers must follow a strict protocol so that the interaction of the researcher with participants is comparable across all groups, and also to avoid the use of leading questions. This is done to ensure that the researcher can become aware of the perspective, or the 'voice', of participants.

The focus groups we conducted had 6–10 participants in each session, and were held in Arkansas, Iowa, Minnesota, and North Carolina (Dentzman et al. 2016; Dentzman and Jussaume 2017; Jussaume and Dentzman 2017; Dentzman 2018). Although these sites cannot be said to be representative of all regions of the United States, they did provide a valuable cross section of different geographies where herbicide resistance has become a significant problem. The participants were identified with the assistance of weed scientists who were on the team. Between February and May of 2015, 10 focus groups were conducted with corn and soybean farmers. The same three main lines of questioning were used with all 10 groups: 1) how should a farmer *ideally* react to HR weeds on their own farm versus how they would *actually* react, 2) how should a farmer *ideally* react to HR weeds on their neighbor's farm versus how they would *actually* react, and 3) is herbicide resistance a short-term or long-term problem and why? A coding approach that included eclectic coding and code mapping was used to identify overarching themes and important categories from the focus group sessions. We utilize some of the observations obtained during those interviews in the remainder of this paper.

The focus group sessions also were instrumental in helping us design a survey questionnaire—one that responded to the needs and perceptions of farmers and not just the interests and outside perspectives of the researchers. Thus, the focus group findings were used to develop a self-reported internet and mail survey that combined researcher expertise and interests with themes and ideas expressed in the focus groups. The goal was to have an instrument that would resonate with potential farmer participants as well as accurately measuring weed management practices and attitudes. The survey was sent to 9,000 corn and soybean growers across the United States in the winter of 2015 and spring of 2016. In total 839 useable surveys were returned for a response rate of 9.3%. Although disappointing, this return rate is just below the national average farmer-response rate for many surveys (Pennings et al. 2002).

Surveys were received from farmers in 28 different states, with 41% of the completed questionnaires coming from farmers in Arkansas, Iowa, Illinois, Minnesota, Nebraska, and Texas. We compared demographic characteristics of respondents with that of Census and USDA information bases (USDA National Agricultural Statistics Survey 2012). This comparison revealed that respondents to our survey were skewed toward older white farmers who operated slightly larger-than-average farms. Although this does reflect a good deal of the actual farmed acreage in the United States—and indeed a good deal of the herbicide use—the bias of our sample must be taken into account in the interpretation of results. Small acreage, minority, and women farmers were underrepresented, which means that this survey does not reflect adequately the opinions and attitudes of farmers from those social groups. The results of this survey are also presented as empirical evidence in this paper.

A Sociological Perspective on Weeds

Before we present some of our discoveries from this project, we share the sociological foundation for the questions we asked and how we interpreted what we learned. A dominant theme in sociology for many years has been that of macro and micro sociology, sometimes known as structure versus agency (Ritzer and Stepnisky 2018). Although sometimes presented as a debate, discussions about macro and micro sociology represent complementary understandings of how social change can take place. Macro sociology focuses on the study of institutions, ideologies, and other social structures that have been created by societies over time and which set parameters for our options in lives. Micro sociology focuses on the attitudes and choices made by individuals *within* the structure of society. Importantly, macro and micro social processes function together. A common misconception is that either macro social structures *or* micro social interactions shape society and behavior independently of each other. However, most sociologists would argue that individuals and groups have opportunities to act while recognizing that not all groups have equal opportunities due to the limitations of social structures. We took these perspectives into account when we developed questions for farmers about how they manage HR weeds, recognizing that farmers have individual attitudes and make personal choices, but are also constrained and influenced by larger structures such as the U.S. agricultural system and roles played by major institutions.

Many sociologists have recently begun to address the issue of how to integrate macro and micro understandings of social change by investigating how social networks act as a local-level social structure that integrates individual behavior into larger social structures. This includes work on change in the agricultural sector. For example, Carolan (2006) argues that the increasing legitimacy of sustainable agriculture has been made possible through the ways in which sustainable agricultural practitioners have created network relationships with those individuals and groups who are active in more mainstream agriculture. In essence, social networks provide farmers with knowledge and resources external to their farm operation, while at the same time enabling farmers to have impacts on social structures external to their farm. Thus, in our work, we seek to examine whether and how social networks, as well as micro and macro factors, influence farmer attitudes and decision-making with respect to weed management.

Empirical Findings on Farmer Approaches to Weed Management

Are farmers cognizant of the problem of HR weeds? Our research findings suggest that they are very aware. This was evident in both the qualitative and quantitative aspects of our research. Seventy-four per cent of respondents to our survey reported that they were aware of HR weeds on or near their farms, whereas 30.4% of all respondents indicated that there were aware of weeds that were resistant to *multiple* herbicides on or near their own farms. In addition, 94.5% of all respondents were somewhat or very concerned about the presence of weeds resistant to a single herbicide *on their own farms*, and 84.5% were somewhat or very concerned about the presence of weeds resistant to multiple herbicides *on their own farms*. This suggests to us that not only is there a broad awareness of the HR weed issue, but that most farmers, because of their awareness and concern, are making efforts to identify whether this problem exists on the lands they manage.

Our results suggest that that farmers appear to be widely aware of HR weeds, on their own farm, but how are they actually managing weeds? Table 1 shows the array of weed management practices that farmers in our survey were asked to report. Weed scientists on the project suggested the practices that are included in this list. We found that the practices most commonly used on most fields relate to the use of herbicides, whereas nonherbicide practices are not used as widely. These nonherbicide practices are a fundamental part of the IPM approach that many weed scientists recommend. Yet even with high farmer awareness of HR weeds, these practices are used only sparsely. This was interesting—and even seemed irrational—for many members of our team. For instance, several team members were surprised to learn that barely any farmers used weed maps as part of their weed management strategy, which in many cases continued to rely heavily on the use of herbicides.

This finding parallels what we discovered in our focus groups. Specifically, focus group participants were less interested in nonherbicide weed management practices because they were hopeful that a new 'silver bullet' herbicide would soon be discovered. They believed that such an herbicide would enable them to maintain a successful weed management strategy that is herbicide reliant and thus enable them to maintain an industrial-style agricultural production system they have become used to operating. For instance, a focus group participant from Minnesota prioritized discovering new herbicides over agricultural practices for controlling herbicide resistance in the following way:

Participant: 'In other words, trying to keep a company keeping new products moving in the pipeline – because that's what's eventually is going to have to happen is…this is never going to go away. You're always going to have an issue with whatever herbicide comes out. So keeping new options coming is more important than really the agricultural practices and all that'.

This sentiment was echoed in two different focus groups in Arkansas in which participants expressed their belief that chemical companies

Table 1. Extent of weed management strategy use by size of farm (<500 acres/>500 acres)

	Do Not Use at All	Use on <60% of fields	Use on >60% of fields
Herbicide-based practices			
Pre-Emergent Herbicide*	17.9%/7.8%	22.2%/17.0%	59.9%/65.2%
Post-Emergent Herbicide*	9.0%/5.0%	16.1%/11.2%	74.9%/83.8%
Post-Harvest Herbicide*	71.2%/52.4%	21.0%/32.3%	7.8%/15.3%
Herbicide Mixes*	14.1%/5.4%	19.9%/14.1%	66.0%/80.5%
Multiple Herbicides*	14.8%/4.7%	18.8%/15.3%	65.4%/80.0%
Use Full Label Rate*	10.1%/5.6%	19.8%/14.7%	70.1%/79.7%
Rotate MOAs Annually*	28.8%/13.2%	29.6%/28.1%	41.6%/58.7%
Nonherbicide-based practices			
Inter-Row Cultivation	79.4%/77.8%	13.2%/15.6%	7.4%/6.6%
Tillage*	34.6%/24.8%	30.7%/34.2%	34.6%/41.0%
Crop Rotation*	15.2%/6.5%	21.4%/22.3%	63.4%/71.2%
High Planting Densities*	51.4%/49.8%	24.1%/33.9%	24.5%/16.3%
Hand Weeding*	48.0%/41.4%	39.5%/50.6%	12.5%/7.0%
Cover Crop or Mulches	64.2%/60.4%	23.4%/30.7%	12.4%/8.9%
Special Planting Date	60.7%/59.7%	23.0%/27.0%	16.3%/13.3%
Narrow Rows	40.5%/39.1%	14.4%/22.2%	45.1%/39.7%
Weed Maps	85.2%/83.7%	9.0%/11.6%	5.8%/4.7%

*Indicates that the chi-square probability estimate is <.05.

would certainly be able to develop a new herbicide to combat herbicide resistance:

Participant 1: 'I'm a little discouraged with the chemical industry. I think – I don't think they're looking at the opportunity. . .I think it just – I think the chemical company just rolled over and held her hands up. [They] just want to throw some 2,4-D at it. What? That's baloney. Those people are supposed to be intelligent. Well, duh'.

Participant 2: 'I agree, totally'.

Participant 3: 'You can't tell me that it can't be done. You can't tell me that there ain't a chemical out there to kill that weed. I will never believe it'.

Participant: 'Well, the one thing that we don't know anything about is what new chemistry is coming. But the more that we have resistance, the harder they're going to work to find something. […] We're too big of an industry not to'.

We would argue that not only has this dependence on herbicides become part of an ideology that supports modern farming practices, but that this ideology is linked to the structural and personal position in which farmers find themselves. To help illustrate this connection, we will share how use of different weed management practices in our sample is connected with the size of farming operation. Some sociologists argue that farm size is an indirect indicator of how a farm fits into the overall farming structure. The argument is made that the ability to grow a farming operation is at least partly dependent on off-farm factors. Additionally, it is thought that once a farm becomes a certain size, there are external pressures to maintain or increase in size. Regardless of the sociological perspective, most would at least hypothesize that size is related to use of farm management practices, including weed management.

In Table 1, we break down the use of weed management practices by whether the management size of a farm (including both owned and rented land) is smaller or larger than 500 acres. The data suggest that large farmers are more likely to use a range of herbicide-based weed management strategies on a greater percentage of their fields. For example, 80% of respondents who managed more than 500 acres used herbicide mixes and multiple mixes on more than 60% of their fields, as opposed to roughly two-thirds of farms of less than 500 acres. At the same time, certain strategies like inter-row cultivation, cover crops and mulches, selection of special planting dates, and weed maps are used by a minority of farmers regardless of size.

These survey results had parallels in our focus group data. Multiple participants suggested that herbicide-based practices were dominant on large farms because the very size of these farms necessitated a simplified weed management strategy based on herbicides. For example, this conversation between participants in Minnesota emphasizes the perceived necessity of chemical weed management on large farms.

Participant 1: 'And you look at some of those farmers, the bigger farmers, and you wonder how in the heck they're ever going to be able to do that [Integrated Weed Management]. It's just -- the size matters, you know, the size of the operation'.

Participant 2: 'Roundup definitely allowed people to get bigger because it worked so good for so long that you could double your acres easily and get the work done. But I don't see the cultivator coming back'. (laughter)

Participant 1: 'No, I don't see it coming back, that's right'.

Participant 2: 'I think we're going to have to find chemicals'.

Participant 1: 'Yeah, you're right'.

This may help explain why larger farmers, who are also more likely to have greater economic resources, choose to manage herbicide resistance through a diversity of herbicide-based practices as opposed to nonherbicide practices. Smaller farms tend not to use diverse weed control practices at all, whether herbicide based or nonherbicide based, perhaps because they do not have the financial or human capital to invest in a diversity of management practices.

Beyond the macro level, we were particularly interested in investigating the role of social networks in HR weed management. Specifically, we have argued that HR weeds are a common pool resource issue, and thus managing HR weeds cooperatively should be important, especially for farmers in certain social networks. Also, previous research has shown that, for some agricultural practices at least, social networks can be useful means for farmers to learn about new weed management approaches and navigate structural constraints. Thus, beginning with our focus groups, we asked farmers to what extent they exchanged information about HR weeds and how to manage them with neighboring farmers. The following exchanges, first from Iowa and then Arkansas, highlight what may and may not be plausible.

Participant 1: I think it depends on if the neighbor is the—first of all, if you're on talking terms. And trying to help educate them may or may not work.

Moderator: Can you elaborate on that a little?

Participant 1: Well, I mean if it's a person you're willing to talk to, or willing to listen to, you know, it's one that you talk to normally, you know, 'Hey, what are you doing for weed control this year?' Trying to help educate the—done that before, I don't know that it's been successful. Especially—I don't know, that's pretty tough.

Participant 2: If the neighbor is really concerned about his fields, he'll ask you what you're doing right. He shouldn't, you know, his mindset has to be there in the first place.

Participant: I mean, me and my neighbor talked yesterday, and we've both got cover crops. And we were talking about what we're going to use to leave our cover and protect us, we're talking about Dicamba and Valor. I guess we can put that together. And that's kind of what happens. I called him, he said, 'What are you going to do on that?' And I said, 'Well, I don't know'. And then we talk about it. But that's kind of how it works.

These conversations emphasize that farmers appreciate the value of discussing HR weed management with their neighbors, but may be hesitant about initiating such conversations with neighbors they do not know well. Some of our participants perceived that some of their neighbors would listen, but others would be unwilling and even upset by actions that would be perceived as interference. This leads us to investigate whether those who participated in our survey who valued information from other growers were more or less likely to use different HR weed management practices.

In Table 2, we present evidence that respondents who valued information from neighbors about HR weed management were more likely to use certain weed management practices, although in terms of herbicide use, there are no significant differences. However, respondents who value information from neighbors were more likely to use high planting population densities, hand weeding, alternative planting dates, and narrow rows, although a minority of all respondents used these techniques. This would suggest that, among farmers who are receptive to information from neighbors, social networks are associated with greater use of nonherbicide weed management practices. Therefore, it appears that working through farmer networks and encouraging conversation might be a valuable tool for those wishing to disseminate more integrated weed management practices.

We noted earlier that attitudes play a role in helping to understand individual behaviors. In most cases, though, simply trying to change people's attitudes without understanding the social groups, networks, and structures that people are a part of is unlikely to bear much fruit. Table 3 provides some evidence of this by showing whether farmers' individual environmental

Table 2. Extent of weed management strategy use by whether respondent valued information from other growers as 'very important' (not very important/very important)

	Do Not Use at All	Use on <60% of fields	Use on >60% of fields
Herbicide-based practices			
Pre-Emergent Herbicide	10.7%/11.4%	19.3%/16.7%	70.0%/71.9%
Post-Emergent Herbicide	6.3%/6.2%	12.2%/13.9%	81.5%/78.9%
Post-Harvest Herbicide	61.2%/49.5%	27.0%/34.3%	11.8%/16.2%
Herbicide Mixes	8.8%/5.7%	16.2%/14.8%	75.0%/79.5%
Multiple Herbicides	8.4%/6.2%	17.0%/14.3%	74.6%/79.5%
Use Full Label Rate	7.1%/6.7%	16.4%/16.6%	76.7%/76.8%
Rotate MOAs Annually	18.8%/15.7%	29.2%/26.7%	52.0%/57.6%
Nonherbicide-based practices			
Inter-Row Cultivation	78.7%/77.1%	14.9%/14.8%	6.4%/8.1%
Tillage	34.6%/24.8%	30.7%/34.2%	34.6%/41.0%
Crop Rotation	9.3%/8.6%	22.1%/23.0%	68.6%/69.4%
High Planting Densities*	53.5%/40.9%	29.7%/34.3%	16.8%/24.8%
Hand Weeding*	46.1%/35.7%	45.4%/52.4%	7.5%/11.9%
Cover Crop or Mulches	64.5%/52.9%	25.9%/36.2%	9.6%/10.9%
Special Planting Date*	64.0%/48.1%	24.1%/30.9%	11.9%/21.0%
Narrow Rows*	42.1%/31.9%	19.7%/20.0%	38.2%/48.1%
Weed Maps	84.7%/82.4%	9.8%/13.8%	4.5%/3.8%

*Indicates that the chi-square probability estimate is <.05.

Table 3. Extent of weed management strategy use by whether respondent strongly agreed that the natural environment was an important part of respondent's identity (less than strong agreement/strongly agreed)

	Do Not Use at All	Use on <60% of fields	Use on >60% of fields
Herbicide-based practices			
Pre-Emergent Herbicide	11.0%/10.9%	19.7%/16.9%	69.3%/72.2%
Post-Emergent Herbicide	7.0%/5.1%	12.0%/13.6%	81.0%/81.3%
Post-Harvest Herbicide	59.8%/55.9%	29.0%/28.4%	10.2%/15.7%
Herbicide Mixes	8.4%/7.6%	17.5%/13.3%	74.1%/79.1%
Multiple Herbicides	8.2%/8.8%	18.3%/13.3%	74.5%/77.9%
Use Full Label Rate	6.8%/7.3%	17.3%/14.8%	74.9%/77.9%
Rotate MOAs Annually	18.9%/16.6%	28.7%/28.4%	52.4%/55.0%
Nonherbicide-based practices			
Inter-Row Cultivation	80.5%/74.9%	14.3%/15.7%	5.2%/9.4%
Tillage	26.5%/29.9%	33.5%/32.6%	40.0%/37.5%
Crop Rotation	9.6%/8.5%	22.9%/20.6%	67.5%/70.9%
High Planting Densities*	52.5%/46.8%	32.2%/29.0%	15.3%/24.2%
Hand Weeding	44.9%/41.2%	46.9%/47.6%	8.2%/11.2%
Cover Crop or Mulches	63.5%/58.6%	26.9%/30.8%	9.6%/10.6%
Special Planting Date*	63.4%/55.0%	25.1%/26.9%	11.6%/18.1%
Narrow Rows	40.2%/38.4%	21.1%/17.8%	37.7%/43.8%
Weed Maps	84.7%/83.4%	11.7%/9.3%	3.6%/7.3%

*Indicates that the chi-square probability estimate is <.05.

identity affected their use of HR weed management strategies. Respondents who strongly agreed about the importance of the natural environment in framing their identity as a farmer were more likely to utilize high planting population densities and alternative planting dates. However, none of the other weed management practices were associated with this attitude, which indicates that farmer attitudes may be less important, or at least circumscribed, by the limitations and opportunities of social networks and macro social structures.

This was reflected in the focus groups, where discussion of individual farmer characteristics was limited. Instead, participants specifically discussed the constraints of macro sociological factors, such as farm size and the economy, as limiting individual choices. For instance, in an Iowa focus group, one participant described economics as the ultimate determinant of weed management.

Participant: Your original question was what to do if the neighbor has weeds, though. My answer would be nothing. I don't see myself going up and knocking on the door and saying, 'You need to get rid of your weeds'. And I think that's probably going to be a typical answer. Economics have to run the show; it has to become affordable for that person to operate that way.

A discussion in a different Iowa focus group included farm size, geography, and the National Resource Conservation Service as factors that prevented them from using tillage to manage weeds, even though they may have preferred to.

Participant 1: The farm sizes have got to the point where you can't mechanically do it anymore. You can't get it accomplished.

Participant 2: Especially in southern Iowa where too many contours and hills and . . . Participant 1: All our—I think the NRCS offices have made us go to more chemicals with less diligence.

Finally, a common thread throughout the focus groups was how the agricultural chemical industry imposed limitations on farmers. Sometimes, participants discussed how chemical companies such as Monsanto had encouraged practices that would worsen herbicide resistance. Other times, as in the following discussion in North Carolina, participants blamed agricultural chemical companies and government regulation for limiting which herbicides were available to choose from.

Participant: Sometimes you want to blame the herbicide people. Anything that really worked years ago, you know, they outlawed it.

Moderator: Can you give me an example?

Participant: Not right off and everything, but it was working really good on some of the crops and everything, and then you can't use it anymore.

Moderator: Why did they ban it?

Participant: I don't know. Maybe it worked too good.

Insights and Implications

The goal of this analysis has been to help those interested in IPM understand how sociologists' understanding of weed management issues could contribute to an improved analysis of farmer adoption of IPM strategies. Through our work on HR weeds, we have presented an analysis of how the spread of these weeds, and farmer responses to the problem, involve social processes.

The evidence we have presented demonstrates that farmers, like all social groups, are heterogeneous. Their situations vary, as do their responses to farming challenges. Not all farmers respond to the same conditions in the same way. Thus, although it is true that more than two-thirds of those who responded to our survey use pre-emergent and postemergent herbicides on most of the fields they manage, nearly 30% of respondents use pre-emergent herbicides on less than 60% of their fields, and 19% use postemergent herbicides on less than 60% of the fields they manage. Similarly, 40% reported that they use narrow rows as a technique for managing weeds on more than 60% of their fields. Not all farmers are the same and many are using multiple approaches to manage weeds.

We have also shown, through both qualitative and quantitative data, that the explanations for why different farmers use different strategies includes macro, micro, and social network factors. At the macro level, those who farm more than 500 acres are more likely to be more intensive in their weed management, in part because they are part of a system that encourages the use of more inputs in order to maximize production. Additionally, quotes from our focus groups indicate that some of these farmers view themselves as part of a production system that is so dependent on high use of inputs, including herbicides, that it is difficult for them to accept that a new generation 'silver bullet' herbicide will not be forthcoming in the near future.

On the other hand, farmer social networks and attitudes about how their farm fit into the local environment are associated with the use of some HR weed management techniques, particularly those that are not herbicide based. This finding fits well within what sociological theory would lead us to expect and suggests that working interactively with farmers via their own social networks is one approach to consider for those interested in promoting IPM strategies in agriculture.

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