Decision-Making in Local Context: Expertise, Experience, and the Importance of Neighbours in Farmers' Insect Pest Management

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Abstract

Drawing on data from four focus groups with alfalfa farmers conducted in Spring 2014 and 2015 in four counties in Wyoming, USA, we analyse how farmers make decisions about insect pest management. Our generative focus group data allow us to examine how farmers frame and value different sources of information and why and when they rely on them. Our results reveal that in order to be useful, expert information needed to be local and to consider the complex realities of farming. Neighbours, especially those with deep roots in the community, were seen as valuable and trusted sources of information. Chemical companies and co-op representatives, on the other hand, received more mixed treatment. We describe the dimensions by which growers categorise information: relevancy, accuracy, locality, and diagnostic/prognostic. Our results underscore the reflexive nature and motivation for farmers' evaluation of information and advice about insect pests.

Introduction

Farmers balance a large number of considerations in running their operations. They must consider economic, climatic, and environmental conditions which are outside of their control together with weighing advice and information in the quest to maximise quantity and quality of crop while managing insect, weed, and other pests. Drawing on data from four focus groups of alfalfa farmers conducted in Spring 2014 and 2015 in four counties across the state of Wyoming, in the Western United States, we seek to understand how farmers make decisions about insect pest management. In particular, we examine where farmers learn and seek information, and how they consider expert information as compared with their neighbours', friends, and their own experiences in making pest management decisions.

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Alfalfa is the largest acreage crop in the state of Wyoming, valued at over $200 million in 2017 (USDA-NASS 2018). Alfalfa is most often harvested for hay (either for sale or for feeding on-farm animals) and sometimes farmed for seed. Insect pest management in alfalfa remains a major challenge not only in Wyoming but throughout the Western United States and is a central concern of farmers. Understanding farmers' decision making allows us to make several contributions: *first*, our study contributes to the literature in rural sociology that seeks to understand how farmers make decisions and weigh information in the context of complex systems by introducing additional data from generative focus groups; *second*, our analysis synthesises largely disparate streams of research on expertise (coming out of sociology and social science), communities and networks (coming out of rural sociology), and farmer decision-making (coming out of agricultural research) to understand insect pest management, distinguishing across sources and types of information; and *third*, our results contribute to the practical body of scholarship by agroecologists and university Extension professionals that seek to understand how farmers make decisions in the face of insect pests and other challenges in an effort to facilitate learning and better farming techniques.

There exists a tension in both science and technology studies and rural sociology between conceptions of expertise and experience. While the former is more focused on theoretical and conceptual distinctions, the latter is often more interested in farmers' behaviours and lived experience. Further, this literature in rural sociology points squarely to the importance of social context: farmers draw on local and personal experience and information differentially based on trust and embeddedness in different communities and relationships with different actors. Further complicating the landscape, an interdisciplinary effort across agricultural, social, and behavioural sciences seeks to map farmer decision making. We begin by reviewing these three streams of literature, discuss our data and analytic approach. Then, we identify themes in the data, and discuss how they bear on existing research on expertise, experience, and farmer decision-making. Finally, we conclude with an overview of our findings and a discussion of the implications of this research.

Expertise and experience

Expertise and in particular scientific expertise relies on the ability of experts to provide certified knowledge (Merton [1942] 1973; Nelkin 1975). In particular, scientists provide technical knowledge, producing valid and reliable information about the world (O'Brien 2012). Scientific information is often viewed as valid and reliable by virtue of the method of its collection. However, this conception of expert information relied not just on scientific *methods* but also on scientific *credentials*.

However, scientific information, particularly that collected in labs or via randomised and control versus treatment conditions, may be seen as too far removed from the complex reality of farming (Wynne 1992; Röling and van de Fliert 1994). In this way, science may seek to generalise or universalise information in a way that renders it less useful to farmers or other practitioners. Local information and expertise, often based on experience rather than scientific findings, is particularly important

in farming, where farmers are subject to conditions that are not only unpredictable (weather, rainfall), but also mutually constitutive (weather affects insect populations) and localised (neighbour's decisions on whether and how to address insect pests may affect their prevalence in your field). Therefore, sources of information that are localised will likely be more prized. Temporality too can influence how experience becomes expertise: farmers are oriented towards past history and their own experiences which may challenge uptake of new information with its focus on continuity and incremental progression (Riley 2008). This is consistent with research that finds farmers' learning relies on first-hand experiences both in the USA and internationally (Eckert and Bell 2005, 2006; Wyckhuys and O'Neil 2007; Franz *et al*. 2010), experience is predictive of long-term strategies for weed management (Jabbour *et al*. 2014), and grower-to-grower information sharing is particularly effective (Röling and van de Fliert 1994; Crawford *et al*. 2015).

At the same time, farmers are becoming increasingly reliant on external support to run their farms: both for fixing broken machinery, and adapting to legislation, environmental processes, and policy issues (Tousvalis *et al*. 2000; Ingram 2008). Existing research has argued that agriculture has undergone a process of 'deskilling' (Braverman 1974; Bell *et al*. 2015) whereby new technologies and chemicals come to replace skilled labour (Pfeffer 1992). In farming, the grower is both a manager and a labourer which makes such deskilling less straightforward. Nonetheless, scholars have argued that technology has replaced farmer expertise in some instances.

The dependence on external information (regulatory, chemical, technological, and technical) introduces new 'knowledge-cultures' (Tousvalis *et al*. 2000, p. 911) where sense-making (though it is interactive and fluid) varies across types of practical understanding and knowledge (Morris 2006). The result may be that regulatory and commercial frameworks, which emphasise universal and uniform knowledge, come to increasingly influence decision-making. For example, Moore (2008) uses evidence from Mali, the Ukraine, and Indonesia and finds that while local and scientific knowledge contribute to farmers' decision-making, commercial knowledge networks, including exporters, importing brokers, and inspection agents, were dominant. In another example, the development of hybrid corn meant that farmers no longer utilise their own carefully honed knowledge to select corn seed. Seed companies then function as 'experts' replacing farmer experimentation and experience (Fitzegerald 1993).

There are several actors that straddle the conceptual border between expert and non-expert. For example, Extension professionals can lay claim to scientific expertise by virtue of educational and other credentialing though their methods are not always reliant on scientific expertise. Instead, they are also often deeply embedded in the community and have localised knowledge and experience, factors that have been recently highlighted as key to improving Extension efficacy (Bessette *et al*. 2018). This is also true of Weed and Pest professionals in Wyoming, where Weed and Pest is a programme out of the state's Department of Agriculture Technical Service and is tasked with coordinating weed and pest activities in Wyoming via county-level local personnel. Finally, a farmer who has been effectively dealing with a challenge (for example, a particular insect pest) may be seen as an expert by virtue of experience rather than any educational credentialing or the application of standard scientific methods (e.g., control and treatment groups) to the treatment of a particular problem. That is,

growers may rely on experience rather than scientific credentials or methodologies for addressing issues and therefore recognise that as expertise.

The importance of context: farmer networks, trust, and learning

Farmer networks have been shown to be important for farmers' decision-making in several domains. For example, recent research on farmers' adaptation to climate change also suggests that more scientific information may be insufficient to influence farmers' practices but rather that knowledge needs to be linked to trusted agricultural networks. This further underscores the importance of sources of information and how they are embedded in broader social context (Morton *et al.* 2017). One meta-analysis of farmers' adoption of Best Management Practices (BMP, otherwise known as conservation practices to reduce runoff from agricultural lands and subsequent pollution of waterways) suggests that access to and quality of information is most influential in farmers' adopting best practices, but that being connected to local networks of farmers was also a salient factor (Baumgart-Getz *et al.* 2012).

Scientific insights have been found to be more effective, and farmers more receptive to them, when they interact with 'local knowledge stocks' (Clark and Murdoch 1997, p. 56) and when scientists engage with local actors. This may be partly owing to the imbalance of power and intervention between farmers and experts where experts with agendas aim to convince farmers to follow their advice (Long and van der Ploeg 1989; Ingram 2008). A recent report from the UK recommends involving friends and family in knowledge exchange activities, and channelling new information via existing networks to maximise engagement (Rose *et al.* 2018a). Community context is also important, for example, farmers were more likely to seek to control invasive species if they felt this was normative and that there would be community reciprocity (Niemec *et al.* 2016). The acceptance of scientific evidence by farmers relies on trust and credibility, which are often contingent on the social relationships and identities of those producing and disseminating scientific knowledge (Wynne 1992). Altogether, these literatures urge us to move away from focusing on farmers as disconnected individuals, rather centring farmers' decision-making in context (Rose *et al.* 2018b).

Farmer decision-making and technology

Within rural sociology and agricultural studies, another related stream of research focuses more squarely on farmer decision-making. While this literature necessarily incorporates insights on experience, expertise, contexts, and resources, it more squarely positions farmers as considering competing demands, and their interaction with new technologies and challenges. Researchers find that when confronting weeds and weed management, farmer and scientific expert 'mental models' were similar in terms of conceptual knowledge, but differ in emphasis (Jabbour *et al.* 2013; Zwickle *et al.* 2016). For example, while experts focused on yield loss as a result of weeds, farmers discussed not only yield lost but also time and labour costs. In another example, farmers' decisions about using Bt corn (genetically modified to express the *Bacillus thuringiensis* toxin) relies most strongly on farmers' own or other local experiences in

making this decision, challenging the notion that technology necessarily displaces farmer skills, at least in decision-making (Kaup 2008). This experiential knowledge is characterised by attentiveness, responsiveness, and adaptation to the material environment and create situated expertise among farmers (Krzywoszynska 2016).

Despite the undeniable effect that new technologies have on farmer behaviour other studies continue to highlight the importance of peer networks and farmer-to-farmer learning together with farmers' own experiences in informing their behaviours (Thomas *et al*. 1990; Compagnone and Hellec 2015; Noy and Jabbour 2017). Some of these insights come from the understanding that experimental research, under controlled conditions 'can have only limited applicability to actual farming operations because of limitations intrinsic to the probabilistic extrapolation of experimental results to highly variable biological and social systems' (Kloppenburg 1991, p. 521). This concern with complexity, and the applicability of 'expert' technology, including pesticides, and information to their own situations shapes the ways in which growers weigh the benefits and costs of different solutions to multiple and varied problems.

Data and methods

We draw on data from four focus groups in four counties across the state of Wyoming in Spring 2014 and Fall 2015, which we have named: North, South, East, and Middle Counties in order to preserve anonymity. Informed consent was obtained from all individual participants included in the study. These focus groups were part of a larger cross-disciplinary, mixed-methods project intended to understand the priorities, challenges, and perceptions of Wyoming alfalfa farmers, with a focus on insect pests. We selected four counties that were dispersed across the state, since these often serve different markets (e.g., seed versus hay) and experience different types of challenges. The producers were recruited by the county Extension educator according to our request that producers vary according to experience level, market, and scale of operation. Since there was no other registry available to us of alfalfa farmers in the state this was a good way to recruit focus group participants. We do not believe this recruitment strategy has biased results in terms of themes and experiences conveyed as Extension professionals are a ubiquitous feature in farming in Wyoming and we particularly asked for varied characteristics in terms of farm size and experience, which we achieved in each of the focus groups (see Table 1). The protocol was approved as exempt by the University of Wyoming Institutional Review Board. All alfalfa growers and counties are referred to by pseudonyms to protect their identity. The focus group in East county was conducted in January 2014 and attended by six growers, the focus group in South county was conducted in February 2014 was attended by seven growers, the North county focus group was conducted in February 2015 and was attended by nine growers, and the Middle county focus group was conducted in March 2015 and attended by three growers.

Table 1 presents descriptive data on the focus groups gleaned from a short survey administered before the focus group to gather information about the growers and their operations.

Table 1: *Descriptive statistics for focus group respondents*

County	East	South	North	Middle
Date of focus group	January 2014	February 2014	February 2015	March 2015
Number of participants	6	9	7	3
Average acres for total dryland crop production	23.33	50	0	0
Average acres for dryland alfalfa	6.67	12.5	0	0
Average acres total irrigated crop production	883.33	396.88	1022.11	234.33
Average acres irrigated alfalfa	537.5	318.75	274.22	126.67
Average acres total rangeland	12.5	4115.38	415.67	143.33
Alfalfa produced for	Primarily hay	Primarily hay, some feed	Half seed, Half on feed and hay	Hay and on farm feed
Annual gross agricultural sales (average category)	$250-500k	$50-100k	$250-500k	$100-250k
Percent of Household Income from Farming/Ranching	80.67	77.14	90.67	66.67
Age (average category)	45-54	45-54	55-59	45-54
Education (average category)	Some college	Some college	Some college	Technical/vocational degree

Overall, we had variability in both farm size and function: while growers in two focus groups had exclusively irrigated alfalfa others had a mix of both dryland and irrigated alfalfa. There was also variation in the use of alfalfa: ranging from primarily hay to combination with on-farm feed and in North county, alfalfa was also grown for seed. There was also diversity in terms of gross agricultural sales, with East and North county growers' having higher grossing farms, on average, followed by Middle then South counties. In South county and East county farming and ranching made up about 80 per cent of household income whereas in Middle county this was nearly 70 per cent and in North county slightly over 90 per cent. Finally, while all of our focus group participants were men, the participants from North county were on average older, and those in Middle county had the highest average level of education, at a technical or vocational degree whereas the average for growers in the other counties was some college education but no terminal degree. There was considerable variability both within and across focus groups both in terms of size and output but also in terms of how farmers discussed insect pest challenges, partly owing to the generative nature of focus group discussions.

We began the focus group with introductions of ourselves then asked our participants to introduce themselves, we then asked them about the insect pests they had encountered, which they considered most problematic and why, then how they address pest problems and in particular what influences their decisions to use particular management practices, where they went to learn about pest management in alfalfa, and finally what information would be useful to them. In this article we examine how alfalfa growers seek information in addressing uncertainty and challenges in dealing with insect pests and how they frame expertise, experience, and their own learning. Our understanding of learning, experience, and farmers' views of expertise are well addressed using the rich, interactive data generated by focus groups. Focus groups are particularly valuable in helping us understand how participants think about issues, giving priority to their language and concepts and their framework for understanding the world (Kitzinger 1994). Focus groups also de-centre methodological and theoretical individualism as they are a generative and collaborative information-sharing and gathering space. Group participants provide an audience for each other, and allow the researcher to observe shared meanings, discussion, and understandings. It is in the interaction that the researcher is able to best understand what respondents know and what they mean. In doing so, focus groups reveal dimensions of understanding and information exchange that are hidden in individual interviews or surveys because of their interactive and generative nature.

Our data analysis was thematic and conceptual: in particular, after all focus group recordings were transcribed, we examined themes as they related to expertise and advice. In this analysis we were guided by existing literature on expertise and experience, and insights about how farmers weigh and consider different sources of information on the one hand, and themes emerging from the data itself on the other. For the latter, we followed an inductive approach, thematically grouping discussions related to advice and decision-making and then using these themes to guide our discussion of results.

Results

We began with an interest in expertise, experience, and farmer decision-making. Keeping in mind the issues highlighted in the literature on experience, expertise, networks, communities, and farmer decision-making we thematically grouped discussions of experience, expertise, and networks, allowing concepts and dimensions of discussion to emerge from the data. Our discursive analysis of the focus group data, yielded four primary themes: *first*, a discussion of experience in pest management, *second*, a discussion of neighbours and networks, *third*, a discussion of bias, particularly among chemical companies and, *fourth* and finally, dimensions by which farmers categorise and evaluate useful information. We proceed by discussing each of these themes.

Experience and networks

Consistent with existing studies, farmers reported relying heavily on experiential knowledge (Tousvalis *et al*. 2000; Morris 2006; Ingram 2008). The most commonly

mentioned sources for dealing with insects pests were experienced neighbours, rather than farmers' own experience: 'the guys who've just been doing it for years. they know what is good, especially like when you get into stuff you don't see like the grasshoppers and the beetles … I'd say that I count on my friends and neighbours more than anybody' (Ned, South County). Friends were named as significant as well, reinforcing the importance of trust and social (not only physical, as in the case of neighbours) closeness in shaping farmers' information seeking.

This was echoed in the other focus groups with some mention that reliance on neighbours sometimes did not even require a conversation, but rather just observations:

> 'Richard: But then again, you're also, you're out irrigating and you meet your neighbour and out driving the sprayer and ask me what I'm spraying, and I ask what he's spraying. And uh, but then you talk to them and say well I've started to see this in my fields, and well that's starting to come out in my fields too. You kinda plot your neighbours too.
>
> Cole: I don't even talk. I just see Zeke's sprayer in the field and I just start sweeping. Find out what he's spraying for' (North County).

This idea of watching one's neighbours was passed on generationally: 'When I first started farming, my dad told me that Wyatt across the road – when he hooks up the plow you go hook up the plow. When he takes it to the field, you go to the field. And there's a lotta truth to that' (Art, East County). 'Old timer' was the descriptor for experienced Wyoming farmers that emerged in two of the four focus groups. The discussion of following neighbours' lead in this focus group was preceded by an exchange that noted that first-hand experience was an excellent teacher, but also discussed the importance of new information, often imparted by neighbours:

> Art: Cause we've seen people move in from out of state or where ever, first of all some of 'em weren't from an Ag[ricture] background and thought farming was easy. Throw the seed ya harvest and just bank it. But there's and often times there's a reason you neighbour is doing this, this, this and this. You may not have done it Wisconsin but ya do it here. And (pause) it doesn't, it is a smart move to go talk to the old timer and say, not that the old timers can't adopt new practices, they need to but,
>
> Tim: They're yeah, they're doing that stuff for a reason and most of the time it's not because of, it's not because they just want the extra work … It's worked for 'em in the past (East County).

Alfalfa weevil was unanimously, across the focus groups and farmers, named the most problematic insect pest. Sam, in East County, notes that watching and talking to neighbours was important in particular because alfalfa weevil would devastate a crop very quickly: 'Another thing I noticed is you can check 'em on Monday and everything looks still pretty good and then on Wednesday you could've lost half your field, They can skeletonise the crop in, in two days, it's just amazing how fast they can, so you can be hunting 'em and looking for 'em and think there's not very many, so it's almost like one of those deals where you should get on a rotation where you do it all the time consistently, you know'. In terms of deciding, what to do about alfalfa weevil in a given season, growers noted talking to neighbours as soon as they saw 'symptoms':

Gabe: You ask your neighbour.

Tim: And here's how your neighbour knows.

Gabe: You'll see your crop kind of go to hell (East County).

In another focus Lawrence echoed this sentiment: '... there's a wealth of information if you'll talk to the guys that have been in this country their whole life farming they've seen a lot of things' (Middle County). Therefore, observing and interacting with neighbours, who were experts by virtue of their experience, was a popular and successful insect pest management strategy.

Substantively, several interventions to manage insect pests were suggested by neighbours: disturbing the soil was a common response to alfalfa weevil, and this practice was deemed effective because of farmers' own experiences or the advice of experienced farmers (Middle County, South County). In this way, neighbours and farmer friends provide diagnostic information about which pests and amounts but also prognostic information about how to manage pests. One farmer indicated that while he had not tried it and did not know if raking the soil would lead to less yield loss from weevil this was something that he was interested in trying: 'I like the idea of rake. I really think there is probably, definitely something to that. It's not a practice that I've used but I mean it's definitely a practice that, is definitely worth trying, you're gonna rake it anyway' (Matt, East County).

These exchanges underscore the generative nature of focus groups, where farmers were able to learn from one another and evaluate information based on their experience. Soil disturbance via harrowing was also thought to be a deterrent in not only disturbing weevils but also egg masses for later in the season, Matt continues: 'You know I wonder, I never thought about this and I harrow all my alfalfa fields every year, I wonder if harrowing does something to disturb the egg masses ... like I said, I haven't had a problem [with weevil] in the last couple years but I harrow every spring, and I haven't had, I haven't like I a problem on you know, here and there on fields but the past five years but consistently I don't have a problem.' Discussions of soil disturbance were particularly interesting because some farmers, as the above quote from Matt demonstrates, did not think extensively about *why* it worked prior to the focus group, but had simply taken it on experience.

Neighbours as variables and neighbourliness as community-building

Neighbours functioned as important sources of information, and most valuably proximal and local information, but neighbours were not only a *source* but also an important *variable* in the type and quantity of insect pests encountered and their treatment. For example, one grower indicated that he has been relatively sheltered from weevil because of the isolated location of his field: 'I didn't have any weevil last year. And I think part of it, that's where my hay is, there isn't a lot of neighbours around ... There is a field of grass alfalfa next to me and then the rest of its just rangeland' (Darren, South County).

Because insects are mobile, there is an important coordination component, beyond whether and how close by the neighbours are there was a consensus that whether neighbours sprayed insecticides in their fields has implications for the effectiveness

of pest management in growers' own fields: 'We got the big ranch up the canyon you know, quite a few thousand, 10,000 plus acres and the guy I work for, you know, he's wealthy so he goes in and he sprays his, but the [other] one didn't spray so they all would come back on us anyways' (Ned, South County).

Coordination with neighbours was important in terms of not just *whether* to spray but *what* to spray. Many of the growers used aerial spraying, and hired someone to spray (that is, they did not own their own spraying plane), and this was often the only person available. Therefore, those with smaller acreage typically deferred to their larger acreage neighbours and/or the sprayer as that was their only option if they wanted to spray: 'That's what everybody else is spraying, and that's what the plane's set up for, so, my small acreage, I don't argue I just say what are they doing? That'll work for me. Maybe that's crazy, and out there where we're at we're pretty isolated. So you either have them spray when they're there or you don't' (Lawrence, Middle County).

Farmers also discussed the importance of acting neighbourly themselves, not just in terms of sharing advice and sprayer planes but also to warn those that had bees on their property when spraying, since most of the pesticides were harmful to bees. Later in this same focus group one grower shares 'We told them when they were gonna spray and I says you need to come out and watch or whatever you know. And cover them [the bees] or something. And the come out and threw a quick tarp over them for a little while' (Zach, Middle County).

Chemicals: flexibility in cutting and concern about corporate agendas

Chemicals were a popular choice in insect pest management. Despite the promise of early cutting and soil disturbance, ultimately, however, for alfalfa weevil the growers agreed that spraying pesticides was the only option if early cutting, dragging, and other strategies were not effective. Spraying had the added benefit of allowing flexibility, since early cutting (getting the crop harvested before the insects ravaged it) was another popular, though limiting approach: 'So that's a big, a big reason why we spray a lot ... it means I'm not going to have to cut because of bugs, I cut whenever I wanna cut' (Jason, Middle County). Therefore, even techniques that were deemed effective (either owing to others' recommendations or farmer's own experience) were eschewed because of other considerations such as time, timing, and yield. This underscores the contingent nature of decision making in the farming context, which varies not only by season, but also by farmers' goals, including flexibility beyond the standard focus on quality and quantity of crop harvest.

Growers then would often turn to chemical companies and their representatives in dealing with insect pests. Dan, one of the participants in the South County focus group, who had emerged as a particular good local source (everyone in his focus group turned to him for advice save one, and the one who did not indicated: 'I just met Dan today, so I don't go to Dan, but I'll probably start going to Dan' which prompted another grower to suggest 'Get his phone number before you leave'). When asked where he got his information Dan suggested that when he had questions he asked 'Oh, usually the people with the chemicals or whatever, there. BASF or you know DuPont [chemical companies], any of 'em, they all have their chemicals and what they're doing with em' (South County). Farmers often consulted chemical companies

in conjunction with Weed and Pest as another respondent elaborates 'Sprayer guys, yeah the local co-op guys or weed and pest, if I ever have anything' (Darren, South County).

One member of another focus group noted that this reliance on chemical company and even farmer co-op representatives despite being mentioned as very helpful (a 'blessing' in East County) may be problematic because of their interests: 'You always got to keep in mind that they're trying to sell chemical' (Cole, North County). However, there were differences of opinion about how biased chemical companies were. For example, in the discussion of the co-op representative who was a 'blessing' and 'walked more fields' than anyone else they knew in East County did not raise any issues of bias among that set of farmers. Others were more cynical about their motives: 'they get a commission for what they sell. Sometimes they want to sell you the most expensive and most, I mean that's my own personal feelings, you just got to be careful, you gotta make your own decisions' (Grant, North County) while another notes that it may not be bad intentions, but rather the complexity and differences across fields: 'And sometimes they will be giving you the best advice they can based on what they know. But they haven't been in your field with your soil and set up or that year where you got all that rain that they've never had before' (Richard, North County).

We ended each focus group by asking what kind of information growers would like more of (in an effort to make future research by the project team useful to growers and to understand where information gaps lay). One grower indicated that he was doing his own research about quality in dry versus wet hay in terms of protein content in particular but would like the university to do some more of this research (Dan, South County). In another focus group growers requested perhaps not new information but unbiased information: 'I guess having non-biased information out there too ... knowing whether it's non-biased on the chemical or whatever you're using, you know to where there are studies done on it and, you know that it ain't the company studies it's universities or whatever else you know, to do that ...' (Tom, North County).

The utility of different types of information: relevance, locality, accuracy, and diagnosis/prognosis

Information was also judged not just based on *source* and along questions of bias, but was also based on *types* of information: its relevance, accuracy, and whether it was diagnostic or prognostic in addition to local versus universal information which altogether helped determine the utility of information to farmers. One distinction was between relevant and irrelevant information rather than its accuracy. As Richard explains: 'Yeah, because sometimes even if you find the information, like I said, you gotta sort through is this actually information we can trust? And if you trust it, is it something you'd actually use' (North County). Particularly, some information was not doubted to be accurate but its practical significance was in question, one grower reports that he read in a trade magazine:

> Jason: 'If you get past 4 July[for cutting] then you're starting to get into potential monsoonal flows, and you'll start to have those afternoon thunderstorms pop up and it's more hit or miss. So we want to be ready to go in that window and then you know you're looking at

those factors, how, when did I irrigate? What last? You're kinda trying to do the water, do you get to sequence it? We're gonna cut this hay first, we're gonna go to that hay, we're gonna go to that hay. So and that's where I get a kick out of like these, you read these Hay and Forage [a magazine], and they say you get higher protein if you cut your hay in the afternoon. And I, no doubt someone got tenure off of proving that you can (laughter) get more, a tenth of a percent or half percent, of protein more by cutting your hay in the afternoon. And God bless those people, but there's no way that I can just cut my hay in the afternoon and get that half a percent of protein. There's so many other things that go into it. (laughter) You know what, when I read that I just laughed. I don't know if you saw that, it was in Hay and Forage, it was like afternoon hay cutting has higher protein.

Lawrence: I've heard so many different ideas like that over the years that at some point you just kinda.

Jason: Oh I'm sure they proved it. But I can't really only cut half a day' (Middle County).

The question here was not whether this information was accurate but whether it was useful and the assumption was that it was an academic that had conducted this research (and earned tenure for it) when it held little practical value to farmers because of other considerations and variables. This information was not useful not necessarily because it was universal or irrelevant: farmers care about protein content in their hay, but rather the information did not account for the complexity of competing considerations in decision-making.

Farmers' own experiences and neighbours' advice were particularly valued because the information was both local and tailored to farmers' own challenges, rendering it *useful*. That is, being local was prized as both an attribute of the source but also the type of information. County Weed and Pest and Extension officials were identified less often than neighbours, friends, and even chemical company representatives as sources of information and advice but were trusted more than the latter: 'I call my other neighbour, they're a friend of ours. But I call the County Weed and Pest almost always for weeds. I talk to the neighbours too. But also my Dad's been doing it in this country since I was little tiny. So he's a pretty good source' (Lawrence, Middle County). Here experience results in localised expertise.

Different sources were also consulted for another dimension distinguishing types of information: prognostic versus diagnostic. Extension professionals and Weed and Pest personnel were more likely to be asked for factual information, such as help identifying insects: 'I had Cody [local Extension professional] come out thinking it was the cutworms cause it looked like a cutworm damage but there was just nothing and we dug down and there wasn't anything (Nick, South County).

Similarly, a co-op representative was known in the area for being able to raise an alarm early about weevils, not only because of his education but also his experience: 'He's an agronomist that, with the [name removed] co-op and because those agronomists are in so many different fields in this area all the time they see a problem they'll report it and when, when Harry [co-op representative] says well we're beginning to see some alfalfa weevil in some of these fields, at that point I maybe haven't, I maybe haven't checked for any alfalfa weevil but at that point when I hear Harry say that on his programme I'm gonna, I'm gonna go start checking for some alfalfa weevil' (Tim, East County)

and another adds: 'Harry's one of those people you can believe everything he says ... This guy's been in more fields than any man I've ever met' (Art, East County). Beyond diagnostic information identifying insect pests which farmers often turned to Weed and Pest, Extension, and sometimes co-op representatives for, neighbours were the preferred source for pest management – prognostic – information as discussed above.

Another issue was a question of accuracy of information: information was sometimes deemed inaccurate if it conflicted with experience. In addition to concerns about chemical company representatives being biased there was also concern that experts were simply wrong. This concern was voiced in connection not to agronomists but to a vet, and the benefits of different kind of hay (high versus lower protein) for feeding different (younger or older) animals (Middle County).

In the face of contradictory evidence, we found that farmers trust their own experience over that of experts. This does not mean, however, that they necessarily dismiss expert information in other settings. That is, farmers are selective and reflexive about the information they believe, based on their own experiences, and that of peers. This suggests that if universal knowledge is to be taken up by farmers, it requires some translation and introduction by trusted informants. However, our focus group also yielded an exception to the pattern that information that is local, relevant, and accurate would be useful. Soil and subsequent insect disturbance, which was preferred to spraying pesticides, partly due to cost, was sometimes untenable because of the time it took beyond difficult terrain, where rocky land was noted in the Middle County focus group as making it unfeasible to harrow. Ned explains that the issue was not terrain but time: he does not 'have the time to do what you're trying to [because you have to] get on to the next field that's just more, that's another eight hours, six hours of work' (South County). This information was therefore relevant, deemed accurate, local, and prognostic but was less useful given other constraints and factors, including time.

The growers therefore distinguish different types of information together with the source of information, where companies were motivated by sales and therefore perhaps providing biased information as compared with university scientific studies which were viewed as more trustworthy (though not always practical or workable, such as only cutting in the afternoon to increase protein content). Farmers then considered local versus universal information, where trust in each depended on the sources and its relevancy. That is, information could be relevant (e.g., strategies for maximising protein content) but not useful because of local conditions or overriding considerations (e.g., flexibility in cutting).

Discussion

Our results reveal some interesting insights. In order to be useful, expert information needed to be local and to consider the complex realities of farming. When farmers questioned information, it was because it did not fit with their experience, whether that information was from experts or others. Neighbours were particularly valued for their experience based-insights, consistent with accounts that note the importance of trust and networks in utilisation of expert information (Wynne 1992; Clark and Murdoch 1997; Baumgart-Getz *et al.* 2012). However, our analysis also finds that

neighbours are not only a source of information, but an important variable in guiding growers' insect pest management strategies. Some information was not challenged on accuracy grounds, but rather, was simply deemed irrelevant or not useful albeit correct. That is, this information focused on only one variable (early cutting to maximise protein content, or soil disturbance to manage insect pests) without considering the complex realities faced by farmers who had to juggle the weather, water availability and rainfall, insect pests, weeds, yield and quality of the crop, and their buyers among other factors.

Weed and Pest and Extension professionals, especially those who had deep roots in the community, were seen as valuable and trusted sources of information, especially for diagnostic purposes. In this way, they were not only experts by virtue of education, technical credentials, or scientific methods but also experts with localised information and experience, which made their advice particularly valuable. Therefore, their expertise did not rest necessarily on their scientific training but also on their experience in these counties and communities. Chemical companies and co-op representatives on the other hand received more mixed treatment. They were viewed as important sources of information, unsurprisingly about chemicals, but growers also expressed that their interests (in selling products) may bias the type of information and advice they provided. This is consistent with existing studies that point to the fact that farmers are more open to expert information when experts, in our data these are Weed and Pest and Extension personnel, interact with farmers and build trust (Wynne 1992; Clark and Murdoch 1997).

Our results extend the literature in rural sociology and agriculture on farmers by underscoring the reflexive nature of farmers' information seeking, validation, and utilisation, and the primary actors from which they draw on. In doing so, we identify how farmers think about the utility, relevance, and bias in information that they receive, together with the importance of personal, communal, and local ties in decision making. Our analysis further identifies the dimensions by which farmers evaluate information: relevancy, accuracy, and whether it is prognostic/diagnostic and local/universal, all of which, together with other considerations about each growers' priorities, feed into their assessment of its utility. Our findings can be useful to Weed and Pest, Extension, and other actors in agriculture who create materials and offer assistance to farmers. The dimensions of information-evaluation discussed by farmers together with other competing demands (time, resources) can be used to more relevantly frame Extension communications intended for farmers. Our results suggest that both rural sociologists and practitioners should account for how neighbours function as a resource in terms of information and experience, but also as variables to be contended with, especially in smaller farms (e.g., those that share a spraying plane with a neighbouring farm), working to both expand and constrain farmers' decision-making. Finally, our analysis highlights the conceptual utility to sociologists of considering experience – both one's own and neighbours—as a type of expertise, beyond scientific and technical expertise which focuses on methods and credentials, to experience which focuses on outcomes, and is prized in situations where isolating a single issue or variable (e.g., weather, insects pests, weeds) is impractical and impossible for practitioners, as is the case with farming.

Conclusion

The alfalfa growers we spoke to reported neighbours as a primary source of advice as well as drawing on their own experience, together with Weed and Pest offices, Extension personnel, and other sources. Farmers often turned towards chemical treatment for insect pests, but rather than saving labour this was seen as maximising crop yield. The question of when to apply chemicals (especially in relation to crop cutting time) relied on experience and expertise and neighbours' decisions and behaviour, contradicting the classic formulation of labour deskilling whereby chemicals and technology come to replace experience and expertise of farmers. Far from diminishing farmer reflexivity and farmer involvement in farm management decision-making, these technological, including chemical, innovations and products require careful attention in farmer decision-making about insect pest management amidst a myriad other information and considerations.

Weed and Pest and Extension personnel were viewed as valuable sources of information partly because of their deep embeddedness in the community, underscoring the importance of networks. Experience in particular was prized given the localised nature of challenges, and the relationship between weather, weeds, insect pests, water availability, and market demands. This is consistent with existing literatures that note the importance of local knowledge and the importance of networks in knowledge exchange. But, neighbours did not function only as sources of information, but as important variables in insect pest management: what and when to spray and what kinds of pests became problems depended on neighbouring farms, and neighbour farmers' pest management strategies.

Conflict of Interest

The authors declare no conflict of interest.

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References

Baumgart-Getz, A., L.S. Prokopy and K. Floress (2012) Why farmers adopt best management practice in the United States: A meta-analysis of the adoption literature. *Journal of Environmental Management* 96 pp. 17–25

Bell, S.E., A. Hullinger and L. Brislen (2015) Manipulated masculinities: Agribusiness, deskilling, and the rise of the businessman-farmer in the United States. *Rural Sociology* 80 (3) pp. 285–313

Bessette, D., S. Zwickle and R. Wilson (2018) In the weeds: Distinguishing organic farmers who want information about ecological weed management from those who need it. *Renewable Agriculture and Food Systems* FirstView, published online 31 January 2018 pp. 1–12
Braverman, H. (1974) Labor and monopoly capital: The degradation of work in the twentieth century (New York: Monthly Review Press)
Clark, J. and J. Murdoch (1997) Local knowledge and the precarious extension of scientific networks: A reflection three case studies. *Sociologia Ruralis* 37 (1) pp. 38–60
Compagnone, C. and F. Hellec (2015) Farmers' professional dialogue networks and dynamics of change: The case of ICP and no-tillage adoption in Burgundy (France). *Rural Sociology* 80 (2) pp. 248–273
Crawford, C., J. Grossman, S.T. Warren *et al.* (2015) Grower communication networks: Information sources for organic farmers. *Journal of Extension* 53 (3) pp. 3FEA9
Eckert, E. and A. Bell (2005) Invisible force: Farmers' mental models and how they influence learning and actions. *Journal of Extension* 43 (3) pp. 3FEA2
Eckert, E. and A. Bell (2006) Continuity and change: Themes of mental model development among small-scale farmers. *Journal of Extension* 44 (1) pp. 1FEA2
Fitzgerald, D. (1993) Farmers deskilled: Hybrid corn and farmers' work. *Technology and Culture* 34 pp. 324–43
Franz, N., F. Piercy, J. Donaldson *et al.* (2010) How farmers learn: Implications for agricultural educators. *Journal of Rural Social Sciences* 25 (1) pp. 37–59
Ingram, J. (2008) Agronomist-farmer knowledge encounters: An analysis of knowledge exchange in the context of best management practices in England. *Agriculture and Human Values* 25 pp. 405–418
Jabbour, R., S. Zwickle, E.R. Gallandt *et al.* (2013) Mental models of organic weed management: Comparison of New England US farmer and expert models. *Renewable Agriculture and Food Systems* 29 pp. 319–333
Jabbour, R., E.R. Gallandt, S. Zwickle *et al.* (2014) Organic farmer knowledge and perceptions are associated with on-farm weed seedbank densities in northern New England. *Weed Science* 62 pp. 338–349
Kaup, B.Z. (2008) The reflective producer: The influence of farmer knowledge upon the use of Bt corn. *Rural Sociology* 73 (1) pp. 62–81
Kitzinger, J. (1994) The methodology of focus groups: The importance of interaction between research participants. *Sociology of Health & Illness* 16 (1) pp. 103–121
Kloppenburg, J.J. (1991) Social theory and the de/reconstruction of agricultural science: Local knowledge for an alternative agriculture. *Rural Sociology* 56 (4) pp. 519–548
Krzywoszynska, A. (2016) What farmers know: Experiential knowledge and care in vine growing. *Sociologia Ruralis* 56 (2) pp. 289–310
Long, N. and J.D. van der Ploeg (1989) Demythologizing planned intervention. *Sociologia Ruralis* 29 (3/4) pp. 227–249
Merton, R. ([1942] 1973) The normative structure of science. Pp. 267–280 in N. Storer ed., The Sociology of Science (Chicago, IL: University of Chicago Press)
Moore, K.M. (2008) Network framing of pest management knowledge and practice. *Rural Sociology* 73 (3) pp. 414–429
Morris, C. (2006) Negotiating the boundary between state-led and farmer approaches to knowing nature: An analysis of UK agri-environment schemes. *Geoforum* 37 pp. 113–127
Morton, L.W., G. Roesch-McNally and A.K. White (2017) Upper Midwest farmer perceptions: Too much uncertainty about impacts of climate change to justify changing current agricultural practices. *Journal of Soil and Water Conservation* 72 (3) pp. 215–225
Nelkin, D. (1975) The political impact of technical expertise. *Social Studies of Science* 5 pp. 35–54
Niemec, R.M., N.M. Adroin, C.B. Wharton *et al.* (2016) Motivating residents to combat invasive species on private lands: Social norms and community reciprocity. *Ecology and Society* 21 (2) pp. 30–40

Noy, S. and R. Jabbour (2017) Using egocentric networks to illustrate information seeking and sharing by Alfalfa farmers in Wyoming. *Journal of Extension* 55 (2) pp. 2RIB1
O'Brien, T.L. (2012) Scientific authority in policy contexts: Public attitudes about environmental scientists, medical researchers, and economists. *Public Understand of Science* 22 (7) pp. 799–816
Pfeffer, M.J. (1992) Labor and production barriers to the reduction of agricultural chemical inputs. *Rural Sociology* 57 (3) pp. 347–362
Riley, M. (2008) Experts in their fields: Farmer-expert knowledges and environmentally friendly farming practices. *Environment and Planning* 40 (6) pp. 1277–1293
Röling, N. and E. van de Fliert (1994) Transforming extension for sustainable agriculture: The case of integrated pest management in rice in Indonesia. *Agriculture and Human Values* 11 (2–3) pp. 96–108
Rose, D., C. Keating and C. Morris (2018a) Understanding how to influence farmers' decision-making behaviour: A social science literature review. Report to the AHDB https://projectblue.blob.core.windows.net/media/Default/Imported%20Publication%20Docs/FarmersDecisionMaking_2018_09_18.pdf
Rose, D., C. Keating and C. Morris (2018b) Beyond individuals: Toward a 'distributed' approach to farmer decision-making behaviour. *Food and Energy Security* 7 (4) pp. 1–4
Thomas, J.K., H. Ladewig and W.A. McIntosh (1990) The adoption of integrated pest managements practices among Texas cotton growers. *Rural Sociology* 55 (3) pp. 395–410
Tsouvalis, J., S. Seymour and C. Watkins (2000) Exploring knowledge-cultures: Precision farming, yield mapping, and expert-farmer interface. *Environment and Planning* 32 (5) pp. 909–924
USDA-NASS (2018) State agricultural overview Available online at https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=WYOMING [accessed 10 September 2018]
Wyckhuys, K.A.G. andR.J. O'Neil (2007) Local agro-ecological knowledge and its relationship to farmers' pest management decision making in rural Honduras. *Agriculture and Human Values* 24 pp. 307–321
Wynne, B. (1992) Misunderstood misunderstanding: Social identities and public uptake of science. *Public Understanding of Science* 1 (3) pp. 281–304
Zwickle, S., R. Wilson, D. Bessette *et al.* (2016) Facilitating ecological weed management decisions by assessing risk-benefit tradeoffs. *Agroecology and Sustainable Food Systems* 40 pp. 635–659

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