

Skeptical but Adapting: What Midwestern Farmers Say about Climate Change

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ABSTRACT

Farmers stand to be greatly affected by changes in the climate, necessitating adaptive responses, yet little is documented on how U.S. Midwestern farmers understand and perceive climate change adaptation. Eight focus groups with 53 Michigan farmers were conducted in 2011–12 to better understand the following: 1) what do farmers think about the relationship between climate change and agriculture, 2) what differentiates normal weather-related management from climate change adaptation actions, and 3) how do farmers understand the term “climate change adaptation.” Farmers expressed skepticism at global climate change yet conveyed specific details about the local changes in climate they are experiencing on their farms. They were not able to clearly define the term “climate change adaptation” but did note specific adaptive actions they have already implemented. The farmers explained that nonclimate factors were of more concern to them when making management decisions, and they showed reactive (not proactive) actions toward adaptation. Farmers noted that any action they take has to address their specific situation, suggesting that generalized adaptation actions and language might not resonate with them. Building on quantitative surveys conducted by others, the findings in this paper contribute to ongoing efforts to more effectively assess farmers’ perceptions related to climate change adaptation and to use that understanding to promote education, outreach, research, and public policies to more proactively address the consequences posed by climate change.

1. Introduction

While farmers of the U.S. Midwest are some of the world’s leaders in producing high-yielding crops, changing climate conditions out of their control—including increased rainfall intensity and variability, warmer temperatures, and shifting seasonal patterns—are affecting production (Hatfield et al. 2014). Over the last several decades, climate change has affected the U.S. Midwest in several significant ways: warmer annual average temperatures, longer growing seasons, 10%–15% more annual precipitation, and a 37% increase in extreme rainfall

events. These trends are expected to continue and worsen (Walsh et al. 2014) and interact in complex ways with elevated carbon dioxide levels, soil nutrient dynamics, weed and insect pests, diseases, and air pollutants, all affecting plant growth and yield (Tubiello et al. 2007). Analysis of historical trends shows that several major U.S. crops have already shifted production regions as a result of climate (Cho and McCarl 2017). Schlenker and Roberts (2009, p.15 595) show that corn and soybean yields may increase with daily maximum temperatures up to a point (up to 29°C for corn and 30°C for soybeans) but that with corn, for example, “substituting a full day (24 h) at 29° C temperature with a full day at 40°C temperature results in a predicted yield decline of ~7%, holding all else the same.” In the U.S. Midwest, projected increases in precipitation amount, variability, and intensity, coupled with rising temperatures,

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are predicted to negatively affect grain crop yields (Pryor et al. 2014; Schaubberger et al. 2017), necessitating adaptive responses from farmers.

The National Climate Assessment defines adaptation as “actions to prepare for and adjust to new conditions, thereby reducing harm or taking advantage of new opportunities” (Melillo et al. 2014, p. 10). Throughout history, farmers have skillfully adapted to slow changes in the climate and to weather variability (Hatfield et al. 2014; Lengnick 2015), yet the current rate and intensity of change calls for new adaptive measures (Hatfield et al. 2014). In the short term, adaptation in agriculture will continue to rely on existing technologies and strategies; however, without increased innovation, longer-term changes in the climate will undermine agricultural adaptation (Hatfield et al. 2014). Even with innovation, the cost and difficulty of adaptation will increase (Hatfield et al. 2014). Adaptation recommendations are generally based on projected climate trends (e.g., Howden et al. 2007; Easterling 2011; Hatfield et al. 2014). For example, in response to longer growing seasons, farmers are advised to plant earlier or relocate crop production across the Midwest. Other recommendations based on projected changes include technological innovations, such as breeding and genetic modification of crops and better climate forecasting. Increasing the resilience, or sustainability, of cropping systems is a common adaptation recommendation and includes practices aimed at better soil and water conservation and diversifying crops and income source (Wall and Smit 2005). These and other recommendations often promote a suite of adaptation options for the agricultural sector. The Adaptation Toolkit (Easterling 2011), for example, includes current and future adaptation tools in four primary categories: natural resources and inputs, technological innovation, human ingenuity, and information and knowledge.

While climate change adaptation has received significant attention from academics, less attention has focused on how farmers experience climate change adaptation measures and how they perceive climate change adaptation. Although adaptation is a seemingly straightforward notion (taking actions, reactively or proactively, to respond to climate change), recent work highlights the complexity associated with adaptation. Petersen et al. (2013) showed that even individuals working in similar disciplines can have highly divergent views regarding definitions and perceptions related to climate change adaptation. Even when fully understood, social and individual factors affect actionable climate change adaptations and potentially undermine their potency (Adger et al. 2009). There is some evidence that a farmer’s biophysical situation also influences his

or her selection of adaptation practices, as does his or her identity as a conservationist or productivist (Morton et al. 2017). In addition, factors such as sociocultural identity (Hyland et al. 2016), values (Wolf et al. 2013), and length of time farming (Evans et al. 2011) shape and determine how farmers will interpret climate change risks and take action to mitigate or adapt. For example, the more farmers see themselves as business managers, maximizing natural resources for the purposes of profit (Burton and Wilson 2006), the more they self-identify as politically conservative (McCright and Dunlap 2011; Leiserowitz et al. 2015a).

Researchers, however, have largely shaped the definition of climate change adaptation. We wanted to know what farmers thought of adaptation, in more detail. How do they understand this term and concept? This matters because a farmer’s ability to adapt to climate change is directly related to the sustainability of the farm and to the farm family’s livelihood. In addition, understanding how farmers view climate change adaptation may help to shape research agendas, policy initiatives, and educational programs aimed at helping agriculture adapt to climate change.

While Midwestern farmers’ views on climate change are well-documented, less is known about their views on climate change adaptation specifically. Research that investigates Midwestern farmers’ attitudes about climate change often relies on written survey instruments that ask participants to respond to statements the researchers deem to be adaptation related, such as their responses to extreme weather events (e.g., Arbuckle et al. 2015; Morton et al. 2015; Mase et al. 2017), rather than asking farmers directly what they think about climate change adaptation. Surveys are strong tools for descriptive and analytical purposes (Buckingham and Saunders 2007), and these large surveys of Midwestern farmers have provided valuable information on what farmers believe about climate change and how that influences their perceived risk of climate change and their support for mitigation and adaptation (Arbuckle et al. 2013, 2014, 2015; Mase et al. 2017). These results have important implications for policy and outreach efforts. By receiving input from thousands of farmers, generalizable information on patterns and trends in beliefs can be documented.

What is more difficult to ascertain from such large surveys, however, is farmers’ thoughts—in their own words—about how they are experiencing climate change on the farm, specific actions they are taking in response, and their understanding of terms such as climate change adaptation. It also is difficult to obtain new or unexplored themes from survey data (Buckingham and Saunders 2007). Focus groups can help identify new

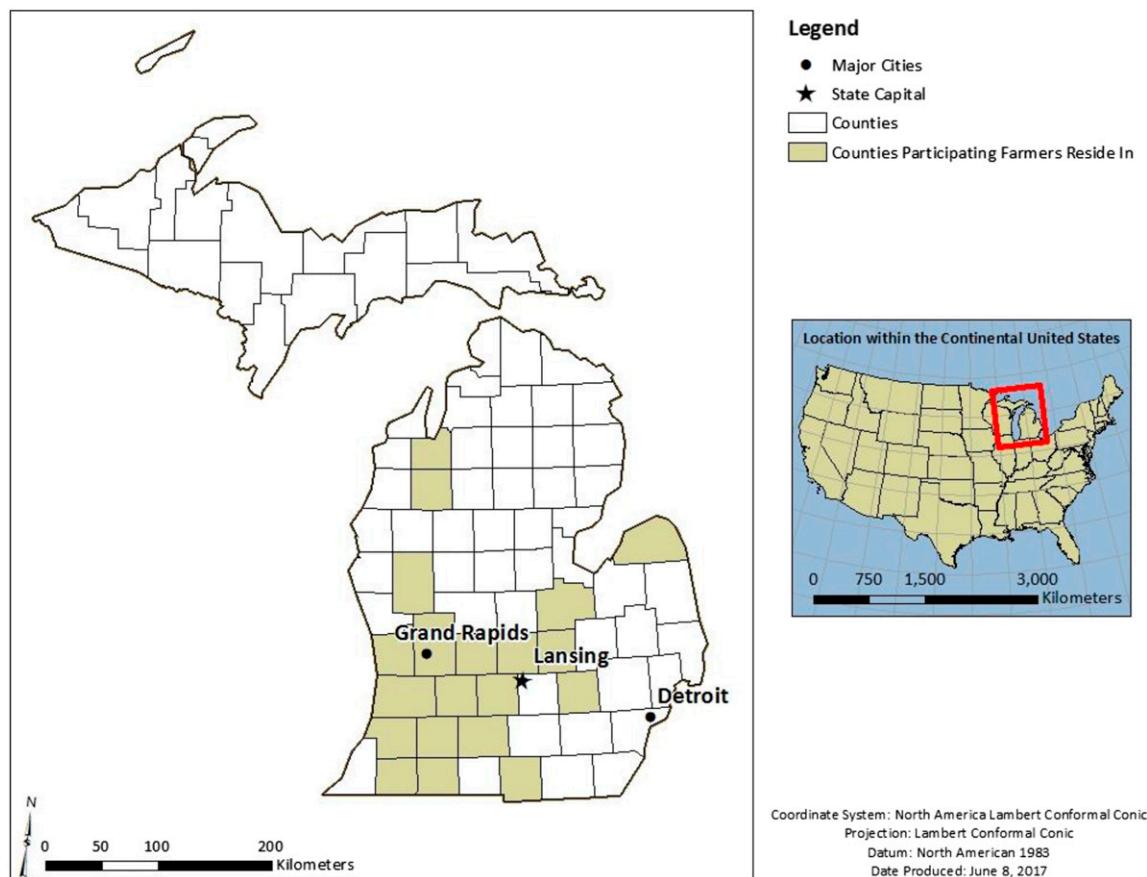


FIG. 1. Michigan counties (shaded gray) that were represented in the farmer focus groups.

themes and provide understanding and insight (Krueger and Casey 2009). When used with Midwestern farmers to discuss management decisions in the context of climate change, researchers were able to identify important themes and found that the qualitative data was both “valuable and enlightening” (Prokopy et al. 2017). To more deeply understand farmers’ perceptions of climate change adaptation and to capture new themes and insights from farmers, we conducted focus groups in which we asked farmers about their perspectives on climate change and adaptation without providing them any guidance or parameters to consider. This approach allowed for unfiltered responses, where respondents were not primed by background information or narrowly focused questions. Through two rounds of focus groups with Michigan grain crop farmers we sought to answer the following questions: 1) what do farmers think about the relationship between climate change and agriculture; 2) what differentiates normal weather-related management from climate change adaptation actions; and 3) how do farmers understand the term “climate change adaptation?”

2. Materials and methods

a. Study context

Agriculture represents an important cultural and economic industry in the U.S. Midwest. In Michigan, the food and agriculture sector contributes over \$91 billion annually to the state’s economy and employs almost one million people (Knudson and Peterson 2012). Here we focus on farmers growing three of Michigan’s most important agricultural crops covering over 5,080,000 acres—maize, soybeans, and wheat [USDA National Agricultural Statistics Service (NASS 2016)]. Michigan yields are similar to average yields across the country; for example, yields from a long-term cropping systems trial in Kalamazoo County were representative both of Michigan and the United States as a whole (Robertson and Hamilton 2015).

A total of 53 farmers and one agribusiness professional participated in our focus groups, representing approximately 60,000 acres of farmed land across 20 counties (Fig. 1). The mean farm size was approximately 1126 acres with a range of 20–7000 acres; about 36% of

these farms were over 1000 acres in size. With the exception of three farmers, all produced some combination of corn, soybeans, or wheat, and about half additionally farmed alfalfa or raised livestock, including beef and dairy cattle, chicken, and hogs. Years in farming ranged from 2 to 70, with many simply noting they had farmed “for life.” Over 80% of farmers indicated they had farmed for over 20 years.

b. Data collection and analysis

We held four farmer focus groups during the winter of 2011 and four in the winter of 2012. The focus groups were held in various locations across the state to recruit a diversity of farmers. We partnered with Michigan State University Extension (here referred to as Extension), Michigan Farm Bureau, and a local Soil and Water Conservation District to identify farmers for the focus groups by giving them information and background on the research and asking them to identify appropriate farmers to participate. These groups reached out to individual farmers, providing them with information on this research, and asking them to participate in the focus groups. When farmers agreed to participate, these organizations worked with them to ensure they attended the focus groups. The farmers were told they would be participating in a discussion about climate change and agriculture.

On four occasions a focus group was held during a larger farmer event: for example, during the 2011 Ag Action Day in southwest Michigan. In these cases, small groups of farmers were recruited to participate. In other cases, we organized and facilitated focus groups with farmers solely to talk about climate change. In all cases, the focus group discussion was held in a private room, participants and facilitators sat around one table, and the following format was used: participants filled out a demographic questionnaire, a round of introductions was held, the focus group process was described to participants, and ground rules for discussion were agreed upon. Ground rules included five elements: listen to understand, be clear and brief, avoid interrupting others, everyone has wisdom, and it is okay to disagree (Rees 2005). Facilitation included making sure these ground rules were kept, asking participants questions, and making sure every participant had a chance to speak. Participants were either reimbursed for their mileage to attend the focus group or given a small flat fee stipend. In one case at the Ag Action Day, farmers were offered continuing education credits for participating.

We asked a series of open-ended questions related to climate change and agriculture (Table 1). For the first (2011) round of focus groups, the questions focused on the relationship between agriculture and climate change

TABLE 1. Questions used during the focus groups with Michigan farmers.

Winter 2011	
1.	How do you see climate change and agriculture being linked?
2.	Where do you hear climate change being discussed?
3.	What are your current sources of information about climate change?
4.	If you would want more information where would you go?
5.	What topics regarding climate change would be important for you to understand more fully?
6.	Do you see Extension having a role in this? And if so, in what ways?
7.	How would you best receive information about climate change?
8.	Would you be interested in a workshop or training regarding agriculture and climate change?
Winter 2012	
1.	When you hear the term “climate change adaptation” what does it mean to you?
2.	Can you list some examples of climate change adaptation for farms?
3.	What are some things that have caused you to change your farming practices since you started farming?
4.	Have you changed any farming practices because of changes in the climate?
5.	Relative to other factors, how important are changes in climate when you make management decisions?
6.	What are some changes you think will happen in the future that you’ll have to adapt to?
7.	What would be helpful for you as a farmer to adapt to future changes in the climate?

and sources of climate change information and resources. Building on the themes discussed in the first round, we tailored the 2012 questions to further explore climate change adaptation. We did not offer definitions of climate change adaptation, but rather explained that it was a topic much discussed in academic and policy circles and our hope was to understand how farmers understood and experienced it.

For focus group data analysis, we followed the approach put forth by Miles and Huberman (1994). Analyzing conversations and drawing conclusions from them requires coding the transcribed discussion to draw out key themes that relate directly to the research questions in this study. Codes represent labels assigned to descriptive or inferential information (Miles and Huberman 1994). In our case, we transcribed the focus group conversations and used a grounded theory approach (Charmaz 2014), given that we had no preconceived notions of how farmers might construe adaptation, to inductively build codes as we analyzed the transcripts. We read through the transcripts individually multiple times and used open coding to group responses into clusters, a process that tries to “understand a phenomenon better by grouping and then conceptualizing objects that have

similar patterns or characteristics” (Miles and Huberman 2014, p. 279). We (coauthors 1 and 2) then compared the emergent themes together based on the codes that we each had identified. From that process, we collectively drew conclusions from the coding analysis based on our research questions. In addition, we identified representative quotes, which we use below to illustrate our primary findings.

3. Results and discussion

Analyzing the results from the focus groups yielded important insights into how farmers in Michigan view climate change and adaptation. Despite differences in crops, farm sizes, geography, and age distributions, focus group farmers had remarkably similar views relating to climate change. In short, climate change adaptation did not represent a clear idea to these farmers. They expressed uncertainty about it and continually asked those leading the focus groups to explain what we meant by it. We did not define adaptation, provide actions as examples, or suggest farmers should adapt. This was a deliberate decision in order to hear farmers’ unfiltered views on climate change and adaptation. Rather, we noted to the farmers that scientists and policy-makers have suggested that climate change has important implications for agriculture and that adaptation has received significant attention. The focus groups provided an opportunity for farmers to interpret climate change and adaptation in their own terms.

Like surveys, focus groups use reported, not observed, behaviors and are held at a certain point in time, reflecting farmer views at that particular time. While the focus groups occurred over two years and across a wide geographic region in Michigan, using focus group data to generalize across the whole farmer population is problematic and was not our intention. Despite these limitations, a number of themes emerged from the discussions that provide important insights into how farmers think about and conceptualize climate change adaptation. In the following section, we describe these themes and present representative quotes from the farmers that highlight each theme.

a. Environmental defensiveness

Initially, farmers responded with defensiveness, questioning whether climate change exists and going to great lengths to articulate how agriculture has served society and reduced environmental problems. One farmer expressed frustration that, “We really don’t hear some of the positive things that agriculture has on the climate.” Others felt unfairly singled out, believing

that U.S. farming has to operate under tighter regulations than in other places. As one farmer put it, “70% of the earth’s population isn’t taking the same precautions that we are. I would hate to get steamrolled by the other economies.” Farmers felt constrained by needing to produce food for the world and at the same time doing it in a way that consumers accept. One farmer noted, “These people buying the product in the city saying, ‘well, I’m not sure I like you doing that.’ Well, I’ve got to make a living. What do you want me to do? [The consumer says] ‘I’m not willing to give you a dime more for it, but I don’t want you doing that either.’”

Their defensiveness waned when they understood that the format of the focus groups was intended to give them a voice in the climate change adaptation discussion, rather than accuse them or tell them how to operate their farms. But they still defended themselves and their operations by stating that intensifying agriculture in the United States provided food for growing populations around the world and minimized the land area needed for cultivation. Many participants felt as though agriculture had received unfair negative attention with respect to climate change. Participants argued that agriculture does not produce significant greenhouse gases relative to other sources like electricity production or transportation. They generally felt blamed unfairly, as indicated by this sentiment: “I feel like agriculture has been the scapegoat for a lot of things that happen in society. In a way we’ve been blamed, along with manufacturing and other things, and for years we have been looked at as polluters.” These farmers’ defensiveness is likely a response to real public blame. Research by Harris and Bailey (2002) found that the public points to agriculture as the sector causing the most environmental damage.

b. Denial of global climate change

If farmers do not view climate change as a problem to address, they may not respond to calls to undertake adaptation actions. Why adapt to something that one does not view as a problem? The farmers in our focus groups did not view climate change as a problem. The majority spent significant time in each focus group downplaying the notion that climate change represents a significant challenge. A common refrain had to do with whether current climate change differed from historical trends. As one person put it, climate change is, “Just like the weather, it’s all cyclical.” Others drew on their personal experiences to downplay the notion humans have caused global warming: “I’ve seen it get hot and get cold, get hot and get cold, you know, at different periods of my life. So I think it’s more

of a cycle than it is a total climate change,” and, “Everything goes in cycles, the earth has been taking care of itself for all of these years, I think it will continue to do so. And nothing quick term—this is a long-term deal.” Another participant observed, “Climate change happens. Today it’s snowing, tomorrow it may not be. That’s not global warming,” indicating that some farmers do not distinguish climate from weather. One farmer added that, “I think that’s why farmers tend to treat climate change cynically, because we see it every day. We never see the same thing two years in a row.” One respondent stated emphatically, “You know the world has gone through a lot of changing; I don’t think we change it quite that fast,” suggesting skepticism about human-induced climate change. Others noted that humans have not been around long enough, “so it’s hard to take 30, 40, 50, 60, whatever years and say that this is normal.” Another farmer noted that “When I was growing up in Michigan, it was always a variable what the weather was going to be,” again suggesting that scientific evidence had not persuaded this farmer that humans have contributed to a changing climate. In fact, many participants noted that they did not believe the science nor trust scientists. Many speculated that scientists had created climate change to reap money or that they had simply made it up. One farmer drew on a recent climate change controversy, suggesting that “Well, the global warming stuff started out of East Anglia University in England, and they found out that they made up their information and stuff, their hockey stick graphs and stuff, they weren’t based on any fact.” The farmers, similar to many rural conservative men (McCright and Dunlap 2010), expressed distrust toward science that threatens their identities and livelihoods.

Several inquiries have found no wrongdoing from the East Anglia “climategate” incident, and numerous studies, most notably the latest assessment report from Intergovernmental Panel on Climate Change (IPCC 2014), reaffirmed the scientific basis for linking human activities to climate change. But farmers continually questioned the science. One went so far as to say, “You are asking us how we’re going to cure all this; but nobody even talked about it 20 years ago, nobody even talked about it. Now, all of a sudden, it’s come right to the forefront because of the ecologists and all of that. And that’s just it, too. They have opinion, they don’t have a lot of fact to back this, as far as I’m aware of. You know, what their fact is, is just opinion—the same as ours.” Statements such as these suggest that these farmers viewed scientific positions merely as opinions, a telling position that has important implications for addressing adaptation measures.

How did the views of farmers in our focus groups compare with the more general public? In the United States, adults’ beliefs about climate change fluctuate over time, with recent surveys showing that 67% of U.S. adults think climate change is happening, with about half of those thinking that the changes are mostly human caused (Leiserowitz et al. 2015b). A 2012 survey of Midwestern farmers revealed that 66% of farmers believe climate change is occurring; 8% of the farmers surveyed thought changes were mostly caused by humans, 33% equally human and natural, and 25% natural causes (Arbuckle et al. 2013). Arbuckle’s survey suggests that farmers are more reluctant than the average U.S. adult to agree that climate change is primarily human induced, and these findings were similar to the views of agricultural advisors, who play an important role in farmer decision-making (Prokopy et al. 2015). Large farmer surveys have revealed that this may matter: farmers who acknowledge anthropogenic climate change are more likely to notice more variable weather across the U.S. Corn Belt and on the farm and are more likely to view these changes as a risk to their farms, in turn affecting adaptation behavior (Mase et al. 2017). Our focus group discussions brought forward a more nuanced theme: the farmers who participated in our focus groups simultaneously articulated the changes they are experiencing—how climate changes are affecting their operations (discussed below)—and that climate change is not real.

In addition to harboring skepticism, farmers repeatedly mentioned the benefits climate change might have for agriculture or how agriculture helps prevent climate change. One farmer noted that crops sequester carbon dioxide, suggesting, “I guess that could be a linkage that agriculture is kind of doing a positive thing, as far as this whole thing of pollution or the environment.” Others pointed to specific benefits for agriculture, stating how much better corn will grow with warmer temperatures. As one farmer put it, “You know, they get much higher yields with the higher CO₂ count. I mean, plants love carbon dioxide.” Others noted that climate change will on the whole prove more beneficial than detrimental, as indicated by this statement: “I think that global warming a few degrees would increase food production and, in one of our earlier sessions, we talked about 9 billion people in 40 years. We need to produce food.”

c. Acceptance of climate change impacts on the farm

Although the majority of participants spent significant time and attention outlining why they felt global climate change is not real, they nevertheless pointed out significant changes they had witnessed and experienced on

their farms related to climate and weather. These changes have had tangible implications for their operations, but participants did not link these to long-term change caused by humans. Farmers commonly cited general trends related to temperature and the seasons. They noted that, “It’s obviously getting warmer” and that the seasons are changing. Some again pointed to benefits these changes might bring, with one farmer explaining that “We do have a longer growing season than we did 20 or 30 years ago.”

Although temperature trends received attention, most farmers across the focus groups noted changes in precipitation as the most consequential changes for their operations, a concern of farmers across the Midwest (Morton et al. 2015). Michigan farmers noted that, recently, rain events have increased in severity and occurrence. In this region, rainwater represents a critical resource even for those using irrigation. Changes in rainfall thus have tremendous consequences for farm production. One farmer highlighted the dramatic change farmers across the region have experienced in recent years, recounting that “We talked about variations in the weather and precipitation, well in the time that I’ve been farming—this past growing season and the 2009 growing season, were as opposite as I have ever seen in my whole career.” Others mentioned the dramatic variation they see: “This last year, at least down where I live, we went 33 days without a drop of rain. And then we got dumped on with four or five inches all at once. So you go through these dry spells and then huge rain events, and I think that’s more of a change from what we used to see.” Another farmer simply stated, “We’re getting heavy spring rains, four to five inches, that we didn’t use to have before on a regular basis.”

Large rain events have practical implications for farms. One farmer noted that “We’ve noticed small spots in the field that used to be wet—you might miss it one year, you might have to plant around that spot one year. We’ve got a few spots that haven’t been planted in 8 to 10 years now, okay? They’re just not drying out.” The inability to plant in those areas reduces the area in cultivation and ultimately affects yields. This problem with drainage has multiple consequences for agricultural production. Farmers noted that large rain events can wash away fertilizer and nutrients, expose seeds, cause erosion and soil loss, and damage crops. Most significantly, however, farmers noted how large spring rains have significantly reduced their ability to plant their crops. One simply stated they now have “a very limited window to plant in.” This shrinking planting window also has significant economic implications for farmers. Having fewer days to plant puts more pressure on having

the ability to plant in a timely fashion. With these changes, farmers noted, “It seems like it’s even harder to get our corn planted these last few years. It seemed like we had plenty of time years ago.” Farmers noted that an inability to plant crops in a short time period could then prevent field access for up to four weeks, threatening crop viability.

Not only has rain intensity changed, but precipitation patterns and types also have changed. Farmers noticed changes in the area where rain falls across the farm. As one farmer put it, “Instead of general rains, it’s spotty rains.” Similarly, farmers described a recent peculiarity in which they receive different rain patterns than even adjacent landowners. As one farmer mentioned, “For one reason or another you’ll see the most amazing differences in rainfall within a 15-mile stretch.” One farmer even suggested he has varied precipitation patterns and levels within his own fields. On a more seasonal level, farmers expressed seeing changes in precipitation patterns year-round. One farmer suggested that precipitation “just comes at different times.” Along with problems associated with too much rain or with heavy rain events, many farmers discussed how they likely will have to increase irrigation in the future to accommodate warmer, drier conditions. While they have experienced heavy rain events, they also voiced concern with increasing water scarcity. Climate change projections often show decreases or increases in overall precipitation levels, but participants talked about more nuanced trends that likely have more significant implications for their operations.

Farmers noted other changes they have witnessed in recent years. Several pointed to changes in wind patterns. They suggested winds have increased in force, leading to soil loss and consequences for crops. Others noted changes in wind patterns but attributed them to non-climate-related factors. Some suggested that the windier conditions stem from taking out windbreaks to increase production acreage or to leveling fields, or as one farmer put it, “Now with a bigger outfit [acreage], you’re more aware of when it’s windy.” Another common change farmers mentioned related to pests. In addition to seeing more pests, farmers noted that, “We’re seeing insects earlier every year, and there are some that we haven’t seen before, like the Chinese beetle.” Another farmer stated, “We didn’t have near the insect problems we have now.” They attributed these problems to warmer temperatures and changing precipitation patterns that favor new species. These changes in pests represent important secondary consequences to agriculture related to changing climate and weather patterns.

Farmers may see little value in observed and predicted global trends when considering management

decisions for their farms, and more information on how climate patterns play out at the local level is needed (Morton et al. 2015). Our results indicate that, while farmers consistently denied changes in global climate, they were able to articulate ways that climate change is having local impacts on their farms. Research shows that for climate change communication to be effective, focusing on local impacts and highlighting personal experience is key [Moser and Dilling 2007; Center for Research on Environmental Decisions (CRED 2014)]. Therefore, these farmer experiences may help in education and outreach efforts to farmers. The majority of those who advise farmers—including agency personnel and university-based and private sector advisors—have noticed more variable and more unusual weather across the U.S. Corn Belt, even though fewer than 25% of them agree these changes are hurting farmers (Haigh et al. 2015). Advisors who provide agricultural and conservation information to farmers do show a willingness to use climate-based information in their recommendations (Haigh et al. 2015).

d. Perceptions of climate change adaptation

Participants struggled to formalize what climate change adaptation meant. When asked to describe what the term meant to them, they often downplayed climate change generally. Farmers often asked for clarification, but, as stated above, we did not divulge any, instead letting them articulate what the term meant to them. Through discussions, insights emerged into how farmers view “climate change adaptation,” but, in short, they did not view it as an appropriate or useful phrase, which is similar to the findings of interviews with Canadian farmers (Wall and Smit 2006).

Participants repeatedly noted, “Farmers always adapt.” This raises an important question: if farmers always adapt, then what does climate change adaptation represent? Stated another way, if they always adapt, how does climate change adaptation differ from their normal farming adaptations? A common theme from the focus groups emerged: farmers do not view climate change adaptation as separate from any other changes in management they make to stay viable. Farmers noted that “We’re adapting on a daily basis to the climate that’s given to us, or presented to us,” and that “We adapt on the fly almost” and that “You wouldn’t be talking to anyone here if they didn’t adapt.” These sentiments imply that they believe adaptation represents a core component in successful farming operations. They often expressed exasperation that they had to convey to us that they adapt.

Farmers expressed that weather and climate play out differently across the landscape and across years.

That variation, along with other farm and farmer characteristics, creates a rugged individuality among farmers. One farmer expressed that “Everybody farms differently because they’ve selected ways to farm that fit their operation the best.” Another farmer stated, “I can’t remember a single year that’s been the same since I can remember farming. Honestly, I think we do it all the time as farmers. We continually have to adapt.” But again, they did not make a clear link between human-induced climate change and taking specific actions to address those changes. They continually expressed skepticism about climate change and the need to address it. One farmer questioned responding to human-induced climate change, asking, “It is what it is, what are you going to do about it? There’s nothing you can do about it anyway, so why? So you diversify and change your crop? You buy a longer day hybrid? I don’t know. . . You change your cropping operation because it is warmer? I don’t know if it’s feasible to do that.” These sentiments and others showcased the unease farmers had with the term climate change adaptation. It did not resonate well with them.

The adaptation discussion often led to the notion that technology would allow farmers to adapt. This included machinery but also crop genetics. As one farmer relayed, “With just the technology aspect, we have the capabilities now, we’re adapting, you know, when you’re spraying, it shuts off your nozzle—so you don’t over spray; it shuts off your binder so you don’t over plant. We are out there being very cost effective, which is a way of adaptation, but I’m not sure if it’s necessarily a form of climate adaptation.” This highlighted how farmers think about adaptation independent from climate change. In addition, they expressed concern that some adaptation actions remain impractical. As mentioned above, a farmer suggested that climate change might cause farmers to “change your cropping operation because it’s warmer? I don’t know if it’s feasible to do that.” Farmers also felt that “seed companies have kind of adapted for us,” suggesting that they may not need to adapt on their own. This complemented perceptions they described relating to insufficient information to adapt to climate change. As one farmer stated, “If we could guess what was going to happen, you’d be in the driver’s seat. But one guesses one way, the other goes the other direction. One is going to be right and one is going to be wrong.” In this sense, adaptation represents trial by error, not a calculated undertaking. The adaptation they expressed was more reactive than proactive: “If it’s wind we deal with the wind. If it’s rain we deal with the rain.”

Perhaps the most telling statement from all the discussions came when one farmer said bluntly, “You use the term adaptation, we use the term management decisions. It’s all the same thing.” This sentiment highlights how climate change adaptation did not resonate with the farmers we spoke with. Another farmer supported this position by stating, “When it comes to making decisions, we don’t think about climate by itself. We just, we learn from where we’ve been, and we change and modify to take some of those risks away.” That risk may occur because climate scientists cannot provide what farmers expressed they need—accurate weather predictions at different time scales. Farmers work on short time horizons and do not view climate change in the same temporal scale that scientists do: “I guess, if I could summarize, it doesn’t matter what the weather is going to be 20–30 years from now. It only matters what it’s going to be next year, and nobody can predict that.”

e. Adapting to climate change on the farm

Despite voicing skepticism about human-induced climate change and not viewing climate change adaptation as a useful concept, many farmers pointed to specific adaptation actions they have implemented. They specified that they do not view them as adaptation to climate change, but they did discuss these actions as those implemented in response to changes in climate and weather.

Farmers consistently stated that large, frequent rain events in the spring dramatically reduced the days they could plant. Therefore, some farmers were investing in larger farm equipment in order to complete field activities in a timely manner. In a rare acknowledgment that climate plays a role, one farmer explained the new situation the following way: “Because of climate change you are buying bigger machinery. You are doing stuff in a hurry. Ha, you’re spraying in two days what used to take two weeks. You’re combining in three days what used to be three weeks.” Others maintained their ambivalence regarding climate change. But they concurred that new rain patterns had caused them to buy different equipment. A reduced planting window caused significant stress for farmers. As one farmer put it, “Just like this last year, the planting dates were so late. My gracious, I was as nervous as a pet coon on a hot tin roof, when are we going to get in the field and get this thing going? That’s our livelihood. And to me, that’s adaptation.”

In addition to farm machinery, farmers also talked about buying more irrigation pivots to accommodate warmer, drier summers. One farmer mentioned, “I kind of think of, over the years, irrigation has become so

much more popular, with less water and more heat. I put up seven pivots in the last four years; I never had irrigation before.”

At the same time, many discussed putting in drainage and tiling to help remove excess water from their fields. More variable precipitation has created a need for more water at certain times and a need to remove water at others. These changing conditions have led some to implement no-till practices and cover crops to protect the soil, hold in moisture, and reduce erosion from rain and wind events. To alleviate a situation in which spring rains disrupt planting, farmers mentioned planting earlier and with larger machinery as noted above. But others also talked about the variation across years causing early planting one year and much later planting the next.

Farmers frequently mentioned instituting more monitoring to track weather trends. They use and regularly check rain gauges and have purchased computer equipment that helps them track weather. But that information has not greatly reduced their risk. To reduce risk, farmers explained how they might purchase a variety of seed genetics to ensure some survive and thrive. They purchase drought-tolerant corn and buy seeds that mature faster. One farmer suggested that “Our weather patterns have changed, and our hybrids allow us to get out earlier [than] normally if we had been planting with the hybrids and seeds we used to 30 years ago.” Farmers select specific varieties based on potential weather patterns and trends. As noted above, changing weather patterns also have increased pest and disease problems. In addition to utilizing chemical applications to address pests, farmers noted taking far more time to scout to find problems as they emerge. They also noted purchasing hybrid seeds that had higher resistance to pests and disease.

Farmers continue to adapt, but not because they are focused on climate change; in other words, they do not attribute their adaptations to human-induced climate change. The reduced planting window represents a climate change consequence that farmers have addressed, but, as one farmer put it, “But going back to this planting window, we don’t really know what caused it. You or somebody, Al Gore, might say that man caused it all, and we might say ‘Well, it’s happened since the ice age. Times change.’ It doesn’t really matter. We just know that we have a compressed window right now, and we need to put it [seed] in.” Several farmers did mention adapting, but more often they referred to management decisions. To one farmer, “Management decisions are, should I invest in a new planter, a new tractor, something that will speed my planting up? Should I invest in a larger combine, a larger grain drier to get my crops out

faster in the fall? Should I plant corn on this field continuously? I mean, that's all, they're just management decisions that we deal with every day of the year."

We asked farmers what information or resources they would want to help them prepare for or adapt to climate change. They had difficulty in coming up with specific ideas. A common retort revolved around a crystal ball telling them what the weather would do tomorrow or next season. Several mentioned more climate information, more help and guidance from Extension professionals, courses they could take, or examples from other farmers. They consistently expressed that reduced regulations would help them adapt, as would money from the government. But overall they could not identify specific tools to help them, which may reflect the difficulty they had in distinguishing climate change adaptation from other decisions they make. In fact, the farmers in our focus groups implicitly and explicitly conveyed their inability to differentiate dealing with climate change in isolation from everything else they respond to on the farm. In their minds, climate change does not represent a stand-alone issue, but rather one of many issues farmers respond to constantly.

f. Nonclimate factors influence farm management

Although farmers offered few specific adaptation actions, they did have much to say about nonclimate factors that have caused them to change their operations. This relates directly to the discussion above in which farmers did not disassociate climate change from other factors they deal with regularly. From their perspective, change represents a constant on the farm, and they did not distinguish climate from among all the other factors to which they react. Similar to findings in other regions (Wall and Smit 2006), Michigan farmers change their management and operations all the time for many reasons, none of which they view as strictly due to climate change.

The most common factor causing farmers to change their practices had to do with economics. They noted how globalization had fundamentally changed competition, prices, and demand for commodities. These changes, among others, have put increased financial pressure on farmers, causing many farms to increase in size and to buy more equipment. Another primary change has to do with commodity prices. Relatively high corn prices at the time of the focus groups (2011–12), for example, had direct influence on rotation decisions. As one farmer put it, "In the old days they used to rotate corn, wheat, oats, a field of clover, and they had all this root growth worked up. Now we're just farming it to death." Another stated that a farming operation "becomes more economic with less diversity. If it makes you

more money, you're going to plant only one crop." At the time of these focus groups, farmers had an economic incentive to plant continuous corn or significantly fewer rotations to soybeans or other crops because of changes in corn prices.

Farmers also expressed that input costs had influenced their management. They discussed how low nitrogen costs in the past contributed to overapplication. Higher input costs had prompted them to buy more efficient equipment, enabling them to use fewer inputs. As one farmer noted, "With the machinery we use today, we don't have to make 10 applications, just 2 or 3." Similarly, technology change generally has caused farmers to upgrade to both make their operations more efficient and to keep pace with competitors. Computers, monitoring equipment providing real-time data, global positioning system (GPS) equipment, sensors, and other technological advancements, such as crop genetics, have had significant influences on the farmers' operations.

Other factors driving change on the farm included the variable cost of credit. Farmers talked about high interest rates in the 1980s, which made purchasing new equipment, expanding acreage, and generally having access to credit to make farm upgrades difficult. Farmers pointed to new regulations causing them to make many changes on the farm. This included not only keeping more records and spending more time on paperwork, but also influencing how they operate their farms. Consumers have also had an influence. Public scrutiny regarding farming practices as well as consumer demand for food produced in particular ways has altered how farmers operate.

g. Agency to change

As mentioned previously, the National Climate Assessment defines adaptation as "actions to prepare for and adjust to new conditions, thereby reducing harm or taking advantage of new opportunities" (Melillo et al. 2014, p. 10). Some Michigan farmers did think about taking advantage of new opportunities, as discussed previously, trying to put a positive spin on climate change. However, the discussions mostly concerned denying climate change or noting that they simply have more pressing concerns to address, with one stating "I'm more concerned with something catastrophic happening than I am a slow change, like we have with the carbon dioxide" and another stating, "The climate change we all deal with is more public climate than it is weather climate."

Adapting to climate change can be reactive or proactive (Bierbaum et al. 2014). Farmers in our focus groups described actions they are taking in response to

changes in climate. That is, the farmers were reacting to climate change, not proactively preparing for it. While noting that farmers always adapt (to weather and non-climate factors) and are good at it, they did not view themselves as having a great deal of agency when it came to climate change adaptation, with one farmer saying, “You can’t do anything about it,” and another noting, “I guess, if I could summarize, it doesn’t matter what the weather is going to be in 20–30 years from now. It only matters what it’s going to be next year, and nobody can predict that.” These results differ from those of Arbuckle et al. (2014), who documented that Midwestern farmers indicated that they are confident they will be “able to use their knowledge, skills, and tools available to them to adapt to future changes in climate” and were relatively supportive of adaptation actions by farmers, government, and the private sector (Arbuckle et al. 2014). This could be a result of methodology, with focus groups providing an opportunity to receive unfiltered responses on a topic and allowing farmers to delve into the nuances of adaptation in a way that is not possible in a written survey.

4. Conclusions

The farmers in our focus groups expressed skepticism about global, human-induced climate change and yet articulated climate change impacts they have experienced on their farms. They struggled to separate climate change adaptation actions from all the management decisions they make in an ever-shifting agricultural world. That farmers struggle to define the term, referring instead to “management decisions,” reflects this disconnect. The farmers noted specific adaptations they have implemented on their farms—mostly reactive, not proactive—and did not express a great deal of agency in their ability to adapt to future changes in the climate. Respondents in our focus groups made clear that any “adaptation” had to reflect their individual situation, corroborating results of others (Morton et al. 2015) showing that broad adaptation actions serve little purpose, given the complexity and unique problems individual farmers face.

Coupling the quantitative results from farmer surveys undertaken by others and insights from qualitative work such as ours can collectively help to inform adaptation education and outreach efforts, research, and policies. It might also help to promote a more common understanding of agricultural adaptation that could enhance dialogue within and between groups, including farmers, academics, resource managers, and other decision-makers in order to address the challenges that climate change presents.

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REFERENCES

- Adger, W. N., and Coauthors, 2009: Are there social limits to adaptation to climate change? *Climatic Change*, **93**, 335–354, doi:10.1007/s10584-008-9520-z.
- Arbuckle, J. G., L. S. Prokopy, T. Haigh, J. Hobbs, T. Knoot, C. Knutson, and M. Widhalm, 2013: Climate change beliefs, concerns, and attitudes toward adaptation and mitigation among farmers in the Midwestern United States. *Climatic Change*, **117**, 943–950, doi:10.1007/s10584-013-0707-6.
- , J. Hobbs, A. Loy, L. W. Morton, L. S. Prokopy, and J. Tyndall, 2014: Understanding Corn Belt farmer perspectives on climate change to inform engagement strategies for adaptation and mitigation. *J. Soil Water Conserv.*, **69**, 505–516, doi:10.2489/jswc.69.6.505.
- , L. W. Morton, and J. Hobbs, 2015: Understanding farmer perspectives on climate change adaptation and mitigation: The roles of trust in sources of information, climate change beliefs, and perceived risk. *Environ. Behav.*, **47**, 205–234, doi:10.1177/0013916513503832.
- Bierbaum, R., A. Lee, J. Smith, M. Blair, L. M. Carter, F. S. Chapin III, and E. Seyller, 2014: Adaptation. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, T. C. Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 670–706.
- Buckingham, A., and P. Saunders, 2007: *The Survey Methods Workbook*. Polity Press, 309 pp.
- Burton, R. J., and G. A. Wilson, 2006: Injecting social psychology theory into conceptualisations of agricultural agency: Towards a post-productivist farmer self-identity? *J. Rural Stud.*, **22**, 95–115, doi:10.1016/j.jrurstud.2005.07.004.
- Charmaz, K., 2014: *Constructing Grounded Theory*. 2nd ed. Sage Publications, 393 pp.
- Cho, S. J., and B. A. McCarl, 2017: Climate change influences on crop mix shifts in the United States. *Sci. Rep.*, **7**, 40845, doi:10.1038/srep40845.
- CRED, 2014: *Connecting on Climate: A Guide to Effective Climate Change Communication*. Columbia University, 89 pp.

- Easterling, W. E., 2011: Guidelines for adapting agriculture to climate change. *Handbook of Climate Change and Agroecosystems: Impacts, Adaptation, and Mitigation*, D. Hillel and C. Rosenzweig, Eds., Imperial College Press, 269–286.
- Evans, C., C. Storer, and A. Wardell-Johnson, 2011: Rural farming community climate change acceptance: Impact of science and government credibility. *Int. J. Sociol. Agric. Food*, **18**, 217–235.
- Haigh, T., L. W. Morton, M. C. Lemos, C. Knutson, L. S. Prokopy, Y. J. Lo, and J. Angel, 2015: Agricultural advisors as climate information intermediaries: Exploring differences in capacity to communicate climate. *Wea. Climate Soc.*, **7**, 83–93, doi:10.1175/WCAS-D-14-00015.1.
- Harris, C. K., and C. Bailey, 2002: Public support for a clean, green, U.S. agriculture machine. *The Social Risks of Agriculture: Americans Speak Out on Food, Farming, and the Environment*, R. C. Wimberley et al., Eds., Praeger, 31–42.
- Hatfield, J., G. Takle, R. Grotjahn, P. Holden, R. C. Izaurralde, T. Mader, and D. Liverman, 2014: Agriculture. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, T. C. Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 150–174.
- Howden, S. M., J.-F. Soussana, F. N. Tubiello, N. Chhetri, M. Dunlop, and H. Meinke, 2007: Adapting agriculture to climate change. *Proc. Natl. Acad. Sci.*, **104**, 19691–19696, doi:10.1073/pnas.0701890104.
- Hyland, J. J., D. L. Jones, K. A. Parkhill, A. P. Barnes, and A. P. Williams, 2016: Farmers perception of climate change: Identifying types. *Agric. Hum. Values*, **33**, 323–339, doi:10.1007/s10460-015-9608-9.
- IPCC, 2014: *Climate Change 2014: Synthesis Report*. R. K. Pachauri and L. A. Meyer, Eds., IPCC, 151 pp.
- Knudson, W. A., and H. C. Peterson, 2012: The economic impact of Michigan's food and agriculture system. Michigan State University Working Paper 01-0312, 13 pp. [Available online at <https://productcenter.msu.edu/uploads/files/MSUProductCenter2012EconomicImpactReport1.pdf>.]
- Krueger, R. A., and M. A. Casey, 2009: *Focus Groups: A Practical Guide for Applied Research*. SAGE Publications, 240 pp.
- Leiserowitz, A., E. Maibach, C. Roser-Renouf, G. Feinberg, and S. Rosenthal, 2015a: Politics and global warming, fall 2015. Yale Program on Climate Change Communication and George Mason University Center for Climate Change Communication Rep., 47 pp.
- , —, —, —, and —, 2015b: Climate change in the American mind: October 2015. Yale Program on Climate Change Communication and George Mason University Center for Climate Change Communication Rep., 45 pp. [Available online at <http://environment.yale.edu/climate-communication-OFF/files/Climate-Change-American-Mind-October-2015.pdf>.]
- Lengnick, L., 2015: *Resilient Agriculture: Cultivating Food Systems for a Changing Climate*. New Society Publishers, 356 pp.
- Mase, A. S., B. M. Gramig, and L. S. Prokopy, 2017: Climate change beliefs, risk perceptions, and adaptation behavior among Midwestern U.S. crop farmers. *Climate Risk Manage.*, **15**, 8–17, doi:10.1016/j.crm.2016.11.004.
- McCright, A., and R. Dunlap, 2010: Anti-reflexivity: The American conservative movement's success in undermining climate science and policy. *Theory Cult. Soc.*, **27**, 100–133, doi:10.1177/0263276409356001.
- , and —, 2011: The politicization of climate change and the polarization in the American public's view of global warming, 2001–2010. *Sociol. Q.*, **52**, 155–194, doi:10.1111/j.1533-8525.2011.01198.x.
- Melillo, J. M., T. C. Richmond, and G. W. Yohe, Eds., 2014: Highlights of *Climate Change Impacts* in the United States: The *Third National Climate Assessment*. U.S. Global Change Research Program, 137 pp.
- Miles, M. B., and A. M. Huberman, 1994: *Qualitative Data Analysis*. 2nd ed. Sage Publications, 352 pp.
- , and —, 2014: *Qualitative Data Analysis*. 3rd ed. Sage, 383 pp.
- Morton, L. W., J. Hobbs, J. G. Arbuckle, and A. Loy, 2015: Upper Midwest climate variations: Farmer responses to excess water risks. *J. Environ. Qual.*, **44**, 810–822, doi:10.2134/jeq2014.08.0352.
- , J. M. McGuire, and A. D. Cast, 2017: A good farmer pays attention to the weather. *Climate Risk Manage.*, **15**, 18–31, doi:10.1016/j.crm.2016.09.002.
- Moser, S. C., and L. Dilling, 2007: Toward the social tipping point: Creating a climate for change. *Creating a Climate for Change: Communicating Climate Change and Facilitating Social Change*, S. C. Moser and L. Dilling, Eds., Cambridge University Press, 491–516.
- NASS 2016: State agriculture overview—Michigan. Accessed 31 August 2017. [Available online at https://www.nass.usda.gov/QuickStats/Ag_Overview/stateOverview.php?state=MICHIGAN.]
- Petersen, B., K. R. Hall, K. Kahl, and P. J. Doran, 2013: In their own words: Perceptions of climate change adaptation from the Great Lakes region's resource management community. *Environ. Pract.*, **15**, 377–392, doi:10.1017/S1466046613000446.
- Prokopy, L. S., L. W. Morton, J. G. Arbuckle Jr., A. S. Mase, and A. K. Wilke, 2015: Agricultural stakeholder views on climate change: Implications for conducting research and outreach. *Bull. Amer. Meteor. Soc.*, **96**, 181–190, doi:10.1175/BAMS-D-13-00172.1.
- , J. S. Carlton, T. Haigh, M. C. Lemos, A. S. Mase, and M. Widhalm, 2017: Useful to usable: Developing usable climate science for agriculture. *Climate Risk Manage.*, **15**, 1–7, doi:10.1016/j.crm.2016.10.004.
- Pryor, S. C., D. Scavia, C. Downer, M. Gaden, L. Iverson, R. Nordstrom, and G. P. Robertson, 2014: Midwest. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J. M. Melillo, T. C. Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 418–440.
- Rees, F., 2005: *The Facilitator Excellence Handbook*. John Wiley & Sons, Inc., 402 pp.
- Robertson, G. P., and S. K. Hamilton, 2015: Long-term ecological research in agricultural landscapes at the Kellogg Biological Station LTER site: Conceptual and experimental framework. *The Ecology of Agricultural Landscapes: Long-Term Research on the Path to Sustainability*, S. K. Hamilton, J. E. Doll, and G. P. Robertson, Eds., Oxford University Press, 1–32.
- Schauberger, B., and Coauthors, 2017: Consistent negative response of US crops to high temperatures in observations and crop models. *Nat. Commun.*, **8**, 13931, doi:10.1038/ncomms13931.
- Schlenker, W., and M. J. Roberts, 2009: Nonlinear temperature effects indicate severe damages to U.S. crop yields under climate change. *Proc. Natl. Acad. Sci. USA*, **106**, 15 594–15 598, doi:10.1073/pnas.0906865106.

- Tubiello, F. N., J.-F. Soussana, and S. M. Howden, 2007: Crop and pasture response to climate change. *Proc. Natl. Acad. Sci. USA*, **104**, 19 686–19 690, doi:[10.1073/pnas.0701728104](https://doi.org/10.1073/pnas.0701728104).
- Wall, E., and B. Smit, 2005: Climate change adaptation in light of sustainable agriculture. *J. Sustain. Agric.*, **27**, 113–123, doi:[10.1300/J064v27n01_07](https://doi.org/10.1300/J064v27n01_07).
- and —, 2006: Agricultural adaptation to climate change in the news. *Int. J. Sustain. Dev.*, **9**, 355–369, doi:[10.1504/IJSD.2006.014220](https://doi.org/10.1504/IJSD.2006.014220).
- Walsh, J., D. Wuebbles, K. Hayhoe, J. Kossin, K. Kunkel, G. Stephens, and R. Somerville, 2014: Our changing climate. *The Third National Climate Assessment*, J. M. Melillo, T. C. Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 19–67.
- Wolf, J., I. Alice, and T. Bell, 2013: Values, climate change, and implications for adaptation: Evidence from two communities in Labrador, Canada. *Global Environ. Change*, **23**, 548–562, doi:[10.1016/j.gloenvcha.2012.11.007](https://doi.org/10.1016/j.gloenvcha.2012.11.007).