# CLIMATE CHANGE AND AGRICULTURAL EXTENSION

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## Building capacity for land grant university extension services to address the agricultural impacts of climate change and adaptive management needs of agricultural stakeholders

Technical Report Series:
Findings and Recommendations of the
Climate and Corn-Based Cropping Systems
Coordinated Agricultural Project

Volume 3 of 5

## ACKNOWLEDGEMENTS

This document will be cited as:
Wright Morton, L., L.S. Prokopy, J.G. Arbuckle, Jr., C. Ingels, M. Thelen, R. Bellm, D. Bowman, L. Edwards, C. Ellis, R. Higgins, T. Higgins, D. Hudgins, R. Hoorman, J. Neufelder, B. Overstreet, A. Peltier, H. Schmitz, J. Voit, C. Wegehaupt, S. Wohnoutka, R. Wolkowski, L. Abendroth, J. Angel, T. Haigh, C. Hart, J. Klink, C. Knutson, R. Power, D. Todey, and M. Widhalm. 2016. *Climate Change and Agricultural Extension; Building Capacity for Land Grant Extension Services to Address the Agricultural Impacts of Climate Change and the Adaptive Management Needs of Agricultural Stakeholders.* Technical Report Series: Findings and Recommendations of the Climate and Corn-based Cropping Systems Coordinated Agricultural Project. Vol 3 of 5. CSCAP Publication no. CSCAP-0192-2016.

**Design/Copyediting**
Lynn Laws

**March 2016**

This document was produced as a part of two USDA-NIFA projects:

The Sustainable Corn CAP project (officially referred to as the Climate and Corn-based Cropping Systems Coordinated Agricultural Project) is a transdisciplinary partnership among 11 institutions: Iowa State University, Lincoln University, Michigan State University, The Ohio State University, Purdue University, South Dakota State University, University of Illinois, University of Minnesota, University of Missouri, University of Wisconsin, USDA Agricultural Research Service – Columbus, Ohio, and USDA National Institute of Food and Agriculture (USDA-NIFA). (Award No. 2011-68002-30190) http://sustainablecorn.org.

Useful to Usable (U2U): Transforming Climate Variability and Change Information for Cereal Crop Producers is a partnership among Purdue University, Iowa State University, Michigan State University, South Dakota State University, University of Illinois, University of Michigan, University of Missouri, University of Nebraska-Lincoln, University of Wisconsin, Midwestern Regional Climate Center, High Plains Regional Climate Center, and the National Drought Mitigation Center. (USDA-NIFA Award No. 2011-68002-30220) https://www.AgClimate4U.org.

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U2U useful to usable

This report is available on the Web at: http://store.extension.iastate.edu/Topic/Crops/Climate-and-Agriculture.

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# CONTENTS

# CLIMATE CHANGE AND AGRICULTURAL EXTENSION

**Building capacity for land grant university extension services to address the agricultural impacts of climate change and adaptive management needs of agricultural stakeholders**

## EXECUTIVE SUMMARY


In this paper we describe lessons learned from 1) social science research and 2) the experiences of a team of university extension and outreach educators. The research and the educators were a part of two USDA-NIFA climate projects,[1] which were funded to increase Corn Belt agriculture's capacity to adapt to and to assist in mitigating the impacts of climate change. These lessons give us a deeper understanding of the beliefs and knowledge of agricultural stakeholders at the intersection of climate and agriculture. They provide insights into farmers' readiness to learn about climate science and to engage in adaptive and mitigative agricultural management.

In addition, extension educators' experiences in these projects offer a valuable foundation from which to expand university extension and outreach capacities within states and across the region to address nitrogen management, build and improve soil resources, manage flooding, handle drought and water resource limitations, improve crop productivity, and manage the variety of challenges and opportunities associated with the impacts of climate change on corn-based agricultural systems.


### Key social science recommendations:

1. Farmers have a great deal of experience with variability in weather and many are confident in their capacity to deal with increasing variability. Engagement strategies that appeal to farmers' confidence and capacity to adapt are likely to attract and increase their interest.
2. Successful use of adaptive management tools and practices requires science- and experience-based knowledge. Farm advisers reported that they trust "University extension as a source of climate information," suggesting that extension educators can play a role in changing attitudes and motivating adaptive management of agriculture and natural resources.
3. Because many farmers do not believe that humans are the primary cause of climate change, direct outreach (e.g., meetings and workshops) to farmers and advisers may be more effective when the message focuses not on climate change, but instead on agricultural vulnerabilities to increased weather variability and extreme weather, and adaptive management strategies.
4. Conversations about soil health and erosion control are ways to introduce adaptive management strategies that can provide field, farm, and watershed level benefits. These topics interest all farmers, including the sixty percent of north central region farmers who are either uncertain or do not agree with the science on climate change.

## Extension and outreach educators identified needs that would help them be more effective in their programming:

1. Timely receipt of university climate and agricultural science, in accessible language that can be shared with extension educator audiences.
2. Opportunities for formal and informal science and knowledge exchanges among university scientists and Extension and Outreach educators.
3. Opportunities to communicate with and build relationships with state and university climatologists.
4. Opportunities and/or mechanisms to involve extension and outreach educators in defining research questions that make science more useful to stakeholders.
5. Increased communication among field staff and state specialists.
6. More audience-specific tools, products, educational materials, media, and on-line resources.
7. Effective ways to incorporate climate materials into agricultural programming.

## Institutional support:

Land grant university (LGU) extension services reach a wide variety of stakeholders with diverse needs. These stakeholders often have differing and sometimes conflicting priorities that make extension and outreach programming a challenge. Extension, in general, has not yet developed a coordinated effort to identify priority investments at the intersection of climate and agriculture at state and regional levels. There is a need for more research and meta-analysis that synthesizes and translates vast and complicated research results into information that extension and outreach educators can use to educate agricultural stakeholders.

## Institutional observations and suggested action items to increase the effectiveness and relevance of NCR LGU extension and outreach programs:

1. Commitment to climate change adaptation and mitigation in agriculture must be strongly signaled at all levels of the LGU extension system. USDA is providing a consistent message that the nation must act to adapt to climate change and reduce emissions of heat-trapping gases. Extension should match that message.
2. Purposefully and systematically work to ensure that extension and outreach educators are consistently exposed to locally-relevant science on climate change and agriculture.
3. Generate science that answers critical questions for agriculture, and put the science in usable formats and language that enhances the ability of extension and outreach educators to convey the science.
4. Strengthen internal partnerships. University scientists should be proactive in sharing the science with extension and other university staff, who have outreach responsibilities, in a timely and accessible way.
5. Identify a state climate coordinator to facilitate exchanges within and outside of the university by linking individuals and programs.

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The North Central region land grant universities have a unique opportunity to leverage the initial capacity building begun by these two projects, to build out a robust, regionally coordinated extension program.

# CLIMATE CHANGE AND AGRICULTURAL EXTENSION

**Building capacity for land grant university extension services to address the agricultural impacts of climate change and adaptive management needs of agricultural stakeholders**

## INTRODUCTION

The United States Department of Agriculture-National Institute for Food and Agriculture (USDA NIFA) funded two climate and agriculture grants (2011-2016), Sustainable Corn Coordinated Agricultural Project (CAP)[2] and Useful to Usable (U2U),[3] to increase Corn Belt agriculture's capacity to adapt to and to assist in mitigating the impacts of climate change.

During the last five years, the Sustainable Corn CAP and U2U project have utilized their research-extension investments to expand agro-climate science and to strengthen the research-extension linkages throughout the north central (NC) region of the United States.

The Sustainable Corn CAP multi-disciplinary team of 140 scientists collected measurements at 35 field sites, in eight NC states, and entered all data into a centralized database. Researchers analyzed, modeled, and interpreted the data to better understand how drainage, cover crops, tillage, fertilizers and crop rotations affect water, carbon and nitrogen cycles under variable weather conditions.

Concurrent with the field trials, social scientists in the Sustainable Corn CAP and U2U projects gathered data from Corn Belt farmers, crop advisers, and climatologists. The data provided insights about perceptions of risk, vulnerabilities, and opportunities associated with increasingly variable weather and climate, and were used to inform engagement with farmers and agricultural advisors.

Scientific findings have been reported in 163 refereed journal articles, 213 extension publications and 1108 presentations to stakeholders, resulting in a total audience reach of 97,477. Many of the instructional videos, facts sheets and other publications can be found at university extension online stores. (See http://store.extension.iastate.edu/Topic/Crops/Climate-and-Agriculture.)

The 50-member interdisciplinary U2U team developed five climate-based decision support tools, available online at https://mygeohub.org/groups/u2u/tools. Based on intensive stakeholder input, the tools are aimed at helping farmers adapt to changing climate conditions. In addition, the team produced over 50 journal and extension publications, provided the agricultural community with over 140 training events, and received national and local recognitions for success in research and extension integration.

The work of these complementary projects brought increased understanding of carbon, nitrogen, and water cycles in corn-based systems and responses to management practices under different climate scenarios; enhanced the usability and up-take of climate information; and bolstered extension's capacity to address agro-climate concerns and support more resilient and

profitable agricultural systems in a changing climate. Though the five-year Sustainable Corn CAP and U2U projects are coming to a close, many of the principal investigators will continue to utilize project databases and develop recommendations for field, watershed, and regional decision making.

When these projects started in 2011, few extension educators across the region provided programming focused on helping Corn Belt farmers identify and implement management strategies in response to extreme weather events, short-term climate variability, and long-term climate change. Even fewer were helping farmers identify potential climate mitigation strategies.

For five years, the Sustainable Corn CAP engaged and partially funded 18 extension educators and outreach watershed coordinators, in the NC region, to build capacity for extension and outreach efforts that address climate change and its impacts on corn production systems. The integration of social, climate, hydrological and agronomic sciences 1) increased educators' knowledge about climate science and applications to agriculture; 2) involved educators in the assessment of farmers' awareness, knowledge, and current responses to extreme weather and variable climate conditions to guide extension of scientific findings to stakeholders; and 3) engaged a small cohort (~140) of conservation-oriented farmers in learning about climate science and project-related agricultural adaptive management practices.

The U2U project developed decision support tools and educational resources that continue to be refined based on direct feedback gathered from farmers, advisers, the Sustainable Corn CAP extension and outreach educators, and other experts.

The capacity-building and knowledge-transfer activities of both projects were uniquely different, but complementary. They had common goals of integrating agro-climate knowledge into extension and outreach plans of work and the pilot testing of adaptive management tools and strategies with farmers to help them better respond to current and projected climate changes across the region. These efforts complemented existing extension endeavors and strengthened the reputation of Extension as a leader in programming focused on climate resilient agriculture.

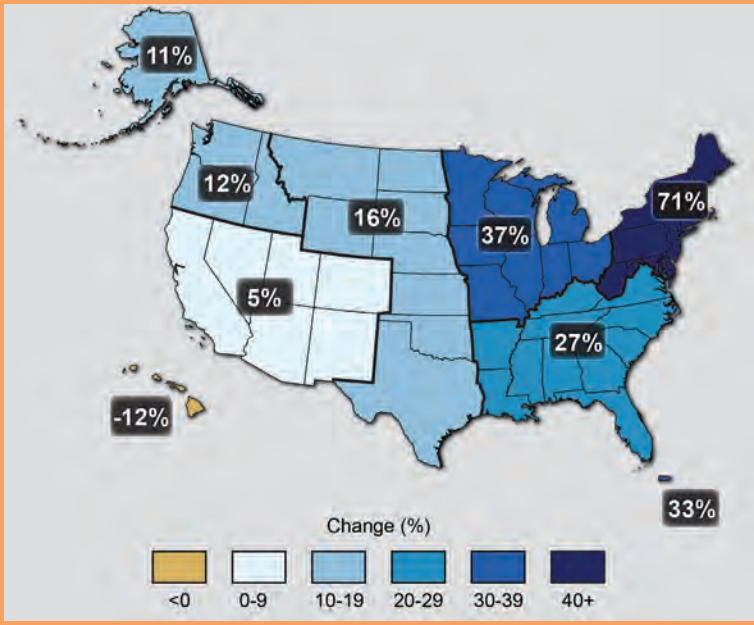


FIGURE 1 | Percent of Increase in Amounts of Very Heavy Precipitation events from 1958 to 2012. Figure obtained online Feb. 29, 2016, from the U.S. Global Change Research Program: nca2014.globalchange.gov./report/our-changing-climate/heavy-downpours-increasing#tab2-images.

While these two USDA projects were term-limited grants, the need for agro-climate extension and outreach grows. The United States Third National Climate Assessment (2014)[4] and supporting reports[5] not only document that climate disruptions to agriculture have been increasing over the past 50 years, but also project a rising incidence of weather extremes. The map above (Figure 1), for example, shows large increases in heavy precipitation events have occurred in the Northeast, Midwest, and Great Plains. Heavy downpours have frequently led to runoff that exceeded the capacity of storm drains and levees, caused flooding events and accelerated erosion. Extreme weather events will increasingly impact crop and livestock productivity and substantive degradation of soil and water resources. The NC region land grant universities have a unique opportunity to to leverage the initial capacity building begun by these two projects, to build out a robust, regionally coordinated extension program.

In this paper we document the lessons learned from 1) the social science of these projects and 2) the experiences of Extension and outreach educators involved with these projects. These lessons give us a deeper understanding of the beliefs and knowledge of agricultural stakeholders at the intersection of climate and agriculture. They provide insights into stakeholder readiness to learn about climate science and engage in adaptive management. Knowing and understanding the current capacity of educators and stakeholders to act on the science and their own knowledge can improve adaptive management responses.

Lessons learned from social science findings are presented first, followed by extension and outreach educators' self-assessment of the challenges of talking about climate science and agriculture with stakeholders, how to frame educational messages, and tips on moving their agricultural audiences to adaptive management solutions. This paper identifies structural and institutional challenges of developing learning environments and the iterative exchange of agriculture and climate knowledge. Lastly, recommendations for extension and outreach efforts that address adaptive management solutions for agriculture in the NC region are offered.

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PART 1

# Lessons Learned from Sustainable Corn CAP and U2U SOCIAL SCIENCE

A key message of the U.S. Third National Climate Assessment report[6] is that climate change poses threats to agriculture and will require adaptation and mitigation by farmers. However, very little research about farmers' and agricultural advisers' perspectives on climate change had been conducted prior to 2011. The social scientists in the Sustainable Corn CAP and U2U projects recognized that transfer of university science and effective interventions required deeper understanding of current agricultural practices, beliefs and attitudes about climate change, and the willingness and capacities of stakeholders to change behaviors. To obtain insights into their perceptions regarding these topics, the scientists conducted surveys, interviews, focus groups, and an analysis of media messages in agricultural trade publications.

The social scientists asked a number of basic research questions: What do farmers and their advisers believe about climate change? Are they concerned about increasing weather variability? What climate impacts are of most concern and present significant risks to the farm enterprise? Do they support action (adaptation and/or mitigation) and by whom? Do farmers think they should change the way they farm? Who influences farmers in their management decisions? Do they think that universities, farm groups, and government agencies should help? What types of climate information are farmers using to make decisions?

Specifically, data were gathered using quantitative and qualitative research methods including a spring 2012 mail survey of 4,778 farmers from across the Corn Belt,[7] 159 in-depth interviews with farmers from 9 states, longitudinal on-line surveys of advisers in 2012[8] (n=2087) and 2013[9] (n=864), 12 focus groups (July 2012 – Dec 2013), 57 in-depth interviews with public and private advisers, and an archival analysis of media messages in 1000 articles from news outlets and ag-related trade publications (April 1, 2012-March 31, 2014). The Corn Belt farmer survey sampled larger-scale farmers (at least 80 acres of corn and $100,000 in gross farm income), in 22 HUC 6 watersheds representing about 80 percent of farmland in the NC region. Descriptive data and maps of the region are published in two farmer statistical atlases, which

can be found at: http://store.extension.iastate.edu/Topic/Crops/Climate-and-Agriculture. A bibliography of published findings from this research to-date is listed in Appendix A.

## Key findings from the Social Science Research

*(Endnotes indicate references in which specific findings are published.)*

### What do we know about Corn Belt farmers' and agricultural advisers' perspectives on climate change?

### Beliefs, concerns and perceptions

1. Most farmers (66 percent) believe that climate change is occurring. About 8 percent attribute climate change primarily to human activity, 33 percent to both human and natural causes, and 25 percent to mostly natural causes.[10]
2. Many farmers and advisers are concerned about the predicted impacts of climate change. Half or more are concerned or very concerned about drought, heat, pests, disease, and extreme precipitation.[11] [12] [13]
3. Climate change beliefs are related to perceived risks.[14] Farmers who believe climate change is happening and due at least in part to human activity are more concerned about impacts and are much more supportive of both adaptation and mitigation actions. For example, two-thirds of farmers who believe that climate change is happening and due primarily to human activity indicate they are concerned or very concerned about longer dry periods or drought in the future, compared to 47 percent of farmers who do not believe that climate change is occurring.[15]
4. Beliefs, perceived risks, confidence, attitudes, and current practices vary widely across the NC region.[16]
5. Climate change beliefs vary by group.[17] Farmers, crop advisers and extension educators' beliefs align more closely to one another than to university scientists and state climatologists.[18]
6. Among the former groups, half or fewer believe that climate change is occurring and due substantially to human activity, compared to between 80-90 percent for the latter groups.[19]
7. Climate change beliefs can shift over time. Surveys of Iowa farmers found that between 2011 and 2013, 48 percent changed belief position, with 31 percent moving toward belief in anthropogenic climate change, and 17 percent toward uncertainty or non-belief in climate change. However, agricultural advisers showed no significant change in climate change belief between the times they were surveyed in 2012 and 2013.[20]

### Adaptation and Mitigation

8. Most farmer survey respondents (66 percent) agree that farmers in general should take additional steps to protect land from increased weather variability.[21]
9. Climate change beliefs are related to support for adaptation and mitigation. Farmers who believe climate change is happening and due at least in part to human activity are more concerned about impacts and are more supportive of both adaptation and mitigation actions. For example, 80 percent of farmers who believe that climate change is occurring and due mostly to human activity agree that farmers should take additional action to protect their land from increased weather variability, compared to 45 percent of farmers who do not believe that climate change is occurring. The correlation is stronger for mitigation: 60 percent of farmers who believe in anthropogenic climate change support government action to reduce greenhouse gas emissions, compared to 15 percent of farmers

Colo, Iowa March 2013

who believe that climate change is due mostly to natural causes.[22] Most advisers surveyed agree that farmers will need to change practices to cope with more variable weather and climate conditions. However, advisers' willingness and confidence in using climate information in their crop related advice is lacking.[23]

10. Advisers' attitudes toward adaptation are also closely related to climate change beliefs. Those advisers who agree that climate change is at least partly caused by human activities report stronger agreement that adaptation is important.[24]

11. Seventy-three percent of extension educators surveyed agree or strongly agree they should help farmers to prepare for the impacts of increased weather variability, while 20 percent are uncertain if they should help.[25]

12. Many farmers support public and private sector action to help them adapt. For example, 84 percent agree that "seed companies should develop crop varieties adapted to increased weather variability," and 62 percent agree that "university extension should help farmers to prepare for increased weather variability."[26]

13. Farmers are generally confident in their capacity to adapt to increased weather variability, but many report uncertainty.[27]

14. Farmers are already adapting to increases in warm season precipitation by selectively using a combination of no-till/reduced tillage, cover crops, tile drainage and increasing planting to highly erodible lands based on their geographic location and on-farm experiences.[28]

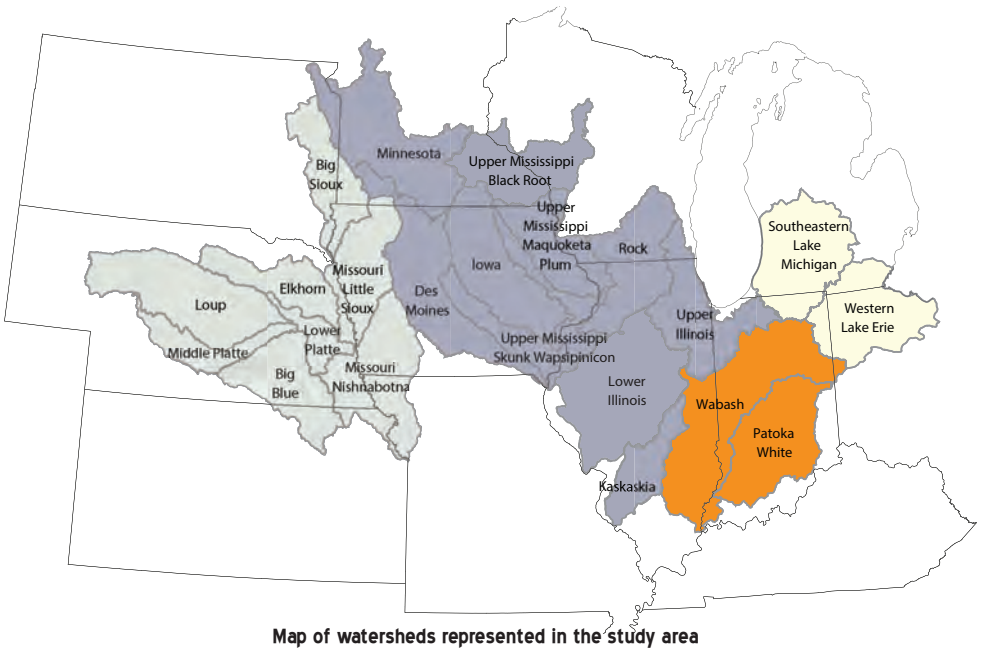
15. Some farmers are taking adaptive actions that can have positive short-term impacts on yields (e.g., increased spring tillage or increased tile drainage) but which may undermine long-term soil and water resource integrity.[29]

## Institutions

16. For Corn Belt agricultural advisers, extension and university scientists are trusted sources of information on climate change. [30 31]

17. Results from a study of Iowa farmers indicates that university scientists are their most trusted sources of information on climate change.[32]

18. For general decisions about agricultural practices and strategies, farmer survey respondents indicate that private sector actors such as seed dealers and agricultural chemical dealers are most influential.[33 34 35 36]




**Map of watersheds represented in the study area**

19. Advisers are an untapped resource that can potentially help increase the use of weather and climate information in ag-related decision making.[37] Agronomic and conservation advisers show promising interest in and ability to use climate information in their day-to-day advice, while financial advisers are less interested.[38]

20. Despite the clear importance of financial information in best management practice (BMP)

decision-making, published cost assessments are rare, and those that are available often lack transparency.[39]

21. Advisers may be more or less inclined to provide climate information, depending on the presence or lack of a) institutional support and collaboration, b) advisee focus on long-term climate risk versus short-term risk, and c) in the case of advisers who are employed at for-profit businesses, climate information that contraindicates a product or program of their business.[40]

## Recommendations from Social Science Findings

### Communicating the science

1. Climate scientists and extension educators may be more effective if they tailor their messages in ways that reduce threats to individual viewpoints and increase dialogue among those with differing views.
2. Because many farmers do not believe that humans are the primary cause of climate change, direct outreach (e.g., meetings and workshops) to farmers and advisers may be more effective when the message focuses on adapting to increased weather variability, extreme weather, agricultural vulnerability, and related risks. This suggests limiting discussion of the causes of climate change, which are less relevant to changing farm practices and more likely to alienate audiences.
3. Because many farmers and advisers do not currently believe the scientific consensus on anthropogenic climate change, over the long term it is important to develop strategies to communicate a) the science of climate change and its current and predicted impacts and b) the relevance and urgency of adaptive and mitigative actions.
4. Similar to other large-scale, diffused problems like non-point source water pollution, focusing on specific actions that farmers and advisers can take will be an important part of communication strategies.
5. Outreach strategies should take into account that farmers and advisers, like anyone else, can change their perspectives on things as they learn from new experiences and information. Extension should continue to incorporate science-based information on climate change, its potential impacts, and adaptation and mitigation strategies into programming for farmers and advisers.
6. Research suggests that extension is a trusted source of information to advisers and farmers about climate change. Thus, extension is uniquely positioned to help the agricultural sector increase climate adaptive capacity and the resilience of corn-based cropping systems, and to explore agricultural practices which can contribute to mitigating greenhouse gases (GHGs).
7. Farmers are more supportive of adaption to increase resilience than they are of GHG mitigation. Therefore, emphasizing the resilience-enhancing benefits of farm practices that may also have GHG-reducing properties (cover crops, reduced tillage, extended rotations, and nitrogen management), rather than the climate-change mitigative aspects of the practices, is advisable.
8. Because farmers' perspectives and behaviors vary across the Corn Belt region, align engagement and outreach programs and materials with local conditions and contexts.

## Encouraging adaptive management

9. Develop strategies to help extension and private sector advisers better understand the science on climate change and to recognize that farmers need to take adaptive (and mitigative) actions to ensure sustainability of agroecosystems.
10. Successful use of adaptive management tools and practices require science- and experience-based knowledge. Farmers and advisers trust extension, suggesting that extension can play a role in changing attitudes and motivating adaptive management of agricultural and natural resources.
11. Farmers have a great deal of experience with variability in weather and many are confident in their capacity to deal with increased variability. Engagement strategies that appeal to confidence and capacity to adapt are likely to increase stakeholder interest.
12. Encourage farmers to use and experiment with a combination of practices and customize management to their own field and farm conditions, observing how different weather patterns affect soil loss, water drainage, and productivity.
13. Encourage cropping practices that reduce soil erosion and enhance productivity. More timely and accurate local weather/climate information would help farmers make better management decisions. Decision support tools can help farmers improve their management trade-off decisions in selecting a particular combination of practices that ensure protection of their soil and water resources under different weather conditions.
14. Conversations about soil health and erosion control are ways to introduce management strategies for adaptation. These are themes that could help the 60 percent of NC region farmers who are either uncertain or do not agree with the science on climate change to implement adaptive actions that provide field, farm, and watershed level benefits.
15. Because most farmers 1) believe that they should take steps to protect their land and 2) support efforts by private and public advisers to help them adapt, this points to opportunities for advisers to increase efforts to promote appropriate adaptive (and mitigative) actions.

## Institutional Action

16. Capitalize on extension's role as a trusted provider of climate change information. Integrate information about climate change impacts and the need for adaptation into programming for both farmers and advisers. Extension is uniquely positioned to help the agricultural sector to improve resilience and adaptive capacity and to address GHG mitigation.
17. Broaden the conversations related to climate change, mitigation, and adaptation to include business and agricultural advisers (e.g., agricultural retailers, custom operators, financial

advisers). Understand the roles that different types of advisers play in agricultural decision making and engage each appropriately.

18. Ensure extension faculty and staff across program areas and at all organizational levels incorporate adaptation and mitigation into existing programming. These programs are already designed to address farmer and adviser decision-making needs and, therefore, provide excellent communication pathways.

19. Extension administration should communicate to field staff the urgency of understanding climate science and the range of adaptive actions that can increase the resilience of agricultural systems.

20. Continue adapting climate information to address farmer and farm adviser decision-making. While substantial progress has been made in this area, more bridging among climate, agriculture, and natural resource disciplines is necessary to make climate information usable.

21. Empower agricultural advisers to include climate change adaptation information into the operational, tactical, and strategic advice they provide, as appropriate.

22. Consider how climate change education might fit into professional development trainings and continuing education credits for agricultural professionals and advisers. Improve the knowledge, support and collaboration that advisers have access to in this area.

23. Engage the financial advice sector to improve the quality of climate-smart financial information for BMP decision-making.

24. Work with Certified Crop Adviser (CCA) boards to include climate science and adaption in each state's performance objectives and in the international performance objectives.

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PART 2

# Lessons Learned from Sustainable Corn CAP and U2U EXTENSION AND OUTREACH

The Sustainable Corn CAP extension and outreach educators and social scientists met with the U2U social scientists and outreach team in May 2015. The goal of the meeting was to self-reflect and summarize what they had learned about the transfer of climate science, agricultural practices, the facilitation of stakeholder learning, and adaptive management of corn-based cropping systems. Prompts for this discussion are in Appendix B. Thirty-four people participated in this three-hour conversation. Key lessons learned are summarized below.

## Talking with farmers and crop advisers about climate change and agriculture

### Starting the conversation

There is great variation in farmer and agricultural adviser views and understanding about climate change and its impacts on agriculture. Knowing your audience is critical to how and where an educator starts the conversation. Although two-thirds of farmers believe that climate change is occurring, only 40 percent implicate human activity. One-third of farmers are uncertain whether it is happening or not. Farmers are more willing to investigate and evaluate solutions to challenges caused by variable weather, than to discuss causes of climate change or mitigation activities. The setting, language and message an educator uses to convey climate science and adaptive management information needs to be carefully chosen.

**The Sustainable Corn CAP extension educators. Back row from left: Todd Higgins, Lincoln University; Charles Ellis, University of Missouri; Brian Overstreet, Purdue University; Marilyn Thelen, Michigan State University; Deana Hudgins, The Ohio State University; Laura Edwards, South Dakota State University; and Richard Wolkowski, University of Wisconsin. Front row from left: Hans Schmitz, Purdue University; Jon Neufelder, Purdue University; Chad Ingels, Iowa State University; and Catherine Wegehaupt, Heron Lake Watershed District (MN). Extension educators not shown: Robert Bellm, Dennis Bowman, Russ Higgins and Angie Peltier, University of Illinois; Richard Hoormann, University of Missouri; Kerry Netzke and Shawn Wohnoutka, Redwood-Cotton Rivers Control Area (MN); Jan Voit, Heron Lake Watershed District (MN).**

## Tips for successful exchanges

### The Setting

How the conversation begins is affected by the setting in which educators talk with farmers about climate change. Sustainable Corn and U2U educators used a variety of settings to encourage learning and information exchange: on-farm visits, small local groups that meet regularly (i.e., watershed groups or neighbor groups), small groups for hands-on skill development with tools and data, field days, winter meetings, webinars, and conferences.

### One-on-one

In one-on-one situations, educators must first establish their credentials and build trust.

One-on-one exchanges allow the educator to personalize the climate science conversation to the farmer's or crop adviser's understanding, thereby increasing the comfort level to discuss climate (which they may be reluctant to do in a group setting). This is also an opportunity to build a relationship that "permits" the educator to bring in climate science that may not be easily accepted otherwise.

### Group events

Small groups are opportunities to have conversations about weather variability. Group size and diversity influence how climate science is presented and received, and the kind of exchanges that occur.

1. Group dynamics imply leadership. Someone formally or informally directs the initial activities and discussion—once one person starts the conversation, others build on or challenge the ideas presented, with some people remaining silent and not contributing.
2. Farmer peer-to-peer led groups can mobilize farmers in their watershed or local area to try something new or re-affirm the status quo (i.e., what we're currently doing is enough).
3. One person in the group can take the conversation to a negative or political place unless others censure and shut it down. The educator needs to have a plan to re-direct the group's conversation back to the science.
4. Trust is necessary among farmers in the group for knowledge exchanges to occur with low risk to members.
5. Each group has different dynamics. Crop advisers seem more likely to ask questions and engage the science presented. Large groups seem less engaged and less likely to ask questions.
6. An offer of Certified Crop Adviser Continuing Education Credits encourages advisers to attend meetings that link soil, water, weather, and climate.
7. Group meetings offer an opportunity to demonstrate U2U and other decision-making tools to attract and engage audiences. There is strong interest in technology. These tools

and products provide opportunities to weave climate science and agriculture into management conversations and formulate adjustments to on-farm decisions.

8. Webinar presentations provide limited opportunities for exchange between presenter and audiences. Question and answer opportunities are presented but audiences seldom engage.

## Word choice

Extension educators found the words they used to start the conversation and frame their message made a difference in listener receptivity and openness to learning. They advise:

1. Engage stakeholders by talking about the local weather.
   a. Begin by discussing current or recent weather and transition to long-term weather (climate) events and patterns (last month, last year, and historical weather, such as the last 30 years).
   b. Terms like "increasing weather variability," "long-term weather patterns," and "extreme weather events" and their local impacts are less controversial than the topic of climate change.
   c. Invite stakeholders to discuss past weather and climate differences they have observed over the course of their farming career and impacts on their farm enterprise. This is an especially good "ice breaker" in group settings if at least one person in the audience has been farming 30 or more years.
   d. Defuse any tension that arises about climate change by acknowledging that the phrases "climate change" and "global warming" have become politicized. Then avoid engaging in discussions about political positions and personalities which could polarize the exchange and close down discussion and exchange.
2. Once focused on the weather, move the discussion to how precipitation and temperature impact different aspects of their operation and crop management decisions. Ask how particular weather events affected their farm enterprise (e.g., drought caused plants to not germinate; saturated soil delayed planting; flooding eroded soil from productive fields making them less productive; or how frost, planting and harvest date timing affected yields) and what they did in response.
3. In group discussions, encourage exchanges among peers regarding observations of weather and climate patterns and how they adapted (changed their practices and management) because of the local climate and weather conditions. Peer-to-peer learning can accelerate uptake of information and motivation to try something new.
4. Situate local climate

and weather conditions within a regional and global climate context. It is important to recognize that different geographies worldwide and within US regions experience climate differently. Farmers know this because they participate in global markets. Variable global climate (e.g., drought in California or Brazil) directly affects the prices of seed, production inputs, and grain and whether they make a profit or lose money. However, these "distant" events are viewed as something out of their control. Local extreme weather events that affect their production are more likely to grab their attention and motivate them to act and adapt when they perceive they can manage or reduce their exposure to risk through their management practices.

**Terms like "increasing weather variability" and "extreme weather" are less controversial than the topic of climate change.**

5. Discussions of extreme weather patterns and their challenges build awareness and problem identification. This creates a "readiness" in stakeholders to discuss solutions. Farmers are problem solvers and once they have identified the problem they are ready to explore options to solve it. Once the problem is identified, educators can transition into talking about how to prepare and adapt to more extreme and variable weather in the future.
6. Talk about trends over time, such as the relationship between weather patterns and soil health, and what they might do about reducing erosion and increasing soil carbon.
7. Focus on solutions. Farmers can get frustrated if you don't quickly take the discussion to the level of solutions. Many people find global problems, such as climate change, remote and difficult to connect to their own lives and decisions. Behavior change is facilitated by a personal sense of control. Perceptions of lack of control can be barriers to action. Focus on how to adapt/take action/do something about the weather and climate conditions that are affecting them. The U2U tools and products help stakeholders explore their options and find solutions that fit their own situation [e.g. growing degree days (GDD) tool; Split N tool].
8. There are three kinds of climate change discussions: science (extension's responsibility to convey), assessments of current "probabilities" and "scenarios" of potential climate trend outcomes on agriculture, and policy (not well received by farm or crop advisers). Knowing when and with whom to use each is important to effective education.
9. When talking about climate science, weather and climate data, and historical trends, it can be helpful to talk about how data are generated without bias by thousands of volunteers and weather stations.
10. Climate science can be introduced by linking stakeholder perceptions of weather and climate to long-term data, and can be inserted into discussions to confirm perceptions and correct misperceptions.
11. Utilize key moments in seasons to convey real-time information and link to science-based adaptive strategies.
12. Be selective about using "buzz" words such as "sustainability," "resilience," "adaptive management," and "stewardship," based on what you know about your audience.

## The message

How the message is framed can influence how receptive stakeholders are to climate science and to discussing adjustments to current management as a response to changing conditions.

1. Frame the message around adapting to increasingly variable and extreme weather and related threats to agriculture.
2. Embed the message within the context of common agricultural issues, to emphasize the influence of variable weather and climate to

agroecosystem impacts (e.g., productivity, off-farm nitrogen and phosphorus losses, water quality, soil erosion, soil health).
3. Link changing longer-term weather and climate conditions to the need for risk management strategies.
4. Help stakeholders identify current and local agricultural adaptive strategies that address increasing extreme weather events and a variable climate.
5. Talk about how changing and variable weather presents new opportunities for new markets, new crops, and new management strategies.
6. Convey how university science can inform

adaptive management options in response to extreme weather events, and variable climate conditions.
7. Deliver the science at an action-specific level. For example, explain how nitrogen efficiency and off-field impacts are affected by too much or too little precipitation. Then invite the audience to explore possible management options.
8. Help stakeholders identify something they can do. Presenting a problem without solutions can leave audiences feeling helpless and unable to act.
9. Some stakeholders fear increased regulation due to community-scale problems, such as water quality. Help them connect extreme weather events to these issues and point out how they can be addressed at the local level through on-farm and watershed-level solutions.

## Extension educator challenges to integrating climate science into extension programming

### Challenges and barriers

There are a number of challenges and barriers that can make it difficult for extension and outreach educators to integrate climate science into agricultural programming. These include:

1. Local norms associated with agricultural practices are generally focused on short-term rather than long-term outcomes. Therefore, the concern about long-term weather patterns (climate) may not seem relevant to a stakeholder concerned about the current season.
2. Stakeholders are faced with competing messages about climate change and its impacts from media, local and national organizations and agencies, family, friends, and acquaintances.
3. University science associated with climate may be viewed as a "liberal" institution "opinion" rather than science.
4. Stakeholder discomfort and distrust of regulatory and legislative activities reduces willingness to talk about climate change.
5. High levels of confidence that technology will "save us" can deter a stakeholder's willingness to consider new management strategies.
6. University specialists utilize a variety of scientific sources which can lead to differing interpretations of scientific facts. They also may differ in beliefs and comfort levels about climate science, which sends mixed messages to extension and outreach educators and their audiences.
7. University specialists sometimes lack understanding of local audiences and use language and messages that do not well convey the known science about climate and weather conditions.

8. Extreme weather problems (e.g., flooding, saturated soils, drought, and extreme heat) are well known and easily identified; but effective solutions are less known and complex.
9. In the north central region, local climate observations can differ from global climate trends. Although overall temperature has increased globally during the past century, average daytime maximum temperatures during Midwest summers have not increased appreciably.[41] The global message sometimes confounds the message NC region extension and outreach educators are giving to their local audiences.
10. Extension and outreach educators have a variety of specialties that are often not related to cropping systems and climate variability impacts.
11. Extension and outreach educators, advisers and farmers lack understanding of how to interpret and give meaning to probability and synthesis derived from climate models.
12. Climate science resources for extension and outreach programming are limited. Extension educators need more research findings tailored to farm decision-making to be able to give science-based recommendations.
13. Some stakeholders perceive recommended best management practices (BMPs) for resilient cropping systems are not practical for their management system or locale.

## Overcoming challenges and barriers

Overcoming the barriers listed above will require purposeful and specific programmatic planning to help reduce their impact and influence on stakeholders. Strategies for addressing these barriers are:

1. Develop a regional capacity and communication strategy that prioritizes and integrates opportunities for impact. (Barrier 6, 7, 10, 11, 12)
2. Build a core group of farmers and service provider leaders interested in learning and experimenting with strategies to provide stakeholder support to extension programming. Use them as success stories. Encourage peer-to-peer learning that utilizes science. (Barrier 12, 13)
3. Partner with experts. Connect with state climatologists, Regional Climate Center climatologists, extension climatologists (where available), university faculty and agencies such as National Oceanic and Atmospheric Administration (NOAA) to increase professional climate science knowledge and to provide a resource for stakeholders to ask questions beyond extension and outreach educator expertise. Continue to strengthen connections among extension climatologists, educators, and crop and livestock specialists. (Barrier 2, 5, 6, 8, 11)
4. Sustain current relationships and be purposeful in expanding relationships with farmers and advisers to increase trust in Extension. (Barrier 2, 3, 9)
5. Use examples of recent extreme weather events and impacts at field, farm, and watershed levels to get farmer and advisers attention. (Barrier 1, 2, 7).
6. Offer farmers and advisers hands-on resources and tools (e.g., U2U tools, GDD, Sustainable Corn CAP research). (Barrier 7, 10)
7. Leverage existing Extension, Natural Resource Conservation Service (NRCS), Soil and Water Conservation Districts (SWCD), and other conservation organizations to expand outreach. (Barrier 10)
8. Increase funding for field-level research and demonstrations that address climate-resilient cropping systems and improve the transfer of knowledge to extension and outreach educators for use in recommendations. (Barrier, 6, 10, 12)
9. Demonstrate adaptive management strategies: cover crops, controlled drainage, erosion control practices, tillage comparisons, and rainfall simulator, using field days and videos. (Barrier 1, 6, 7, 12)
10. Focus on young and next generation farmers who are tech savvy and often open to new solutions. (Barrier 1, 3, 4, 12, 13)
11. Establish adaption demonstration sites at state agricultural research stations. (Barrier 1, 2, 4, 7, 12, 13)

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PART 3

# Building North Central Region Extension and Outreach Institutional Capacity

## Institutional and structural resources and challenges

Current climate extension and outreach programming across the north central (NC) region varies by state and institution. The NC Cooperative Extension Association and the NC Regional Association of State Agricultural Experiment Station Directors have created an online directory of these climate-related activities. See www.nc-climate.org.

Beyond extension specialists supported by USDA-NIFA grants – the Sustainable Corn CAP and U2U projects – only a few states have extension specialists with explicit climate program responsibilities. But some NC region land grant universities (LGUs) are proactively conducting needs assessments and crafting strategies.

In 2012 and 2013, the USDA-funded Great Lakes Regional Water Program and their partners conducted a needs assessment, surveying extension educators, from LGUs and National Sea Grant College Programs, in six states in the NC region. They measured extension educators' knowledge, confidence and perceived barriers to providing climate change adaptation education for stakeholders. The study revealed a high level of need to increase educators' knowledge about climate change. This study also found a much

higher capacity to do climate change adaptation education among Sea Grant educators, and recommended that LGUs learn from Sea Grants going forward. Another of the group's activities was to create climate change educational core competencies for outreach professionals (not specific to agriculture).

The University of Wisconsin established the University of Wisconsin-Extension Climate Change Task Force in 2014. They conducted an assessment last year across all four extension program areas and found relevance to many existing programming topics. Further, a surprisingly high percentage of educators were already doing climate change education in some form or thought Extension should be doing climate change education.

The NC region has a number of agencies and organizations with missions and expertise associated with different aspects of climate and agricultural sciences that could serve as resources and partners with LGU extension and outreach efforts.

Every state has a state climatologist. In the Corn Belt, nearly all of them are associated with land grant universities, while a few are in state agriculture (IA) or natural resources departments (MN). Many of them may already be involved with extension programs at some level. Some are more versed in linking climate to agriculture than others, but they are a critical resource with access to historical climate data, an awareness of trends and current conditions across their state, and an understanding of seasonal forecasts.

The NC Region Water Network addresses many water-related issues that are associated with changing climate conditions. (See http://northcentralwater.org/.) Climate change and adaptation is a priority issue for the network and is associated with agriculture's influence on water resources such as nutrient and manure management, and soil health. The Network can help connect climate researchers and educators with those more focused on crops and livestock. In addition, the Network provides seed funding for building LGU extension capacity to address climate adaptation and mitigation needs. Seed funding can be used to increase competitiveness for larger grants, deliver programs, or provide professional development for university specialists and educators.

There are potential partner institutions in the region (NOAA, Regional Climate Centers (RCC), Great Lakes Integrated Sciences and Assessment Program (GLISA), USDA Midwest and Northern Climate Hubs, Sustainable Agriculture Research & Education (SARE), National Drought Mitigation Center (NDMC), DOI Climate Science Centers, NCR Water Network, National Integrated Drought Information System (NIDIS), state monitoring networks which provide weather data, and local watershed groups that perform water, weather, and/or climate outreach functions. However, many of these do not have agronomic and/or social sciences expertise linked to their climate science outreach missions.

## Extension educator needs identified

Extension and outreach educators and scientists are partners in assuring university-generated science is extended to non-scientific audiences. If extension and outreach educators are to disseminate university science, how can we best ensure that they know about and understand university-generated climate science? Extension and outreach educators are often responsible for multiple geographic areas and subject matters. This suggests a need for local weather and climate information. How might we make the structure more fluid to facilitate the science-to-educator transfer?

Extension and outreach educators in the Sustainable Corn CAP and U2U projects identified a number of needs that would help them be more effective in their programming:

1. Timely receipt of university climate and

agricultural science, in accessible language that can be shared with extension educator clients/audiences.
2. Opportunities for formal and informal science and knowledge exchanges among university scientists and extension and outreach educators.
3. Opportunities to communicate with and build relationships with state and university climatologists.
4. Opportunities and/or mechanisms to involve extension and outreach educators in defining the research questions that make science more useful to stakeholders.
5. Increased communication among field staff and state specialists.
6. More audience-specific tools, products, educational materials, media, and on-line resources.
7. Effective ways of incorporating climate materials into agricultural production programming.

## Institutional support

Extension serves a wide variety of stakeholders with different needs. These stakeholders often have differing and sometimes conflicting priorities that make extension and outreach programming a challenge. Extension, in general, has not yet developed a coordinated effort to identify priority investments at the intersection of climate and agriculture at state and regional levels. There is a need for more translational research and meta-analysis that synthesizes vast research results into useful information that extension and outreach educators can use.

**Extension and outreach educators and scientists are partners in assuring university-generated science is extended to non-scientific audiences.**

### Institutional observations and suggested action items to increase NC region LGU extension relevance and effectiveness are:

1. Commitment to climate change adaptation and mitigation in agriculture must be strongly signaled at all levels of the extension organization. USDA is providing a consistent message that the nation must act to adapt to climate change and reduce emissions of heat-trapping gases. Extension programs should match that message.
2. Purposefully and systematically work to ensure that extension and outreach educators are consistently exposed to locally-relevant science on climate change and agriculture.
3. Generate science that answers critical questions for agriculture, and put the science in usable formats and language that enhance the ability of extension and outreach educators to convey the science.
4. Strengthen partnerships. University scientists should be proactive in sharing the science with extension and other university personnel with outreach responsibilities in a timely and accessible way.

## Summary of recommendations for institutional and structural support to initiate and continue climate and agriculture programming

The training, experiences and lessons learned by extension and outreach educators participating in the USDA-NIFA Sustainable Corn and U2U projects over the last five years provide a strong foundation and a unique opportunity for LGUs in the region to build and strengthen institutional capacity to provide extension programming at the intersection of climate and agriculture. Climate science and our agricultural stakeholders and partners tell us the need for this programming will continue. Institutional support that addresses the needs of extension and outreach educators and trains and supports new and current educators is needed to leverage this opportunity.

1. Establish core leadership groups. At state and multi-state (NC region) levels, create core groups consisting of scientists and educators responsible for leading climate and agriculture exchanges and programming for stakeholders.
2. Identify other program areas needing to integrate climate education. Extreme weather and an increasingly variable climate will have differential effects on most of Extension's stakeholders. This report only addresses what has been learned from work with corn-based cropping systems in agriculture. Climate education and outreach will also need to be integrated into community development, 4-H and youth and family programming.
3. Designate an agri-climate coordinator for each state. LGU investments in an agri-climate coordinator (e.g., state specialist position) in each NC state can help incorporate climate variability and climate change information into programming and serve to increase tools and resources.
4. Increase and improve communication between land grant university researchers (with and without extension appointments) and extension educators. Land grant university researchers need to do a better job communicating climate-related scientific findings to extension educators. Similarly, extension and outreach educators need to communicate to researchers what they are hearing from farmers, agricultural advisers, and agriculture and conservation agencies and organizations — those with a stake in research results. Extension educators can help ensure that research is both meeting user needs and is communicated effectively.
5. Continue to cultivate relationships with agricultural advisers. Extension administration, faculty, and field staff must continue to cultivate relationships with agricultural advisers and expand programs that emphasize agricultural advisers as recipients of university research and tools. Given that farmers and agricultural advisers trust Extension, and given that the number of extension personnel is decreasing in many states, strengthening programming to agricultural advisers can maximize impact and be a strategic allocation of land grant university resources.

## Potential roles and responsibilities of an agri-climate coordinator

The intent of identifying faculty and staff with agri-climate coordination roles and responsibilities is to increase communication and coordination exchanges and access to content within Extension and among

universities, agencies, and stakeholders. The goal is for Extension to 1) help stakeholders to better understand current and predicted agricultural impacts of extreme weather events and variable climate, and 2) provide information and alternatives for adapting and minimizing impacts in response to changing conditions. An agri-climate coordinator would link individuals, outreach programs, and research in ways that

facilitate exchanges associated with climate, weather and agriculture. This would include tracking the science within the university and across the region, and nationally linking departments, curricula and programs. It could include relationships with Natural Resources Conservation Service, state departments of agriculture and the environment, US Army Corps of Engineers, National Oceanic and Atmospheric Administration, U. S. or a regional Environmental Protection Agency office, private natural resource organizations, and agribusinesses.

## Roles associated with communication, content and coordination might include:

### Communication

1. Facilitate exchanges with the USDA regional climate hubs and LGUs.
2. Facilitate exchanges between university researchers and extension educators.
3. Work with media including social media to distribute and collect information appropriate to the NC region with special attention to the differences between regional and international trends.

### Coordination

1. Identify funding opportunities and potential teams to seek out funding.
2. Initiate and support regional meetings of extension and outreach educators.
3. Connect with public and private partners and stakeholders.
4. Proactively collaborate with state climatologists to ensure/increase agricultural capacity for analyzing and interpreting data and information exchange.
5. Work closely with the NC Region Water Network to develop and provide a regional short course for extension and outreach educators designed to include basic climate science and climate change adaption, management and communication, thus building a cohort of expertise and a support network.
6. Explicitly build relationships with the NOAA Regional Climate Centers (RCC) to leverage resources within the region.

### Content

1. Develop and/or identify web-based resources for use by educators and stakeholders.
2. Increase extension and outreach educators' familiarity with and access to climate data and tools; and describe how they could be used in Extension ANR programming.
3. Encourage and identify institutional incentives for extension faculty and staff to synthesize and interpret data for extension and outreach educator use.
4. Develop program delivery metrics for extension and outreach climate programming.
5. Monitor, assess and evaluate data and decisions support tool needs of extension educators, crop advisers and farmers.

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# End notes

## Executive Summary

1. The Sustainable Corn CAP project (officially referred to as the Climate and Corn-based Cropping Systems Coordinated Agricultural Project) is a transdisciplinary partnership among 11 institutions: Iowa State University, Lincoln University, Michigan State University, The Ohio State University, Purdue University, South Dakota State University, University of Illinois, University of Minnesota, University of Missouri, University of Wisconsin, USDA Agricultural Research Service – Columbus, Ohio, and USDA National Institute of Food and Agriculture (USDA-NIFA). (Award No. 2011-68002-30190) http://sustainablecorn.org.

Useful to Usable (U2U): Transforming Climate Variability and Change Information for Cereal Crop Producers is a partnership among Purdue University, Iowa State University, Michigan State University, South Dakota State University, University of Illinois, University of Michigan, University of Missouri, University of Nebraska-Lincoln, University of Wisconsin, Midwestern Regional Climate Center, High Plains Regional Climate Center, and the National Drought Mitigation Center. (USDA-NIFA Award No. 2011-68002-30220) https://www.AgClimate4U.org.

## Introduction

2. The Sustainable Corn CAP project (officially referred to as the Climate and Corn-based Cropping Systems Coordinated Agricultural Project) is a transdisciplinary partnership among 11 institutions: Iowa State University, Lincoln University, Michigan State University, The Ohio State University, Purdue University, South Dakota State University, University of Illinois, University of Minnesota, University of Missouri, University of Wisconsin, USDA Agricultural Research Service – Columbus, Ohio, and USDA National Institute of Food and Agriculture (USDA-NIFA). (Award No. 2011-68002-30190) http://sustainablecorn.org.

3. Useful to Usable (U2U): Transforming Climate Variability and Change Information for Cereal Crop

Producers is a partnership among Purdue University, Iowa State University, Michigan State University, South Dakota State University, University of Illinois, University of Michigan, University of Missouri, University of Nebraska-Lincoln, University of Wisconsin, Midwestern Regional Climate Center, High Plains Regional Climate Center, and the National Drought Mitigation Center. (USDA-NIFA Award No. 2011-68002-30220) https://www.AgClimate4U.org.

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Find the 2014 Resilient Agriculture report and all of the extension publications of the Sustainable Corn CAP at:

**http://store.extension.iastate.edu/Topic/Crops/Climate-and-Agriculture**

# Appendix A: Bibliography of Sustainable Corn CAP and U2U Social Science Publications


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# Appendix B: WORKSHEET: Recommendations to build collective capacity to conduct extension programming around climate science and agriculture (page 1 of 2)

*May 19-20, 2015 CSCAP-U2U meeting Davenport, IA*

I. Lessons learned
Outcome. Identify lessons learned from project experiences re: incorporating climate science into agriculture and natural resource Extension programming

Small group discussion. Record ideas

1. What are some of the best ways to talk with farmers about climate change?

2. What kind of situations made it easier to have a climate science conversation?

3. What were some of the situations in which farmers were reluctant to talk about climate change?

4. What were some of the barriers that made it difficult for you to integrate climate science into your extension programming?

5. What has enabled you to overcome some of these barriers?

6. What are some issues you still struggle with?

Report out…Advice to future Extension educators trying to link climate and weather to agricultural decisions. Each group offers…

1. What advice and guidance would you give to Extension educators needing to incorporate climate into their programming?

2. What resources do you think they would need to be successful?

# APPENDIX B (page 2 of 2)

II. Institutional support for future agriculture and climate science Extension programming. Small group discussion. Record ideas.

1. What does the system need to look like for extension to be successful in including climate science in our programming?

2. What kind of climate extension programming is happening at your institution?

3. Extension educators and scientists are partners in assuring university-generated science is extended to non-scientific audiences. If extension educators are to disseminate university science, how can we best ensure that they know about and understand university-generated science?

4. How supportive do you think your institution is to continuing or expanding this kind of extension programming?

5. What would you need in institutional support to program around climate and agriculture in the future, once CSCAP/U2U project resources are gone?

6. What would be the value of a regional climate extension educators' network?

Report out. What specific recommendations would you like to make to your institutional and regional extension leadership?

III. Ideas for structuring a document that summarizes our experiences and makes recommendations for North-Central Region climate and agriculture/natural resource programming (whole group)

1. What do you think your Extension administrators would need to know that would help them better support climate and agriculture programming?

2. What format do you think would get their attention?

3. What processes would you recommend for involving them in a regional discussion to develop support for regional Extension programming that incorporates climate science?

# Appendix C: Sustainable Corn CAP Principal Investigators

Lois Wright Morton, project director and professor, Iowa State University

Lori J. Abendroth, project manager, Iowa State University

Robert Anex, professor, University of Wisconsin

J. Gordon Arbuckle, Jr., associate professor, Iowa State University

Raymond W. Arritt, professor, Iowa State University

Bruno Basso, professor, Michigan State University

Jamie Benning, extension program manager, Iowa State University

Laura Bowling, associate professor, Purdue University

Michael Castellano, associate professor, Iowa State University

Joe P. Colletti, senior associate dean, Ag & Life Sciences; director, Experiment Station, Iowa State University

Richard M. Cruse, professor, Iowa State University, director, Iowa Water Center

Warren A. Dick, professor, The Ohio State University

Norman Fausey, research leader and soil scientist, USDA-ARS, Columbus, Ohio

Jane Frankenberger, professor, Purdue University

Philip Gassman, associate scientist, Iowa State University

Aaron J. Gassmann, associate professor, Iowa State University

Matthew Helmers, professor, Iowa State University

Daryl Herzmann, systems administrator and analyst, Iowa State University

Chad G. Ingels, extension program specialist, Iowa State University

Eileen J. Kladivko, professor, Purdue University

Catherine L. Kling, distinguished professor, Iowa State University

Sasha Kravchenko, professor, Michigan State University

Rattan Lal, professor, The Ohio State University

Joseph G. Lauer, professor, University of Wisconsin

Kristi Lekies, associate professor, The Ohio State University

Fernando E. Miguez, assistant professor, Iowa State University

Wade Miller, professor, Iowa State University

Richard H. Moore, professor, The Ohio State University; executive director, Environmental Science Network

Daren S. Mueller, assistant professor, Iowa State University

Emerson D. Nafziger, professor, University of Illinois

Nsalambi Nkongolo, professor, Lincoln University

Matthew O'Neal, associate professor, Iowa State University

Lloyd Owens, research soil scientist, USDA-ARS

Phillip Owens, associate professor, Purdue University

John E. Sawyer, professor, Iowa State University

Peter Scharf, professor, University of Missouri

Martin Shipitalo, research soil scientist, USDA-ARS

Jeffrey S. Strock, professor, University of Minnesota

Dennis Todey, associate professor and state climatologist, South Dakota State University

John Tyndall, associate professor, Iowa State University

Maria B. Villamil, assistant professor, University of Illinois

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# Appendix D: Useful to Usable Principal Investigators

Linda Prokopy, project director and professor, Purdue University

Jim Angel, state climatologist, University of Illinois

Jeff Andresen, professor and state climatologist, Michigan State University

Otto Doering, professor, Purdue University

Roger Elmore, professor, Iowa State University

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Chad Hart, associate professor and extension economist, Iowa State University

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Cody Knutson, research associate professor, University of Nebraska-Lincoln

Maria Carmen Lemos, professor and associate dean for research, University of Michigan

Ray Massey, extension professor, University of Missouri

Lois Wright Morton, professor, Iowa State University

Dev Niyogi, professor and state climatologist, Purdue University

Rebecca Power, North Central Region Water Network director, University of Wisconsin

Martha Shulski, Nebraska State Climate Office director, University of Nebraska-Lincoln

Carol Song, senior research scientist, Purdue University

Eugene Takle, professor, Iowa State University

Dennis Todey, associate professor and state climatologist, South Dakota State University

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The Climate and Corn-based Cropping Systems CAP (Climate & Corn CAP) is a USDA-NIFA supported program, Award No. 2011-68002-30190. It is a transdisciplinary partnership among 11 institutions creating new science and educational opportunities. The Climate & Corn CAP seeks to increase resilience and adaptability of Midwest agriculture to more volatile weather patterns by identifying farmer practices and policies that increase sustainability while meeting crop demand. Useful to Usable (U2U): Transforming Climate Variability and Change Information for Cereal Crop Producers, is a USDA-funded project, Award No. 2011-68002-30220. The U2U team of over 50 faculty, staff, and students from nine Midwestern universities are working together, and with members of the agricultural community, to develop decision support tools, resource materials, and training methods that lead to more effective decision making and the adoption of climate-resilient practices.

SUSTAINABLE CORN.ORG
CROPS, CLIMATE, CULTURE AND CHANGE

useful to usable

USDA United States Department of Agriculture | National Institute of Food and Agriculture

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Climate and Corn-based Cropping Systems Coordinated Agricultural Project (Sustainable Corn Project) Project Partners

Agricultural Research Service

North Central SARE Sustainable Agriculture Research & Education

Iowa State University Extension and Outreach

University of Illinois Extension

Southwest Research and Outreach Center, University of Minnesota

The Ohio State University

UW Extension, University of Wisconsin–Extension

Lincoln University Cooperative Extension and Research

Michigan State University Extension

University of Missouri Extension

Purdue Extension | Local Faces Countless Connections

SDSU Extension

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Useful to Usable (U2): Transforming Climate Variability and Change Information for Cereal Crop Producers Project Partners

University of Nebraska

HPRCC

University of Michigan

Iowa State University Extension and Outreach

Michigan State University Extension

National Drought Mitigation Center

SDSU Extension

University of Missouri Extension

MRCC Midwestern Regional Climate Center

UW Extension, University of Wisconsin–Extension

Purdue Extension | Local Faces Countless Connections

University of Illinois Extension