Journal of Rural Social Sciences

Volume 30
Issue 1 *Volume 30, Issue 1*

Article 3

12-31-2015

Toward Engagement in Climate Training: Findings from Interviews with Agricultural Extension Professionals

David C. Diehl
University of Florida, dcdiehl@ufl.edu

Nicole L. Sloan
University of Florida

Sebastian Galindo-Gonzalez
University of Florida

Wendy-Lin Bartels
University of Florida

Daniel R. Dourte
University of Florida

See next page for additional authors

Toward Engagement in Climate Training: Findings from Interviews with Agricultural Extension Professionals

Authors

David C. Diehl, Nicole L. Sloan, Sebastian Galindo-Gonzalez, Wendy-Lin Bartels, Daniel R. Dourte, Carrie Furman, and Clyde W. Fraisse

Journal of Rural Social Sciences, 30(1), 2015, pp. 25–50.

TOWARD ENGAGEMENT IN CLIMATE TRAINING: FINDINGS FROM INTERVIEWS WITH AGRICULTURAL EXTENSION PROFESSIONALS

DAVID C. DIEHL[*]
UNIVERSITY OF FLORIDA

NICOLE L. SLOAN
UNIVERSITY OF FLORIDA

SEBASTIAN GALINDO-GONZALEZ
UNIVERSITY OF FLORIDA

WENDY-LIN BARTELS
UNIVERSITY OF FLORIDA

DANIEL R. DOURTE
UNIVERSITY OF FLORIDA

CARRIE FURMAN
UNIVERSITY OF GEORGIA

CLYDE W. FRAISSE
UNIVERSITY OF FLORIDA

ABSTRACT

With scientific consensus regarding the occurrence of climate variability and climate change it is clear that farmers can benefit from science-based adaptation strategies for managing climate-related risk. To this end, cooperative extension professionals must engage in climate training events that are carefully planned and tailored to their specific needs. This study consisted of 50 interviews with extension professionals from four states (Alabama, Florida, Georgia, and South Carolina) and collected information about the perceptions of climate variability and change as well as the preferred approaches for climate-related training in extension. Results include the need for accessible, climate-related training that prepares extension professionals to: understand both management- and technology-related adaptation strategies, engage in productive conversations with all stakeholders, and participate in the coproduction of knowledge related to climate issues.

Over time, farmers have adapted to a variety of changing conditions, including market demands, technological advances, and weather events (Walthall et al. 2012). Such historical adaptation has been mainly an intuitive or reactive response to these fluctuations (Meinke et al. 2009) with successful producers synthesizing complex and dynamic information ranging from on-farm conditions to weather forecasts to the influence of global markets. With scientific consensus that climate change is happening and that it significantly influences agricultural production (Anderegg et al. 2010; Lobell, Schlenker, and Costa-Roberts 2011; Melillo, Richmond, and Yohe 2014), it has now become more apparent that farmers are facing another layer of

[*]Corresponding Author: Associate Professor Family, Youth and Community Sciences, Institute of Food and Agricultural Sciences, University of Florida, PO Box 110310, Gainesville, FL 32611-0310, (352) 273-3526. (Email:, dcdiehl@ufl.edu).

complexity in their management decisions. Increasingly, climate variability and climate change, with associated variations in temperatures, rainfall patterns, extreme weather events, and insect and disease pressures, require science-based adaptation strategies. Although the impacts on agriculture may be "broad and not completely understood" (Fraisse et al. 2009:3), climate variability and change have the potential to both increase and decrease agricultural yields depending upon location and crop choice (Fraisse et al. 2009). Further, Walthall and his colleagues (2012) acknowledged that impacts of climate change on agriculture will be mixed, but suggest that the impacts will be more negative than positive.

Many agricultural and business decisions farmers make are linked to risk management such as the vulnerability of crops to weather events and conditions (Prokopy et al. 2013). According to Hansen (2002:310), critical agricultural decisions such as crop selection, pest management, and marketing are usually made several months before actual conditions are known and this intrinsic uncertainty "requires decision makers to prepare for the range of possibilities, often leading to conservative risk management strategies that reduce negative impacts in poor years, but often at the expense of reduced average productivity and profitability" (p. 310). Considering the cutting-edge science that is currently available and the power of high-speed computing technology, these decisions could greatly benefit from climate adaptation tools designed to give farmers the best possible information for maximizing their success.

Adaptation Strategies

Researchers and extension specialists are developing adaptation tools and strategies to assist agricultural producers trying to adapt to climate change and manage agricultural risks (Asseng et al. 2013; Battisti, and Naylor 2009; Ramirez-Villegas, and Khoury 2013; Seo 2013). Risks may include less predictable weather patterns, higher temperatures, less rainfall, extreme weather events, and pest and disease pressures associated with changing conditions. Adaptation strategies can be applied to farm management practices (i.e., planting dates, fertilizer application, and crop varieties), land use practices (i.e., crop rotation and tillage), water management practices (i.e., irrigation), pest management, financial risk management, and climate forecasting and crop modeling (Anwar et al. 2013). Examples of specific adaptation strategies include conservation tillage, high-residue cover crops, microirrigation, variable-rate irrigation, sod-based rotation, sensor-based Nitrogen application, soil moisture monitoring, and online decision support tools such as AgroClimate (AgroClimate 2014; Asseng et al. 2013).

Research shows that the selection of adaptation options is influenced by farmers' production systems, resource management strategies, and geographic location as well as the economic, social, and cultural characteristics of rural households, communities, and regions (Crane et al. 2010; Furman et al. 2011; Meinke et al. 2009). Researchers have relied on surveys and assessments to develop climate-related decision support tools and strategies tailored to the diverse needs of communities (Breuer et al. 2008; Furman et al. 2011). Expanding on these efforts, recent climate adaptation initiatives have explored innovative ways to structure interactions among farmers, extension professionals, and scientists (Bartels et al. 2012). As opposed to the conventional one-way information transfer approach, these interactive learning environments provide opportunities for knowledge exchange that are mutually beneficial to all participants. The ongoing nature of these engagements ensures that stakeholders actively partner with scientists in generating, testing, and evaluating suitable adaptation options (Bartels et al. 2012; Furman et al. 2011; Meinke et al. 2009; Patwardhan et al. 2009).

Role of Cooperative Extension

Broadly, agricultural extension services around the world work to build clientele knowledge and skills to solve their immediate problems and improve their management practices (Rivera, Qamar, and Van Crowder 2001). In the United States, the Cooperative Extension System (CES) can be a key player in convening farmers, researchers, and extension professionals in discussions related to climate education and the generation of solutions for farmers (Susko et al. 2013). Because climate change affects growing conditions and agricultural production, producers must modify their practices to maintain economically viable operations. In close collaboration with the research branch of the land-grant university system, CES aims to develop a more climate-literate populace capable of making informed decisions regarding agriculture, forestry, and water resources (Susko et al. 2013). This collaboration has been an ongoing process aligned with the USDA's National Institute for Food and Agriculture (NIFA) priority area focused on adapting to and mitigating global climate variability and change. The USDA (2013:slide 4) has created regional climate hubs, whose mission is: "To develop and deliver science-based, region-specific information and technologies to agricultural and natural resource managers that enable climate-smart decision-making and provide assistance to enable land managers to implement those decisions."

In the southeastern United States extension faculty and staff work to address climate variability and change by convening respectful dialogues with agricultural

stakeholders and by developing, validating, and disseminating different tools and practices for effective adaptation to climate variability and change (Bartels et al. 2012; Fraisse et al. 2009; Galindo-Gonzalez et al. 2011; Paz, and Hoogenboom 2011; Southeast Climate Consortium 2009). Increasingly, extension agents are being trained to use climate information to identify variables relevant for agriculture and incorporate them into their current and future programs (Breuer et al. 2011; Dinon et al. 2012; Fraisse et al. 2009; Galindo-Gonzalez et al. 2011; Susko et al. 2013). Although the magnitude of the risk that global climate variability and change poses to agriculture is still uncertain, extension agents in Florida, for example, are interested in developing the skills required to enhance the climate literacy of their clientele (Fraisse et al. 2009). In a five-year study, Breuer, Fraisse, and Cabrera (2010:3) reported that over time Florida extension agents showed greater understanding and inclination to use climate forecasts and information with their clients; from 2004 to 2009, the percentage of extension agents reporting that it was "helpful to know the coming season's climate" increased from 50% to 85%.

Extension agents still need specific training in the basics of climate science and how it relates to agriculture, as well as training on how to communicate climate information that will actively engage farmers. Dinon (2012) found that almost 85% of extension agents have not been formally trained in climate-related subjects although more than 80% of the agents believe that their work is affected by climate events and that their clientele would benefit from the utilization of climate forecasts for planting decisions. Extension agents require additional training to effectively enhance climate literacy and empower the farmers to make informed decisions focused on mitigating or adapting to effects of climate variability and change. However, climate change can be a controversial topic and some audiences may not be receptive to this information; survey research has identified agricultural extension agents to be especially skeptical of climate change (Adams et al. 2011; Monroe et al. 2014; Wojcik et al. 2014). Research on Florida extension agents reveals some skepticism about the accuracy of seasonal climate forecasts and their utility for agricultural producers (Cabrera et al. 2006). Training curricula for agents should include strategies that teach them how to address the issues of climate variability and change, that depoliticize the topic, and that frame it in ways that are culturally relevant to farmers. Using peer teachers, having farmers help train county agents, and engaging farmers in discussion and participatory research are promising education methods that can help extension achieve these goals (Bartels et al. 2012; Franz et al. 2010; Furman et al. 2011). Although climate variability is

relevant to agriculture, and adaptation strategies can be effective tools for managing agricultural risk, little research exists on how to tailor climate training to agricultural extension professionals in ways that will optimize engagement and the dissemination of useful information to farmers.

This study was conducted as part of Southeast Climate Extension, a NIFA-funded project to improve the climate extension programs in Alabama, Florida, Georgia, and South Carolina. Project partners engage agricultural stakeholders, including researchers, extension professionals, and producers, in an active dialogue about effective management solutions for reducing climate risks and improving production efficiency. The primary goal of this study is to provide recommendations regarding the content and delivery of climate trainings, meetings, or workshops offered by extension. The following research areas were addressed: the number of previous climate-related events respondents attended, the benefits respondents gained from those events, and the content areas and delivery methods that respondents suggested to maximize quality and encourage extension professionals' engagement at future climate-related training events.

METHODS

Fifty extension professionals from Alabama, Florida, Georgia, and South Carolina were interviewed to collect information about their perceptions of climate variability and change and to determine preferred approaches for information delivery in extension settings. Potential respondents were identified based on existing contact lists and recommendations of project staff from the respective states. Using snowball sampling, additional participants were identified during the interview process. The 50 respondents were categorized according to their primary role: county faculty/extension agents (n = 13), state extension faculty (n = 17), researchers (n = 10), and administrators (n = 10). The sample characteristics of respondents are listed in Table 1.

The interview questions were developed in collaboration with the larger project team and partners through a process of identifying topics of interest, drafting and piloting questions, and finalizing the interview protocol. Interviews were conducted via phone and respondents also completed a brief online survey addressing respondent demographics and beliefs related to climate and agriculture. The 45- to 60-minute interviews were semi-structured and included open- and closed-ended questions addressing extension experiences on climate- and agriculture-related issues, attendance at climate-related training meetings, recommendations for

TABLE 1. SAMPLE CHARACTERISTICS OF RESPONDENTS

	N	%
Gender		
Male	39	78
Female	11	22
Ethnicity		
Caucasian	40	80
African-American	5	10
Hispanic	5	10
Education		
Bachelor's degree	2	4
Master's degree	17	34
Doctoral degree	31	62
Extension role		
County faculty/extension agent	13	26
State extension agent	17	34
Researcher	10	20
Administrator/director	10	20
State		
Alabama	11	22
Florida	18	36
Georgia	11	22
South Carolina	10	20
Provide climate information		
Yes	28	56
No	22	44
Target information for client information		
Farmers	25	50
Ranchers	8	16
Faculty	17	34

	MEAN	MINIMUM	MAXIMUM
Age (years)	49	29	69
Extension Experience (years)	15	1	37

training content and delivery, and suggestions for maximizing the success of the larger project. The data were collected during Fall and Winter of 2011-2012.

Each interview was recorded and transcribed for qualitative analysis. Interviews were analyzed by a three-person team using an inductive approach (Thomas 2006) that identified key themes emerging from the interview data (Patton 2002). Through open coding (Gibbs 2011) relevant categories present in the data were identified, resulting in three coding frameworks: benefits of training, training content, and training delivery. Over multiple readings, the final codes were assigned upon consensus and integrated through axial coding; themes were compared and contrasted across roles of participants (Gibbs 2011). A complete list of codes and their frequency of occurrence are presented in the appendices.

Because the study sample was primarily drawn from existing networks of extension professionals engaged in activities related to climate and agriculture, the sample is not broadly representative of all extension personnel or agricultural extension. Based on the regionally-bound nature of the sample, its application elsewhere—especially in areas hit more severely with extreme climate events such as drought—is uncertain. Also, this study did not address structural and administrative issues in terms of support for climate training. Planners in other states and regions should consider how to tailor these recommendations to their specific needs and dynamics.

RESULTS

The current paper presents both the quantitative and qualitative results from the interviews and focuses specifically on the questions related to extension climate training.

Previous Climate Training Attendance

Respondents were asked: *Have you been to any training/workshops related to climate offered by Extension in the last two years?* Response categories were: *none, 1-2, 3-4, and more than 4*. Based on the data (Figure 1), state extension faculty attended the most events, with 58% attending at least three events in the last two years, a notably high rate of repeat attendance. Across all roles, 70-80% of respondents reported attending at least one climate-related event in the last two years. However, the 20-30% of respondents not attending any events may represent an additional audience for future training events. Collectively, these groups play an important role in delivering high-quality extension programming—administrators in providing financial and organizational support, researchers in providing the foundational

research and data, state extension faculty in translating research into useful tools for producers, and county faculty in engaging producers and delivering educational content at the local level. To better engage these individuals, understanding both the barriers to and benefits of attending training is necessary.

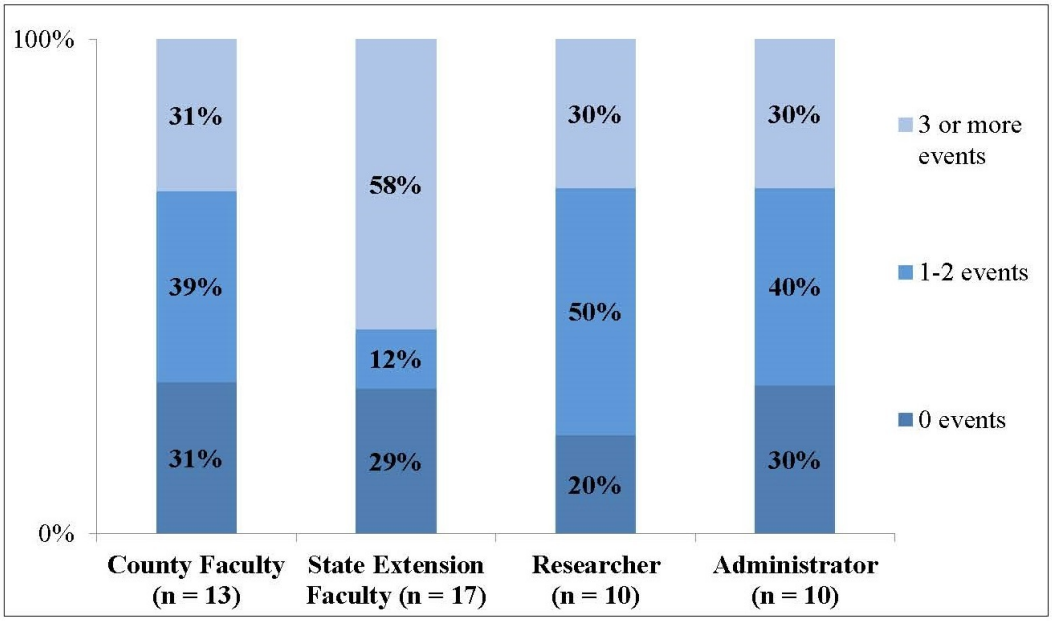

FIGURE 1. ATTENDANCE AT CLIMATE-RELATED EVENTS BY ROLE

Main Benefits of Attending Climate-related Events

Respondents who indicated they attended one or more climate-related meetings, trainings, and workshops were asked: *Please describe the main ways you benefit from these meetings, trainings, or workshops.* The most frequently mentioned benefits clustered around the ways in which climate information could be translated into actionable information and solutions for farmers. Extension professionals often value training that focuses on adaptation strategies, forecasts, and decision support tools that can shape the farm practices and risk management strategies of producers. Extension professionals also expressed some desire for education related to current climate science and basic climate concepts. Finally, some respondents see training events as opportunities for mutual exchange of information rather than the traditional one-way transmission of knowledge from a trainer to an audience. The most frequently mentioned codes are presented in Figure 2 and a discussion of the results follows.

Forecasting (18 mentions). Forecasting mentions were organized into three categories: ENSO-based seasonal forecasting (11), seasonal forecasting not mentioning ENSO (4), and long-term climate forecasting (3). One county faculty member described the benefits of ENSO-based forecasting: "El Niño, La Niña, what

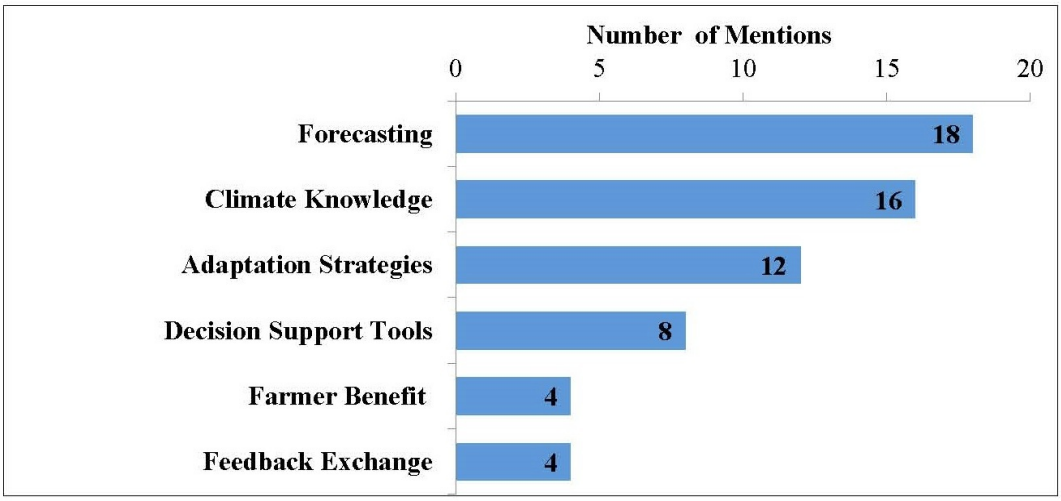

FIGURE 2. MOST FREQUENTLY MENTIONED BENEFITS OF ATTENDING CLIMATE-RELATED EXTENSION EVENTS

they do, how they affect us . . . [I] have been able to use that information in order to help growers plan for better strategies." Four respondents mentioned seasonal forecasting without mentioning ENSO with one state extension faculty member saying, "If I know what the weather is going to be from March until June, or July, I can help [growers] make decisions on planting dates, on what crops to plant." Long-term climate forecasting was mentioned three times, with one administrator stating that extension professionals need "some handle on how climate is expected to change over time—that is what they really don't have."

Climate Knowledge (16 mentions). Mentions of climate knowledge were organized into three categories: general knowledge (8), state of climate science (6), and climate basics (2). General knowledge included nonspecific comments mentioning learning. A state extension faculty member said, "I get a bit more knowledge," and an administrator mentioned, "I increase my knowledge." For state of climate science, some respondents indicated they benefit from hearing the latest information related to climate science and how it affects agriculture in their areas. According to one administrator, "The main benefit is the increase in what the science is saying, dealing with the issues and particularly in the agriculture business." A researcher

also stated, "For me, it just gives a better understanding of both the issues and where the science is in terms of offering solutions." Two individuals mentioned learning climate basics as a benefit, with a county faculty member mentioning the need "to help [growers] understand that there is a science behind climate change, I mean that there are facts."

Adaptation Strategies (12 mentions). Many respondents indicated they benefited from information related to adaptation strategies; according to one researcher:

> A bigger and more important issue for farmers is just how can they adapt to any vagaries in production that are climate or weather related. So I think the focus on technology that can help farmers adapt is the right way to approach them.

This focus on adaptation strategies also arises in the discussion of training content and is consistent with an overall emphasis on training that benefits farmers.

Decision Support Tools (8 mentions). Several respondents mentioned decision support tools such as AgroClimate, crop models, and climate change scenarios. A county faculty/extension agent related:

> I don't have the knowledge about the climate and how all the pieces come together. But if somebody could tell me, 'Hey, this is more than likely what is going to happen, this is what you can look forward to these next months, and you can go to this website on the computer anytime you need this data.' I can take that data and I can put it in my newsletters, I can do a bunch of stuff with that.

Farmer Benefit (4 mentions). Respondents in this category stated they benefit from receiving information that directly helps the farmers they serve. A researcher offered a nice summary of farmer benefits:

> Extension faculty have responsibilities working with farmers and all of our trainings are related to that. So if these workshops offer solutions to real-world problems, most extension faculty will attend them—something to learn and take it to the farmer, so the farmer can use it.

Feedback Exchange (4 mentions). These mentions centered on training that served as a multidirectional exchange of information between farmers, extension

professionals, and researchers. One state extension faculty member highlighted this benefit: "Mostly just hearing from the growers and agents and the interaction, what's happening with them. Even if you're presenting, of course, that's valuable. And you get the interaction with the specialists in other areas." From this perspective, training is a collaborative opportunity to learn not only from researchers and state specialists, but also from farmers and other extension agents.

Recommendations for Training Content

Respondents were asked: *What would it take for you to attend more of these workshops? Do you have suggestions for how best to engage extension faculty in these workshops/trainings?* and *What type of climate-related in-service training or professional development for faculty do you think extension should offer?* The most frequently mentioned codes for training content are presented in Figure 3.

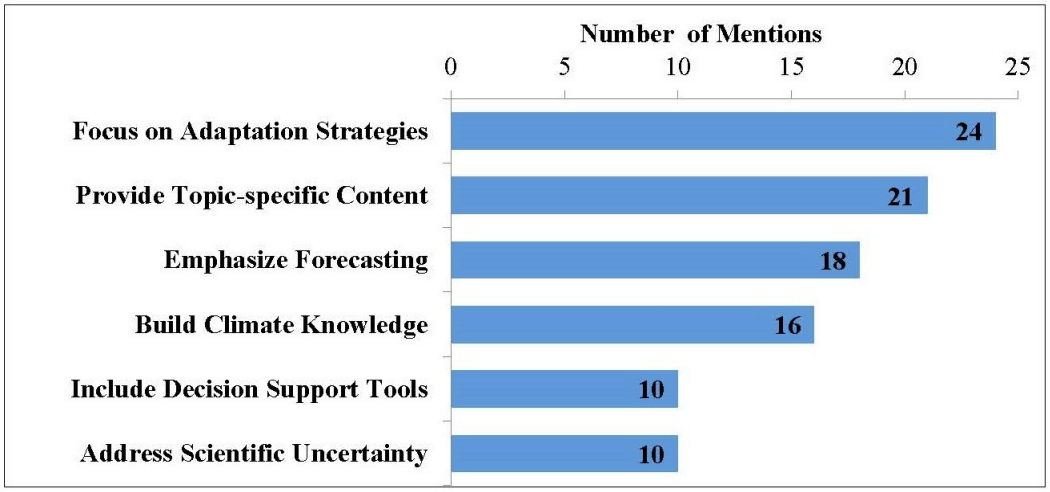

FIGURE 3. MOST FREQUENTLY MENTIONED RECOMMENDATIONS FOR TRAINING CONTENT

Consistent with the identified benefits of training, the recommendations for training content also focused on issues related to how producers can adapt their practices to changing climate conditions (i.e., frequent mentions of adaptation strategies, forecasting, and decision support tools). When discussing climate training issues, extension professionals are strongly oriented to topics of immediate concern to farmers, such as irrigation and drought, specific commodities, and pests and diseases. These findings are consistent with the underlying approach of Southeast Climate Extension, which is to engage producers in a constructive

dialogue based on addressing issues that are immediate and tangible in their lives. Other frequently mentioned recommendations include building basic climate knowledge and including strategies for addressing scientific uncertainty around climate issues.

Focus on Adaptation Strategies (24 mentions). Respondents discussed the need to focus training content on strategies that help farmers adapt to climate variability and manage risk. One researcher stated that "reminding or informing faculty, or asking faculty for the latest and greatest technological development that might deal with adaptation is important." An administrator suggested that training needs to "focus on where we are now, what has brought us to this point, how are we making adaptations, how are we dealing with risk and variability."

Provide Topic-specific Content (21 mentions). Respondents suggested climate training with a focus on specific content areas of interest to extension personnel, with the top mentions being irrigation and drought (6), specific commodities (4), and pests and diseases (4). An administrator summed up what we heard from multiple people:

> I think one of the things we can do to get more extension agents, is making it, in some cases, more specific to what they do. For instance, if I'm dealing with certain crops and commodities, we can say, we're going to focus, maybe an afternoon or a couple of hours on how these potential climate variations, variability, and changes could affect your specific crop.

Emphasize Forecasting (18 mentions). Requests for forecasting information were concentrated on seasonal forecasting, with ten of these specifically related to ENSO, and all other categories receiving three or fewer mentions each. An administrator said, "If we can throw out information that says 'we're starting to go into an El Niño situation and we expect this to happen over the next six months,' then people start paying attention."

Build Climate Knowledge (16 mentions). Requested topics related to building climate knowledge were focused on climate basics (9) and the state of climate science (7). One state extension faculty member summed up the importance of climate knowledge, combining it with several other relevant recommendations:

> Sometimes we think, 'well we are repeating everything, every time we talk about how El Niño, how La Niña affects Florida, etc.,' but the reality is that the more we talk about it, the message is getting across. I feel like we have

> to be always giving an overview of the basic ideas of climate. So the format is an overview of basic ideas, always a review of current conditions because people like this, and always a little bit of what may be coming next. If we mix this with a focus on commodities or topics of interest, I think it's a winning model.

Include Decision Support Tools (10 mentions). Respondents mentioned content involving decision support tools such as AgroClimate, crop models, and climate change scenarios. A county faculty/extension agent stated that some producers were using the AgroClimate website and that this was "helping them make some management decisions."

Address Scientific Uncertainty (10 mentions). The concept of scientific uncertainty around climate variability and climate change links to adaptation technologies, which are designed to maximize farmer success. Some respondents wanted more content focused on how to deal with the scientific uncertainty surrounding climate science and what to communicate. According to one state extension faculty member, "There are going to be a lot of uncertainties in [climate forecasts], but you can weave those uncertainties in between some of the more certain outcomes."

Recommendations for Training Delivery

The training delivery responses were drawn from the same questions as the training content. *What would it take for you to attend more of these workshops? Do you have suggestions for how best to engage extension faculty in these workshops/trainings?* and *What type of climate-related in-service training or professional development for faculty do you think extension should offer?* The most frequently mentioned codes for training delivery are presented in Figure 4.

It is challenging to create and deliver training programs in the extension system due to the dispersion of audiences across large areas, competing time demands for extension professionals, and the expenses associated with travel. These concerns related to accessibility were mentioned much more frequently than any others related to training delivery. Respondents also recommended that content be tailored to the specific needs of the audience based on commodity, location, and areas of extension agent expertise. Providing hands-on training and training that directly benefits farmers were also mentioned. Finally, respondents recognized the need to understand message framing and message strategy related to climate.

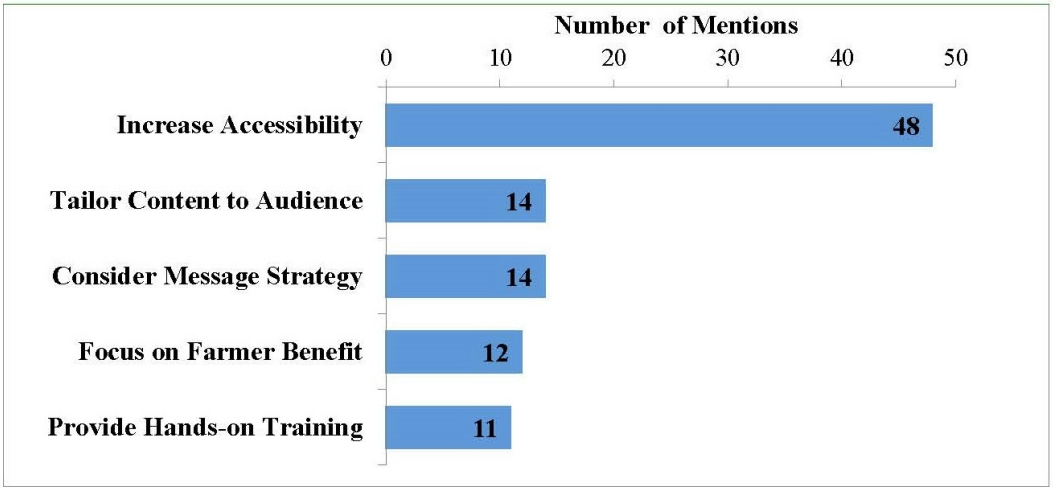

FIGURE 4. MOST FREQUENTLY MENTIONED RECOMMENDATIONS FOR TRAINING DELIVERY

Increase Accessibility (48 mentions). Feedback regarding the accessibility of climate training received by far the highest number of mentions. The most frequently mentioned areas were timing (14), integration and short modules (14), location (8), virtual training (7), and cost (5). Responses related to the timing category focused on scheduling training events at less busy times of the year and making them shorter. Respondents also acknowledged the inherent difficulties associated with scheduling meetings because extension professionals are taxed for time. Fourteen respondents mentioned integrating climate training into existing in-service training and extension meetings, including larger meetings as well as smaller subject-specific meetings. Some respondents identified the difficulty of frequently having to travel to the main university for meetings and suggested choosing alternative locations throughout the state. There were seven mentions of providing virtual training in the form of online modules with a county faculty member suggesting the possibility of a face-to-face meeting after the modules were completed, saying that virtual training "could be available for people that couldn't attend the live presentation . . . and then have a follow-up get together or conference, or symposium or whatever, just to get everybody together in person." Cost of travel to meetings was also frequently mentioned, with one state extension faculty member offering virtual training as a possible solution to the financial burden of travel:

> The odds of me being able to take two or three days and drive or fly somewhere are just about zero. But if I can do it through a webinar or something like that where I can sit down and have some interaction for an hour or two, or however long it is, then I am more likely to do that than I am to spend money that is already short to start with. And time is gold, I can tell you.

Tailor Content to the Audience (14 mentions). Many respondents recognized the benefit of tailoring the content of events to the specific needs of audiences, including commodity-specific information (7), location-specific information (3), and information tailored to the area of expertise of the extension agent (3). When discussing how to increase attendance, one researcher said, "They need to include more of the types of crops that our farmers grow, like the subsistence type crops, traditional type crops, rather than just focusing on the cash crops." An administrator commented,

> I think it's going to have to be focused towards the specialist's particular area . . . If they're an insect, disease, weed kind of person, then you know it's got to be something that focuses on the impact of climate change on biological systems. If you're a water guy then, it's got to be more water and hydrology.

Consider Message Strategy (14 mentions). Respondents mentioned the need to deliver climate information in ways that are not politically charged and through messengers who are strong, well-informed communicators. One state extension faculty member said that the message would resonate best if "the messenger is the right messenger, someone who can communicate well and is comfortable being challenged without feeling antagonized."

Focus on Farmer Benefit (12 mentions). Mentions of farmer benefit suggested providing practical information farmers can use such as this statement from a county faculty member: "You've got to give [extension agents] something that's going to benefit their clientele." Another county faculty member added, "It needs to be more business applicable, because farmers are businessmen." Because farmers need to pay attention to the financial bottom line, both farmers and extension faculty are keenly aware of the need for extension information to have immediate applicability. This is consistent with our earlier findings emphasizing the need for practical solutions and adaptation strategies.

Provide Hands-on Training (11 mentions). Respondents also mentioned the need for events to include hands-on experiences, which can apply to both online decision support tools and field-based adaptation strategies. If extension faculty are to convey decision support tools and adaptation strategies, they must first achieve mastery through hands-on training. Comments included this one from an administrator:

> If you could take [these new decision tools] into the field and have it on an IPad, you can work with the farmer and say, 'look, we're sitting in the middle of your soybean field, and by the way, let's talk about if it looks like it's going to be wetter, or it's going to be drier and hotter this year.'

DISCUSSION

Extension professionals clearly articulated numerous benefits of attending climate-related, agricultural training events and did so by focusing on the tangible benefits for producers—seasonal forecasting, decision support tools, and adaptation strategies that can be implemented to minimize risk and maximize yields. Our findings are consistent with the application of adult learning principles, based on Knowles (1980), especially that adults are practical, focused on usefulness, and thrive in respectful environments (Swann 2012). Respondents suggested providing training on basic climate concepts through applied agricultural examples tailored to both their content areas and the needs of their clients, enhancing the ability of extension agents to address producer concerns.

Training organizers must also consider when to offer trainings that do not conflict with other professional meetings or agricultural events such as planting and harvesting. Planners can reduce competition with other events by infusing climate concepts into other relevant trainings that agents regularly attend and integrating into existing content areas such as pests and diseases, irrigation, and soil management. This would allow training to be delivered in a trusted setting and reach larger audiences, possibly enhancing the relevancy, applicability, and perceived benefits of the training.

Discussions around participant engagement centered on training accessibility and training delivery. Because of budget constraints and time limitations, many extension agents find it difficult to attend face-to-face training events. Respondents suggested online training approaches as a partial solution to this challenge. Based on their experience developing large-scale training events in extension, Franz and

her colleagues (2014) suggested combining virtual training with advance self-study and group discussions at satellite locations, which would allow for cost-effective delivery of information while encouraging group discussions and networking that are critical to learning. Such a hybrid approach addresses some logistical concerns related to training accessibility, while maintaining the advantages of face-to-face learning.

Respondents also discussed the concept of joint creation of knowledge by producers, extension professionals, and researchers. Such coproduction involves participating in an extended dialogue of meaningful planning and, especially with controversial topics such as climate change, places researchers in a community of practice where trust in science can be fostered (Furman et al. 2011; Swann 2012). The integration of research and extension presents some challenges, including obligations of extension professionals for program delivery and reporting, productivity expectations for researchers, and the limited budgets and time constraints that both groups face (Radhakrishna, Tobin, and Foley 2014; Susko et al. 2013). Another core issue identified by these authors is a lack of alignment between extension activities and the criteria of tenure and promotion for researchers, a challenging tension connected to the core motivation of research faculty. Radhakrishna and his colleagues (2014) identified relevance, capacity, and impact as three important considerations related to the integration of research and extension. In our findings, relevance is largely defined by meaningful training that builds the capacity of extension professionals to provide practical solutions for farmers. Organizers who strive to create stronger integration of research and extension must take great care to make excellent use of participants' time and to clearly articulate meaningful and achievable goals that are in the interests of all parties. Ultimately, extension and research faculty will continue to participate only if the initiative is perceived to be valuable and time-effective relative to the professional expectations of their positions.

Susko et al. (2013) emphasized the importance of message strategy related to climate change and suggested that extension agents can benefit from training on communication of climate issues, conflict management, and group facilitation. In keeping with this idea and consistent with the findings of our interviews, Southeast Climate Extension team members continue to frame climate-related issues toward adaptation strategies and resource efficiencies, with an emphasis on practical solutions to immediate farming challenges in the context of climate variability. The project does not frame the issues in terms of attribution of climate change to farmers, mitigation of climate impacts, or the politics of climate change. This

strategy builds trust, dialogue, and repeat attendance that is the foundation for future work on larger climate issues. Within cooperative extension, framing science education with an emphasis on objectivity as well as relevance for the audience is important, which leads to greater use of the information presented (Robinson 2013).

To share climate adaptation strategies and establish a relationship between researchers, extension agents, and producers, Southeast Climate Extension has conducted climate workshops called adaptation exchanges (Bartels et al. 2012). The goals of these daylong workshops are to learn how alternative management technologies and strategies can make production more efficient, profitable, and resilient to climate variability; review current climate conditions and latest projections for the upcoming season; and strengthen a network of agricultural stakeholders to continue to develop best bets for management that reduces climate-related risks and cuts costs in Southeastern agriculture. Participants visit management strategy stations at which a specialist and a producer with experience using the highlighted strategy present an overview and discussion focused on the details of the technology and the impacts on climate-related risks. Throughout the day, the agenda includes opportunities for dialogue and networking that taps into the expertise of all attendees—from farmers to extension agents to researchers.

Complementing this one-day adaptation exchange model, Southeast Climate Extension also supports an iterative engagement model that convenes row crop stakeholders from Georgia, Alabama, and Florida in biannual meetings on climate-related adaptation. Participants in this "Tri-state climate learning network" explore specific management practices through hands-on farmer-led demonstrations and deliberate the benefits, barriers, and opportunities of each adaptive option (Bartels et al. 2012). Between meetings, these researchers, extension agents, and producers continue to exchange ideas and post field experiences online at SIFT (Southeast Innovative Farming Team), a virtual community of practice (www.siftag.org).

CONCLUSIONS AND FUTURE DIRECTIONS

Adaptation strategies, particularly management or technology that can make production more resilient to climate risks, and training accessibility were the two key findings for improving extension programming to reduce climate risk. When planning climate training events our results support the coproduction of knowledge and materials as well as the careful messaging of climate issues to avoid conflict with political views and increase the trust in science.

Southeast Climate Extension will continue the adaptation exchange workshop model and the tri-state climate learning network to facilitate dialogue between

producers, extension professionals, and researchers on climate adaptation strategies. In their discussion of the role of extension in climate adaptation, Susko et al. (2013) outline the existing Sea Grant training academy as a potential model for a joint Land and Sea Grant effort. The idea of a joint effort is supported by the findings of Wojcik and Monroe (2014) who recommend a comprehensive strategy through which extension can more effectively address climate change issues including administrative buy-in and dialogue between researchers, state specialists, and extension agents to overcome communication "bottlenecks."

Toward such a joint effort, members from four NIFA-funded programs (Southeast Climate Extension, SeaGrant, Pine Integrated Network: Education, Mitigation, and Adaptation project (PINEMAP), and Animal Agriculture in a Changing Climate) have created the Southern Region Extension Climate Academy (SRECA). SRECA has been developed to improve climate extension by focusing on management solutions that can directly make production systems more resilient to climate risks and more resource efficient. The Climate Academy targets respected extension professionals who: receive training on the fundamentals of climate variability, climate change, and climate impacts; work in small groups to develop outreach materials; and disseminate climate information to their extension colleagues. The training model aims to build the capacity of participants to become leaders and facilitators in developing relevant programming in climate variability and change within the extension system. Armed with this knowledge, extension professionals can more effectively engage in climate-related discussions with clientele and disseminate appropriate adaptation strategies to assist farmers in responding to climate-related risks.

AUTHOR BIOGRAPHIES

David C. Diehl is an associate professor of program planning and evaluation in the Department of Family, Youth and Community Sciences at the University of Florida. Dr. Diehl conducts evaluation research and provides program planning and evaluation support for extension faculty in a diversity of areas, including climate education, food safety, nutrition, financial education, and parenting. E-Mail: dcdiehl@ufl.edu

Nicole L. Sloan is an education and training program coordinator in the Department of Family, Youth and Community Sciences at the University of Florida. She is a professional editor and writer who has worked on scholarly and extension publications for many departments in UF's Institute of Food and Agricultural Sciences. E-Mail: nlsloan@ufl.edu

Sebastian Galindo-Gonzalez is a research assistant professor in the Department of Agricultural Education and Communication (AEC) at the University of Florida. Sebastian is currently responsible for designing and executing the evaluation components for a variety of multidisciplinary projects. His teaching and research interests include program planning and evaluation, planned organizational change, participatory research, and the use of mixed methods for the evaluation of teaching, research, and extension initiatives. E-Mail: sgalindo@ufl.edu

Wendy-Lin Bartels is an assistant research scientist in the Department of Agricultural and Biological Engineering at the University of Florida. She conducts anthropological research and outreach related to climate risk management and the value of learning networks for the co-development of adaptive strategies among agricultural stakeholders in the southeastern United States of America. E-Mail: wendylin@ad.ufl.edu

Daniel Dourte is a research and extension associate in Agricultural and Biological Engineering at the University of Florida. He specializes in the intersections of water, climate, and agriculture. He has published recently in Agricultural Systems and in Hydrological Processes on research and Extension related to water consumption in agriculture. E-Mail: ddourte@ufl.edu

Carrie Furman is an assistant research scientist and environmental anthropologist in the Department of Crop and Soil Sciences at the University of Georgia. For the past seven years she has been working with the Southeast Climate Consortium (SECC) on a multi-disciplinary project that aims to assess the relevance, accessibility, and usefulness of climate-based decision support tools and information directed to extension agents and organic and African American produce and row crop producers in the southeastern United States. She has published in Climatic Change, Agriculture and Human Values, Climate Risk Management, among others. E-Mail: cfurman@uga.edu

Clyde Fraisse is an associate professor at the Agricultural & Biological Engineering Department, University of Florida. Dr. Fraisse's extension and applied research program focus on developing and providing climate information and decision support tools to help agricultural producers better cope with risks associated with climate variability and change. Dr. Fraisse developed and maintains AgroClimate.org, a web-based climate information system customized for the agricultural industry in the southeastern United States and coordinates a climate extension program under the Southeast Climate Consortium. E-Mail: cfraisse@ufl.edu

REFERENCES

Adams, Damian C., Martha C. Monroe, Richard Plate, and Deborah Wojcik. 2011. "The Six Americas of Climate Change: Perceptions of Southeast Extension Professionals." University of Florida, Gainesville, FL.

Anderegg, William. R., James W. Prall, Jacob Harold, and Stephen H. Schneider. 2010. "Expert Credibility in Climate Change." *Proceedings of the National Academy of Sciences* 107:12107–9.

AgroClimate. 2014. AgroClimate: Tools for Managing Climate Risk in Agriculture. Retrived March 28, 2015 (http://agroclimate.org/).

Anwar, Muhuddin R., De Li Liu, Ian Macadam, and Georgina Kelly. 2013. "Adapting Agriculture to Climate Change: A Review." *Theoretical and Applied Climatology* 113:225–45.

Asseng, S., W. L. Bartels, K. J. Boote, N. E. Breuer, D. Cammarano, C. C. Fortuin, C. Fraisse, C. A. Furman, G. Hoogenboom, K. Ingram, J. W. Jones, D. Letson, B. V. Ortiz, S. D. Risse, F. Royce, S. D. Shuford, and D. Solis. 2013. "Agriculture and Climate Change in the Southeast USA." in *Climate of the Southeast United States: Variability, Change, Impacts, and Vulnerability*, edited by K. T. Ingram, K. Dow, L. Carter, and J. Anderson. Washington, D.C.: Island Press.

Bartels, Wendy-Lin, Carrie A. Furman, David C. Diehl, Fred S. Royce, Daniel R. Dourte, Brenda V. Ortiz, David F. Zierden, Tracy A. Irani, Clyde W. Fraisse, and James W. Jones. 2012. "Warming up to Climate Change: A Participatory Approach to Engaging with Agricultural Stakeholders in the Southeast US." *Regional Environmental Change* 13:45–55.

Battisti, David and Rosamond Naylor. 2009. "Historical Warnings of Future Food Insecurity with Unprecedented Seasonal Heat." *Science* 323:240–3.

Breuer, Norman E., Victor E. Cabrera, Keith Ingram, T., Kenneth Broad, and Peter E. Hildebrand. 2008. "Agclimate: A Case Study in Participatory Decision Support System Development." *Climatic Change* 87:385–403.

Breuer, Norman E., Heather Dinon, Ryan Boyles, and Gail Wilkerson. 2011. "Extension Agent Awareness of Climate and New Directors for Research in North Carolina." *Journal of Service Climatology* 5:1–20.

Breuer, Norman E., Clyde W. Fraisse, and Victor E. Cabrera. 2010. "The Cooperative Extension Service as a Boundary Organization for Diffusion of Climate Forecasts a 5-Year Study." *Journal of Extension* 48:1–5.

Cabrera, Victor E., Norman E. Breuer, John G. Bellow, and Clyde W. Fraisse. 2006. "Extension Agent Knowledge and Perceptions of Seasonal Climate Forecasts in Florida." University of Florida, Gainesville, FL.

Crane, Todd A., Carla Roncoli, Joel O. Paz, Norman E. Breuer, Kenneth Broad, Keith T. Ingram, and Gerrit Hoogenboom. 2010. "Forecast Skill and Farmers' Skills: Seasonal Climate Forecasts and Agricultural Risk Management in the Southeastern United States." *Weather, Climate, and Society* 2:44–59.

Dinon, Heather, Norman E. Breuer, Ryan Boyles, and Gail Wilkerson. 2012. "North Carolina Extension Agent Awareness of and Interest in Climate Information for Agriculture." *Southeast Climate Consortium Tech. Rep.* 12:1-44.

Fraisse, Clyde W., Norman E. Breuer, David F. Zierden, and Keith T. Ingram. 2009. "From Climate Variability to Climate Change: Challenges and Opportunities to Extension." *Journal of Extension* 47:1–10.

Franz, Nancy K., Robin Brekke, Deb Coates, Cathann Kress, and Julie Hlas. 2014. "The Virtual Extension Annual Conference: Addressing Contemporary Professional Development Needs." *Journal of Extension* 52:1–5.

Franz, Nancy K., Fred Piercy, Joseph Donaldson, Johnnie Westbrook, and Robert Richard. 2010. "Farmer, Agent, and Specialist Perspectives on Preferences for Learning among Today's Farmers." *Journal of Extension* 48:1–10.

Furman, Carrie A., Carla Roncoli, Todd A. Crane, and Gerrit Hoogenboom. 2011. "Beyond the 'Fit': Introducing Climate Forecasts among Organic Farmers in Georgia (United States)." *Climate Change* 109:791–9.

Galindo-Gonzalez, Sebastian, Leonard Berry, Carolyn Cox, Alana Edwards, Robert Ellingson, Allan Feldman, Tracy A. Irani, James W. Jones, Julie Lambert, Chrsitine Lockhart, Mantha Mehallis, and Jeffrey G. Ryan. 2011. "Florida Climate Change Education and Training: State University System Cooperative Plan, Florida Climate Change Task Force." Available online: http://floridaclimate.org/whitepapers/.

Gibbs, Graham R. 2011. *Analyzing Qualitative Data: The Sage Qualitative Research Kit.* Thousand Oaks, CA: Sage.

Hansen, James. 2002. "Realizing the Potential Benefits of Climate Prediction to Agriculture: Issues, Approaches, Challenges." *Agricultural Systems* 74:309–30.

Knowles, Malcolm S. 1980. *The Modern Practice of Adult Education: Andragogy Versus Pedagogy.* New York: Association Press.

Lobell, David B., Wolfram Schlenker, and Justin Costa-Roberts. 2011. "Climate Trends and Global Crop Production Since 1980." *Science* 333:616–20.

Meinke, Holger, S. Mark. Howden, Paul C. Struik, Rohan Nelson, Daniel Rodriguez, and Scott C. Chapman. 2009. "Adaptation Science for Agriculture and Natural Resource Management - Urgency and Theoretical Basis." *Current Opinion in Environmental Sustainability* 1:69–76.

Melillo, Jerry M., Terese Richmond, and Gary W. Yohe. 2014. "Climate Change Impacts in the United States: The Third National Climate Assessment." U.S. Global Change Research Program.

Monroe, Martha C, Richard R Plate, Damian C Adams, and Deborah J Wojcik. 2014. "Harnessing Homophily to Improve Climate Change Education." *Environmental Education Research*:1–18.

Patton, Michael Q. 2002. *Qualitative Research and Evaluation Methods.* Thousand Oaks, CA: Sage.

Patwardhan, Anand, Tom Downing, Neil Leary, and Tom Wilbanks. 2009. "Towards an Integrated Agenda for Adaptation Research: Theory, Practice and Policy: Strategy Paper." *Current Opinion in Environmental Sustainability* 1:219–25.

Paz, Joel O. and Gerrit Hoogenboom. 2011. "Climate and Weather Information for Georgia Farmers." The University of Georgia Cooperative Extension, Athens, GA.

Prokopy, Linda S., Tonya Haigh, Amber S. Mase, Jim Angel, Chad Hart, Cody Knutson, Maria C. Lemos, Yun-Jia Lo, Jean McGuire, Lois W. Morton, Jennifer Perron, Dennis Todey, and Melissa Widhalm. 2013. "Agricultural Advisors: A Receptive Audience for Weather and Climate Information." *Weather, Climate and Society* 5:162–7.

Radhakrishna, Rama, Daniel Tobin, and Caitlin Foley. 2014. "Integrating Extension and Research Activities: An Exploratory Study." *Journal of Extension* 52:1–10.

Ramirez-Villegas, Julian and Colin K. Khoury. 2013. "Reconciling Approaches to Climate Change Adaptation for Colombian Agriculture." *Climatic Change* 119:575–83.

Rivera, William, M. Kalim Qamar, and L. Van Crowder. 2001. "Agricultural and Rural Extension Worldwide; Options for Institutional Reform in Developing Countries." Food and Agriculture Organization of the United Nations (FAO), Rome.

Robinson, Patrick. 2013. "Effectively Communicating Science to Extension Audiences." *Journal of Extension* 51:1–4.

Seo, S. Niggol. 2013. "An Essay on the Impact of Climate Change on US Agriculture: Weather Fluctuations, Climatic Shifts, and Adaptation Strategies." *Climatic Change* 121:115–24.

Southeast Climate Consortium. 2009. "Extension and the Climate Change Challenge: Providing Climate Services to Citizens and Communities." University of Florida, Gainesville, FL.

Susko, Emily, Michael Spranger, Luis Tupas, Joshua Brown, and Michael Liffmann. 2013. "The Role of Extension in Climate Adaptation in the United States." in *Land Grant - Sea Grant Climate Extension Summit*. Silver Spring, Maryland.

Swann, LaDon. 2012. "Southeast USA Regional Climate Extension, Outreach, Education, and Training." Pp. 321–41 in *Climate of the Southeast United States: Variability, Change, Impacts, and Vulnerability*, edited by J. Carroll, L. Carter, S. Foster, and S. VanParreren. Washington, D.C.: Island Press.

Thomas, David R. 2006. "A General Inductive Approach for Analyzing Qualitative Evaluation Data." *American Journal of Evaluation* 27:237–46.

USDA. 2013. "USDA Regional Hubs for Risk Adaptation and Mitigation to Climate Change." [Webinar]. July 19, 2013.

Walthall, C.L., J. Hatfield, P. Backlund, L. Lengnick, E. Marshall, M. Walsh, S. Adkins, M. Aillery, E.A. Ainsworth, and C. Ammann. 2012. "Climate Change and Agriculture in the United States: Effects and Adaptation." USDA Technical Bulletin 1935, Washington, DC.

Wojcik, Deborah J., Martha C. Monroe, Damian C. Adams, and Richard R. Plate. 2014. "Message in a Bottleneck? Attitudes and Perceptions of Climate Change in the Cooperative Extension Service in the Southeastern United States." *Journal of Human Sciences and Extension* 2:51–70.

APPENDIX A. BENEFITS OF ATTENDING CLIMATE TRAINING MEETINGS BY NUMBER OF MENTIONS

CODE	NO. OF MENTIONS
Forecasting	18
Climate knowledge	16
Adaptation strategies	12
Decision support tools	8
Farmer benefit	4
Feedback exchange	4
Cross disciplinary scholarship	2
Extension needs	2
Messaging	2
Mitigation	2
Scientific uncertainty	2
Tailoring to audience	2
Communication methods	1
Location-specific information	1
Networking	1
Relevancy for extension	1

APPENDIX B. RECOMMENDATIONS FOR TRAINING CONTENT BY NUMBER OF MENTIONS

CODE	NO. OF MENTIONS
Focus on adaptation strategies	24
Provide topic-specific content	21
Emphasize forecasting	18
Build climate knowledge	16
Include decision support tools	10
Address scientific uncertainty	10
Address mitigation	5
Identify relevancy for extension	2
Focus on changing weather patterns	1
Address lack of expertise	1
Include social science	1

APPENDIX C. RECOMMENDATIONS FOR TRAINING DELIVERY BY NUMBER OF MENTIONS

CODE	NO. OF MENTIONS
Increase accessibility	48
Tailor content to audience	14
Consider message strategy	14
Focus on farmer benefit	12
Provide hands-on training	11
Already motivated	7
Climate skepticism	6
Include interactive discussions	5
Targeted invitations	5
Training not a priority	5
Create feedback exchange	4
Consider the messenger	3
Create administrative buy-in	2
Emphasize shared ownership	2
Consider timeliness of delivery	2
Create a community of practice	1
Include cross-disciplinary content	1
Encourage networking/group membership	1
Create print materials	1
Deliver recurrent training	1
Identify relevancy to extension	1
Provide sequential training	1
Deliver short workshops	1
Include strategic planning	1
Train early adopters	1