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Farming in the Face of Uncertainty: How Colombian Coffee Farmers Conceptualize and Communicate Their Experiences With Climate Change

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Climate change is impacting agricultural systems around the globe, but little research has focused on how agricultural producers communicate their firsthand experiences with climate change impacts. Coffee, Colombia's largest agricultural export (indirectly responsible for the livelihood of 2 million Colombians), is uniquely vulnerable to climate change. This study lays the groundwork for future adaptation communication efforts by analyzing 45 in-person, in-depth interviews of coffee farmers in Risaralda, Colombia. Dimensionalization, a grounded theory approach, is used to offer a theoretical data matrix to capture the major factors involved in Colombian farmers' experiences with climate change from the farmers' own perspective. The findings illustrate the conditions underlying Colombian coffee farmers' belief that climate change impacts threaten their livelihoods and put farmers in a constant state of uncertainty.

Keywords: climate change, environmental communication, Colombia, coffee farming

In a 2009 statement released by the American Association for the Advancement of Science (AAAS), Alan I. Leshner, chief executive officer of AAAS and executive publisher of the journal *Science*, stated,

> The vast preponderance of evidence, based on years of research conducted by a wide array of different investigators at many institutions, clearly indicates that global climate change is real, it is caused largely by human activities, and the need to take action is urgent. (p. 1)

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Changing climates around the world already impact millions of people (Watts et al., 2017), and as a global society, we therefore confront not only mitigation (decreasing greenhouse gas [GHG] emissions) but also adaptation (adjusting to an already changed climate).

Adaptation is a key factor shaping the future severity of climate change impacts on food production (McCarthy, Canziani, Leary, Dokken, & White, 2001). Within climate change adaptation literature, calls have been made to prioritize consideration of social aspects of vulnerability, such as the existing adaptive capacity in a region or the difficulty of making adaptations for specific systems (Lobell et al., 2008). Developing adaptive farming strategies in a new and unpredictable environment requires a detailed understanding of how a given population is vulnerable to climate change now and in the future (Klein, 2011).

In this study, we examine how coffee farmers in Risaralda, Colombia, communicate their firsthand experiences with climate change impacts to obtain a detailed understanding of this populations' self-identified vulnerabilities to support future adaptation campaigns. First, we designed this study to leverage the unique contributions of a communicative approach to learn how farmers conceptualize and communicate about climate change. Second, we take scholars' recommendations about effective communication strategies for social change to heart by investigating climate change impacts from the impacted population's point of view. This not only privileges the farmers' perspective and magnifies their voices, but also responds to the need to make climate change more "real" to laypeople and policymakers given the global lack of knowledge about climate change (Lee, Markowitz, Howe, Ko, & Leiserowitz, 2015) and that scientific accounts of such phenomena are rarely palatable to the general public (Shome et al., 2009). Climate change is a real threat to the Colombian coffee supply chain (Ramirez-Villegas, Salazar, Jarvis, & Navarro-Racines, 2012) and first-person accounts about the threat to a beloved morning ritual could be an effective "hook" for attracting the interest of a broad audience. More importantly, however, is the need for research that can increase the success of adaptation; there are more than 300,000 coffee farmers in Colombia whose livelihoods are being threatened by an increasingly chaotic climate because of climate change impacts (World Bank, CIAT, CATIE, 2014). An understanding of the challenges these farmers face will lay the groundwork for communication campaigns designed to bring stakeholders together to combat and adapt to climate change in the areas of the world that are impacted the most.

Climate Change in Colombia

Because of its unique geography, Colombia is particularly vulnerable to climate change (Giorgi, 2006). Most of the population and the majority of farmers live (1) in the elevated Andes, where water shortages and land instability are already prevalent, and (2) on the coast, where there are increases in sea level and floods (United Nations Development Programme [UNDP], 2010). Furthermore, the country has a high incidence of extreme weather events with increasingly frequent weather emergencies being associated with climate conditions (UNDP, 2010). By value, coffee is the most important agricultural export in Colombia, and coffee production (all stages) is the most essential crop for the livelihoods of more than 300,000 farmers, providing jobs for over 2 million people (World Bank, CIAT, & CATIE, 2014). Climatic instability and severe weather events associated with climate change impact coffee production and thereby risk the livelihoods of millions of people, as well as political and economic stability in Colombia (Ramirez-Villegas et

al., 2012). Colombian coffee farmers' capacity to adapt to climate change in the coffee-growing regions of Colombia is essential for the stability of the country and surrounding region.

The United Nations Development Programme (2010) has identified adaptation as a focal point for addressing climate change in Colombia: "One way to address adaptation is to 'mainstream,' or integrate, its considerations into planning and decision-making processes. This involves taking into account the risks and opportunities, and putting in place adaptation measures that have a long-term vision of development" (p. 3).

Specific to the Colombian context, the UNDP has outlined specific measures that countrywide adaptation considerations ought to address: (1) Decreasing the vulnerability of the land because of negative impacts of climate change; (2) Increasing the capacity of communities to withstand extreme events and to recover in the aftermath; (3) Increasing the capacity of communities and productive sectors to adapt to climate change; (4) Avoiding maladaptation decision-making processes; (5) Reducing GHG emissions; and (6) more effective, safer, and more sustainable development projects (UNDP, 2010).

Of the six UNDP adaptation measures specific to the Colombian context, success in all areas is dependent on effective communication among stakeholders. Numbers 1 and 5 are arguably the least "communication" centric. Nonetheless, information on *how* to do these things must flow between scientists and stakeholders, and any successful behavioral change program will be built on formative research centered on the communicative (Peterson et al., 1994). Regarding the remaining measures, effective communication practices are clearly major determinants in whether these considerations are and will be successfully enacted. Tackling all of these considerations during a climate change behavior campaign is a complex problem because such a campaign demands an interdisciplinary approach that folds in communication, climatology, horticulture, agricultural economics, and other fields.

Climate Change Communication

Climate change is an inherently difficult topic around which to communicate, as individuals and groups face difficulties in processing and responding effectively to information surrounding long-term and complex societal challenges such as climate change (Shome et al., 2009). Communication scholars must build from the ground up when assessing the climate change informational and attitudinal landscapes of Colombian stakeholders because the characteristics and history of climate change communication in Colombia are not well known (Vélez, Hermelin, Fontecha, & Urrego, 2017). Additionally, only limited information is available on tropical Latin American rural populations' perceptions of climate change, despite the fact that these groups experience significant climate change impacts in the form of changes in both temperature and precipitation that negatively affect these populations' livelihoods (Barrucand, Giraldo Vieira, & Canziani, 2017).

Taking action on a global, complex, and politicized problem requires interdisciplinary perspectives, and the communication processes of citizens and institutions have a crucial role to play (Tufte, 2017). Within the field of communication, the lion's share of research has focused on developed countries' perceptions of climate change (Comfort & Park, 2018). The minority of studies focusing on countries outside of the global west have argued for the importance of formative research for understanding how local climate change

knowledge, perceptions of risk (Lata & Nunn, 2012; Murphy & Tinga, 2019), religious beliefs (Mortreux & Barnett, 2009), and place attachment (Nicolosi & Corbett, 2018) impact the likelihood of climate change adaptation. A prominent line of climate change communication research done around the world examines the potential for media to impact climate change knowledge, attitudes, and engagement (for example, Billett, 2009; Olausson, 2011; Thaker, Zhao, & Leiserowitz, 2017). When examining climate change research as a whole, there is still comparatively limited knowledge of tropical Latin American rural populations' perceptions of climate change (Comfort & Park, 2018; Barrucand et al., 2017).

An in-depth review of climate change research found that climate change experiences and engagement around the world vary widely, and that these variations cannot be explained by any one theory (Wolff & Moser, 2011). Mental models for climate change also vary frequently based on the country and context (Moser & Dilling, 2007). Considering this local variation and lack of knowledge about Colombian coffee farmers' experiences with climate change, it is necessary to conduct formative research in this context before launching adaptation campaigns or population-level survey research intended to inform adaptation policy in Colombia. Juan Díaz Bordenave's (Gumucio Dagron & Tufte, 2006) essay excerpt "Communication of Agricultural Innovations in Latin America: The Need for New Models" argues for receiver-centered communication that is "more conscious of social structure" (p. 111) when creating education communication for receivers in Latin America. We therefore leverage a communicative approach to the problem of climate change by focusing on how an at-risk group of people experiencing climate change, coffee farmers in the Andean region, communicate their experience of climate change. Ultimately, successful adaptation will involve communication and coordination among farmers, policymakers, scientists, the media, and other stakeholders, and so attending closely to how farmers communicate their conceptualizations of climate change and its impacts is essential for generating findings that are useful to the coffee stakeholders. Existing scholarly work supports the importance of taking this kind of participatory and culture-centered approach when the ultimate goal of research is communicating social change (Dutta, 2011; Melkote & Steeves, 2001) and increasing political engagement (Carvalho, van Wessel, & Maeseele, 2017), while avoiding common pitfalls such as applying the diffusion model of communication that is typically used in the United States but is often inappropriate in countries with different political structures and cultural beliefs in place (Gumucio Dagron & Tufte, 2006).

Communication for development and social change is a long-standing and vibrant body of scholarship that supports campaign efforts around climate change (Tufte, 2017), emphasizing the importance of participatory communication (Tufte & Mefalopulos, 2009), with one such component being participation by consultation, whereby stakeholders provide researchers with the knowledge to deploy a course of action such as information and behavior change campaigns (Mefalopulos, 2008). Campaigns designed on the basis of outsiders' intuitive beliefs about "what works" run the risk of having no effect or, even worse, backfiring (Atkin, 1981; Flora, Moccoby, & Farquhar, 1989; Michal-Johnson & Bowen, 1992; Salmon, 1989). Additionally, scientific arguments are not good at motivating stakeholders, as scientific knowledge rarely translates into behavioral practice (Burgoon, 1992). Formative research (developmental research that improves the design theory behind instructional practices [Frick & Reigeluth, 1999]) specific to the local context can result in a more successful climate change adaptation campaign by evoking stakeholders' lived experiences of climate change instead of relying on scientific arguments. We take a novel approach to assessing climate change knowledge by working to understand how coffee farmers in the

Colombian coffee axis conceptualize and communicate about their own experiences with climate change, as opposed to evaluating coffee farmers' knowledge of climate change in scientific or Western terms. This leads us to the following research question:

RQ1: How do Colombian coffee farmers conceptualize climate change?

An evaluation of the specific climate change impacts that coffee farmers face is also essential information for understanding farmers' perspectives of climate change. We therefore also ask:

RQ2: How, if at all, do Colombian coffee farmers communicate how they are affected by climate change impacts?

Methodology

Research Subjects and Data Collection

This study is based on in-depth, semi-structured interviews of approximately 60–90 minutes with 45 coffee farmers in Risaralda, Colombia. Risaralda is one of Colombia's 32 departments located in the foothills of the Andes. Risaralda is a coffee-producing area officially known as the Coffee Axis, which forms part of the UNESCO World Heritage Site known as the Coffee Cultural Landscape of Colombia. Research participants were selected from each of Risaralda's 14 municipalities, with two to four interviewees from each municipality. Members of the research team included collaborators at a local Colombian university who worked with the authors to develop a culturally appropriate and effective recruitment strategy, which was comprised of the distribution of recruitment information to coffee farmers through regional coffee producer associations. Within this region, coffee farmers frequently associate with one or more of these self-organizing local coffee-growing organizations, which often serve as a helpful hub for information and support to farmers in hard-to-reach geographic regions with limited information access. A member of the research team, a CITI-certified and IRB-approved adjunct professor at the local Colombian university, conducted the initial outreach to associations using IRB-approved recruitment language and materials because of her longstanding engagement with this demographic and familiarity with farmers' customs and norms. Participants subsequently met the researchers in a central location in each municipality's major city or town since geographical constraints prevented researchers from visiting individual farms.

Four members of the research team, including one of the authors, conducted the interviews in Spanish over a two-week period. Interview participants did not receive compensation for their participation in the study, as payment was found to be culturally inappropriate for this context. All participants signed a language-appropriate informed consent form before commencement of the interview. Two of the 45 interviews were incomplete and were not included in the analysis. Of the 43 interviewees, seven identified as female and 35 as male. Participant ages ranged from 30 to 81, with the mean age being 51 years. In the 14 municipalities of Risaralda, the interviewees were broken down as follows: Apía (4), Balboa (3), Belén de Umbría (4), Dosquebradas (4), Guática (4), La Celia (3), La Virginia (3), Marsella (2), Mistrató (3), Pereira (4), Pueblo Rico (2), Quinchía (2), Santa Rosa de Cabal (2), and Santuario (3).

The wording and order of questions were carefully selected to measure how climate change is conceptualized by each participant in his or her role as a coffee farmer as well as to minimize leading questions as much as possible. Before asking about climate change, no definition of climate change was provided; neither were any climate change phenomena discussed by the researcher, apart from inclusion as a general description of the project in the consent process preceding each interview. We began with basic demographic questions, followed by open-ended questions about common challenges farmers face to have a basis of comparison for understanding the impacts of climate change on farmers compared with other types of challenges. We followed with climate change–specific questions, such as:

1. Have you heard of the term "climate change?"
2. If so, where and when did you first hear about it?
3. What does the term "climate change" mean to you as a farmer?
4. Who has provided you with information on this topic?
5. Has climate change affected you as a farmer?
6. If so, how?
7. If so, do you remember the first time you started to notice climate change?
8. If so, do you feel like anyone had prepared you for it?

We followed questions about climate change with questions about climatological impacts farmers have observed on their farms. Audio recordings of the interviews were transcribed by native Spanish speakers and translated into English by bilingual members of the research team. After the first round of analysis, described below, we conducted follow-up questions as part of theoretical sampling. Follow-up questions focused on gaining depth of information about farmers' experiences with uncertainty and how climate change impacts had a broader effect on their lives beyond coffee yields and altered farming techniques.

Data Analysis

Dimensionalization is a grounded theory approach rooted in symbolic interactionism that is considered a naturalistic analytic strategy designed to capture individuals' constructions of a phenomenon or other aspects of social reality (Bowers & Schatzman, 2009). Dimensionalization differs from other forms of grounded theory (i.e., Glaser & Strauss, 1967; Charmaz, 2006) in that instead of "attempt[ing] to arrive at a theory by identifying a basic social process," it works to identify all of the dimensions of a problem to "provid[e] a broader view of its complexity" (Kools, McCarthy, Durham, & Robrecht, 1996, p. 316). During dimensionalization, the analyst first considers a broad range of conceptual possibilities before more abstractly representing a phenomenon or concept as dimensions organized in relation to one another (Kools et al., 1996). Dimensional analysis results in theory built from a set of dimensions and their properties, arranged within an explanatory matrix that relates the salience of the dimensions. Our goal in this project was to understand, in a highly contextualized manner, all that is involved in Colombian farmers' experiences with climate change from the farmers' own perspective. Dimensionalization was therefore well matched with our desire to map out the farmers' lived experiences with this phenomenon. In this vein, we named dimensions using farmers' own words and referred back to the predominant narratives within the data to relate the dimensions to one another most parsimoniously with farmers' reported experiences.

Initial natural analysis took place after the first round of data collection. The first set of interviews indicated that many farmers linked climate change with their experiences of the seasons. During theoretical sampling, our strategy was to recruit participants from all of the municipalities of Risaralda and from a wide age group to avoid results biased toward experiences with local weather patterns or toward farmers with longer- or shorter-lived memories of the seasons. Both authors performed the following analyses independently and then compared their results, agreeing on which dimensions were the most salient to include in the explanatory matrix.

Data was analyzed using line-by-line coding and the constant comparative technique as outlined by Strauss (1987) and Strauss & Corbin (1998). During line-by-line coding, each author developed a vocabulary that enabled her to identify a list of provisional dimensions, a process called dimensionalization (Kools et al., 1996). The authors recorded notes and memos about the range of properties of each of these initial dimensions, as well as the relative importance these dimensions held for the farmers' communicated experiences of climate change. Memos written independently throughout the analytic process captured the authors' belief that a "critical mass" (Kools et al., 1996, p. 324) of dimensions were identified after analyzing the first two-thirds of the participants' responses, but both authors continued analysis of the entire data set to ensure that regional experience did not skew the results. After theoretical sampling, these additional responses were analyzed using line-by-line coding. The results mapped very well onto the original set of dimensions, but the results of theoretical sampling caused one dimension to be reconceptualized as an "outcome" of the underlying process. During the next step of analysis, differentiation, the dimension that both authors believed to have the most explanatory power was selected as the perspective of the explanatory matrix. The remaining dimensions were then related to one another as either the conditions, process, or outcomes of the perspective during the integration and reintegration stage of analysis (Schatzman, 1991). The results of the analysis along with exemplary quotes from the interviews are presented in the following section.

Results

The results of the analysis are presented in the explanatory data matrix in Figure 1. The dimensions identified during analysis all linked back to participants' lives as farmers, and so the context in which all of the factors occur was defined as that of coffee farmers in Risaralda, Colombia, experiencing climate change.

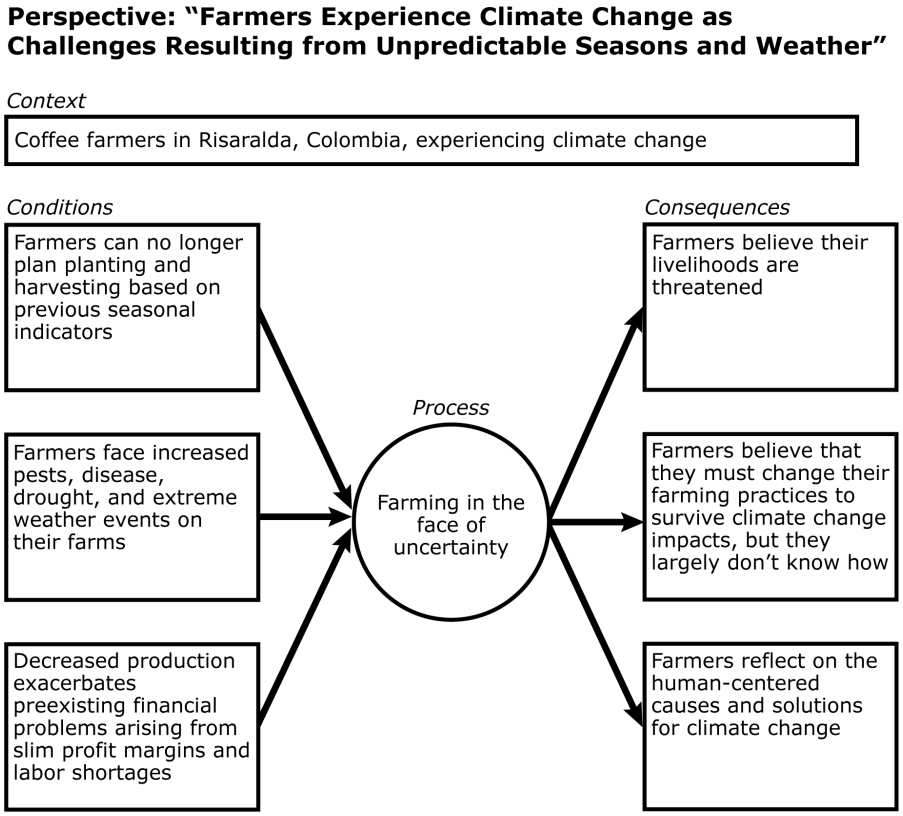

Figure 1. Results of dimensional analysis.

Perspective

The dimension *Farmers experience climate change as challenges resulting from unpredictable seasons and weather*[2] was chosen as the perspective of the data matrix not only because this dimension encompassed the greatest proportion of the data, but also because both authors agreed that it was the predominant lens through which the farmers viewed climate change. Although the farmers clearly understood basic global climate change processes, farmers' responses repeatedly stressed that the farmers experience and conceptualize climate change as unpredictable seasons and weather (RQ1). The most common narrative within the perspective was a juxtaposition of how the seasons used to operate compared with the unpredictable nature of the seasons that farmers now experience. One participant described the change in seasonal weather patterns by stating:

[2] References to the components of the dimensionalization model are italicized for clarity.

> We were used to the seasons of rain[3] and summer being defined. We knew that there was summer in December, January, February and part of March. Winter was part of March, April, May and part of June. Again, summer part of June, July, August and part of September; and Winter part of September, October, November and part of December.[4] All of life had been like this. When climatic variability began, we no longer knew what weather it was going to be each month.

Many participants described this change in seasonal patterns as making the seasons "unpredictable." The farmers characterized qualities of this unpredictable, changed climate pattern as a "lack of defined seasons," a "switching of the seasons," and by describing how "the climate no longer behaves as it once did before." As can be seen in the prior quotation, farmers often drew on their years of farming experience to compare current, unpredictable seasonal patterns with the regular seasonal patterns that the farmers, and often the previous generations of farmers in their families, had observed in the past. One farmer explained how:

> The seasons change. They are different than what one was accustomed to. For example, what we know is that in January one was accustomed to summer, and this year? No. We are in winter. Much rain has fallen.

Another farmer compared past with present experiences with the predictability of the seasons by saying, "Before, we knew in what time of year there would be summer and in what time of year there would be winter. Today, we don't know."

Conditions

Three dimensions were placed within the explanatory data matrix as the conditions that shaped the farmers' perspectives of *Climate change as challenges resulting from unpredictable seasons and weather* and pushed farmers toward the main process they enacted within this perspective, *Farming in the face of uncertainty* (Figure 1). Because of unpredictability of the seasons, Condition 1 is: *Farmers can no longer plan planting and harvesting based on previous seasonal indicators.* In the past, coffee farmers in Risaralda planted and harvested around seasonal rains and hot seasons. As one farmer describes:

> Before, we knew in what time of year there would be summer and in what time of year there would be winter. Today, we don't know. People would plan when they would plant because they knew in what season it would rain, but today it is uncertain.

Most farmers must hire additional manual labor to assist with the harvest since the steep terrain often prohibits mechanized harvesting. There is a shortage of available short-term farming labor, and so planning the hiring of extra labor is time sensitive as well as a significant investment of monetary resources. From

[3] Farmers frequently use "the rain" and "the rainy season" interchangeably with winter because of the increased rains traditionally associated with this time period.

[4] There are two coffee-growing seasons in Risaralda that are known as winter and summer. Farmers refer to the two primary planting seasons as "summer" and the two primary harvest seasons as "winter."

the farmers' perspective, the lack of seasonal indicators along with unpredictable rains makes planning for seasonal labor almost impossible. As one farmer stated:

> Before, we could plan the work, the seasons of harvest, investments aligning with the flowering. Now, the plant flowers and we do not know when we are going to harvest because it either rains a lot or there is a lot of drought. So we are always walking a tightrope, because we do not know.

Other farmers described the inability to plan farming activities as a "lack of control" that caused them to revert from planning these decisions to "mak[ing] approximations" about when to plant and harvest. One farmer felt that farmers with few resources cannot plan, and instead are at the mercy of unpredictable weather:

> It is a very serious and harmful problem because we are accustomed to the practice of planting in a certain season and what happens now is that rich people plant in January and buy two or three motor pumps to irrigate the crops. But the ones without money go to the church and pray for rain so their seeds aren't damaged.

Condition 2 under this perspective, *Farmers face increased pests, disease, drought, and extreme weather events on their farms*, helps to answer RQ2. During the interviews, the farmers gave specific examples of how their productivity has been directly influenced by the unpredictable seasons and weather that they attribute to climate change. Farmers frequently described periods of excessive rain as well as drought:

> The rains damage us a lot. For picking, drying, for all the things that have to do with the well-being of the coffee.

> But now there are extreme heats and rains.

> It's something very hard. I've experienced it for three years with the water on the farm. I'm not able to count on having sufficient resources because there was a period of approximately six months of drought.

Farmers linked excessive rain and drought with other problems like pests and soil quality reduction:

> There was a season of very extreme drought, resulting in the coffee borer beetle because this is the ideal climate for them to reproduce and this completely affected the quality of the coffee.

> Now, we have climates that aren't suitable. We have difficulties with the topsoil, problems with the sun penetrating the nutrients in the soil, amidst others.

All of these problems ultimately resulted in observable decreases in production on the Risaralda coffee farms.

Condition 3 in the data matrix model is an indirect climate change impact (RQ2): *Decreased production exacerbates preexisting financial problems arising from slim profit margins and labor shortages*. When asked about the challenges they faced and about climate change in general, farmers' responses frequently connected decreased coffee production because of climate change impacts with other preexisting financial problems. Farmers described how decreased production attributed to climate change impacts made it difficult to pay off farming loans and to cover production costs like workers' salaries. As one farmer stated, "I think climate change [is my biggest challenge], because if we do not have a good product, practically we won't be able to pay debts and things." Another farmer described how "a big challenge as a coffee grower is the production costs," which make it difficult for farmers to turn a profit when extreme weather like high temperatures and rains decrease production.

Farmers explained how the price at which they can sell their coffee is also a source of uncertainty. Many coffee farmers sell their coffee to the National Federation of Coffee Growers of Colombia (Álvarez & Furio, 2010), which purchases coffee beans from the farmers at a fluctuating price calculated according to the closing price of the New York Stock Exchange and other variable factors (Federación Nacional de Cafeteros de Colombia, 2018). Farmers frequently listed the coffee sale price and climate change impacts in the same thought when describing the biggest challenges they face:

> The biggest [challenge] is the matter of pricing. The price at the national level is not profitable. The coffee is good and profitable from the port and beyond. There are a lot of intermediaries from there onward. Those who do the true work of producing the best coffee in the world are not receiving compensation. I see this as one of the things that most affects us, but also climate change.

The results indicate that an understanding of climate change impacts on coffee farmers must take into account the interaction of climate-related impacts with personal and supply chain financial stressors.

Process

The process component of an explanatory data matrix is "an intended or unintended action or interaction that is impelled by specific conditions" (Kools et al., 1996, p. 329). All three conditions in the data matrix led to a process wherein farmers are *Farming in the face of uncertainty*. Condition 1 describes the dimension of farmers' experience with the unpredictability of the seasons that was related to planning and decision making. Although not all farmers used the term "uncertainty," their descriptions of their struggles when deciding when to plant and harvest is captured by this concept. There are many definitions of uncertainty across health, economic, and communication fields, but the most useful conceptualization for describing the action arising from the conditions of the data matrix is uncertainty as a type of "metacognition" about the uncertainty resulting from experiencing the three conditions (Flavell, 1976, pp. 231–236). The uncertainty that results from the combination of these conditions is not because of a lack of information—much the opposite; it comes from farmers being aware of the fact that they do not have the information they need to make decisions, nor are they able to control or influence factors with the potential to devastate their lives. A previously quoted farmer described the uncertainty about deciding when to plant or harvest as "walking a tightrope." Another talked about how, in the past, farmers "would plan when they

would plant because they knew in what season it would rain, but today it is uncertain." One farmer defined climate change as "something unknown about the climate," since the weather could change quickly "from one moment to the next," when before weather patterns were "something that [farmers] knew." Other farmers described this experience of uncertainty as a "lack of control," the ability to "only make approximations" when making farming decisions, an inability to "know how the climate will be each month," and even as a lack of confidence in meteorologists' predictions.

Consequences

Three dimensions were best situated within the data matrix as the consequences, or outcomes of the process (Figure 1). Consequence 1 is: *Farmers believe that their livelihoods are threatened.* The farmers expressed in no uncertain terms that farming when facing so many uncertainties makes them feel that their livelihoods as farmers are threatened: "[Climate change] for me means threat," "[climate change] is a very serious and harmful problem," "[climate change] means that I am suffering," and "undoubtedly, [climate change] is the ending of the earth."

In addition to talking about climate change as a general threat, farmers also specifically referenced the economic component of the damage to their livelihoods. They expressed how farming under such uncertain conditions hurts their ability to do their job (produce) and to sustain themselves and their families at an adequate economic level (income):

> [Climate change] hurts us a lot because of production. We need certain climatic standards to be able to produce.
>
> [Climate change] means many things; more poverty, more need and that life is going to end for us farmers little by little.
>
> Danger, because it affects us so much. It affects us economically.
>
> It's something very hard . . . I'm not able to count on having sufficient resources.

Consequence 2 captures farmers' willingness to adapt to climate change–induced problems: *Farmers believe that they must change their farming practices to survive climate change impacts, but they largely don't know how.* After discussing the challenges that resulted from climate change impacts on their farms, farmers often talked about how adaptation is necessary; for example, "Now what we must do is adapt to [climate change problems]." Adaptation was seen as necessary and complex, and while two-thirds of farmers reported experimenting with adaptation techniques, no farmer reported having found a successful adaptation strategy. As one farmer stated, "Today, it is very complex and difficult to manage climate change because it is a situation that we cannot manage, but we must cope with it." Farmers had the mentality that they needed to "prepare for" climate change impacts, that "certain precautions must be taken" because of changed climatic conditions, but no farmers reported implementing adaptations that solved their climate change–related problems. Adaptation was so

challenging that some farmers' strategy was to try to be prepared for all types of extreme seasons at all times.

Consequence 3 in the data matrix model is: *Farmers reflect on the human-centered causes and solutions for climate change.* Although no interview question asked farmers about who is responsible for climate change, the responses show how the farmers conceptualize climate change as being brought about by human behavior. As one farmer stated:

> Climate change is the way in which the environment is changing due to some prior and current behaviors we have engaged in and unfortunately the environment adapts and does what it must do; therefore, now what we must do is adapt to it.

When making sense of why they faced so many impacts, farmers often gave examples of specific human behaviors that they believed were contributing to climate change:

> On matters of the climate, we are destroying it ourselves.

> Many blame man for knocking down mountains, cutting trees and it is partly man's fault.

> On matters of the climate, we are destroying it ourselves. For example, for all the burning that they do.

Farmers held a negative outlook about their ability to stop climate change but still expressed a desire to do so:

> Our ability to counteract the effects of climate change is minimal. I am not a scientist, but I understand that they are irreversible. It's mitigable but not reversible.

> Our ability to counteract the effects of climate change is minimal. It is a threat with the force of immense incapacitation. We must be very attentive to the little we can do to contribute.

> We cannot be so destructive with the earth and we must take care of it.

Even though (or perhaps because) many of the farmers believed that the effects of climate were irreversible, more than half of the farmers we talked to were actively attempting to adapt to climate change impacts. Additionally, the farmers have a longstanding history of attending workshops presented by agricultural extension agents or association leadership, and some farmers had invested notable time and resources in adaptation experimentations on their farms such as planting shade trees to reduce the sun exposure and soil temperature. Finding the farmers open to engaging in new farming practices to address farming problems, we next discuss these findings in terms of how this information can inform communication campaigns designed to engage local stakeholders in climate change adaptation efforts.

Discussion

This formative research evaluation of Colombian coffee farmers used grounded theory to analyze how farmers, in their own words, conceptualize, experience, and communicate about their experiences with climate change. Our findings demonstrate that Colombian coffee farmers know what climate change is, both as a consequence of human behavior and as a lived experience. Farmers' primary perspective of climate change is that it presents many farming challenges as a result of unpredictable seasons and weather. In this perspective, farmers find that they farm in the face of uncertainty. This uncertainty is shaped by three main conditions: (1) Farmers can no longer plan planting and harvesting based on previous seasonal indicators; (2) Farmers face increased pests, disease, drought, and extreme weather events on their farms; and (3) Decreased production exacerbates preexisting financial problems arising from slim profit margins and labor shortages. The outcomes of this perspective are that farmers feel that their livelihoods are threatened by climate change, that they must change their farming practices to survive climate change impacts, but they largely don't know how; and farmers attempt to make sense of how humans are both the cause of climate change and must be part of the solution.

Theoretical Implications

For this study, the theory drawn from this model is, in essence, a "micro" theory that applies specifically to coffee farmers of Risaralda and their experiences with climate change. In doing so, it demonstrates how climate change is not merely a meteorological phenomenon, but an all-encompassing human experience that permeates the many facets of the farmers' lives. These farmers' experiences with uncertainty can be further understood using an uncertainty management theoretical lens. Brashers (2001) wrote about aspects of the nature of uncertainty: (1) situational factors such as ambiguity, complexity, unpredictability, unavailable or inconsistent information, and people's insecurity in their own state of knowledge; and (2) assessments about the probability of an event. These descriptions of the nature of uncertainty closely mirror the farmers' experiences with unpredictable weather and a lack of information that they can use to make farming decisions with predictable outcomes. Uncertainty management theories have described the importance of understanding people's responses to uncertainty such as "appraisals and emotional reactions to the experience" (Brashers, 2001, p. 481). The farmers' emotional descriptions of uncertainty due to climate change impacts as a financial and career-ending threat certainly qualify as negative emotional responses, a "signal of a troubled appraisal when uncertainty is viewed as a danger or threat" (Brashers, 2001, p. 482).

There are various ways in which people who are in a state of uncertainty engage in uncertainty management. Seeking or avoiding information to reduce, increase, or maintain uncertainty levels is a common strategy (Brashers et al., 2000), as are adapting to chronic uncertainty (Mishel, 1990) and seeking out social support to help manage uncertainty (Brashers, Neidig, & Goldsmith, 2004). The coffee farmers most frequently reported looking for necessary information in the natural environment, such as weather patterns and signs of the health and growth stages of their crops. They also described talking with neighbors, local coffee growing associations, and local extension agents about their farming problems, but future research must be done to investigate in-depth the sources and the nature of information seeking conducted by the farmers to reduce their uncertainty. In situations where uncertainty is ongoing and unlikely to change,

some people adapt to chronic uncertainty by developing a tolerance for ambiguity (Mumby & Putnam, 1992), ignoring the uncertainty-provoking event or relying on religious beliefs (Emmers & Canary, 1996), changing how they make decisions (Brashers et al., 2000), developing new structures and routines (Merry, 1995), or by drawing on social support (Burleson, Albrecht, & Sarason, 1994). In their case, coffee farmers simply cannot afford to ignore the sources of uncertainty because adaptation is necessary for the financial survival of their farms. Many farmers reported the development of new farming routines like switching to new crops and experimenting with new farming techniques like adding shade crops and developing new insecticides. Developing new routines therefore appears to be the most popular way of managing uncertainty about farming decisions, along with some social support in the form of talking with other farmers about what new techniques seem to be working within particular microclimates. Farmers are still entrenched in the traditional practice of looking for seasonal indicators for cues about when to plant and harvest, even though changing weather patterns have obliterated many of these natural rhythms. This new disconnect between farmers and their former ability to gather vital information from the natural environment is the greatest source of farmers' uncertainty, and unfortunately, climate studies indicate that these changes in climate are permanent and are likely to get much worse over time. Farmers must therefore be connected with new sources of reliable information in order for them to successfully adapt to climate change.

Climate Change Adaptation Communication with Colombian Coffee Farmers

The coffee farmers interviewed for this study communicated their climate change worldview as a constant experience of uncertainty as a result of climate change impacts that put them in a financially insecure state. The farmers overwhelmingly indicated that they are open to adaptation when they have the necessary financial and informational resources. We believe this understanding of how farmers communicate their climate change experiences can help policymakers and other coffee stakeholders in Colombia more successfully communicate and engage with farmers around this problem. Primarily, communication campaigns or adaptation initiatives involving these coffee farmers must recognize the uncertainty the farmers face when making everyday farming decisions. Of vital importance is the farmers' emphasis on the absence of previous seasonal indicators necessary to make farming decisions. Based on these findings, a next-step for policymakers can be the allocation of resources for the development of affordable climate change adaptation farming techniques. The existing financial pressures that compound the impact of climate change on farmers' financial survival must also be addressed. Many farmers we spoke to are one bad harvest away from financial insolvency, and several had fallen into an unsustainable cycle of taking out expensive loans to pay off the previous year's farming loan. This situation requires an unprecedented change in how farmers are compensated through the coffee supply chain, either at the farmers' end of the supply chain through increased profit at their point of sale, or from the opposite end of the chain with increased profit-sharing from intermediaries and consumers. Additionally, adaptation campaigns should clearly link adaptation recommendations to the specific production problems faced by the farming population, as well as to farmers' grave concerns about profitability.

Finally, it is important for the world to note people's experiences with climate change impacts who live in areas of the world highly vulnerable to climate change, because these experiences are warning signs of what can be expected as climate change impacts unfold globally in agricultural communities. Researchers should note how local context influences communities' lived experiences with climate change impacts,

constraining which adaptive measures are most likely to be successful. The results of this study indicate that climate change is a phenomenon the coffee farmers experience in almost all aspects of their farming work, and that adaptation will require a fundamental shift in how farmers receive information and make everyday farming decisions. The work before those who wish to help lies in continuing to understand these local climate change experiences, as this study has done, and to come together with scholars and practitioners across disciplines to create localized adaptation strategies that are designed to manage both environmental impacts and human uncertainty generated by climate change.

Limitations

This study is limited in several ways. Three Colombian states make up the majority of the Colombian Coffee Axis, or the *Eje Cafetero*. For our study, we only visited the state of Risaralda, which is located at the center of this coffee-growing region. Although we did garner a fairly representative sample of Risaralda by interviewing coffee farmers in each of the state's 14 municipalities, we may not be able to extrapolate these farmers' experiences to the whole of the Coffee Axis. Additionally, great care was taken in translating the Spanish responses to English, but there are subtle nuances in language that can be lost despite best efforts. For instance, the commonly used adjective *brusco*, which was frequently applied to descriptions of the weather and seasonal changes, has three potential translations: abrupt, sudden, or sharp. Lastly, local coffee associations in Risaralda assisted in disseminating the researchers' call for interviews. The majority of coffee farmers are associated (no reliable statistics exist, this is anecdotal through local stakeholders); however, this did likely skew the interviewees toward both associated and engaged coffee farmers and did not include as many independent or less-engaged farmers. We are confident in this study's finding that uncertainty is the central process of a model focused on the farmers' experiences with climate change, but more research is necessary to build a deeper understanding of the farmers' experiences of uncertainty and how they manage and communicate this uncertainty.

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