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Farming adaptations in the face of climate change

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Abstract

Agriculture is one of the most vulnerable sectors to climate change, and in many agricultural communities climate change adaptations by farmers are underway. Farmers' beliefs about climate change and their experiences with climate change, along with a range of other factors, could influence climate change adaptation. Utilizing a framework which draws from research examining how farmers' climate change beliefs and experiences affect their adaptation strategies, and research on farm succession and adaptation at the rural–urban interface (RUI), we ask 'How do climate change beliefs and different farm attributes (particularly the presence of an heir and location at the RUI) affect adaptation strategies?' Preliminary findings indicate that adaptation varies based on multiple factors, including belief in climate change, the presence of an heir, geographical location and a variety of other farm characteristics and farmer attributes.

Introduction

Agriculture is one of the most vulnerable sectors to climate change, and many farmers are currently engaging in climate change adaptation. A range of factors may influence climate change adaptation in agricultural communities, including beliefs about and experiences with climate change. Other factors may also influence how farmers adapt to climate change, including location at the rural–urban interface (RUI) and the presence of an heir. In this paper, we discuss in-progress research which examines the ways in which beliefs about and experiences with climate change influence climate change adaptation, and the ways in which other factors influence this relationship, including location at the RUI and the presence of an heir. Utilizing preliminary data collected, we develop a framework to examine adaptation, drawing from Wheeler et al.'s (2013) research on how farmers' climate change beliefs affect their adaptation strategies, Inwood and Sharp's (2012) research on farm succession (the process of transferring the farm to the next generation) and literature examining farming operations in urbanizing areas (Jackson-Smith and Sharp, 2008).

Agricultural adaptation

Climate change adaptation is defined by the IPCC (2001) as 'adjustments in ecological, social or economic systems in response to actual or expected climatic stimuli and their effects or impacts' (pg. 818). Many farmers are adapting to climate change, both experienced and projected (Moser and Ekstrom, 2010). Farmers may adapt to climate change in a number of ways. For instance, farmers may adopt new hybrid crop varieties, diversify cropping systems, diversify livestock breeds, utilize crop insurance, transition to no-till farming, adjust the intensification of production, utilize cover crops, change the location of operations, adjust timing of operations, utilize new water management innovations, diversify farm income, improve soil conditions or use tile drainage (Smit et al., 1996; Smit and Skinner, 2002; Kurukulasuriya and Rosenthal, 2013; Wheeler et al., 2013).

Farmers are critical decision makers in adapting agriculture to changing climate conditions (Arbuckle et al., 2013a), and a variety of factors, including economic, cultural, political and environmental, may influence decisions in agriculture, some of which are outside of the control of individual farmers (Ilbery, 1985; Smit and Skinner, 2002; Smit and Wandel, 2006). In this paper, we are interested in the ways in which belief about and experiences with climate change influence adaptation, as well as how other factors, particularly presence of an heir and proximity to the RUI, influence this adaptation. Currently, little research addresses the effects that the combined pressures of climate change and urban development have on farmers' adaptation strategies.

Existing literature suggests that farmers' perceived vulnerability is important to consider when understanding climate change adaptation, and that belief in climate change as well as the perception of it being a threat to livelihoods can influence whether and how farmers

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adapt (Arbuckle et al., 2013a). A number of studies have examined the relationship between climate change beliefs (including whether it is occurring, and whether it is anthropogenic in nature), as well as experiences with climate change, and adaptation. While some research has found little support for the notion that beliefs about climate change influence farmer attitudes toward adaptation (Arbuckle et al., 2013a), other research has found a link between climate change beliefs and climate change adaptation. Wheeler et al. (2013), for instance, found that farmers who believe that climate change is occurring are less likely to expand their farms, but are more likely to change their crop mix and adopt more efficient irrigation methods. Others found that farmers who are more concerned about the impacts of climate change, and believe that it can be partially attributed to human activities, were more likely to think that they should adapt to protect farmland from climate change impacts (e.g., Arbuckle et al., 2013b). Past experiences with climate change may also influence climate change adaptation. Farmers who have seen climatic changes in the past are more likely to be concerned about future changes and are willing to plan and adapt accordingly (Haden et al., 2012). Climate change belief, as well as past experiences with losses related to climate change, may shape the risk perceptions of farmers, which can then influence adaptation behavior (Menapace et al., 2015).

A range of other factors can influence climate change adaptation, including the decision-making and adaptive capacity of farmers (Blesh and Wolf, 2014; Li et al., 2017). Farm age, growth rate, number of employees, operation size, farm type and markets used may all influence adaptation (Pannell et al., 2006; Wheeler et al., 2012, 2013). Socio-demographics such as age, income, education, gender, farmer health and off-farm income may also influence climate change adaptation (Pannell et al., 2006; Knowler and Bradshaw, 2007; Prokopy et al., 2008; Baumgart-Getz et al., 2012; Below et al., 2012; Wheeler et al., 2013). For instance, younger farmers have been found to be more likely to adopt conservation management practices (Prokopy et al., 2008; Baumgart-Getz et al., 2012), and may be more likely to engage in adaptation that involves expanding an agricultural operation, such as Community Supported Agriculture (CSA) operations (Brown and Miller, 2008). More years of education has been associated with improved understanding of ecological systems, and participation in agri-environmental schemes (Low and Vogel, 2011; Burton, 2014).

Some scholars have called for more empirical literature on actual farm adaptation behavior, and note that much of the existing literature focuses on developing countries (Wheeler et al., 2013). Further, some factors that may be important to consider have received less attention in climate change adaptation literature, such as the presence of an heir, and location at the RUI. A robust literature does document how the presence of an heir and location at the RUI may affect farmers' plans for adapting their agricultural operations more generally. We argue here that these factors may also influence how farmers adapt to climate change. For instance, the number of children a farmer has can be positively associated with farm succession, the process of having the farm taken over by another person, most often a child (Bertoni and Cavicchioli, 2016). Multiple factors including the value of the tradition of farming in a family (Wheeler et al., 2012) and the amount of time a farm has belonged to a family (Inwood et al., 2013) can influence the likelihood of a farm being passed down. Further, Wheeler et al. (2013) found that having a successor identified was significantly associated with planning to adapt to climate change. We therefore hypothesize that in responding to climate change, the presence of an heir will make farmers more likely to engage in expansive adaptation, rather than contractive.

Research also suggests that geography can influence farmers' plans for adaptation of their farms. Farms that exist where there are urban pressures such as land-use change and population growth may not be able to adapt horizontally by acquiring more land due to inflated costs; in these instances, farmers must choose whether to expand vertically by entering new markets or contract by selling their farms (Inwood and Sharp, 2012). However, residing at the RUI provides farmers greater access to direct marketing opportunities and the growing demand for higher value specialty crops (Jackson-Smith and Sharp, 2008). Farmers may also expand horizontally (Inwood and Sharp, 2012) by moving their operations further from urban centers. In this research, we extend this literature on the presence of an heir and location at the RUI in order to consider how these factors may influence climate change adaptation.

We focus here on three adaptation approaches to climate change that farmers in the Treasure Valley may employ. The first is contractive, reducing resource use and/or selling the farm (Wheeler et al., 2013). The second is horizontal expansion, where a farmer would acquire more land. The third is vertical expansion, where a farmer would explore new markets and technologies to increase production without acquiring more land (Inwood and Sharp, 2012; Wheeler et al., 2013).

We hypothesize that:

1. Farmers who believe climate change is a threat are more likely to engage in adaptation (both expansive and contractive), whereas farmers who do not believe climate change is a threat are less likely to engage in adaptation.

However, a range of other factors, including farmer attributes and farm characteristics, will influence whether and how they adapt. In addition to factors that have been documented in current literature, such as size of operation, age of operation, crop type and markets utilized, years of education, and farmer age, we hypothesize that being located at the RUI and presence of an heir will influence climate change adaptation. In particular,

2. Being located at the RUI will influence the climate adaptation strategies of farmers.
    a. Farmers who are operating at the RUI have more opportunities for vertical expansion. Therefore, among farmers at the RUI, those who believe climate change is a threat, regardless of cause, are more likely to expand vertically, relative to farmers in more rural settings.
    b. Some farmers at the RUI who believe climate change is a threat might also respond by moving their operation, thus expanding horizontally; this will be because of pressures from urbanization, but may also be motivated by belief in changing climate.
3. The presence of an heir will influence the climate adaptation of farmers.
    a. Farmers with an heir will be more likely to engage in expansive adaptation strategies associated with climate change, both horizontal and vertical, relative to farmers without an heir.
    b. A farmer who believes climate change is a threat or who has experienced the threat of climate change but does not have an heir may engage in contraction.

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Methods

To test these hypotheses and build a model of climate change adaptation which accounts for the potential influence of location at the RUI and presence of an heir, we are utilizing a mixed-methods approach, with a geographic focus on the Treasure Valley, a region of Southwestern Idaho. Below we describe this region of study, and provide details regarding our methodology.

Agricultural change in the Treasure Valley

Given that climate change impacts are expected to vary across landscapes (IPCC, 2014; Melillo et al., 2014), it is important for place-based studies to tap into local knowledge and practices to paint a clearer picture of what climate change adaptation looks like in specific areas (Smit and Wandel, 2006; Fortmann et al., 2014; Wright Morton and Rudel, 2014). In our own community of the Treasure Valley, a region of Southwestern Idaho spanning Ada, Canyon and Owyhee counties, populations are growing and land use is changing (Dahal et al., 2016). Further, Idaho is facing climatic changes that threaten agriculture, including increased temperatures, and earlier melting of snowpack (EPA, 2016). The fact that the Treasure Valley is a rapidly developing area, where farms exist largely at the RUI, and are competing for resources in the face of climate change and urbanization, make it an ideal study site

Data collection and analysis

This project was inspired by a focus group conducted in the spring of 2016. The focus group gathered 12 individuals involved in agricultural irrigation in the Treasure Valley; participants were primarily farmers, but also included irrigation suppliers, and soil conservation professionals. The aim of the focus group was to understand how farmers were anticipating and adapting to shifting conditions around water and land-use change in the Treasure Valley. A semi-structured format approved by the Institutional Review Board (IRB) guided participants through topical questions while leaving time and opportunity for freeform interactions and conversations to happen among participants. Based on findings from this focus group, we decided to pursue a research project focused on examining the various factors that may influence how farmers in the Treasure Valley are adapting to climate change.

We are utilizing an IRB approved mixed-methods approach for this research, including semi-structured interviews, unstructured interviews, participant observation and surveys. Informal interviews and participant observation have been conducted at a range of agricultural events in the Treasure Valley, including farmers' markets, and local and regional agriculturally oriented conferences. We are using purposive and snowball sampling (Marshall and Rossman, 2011) to recruit participants for the semi-structured interviews, in order to understand how various farm attributes, socio-demographic factors, and climate change beliefs and experiences may be influencing adaptive plans and strategies. We are interviewing farmers operating in a range of geographic locations, including those located at the RUI, interviewing farmers operating both large- and small-scale farms, as well as conventional and organic farmers and those working in niche markets, such as local. We are also working to ensure that respondents vary with regards to age, gender and presence of an heir. Data analysis has consisted of coding interviews and notes; these data have been evaluated to establish links to the research objectives, and finally used to develop a model (Thomas, 2006).

While data collection is in its initial stages, and we do not yet have sufficient data collected to present quantitative results or robust, generalizable qualitative results, initial results have helped us to build and refine a model that illustrates what we anticipate we will find as data collection continues. Below we discuss these preliminary findings, and then present the model.

Preliminary findings

We begin here by discussing the findings from the focus group, and then move to discussing initial findings from the interviews. While most focus group participants, particularly those directly involved in farming, were hesitant to say that they believed in anthropogenic climate change, they all agreed that they were seeing changing climatic conditions in the region such as hotter summers, earlier warming in the spring and changing water conditions. Further, most respondents believed there would be more frequent extreme weather conditions, including colder winters, hotter summers and changes regarding seasonal warming and cooling in the future. They believed that this would lead to adaptation of farming practices, primarily by shifting what is farmed. They also anticipated changes such as shifting toward no-till practices and adopting more efficient irrigation practices. Farmers overall did not believe that extreme weather conditions would lead farmers to sell their land, but rather that it would force them to adapt what they produced, and how. Respondents spoke of farmland increasingly being broken up into smaller parcels and farming becoming more difficult in the Treasure Valley, trends that they predicted will continue. Respondents also reported concern about the loss of efficiencies, as well as changing water conditions. Because of these factors, many farmers believed that more farmland would be sold for development, and several farmers in the focus group cited specific examples of friends and neighbors who either got out of farming, or moved their operations further from the city centers.

Similar to the findings revealed during this focus group, many farmers we have interviewed have been hesitant to state that they believe in anthropogenic climate change. Those who have been more likely to report belief in anthropogenic climate change have been younger, have more formal education and operate smaller scale operations. However, all farmers have reported that weather has been more variable in recent years, and that water availability has been more unpredictable.

Concerns with water appear to be influencing farmer adaptation strategies. In order to reduce their vulnerability, some farmers were engaging in vertical expansion by shifting their irrigation practices. This appears to be more prevalent among farmers with previous experience with water shortages. They viewed their future plans as more stable when they were using more efficient methods of irrigation, such as drip irrigation. The 2016/2017 winter was harsh, and the spring was very wet and cold. Thus, throughout the initial period of data collection, farmers were being kept out of the fields, and they were anticipating a shorter growing season. For this reason, some farmers also mentioned having to potentially contract parts of their operation (such as purchasing animal feed rather than growing it), or engage in other adaptations such as shifting the crops grown or the irrigation practices used.

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Supporting previous literature, initial data suggest that the presence of an heir influences current farmer adaptation, as well as future plans for adaptation. Farmers who have an heir involved in the operation appear more likely to be engaging in expansive adaptive strategies. For instance, on one operation a father had been unsure if he would have anyone to take over the farm, and had been planning to sell the operation to an adjacent farm. However, when his daughters expressed interest in being involved in the operation, his plans shifted. Now, he and two daughters are working the operation together, and they have expanded the operation by taking on more acreage and diversifying varieties of existing crops, as well as the range of crops grown. We were told that these adaptations would not have occurred without the involvement of the daughters. This finding has been echoed in other interviews. However, farmers without an heir see their future as more uncertain and do not appear to be engaging in the same type of active adaptation strategies.

Age may also influence the adaptive strategies of operations, particularly the age of heirs. Farmers with younger children were unsure whether their children would want to be involved in farming. However, operations with heirs who were young adults who had made the decision to be actively involved appeared to be the operations experiencing the most active expansive adaptation. Similar to findings from O'Connor et al. (1999), it appears that education, as well as gender, and belief in climate change may be linked within our population. Our initial results do not provide sufficient findings to report out, but these are factors that we will continue to pay attention to as data collection continues. Our preliminary results also suggest that farms that had been passed through multiple generations are more likely to remain active and in the family, and that these factors may influence climate change adaptation. Again, this is something we will pay careful attention to as data collection continues.

Geography also appears to influence how an operation adapts. A number of the farmers noted the influence of urbanization on their operations, and this appears to influence climate change adaptation. For instance, one farmer living in an area that is experiencing water shortages, and is also rapidly transitioning from agricultural land to housing, had previously been operating a conventional hog operation. In response to these pressures, they have decreased the size of the operation, and transitioned to utilizing direct, local markets. While it initially appears the farm is shrinking, further digging reveals these adaptations have resulted in vertical growth into new markets and niche products (organic and local), directly influenced, according to the farmer, by what the growing local urban community wants to purchase. This farm has diversified their operation, raising chickens for meat and eggs, and has expanded into crops such as berries. They have also created a shop on their farm where people can come to purchase food directly. Another small-scale, organic farm that was leasing land recently moved their operation because of the pressures of urbanization; the landowner had chosen to sell the land for housing. Rather than contract the operation, they are expanding by moving to an area further from development, and also exploring new crops in addition to the ones they are currently producing, again, driven by local demand. The changing climate, in addition to urban pressures, appear to be influencing how they are adapting their operation.

Preliminary data collection further suggests that other factors influence adaptive strategies. For respondents engaged in global markets, price shifts play an important role in decision-making, including whether they expand or contract their operation. Not surprisingly farmers will only choose to grow a new product if the market will support it, and they feel both climatic conditions and water availability will not be issues. Being in proximity to urban areas was also important for a number of operations, who described adaptation strategies that took into consideration local demand and preference, and availability of local markets.

Proposed model

Building from the work of Wheeler et al. (2013) and Inwood and Sharp (2012), and informed by our own preliminary data collection, we present a model that considers climate change belief and experience, farm characteristics, and farmer attributes to predict what kind of adaptation strategies are being implemented by farmers in the Treasure Valley (Fig. 1).

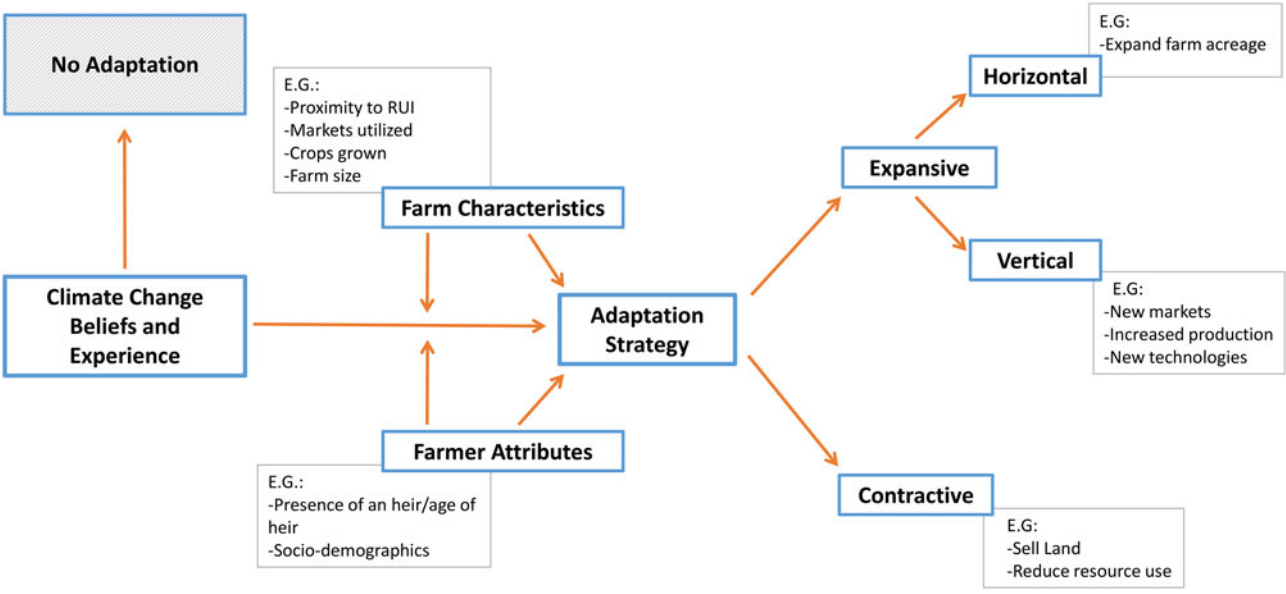


Fig. 1. Climate change beliefs and experiences adaptation model.

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The model first considers how farmers' climate change beliefs will affect their adaptation strategies, but also takes into account the potential influences that farm characteristics and farmer attributes have on this relationship. As noted above, farm characteristics and farmer attributes may affect the adaptation strategies employed. For example, if a farmer who has experienced climate change has an heir that is willing to operate the farm, the adaptation strategy they employ may look different from a farmer who has experienced climate change but has no one to pass the farm to. While additional data are needed to validate this model, initial results from our interviews show farmers adapting in the three ways described in the literature review (contractive, horizontal expansion and vertical expansion), and justifying their adaptation decisions based on experiences with climate change, as well as personal attributes and farm characteristics.

Conclusion

The aim of this research is to explore farmers' adaptation to climate change; we are particularly interested in understanding how having an heir, and location at the RUI may influence climate change adaptation. Building on previous literature, we have developed a model that anticipates that climate change belief, experiences with climate change, location at the RUI, other farm characteristics and farmer attributes will influence adaptive strategies, including whether farmers expand or contract their operations. Initial results from field observations and interviews inform the model, and suggest that adaptation is driven by a number of stressors, as well as other factors, such as presence of an heir. We will continue to collect data in order to further test this model.

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