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Climate change beliefs, risk perceptions, and adaptation behavior among Midwestern U.S. crop farmers

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ABSTRACT

Global climate change presents unique challenges to the resilience of United States agriculture, and farmers and advisors must utilize effective adaptation strategies to be both economically and environmentally sustainable. This study addresses Midwestern U.S. crop farmers' beliefs about climate change, perceived risks from weather and climate, and attitudes toward adaptation that influence their decisions to adopt adaptation strategies. Analyzing a 2012 survey of nearly 5000 corn farmers across 22 Midwestern U.S. Watersheds, we investigate the most common weather and climate risk management strategies, including purchasing additional crop insurance, implementing conservation practices, and adding new technology. U.S. farmers' belief in anthropogenic climate change, perceptions of changing weather patterns, climate risks to their farm and attitudes toward adapting are analyzed. Farmers' perceptions of risk to their own farm, attitudes toward innovation and adaptation attitudes were the most important determinants of adaptation. This study highlights the critical role of risk perceptions in adaptation attitudes as well as behaviors among agriculturalists. Finally, we discuss how these findings could be applied to increase uptake of adaptation strategies and thus resilience of U.S. agriculture to a changing climate.

1. Introduction

1.1. Climate change and agriculture

Agricultural vulnerability to climate change is one of the greatest challenges facing the sustainability of the global food system. While increasing levels of carbon dioxide in the atmosphere could be seen as a boon to crop production, negative impacts of climate change – such as increasing temperatures and more variable rainfall patterns—are expected to outweigh any benefits for agricultural production (Walthall et al., 2012). The Midwestern U.S. Corn Belt contributes substantially to this system through the production of more than one-third of the world's supply of corn (USDA NASS, 2011; USDA FAS, 2012). While U.S. agriculture is a significant contributor to greenhouse gas emissions, it is also vulnerable to changing

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weather patterns, diseases and pests expected to result from climate change (IPCC, 2007; Stern et al., 2006; Walthall et al., 2012).

Climate change has implications for food security. Agriculture, particularly crop production, depends on relatively consistent weather patterns from year to year. Crop production is reliant on predictable temperatures as well as timing and amount of precipitation, particularly during critical stages of plant development. This leaves this industry particularly vulnerable to expected increases in extreme weather events—including extreme heat and drought as seen in the summer of 2012—due to climate change (Walthall et al., 2012). For corn production specifically, increased temperature during critical reproductive stages is expected to decrease yields. Hatfield et al. (2011) predict a 2–3% decrease in U.S. Corn Belt yields over the next 30 years with warming of 0.8 °C. Secondary effects and impacts from global climate change are difficult to predict at a localized level, so there is uncertainty regarding impacts to agriculture across different regions of the U.S.

1.2. Agricultural adaptation to climate change

Smit and Wandel (2006) define vulnerability as the intersection of exposure and sensitivity to a threat, mediated by the system's resilience or adaptive capacity. As Walthall et al. (2012) point out, "Because agricultural systems are human-dominated ecosystems, the vulnerability of agriculture to climate change is strongly dependent not just on the biophysical effects of climate change but also on the responses taken by humans to moderate those effects" (p. 119). Marshall et al. (2009) outline a framework for conceptualizing the connections between the biophysical and human components of agricultural vulnerability to climate change.

In order to maintain productivity in the face of the above climate challenges, the U.S. agriculture system, and particularly corn farmers, need to respond with effective adaptation strategies. Agricultural adaptation to climate change includes modifications made to the agricultural system in response to current or future climate changes, which reduce vulnerability to climate change, and capitalize on opportunities (Smit and Skinner, 2002; Walthall et al., 2012). Smit and Skinner (2002) propose a typology of agricultural adaptation to climate change organized by sector with four broad categories: 1) farm production practices, 2) technological developments, 3) farm financial management, and 4) government programs and insurance. This study addresses, directly or indirectly, each of the four types of agricultural adaptation to climate change described by Smit and Skinner (2002). At the farmer level, which is the primary focus of this paper, potential production adaptations include modifying inputs, crop rotations and harvesting methods, reducing or eliminating tillage, utilizing drought-tolerant corn hybrids, as well as diversifying into different types of crops expected to be more resilient to new weather patterns (Walthall et al., 2012). Within financial management, U.S. farmers can purchase government subsidized crop insurance to reduce the risk of catastrophic financial losses due to poor yields and/or revenue. More informed decision-making by farmers that incorporates weather and climate information and forecasts is a strategy that would fall under technological developments to increase U.S. agriculture's resilience to climate change.

We examine U.S. agriculture using data from a survey of nearly 5000 corn farmers across the Midwest. Current adaptation strategies, both agronomic and financial, employed by Midwestern corn farmers as well as the psychological drivers of their adaptation decisions are explored. Relationships between farmers' climate change beliefs, risk perceptions, adaptation attitudes, attitudes toward innovation, and adaptation behavior are analyzed.

1.3. Social science on agricultural adaptation decision-making

While research on farmers' views and responses to climate change has been conducted recently in the U.K., California, the Southern U.S., and Australia (Donnelly et al., 2009; Fleming and Vanclay, 2010; Haden et al. 2012; Higginbotham et al., 2013; Hogan et al., 2010; Islam et al., 2013; Rejesus et al., 2013), few studies have focused on Midwestern U.S. farmers' risk perceptions, attitudes towards climate change adaptation or risk management strategies they are implementing (But see Arbuckle et al., 2013a; Gramig et al., 2013). Donnelly et al. (2009) and Higginbotham et al. (2013) report that in Australia, farmers are less likely to believe in anthropogenic climate change than typical urban and rural residents, with only about 27% agreeing with the scientific consensus. Similarly, Gramig et al. (2013) found that Indiana farmers were less likely than the American public to believe that human activities are contributing to global warming, with 79% considering it a natural phenomenon. As reported in Arbuckle et al. (2013b), based on the same survey analyzed in this paper, only about 8% of Midwestern corn farmers agree with the scientific consensus that climate change is mostly due to human activities, compared to 49% of the American public (Leiserowitz et al., 2013).

It is important to understand Midwestern U.S. farmers because of their significant role in the national and global food system, and their contribution as well as vulnerability to global climate change. As noted above, U.S. farmers will need to adapt to climate change in order for agriculture and the global food system to remain resilient. In this paper we address these issues by analyzing results from a 2012 mail survey of about 5000 farmers in 22 Midwestern U.S. watersheds spanning the 11 highest corn producing states.

1.4. Research questions and hypotheses

This paper examines two main research questions (RQ) and hypotheses (H), outlined below.

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