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Responding to Climate Change: Barriers to Reflexive Modernization in U.S. Agriculture

Diana Stuart¹,², Rebecca L. Schewe³, and Matthew McDermott²

Abstract
The authors apply Ulrich Beck’s theory of reflexive modernization to examine how farmers in the United States perceive and respond to climate change. Using a case study, the authors identify diversions from Beck’s original theory and explore the importance of social constructionist and political economy perspectives. The article focuses on corn farmers in southwestern Michigan to examine climate risk recognition and reflexive responses, concentrating on the role of nitrogen fertilizer as a significant source of greenhouse gas emissions. Results from interviews, focus groups, and a mail survey indicate that dualistic worldviews and exposure to limited and/or biased information can inhibit farmers from acknowledging climate change as a risk. In addition, structural barriers inhibit farmers from reducing nitrogen fertilizer application in response to climate change. These findings offer insights applicable to climate change mitigation efforts and also demonstrate the importance of both social constructionist and political economy perspectives to identify barriers to reflexive modernization.

Keywords
climate change, agriculture, risk society, reflexive modernization, political economy, social construction, fertilizer, corn production, reflexivity

Introduction
Risks associated with climate change remain difficult for many people to see or even imagine. This may be extremely problematic, given that greenhouse gas (GHG) emissions today will have impacts well into the future (Intergovernmental Panel on Climate Change, 2007). Despite a growing scientific consensus regarding the seriousness of climate impacts, responses to climate change remain politically contentious (Hoffman, 2011). While some argue that changes to industrial systems must be made immediately, others refute that climate change represents a real threat

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and fight to maintain the status quo. These debates also relate to agriculture. While scientists continue to highlight the significant levels of GHG emissions from agriculture and call for mitigation measures, the agricultural sector at large continues to use industrial practices that emit GHGs.

As stated by Weis (2010): “Industrial capitalist agriculture is simultaneously deeply implicated in and threatened by climate change” (p. 318). Agriculture remains an important contributor to GHG emissions. In this article, we focus specifically on nitrous oxide (N₂O) emissions. N₂O is 298 times more effective at heating the atmosphere than carbon dioxide, and agriculture contributes approximately 70% of N₂O emissions in the United States (U.S. Environmental Protection Agency, 2009). Most of these emissions are linked to the use of nitrogen (N) fertilizer (Snyder, Bruulsema, Jensen, & Fixen, 2009). While industrial agriculture has contributed to climate change, climate change will in turn affect agriculture. Scientists expect that warming temperatures will likely result in both positive and negative effects on plant production, while rainfall changes will have clearer negative impacts on U.S. agriculture (Council for Agricultural Science and Technology, 2011). Synthetic fertilizers have aided in the production of food quantities previously thought unimaginable; however, they also have resulted in an array of unintended consequences, including a significant contribution to global climate change.

This scenario closely resembles the “boomerang effect” described by Ulrich Beck in his seminal work, Risk Society: Towards a New Modernity (1992). In this work, Beck claims that modernization has resulted in new risks and that those who have benefited from innovations now face an array of hazards. Members of society are at the same time both perpetrators and victims. Beck calls for reflexive modernization, where society acknowledges and responds to risks. In this article, we apply Beck’s work to examine responses to climate change in the agricultural sector. We explore how farmers perceive and respond to climate risks: Are farmers reflexively responding to climate change and what barriers might prevent them from doing so? In our analysis, we also critically engage with Beck’s work, using a case study to identify diversions from Beck’s general theory and to empirically explore the value of including social constructionist and political economy perspectives.

Our case study examines the use of N fertilizer among corn farmers in southwest Michigan. Reducing the application of N fertilizer represents one of the most effective climate change mitigation strategies that farmers can adopt (Snyder et al., 2009). With this in mind, agricultural scientists have developed a protocol for a market-based offsets program that would pay farmers to reduce N fertilizer application (Millar, Robertson, Grace, Gehl, & Hoben, 2010). Our study explores farmers’ perspectives regarding N fertilizer and climate change and their willingness to participate in an offsets program. We use this case to look for signs of reflexive modernization and identify barriers to reflexivity. We find that significant barriers inhibit the acknowledgement of climate change as a risk. In addition, we find that expecting farmers to individually respond to climate change may be shortsighted given the constraints imposed by systems that reinforce production-oriented management. Although many look toward incentive-based mechanisms to encourage climate change mitigation, the effectiveness of these approaches may be limited without larger scale changes that address the political economy of commodity production.

Theoretical Framework: Risk Society and Reflexive Modernization

Beck’s (1992) theory of the risk society argues that we can no longer ignore the consequences of modernization. Beck discusses the rise of a multitude of side effects linked to the use of technology and industrialization. Actions come back to haunt us in unforeseen ways: “the agents of modernization themselves are emphatically caught in the maelstrom of hazards that they unleash and profit from” (Beck, 1992, p. 37). In Risk Society (1992), Beck uses agriculture as an
example to illustrate his thesis. He describes how the use of fertilizers and pesticides in Germany resulted in the doubling of grain yields, but also resulted in significant environmental degradation. Regarding farmers, Beck states that the “perpetrator and victim sooner or later become identical” (Beck, 1992, p. 38). Beck also highlights problems with prioritizing production: “in the effort to increase productivity, the associated risks have always been and still are being neglected” (Beck, 1992, p. 60).

Through his risk society theory, Beck posits that as these side effects become more apparent citizens will become increasingly skeptical of experts and the previously unquestioned tenants of modern goals (Beck, 1992). Beck claims that this will result in a shift toward “reflexive modernization” (Beck, 1992; Beck, Bonns, & Lau, 2003; Beck, Giddens, & Lash, 1994), which entails revisualizing the boundaries that supported modernization (e.g., between nature and society) and acknowledging new relationships (Beck et al., 2003; Beck & Lau, 2005; Latour, 2003). Beck (1996) highlights the importance of personal and societal self-critique and self-confrontation to reshape practices and institutions. In a reflexive society, actions and policies must be reassessed and adapted as needed to address negative side effects. Beck proposes that this can be done through the growth of individual awareness and actions, the emergence of reflexive social movements, and the rise of “subpolitics” that push forward new worldviews and political agendas (Beck, 1992). According to Beck, reflexivity can occur at the level of the individual or through institutional changes. In some cases, reflexive change may not necessitate individual reflexivity if institutional changes occur. Because of the lack of institutional responses to climate change in US agriculture, we focus on reflexivity among individual farmers and evaluate emerging mitigation approaches that rely on the cumulative actions of individuals.

Beyond simply using Beck’s theory to frame our case study, we use our case study to test the real-world applicability of the theory as well as what may be gained through adopting modifications based on specific critiques. Due in part to the grand nature of Beck’s theory, it has been widely discussed and widely criticized (e.g., Alario & Freudenburg, 2010; Elling, 2008; Elliott, 2002; Higgins & Natalier, 2004). We will not explore all of the critiques of Beck’s work in this paper; however, we will use our case study to engage with three specific critiques. First, Beck has been widely critiqued for lacking empirical validation to support his theoretical and conceptual claims. While some scholars have applied Beck’s work to empirical studies, many continue to call for more case studies to either ground or refute aspects of his theory (Murray 2009; Mythen, 2007; Wilkinson, 2001). Through our case study we will explore what aspects of Beck’s theory can be illustrated and where variations or contradictions emerge.

Second, we wish to address critiques that Beck fails to incorporate social constructionist perspectives. Scholars have criticized Beck’s work for being too generalized, inferring that there is much more variability in risk perception and responses than portrayed by Beck (Jensen & Blok, 2008; Mythen, 2007). Others state that by overlooking social constructionist perspectives Beck “neglects the subjective ways in which risks are constructed” (Higgins & Natalier, 2004, p. 81). Despite resistance to being identified as a realist or a constructionist, in his recent work Beck has increased his attention toward the construction of risks. Beck (2010) explores the relationships between climate discourse and willingness to address climate change. He suggests that society continues to see “the environment” as separate from society, that the media plays a critical role in framing the issue, and that climate change is portrayed as a negative phenomenon that calls for restraint and reduced economic growth. We adopt a social constructionist perspective in our examination to assess if this perspective offers a better understanding of individual reflexivity and social change toward reflexive modernization. In our case study, we will explore how worldviews, information, and framing shape farmers’ responses to climate change.

Third, we respond to critiques that Beck gives insufficient attention to power by incorporating political economy in our analysis, focusing on structural barriers to reflexivity. Beck’s theory has
been criticized for its inability to identify important power relationships that impact transitions toward reflexive modernization (Elliott, 2002; Hannigan, 2006; Higgins & Natalier, 2004; Murray, 2009). Especially in his earlier work, Beck (1992) focuses on how new worldviews, actions, and policies will emerge while largely overlooking power dynamics that may prevent change. Scholars have since highlighted the importance of identifying forces that inhibit reflexivity (Lahsen, 2005; McCright & Dunlap, 2010). Murray (2009) argues that “the real transformation promised by reflexive modernity remains elusive” and that “a broader analysis of power might begin to explain this turn of events” (p. 98). Although scholars have pointed out that in many cases reflexive modernization is not occurring, the project of identifying what reflexive modernization would look like and why it is not occurring remains critical to our understanding of how to address environmental problems (Latour, 2003). In this case, we specifically apply political economy to identify barriers to reflexivity, such as constrained choice and dissonance imposed by market and policy conditions (Brady, Clark, & Davis, 1995).

**Toward Reflexive Agricultural Production: Nitrogen Fertilizer and Climate Change**

Our purpose is to investigate the extent to which agricultural producers are aware of risks associated with climate change and to what extent they are reflexively responding or are willing to respond to these risks. Therefore, we must first explore what reflexivity in this case might entail. Beck (1992) specifically discusses agriculture and claims that because of modernization widespread destruction has ensued that “is painful and visible to the farmer” (Beck, 1992, p. 37). According to his theory, recognition of the negative impacts of industrialization results in self-critique and the questioning of current practices and policies. In this case, farmers would reflexively respond to climate change through changing their practices and/or joining movements in an attempt to change productionist-oriented policies. Responses to climate change may be seen through both individual actions and pushing for systemic changes in agriculture (Bryant et al., 2000). Specific to our case examining N fertilizer use, farmers would individually attempt to reduce N fertilizer application and would work toward policy changes to prioritize the overall reduction of GHG emissions. This represents an ideal reflexive response to climate change.

Many barriers exist that challenge the emergence of this ideal reflexive response to climate change. The literature suggests we should give attention to barriers that both inhibit the perception and acknowledgement of risks as well as barriers to reflexively responding to perceived risks. Therefore, we draw from both social constructionist and political economy perspectives to identify possible barriers. We propose that individual worldviews and exposure to information may result in a diversity of perceptions regarding risk, some that resemble trends described by Beck and others that do not. We also contend that in some cases individuals may be constrained from reflexively responding to perceived risks due to power relations and the challenges involved in deviating from the priorities of dominant political and economic systems. In our case study, we hypothesize that worldviews, information, and structural barriers all play a role in inhibiting reflexive modernization.

Worldviews that fail to realize connections between agriculture and ecosystems may hinder the acknowledgement of climate change as a risk. Some farmers may fail to recognize any linkages between fertilizer practices and climate change. While Beck (1992) claims that there is “natural destruction that is painful and visible to the farmer” (p. 37), others argue that not all farmers see this destruction (Jensen & Blok, 2008). Farmers’ worldviews may inhibit the acknowledgement of relationships between agriculture and climate change, allowing them to avoid responsibility for associated harm (Beck & Lau, 2005). Despite the prevalence of a self-acknowledged stewardship ethos (Lawrence, Cheshire, & Ackroyd Richards, 2004), many...
producers may be more aligned with the Human Exemptionalist Paradigm (HEP); (Catton & Dunlap, 1978; Dunlap & Catton, 1994). In these cases, a self-critical risk society may fail to emerge if farmers’ worldviews inhibit the recognition of relationships and disassociate them from responsibility.

Exposure to limited, incomplete, or biased information about climate change and fertilizer may also inhibit the acknowledgement of risks. Despite Beck’s (1992) description of citizens increasingly questioning experts, farmers may continue to value sources of information they know and trust. Exposure to mass media also shapes perceptions of problems among farmers (Jensen & Blok, 2008). Repeated exposure to the same politically oriented media sources may reinforce skeptical perspectives about climate change (McCright, 2011). While reflexive science is increasingly critical of modernization, those who benefit from the status quo have fought hard to refute scientific findings through “anti-reflexivity” campaigns (Lahsen, 2005; McCright & Dunlap, 2010). These campaigns push forward arguments to prevent reflexive responses to climate change: Scientists are not in agreement about climate change (promoting fringe, contrary science), climate change is a natural cycle, human activities represent a very small contribution, trying to prevent climate change will do more harm than good, and it is unfair for the United States to respond if other countries such as India and China are not (McCright & Dunlap, 2010). Many of these narratives may serve to influence how farmers perceive climate risks.

Studies on the political economy of agriculture indicate that production-oriented policies and agri-food companies have tremendous influence over farmer decision making and may therefore inhibit reflexive responses to climate change. Political economy has made substantial contributions to agri-food studies, including work on commodity chains, globalization, and the social and environmental consequences of capitalist food production (e.g., Bonnano, Busch, Friedland, Gouveia, & Mingione, 1994; Friedland, Barton, & Thomas, 1981; Goodman, Sorji, & Wilkinson, 1987). Regarding climate change, agricultural policies in the United States (e.g., commodity support and disaster assistance) maintain important influence over production decisions and may affect reflexive responses (Reilly, 2011). Government policies to protect farmers from financial losses may also reduce farmers’ concerns about climate risks (Lewandrowski & Brazee, 1993; Reilly et al., 2003). In addition, farmers can experience constrained choices because of relationships with large companies that increasingly control access to markets (Hendrickson & James, 2005; Stuart, 2009). Contract production, such as in the poultry industry, has been shown to significantly constrain farmers’ choices and create a production system in which global sourcing allows transnational corporations to be highly mobile and sever contracts with “noncompliant” farmers (Constance & Heffernan, 1991; Heffernan & Lind, 2000). Farmers experiencing constrained choice may also experience cognitive dissonance, which can emerge because of public and private sector decisions (Brady et al., 1995). Cognitive dissonance is the psychological unease experienced when an individual makes choices that are inconsistent with their values or beliefs (Festinger, 1957). Farmers’ attempts to respond to the side effects of industrialized agriculture may be inhibited by powerful actors, causing constrained choice and dissonance. Therefore, efforts focusing on individual reflexivity may be ineffective without addressing structural barriers (Bos & Grin, 2008; Lawrence et al., 2004).

To explore the influence of these potential barriers, we now turn to our case study. We examine corn farmers’ perceptions and responses to risks associated with climate change and N fertilizer in southwest Michigan. Our study focuses on (a) factors influencing farmers’ application of N fertilizer; (b) farmers’ perceptions of risks associated with N fertilizer, including climate change; (c) farmers’ willingness to reduce N fertilizer application; and (d) farmers’ willingness to reduce application if paid through a market-based offsets program. Our findings offer important insights specific to climate change mitigation efforts in agriculture and also provide an
opportunity to evaluate the importance of social constructionist and political economy perspectives when applying reflexive modernization to empirical studies.

Research Methods

Study Region and Population

Our research focused on corn farmers in four counties in southwest Michigan: Branch, Calhoun, Kalamazoo, and St. Joseph. These counties are home to 1200 farms and more than 300,000 acres of corn (U.S. Department of Agriculture, Census of Agriculture, 2007). We selected corn farmers for our study because of their high use of N fertilizer. Focusing on farmers in these counties provided information on both commercial and seed corn farmers. Seed corn farmers typically have contracts with seed corn companies and grow seed varieties that will later be sold to commercial corn farmers. Southwest Michigan represents a prime area for seed corn production: Regional seed corn production headquarters for both Pioneer and Monsanto are located in St. Joseph County.

Mail Survey

To provide a broad view of farmers’ use of N fertilizer, willingness to reduce application, and perspectives on climate change, we conducted a mail survey. Despite overall declining response rates for mail surveys (de Leeuw & de Heer 2002; Dillman 2000), they are still generally considered to be the best way to reach large numbers of farmers: mailing addresses are the only contact information provided in representative sampling frames (such as the Agricultural Census and state Departments of Agriculture) and postal mail is still the best method to reach older respondents. The survey for this study was mailed in February and March of 2011 to a stratified random sample of 1,000 corn farmers in the four counties. The survey went through several rounds of pretesting with agricultural experts and corn farmers. The survey was administered with the assistance of the National Agricultural Statistical Service. Farms were divided into four strata based on corn acreage. Different sampling rates were applied to each stratum to ensure that the final sample of respondents included an adequate number of farms from each stratum. We received 274 completed responses (27.4%). Despite our low response rate, no significant differences were found between our respondents and respondents to a 2008 statewide survey of corn and soy farmers with a 56.4% response rate (details in Jolejole, 2009) regarding several key variables, including farm size, irrigated acres, age, education, and farm income. To analyze our data, the sample was weighted to reflect that both the sampling rate and the size of strata vary. Statistical analysis included descriptive statistics, principle component factor analysis, and multivariate linear and logistic regression using STATA. All analysis was performed with appropriate probability weights to reflect the sample stratification. In this article, we share only selected survey results that are most relevant to our discussion.

Personal Interviews

In-depth personal interviews with 40 farmers were conducted between January and May 2011. Initial contacts were obtained from Michigan State University (MSU) Extension agents. A snowball sampling technique was used to obtain subsequent contacts. In total, we interviewed 11 farmers in Calhoun County, 9 in Kalamazoo County, 12 in St. Joseph County, and 8 in Branch County. Of the farmers interviewed, 23 farmers were commercial corn farmers, 11 were strictly seed corn farmers, and 11 grew both seed corn and commercial corn. Interviews were conducted
on-farm, using an interview guide, and recorded whenever possible. Interview questions focused on factors influencing fertilizer application, willingness to reduce N fertilizer, and interest in a potential offsets program. To explore perceptions regarding linkages between agriculture and the environment, farmers were also asked about relationships between farm practices and water quality. We also asked participants about relationships between fertilizer and climate change. Interviews were transcribed and imported into NVivo software for coding and analysis.

**Focus Groups**

We also conducted focus groups with corn farmers. Facilitated focus groups use group dynamics to help participants “explore and clarify their views in ways that would be less easily accessible in a one to one interview” (Kitzinger 1995, p. 299). During February and March of 2011, we conducted four focus groups: one in each of our study counties. The focus groups in Branch, Calhoun, and Kalamazoo counties involved commercial corn farmers. The St. Joseph County focus group involved only seed corn farmers. Each focus group consisted of participants identified by local MSU Extension agents, recruited at local farm meetings, or invited by another participant. Participation ranged from five to eight farmers in each group. The same list of questions guided each discussion and focused on factors influencing N fertilizer application, interest in a possible offsets program to reduce N fertilizer application, perspectives on climate change, and the linkages between fertilizer and climate change. Focus groups were recorded, transcribed, and imported into NVivo software for coding and analysis.

**Results**

**Factors Influencing Nitrogen Fertilizer Application Rates**

Interviews, focus groups, and survey results indicated that nearly all farmers are conscientious business owners who manage their farm to maximize economic returns. For commercial corn farmers in many cases this does not mean maximizing yields. As one farmer explained, “maximizing yield doesn’t really help you if you have to spend a lot to get there.” Commercial corn farmers take into account the price of corn and the price of fertilizer when determining how much fertilizer to apply. As fertilizer prices have increased, application rates have tended to decrease. However, rising corn prices in recent years has also encouraged some farmers to increase N fertilizer to reap the benefits of high corn prices: “you can’t afford to be short on N at $6 a bushel.” Approximately 72% of survey respondents stated they prioritize economic return over yields. However, seed corn farmers were significantly more likely to prioritize yield than commercial corn farmers (21%, $F = 3.0637*$).

For seed corn farmers the payment structures of company contracts are linked directly to yield, therefore many focus on maximizing yield. Many apply more fertilizer even when the price is high: “you do what you have to for the yield, up to where it doesn’t make economic sense.” Another farmer explained,

> We’re in a different position than the commercial corn farmers . . . we have the extra income to put into fertilizer. It really doesn’t matter what the cost of fertilizer is . . . because it’s competitive and . . . we don’t have a choice.

Seed corn farmers operate through contracts with yield incentives that can far exceed commercial corn payments and therefore are more likely to allocate additional funds to fertilizer. As described more below, a competitive contract system encourages seed corn farmers to add more...
N fertilizer than commercial corn farmers. Survey results show that seed corn farmers add significantly more N fertilizer than commercial corn farmers (Table 1).

For both commercial and seed corn farmers, applying extra N fertilizer is generally viewed as a risk-reducing activity. As one commercial corn farmer explained, “additional fertilizer application offsets risks of run-off, leaching, and de-nitrification.” Many admitted that they apply more fertilizer than needed as a type of insurance policy: “if you put on more than you need, then even if you lose some you will be OK.” Seed corn farmers in particular tend to apply more N fertilizer as a form of insurance: they stand to lose more if their yields are below average. Despite these explanations, only 14% of survey respondents indicated they think they apply too much fertilizer. While they recognize that some fertilizer remains unused, most farmers felt that any reductions would jeopardize yields. When asked about a possible payment program to offset risks of reduced yields, many remained skeptical.

Commercial corn farmers also expressed concerns that reducing N fertilizer would affect world food supplies. Farmers expressed taking great pride in providing food for a growing world population and argued that it is their duty to maximize production: “if you reduce production in any way, shape, or form, that just means that millions of people are going to starve . . . we need to produce more.” This sentiment emerged in many interviews and in all three focus groups with commercial corn farmers. Some farmers felt that their duty to feed the world justified the use of chemicals that may have adverse environmental effects: “if we farmers are spraying excessively, then shame on us, but we still have to feed the world.” This emphasis on “feeding the world” mirrors discourse from large commodity organizations.

Acknowledging Linkages Between Agriculture and “The Environment”

Most farmers claimed that they, or farmers in general, are good stewards of the environment. They all agreed that farmers apply less N fertilizer now than 20 to 30 years ago. They also now apply N in multiple, smaller applications rather than one large application and some use slow-release products. To gauge farmers’ views regarding connections between N fertilizer applications and environment impacts, interviews included questions about water quality. Water quality represents an important regional issue, with ongoing efforts to address nitrate pollution over the past 30 years. However, approximately 80% of interview participants did not think that water quality represented a serious issue. In addition, while most farmers interviewed recognized linkages between N fertilizers and water quality, about a quarter of participants did not. Several farmers shared their experiences with well water contaminated with nitrates, requiring families to drink bottled water. These farmers demonstrated a more in-depth awareness about relationships between fertilizer and water quality. Others clearly expressed that they saw no connections between water quality and fertilizers (Table 2).

Most farmers who participated in the focus groups and interviews were skeptical about anthropogenic climate change and did not acknowledge relationships between climate change and agriculture. Some farmers stated that they felt climate change was “made up” or something
that was “invented by Al Gore.” Most argued that they had not experienced any events that made
them believe that climate change was occurring. In contrast, one focus group participant shared
that he believed Michigan had experienced more severe rain events in recent years and another
felt that the temperatures seemed warmer now than 30 years ago. Others simply stated they were
not concerned about climate change. One farmer who participates in the Michigan Farm Bureau
described how the group had decided that climate change is not an issue for Michigan producers.
Despite these remarks, the majority of survey respondents (62%) indicated that climate change
represents an important issue to society (but perhaps not to them) and that farmers can play a role
in reducing GHG emissions (68%). Although most of the farmers interviewed denied that their
actions contributed to climate change, almost all responded positively when asked if farmers
could play a role in mitigation.

A small minority of farmers who participated in the focus groups and interviews stated that
they believed climate change is occurring and that farmers should be prepared to change their
practices. Several felt confident that farmers had the ingenuity and skills to adapt as needed. One
farmer expressed enthusiasm about the potential positive impacts of climate change: “Bring it
on! It will just make our growing season better!” Several farmers in the focus groups had less
positive views of climate change and stated that farmers need to act responsibly. For these farm-
ers, modifying practices to respond to climate change was portrayed as an extension of their role
as stewards of the environment. To one farmer this meant proactively reducing GHG emissions
even if the consequences of climate change remain unclear. Although these farmers were not
actively reshaping farm management in response to climate risks, they did express a willingness
to learn more about risks and explore changing their practices.

Almost all farmers in interviews and focus groups expressed skepticism regarding the role of
N fertilizer in contributing to climate change. The idea was new to most participants, and most
responded that they did not believe that substantial quantities of gas were released from fertilizer
application or did not think fertilizer could have an impact on global climate: “I don’t think we
can affect the whole globe.” Another farmer stated, “If the earth’s surface changes one degree . . .
you’re not going to change it by using less nitrogen.” While most were surprised about the con-
nection, some were more open to the idea but felt it would take time for farmers to accept it. One
farmer explained how overall awareness about linkages between agriculture and ecological
issues is slowly evolving among agricultural producers:

We talk about being good stewards of the land, but for a long time my dad never thought
about cattle manure running down in the well water and getting nitrates or atrazine in the
water . . . and now it is common knowledge. I think the way we look at ground water our
kids will look at the atmosphere . . . I think it is just the next step of evolutionary thought about how we are contaminating things.

Other farmers indicated that this evolution of worldviews faces many barriers. A focus group participant stated that farmers do not want to recognize environmental problems, such as water pollution and climate change, because if they did it would require them to acknowledge their role as contributors to these problems. An interview respondent described how challenging it is to change farmers’ views: “It is difficult to change a group like this that are so independent . . . it is going to be tough because farmers are very stubborn.” Finally another interview respondent personally acknowledged that he had been exposed to scientific information about climate change and that he might believe this information if it did not conflict with his prior views: “My preconceived notions are holding sway on me probably harder than they should be.”

In each focus group and in many interviews, farmers also stated that agriculture should not be singled out as a primary source of environmental problems. Regarding N fertilizer use and its contributions to both water pollution and climate change, farmers pointed toward urban and suburban sources including golf courses, neighborhood lawns, and automobiles. Many argued that these sources represent a much more significant contribution to overall pollution than sources from agriculture and that other citizens should change their practices before expecting farmers to change theirs.

Information: Sources, Skepticism, and Gaps in Knowledge

Farmers receive information about N fertilizer application rates from a variety of sources; however, survey results indicate that the majority of respondents (69%) get information from fertilizer dealers and for nearly 37% this represents their most important source of information (Table 3). Seed corn farmers sometimes receive fertilizer recommendations from seed corn company agronomists or as indicated in growing guidelines, when provided. In interviews and focus groups, participants also stated that they usually rely on more than one source of information and that personal experience and knowledge about their land represent important factors when determining application rates.

Despite their reliance on fertilizer dealer and company recommendations, some farmers expressed concern about this information. One farmer stated, “I wouldn’t trust people that are working for the chemical or fertilizer companies.” Another farmer expressed skepticism regarding their use of environment-friendly slogans: “They [the companies] are hiding behind fronts with names that sound like they might be interested in the environment, but when you find out

<table>
<thead>
<tr>
<th>Source</th>
<th>% Getting Information From Source</th>
<th>% Using as Most Important Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer dealers</td>
<td>69.58</td>
<td>36.53</td>
</tr>
<tr>
<td>Seed company agronomist</td>
<td>44.73</td>
<td>17.88</td>
</tr>
<tr>
<td>Other farmers</td>
<td>33.13</td>
<td>7.86</td>
</tr>
<tr>
<td>Magazines</td>
<td>23.28</td>
<td>3.35</td>
</tr>
<tr>
<td>Company fieldman</td>
<td>5.42</td>
<td>0.97</td>
</tr>
<tr>
<td>Private consultant</td>
<td>18.68</td>
<td>7.37</td>
</tr>
<tr>
<td>University recommendations</td>
<td>31.14</td>
<td>15.83</td>
</tr>
<tr>
<td>Other</td>
<td>12.88</td>
<td>10.21</td>
</tr>
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Table 3. Sources of information farmers use to determine N fertilizer application rates
what they are really about it takes on a whole new light.” Some farmers expressed concern about company products and information about these products being withheld: “We thought Roundup was a very good chemical, . . . but are there some bad effects that the company really didn’t know about when they brought it out to us that we need to address now?” Despite continued reliance on information from fertilizer and chemical companies, farmers question the legitimacy of these sources and demonstrate clear doubts about their motives.

Although the survey did not ask specific questions regarding sources of information about climate change, interviews and focus groups indicated that farmers are exposed to this information from a variety of sources. These include local and national television news programs, talk radio programs, science television programs, and the Internet. Farmers’ statements about climate change greatly resemble arguments associated with conservative “anti-reflexivity” campaigns that resist responses to climate change. These arguments include the following: scientists are not in agreement about climate change, climate change is a natural cycle, human activities do not contribute to climate change, and it is unfair for the United States to respond if other countries are not (McCright & Dunlap, 2010). Farmers’ own words closely match these arguments (Table 4).

Several farmers also stated religious views: The Bible is the best source of information on climate change, global temperature change is God’s will, and that people are arrogant to think their actions have any impact on climate.

Almost all the farmers interviewed and all the farmers participating in the focus groups had no prior knowledge about linkages between N fertilizer, N\textsubscript{2}O, and climate change. Surprisingly this contrasted with survey results, where 35.7% of respondents claimed that they were aware of linkages between N\textsubscript{2}O and fertilizer, and 43.4% stated they were aware that N\textsubscript{2}O is a GHG. Farmers participating in focus groups were especially vocal about the lack of information being provided about N\textsubscript{2}O and fertilizer. One farmer stated, “This information should be available to us through [MSU] Extension. It never entered my mind.” Participants had many questions regarding N\textsubscript{2}O and fertilizer, including what chemical processes lead to N\textsubscript{2}O emissions, what fertilizer practices released more N\textsubscript{2}O, and why they had not been told about N\textsubscript{2}O and fertilizer before. Despite these sentiments, most farmers participating remained skeptical about the linkage between fertilizer and climate change.

### Table 4. Farmers’ Arguments for Inaction Regarding Climate Change

<table>
<thead>
<tr>
<th>Argument</th>
</tr>
</thead>
<tbody>
<tr>
<td>“I don’t think there is enough research done.”</td>
</tr>
<tr>
<td>“Ninety-five percent of farmers don’t believe in climate change because they have not shown us any data.”</td>
</tr>
<tr>
<td>“For everything you read that points at one side [climate change is happening] you can find something that points to the other side [climate change is not happening].”</td>
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<tr>
<td>“Whose to say this isn’t a 600-year cycle. Michigan was once covered in ice.”</td>
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<td>“Why should the U.S. bear all the costs when other countries aren’t going to do anything?”</td>
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<td>“One farmer can’t make that much of a difference. You have to have everyone on board.”</td>
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Political and Economic Constraints to Climate Change Mitigation

A few farmers participating in focus groups and interviews raised concerns about how efforts to reduce N fertilizer use might be inhibited by current government and/or loan programs. For example, one farmer felt that lost yields associated with reducing N fertilizer application would impact crop insurance programs: “It’s going to be a tough thing because if you reduce yields it’s all tied back to crop insurance and that’s your revenue protection.” Another farmer related that
any effect on yields would affect relationships with lenders: “for the last 20 years at least, it [yield] is something that the lenders really look at.” As we did not ask specific questions about how current policies and programs may inhibit responses, these few comments suggest that many other farmers may also feel constrained by these programs.

All seed corn farmers who participated in both the interviews and the focus group agreed that they apply more N fertilizer than commercial corn farmers, and more then they need to, because of the competitive structure of contracts with seed corn companies. Seed corn companies sign annual contracts with farmers, who are selected based on past yields compared with other farmers growing the same variety. Farmers’ yields are ranked each year. Those who produced above average reap extra financial rewards, which can be substantial, while those who produce below average receive a reduced payment. Those with poor performance over several years may lose their contracts. Each company varies on how they determine their payment structure. Some provide greater rewards for top producers, therefore encouraging more competition. Farmers stated that the companies discourage them from talking to each other about their practices and encourage them to be competitive. At the start of each season, farmers are told limited information about corn varieties. Sometimes companies provide expected yield or fertilizer recommendations, but this often is not the case. With the competition in mind, farmers use their best judgment as to how much fertilizer to apply.

The competitive structure of seed corn contracts has encouraged farmers to apply more N fertilizer than they would otherwise. One farmer explained,

> It is a competitive contract and everybody is looking for that little bit of an advantage to get them ahead of the rest of the pack and I think that is what we are doing with nitrogen. I think we are way over applying.

Seed corn farmers described how putting on an extra 10 to 15 pounds of N could mean an extra few bushels of corn and that represents a significant economic advantage. In some cases, seed corn companies have specifically told farmers to increase their N fertilizer rates: “They had us up our N rates the last two years over what we were doing because they felt we were not competing as favorably.” Some farmers stated that they liked the competitive contracts and always aim for the top of the list. Most disliked the competition: A few felt that the system was extremely wasteful and several admitted being fearful of losing their contracts.

When asked about reducing N fertilizer application, most all the seed corn farmers who participated in the interviews and focus group felt that this would not be possible. A few less competitive farmers had already reduced fertilizer application compared to previous years. The majority of seed corn farmers felt that reducing fertilizer was an unreasonable idea given their production contracts. When asked about a possible program that would pay them to reduce N fertilizer application, participants responded that even with high payments that offset yield losses they would not agree to participate without the consent of the seed corn companies: “If it doesn’t have the blessing of the production manager, I wouldn’t touch it with a 10 foot pole, I don’t care how much it pays.” Several seed corn farmers expressed that despite links between N fertilizer and environmental degradation, they felt unable to address this concern given their production contracts. The mail survey verified that seed corn farmers are wary of participating in a possible offsets program: Only 16.5% of seed corn farmers said they would be willing to participate without the direct support of their seed corn company.

Interviews and focus groups also revealed additional views regarding how powerful agricultural interest groups inhibit responses to climate change. As previously mentioned, one participant described how the Farm Bureau in Michigan had decided that climate change is not an important issue. Another farmer expressed frustration about how agricultural groups, such as the
Farm Bureau, continue to influence environmental legislation: “I find it really upsetting that the Farm Bureau and a few of these groups are basically the ones that killed the whole clean air proposal.” Farmers not only recognize the power of the Farm Bureau but also the influence that large corporations and wealthy individuals continue to have over Farm Bureau policies: “A lot of things that the Farm Bureau has pushed is because there are certain powers that benefit and they basically hijack the Farm Bureau policy.” Many farmers feel powerless to counter powerful companies and interest groups that continue to shape agricultural policies.

**Discussion**

Beck’s (1992) theory of reflexive modernization describes how individuals will increasingly become aware of the risks associated with modernization, question expert opinions, respond to risks, and join movements to push forward new priorities and policies. Our results indicate that reflexive modernization in these terms is not occurring among corn farmers in southwest Michigan. While all farmers have been exposed to information about climate change, many are unaware of or reject the linkages between climate change and agriculture. We do not find farmers actively changing their management practices in response to climate risks or organizing or joining social movements to encourage institutional responses. We also find limited willingness to participate in a potential offsets program to reduce N fertilizer use.

While scholars have debated over whether Beck truly believes that reflexive modernization is occurring in European countries, we interpret his work to suggest that reflexive modernization has not yet fully emerged and that society remains in transition. In this U.S. case study, we do see signs of a transition: Certain farmers acknowledge climate risks, question production-oriented experts, and are open to thinking about new connections. Although examples of reflexive modernization remain difficult to find, we agree that reflexive modernization represents an important narrative, offering ideal courses of action to address risks (Latour, 2003). Comparing actual responses with ideal responses serves to highlight what is missing and what barriers might be preventing reflexivity. We therefore focus our attention on factors that inhibit ideal reflexive responses.

Our findings indicate that farmers evaluate climate risks and mitigation efforts within the context of other risks, which influence their perspectives and responses. In agreement with other work on this topic (e.g., Sheriff, 2005; SriRamaratnam, Bessler, Rister, Matocha, & Novak, 1987), we find that farmers in southwest Michigan view adding extra N fertilizer as a risk-reducing activity to help ensure high yields and economic stability. Therefore, reducing N fertilizer as a mitigation strategy seems risky: Short-term economic risks overshadow long-term climate risks. Holloway and Ilbery (1996) explored British farmers’ attitudes toward climate change and similarly found that those who do perceive climate change as a risk often view it as a distant threat and therefore prioritize economic risks that must be addressed in the short term. In addition, many farmers shared concerns that reducing N fertilizer would be too risky because it could jeopardize world food supplies. This was a common concern even though most all participants grew corn for ethanol, corn syrup, seed, and cattle feed rather than for direct consumption. This emphasis on “feeding the world” mirrors the discourse of large commodity organizations and remains an important rationalization for farmers. These different risks can combine to result in a complex and/or ambiguous perspective (Jensen & Blok, 2008). We agree that there is much more variability and complexity in risk perception than Beck (1992) originally described (Mythen, 2007).

We find evidence to agree with Beck (2010) and others (Nordhaus & Shellenberger, 2007) that portraying climate change as a negative phenomenon that requires restraint and reduced economic growth will inhibit acknowledgement and responses. We found that when framed in a
positive context, participants felt that farmers could help society address climate risks. However, when discussing the role of agriculture in contributing to GHG emissions most farmers dismissed climate change entirely, refuting that agriculture represents a significant contributor and highlighting other sources of GHG emissions. Many farmers may not want to acknowledge climate change as a risk if it means admitting that they are somehow at fault. This indicates that farmers are distancing themselves from the negative aspects of GHG emissions and that there may be more dissonance between perceptions and practices than farmers revealed. This also suggests that moving forward with climate change mitigation efforts, involved parties may wish to consider how they frame climate change, choosing to highlight positive steps forward rather than past or current contributions.

Many farmers who participated in this study demonstrated a worldview with clear boundaries between agriculture and “the environment.” While Beck (1992) describes how environmental destruction has become “painful and visible to farmers” (p. 37) in Germany, in contrast we find examples where U.S. farmers show a lack of acknowledgement or concern. This can be seen through responses to interview questions about water quality: Despite 30 years of regional water quality efforts, a significant proportion of farmers claim they see no connections between farm practices and water quality. Farmers who had been personally affected by N contamination in their drinking water were more aware of environmental issues. In contrast with scenarios described by Beck (1992), environmental impacts are not evenly distributed and neither is awareness. Many farmers successfully distance themselves from water quality problems. Given responses regarding water quality, convincing farmers about connections between N fertilizer and climate change may prove challenging. If worldviews are evolving, this evolution will take time. Study participants admitted that farmers remain a “stubborn” and “independent” group who are difficult to persuade. Our findings agree with Beck’s (2010) recent work, which suggests that society continues to see “the environment” as separate. Worldviews continue to resemble the HEP (Catton & Dunlap, 1978; Dunlap & Catton, 1994). These views help facilitate an organized denial of anthropogenic climate change (Norgaard, 2006) and disassociate society from responsibility (Beck & Lau, 2005).

Although farmers perceive themselves as independent, they continue to be constrained by a heavy reliance on information from agri-business companies and have not been exposed to information that would foster reflexive use of fertilizer. Fertilizer dealers represent the most influential source of information regarding application rates. This continued dependence on fertilizer dealers for information is unlikely to result in reflexive views or responses to climate change. Some farmers expressed skepticism about information from dealers, but they continue to greatly rely on them for information. Jensen and Blok (2008) argue that although Beck (1992) refers to increased skepticism regarding expert opinions, experts may not be easily replaced in agriculture. Although it was not part of this study, further research focusing on social identity may reveal more about which experts and sources of information are deemed legitimate by farmers (Frank, Eakin, & Lopez-Carr, 2011). Last, while many farmers trust information from MSU Extension agents, Extension has not been sharing information about climate change or relationships between climate change and N fertilizer. MSU Extension has thus far chosen not to talk to farmers about climate change in order to maintain trust and positive relationships. This position needs to be reevaluated if Extension wishes to support climate change mitigation.

Farmers’ comments indicate they likely receive most of their information about climate change from politically conservative sources. Farmers’ remarks closely resemble statements from “anti-reflexivity” movements identified by McCright and Dunlap (2010). McCright (2011) suggests that failure to acknowledge climate change as a risk relates to sources of information and argues that media sources in the United States have become increasingly polarized, presenting information that reinforces audiences’ own beliefs. This suggests that most farmers are
repeatedly exposed to conservative media and “anti-reflexivity” arguments that counter climate science and calls for reflexivity. Conservatives are also more likely to support views similar to the HEP (Dunlap & Van Liere, 1984). McCright (2011) suggests that we need to reinstate the “fairness doctrine” that prohibited news sources from reporting with narrow political perspectives. He also suggests that attempts to communicate information about climate change should avoid language that may trigger conservative narratives.

Beyond perceptions and beliefs about climate change, this study also identifies structural barriers to reflexive modernization. While we did not ask farmers specific questions about how agricultural policies and programs in the U.S. may inhibit their willingness to reduce N fertilizer, several farmers stated that program payments or insurance rates based on yields may deter them from reducing fertilizer and/or participating in a possible offsets program. This supports other claims that current U.S. policies and programs tied to production may inhibit farmers’ willingness to respond to climate change (Lewandrowski & Brazee, 1993; Reilly, 2011). Programs that protect farmers from losses may also allow farmers to remain unconcerned about climate change in spite of temperature and precipitation changes (Reilly et al., 2003).

Seed corn farmers who participated in this study feel limited in their ability to respond to climate change because of constraints imposed by seed corn companies and their competitive contract structure. Seed corn farmers feel unable to reduce N fertilizer in fear that it might decrease yields, impacting income and future contracts. In addition, most seed corn farmers will not participate in an offsets program without the consent of the company they contract with. These farmers are therefore constrained in their ability to reflexively respond to climate change. As seen in other studies, constrained choice especially occurs in situations where a few companies control a significant share of a commodity market (Hendrickson & James, 2005; Stuart, 2009) and where producers feel threatened by the withdrawal of contracts (Constance & Heffernan, 1991; Heffernan & Lind, 2000). In this case, two companies (Monsanto and Pioneer) control approximately 65% of the seed corn market (Howard, 2009). Industry consolidation limits farmers’ options regarding whom they can sell to. In addition, contracts allow companies to dictate management practices. Because of constrained choice, cognitive dissonance likely affects the seed corn farmers who expressed disagreement with environmentally harmful practices. These farmers continue to apply environmentally destructive management practices that go against their personal beliefs and values.

Farmers in this case study also expressed concerns about powerful companies and interest groups continuing to dominate agricultural politics. These parties have refused to acknowledge climate change and continue to lobby for policies that prioritize production and profitability. Our findings show that farmers are constrained within a system that does not foster reflexivity. Although individual farmers may attempt to reflexively alter their management practices, they remain embedded in a system that inhibits a full transition to reflexive modernization; therefore, reflexive modernization requires changes in both actions and structure (Bos & Grin, 2008). Market-based incentive programs may encourage individual changes, but these changes will remain limited as long as policies and markets continue to prioritize production. Exploring structural barriers to reflexivity reveals how the prioritization of high-yield and high-input practices remains strongly reinforced by agricultural markets, legislation, and agribusiness companies that greatly profit from the current system. Given their limitations, incentive programs will likely represent minor modifications to the status quo rather than a full transition to reflexive modernization.

**Conclusion**

In this article, we use an empirical example to further examine Beck’s theory of reflexive modernization and engage with insights from social constructionist and political economy perspectives.
Our empirical analysis illustrates that perceptions of risk are much more varied and complex than originally depicted by Beck (1992). We do not find reflexive modernization occurring among Michigan corn farmers, but instead find many barriers to reflexivity. Social constructionist and political economy perspectives help us to better understand the complexity involved in risk perception and to identify barriers to reflexivity. Combining these perspectives offers a more holistic framework that bridges the important micro and macro processes influencing responses to climate change (McLaughlin, 2011; Norgaard, 2006).

Adding a social constructionist perspective is necessary to understand that risks are not simply perceived and acted upon. Perceptions are diverse, and prior perspectives can constrain the recognition of new risks. We agree that risk is relational: “Risk is as much about social identities and social relationships as it is about calculable and identifiable potential of negative outcomes” (Higgins & Natalier, 2004, p. 83). Our results illustrate that a few farmers perceive climate change as a risk, others remain unsure about it, and most do not perceive it as a risk at all. We also find that prioritizing short-term economic goals, HEP worldviews, and repeated exposure to conservative media represent barriers to recognizing climate risks. Farmers who fail to see connections between agriculture and “the environment” also fail to see “boomerang effects” (Beck, 1992) that link specific actions with negative impacts. Without the acknowledgement of risk, reflexive responses will not emerge. In this case, engaging a social constructionist perspective becomes critical for identifying barriers to reflexive modernization.

Adding a political economy perspective critically reveals that those who have gained much through industrial (capitalist) systems will fight to maintain the status quo and that farmers are constrained by market actors. Perhaps Beck’s view of how political and economic institutions will respond to increasing risks remains more relevant in a European context. In contrast to Beck’s (1992) original depiction, we see powerful forces repressing reflexivity in U.S. agriculture. Farmers remain largely powerless to foster a full transition to reflexive modernization. We agree that farmers’ actions must be understood “within the context of much broader structural imperatives and power dynamics that shape and influence the kind of relationships farmers and other producers are able to establish” (Lawrence et al., 2004, p. 224). Encouraging farmers to change their practices while ignoring larger structural barriers will not effectively address GHG emissions. A political economy approach helps us to identify the forces that deter reflexive modernization and highlights the need to address structural barriers. Although we find that reflexive modernization is not occurring, it remains critical to envision what a reflexive response might be and what barriers prevent it from occurring (Latour 2003).

Exploring reflexive responses to climate change among U.S. farmers indicates that those who expect farmers to substantially alter their practices on an individual basis may be expecting too much. Although there are exceptions, many farmers do not believe that climate change represents a real threat. Those who do perceive climate change as a threat weigh climate risks within the context of other risks, including economic stability in a political economy that prioritizes production. Given the gridlock surrounding national climate change legislation, bottom-up strategies that engage individual farmers in mitigation efforts make sense. An offsets program for N fertilizer may serve to reduce N₂O emissions. However, participation in these programs will remain limited without significant changes to policies that prioritize production. In addition, companies with production contracts have considerable power over farm management and may inhibit climate change mitigation efforts.

Mitigation strategies that depend on individual reflexivity, such as offsets programs, may not be as effective as approaches that mandate reduced fertilizer application. Voluntary programs have remained the most popular approach to addressing environmental problems associated with agriculture (Dowd, Press, & Los Huertos, 2008). However, they usually provide small incentives and remain vulnerable to changing political and economic conditions. Mandatory approaches to
reduce fertilizer application include direct regulation, taxes, and fees (Segerson and Walker, 2002; Dowd et al., 2008). A combination of policy tools may be more effective than any single tool alone (Segerson and Walker, 2002; Gunningham, 2007; Dowd et al., 2008). Substantial taxes and fees may serve as an effective “push” to support voluntary approaches (Gunningham, 2007). Increasing the cost of fertilizer through a tax or eliminating subsidies and tariff protections that distort the real costs of fertilizer may result in reduced application. However, any price increase would need to be substantial in order to have an impact on application (Segerson and Walker, 2002). Increased input costs create a situation where farmers have every incentive to be efficient and will experiment with new technologies and crop varieties (Hamblin et al., 2009). Despite potential effectiveness, new taxes and fees for N fertilizer would face considerable opposition.

Farmers, like other citizens, can only make decisions that seem possible within the current social system. When asked about climate change, farmers often point to other sources of GHG emissions and how other citizens should be addressing their own contributions rather than focusing on agriculture. Although agriculture represents the primary source of N,O emissions in the U.S., farmers and other citizens face similar constraints. Just as urban residents feel unable to abandon the use of automobiles in a city that lacks public transportation, farmers feel unable to abandon current practices in an agri-food system that prioritizes production. While citizens rationalize the continued use of automobiles, farmers also rationalize the use of N fertilizer. In both cases, systemic changes are needed to reduce GHG emissions. Beck (2010) argues that policy change is needed to “overcome organized irresponsibility” (p. 259). Addressing this irresponsibility depends on societal recognition of climate change as a risk and strong social movements to push forward political change. The barriers identified in this case study may also apply to efforts to reflexively respond to climate change within society at large.

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