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Actor–Networks, Farmer Decisions, and Identity

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Abstract

Climate change and industrial agricultural practices pose threats to the future of Kansas agriculture. To inform the debate about sustainable agriculture that must soon occur, we seek to illuminate the factors involved in the decision making of farmers in Kansas. Drawing from Actor–Network Theory, we consider how farmers' participation in the industrial agricultural network shapes their decisions, defines the types of knowledge and skills that are valued by farmers and others in the network, transforms what it means to be a Kansas grain farmer, and entrenches unsustainable production practices. [Actor–Network Theory, climate change, industrial agriculture, Ogallala aquifer, water]

Introduction

When measured by total crop yields, industrial agriculture has been wildly successful. Yet current practices are not sustainable as population growth continues to outpace world grain production (Bourne 2009; Heady and Fan 2010), yield growth slows (Food and Agriculture Organization of the United Nations 2002:13), farmers' share of food dollars spent continues its 57-year decline (Canning 2011:10; Pons and Long 2011), and the food production system, particularly in places like the Great Plains, is in danger of social, ecological, and economic collapse.

Economically speaking, industrial farming is a difficult, precarious, and expensive endeavor. Market and climate volatility mean farmers do not know in advance what their costs will be, whether environmental conditions will favor production, nor the prices their products will bring. When grain prices are high, as they have been for the past several years, the costs of inputs tend to go up as the companies that produce them seek to profit from the farmer's windfall (Bremer 2009; Monsanto Company 2013). And some technologies, like combines, are expensive no matter the conditions of the market. In January 2013, the base sticker price of a new, top-of-the-line Case IH combine was over $400,000, a price that did not include the necessary attachments for harvesting.

Farmers are also challenged on the ecological front. Climate change, water scarcity, and the long-term effects of industrial agriculture present economic, environmental, social, and policy challenges that must be addressed if the viability of agriculture in Kansas and the communities and industries that depend on it are to be maintained. Factors such as soil erosion and compaction, simplification of soil and pest complexes, loss of organic matter, salinization, desertification, chemical-resistant weeds, and other pests (including the recently evolved resistance to Bt delta endotoxin by corn rootworm) require continual mitigation (Patzek 2008). In Kansas, the region on which this study focuses, water shortages (either through aquifer depletion or drought) and climate change pose immediate threats to agricultural sustainability. Western Kansas is different from eastern Kansas in that irrigation is a major component of farming operations there. The declining availability of water and its role in western Kansas will be given special consideration later in the paper.

To inform the debate about climate change, allocation of water resources, and sustainable agriculture that must soon occur, we seek to illuminate the factors involved in the decision making of farmers in western Kansas. Drawing from Actor–Network Theory (ANT), we consider how farmers' participation in the indus-

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trial agricultural network influences their decisions, defines the types of knowledge and skills they and others in the network value, demands continual adjustments that reshape what it means to be a Kansas grain farmer, and entrenches unsustainable production practices. We open windows on the network and focus on a selection of actors. We show how these actors stand in relation to the farmer, how the farmer and farming are products of these relations, and what these relations mean for farmers' decisions and identity. We find that the identities and practices of Kansas grain farmers are effects of their deep involvement in the industrial agricultural network and that both the farmers and network change over time. Farmers' participation in the network increases their commitment to the ideologies, practices, and technologies of industrial agriculture. These practices compromise the health of agro-ecosystems, and farmers must focus on short-term mitigations that support crop yields sufficient to ensure the financial survival of the farm. Farmers accomplish this goal by using technological innovations, experts to guide production decisions, and credit, all of which collectively influence the kinds of information that farmers value, the ways they farm, and what it means to be a good farmer. Farmers make adjustments to immediate conditions, adjustments made in the direction of what works in their changing environment. This environment for farmers involves soil and water, but also economic and policy arrangements—all of which reinforce the necessity of short-run success, even at the cost of longevity.

Methods

This paper is the result of research drawn from the Kansas National Science Foundation Experimental Program to Stimulate Competitive Research program to study climate change and renewable energy in the state of Kansas. The authors are members of one of three research teams. We work on the project called Biofuels and Climate Change: Farmers' Land Use Decisions whose goals are to try to understand how Kansas farmers make land and water use decisions under conditions of climate change and a growing biofuels industry.

Our team sent a survey to 10,000 Kansas farmers. About 2,500 of the original surveys were returned, and about 650 individuals completed the form that gave us permission to contact them for in-depth interviews. We examined the characteristics of these 650 farmers and selected 200 of them to call for personal interviews. Sample selection balanced the distribution of geographic area, farm size, and demographic factors. A team of seven researchers (including the authors of this paper) from both the University of Kansas and Kansas State University interviewed 151 of the 200 selected farmers during the summer of 2011. The farmers in our sample are overwhelmingly white and male. Although these demographic characteristics are homogenous, farmers' education levels are not. They range from 8th grade to some PhD coursework. The average age of the farmers in our sample is 60 years, ranging from 22 to 85, with an average of 35 years of farming experience,[1] but ranging from 2 to 64 years. These farmers, often described as "conventional" or industrial farmers because they make extensive use of agrochemicals and mechanization, most commonly grow corn, wheat, soybeans, and milo on farms that range from 26 acres to over 13,000 acres with an average farm size of 1,200 acres. Following a semi-structured interview protocol, the interviews lasted from 45 minutes to 6 hours, with an average estimated time of 2.5 hours. The interviews were recorded, transcribed, and then coded in NVivo (QSR International, Melbourne, Australia). The material for this paper is drawn from these interviews.

Theorizing Decision Making

Studies of agricultural decision making most often view the farmer as an autonomous actor. Agricultural economists (e.g., Bardhan and Udry 1999; Drummond and Goodwin 2011) and formalist anthropologists (e.g., Burling 1968; LeClair et al. 1968) model the behavior of rational, utility-maximizing individuals who choose among various inputs in their production systems. Studies of agricultural development often situate farmers among other producers, as did economists Bandiera and Rasul (2006); in a study of technology adoption in Mozambique, they argued that farmers use probability-based updating to predict the performance of new and risky crops.

Diffusion theory also made its mark in explaining farmers' behaviors. Beginning with a study of hybrid corn adoption, Ryan and Gross (1943) launched a new trajectory in agricultural research. They found that innovation adoption is conditioned by farmers' social relationships and exposure to media. In this study, mass communication introduced the new seed stock, but farmers depended on those they trusted before deciding to adopt it. Others underscored the importance of the social network in producers' decisions. Besley and Case (1994), Bardhan and Udry (1999), Conley and Udry (2010), Foster and Rosenzweig (1995), and Munshi (2004) all showed that farmers look to other farmers before deciding to try something new.

Some scholars have focused on the role of culture. Gladwin et al. (2002) built on the importance of locally recognized expertise in their consideration of local knowledge systems. Raedeke and Rikoon (1997), Maloney (2009), Maloney and Paolisso (2006), and Paolisso and Maloney (2000a, 2000b) also studied local knowledge systems, using ethnographic methods to illuminate farmers' cultural models that provide the framework within which farmers make decisions.

Others further broadened the context within which farmers make choices. Hendrickson and James (2005) described how industrial agriculture constrains farmers' decisions: the market economy limits options available, and farmers are left with new ethical dilemmas to solve in this economic environment. White et al. expanded on innovation–diffusion models (Rogers 2003; Ryan and Gross 1943; Wejnert 2002) by situating farmers in a political–ecological context. In this framework, the farmer is the land manager "whose decisions cause impacts on the landscape that are . . . made within a variety of natural, social, and cultural contexts at different spatial scales" (White et al. 2009:289).

The preceding examples illustrate that multiple disciplines locate farmers in social, economic, and political–ecological context, and acknowledge constraints and incentives that influence their decision making. What these approaches have in common is preservation of the individual, autonomous decision maker. Even in economic anthropology, substantivist theorists such as Polanyi (1957) and George Dalton (1961), and culturists such as Stephen Gudeman (1986), while situating decision makers within a locally defined rationality, locate decision making with the autonomous individual. Only in White et al., among the examples cited above, do we see a hint that farmers may not be as free to decide as they are assumed, or claim, to be. They write, "The goal of much political ecological research is not to identify the factors that help to explain land managers' behavior, but instead to increase awareness of the *interdependent* environmental, cognitive, social, economic, geographic, and political structures that affect those decisions" (White et al. 2009:290, emphasis added). It is this state of interdependence and the tensions inherent in modern farming that bring us to ANT as a means to assess the implications of farmers as members of networks. Our goal is not simply to explain the decisions they make but to comprehend the dynamics and the role these networks play in expanding and constraining decision-making opportunities.

Actor-Network Theory

ANT was developed in the early 1980s, principally by Michel Callon, Bruno Latour, and John Law (Fox 2000). Among its main questions is how knowledge, power, and organizations are developed and maintained. ANT asks, what are the "mechanics of power"? (Law 1992:380–381).

The development of ANT stemmed from frustration that approaches to social theory concentrated too much on either the individual or the social, thus obscuring processes important to answering questions about knowledge and power. Bruno Latour writes that this problem creates a "dual dissatisfaction" when researchers concentrate on the micro level and "quickly realize that many of [the] elements necessary to make sense of the situation are already in place or are coming from far away" (Latour 1999:16). Therefore, researchers refocus their analyses on the social where they pay attention to "notions such as society, norms, values, culture, structure, social context, all terms that aim at designating what gives shape to micro interaction" (Latour 1999:17). But at this point, another dissatisfaction arises: "the abstraction of [these] terms is too great, and. . .one needs to reconnect, through an opposite move, back to the flesh-and-blood local situations from which they had started" (Latour 1999:17). To escape these dual dissatisfactions, ANT researchers concentrate on the movements and circulation of ideas and influence. There is no emphasis on changing scales or moving from the micro to macro. The circulating nature of the social means that every local interaction is a network effect, and every network is a "summing up" of local activities (Latour 1999:16).

ANT researchers view the agency/structure dualism, and other dualisms such as nature/culture and human/nonhuman, as unsolvable and therefore unproductive heuristics. ANT projects concentrate on questions of outcomes rather than origins (Law 1999:3). By focusing on outcomes, these projects necessarily investigate the relations between objects and actors. John Law writes that ANT is a "semiotics of materiality" (Law 1999:4). With regard to the nonhuman elements of a network, ANT posits a generalized symmetry, meaning that no special consideration is afforded *a priori* to humans with regard to animals, objects, or institutions (Latour 2005:76). The principle of generalized symmetry is useful for agricultural studies because as Goodman (2008:190) points out, collapsing the nature/culture dualism allows for the conceptualization of "the materiality of nature as an active, lively, constitutive, and relational presence, rather than only as metabolism." This principle allows researchers to explore how actors, objects, and social institutions affect one another because it allows for the possibility that they can take on the attributes of the other things (or people) that are included in the network (Law 1999:5). It follows that actors themselves are defined by their relationships, or are co-constituted with other actors, objects, and institutions. Actors' participation in networks of people, technologies, and institutions expands and constrains their choices in ways that modify their relationships, actions, and identity.

ANT researchers consider society, actors, machines, and organizations to be effects of a network of "heterogeneous materials," combining both ideological and material influences. Knowledge, often conceived of as an ideological abstract, is considered by ANT researchers to be the product of a network of relations. It is the result of "a lot of hard work in which heterogeneous bits and pieces—test tubes, reagents, organisms, skilled hands, scanning electron microscopes, radiation monitors, other scientists, articles, computer terminals, and all the rest—that would like to make off on their own—are juxtaposed into a patterned network which overcomes their resistance" (Law 1992:381). Resistance is overcome when the network is functioning in a way that satisfies its purpose.

Callon defines the steps to overcome the resistance to which Law referred. It is the process of translation, or, to put it another way, the process of forming a network. The first step is the *problematisation* of an issue wherein one actor recruits another to a shared interest. Recruitment requires definition of an "obligatory passage point," or problem–solution equation, which all network actors must accept in order to reach their goals. In Callon's (1986) review of scientists' and fishermen's attempts to conserve the scallop population in Saint-Brieuc, France, the obligatory passage point was the need to know how and if scallops anchored themselves in their early lives. For the fishermen, answers would mean larger harvests; for scientists, the answers accrued in the form of professional recognition. The second step is *interessement* (or strengthening interests) where the recruiting actor "seeks to lock the other actors into the roles that had been proposed for them" (Callon 1986:196). Callon notes that *interessement* can be accomplished through the use of devices or texts and arguments. The third step is *enrolment* where "a set of interrelated roles is defined and attributed to actors who accept them," and is described by "the group of multilateral negotiations [and] trials of strength, . . . that accompany the *interessements* and enable them to succeed" (Callon 1986:211). In this step, the network builders co-define the relations among the various actors and the actors judge that these roles are better than other available options. The final step is *mobilisation* where all actors commit to the endeavor. The examination by Schneider et al. (2012) of Swiss farmers' adoption of no-till technology uses the language of translation to illustrate how networks of farmers, experts, and scientists interacted with one another to spread the technology.

Callon (1986) notes that these steps are not discrete, are continuously negotiated, and may fail even after a period of success. Latour also recognizes that networks are negotiations. He writes that "ANT . . . seeks to find the procedures which render actors able to negotiate with one another's world building activities" (Latour 1999:19). Burgess et al. applied this idea in their study of recruiting farmers for wetland management in the United Kingdom. They write, "Actor-worlds discursively simplify entities. But actors themselves hold identities, interests and beliefs drawn from participation in a multiplicity of networks which enable them to construe their worlds and act differently" (Burgess et al. 2000:125). Therefore, enrolled actors can resist the definitions that the dominant actors seek to impose on them. In this case study, the farmers resisted the simplified roles that the conservation group assigned them and they negotiated new roles for themselves in the wetland management program. This is in contrast to other ways of conceptualizing agricultural developments, such as the "treadmill" (Bell 2004) that remove or suppress farmers' agency in favor of one-way technological or policy determinism.

Networks not only have the potential to enable activity or outcomes but also to limit them. Busch and Juska (1997) point out that "restrictions on choice can be traced to humans, nature, or human/non-human relationships" and, as mentioned earlier, every interaction is both local and general. Actions in ANT, then, are the result of influence and power among network members who are themselves co-constituted and mobilized to act in particular ways.

Applied to our project, we ask:

- How does participation in an industrial agricultural network influence farmers' decisions and identity?
- Why do Kansas grain farmers continue their current production strategies despite evidence that these strategies appear economically and environmentally unsustainable?

We see industrial agriculture as a dynamic, changing actor-network to which farmers contribute and within which farmers change as the composition of the network changes. We recognize that farmers participate in multiple, often interlinked, networks. In this paper, we confine our analysis to the industrial agricultural network, which we define as the group of businesses, farmers, and institutions focused on maximizing agricultural output using industrial methods and logic. We begin our discussion of farmers as network actors and decision makers with a brief review of the development of industrial agriculture and then move on to a discussion of the modern network in which farmers are embedded.

The Development of Industrial Agriculture

Industrial agriculture is a capital-intensive style of farming that relies on crop specialization, economies of scale, fertilizers and pesticides, managerial expertise, and mechanization. Fitzgerald (2003:13) describes the beginning of industrial agriculture in the United States as an uneven process because of regional variations in climate, soil conditions, topography, and market demands. The first traces of agricultural industrialization appeared early in the 1830s with the mechanical corn sheller and Cyrus McCormick's horse-drawn wheat reaper. A corn picker reduced time devoted to the corn harvest in 1850; farmers could plant corn mechanically by 1853; steam-powered tractors were invented in 1868; and by the late 19th century, farmers in the Great Plains were experimenting with combines (Landenberger 2005). Fitzgerald marks the beginning of industrial agricultural practices in 1918 with the advent of large farms that were managed using the logic of factories and the wide availability of farm tractors (Fitzgerald 2003:16–17). World War I influenced the adoption of more industrial practices because it removed many young men from American farms and at the same time world demand for agricultural goods was high. American farmers, caught in a speculative commodity and land bubble based on wartime prices, expanded their operations and increased their output until the postwar market collapsed a few years after the end of the war. Fitzgerald goes on to describe how many farmers lost their farms and the American agricultural sector was thrown into a crisis (Fitzgerald 2003:17–18). The efficient, standardized logic of the factory seemed to provide the answer, and an industrial approach to farming became more widespread (Fitzgerald 2003:21).

The adoption of tractors in the 1920s enabled and encouraged farmers to bring more land under cultivation (Fitzgerald 2003:107). Grain prices, particularly wheat, recovered, and a new round of speculative farming began (Stephens 1937:754). When the Great Depression and the Dust Bowl once again thrashed American agriculture, the New Deal programs sought to balance the supply and therefore the price of commodity grains (Kenney et al. 1989:136–137). At the end of World War II, the United States used food as a tool in its "democratizing arsenal" (Adams 2007:3) and hoped that cheap food would give the newly freed colonies and developing nations less reason to return to totalitarian regimes (Adams 1987:2). The land-grant colleges that had been established for the benefit of farmers and ranchers formed partnerships with newly ascendant agribusiness corporations to defray the effects of reduced funding from the federal government. Corporate dollars shaped their research programs, and land-grant universities, not surprisingly, began to concentrate on ways to benefit corporations rather than farmers (Berry 1977).

Cold War policies and practices also influenced farmers and the composition and dynamics of an evolving industrial agricultural network. The Farm Bureau, a government-backed actor formed in 1911 as a reaction to the successful, but antimarket, Farmer's Educational and Cooperative Union (FECU), was a major force in transforming the way farmers thought about themselves and their occupation (Durrenberger 1985). The Farm Bureau was allowed to "graft itself onto the newly emerging extension services of the state agricultural colleges" (Durrenberger 1985:15), thereby giving it a legitimacy that the FECU did not enjoy. Jane Adams writes that "the alliance that prevailed was that between business farmers, chambers of commerce, land-grant colleges, the U.S. Department of Agriculture, and other business-dominated groups" (Adams 1987:2), collectively giving new energy to market dynamism and the influence of business within the evolving network. President Nixon's appointment of Earl Butz as Secretary of Agriculture in 1971 solidified the partnership between the federal government and agribusiness. Butz entered the office with close ties to agribusiness and used his position to naturalize, discursively and through federal policy, the merging of agribusiness interests with those of the nation (Carter 1973).

To fulfill his policy goal of abundant, cheap food, Butz admonished farmers to "get big or get out" and to plant "from fencerow to fencerow" (Thompson 1988:69). He wanted farmers to switch to full-tilt production and use the technologies offered by agribusiness. Farmers' acceptance of the role that Butz, the U.S. Department of Agriculture, land-grant institutions, and agribusiness corporations proposed for them led to the mobilization of the industrial agriculture network whose major focus was to increase the export of commodity crops to the world market, enabling the United States to use "food as a weapon" in its foreign policy (Thompson 1988:69). This network supported the U.S. government's cheap food policy at home and abroad, food processors' desire for cheap grain for their mills, agribusiness' market for new products and technology, and, for a time, farmers' financial well-being. Financial incentives such as favorable income tax rules, high crop prices, a speculative land market, and readily available credit changed farmers' views of good farming practices and good farmers as they enrolled themselves in the industrial agricultural network (Strange 1988:18–23). The promise of increased yields and profits strengthened farmers' commitments to large-scale, industrial production, and mobilized the industrial agricultural network.

The farm-level results of Butz's efforts are well known (Bradshaw 2013:250; Thompson 1988). Increased grain output led to decreased crop prices, which encouraged farmers to put more land into production, which necessitated larger and faster equipment, which led to increased grain supplies, which decreased crop prices, and so on. To keep up, farmers relied on credit in order to afford new seed and chemical technologies, equipment upgrades, and land acquisition. Whereas farmers previously provided much of their own food, livestock, and raw materials, the push for modernization encouraged farmers to enroll in the industrial agricultural network as specialists in one or two crops instead of diversified farming, and to produce for a competitive and capricious global market.

The farm crisis of the late 1970s and 1980s threatened to topple the network. Yet disasters for some meant opportunities for other farmers, who expanded their operations with the purchase at auction of foreclosed land and equipment. The crisis solidified surviving farmers' reliance on the technologies of industrial agriculture and the paradigm of large-scale monocropping in order to make a living. Indeed, it necessitated farmers' reliance on industrial farming technologies (J. Ikerd, "Crisis and Revolution in American Agriculture." Keynote Presentation at the Citizens Hearing on Pork Production and the Environment. Brandon, Manitoba, Canada, October 29, 1999). The period after the farm crisis of the 1980s has been characterized by enhanced corporate control over the genetic base of agriculture (Kloppenburg 2004), and continued farm consolidation and shift in political power away from farmers and toward agribusiness (Thu 2009).

An industrial agricultural network is a heterogeneous mix of human and nonhuman components, demonstrating how and why ANT does away with the distinction between culture and nature. (Is a corn seed with a gene from a bacteria inserted into its DNA a natural or a cultural product?) The roles that technologies such as genetically modified (GM) seeds, fertilizers, pesticides, herbicides, and farm equipment play in agricultural production are obvious enough. However, off-farm experts, technologies, and institutions such as farm credit, crop insurance, and crop consultants are today as significant to many farmers' abilities to plant and harvest as are seeds and tractors. Next, we explore how farmers' practices and identities are constructed as they negotiate their world-building activities with other actors in the network, and how these negotiations encourage farmers to continue production strategies that do not benefit them in the long term.

The sections that follow are drawn from our interviews, except where citations are provided. We begin with farm credit.

Practices and Identities

Financing

The use of credit is a prominent feature of modern farming. Creditors provide farmers access to farming technologies and supplies, but they also influence how farmers manage their operations. Not counting off-farm income or fees collected for letting people hunt on their land, farmers make money only when they sell their harvest, meaning that most producers collect a paycheck once or twice per year. Out of that income, farmers must allocate money for repayment of operating loans, land mortgage and rent payments, household needs, auto and farm equipment payments, and other necessities of living. When the crop sales prices or yields are low, there may not be enough money remaining to pay for seed, fertilizer, herbicide, and insecticide for next year's crop. The farmer must borrow money in order to plant again the next year.

A well-established farmer with a small operation in south central Kansas said that he needed to borrow money for his seasonal inputs and to repair the damage that a windstorm inflicted on his center pivot sprinkler system so he could realize a profitable yield. Another respondent expressed his business orientation this way: "I won't borrow money for something that's not income-producing. It's got to generate some type of revenue to make it pay." A third respondent, who grows corn and sunflowers in addition to managing a hog operation in central Kansas, told us that one of her biggest challenges was securing a credit line. "Through the years, probably more so today than it has been in the past, is for people to have access to capital for agriculture. The agriculture *business*." As she noted, and as the credit arrangements confirm, farming is a business and farmers are business people. This business orientation is evident in the way that farmers often refer to themselves as "producers."

Farming's orientation toward business is not a new development. A brief glance through older farming publications such as *The American Farmer* (published between 1881 and 1897) or *Cornell Reading Course for the Farm* (published between 1911 and 1923) demonstrates that business practices and maintaining solvency have long been a concern of farmers. Indeed, the conditions that led to the Dust Bowl were exacerbated by the widespread mechanical cultivation of the Great Plains by farmers who were trying to cash in on high wheat prices (Stephens 1937). Particularly significant in farming-as-a-business in the industrial agricultural network are production specialization, which reduces the diversity of farm activities and products that traditionally served as a hedge against catastrophic failure (Mishra et al. 2004), and the increased reliance on operating loans.

Loans not only allow farmers to access modern technology and inputs and services, but they also influence how farmers think about the future and make decisions. DJ, a corn, wheat, and milo farmer nearing retirement, described his biggest challenges:

> They are economic probably, especially things like building terraces [to prevent erosion on sloped ground]. Those things really cost money, more so than they used to. I think it's economic pressures that prevent people from planning for the long-term. I do it, too. We look for the short-term return rather than twenty or thirty years down the road.

The necessity of servicing debt leads some farmers to make decisions today that have negative implications for tomorrow. The network produces conditions that require credit to stay afloat, leading to decision making that emphasizes short-term cash flows rather than long-term strategies. One of our respondents said, "You have a lot more invested up front than you did, you know, a few years ago. It just seems like the margins are smaller because of the higher input costs."

Another respondent noted that, after the 1970s–1980s farm crises, banks changed their lending practices in ways that direct farmers' decisions and constrain their choices. Banks now make loans based on farmers' ability to repay the debt from farm proceeds rather than the sale of assets like land. A farmer we spoke with addressed this situation when asked about securing credit. He said:

> If you borrow money you're going to have to have crop insurance and all that, that makes that margin even tighter. Then they'll say, "Well, if you're going to buy 160 acres you better have maybe three times that much that you can rent from somebody," and where're you going to rent it?

The bank's demand is an example of how actor-networks can enable and constrain choices, sometimes simultaneously. To secure a loan, this farmer needed to accept the role that the bank required of him. The creditor not only wanted him to have crop insurance but also wanted him to bring an additional 480 acres under cultivation as a way to increase his potential income and ability to repay the loan. The farmer wanted to get a little larger, but the bank wanted him to get significantly larger. The problem, however, is that it is often difficult to find land to rent in Kansas (many landlord/tenant relationships persist for decades, if not generations, and most farmers are loathed to pursue land that another farmer is currently renting), and incorporating many new acres into an existing operation is no small task. Even if this farmer could find 480 acres to rent, he would need to assess whether he and his equipment could handle the additional travel, time, and work. In the end, "good farmers" prefer solvency, but they accept debt acquisition and the rules and constraints that come with it as an expected part of doing business.

Crop Insurance

The need to service their debts and the inherent risks in agriculture have made crop insurance mandatory for some farmers. Crop insurance is required if farmers want to participate in some government programs or secure a line of credit. A lender wants to know that the farmer will have the ability to repay at least some of the loan should the crop fail. Like debt, crop insurance influences farming practices. A corn and wheat farmer, with a medium-sized farm in southwest Kansas, expressed frustration that his insurance adjuster required him to continue to irrigate his corn even though it was clear that, due to the summer heat and drought, his corn was not going to make a crop. The farmer was frustrated because his wells were already failing, and the insurance policy forced him to waste good water on a bad crop. In other cases, crop insurance provides a safety net that has encouraged farmers to experiment with growing new crops that might not be suited for their land. Farmers have planted more corn, a crop with high water needs, in unfavorable conditions because the guaranteed price was attractive. One farmer said, "Sometimes the guarantees are good on a crop, so you'll plant maybe dry-land corn instead of milo [which does better in drier conditions] because the guarantee is better. You'll plant a little corn anyways, but you might plant some more because of insurance."

A young, aggressively expanding, and financially stressed farmer in our sample said this about crop insurance:

> We got some hill ground, and it is not designed for corn, and we have every acre of it planted to corn. It's a dollars and cents thing right now. We've had good production on all of our corn ground so my APH [Actual Production History, the multi-year rolling average of production used to calculate crop insurance payouts] was high enough. I know it'll never grow my APH amount. We're banking on the insurance claim. If it rains, it could grow it, but 9 times out of 10 it won't. And that's why I say crop insurance is a good marketing tool, because if you do have a good production history on something it'll protect you on a bad year, but also it lets you plant corn on a hill that never should be planted corn. But you'll still get some return on that hill based on that.

The downside to this farmer's crop insurance strategy is that he likely lowered his APH, and thus his crop insurance guarantee for the next year. The summer of 2011 was brutally dry and hot in Kansas, and his corn crop on that hill probably did not do well. This farmer needed the cash flow, however, just to be able to continue into the next year. Financial stress can lead farmers to seek ways to maximize short-term yields and profits at the expense of the long-term productivity of the soil and their operations.

Crop insurance can present a moral hazard that enables the farmer to take risks, knowing that the cost of the risks will be passed on to other people (Liang and Coble 2009). Of course, moral hazards are not unique to farming. In this context, the moral hazard sits in opposition to discourses about good stewardship and independence that many farmers espouse. Many people we spoke with in and around agriculture are aware of this moral hazard. The uneasiness and disappointment they express about practices like those outlined above indicate that they understand the personal cost and contradictions inherent in them, but this aspect of the industrial agricultural network and farmers' willing engagement in these practices are normalized as agribusiness institutions require them.

Experts

The complexities of agricultural technologies and the pace of change in the market place make it difficult for farmers to find the time or develop the technical expertise to understand how the innovations work. And few network elements reveal more clearly how farmers have been affected by their enrollment. The drive to maximize efficiency and profit using increasingly sophisticated technologies has encouraged farmers to turn to experts for guidance. A crop consultant is one such expert. Dr. Freddie Lamm, an irrigation specialist at Kansas State University, notes that 90 percent of the irrigators in Kansas use crop consultants (personal communication, 2011). This is consistent with our sample, where all but one of the farmers who irrigate use these experts for irrigation scheduling, pest scouting, soil testing, and recommended remediation. One farmer put it bluntly when asked about how he decides when to spray for pests: "This crop consultant usually tells us what we need to do and when we need to do it." Another farmer said, "I depend on my extension agent a lot for pest control, or a crop consultant. They alert us as to when they're seeing a sudden buildup of pests, of insects that need to be sprayed for." DL, a large operator in extreme southwest Kansas said, "I have a crop consultant. Those people are experts in weeds and pests, stuff like that. They test the soil, see how much fertilizer I need to put on it. They tell me what herbicides and insecticides to put on. They're experts at that."

Crop consultants are not only experts regarding agricultural chemicals; they are able to reverse the scale between the individual farmer and the vastness of nature. They are very much like the astronomer Tycho Brahe, who, through careful observations and coordination with other astronomers, was able to map the motion of heavenly bodies and make the evening sky understandable (Latour 1987:226–227). An individual crop consultant covers a large geographic area and shares information with other consultants. Although a farmer's focus is what is happening in his fields, crop consultants are able to apply knowledge of diseases or pests from observations in many distant fields to the field in which he is working at the moment. They relay ecological knowledge and solutions to the farmers who employ them, eliminating the need for farmers to go into the field and gather the information themselves.

Perhaps more than other factors, the involvement of crop consultants has led farmers to engage the environment in new ways that redefine both the farmer and the land. The properties of the soil, such as nutrient and moisture content, are quantified through laboratory soil tests and translated by the consultants into recommended practices. These new practices devalue farmers' personal, ecological expertise in favor of computer printouts that obviate the need for farmers to understand the ecology of their fields. We see the relationship as not unlike that between a doctor and a patient, where the processes and afflictions of the patient's body are known to the doctor, but mysterious to the patient; and where the patient can expect a return to health if she but faithfully follows the doctor's prescriptions. The expert/client relationship between crop consultant and farmer is strong. However, not all farmers have ceded authority and expertise to crop consultants. One farmer told us, that although he uses crop consultants, he does not always follow their advice. "They don't know my ground like I do," he said.

Farmers use other types of outside experts as well. In an area of western Kansas that already experiences water shortages, one farmer uses probes to measure soil moisture and determines whether or not he should irrigate. These soil probes send the information via satellite to a central server that the farmer can access over the Internet. However, this farmer told us that he did not "*sabe* all this stuff" and hired someone to interpret the data for him. The learning curve requires farmers' reskilling or the use of newly created experts to help farmers use the new technology. Farmers on the verge of retirement told us that keeping up with the changes in farm technology is one of the most difficult aspects of farming. Farmers in the beginning or middle of their careers affirm the importance of staying abreast of technological changes. As one farmer put it, "You've got to be progressively re-educated all the time or you just can't make it." The continuous flow of new technology into agriculture also means the continuous remaking of the farmers that use it.

Equipment and Technology

Much of the equipment and technologies that farmers use extend their abilities by making farming less physical, enabling the farmer to manage more acres and farm later into life. Some technologies, like global positioning system (GPS) guidance systems, allow them to be more efficient in their planting and application of fertilizers and insecticides. These technologies may be beneficial in important ways, but they change what it means to be a farmer by requiring different types of knowledge and changing farmers' relationship with their land, other farmers, and their communities.

The equipment and technology that a farmer uses make some choices possible while simultaneously foreclosing other opportunities. Farmers' decisions are shaped by their associations with technology, as are farmers' understandings of what it means to be a good farmer. When a farmer purchases a $400,000 combine, the design of the machine fits a certain style of farming, and the farmer has an interest in using that combine to its full capabilities. Alternative production strategies—organic farming, polyculture, and growing crops such as vegetables or cotton—are precluded by the design of the machine. Further, the adoption of one technology or method often necessitates the adoption of other technologies. For example, many of the farmers in our project practice no-till agriculture. This method is most successful when used in conjunction with proprietary seed varieties that are resistant to the herbicides that the farmers must use in order to control the weeds that would have been removed through tillage.

The lack of equipment can also determine how a farmer operates. When asked how he makes his cropping decisions, one farmer responded, "Well, part of it is the equipment that you have. I don't really have the equipment to plant corn, or harvest corn, so I don't even consider planting corn."

According to some farmers, modern farm equipment can extend not only their reach and power, but also their mindfulness. One farmer told us he thinks that GPS-guided tractors and related technologies enable him to pay more attention to the condition of his fields because he does not have to drive the tractor with a white-knuckle grip to keep the rows straight. On the other hand, his college-aged son uses his newfound freedom in operating the GPS-guided tractor to text his friends. Some farmers appreciate the extended abilities that modern tractors give them, but feel that they are being insulated from their work. VH, an older farmer with an extremely large operation, explained, "With the air conditioning you can't even smell the ground! If you walk along behind a horse and plow you felt the soil, you were a part of the soil. But today you get in a big air-conditioned tractor cab and you're 10 feet above ground. Well, what's the ground to you?" In this passage, VH, a German Baptist, recalls his youth working with horse teams on his parents' farm. He has experienced a profound shift in the way he relates to his land because of his adoption and use of new technologies.

Irrigation from the Ogallala

Sometimes incorrectly referred to as an underground lake, the Ogallala Aquifer is actually a subsurface mass of saturated clay, silt, and sand formed by fluvial deposition from the Rocky Mountains about ten million years ago (Kromm and White 1992:15). The Ogallala underlies more than 30,000 square miles of the western third of Kansas (Kromm and White 1992:15). It is the only significant source of water for irrigation and municipal use in western Kansas. Beginning in the late 1800s, crude irrigation rigs driven by windmills began to pump the relatively shallow water deposits to the thirsty crops above. Technological advancements, culminating with the development of pumps driven by electricity and internal combustion engines and the center pivot irrigation system in the 1950s, increased water usage and transformed western Kansas into a fertile agricultural area.

What began as an effort to use the Ogallala to irrigate a handful of acres on small farms has become an arrangement where about three million acres of land are irrigated in Kansas alone (Kansas Department of Agriculture, Division of Water Resources 2010). Western Kansas, in particular, is home to two industries that depend on water from the Ogallala and are important not only to the rest of the state but to the Great Plains region as well—beef packing and ethanol production. The beef-packing industry is so concentrated in this region that over 40 percent of all federally inspected beef processing comes from the states of Kansas and Nebraska alone (National Agricultural Statistics Service 2012:12). Water from the Ogallala plays an important role in these industries because irrigation results in the high corn yields that support the needs of the beef-packing and ethanol industries for cheap and abundant corn. Without this irrigated crop, these industries might shut down altogether, need to find alternative supplies and pay increased costs of shipping, or relocate closer to grain supplies.

However, as can happen, this actor is leaving the western Kansas network after a relatively long period of enrollment, with serious implications for other network participants. The irrigation pumps, the devices of *interessement* that have been successful in enrolling the aquifer up until now, are losing their effectiveness because the water levels in the Ogallala are dropping. The average aquifer recharge rate in Kansas is only about a half acre inch per year, but farmers routinely pump more than an acre foot of water per year (Kansas Department of Agriculture, Division of Water Resources 2010:6). The ability of the actors to keep the Ogallala enrolled is diminishing because the technology and resources to harness it are no longer up to the task in many areas—most significantly, but not exclusively, in the state's southwest corner. The Ogallala was considered inexhaustible for much of the time it has been used, but the network did not pay heed to the fact that the nature of the Ogallala is processual, rather than constant.

As the Ogallala recedes from network, the producers who once relied on it are forced to change their operations. In our fieldwork, we encountered several producers who experienced complete well failures and have started developing alternatives to commodity grain agriculture. One producer is establishing a vineyard and hopes to make wine. Some of his friends now grow other specialty produce. Some farmers in the southwest corner of the state have started growing cotton. These alternative or specialty crops offer a greater financial return on the water they require. These crops need water, but the little water that these farmers have left is sufficient to grow and realize a return on such high value crops when that water is delivered with high-efficiency, drip irrigation systems. New knowledge, practices, equipment, and processing will be required to make alternative production strategies and experimental crops successful, however. In short, these farmers are attempting to renegotiate their roles in the industrial agriculture network.

Fertilizer

Other nonhuman components of farmers' production networks require attention. Farmers must "negotiate" with the land and the seeds in order to realize a harvest. The answer to VH's rhetorical question, what is the modern farmer's relationship with the land, is that some farmers view the land as an inert substrate rather than as a living part of the ecosystem.[2]

When asked if they had noticed any changes in their soil productivity, several farmers in our sample pointed to things like seed varieties and fertilizer programs as the reasons for their increased yields. One young farmer said, in response to the question about changes in soil productivity, "No. I have not noticed a change. Just don't ever skimp on your fertilizer and you'll never have a problem with your soil productivity, because that is where your soil gets its nutrition, from the fertilizers."

This young farmer represented an extreme case in our research in that he wielded the technologies of industrial agriculture like a hammer rather than a lever. Nonetheless, his statement is instructive. Farmers must entice the land to stay in the network at every growing season, but the poor rewards farmers offer the land for supporting their crops may not be enough to keep the land enrolled in the network forever. Indeed, Kansas farmers witnessed a devastating land exodus from the network in the 1930s, when the top soil took to the skies.

This view of land as property rather than partner in a network with a particular goal has implications for the decisions that farmers make. Industrial agriculture views land as a resource to be technologically managed or dominated. The complexities of the soil have been reduced to the information provided by a soil test, and important soil services are imperiled. Fertilizer and other soil amendments become increasingly important to ensure that the land, which in some places in Kansas has been intensively farmed for over 100 years, remains productive. The economic situation on some farms, however, can threaten even the modest "payments" that farmers make to the soil.

Some farmers engage in a practice called "mining the soil," wherein the farmer takes advantage of the soil nutrients to grow his crops without replenishing them after the growing season. This practice is antithetical to idealized behaviors described by farmer discourses about stewardship, but it is an excellent example of how financial pressures, in particular the behavior of capricious markets and lenders among network actors, can influence farmers to make decisions with which they are uneasy (Hendrickson and James 2005). One farmer, who is also a seed dealer, told us that he might not apply lime (used to adjust the pH of the soil for optimum growing conditions) to rented ground if he knew he was not going to rent that ground again after his contract with the owner expired. He reasoned that "the next guy's going to benefit from the money you invested in it more than you." Another farmer in northwest Kansas provided the economic rationale for this practice. He speaks in the first person but as the voice of another farmer. He said, "Well, I'll do this for three years: I can make an extra $30 an acre on this [the crops] if I don't put the phosphorous on there. I'm going to give it up at the end. We'll basically mine what someone else has put out there." Farmers also make this decision about their own land:

> I know when fertilizer prices started tripling they [farmers] started skimping, and I'm one of them, you know. But some of the soil down here just don't have a whole lot of push; it needs all the help it can get. And once you start mining that soil out, it might take a long time to get it back. And we're guilty of doing it too, maybe not putting on the recommended amounts, trying to skimp off a little bit. And it's a bad way of doing things because eventually you're going to get to the point where you're going to have to fertilize way more than what you would've done if you just would've kept at your regular rates, 'cause you've mined it out enough. Now you've got to build it back up.

Farmers realize that skimping on fertilizer is a risky proposition, but, as shown above, some of them do it when they know that they are not going to rent that ground anymore, or when they are predicting a bad crop season. Agricultural profit margins are slim enough that saving money by not applying fertilizer can make a big difference to the farmer's balance sheet for that year—even if that strategy may prove costly in the future.

In light of the view of land as a resource to be extracted and the view of soil fertility as something delivered technologically, it makes no sense to deliver costly nutrients to rented land or even owned land in a bad year. A farmer's relationship to the land, whether owned or rented, has been redefined as a more strictly economic one, and that means that farmers' felt responsibilities and understanding of what it means to be a "good farmer" are defined in large measure by the purchase and effective application of costly technologies to ensure profitability.

Tensions and Domination

The farmers in our study use these networks of nature, social arrangements, and technology to maximize their crop yields and respond to the basic problematization of the industrial agricultural network—increased profits. They believe that it is in their best interests to increase farm size as much as possible and to grow as much as they can. This does not mean, however, that they do not assess how their participation in the network affects them. Although there are well-documented problems with industrial agriculture, the farmers we spoke with continue to participate in the network, articulating the values and practices "built" and reproduced by those who constitute it. As Latour (1999:19) said, "Individuals always know what they are up to. They know why they are doing what they do and the forces that are taking them there." This assertion does not mean, however, that farmers like or are always comfortable with the decisions they make. There is a tension between what farmers must do economically as business managers in the short run and what they believe they should do ecologically as environmental stewards over the long term. The tension is prevalent in their talk about their decisions, and it reveals how farmers continuously negotiate their roles in the network.

One tension is between farmers' assertions that they control their own activity and the extent to which their activity is an effect of the network. Many farmers cite "being their own boss" and a sense of independence as positive aspects of farming. While it is true that farmers direct their own daily activities and do not have a supervisor standing over their shoulders, power in the industrial agricultural network accrues to financial institutions, experts, the seed and chemical companies, and companies that buy and process agricultural commodities. Recall that one of our informants was told by his lender that he needed to rent three quarters of a section of land (480 acres) if he wanted a loan to buy one quarter, and that another informant's insurance company made him irrigate his heat-damaged corn crop even though he knew that it was a waste of water. Other informants were directed by their crop consultants when and how much they should irrigate or apply pesticide and soil amendments. The farmer has the ultimate authority to follow the crop consultants' advice, so he is still the boss, but he is far from independent and his agency is constrained by multiple factors.

The purchasers of agricultural products also direct the choices a farmer makes. When we asked one farmer why he grows wheat, he said, "Because this is wheat country. We have always grown wheat around here. That's what you grow." The farmer was not only referring to history, or expected practice, or even the climate and soil conditions. He was also referring to his ability to sell the wheat he grows. Grain farmers in western Kansas work in a monopsony, a market condition where there are only a few buyers. In the sparsely populated regions of western Kansas, the only market for bulk agricultural goods is for grain. The local farmers' co-operative would not accept a semitruck full of another crop, canola for example, or vegetables. A farmer who wants to continue farming must have a market so he needs to grow a crop that he can sell within a short distance of his farm. One of our informants in extreme southwest Kansas decided to experiment with growing grapes. Even if he can grow grapes successfully, it is not entirely clear how he will market them.

Another tension that farmers experience is that between expanding their operations in the name of financial gain and maintaining the health of their communities for the sake of quality of life. This pattern of concentration of more land in fewer hands has led to the depopulation of the countryside and deterioration of rural communities.

Many farmers say that they would buy more land if it was available or if they could afford it, while at the same time lamenting the condition of their communities. One farmer grew emotional when he talked about how there used to be a family on every quarter section (160 acres) and that the entire neighborhood would walk to his patio in the evenings for fellowship. The larger population of farmers supported local businesses and schools, and they participated in local governance. Now, there is not an occupied house within two miles of this farmer who owns more than 10,000 acres of farm ground and grassland. The community now struggles to maintain schools, other government services, and businesses that supply the needs of rural families.

Those that do remain in rural communities have also experienced a change in the way farmers relate to one another. Farm expansion meant that farmers needed to spend more time on their own farms and that they had less time available for reciprocal labor exchanges and socializing with their neighbors. Many farmers in our sample remembered a time when reciprocal labor was more common, but few report having that type of relationship today. Farm expansion and the decline of reciprocal labor were coincident with the advent of larger, faster, and more efficient farm technologies. These technologies made it possible for fewer people to complete more work, and they exacerbated outmigration. Even farmers' children were affected by these changes. The reduced physicality of farm work coupled with higher levels of debt meant that farmers worked later into their lives. Their children, not seeing an opportunity to take over the farm, also began leaving rural communities for other greener pastures.

Another tension related to land is that between the farmers' discourse of being a steward of the land and of treating land like a resource. As discussed earlier, in the industrial agriculture paradigm, the land is considered a resource, that is, something that exists to be used or mined. Many of the farmers we spoke with talked about how they are stewards of God's earth and feel that it is their responsibility to leave the land better than they found it. Yet they engage in farming techniques that have a demonstrably negative impact on the ecosystem. They define success in the short term as the ability to grow a crop year after year (a feat they accomplish with technology, imported energy, and other inputs), not in ecological terms that speak to the need to preserve soil health and clean and abundant water for future generations.

The final tension we observed, once again related to the land, is that between the farmer having an ecologically intimate relationship or a technologically mediated relationship with the land. Our informant VH told us that his big air-conditioned tractor did not let him smell the earth and that he felt separated from the soil. Other informants used soil probes to gauge the moisture content of their soil or hand-held grain moisture meters to tell if their crop was dry enough to harvest. Virtually all use crop consultants and other experts to translate the new kinds of information about their production systems. This information and the need for specialists to interpret it devalues farmers' own experience and resulting knowledge in a deskilling process and redefines what it means to be a good farmer who fulfills his network roles.

The farmers we spoke with are not blind to the negative effects of industrial agriculture. Some of them worried about the effects of herbicides and insecticides on their health and water supplies, and pointed to what they perceived to be high rates of cancer among other farmers. Others suffered economic hardships as they tried to fit themselves into the hyperproduction mold. One farmer told us that at various times, he used the grocery money to buy diesel fuel for his tractor rather than food for his family. If farmers cannot farm as they would want to and worry about their health and finances, why do they continue as they do? How is it that the most numerous single bloc of the industrial agricultural network is unable to exert its will? This answer is that farmers are dominated. In ANT, domination occurs when all or most of the power resides with one actor, or set of actors, who are enabled to determine the roles and behaviors of other actors. It is an outcome of the process of translation where "a few obtain the right to express and to represent the many silent actors of the social and natural worlds they have mobilized" (Callon 1986:224). One particular node of the network that has been able to consolidate power is the node represented by seed companies.

Industrial farming has changed rapidly in response to changes in the seeds that farmers plant. Many commodity crops (corn, soybeans, and cotton, for example) have been genetically modified to resist glyphosate herbicide, or to exude a toxin that kills certain crop pests. Seeds can be coated with fungicide, insecticide, and other biological agents that prevent germination before the soil temperature rises above a certain level. These seeds are high-tech creations that more resemble colorful pellets than what the home gardener would recognize as seeds. Such innovations help reduce the uncertainty inherent in farming. Jack Kloppenburg (2004:6) notes that seed breeding has generally been thought to create only substantial social value, but that in reality it has been responsible for a wide range of negative effects such as

> the exacerbation of regional inequalities, generation of income inequalities at the farm level, increased scales of operation, specialization of production, displacement of labor, accelerating mechanization, depressed product prices, changing tenure patterns, rising land prices, expanding markets for commercial inputs, agrichemical dependence, genetic erosion, pest-vulnerable monocultures, and environmental deterioration.

From an ANT perspective, we must add to these criticisms of seed breeding. Seeds are also mechanisms of domination. GM seed is part of a particular vision of farming that literally becomes implanted directly in the field. This is an example of translation. As Burgess et al. note, "Translation is thus about attempting to gain rights of representation, to speak for others and to impose particular definitions and roles on them. To achieve success, other actors' worlds must be colonized" (Burgess et al. 2000:123–124). High-tech seeds, then, represent colonizing of farmer worldviews and land. To use these engineered seeds, farmers must understand farming as a technological rather than biological process. And they must sign intellectual property agreements with the seed companies and risk being sued if they save their seeds or otherwise use them in an inappropriate manner. Once the seed is planted, the translation is complete—at least for a time.

Companies like Monsanto have come to dominate agriculture by patenting seeds, funding agricultural research, producing fertilizers and pesticides their seeds require, and by defining how the industry operates. Agribusiness efforts have been facilitated by a friendly regulatory environment that enables the spread of new technologies and protects corporate interests. A recent example is seen in courts that have sided with Monsanto's claim of patent infringement against farmers whose non-GM fields have been invaded by Monsanto's product. The result is that when farmers choose to plant a GM seed, they also choose to use the herbicides to which the seed is tolerant and agree to certain restrictions on the use, marketing, and planting of the seed.

Seed companies and other agribusinesses have been very influential in changing farmers' relationships with their land and crops. From seeds to GPS technology and satellite-linked water sensors, agricultural technology has become more complex and oriented to the idea that technological innovations can meet all of industrial agriculture's needs, including the need for solutions to the problems it creates. By the time these technologies reach the farmers' field, they have been "black boxed." Black boxing refers to "knowledge which is accepted and used on a regular basis as a matter of fact" (Yonay 1994:41). For example, farmers do not need to know how seeds are engineered. This knowledge may take the form of artifacts, like GM seed and a GPS-guided combine, or a set of practices like no-till, irrigated corn production. Seed companies offer farmers a package of solutions that almost guarantee success if farmers follow label instructions. In a black-boxed environment such as this, seed companies are the manufacturers of the technology, crop consultants are the experts who troubleshoot the application of the technology, and farmers are techno-managers who use the technology without needing to know how it works. Farmers can purchase additional knowledge or expertise if they desire.

As time passes, the network becomes more stable because of the realization of the dominant actors' goals and the black boxing of ideas and technologies. It becomes more difficult to contemplate changes that would allow farmers to resolve their tensions or define and defend their interests. Farmers have neither set policy nor dominated nature in the ways that the government and industrial agriculture companies have. Nor do they have the control over their produce once it leaves the field that food processors and biofuel refiners have. Additionally, they are directed by lenders and crop insurance companies who set the terms for their participation in agriculture. Farmers' lack of control has left them dominated by all other actors in the network. Although our fiercely independent informants would rather walk their own paths, and insist that they do, their involvement in the industrial agricultural network keeps them in well-defined orbits.

Conclusion

We began our discussion by asking two questions: How are farmers influenced by industrial agriculture and why do they stay within the industrial agriculture paradigm despite mounting evidence, observed both by farmers and scientists, that it is not in their long-term best interests to do so? Regarding the first question, we find that the industrial agriculture network, dynamic in nature, offers successive *enrollments* for farmers, with each choice to enroll defining and refining the farmer's role and depth of commitment. The more farmers commit to the technologies and practices of the network, the more difficult it becomes for them to extricate themselves from it even if they want to. Farmers' participation in industrial agriculture networks has changed the kinds of knowledge and expertise they value. They have had to become consumers of others' expert knowledge (crop consultants, seed and equipment dealers, and chemical distributors) with the goal of maximizing the yields of their farms. This strategy satisfies the farmers' need for income and at the same time supports the needs and goals of other network members by supplying an abundant supply of cheap grain and providing a market for the makers of industrial agricultural technology.

Farmers' engagement with the actor-network is not undertaken blindly. Although all of the farmers in our sample have lived and worked in a for-profit agricultural environment, they have witnessed and contributed to radical changes to their farming practices and communities because of the strength and persistence of the industrial agricultural network. The changes have not always been well received or remained uncontested. Discourses about community, self-reliance, and stewardship challenge the roles that the actor-network assigns to farmers, but industrial agricultural technologies and practices entrench their commitments. These periodic role reassessments can be sources of tension for the farmers with whom we spoke.

We also explain farmers' commitment to unsustainable practices as a result of short-term economic imperatives that exist in tension with their felt obligations to the future. Farmers enthusiastically use technologies that promise to increase their yields or reduce physical demands, but these technologies only achieve these goals within a narrow production paradigm. Farmers' choices are further restricted because the agriculture industry is dominated by a handful of actors that offer a limited set of options. Farmers' commitments to particular practices, and subsequent domination by other actors in the network, create a situation in which the majority of the value generated by farmers' land and labor is captured by other actors. Yet, even within the terms of this network, participating farmers have judged their returns within the network to be greater than the returns they could expect outside of it. After all, farmers have an abundance of empirical evidence that industrial agricultural technology produces high yields and profits. The benefits of participation in the network are not without costs, however. Producers struggle with declining communities, unresolved tensions between idealized discourses and practices of good farming, and degraded environments.

This production paradigm is neither static, unidirectional, nor sustainable for anyone in it. Some farmers in our study have returned to tillage practices to combat herbicide-resistant weeds. Tillage increases erosion and moisture loss, and reduces soil organic carbon (Patzek 2008:7), reversing the gains of no-till agriculture and leading some to return to periodic fallowing. Equipment manufacturers, dependent on a stable if not growing market, must persuade farmers to replace existing machines with new ones by manufacturing needs through the threat of competition and the promise of greater efficiency. The concentration of land in fewer hands and agricultural mechanization have reduced employment opportunities, lowered property tax revenues that support city services and schools, and produced outmigration from rural Kansas. Seed companies, too, are already genetically modifying crops that are resistant to 2,4-D in preparation for the day when glyphosate is no longer an effective herbicide. As more pesticides and fertilizers are needed to support crop yields, the pollution of water resources and other natural areas will increase. Water scarcity, caused by climate change and aquifer depletion, is already a serious problem, especially in western Kansas agriculture. According to Donald Worster, an environmental historian at the University of Kansas, "We can't sustain the level of [irrigated] agriculture we have now in the Great Plains. The best we can do is to try to transition to the dryland farming economy of the past—or something like that" (Hovey 2012).

We are not arguing for a return to an idealized agrarian past. Indeed, Julie Guthman (2004:174) notes that the agrarian imaginary is not without its own serious problems, which include uncritical acceptance of the gender and race relations that made the small family farm possible, the racial components of U.S. land policy, and Christian fundamentalism. Rather, through the lens of ANT, we see possibilities for the emergence of new (and sometimes discordant) voices in the network. The farmers we met who are experimenting with cotton, grapes, and other specialty produce in response to water scarcity are such voices. They will share the results of their experiments with their neighbors and friends. If successful, other farmers may adopt the crop—as has been the case with cotton in southwest Kansas. Wes Jackson, of The Land Institute in Salina, Kansas, is another voice. In addition to advocating for a sustainable polyculture that mimics the diversity of the prairie ecology, his organization is developing sustainable, perennial versions of crops like corn, rice, and wheat. These crops have the potential to alter radically the industrial agricultural network by eroding the dominance of certain actors like seed companies.

These experiments and competing voices are important because, if they are strong enough, that is, if they are successful in creating economically viable perennial grains, alternative crops, and production practices, they can engage in their own process of *interessement* with other Kansas farmers, thus can begin a trial of strength (Latour 1987) between the competing visions of the farm. In any agricultural controversy, farmers are coveted allies because they control both the labor and the land and water resources. No agricultural idea can take root without their agreement, but there must be viable options from which they can choose.

How farmers and the rest of the industrial agricultural network resolve the tensions between short- and long-run needs has implications for the future of farming in Kansas and the sustainability of agriculture in general. Michael Bell's book, *Farming for Us All: Practical Agriculture and the Cultivation of Sustainability* (Bell 2004), offers a good discussion of how some farmers in Iowa have found a way to step off the agricultural treadmill. Looking beneath the current vision of industrial agriculture to practices that reside in memory, they are exploring alternative production strategies and finding ways to enact their values and support their communities. If such a change does not occur in western Kansas, it is possible that the ecosystem (a very important node in the network) may reject technological interventions and "make off on its own," as John Law would say (Law 1992:381).

The network-constructed farmer identity points to why farmers persist in unsustainable practices. While Kansas grain farmers maintain the rhetoric of autonomy and environmental stewardship, the economic imperative and technological transformation of production constrain their practices in ways antithetical to independence and long-term agro-ecosystem health. The prices they get for their crops have generally declined (corn is a recent exception) while the costs of inputs and machinery have increased. The use of fertilizers is necessitated by a century of intensive agriculture that has degraded the soil. Further, the mass agricultural media that farmers consume reinforce a vision of the "proper" farmer. This vision demands a set of practices that, like a *pentimento*, paint over alternatives that no longer serve or would seek to challenge the industrial agriculture paradigm—organic, small-scale production for local markets, for example. By policing the boundaries of farmer identity, the network's dominant actors reinforce farmers' roles that are critical to the functioning of the network. So influential are these actors within the network, and farmers' ideological commitment so strong, that farmers argue against interventions that diverge from conventional network practices.

We need not acquiesce to the psychology of inevitability. We can instead work to understand how the industrial agriculture actor-network influences, changes, and dominates the farmer who participates in it. We can work to deconstruct the technological fundamentalism that we believe devalues farmers' knowledge by black boxing agricultural processes and preventing farmers from changing course in the direction of a sustainable agriculture that encourages a reconnection with the land and water for both the short and long term.

Nor must we restrict our focus to the farm. ANT invites us to see how multiple and different kinds of actors create, negotiate, and reproduce networks based on shared interests. In this paper, we have shown how farmers exist as parts of larger, interdependent networks that work to sustain momentum in an unsustainable direction. By recognizing the paradigm of production as a set of interdependent practices, ideologies, and identities negotiated within actor networks, we can begin to identify ways to change course.

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Notes

1. This average reflects the length of time that our informants have managed their own farms, and does not include the experience they gained while growing up on a farm.

2. The shift away from diversified farms and to monoculture production deprived many farmers of the natural fertilizer available through applications of livestock manure. Further, some farms are so large as to make manure application impractical. Absent this farm byproduct, farmers have turned to costly synthetic inputs.

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