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How to build multifunctional agricultural landscapes in the U.S. Corn Belt: Add perennials and partnerships

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ABSTRACT

Conservation of ecosystem services in agricultural regions worldwide is foundational to, but often perceived to be in competition with, other societal outcomes, including food and energy production and thriving rural communities. To address this tension, we engaged regional leaders in agriculture, conservation, and policy from the state of Iowa (USA) in a participatory workshop and follow-up interviews. Our goal was to determine constraints to, and leverage points for, broad-scale implementation of practices that use perennial vegetation to bolster ecosystem services in agricultural landscapes. Qualitative analysis of workshop and interview data highlighted the complexity involved in achieving multi-objective societal outcomes across privately owned, working landscapes—especially as the Corn Belt region enters a period of rapid reorganization driven by the demand for bioenergy crops. These leaders indicated that initiatives focusing on perennials have the potential to span differences between conservation and agricultural interests by blurring the distinction between working lands and protected areas. Landscape change that transcends private property boundaries to accomplish this goal is dependent upon: (1) facilitation of vertical and horizontal forms of social capital between social actors from different scales and perspectives, and (2) scale appropriate mechanisms that increase the value of perennial practices for farm owners and operators. Our data highlight the adaptive capacity of regional actors to act as intermediaries to shape macro-scale markets, technologies, and policies in ways that are compatible with the needs, the capabilities, and the conservation of local human and natural resources.

Introduction

New crop markets associated with the production of biofuel stocks are driving land use change in agro ecosystems worldwide (Fargione et al., 2008; Field et al., 2008). These changes raise social and environmental concerns about how the appropriation of agricultural resources for biofuel production will effect food supplies, land clearing, loss of biodiversity, and carbon debt (Jordan et al., 2007; Groom et al., 2008; Robertson et al., 2008). Maintenance of ecosystem services and societal goods in the midst of this period of reorganization is dependent upon responsive policies that mediate the drivers and outcomes of land use at broad landscape scales. Because arable agricultural landscapes are often privately owned and operated, landscape-scale change is the product of an amalgamation of decisions by individual actors, which are in turn influenced by local social norms and networks, and macro-level markets, technologies, and policies (McCown, 2005; Atwell et al., 2009b). These policies will be driven not only by economic efficiency and ecological science, but also by social, technological, and political trajectories that are providing strong positive reinforcement of reinforcing production pathways and markets for biofuels presently made from monoculture crops such as corn-based ethanol (Carolan, 2009). Development of policies that bridge micro- and macro-level forces, and alter socio-techno-political trajectories, to protect landscape-scale outcomes is a recognized challenge in agricultural regions (Mattison and Norris, 2005; McCown, 2005).

Resilience science is an emerging approach to understanding and influencing processes of change in complex, multi-scale natural resource management systems (Gunderson and Holling, 2002; Folke et al., 2004; Walker et al., 2006). While it can be expedient to define and analyze ecological and social systems separately, resilience scientists use the term “social-ecological system” to emphasize that they are in fact linked and that such delineation is artificial and arbitrary (Berkes et al., 2003). Resilience science has received widespread attention and application among scientists and practitioners from diverse fields (Carpenter and Folke, 2006;

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Liu et al., 2007), but has not been widely implemented in regions dominated by intensive agricultural production and autonomous private property rights, such as the U.S. Corn Belt.

The term "resilience" was applied to ecological systems by Holling (1973) and refers to the ability of dynamic systems to respond to perturbations and maintain their essential configuration. Resilience is not a normative term; system configurations characterized as resilient may be either desirable or undesirable. In particular, resilience theorists are interested in understanding where resilience, adaptive capacity, and the potential for innovation reside in linked social-ecological systems and how these attributes can be gained, lost, or preserved (Walker et al., 2002). Because human values, perspectives, and collective decisions are fundamental in determining the structure, function, and desirability of social-ecological systems, resilience analyses emphasize the integration of stakeholders and policy makers in scientific and decision-making processes (Gunderson and Holling, 2002; Walker et al., 2002; Berkes et al., 2003; Allison and Hobbes, 2004, 2006).

Much of the research applying resilience theory to natural resource dilemmas has investigated how institutions and policies can bolster desired characteristics in regions with focal common pool resources and/or less autonomous private property rights than those found in the Corn Belt (e.g., developing nations; Lejano et al., 2007), fisheries (Olsson et al., 2004; Armitage et al., 2007), and regions with high proportions of government-owned land or collectively managed resources (Berkes et al., 2003; Lebel et al., 2006). One study which analyzed resilience in the Western Australian Wheat Belt, a region dominated by private land ownership and high agricultural production, found that the land use decisions of farmers were collectively driven by macro-scale markets, technologies, and institutions—forces which influenced, but were not influenced by, regionally specific factors such as population decline, environmental pollution, and resource depletion (Allison and Hobbes, 2004, 2006). This resulted in a resilient, but undesirable, system configuration (referred to as the lock-in trap) maintained by highly connected institutions and policies focused on facilitating commodity production.

Few mechanisms existed in the Western Australian agricultural system that could leverage change in response to regional social and ecological decline. For instance, rising water tables and salinization driven by land clearing for agriculture led to irreversible resource degradation, including lack of crop production, on upwards of 16% of the region's cropland. This loss of cropland coupled with decreased crop prices, higher input costs, and lower farmer profit margin, lead to increased demand for production on other lands. But because of the high degree of "sunk costs" invested in the current system trajectory, Allison and Hobbes (2004, 2006) found this system to be stuck in a trap with little potential for change. Based on their perception that regional social actors had little control over the macro-scale drivers of this system, Allison and Hobbes (2004, 2006) did not include stakeholder input in the process of resilience analysis.

In comparison to the Western Australian Wheat Belt, agricultural production systems in the U.S. Corn Belt are shaped by similar macro-level markets, technologies, and policies aimed at boosting commodity production, and are experiencing similarly complex social and ecological challenges (EWG, 2006; Keeney and Kemp, 2002). From 1950 to 2002, the portion of agricultural revenue returned to farmers decreased from 37% to 19%, while farm input costs increased sevenfold and the real price of corn (adjusted for inflation) decreased fivefold (Duffy, 2006). During this same time period land holdings have been consolidated into fewer larger farms, more land has been devoted to row crop production, average farmer age has increased, and rural population, numbers of young farmers, and social vitality have steadily decreased (USDA_NASS, 2002; Duffy, 2006). Regional increase in row crop production and loss of land in perennial cover has been associated with declines in biodiversity and flood control (Schulte et al., 2006, 2008), and has been implicated as the primary driver of nitrate export from the region's rivers (Hatfield et al., 2008), which is in turn a key driver of the growing hypoxic dead zone in the Gulf of Mexico (EPA_Science_Advisory_Board, 2007).

Despite these social and ecological deficits, and in contrast to the commodity production system in Western Australia, Corn Belt agroecosystems remain highly efficient at producing commodity crops and their derivatives. Corn and soybean yields have continued to increase over the last 50 years despite market consolidation and reorganization, dramatic changes in land tenure, pest outbreaks, and climactic variation (Duffy, 2006). This resilience in regional commodity production is a result of the Corn Belt's amenable natural resources, which include a temperate climate and deep glacial soils. The region also possesses a highly connected socioeconomic system, bolstered by large-scale equipment and practices, hybrid and genetically modified seed technologies, and external inputs of fertilizers, pesticides, herbicides, and government subsidies. The U.S. Corn Belt appears to be stuck in a trap different than that found in the Western Australian Wheat Belt. In this type of trap, which has been referred to as the rigidity trap by resilience theorists (Gunderson and Holling, 2002; Allison and Hobbes, 2004; Atwell et al., 2009b), the high adaptive potential and connectedness of social actors makes it possible to continue to invest in the current way of doing agriculture, in spite of the mounting social and ecological deficits and economic inefficiencies (Harvey, 2004), associated with this trajectory. Another body of research associated with this trajectory.

Currently, the amount of land taken out of production for conservation purposes (e.g., land enrolled in the Conservation Reserve Program) in the Corn Belt is decreasing and land in row crops is increasing in response to markets for corn-based ethanol (Secchi et al., 2008). Despite continued regional investment in high-yield commodity production, recent research highlights a growing concern among Corn Belt residents about the impacts of the emerging bioenergy economy on the environment, natural resources, and the long-term sustainability of rural landscapes (Hinkamp et al., 2007). One strategy to bolster social and ecological resilience of the Corn Belt system while maintaining agricultural profitability involves implementing networks of perennial vegetation across key portions of the landscape. Initial research suggests that strategically positioned perennial land cover (e.g., diverse crop rotations, pasture, riparian buffers, restored wetlands) on relatively small areas of the Corn Belt landscape has the potential to bolster regional water quality, biodiversity, and aesthetics (Schulte et al., 2006; Nassauer et al., 2007; Schulte et al., 2008). While studies of certain watersheds have shown that rural Corn Belt stakeholders voice tentative approval of some perennial conservation practices (Nassauer et al., 2007; Atwell et al., 2009a), these practices are neither well-integrated into rural culture (Atwell et al., 2009a), nor supported by regional policies or production systems (Atwell et al., 2009b), and rural people voiced little sense of efficacy to bring about broad-based change in their landscapes or institutions (Atwell et al., 2009a).

To address these challenges, we engaged Corn Belt leaders in agriculture, environment, and policy in a participatory workshop with the following objectives: (1) understand sources of adaptive capacity, innovation, and resilience in Corn Belt social-ecological systems, including the policy potential for perennial conservation practices, and (2) identify key roadblocks and leverage points (Meadows, 1999) to maintaining biodiversity, ecosystem services, and societal goods in the midst of the emerging bioeconomy. Because of its participatory nature, this research has the potential