Minnesota Landowners' Habitus and Interest in Perennial Energy Crops

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Chapter I: Introduction

Research Problem

Growing public concern about fossil fuels' environmental impact and its long- term sustainability as an energy source is stimulating interest in renewable energy produced from agricultural feedstock. One approach has been to produce transportation fuel (known as ethanol) from corn grain, and thus far most research and investment has gone towards this end (Hill et al. 2006) However, corn crop production considerably affects the environmental and economic sustainability of the farming sector, particularly in the Midwestern United States where the majority of corn feedstock is cultivated. For instance, corn cultivation as well of the cultivation of soybean contributes to the loss of wildlife habitat, pesticide pollution, and spread of harmful exotic species (Gibbs et al. 2009). Further, row crop producers faces serious challenges through rising input cost, pesticide resistance, soil and water degradation, and risk from climate change (Hanson et al. 2007, Zhang et al. 2007).

In response, researchers, resource professionals and farmers are considering a different approach, one that involves growing perennial plants like switchgrass (*Panicum virgatum*), *Mischantus*, native prairie,

hybrid poplar and willow as feedstock for biofuels, biopower, and bioheat production (Tilman and Hill 2006, Jordan et al. 2007, Khanna 2008). The goal of *perennial energy crop* production is to provide a combination of environmental, social and economic benefits to farmers and their communities, while also meeting society's demand for domestic alternative energy. To reach this goal perennial energy crops would need to be cultivated at key landscape positions on the farm including riparian areas; as cover crops during periods when the land is bare; on marginal land; and on land well suited for annual commercial grain crops (Jordan and Warner 2010). For illustration, perennial energy crops, which have been integrated into an annual production system, could be planted on the sloped, swampy, sandy, or hilly parts of the land where returns for annual row crops are marginal. This practice could both reduce the environmental impact of intensive farming and provide an additional source of income through the sale of the commodity to an energy buyer.

Perennial cropping systems are a relatively new farming practice in the United States (Boody et al. 2005, Schulte et al. 2006). And while a segment of farmers may be familiar with haymaking, native prairie restoration or agroforestry, few have approached the cultivation of perennial plants for energy markets as a strategic farming practice.

Currently sustainable agriculture organizations, as well as federal, state, and local agencies are advocating for perennial crop adoption because of its potential to transform industrial agricultural landscapes, yet, little is known about how perennial energy crops can be integrated into existing farming systems.

Since perennial energy crop production is outside the dominant form of industrial production, it is essential to have a good understanding of landowners' attitudes and perceptions, as well as their socioeconomic characteristics in order to influence uptake. Yet simply focusing on landowner's individual capacity is not enough. Individuals must be considered in combination with the social processes at work within farming. This research attempts to bridge that gap by using the theories of Pierre Bourdieu, who developed an analytical framework for understanding the relationship between individual agency and social structure (Bourdieu and Wacquant 1992). Specifically, I apply the concepts of habitus and field to investigate the relationship between landowners' attitudinal and structural characteristics and interest in adopting perennial energy crops. Where habitus is the internal dimension of the individual and refers to the taken-for-granted, shared meanings and behaviors utilized by individuals within a social group, and field, the

network of relationship that constrains habitus (Bourdieu and Wacquant 1992). This framework is bolstered by diffusion of innovations, which is frequently used in agricultural adoption research to explain how an innovation spreads throughout a social system.

Furthermore, specific attention is given to a structural complexity that is often overlooked—land tenure. To shed light on this I analyzed two land tenure categories: owner operators, who actively farm their land and do not rent out land, and landlords, who lease at least some of their land to another party.

The Practice of Perennial Energy Crop Production

The current land use trend in the Midwest is towards increased production of corn and soybean monocultures and reduced levels of participation in federal programs that conserve sensitive land from intensive farming methods (Secchi et al. 2008). This movement towards intensely farmed, simplified systems emerged in the 1940s and the environmental impacts of its rise have been well documented (see McLaughlin and Mineau 1995, Tilman 1999). A prime example is the Gulf of Mexico's seasonal hypoxia that is triggered primarily from chemical fertilizers that have been applied to row crops in the Midwest and have been transported to the Gulf via the Mississippi River (Donner and Kucharik 2008). Moreover, monoculture

cultivation has been shown to impair water quality through sedimentation and runoff of nutrients and pesticides; increase the risk of flooding and groundwater depletion through hydrologic modifications; facilitate the loss of terrestrial and aquatic wildlife habitat; and pollute local air with odors, pesticides and particulates (Jordan et al. 2007).

Recent inquiry suggests that the practice of perennial farming can profitably produce both marketable agricultural commodities, and currently non-marketable ecosystem services more effectively than corn-soybean production (Jordan and Warner 2010). Gantzer et al. (1990) found that loss rates of soil and nitrogen from perennial crops are less than 5 percent of those in annual crops, contributing both to a reduction in petrochemical applications and water quality impacts (McLaughlin and Walsh 1998). Additional environmental benefits of perennial production systems include their capacity to sequester more carbon in the soil than row crops, reduce soil erosion, and provide wildlife habitat (Robertson, Paul, and Harwood 2000, Wilson 2007).

The social benefits of an emerging bioenergy economy are also of significance. Researchers have noted that perennial systems may give small farms a competitive advantage in supplying the market with

bioenergy feedstock, conceivably contributing to the social resiliency of farm communities (in Jordan and Warner 2010).

Incentives for Adoption

Federal and state government is active in stimulating the bioenergy economy. In 2007 Congress passed the Energy Independence and Security Act. The Act imposed a renewable fuel standard (RFS) that mandates domestic production of 36 billion gallons of ethanol by 2022 with 16 billion gallons supplied from cellulosic feedstock. The state of Minnesota is also encouraging the development of biofuel. Currently state law requires that all gasoline sold in the state contain at least 10 percent ethanol. Beginning in 2015 all gasoline sold in the state is to contain 5 percent blend of cellulosic ethanol (Becker et al. 2009).

Renewable Portfolio Standards (RPS) is yet another type of state mandate boosting demand for agricultural feedstock. Most state RPS require utility companies to supply a certain percentage of electricity from renewable sources. Nearly two-thirds of states across the country have ratified a RPS. In Minnesota the RPS was updated in 2007 and mandates that 25 percent of a utilities total retail electricity sales come from renewable sources by 2025. For the largest utility, Xcel Energy, the mandate is 30 percent by 2020 (Becker et al. 2009).

Lastly, in 2008 Congress established the Biomass Crop Assistance Program (BCAP) in the energy title of the Food, Conservation, and Energy Act. BCAP established two programs: one supporting the development of new bioenergy sources in special project areas and the other providing matching payments for the collection, harvest, storage, and transportation (CHST) of existing sources of biomass. The most recent rule (7 CFR Part 1450, September 2011) allocates $112 million dollars to support the production of new crops for bioenergy and bio-based products by providing establishment and annual payments to agricultural and forest landowners. Since its inception BCAP has provided more than a billion dollars worth of incentives (Farm Service Agency 2012).

Theoretical Background: Field

According to Bourdieu's theory of practice, fields are networks of historical and current *objective* relations that are anchored in and give value to capital. Over time fields develop through a process of differentiation to become semi-autonomous and increasingly more specialized. After formation fields tend to follow a set of mostly implicit "rules" thereby producing a certain degree of internal homogeneity (Benson 2006). Central to the concept of field is the emphasis on social relations rather than individuals or social structures (Vandenberghe 1999). According to

DiMaggio (1979), "field refers to both the totality of actors and organizations involved in an arena of social or cultural production and the dynamic relationships among them."

Actors who have a stake in the operation of a field take the objective positions within it. For example, both a corporate CEO and a union representative have a stake in the operation of labor rights. The position of an individual in relation to others in the field is based on one's access and control over the species of capital relevant to the field. For the CEO it may be having enough economic capital to finance a congressional lobbyist. For the union representative it may be having enough social capital to get union members to strike.

Bourdieu highlights four species of capital: economic, social, cultural and symbolic. Economic capital is the command over economic resources such as money and assets. Social capital is based on durable networks of more or less institutionalized relationships such as membership in a group. Cultural capital, which could also be called informational capital, consists of any knowledge, experiences, or connections that an individual acquired throughout life. Finally, symbolic capital is the resources available to someone based on honor, prestige, or social recognition (Bourdieu and Wacquant 1992).

Bourdieu asserts that fields are spaces of constant competition and antagonism as actors attempt to dominate the species of capital that is most effective in that particular field (Vandenberghe 1999). While actors in a field may have a number of strategies they can use to increase or conserve their capital, they can also *transform* the rules of the game or more aptly, the structure of relations of forces that is constitutive of the field (Bourdieu and Wacquant 1992). The positions individuals occupy are determined by an agent's habitus, which can be strategically transformed in order to sustain or alter their distinction from other agents within the field (King 2010). As Bourdieu (1998) writes,

> "A field is a microcosm set within the macrocosm—"it obeys its own laws"—and thus what happens in it cannot be understood by looking only at external factors."

The "Field" of Farming

To participate in the field of farming social actors depend on the objective relations they have with other actors in the field. These actors have differing access to capital, and often, antagonistic motivations. The objective relations between social actors give shape to the field and arguably, over time, have fortified its specialization. Raedeke et al. (2003) identified economic relations, family relations and rental relations as essential elements in the field of farming. I use these three key relationships

to describe the current state of industrial agriculture and highlight the field's key aspects.

Economic Relations

Following the Great Depression the federal government positioned itself as a driving force in the allocation of economic capital. Seeking to stabilize the countryside Congress had passed the Agricultural Adjustment Act of 1933. The intent of the Act was to bolster crop prices by setting up a system of price supports and acreage reduction programs applicable to only a few major commodities. The Act also created distortions in the market by shifting crop sales away from the open market towards contract sales. This set of policy interventions gave birth to modern agricultural policy (Cain and Lovejoy 2004) and the Act's central features—commodity specificity and a focus on income support—are basic elements of current farm policy.

Landowners' relationship to governmental institutions can directly affect their access to capital and markets. By responding to government incentives landowners may enroll in programs that dictate which commodities are grown, at what quantity, and for which markets. Scholars argue that financial support of only a handful of crops has resulted in the loss of farm diversification as landowners limit risk by

growing government-supported commodities (Fleming 1987). These relationships can also push landowners to adopt management practices that have non-monetary benefits. A prime example is the Conservation Reserve Program, which pays landowners to remove land from production for 10 years and convert the land to native plant species, delivering water quality, soil erosion, and wildlife habitat benefits.

Globalized commodity chains are yet another economic link that exerts substantial power in the field. Global markets first impacted agriculture in the early 1900s. Fueled by the steam engine and the telegraph new export markets abroad brought up commodity prices and helped usher in the "Golden Age" of American agriculture (Dimitri, Effland, and Conklin 2005). However the prosperity did not last, and by 1930 open market access subsided as farmers looked to ward off competition. The United States then entered a period of protectionism that lasted until the 1960s.

Farmers and landowners in the field of farming are now intricately connected not only to domestic demands and national policy interventions, but also to the demands and needs of other countries. In 2011 the United States stood as the largest producer and exporter of corn, with exports accounting for 15 percent of domestic demand and billions

of dollars worth of economic activity (Economic Research Service 2009). Given favorable prices and increasing international demand, the US is expected to plant 95.9 million acres in corn during 2012, with Minnesota expected to grow 8.7 million acres, the highest since the Great Depression (Hughlett 2012).

One of the more significant changes to occur to the field of farming is the influence of chemical and biological input industries. From the 1920s to the 1950s farmers made the transition from animal labor to the petroleum fuel tractors. During this time they also began to adopt relatively inexpensive chemical inputs that resulted in significantly higher yields and greater efficiency. Most commonly adopted have been herbicides. In 1970 only 40 percent of corn acreage was treated with herbicides. In 2010 98 percent of acres planted in corn were treated. Farmers applied 50.4 million pounds of pesticides to their corn and soybean crop in 1964; by 2004 this reached 162.1 million pounds (Economic Research Service 2005). In 2007 the Environmental Protection Agency estimates expenditures for pesticides in the agriculture sector reached nearly $8 billion dollars (Grube et al. 2007).

In 1990s another transformation came to the field as farmers began to adopt seeds that had their genes recombined to express agronomically

desirable traits. Known as GMs seeds, these new seeds reduced the crops reliance on pesticides. A prime example is Monsanto Roundup Ready soybeans. Roundup Ready soybeans have been re-engineered to resist the active ingredient in Monsanto's pesticide Roundup, glyphosate, resulting in increased pesticide effectiveness and increased yields (McHughen 2000). The utilization of GM seeds has burgeoned since their first market appearance in 1996. Ninety percent of soybean fields and 70 percent of corn and cotton fields in the U.S. were planted with Roundup Ready varieties in 2010 (Neuman and Pollock 2010).

The success of GM seeds and their widespread adoption has actively structured the field. Following the agricultural input industry success with GM seeds came industry consolidation. Between 1995 and 1998, just 6 firms acquired 68 seed companies. Consolidation and farmers reliance on GM seeds limits the number of actors in the field, particularly for grain producers. Further, seed companies have acquired a patent for their products, and farmers are legally restricted from saving GM seed. Consequently, farmers must purchase seed each year. Many suggest that this has given the input industry significant power over farmers and their production choices (Fernandez-Cornejo 2004).

Social and Rental Relations

At the beginning of the 20th century more than one in every three American lived on a farm. By century's end, only 2 percent of the American population lived on farms and amongst the remaining few, 90 percent of household income came from non-farming sources. A substantial release of agricultural labor came between 1940 and 1980 when the farm population declined tenfold, the number of farms declined by more than half, and the average acreage more than doubled (Lobao and Meyer 2001).

A consequence of farm consolidation and shift in livelihood strategy towards non-farming occupations has been increased absenteeism. According to the 2007 Census of Agriculture, 38 percent of U.S. farms are rented (USDA 2007). Land tenancy rates are higher in the Midwest—in Iowa for example, 50 percent of agricultural land is rented with 21 percent of landlords living outside the state (Arbuckle 2010). Also characteristic of the Midwest is that land is frequently tied up in intergenerational land transfers, and that the heirs frequently maintain ownership but allow an operator to lease the land in exchange for cash rent (Salamon 1993). It has been documented that land consolidation along with high land

values create significant barriers for beginning farmers and many must resort to renting.

One of the primary causes of consolidation and high land values is owed to agriculture's proliferating economies of scale. According to the 2007 Agriculture Census, 90 percent of American farms are small family farms with profits less than $250,000 dollars a year; yet, they only produce a modest 25 percent of production value. The majority of value, 75 percent, originates from large-scale family farms and non-family farms, which account for only 10 percent of U.S. farms (Hoppe et al. 2007). A USDA commission reported that annual gross farm sales below $250,000 cannot adequately support a family, and that survival of farms below that size are "most endangered" (Sommer et al. 1998). Fraser (2004) notes that there is an increase demand for land that is leading to extra "thin" profit margins as farmers drive up rents through competing bids. This often leaves only operators with the most economic capital able to secure access to rental land.

Summary and Research Objectives

Rural farmscapes in the Midwest have undergone significant economic, social, and environmental transformation over the last century. At the core has been the loss of agricultural diversity and population (Lobao and

Meyer 2001, Jordan and Warner 2010). Prior to the 1940s Midwestern farms were family-owned and operated. They kept a variety of crops on rotation including corn, oats, hay and even flax while also raising livestock in lots and pastures. But the Corn Belt was remade following the Great Depression as technology and capital diffused the social and physical landscape. Farmers purchased tractors, adopted hybrid varieties of seed, and began using chemical inputs. Having little semblance of the 1940s, the modern day Midwestern landscape is characterized by large farms, monocultures of corn and soybean, and a small population.

Farmers and their communities have also been restructured in the process. Fewer and fewer farmers have come to work the land, and for those who stay many need to find work off-the-farm to sustain themselves and their family. To maintain profitability or enter the market, many farmers have to rent land, further complicating land management decisions. It is within this field that perennial energy crop adoption will need to emerge.

Bourdieu portrays social fields, like the field of farming, as competitive, with individuals constantly vying for the resources (capital) essential to remain a participant. Amidst the conflict, individuals have the capacity to conserve or transform the field through one's habitus. Habitus is internal to

the individual and refers to the taken-for-granted, shared meanings and behaviors utilized by individuals within a social group (Bourdieu and Wacquant 1992). In contrast to economic theory of human behavior, which assumes that individuals try to maximize their perceived utilities i.e. the value of a given short term gain, habitus follows a practical logic, which is preobjective and imprecise. Habitus emphasizes the embodiment of behaviors, preferences, and attitudes that people acquire throughout their lives, with little calculation of their future cost and benefits. Thus, it is only through the transformation of landowners' habitus will the field of farming be restructured to accommodate the production of perennial energy crops and a new bioenergy economy.

To investigate the potential for perennial energy crops adoption I assessed Minnesota landowners to answer the following questions: 1) What is the relationship between agricultural landowners' attitudes, perceptions, habitus (internal structure), and interest in perennial energy crops? And 2) How do perennial energy crops fit within the field of farming as currently practiced?

My specific ***research objectives*** are:

1. Characterize the relationship between attitudes and perceptions, and habitus (internal structure) of agricultural landowners in two land tenure categories—owner operator and landlords.

2. Measure the relationship between attitudes and perceptions, structural characteristics and interest in perennial energy crops.

3. To empirically investigate the relationship between the hypothesized factors and interest in perennial energy crops.

Chapter II: *Literature Review*

Agricultural Innovation Uptake

For decades public and private interests have attempted to influence farmers' land management choices; choices that affect the provision of food, fiber, fodder, and more recently, energy. Consequently, farmers are frequently introduced to practices that have the potential to bolster profits, reduce farming's impact on the environment, and change the structure and viability of rural communities. For some practices such as conservation tillage, hybrid seed cultivation, and corn ethanol production adoption has been both rapid and widespread (Ryan and Gross 1943, Stonehouse 1997). For others, particularly conservation practices such as riparian buffers, contour stripping, and habitat preservation—practices with little or no market value—adoption has been less predictable and limited.

Presently landowners are being introduced to the practice of growing perennial grasses and short rotation woody crops (agroforestry) for alternative energy markets. This new practice is a radical departure from the practice of growing monoculture row crops. And for that reason it is of value for natural resource practitioners promulgating adoption to understand the challenges and opportunities that lie ahead. However,

research investigating the factors that influence agricultural landowners' interest in perennial energy crops or about how they might fit within landowners' current suite of practices is scarce.

The intent of this study is to fill that gap. To accomplish this I engage with several bodies of literature concerning diffusion of innovations, practical theory and rural sociology. Traditionally adoption studies have utilized diffusion of innovations theory to explore how an agricultural innovation spreads throughout a social system. For this research I use diffusion of innovations as an entry point into the vast body of adoption research, but my analysis focuses primarily on Bourdieu's concepts of habitus and field. I also engage research in rural sociology to examine the complexities of land tenure and its impact on adoption. I synthesize these bodies of literature into a conceptual model of landowner interest in perennial energy crops.

Diffusion of Innovations and Practical Theory

Diffusion of innovations, which was most notably articulated by Everett Rogers, is a theoretical model used extensively in agricultural adoption research. According to Rogers (2003), diffusion is "the process in which an innovation is communicated through certain channels over time among members of a social system." An innovation can take on a variety of

forms—such as an idea, practice, or object—and typically demonstrates an alternative way to solve a problem (Rogers 2003).

One conceptual emphasis of the diffusion model is the categorization of an innovation's perceived attributes. Rogers identified them as an innovation's relative advantage, compatibility, complexity, triability, and observability. Relative advantage "is the degree to which an innovation is perceived as better than the idea it supersedes" and is typically the first consideration for landowners when deliberating adoption. Related concerns include input cost, uncertainty of profitability and markets, and conflicts with farm program policies (Rodriguez et al. 2008). In addition to economics, adoption is hindered by its compatibility with sociocultural values and norms, land tenure, labor availability, and the need for farm diversification. Explicitly, compatibility "is the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters." Complexity is the degree to which an innovation is perceived as difficult to understand. In agriculture, diffusion networks reduce the complexity of new technologies by providing assistance and information on cultivation, harvesting, and marketing (Lubell and Fulton 2007). Triability "is the degree to which an innovation may be experimented with on a limited basis." Ryan and Gross

(1949) showed that triability was positively associated with adoption of hybrid corn as farmers first experimented with the new seed on a portion of their land before committing all their acres. Finally, observability is "the degree to which the results of an innovation are visible to others." Observability has been shown to be positively associated with adoption of conservation practices (Reimer, Weinkauf, and Prokopy 2012).

Diffusion of innovations theory is commonly critiqued for its emphasis on rational choice and individual agency. Rational choice assumes that individuals are capable of deciphering and weighing all the cost and benefits of an action before making a choice. Foundational to rational choice theory is the assumption that societal behaviors and social change are the result of individual actions.

Nowak (1987) addressed the tendency toward rational choice approaches in his seminal study of conservation technology adoption. Nowak responded to Pampel and van Ess (1977) who argued that the costs of most conservation practices exceed the benefits in both the short- and long-term. Therefore, they contend, it is the expectation that a farmer is to bear the cost of an ambiguous, long-term goal that causes most farmers to reject an innovation. Buttel and Swanson (1986) explain, "farmers are able to externalize most of the cost of soil erosion and runoff

so that the incentive for environmentally sound resource management is further weakened" (in Nowak 1987). Nowak tested whether economic, ecological, and informational factors explained adoption of both profitable practices (such as conservation tillage) and unprofitable conservation practices (such as contour planting, strip cropping, grass waterways, and filter or buffer strips). He found that informational and economic factors were important in adoption of both profitable and unprofitable conservation practices, concluding:

> *"The decision processes surrounding the adoption of conservation technologies have a strong economic dimension. Yet what farmers should do according to economic theory is not the same as what farmers actually do in adopting a new technology. Therefore, instead of stopping with the legitimate claim deduction that economics are important in the adoption of conservation practices, we must go on to the equally important task of explaining the variability among farmers in terms of their pursuing conservation objectives."*

The upshot of a rational choice perspective and adoption literature's emphasis on farmers' economic assets is that it bundles landowners into a homogenous group and ignores both the internal complexities of an individual's social world, and the structuring potency of external factors. Modern sociological theorists refer to this as excessive methodological

individualism, or "the claim that social phenomena must be explained by showing how they result from individuals actions" (Postill 2010).

The sociological literature offers a different approach known as practice theory. Practice theory seeks to find a middle ground between agency—the ability for social actors to make their own choices—and structure—the patterned social arrangements that form society, which to some degree, influence the actions of social actors. For practice theorist the human body is the point of engagement with the world. And these engagements take form in social actor's daily practices such as cooking, cleaning, driving a car, or tending a garden. From this perspective, the social practice itself is the unit of sociological analysis. Giddens (1984) observed that:

> *"the basic domain of study of the social sciences . . . is neither the experience of the individual actor, nor the existence of any form of societal totality, but social practices ordered across space and time."*

A chief inference of practice theory is that the core source of behavioral change lies in the development of new practices (Warde 2005). With practice theory as a guiding theoretical framework the product of adopting a new practice is that the practice itself becomes embedded in, and a part of, the normal ways of life. While this may be

the product of adoption irrespective of theory, what practice theory does is remove the individual from the spotlight. Instead, individuals are carriers of social practices.

French sociologist Pierre Bourdieu developed the concepts of habitus and field to understand social practices. Habitus and field are intermediary frameworks used to analyze objective social structures, the internalization of those objective structures in the human body, and the structuring potency of social actor's agency. Bourdieu attempts to merge two divergent sociological theories. One lineage emphasizes individuals' response to external factors such as social or economic conditions. The other emphasizes individuals' responses to internal factors such as intentions. For Bourdieu, "the body is in the social world but the social world is the body" (Bourdieu and Wacquant 1992).

Habitus

According to Bourdieu habitus is the embodiment of particular dispositions and schemas that individuals acquire from the experience of living in society (Costa 2006). It is "a system of lasting and transposable dispositions which, integrating past experiences, functions at every moment as a matrix of perceptions, appreciations, and actions and makes possible the achievement of infinitely diversified tasks" (Bourdieu 1977).

Bourdieu made a concerted effort to separate his theory from that of rational choice theory. Rational choice theory assumes that social agents objectively deliberate their options for achieving a specified goal, have full information on the cost and benefits of their options, and then, make a rational choice regarding the most appropriate course of action. Bourdieu argues that this conception of rationality "ignores the individual and collective history of agents through which the structures of preference inhabit them are constituted in a complex temporal dialectic with the objective structures that produced them and which they tend to reproduce" (Bourdieu and Wacquant 1992). Consequently, for Bourdieu a social agent does not use rationality when making decisions, but uses a "practical sense" which may be imprecise, preobjective and fuzzy.

To illustrate this concept Bourdieu commonly used a sports analogy, for which, habitus is akin to the "feel" or sense of the game that enables a player to perform. For another example, take a corn producer, working within the field of production agriculture. The habitus of farming that she has come to embody through her years in the field allows her to work the tractor, till the land, and determine irrigation levels without an internal narration of her every move. Instead, she is a "virtuoso" who is not dominated by abstract rules and principles, but who knows the script so

well she can improvise and creatively negotiate her social life (Bourdieu 1977).

There are two notions about habitus that are crucial to understand. First, habitus derives directly from an individual's socioeconomic or structural position such as gender, race, ethnicity, class and/or occupation. Hence, throughout life's course social agents unconsciously internalize their objective social reality, such as their economic class, thereby developing the taste and performing the practices that are appropriate for that social position. This internalization results in a match between one's habitus and field, and comes to inform an agent's attitudes, values, perceptions, and dispositions in ways in which the agent is rarely aware. Bourdieu famously used this notion to show how socially dominated individuals, such as women and minorities, adopt and continually reinforce their oppression (King 2000).

The second notion is that despite this internalization of unconscious schemas, habitus is not immutable. In Bourdieu's practical theory, social structures do not exist independent of social relations between individuals. Even if individuals are not seeking to alter their relations, each interaction between individuals builds upon previous interactions, thereby, subtly transforming the meaning of past interactions, and therefore, the

relationship itself. Although constrained by cultural conditioning and structural realities, it is through these interactions that habitus is still open for innovation and creativity. As a result, habitus can be re-orientated when an individual is confronted with a new situation different from the habitus produced by history, but also when an individual seeks to create, transform, or conserve their position within a field.

Combining Theories

While Bourdieu provides a framework for understanding the relationship between the individual, their everyday realities and the external social structure that the individual operates within, diffusion of innovations offers a way of understanding the myriad factors that affect the adoption (or non-adoption) of a new practice. The distinction between the two theories is that Bourdieu's theory of practice moves away from placing the onus of adoption on the individual, and instead appreciates the various social relations, material infrastructure, and "rules of the game" in which an individual performs their habitus. Investigating the issue of adoption by combing both frameworks allows the richness of the adoption research that uses diffusion of innovations to inform hypothesis articulation, while practical theory offers insight into how making and breaking the links between habitus and field can occur, either as a social

agent contests and resists routines and conventions or as different practices from the outside come into contact with each other.

Internal Structure

Internal structure is the embodied structures (habitus) that a social actor has acquired throughout the life course. Although not recognized as such countless adoption studies have used internal structure in their analyses. Common internal structural variables include economic capital, social-psychological variables, and cultural and social relationships (Clearfield and Osgood 1993, Shucksmith 1993, Pattanayak et al. 2003). For this study several discrete variables were hypothesized to be of significance when describing interest in perennial energy crops including: attitudes and perceptions, goals and plans, time, age, social history, program participation, economics and risk, and land tenure. These dimensions were selected based on a review of primarily adoption research, and serve as an entry point into the habitus of landowners in southern Minnesota and their potential relationship to the new practice. What follows is a discussion of the literature concerning these variables, a conceptual model incorporating Rogers' categories and Bourdieu's field and habitus, and a set of hypothesis based on the review of the literature.

Attitudes and Perceptions

Attitudes can be conceptualized as a summary evaluation of a psychological object, where the object may be a person, idea, concept, or physical entity captured in such attribute dimensions as good-bad, harmful-beneficial, pleasant-unpleasant, and likable-dislikable (Ajzen 2001). The combination of one's values and the psychological evaluation of an object is what sustain an attitude. For example, if a farmer believes she is to be a steward of the land, values farming as a way of life, and "rather than controlling nature, [feels she] need[s] to learn to co-exist with the natural environment," that farmer may hold a positive attitude towards a conservation practice such as riparian buffers (Willock et al. 1999, Fairweather and Campbell 2003).

The degree to which environmental behavior is influenced by attitudes has been extensively explored in the sociological literature. Many authors have found that attitudes do not directly predict environmental behavior, but are mediated by structural variables such as time and income (Willock et al. 1999, Best 2010). Best's (2010) research on organic farm adoption offers several ways to conceptualize the relationship between environmental concern and adoption. Best's results show that farmers with high environmental concern perceive the decision

to adopt differently than farmers with low environmental concern. And, as environmental concern rose, preferences for outcomes that benefit the environment increased. The research also shows that environmental concern directly effects the adoption decision when there is an economic cost, but if adoption of organic agricultural was economically attractive, a farmer's environmental attitude was irrelevant to the decision. Other studies have shown that demographic factors influence environmental concern. For example, higher levels of education have been directly linked with positive environmental attitudes (Christianson and Arcury 1992, Wu and Babcock 1998). Further, females are more likely to hold environmental attitudes that positively influences conservation adoption (Feldman and Welsh 1995, Aboub, Sofranko, and Ndiake 1996).

A recent study conducted by Nassauer et al. (2011) reveals the connection between perennial farming practices and stewardship attitudes. After the researchers showed a group of farmers from Iowa photos of future landscapes that included scenarios with perennial farming practices and others with traditional row crops, farmers designated scenarios that included perennials as exhibiting good stewardship, whereas landscapes with row crop production were identified as having poor soil quality. When asked to rank a series of

photos according to the best scenarios for the next 25 years, the same farmers consistently chose landscapes that used perennial farm practices to maximize water quality and biodiversity.

Nassauer et al. are not the only researchers to expose a connection between stewardship attitudes and conservation. Several research studies have shown that a stewardship attitude influences farmer's land management decisions which some times lead to the adoption of soil conservation, minimum tillage practices, and conservation easements (Ryan et al. 2003). Yet, others have demonstrated that possessing stewardship concerns does not always lead to behavioral change (Wicker 1969).

So what is a stewardship attitude? According to agricultural research, stewardship is commonly associated with an attitude of care for the land, rural people, and rural lifestyles (Ahnstrom et al. 2009, Atwell et al. 2009a). One reason reseach sometimes fails to discover a link between conservation practice adoption and stewardship can be attributed to the fact that stewardship is socially constructed. What landowners consider the "right thing to do" or "a good management practice" depends on their unique situation, their land, their goals, their access to capital, their

values, and the values of their family and peers (Burton 2004, Vanclay 2004).

Goals and Plans

At the core, farming is a social activity; it is about people, identities, and livelihoods. Farmers and farm families are diverse, with different levels of social, economic, and cultural capital and different goals and plans for the future. Makeham and Malcolm (1993) found to survive and grow; to farm well and be recognized for this; to acquire extra land or to control a larger business for the future and for heirs to have a satisfying rural way of life; and to have enough money to pursue non-farm interests to be common goals within farming communities. Given such a diversity of goals and unique reasons for participating in the field of farming, many innovations simply do not match the landowners' needs and desires. Klapproth and Johnson (in Kabii and Horwitz 2006) concluded that landowners are more likely to accept an innovation or practice when they viewed it as profitable, simple to implement, and compatible with their goals and objectives for the land. Nevertheless, knowledge and awareness about a practice aids landowners' evaluation of the fit between their goals and the cost and benefits of the practice (Rogers 2003).

Specific conservation-related goals and plans have been connected to farming orientation, Farming orientation is frequently categorized according to a spectrum, with environmental orientation on one side and business orientation on the other (Nowak and Korsching 1998, Willock et al. 1999, Petrzelka 2011). Salamon et al. (1997) discovered that families who had adopted sustainable farming practices frequently had strong environmentalist traditions or stewardship perspectives that influenced their adoption decisions. Arbuckle et al. (2009) found that non-operator landowners with closer ties to farming and stronger financial motivations for landownership were less interested in agroforestry. Raedeke et al. (2003) similarly showed that farmers with a "conventional" orientation towards farming were more doubtful of agroforestry practices.

A strong organizing goal in farming is the desire to preserve farming and rural lifestyles (Fink 1986, Atwell, Schulte, and Westfal 2009a). Neumann et al. (2007) posits that these aspirations converge with conservation when a family operation has a strong intergenerational connection, as farmers are less likely to damage land they hope will be farmed by their kin.

Time and Skills

If a landowner decides to adopt and implement a new practice it is possible they will have to learn practice specific skills. Cooperative Extension has traditionally played the role of transferring scientific knowledge and management skills to landowners, enabling them to take advantage of new practices and economic opportunities. In addition to expert driven knowledge transfer, landowners also learn new skills and acquire information through private and civic organizations including input companies, commodity groups, and issues organizations. Still, many farmers simply learn informally from one another, while at a local diner or seed store. Whatever a landowner's connectedness to these diffusion networks, uptake of an innovation or management practice requires a certain amount of time and effort (Lubell and Fulton 2007). The amount of time and effort needed is of course dependent on myriad factors, including one's age, work/life demands, connectedness to sources of knowledge, and own curiosity and tenacity.

Age

Between the 1940s and 1960s, the farming sector saw a rapid consolidation of farms and release of labor to non-agricultural work. The trend, which is known as outmigration, continues today as young adults

continue to migrate out of rural areas for non-farming careers (Gale 2002). According to 2007 US Census, the average age of a farm operator is fifty-seven. Further, the number of operators 75 years and older grew by 20 percent between 2002 and 2007, while the number of operators under 25 years of age decreased 30 percent. While outmigration is undoubtedly influencing the trend towards a "graying" farm sector, Gale (2002) argues that it is older farmers leaving farming at a slower rate that is the cause of the aging trend.

The trends of aging and outmigration pose a challenge for facilitating adoption. Older farmers may have the depth of knowledge and experience that allows they to maintain in the field of farming, but may lack the mutability of habitus that could facilitate adoption. Further, older landowners' economic capital may be tied up in rental relations. There is evidence that many older landowners are dependent on rental income making them less willing to suggest their tenant adopt a new practice (Carolan 2005, Petrezela and Marquart-Pyatt 2011).

Further, for practices with long lags between investment and payoff, older landowners who do not have an heir, and for which the benefits of adoption may not be fully reflected in the sale price, may forgo making the investment (Pannell 2006). McDonald (1999) found evidence of this

reaction in the coastal plains of North Carolina. McDonald documented that older farmers refuse to invest or expand into certain, labor-intensive crops because further mechanization cost could not be amortized over the years of farming they have left. Older farmers without heirs often choose to rent their land once they could no longer farm. It has been suggested that perennial energy crops would be less labor intensive than row crop production, but the perception of this practice by an older population has yet to be investigated. Previous adoption research has used age as a predictor of agricultural adoption with equivocal success. Several studies found that older farmers were more likely to adopt no-tillage techniques, easements, while others concluded that there was no relationship between age and the use of conservation practices (Clearfield and Osgood 1986, Kabii and Horwitz 2006).

Social History and Tree Farming

Before Europeans settled the Minnesota, most of what is now considered farmland in that state's southeastern region was deciduous forest. Motivated by homesteading initiatives, generations of individuals either moved from other parts of the country or immigrated to the United States to build a livelihood in agriculture. To fulfill their ambitions new settlers had to clear the land of the elms, maples, hornbeams, ashes, and oaks that

had been making nutrient rich soils for thousands of years. Acknowledging this social history, the practice of cultivating trees as either complete replacements of traditional commodity crops (i.e. tree plantations) or as alongside traditional production (i.e. alley cropping, silvopasture, and riparian buffers) may be in opposition to the habitus and values that pervade traditional agriculture, and may even be see as a reversal of generation of progress (Neumann et al. 2007).

The cultivation of trees may also affect the economic and social position of the landowner. If energy trees are to be considered cash crops alternatives they will inevitably be compared to the two most productive Midwestern cash crops—corn and soybean. Comparatively, the economic return of tree cultivation considerably lags behind annual row crops. Landowners who consider growing energy trees may have to forgo a return on their investment for several years whereas profit from traditional row crops is reaped each year.

The southern region of Minnesota is immersed in the agricultural tradition and unlike the northern part of the state, only a small forestry industry exists. Thus, when considering adopting trees for energy landowners may be confronted with a shortage of tree equipment or a lack of knowledge on how to access it.

Program Participation

One of the more well-known and successful conservation programs is the USDA's Conservation Reserve Program (CRP). CRP (and similar programs which are often administered by nonprofits) compensates landowners for restoring and retiring environmentally sensitive farmland to native habitat (such as mixed prairie grassland). More broadly known as easements, these voluntary programs place a legally binding deed restriction on enrolled farmland, limiting its use for 10 to15 years.

Just like other conservation practices, there are myriad factors that influences landowners' decision to adopt including land tenure, age, awareness, goals, and values (Kabii and Horwitz 2006). And for those who have already adopted an easement, it can be deduced that alignment exist between those factors and the program at the time of uptake. After reviewing the literature on easement adoption, Kabii and Horwitz hypothesized that farmers who are less financially dependent on their property, are younger and do not have a long farming history, older without heirs, have a strong nature conservation ethic, perceives easements as a means to avert long term degradation thereby reducing risk, and those with higher levels of awareness and knowledge, would be more likely to adopt.

Lambert et al. (2006) modeled participation rates in CRP and found that retired farmers and residential farmers whose major occupation was not farming adopt CRP. They note that most of these landowners depended on non-farm income sources for their livelihood. Their research also revealed that there is a positive relationship between gender and adoption, with female operators more likely to enroll a larger portion of their land than male operators.

A significant sociological barrier commonly annotated in examinations of government program participation is the high level of mistrust in government in rural communities. Rural people see government as intrusive, nonsensical, and shortsighted (Atwell et al. 2009). Further, participation in government programs often require what is perceived as an excessive amount of paperwork and red tape.

Economics and Risk

Grilliches' (1960) research on hybrid corn in the United States was one of the first contributions by an economist to the innovation diffusion field. Grilliches deemed economics as the major determinant of agricultural adoption, setting the foundation for a perennial debate over the relative importance of social and economic dimensions. One aspect of

economic theory that has had significant impact on framing adoption is the concept of risk (Rogers 2003, Pannell 2006).

Greiner, Patterson and Miller (2009) define risk as the measurable and immeasurable aspects of uncertainty. Deciding to adopt an innovation is a risky choice for landowners. They must choose between alternatives that consequences are uncertain, and for which the probability of loss or gain cannot be fully known (Greiner et al. 2009). Rodriquez et al. (2008) noted that whether perceived or real, risk is often a barrier to adoption by both farmers and change agents. Risk may be attributed to delay in yields during implementation of a new farming practice, uncertainty about future market demand, mixed signals from policymakers, and uncertainty in the proper management techniques.

Shapiro et al. (1992) explored the effect of risk aversion on adoption of double cropping. They discovered that adopters were on average, more risk averse than non-adopters. Although they did find a wide range of risk preferences, what was most important in explaining adoption was their risk perceptions. That is, those who perceived double cropping to lower their risk and increase total crop revenues were more likely to adopt. Lien et al. (2004) also found that the perception of risk determines whether a farmer will adopt a new technology. Lien et al. uncovered that organic

farmers perceive themselves to be more risk averse than conventional farmers.

From the perspective of a landowner farming is the business of producing food, fiber, and fodder, at a profit. And indeed, economics is a consistent cited barrier to adoption (Rodriquez at al. 2008). Some of the primary economic concerns are: the cost of materials, concern about profitability and risk, loss of productivity, changes in labor demand, and alterations to eligibility for government subsidies. Landowners motivated solely by economic outcomes are less likely to invest in conservation and production technologies that have not yet been proven profitable. Similarly, even when conservation practices are profitable, such as conservation tillage, profitability is still dependent on a variety of factors such as soil type, topography, crop rotation, and the farmer's managerial skills and abilities (Stonehouse 1997).

Researchers have found large-scale farms to be positively correlated with conservation behavior (Nowak 1987). Operators of large farms have more flexibility in their decision-making, more access to land for adopting new practices on a trial basis, and a higher capacity to deal with uncertainty and risk. Access and reliance on off-the-farm income has also been shown to influence adoption. While off-the-farm income reduces

dependency on farm income and lends flexibility in economic capital allocation, it decreases landowner willingness to implement practices that have a greater time commitment (see Pannell et al. 2006). The willingness and ability to make long-term investments in further complicated by ownership and tenure arrangements (see Land Tenure below).

Land Tenure

Several authors have drawn attention to the paucity of studies that regard land tenure as a critical variable in understanding adoption (Gilbert and Beckley 1993, Carolan 2005). According to the 2007 Census of Agriculture, 42 percent of American farmland is rented (USDA 2007). Using counties for scale one can see that the amount of rented land varies significantly. For example, in Watonwan County in southern Minnesota, 60 percent of farmland was rented in 2007. Conversely, only 33 percent of farmland in Scott County, Minnesota was rented in 2007. The variability in land tenure across the landscape and across political jurisdictions has implications for who holds the species of capital important to adoption of perennial energy crops.

The concept of land tenure speaks to the social relations of property rights. Two of the more important rights are benefit rights and use rights. Benefit rights such as income allow owners to extricate economic benefit

from their property. Use rights may be seen as the right to make organizational and operational decisions about one's property. Thus, in a farming context, land ownership refers to organizational decisions—investment in conservation and the allocation of land for specific uses—and operational decisions—the day-to-day management. Land tenure portrays "the social divisions of property rights in land, particularly ownership claims to income and decision-making control over the land" (Gilbert and Harris 1984). Gilbert and Beckley (1993) note that while this conceptualization of tenancy is largely uncontested along with the corollary assumption, that organizational decisions precede and place limits on operational decisions, there are some disagreements regarding these assumptions when looking at rented land.

Mooney (1983) contend that landlords have a large amount of control over their tenants. According to Mooney "major (organizational) decisions, such as the quantity of any commodity to be planted/grazed or work that affects the land itself, particularly its productivity or its conservation, reside with the landowner, while day-to-day possession (operational decisions) rest with the tenant." Harvey (1982) disagreed with this supposition, asserting that there is total separation of the landlord from

control over the land wherein landlords merely become passive recipients of rent (Harvey 1982).

Gilbert and Beckley (1993) were the first to empirically test the question: "Do landlords, compared to their tenant farmers, have much control over their land?" Using a case study approach the researchers interviewed landlords and tenants from two townships in Wisconsin. The authors established that landlords and tenants both agree that operational decisions such as commodities grown, application of soil conservation practices, and participation in specific federal programs are under the control of the tenant. Thus, Gilbert and Beckley contend that instead of the dominant landlord-subordinate tenant relationship that Harris (1974) and Mooney (1983) articulated, what may be occurring is the opposite—a dominant tenant-subordinate landlord relationship. Carolan's (2005) research of landlords, tenants, and extension agents within various farming communities in Iowa found evidence towards both conclusions. Of those he studied, half of all tenants who had expressed interest in adopting sustainable agriculture feared that discussing management strategies with their landlords would potentially "rock the boat" and endanger their status as tenants. On the other hand, female landlords

exhibited self-censorship and avoided talking about alternative farming practices for fear of "scaring away good tenants."

The power relationship between landlord and tenant is further complicated by age and gender. Petrzelka and Marquart-Pyatt's (2010) study of absentee landowners in four Great Lake counties found that female landlords participate less in decision-making about farmland relative to their male counterparts. This is consistent with previous research by Rogers and Vandeman (1993). Furthermore, female landlords were significantly more likely to be older, have a greater reliance on the land as a source of income, and be a widow or retiree (Petrzelka and Marquart-Pyatt 2010). Yet, contrary to Gilbert and Beckley (1993), who suggested that ''retired farmers, small landowners, and widows'' are more likely to be in a tenant-subordinate landowner situation, Petrzelka and Marquart-Pyatt (2010) found these factors not to be significant. Several researchers discovered that female landlords, who were retired, and younger landlords, were more likely to be involved in decision-making (Petrzelka and Marquart-Pyatt 2010, Rogers and Vandeman 1993, Constance, Rikoon and Ma 1996). Further, involvement increased if the tenant was a local farmer, lived closer to the land, or rented on a crop share basis rather than cash rent basis (Rogers and Vandeman 1993).

The research tells a somewhat different story when the dynamics of conservation decision-making are analyzed. Constance et al. (1996) examined local landlords (those who lived in the same county as their land) and absentee landlords (those who lived outside the county where there land is owned) for involvement in decision-making on rented agricultural land in Missouri. The researchers found that local and absentee landlords were most likely to be involved in conservation program decisions and least likely to be involved in pesticide decisions. Petrzelka and Marquart-Pyatt (2010) discovered a similar pattern. In their study, for both male and female landlords the number of conservation practices decision they were involved in was relatively low, at 32 percent and 20 percent respectively. Female absentee landlords specifically, were less likely to be involved if they were older, had a higher financial reliance on income from the land, if they were retired, inherited the land, or the land was co-owned with a sibling. And even the more engaged younger landlords were less involved in conservation decisions when a local farmer farmed the land.

Previous research has had conflicting and inconclusive results regarding adoption of conservation practices by absentee landlords and tenants. Mercer (2004) found for agroforestry practices there is a clear link

between secure land tenure and adoption. In a review of agroforestry adoption in the tropics, Pattanayak et al. (2003) found that landowners are more likely than tenants to adopt agroforestry.

Soule et al. (2000) devised a study to determine how land tenure influences adoption of conservation practices. Earlier research suggest that activities like conservation tillage and crops residue management, which have short-term profitability from reduced labor and machinery costs, are more likely to be adopted by owner operators than tenants (Belknap and Saupe 1988; Lynne, Shonkwiler and Rola 1998). For practices such as crop rotations, stripcropping, grassed waterways, and contour farming, which are expected to produce long-term benefits but have significant short-term costs, the conventional logic suggest that secure land tenure is positively associated with adoption.

Soule et al. (2000) found evidence that cash renters and sharecroppers were less likely to adopt practices with longer investment horizons compared to owner operators, and that cash renters were also less likely to invest in practices with near term returns than owner operators and sharecroppers. This suggests that investments in certain conservation practices are positively associated with secure land tenure.

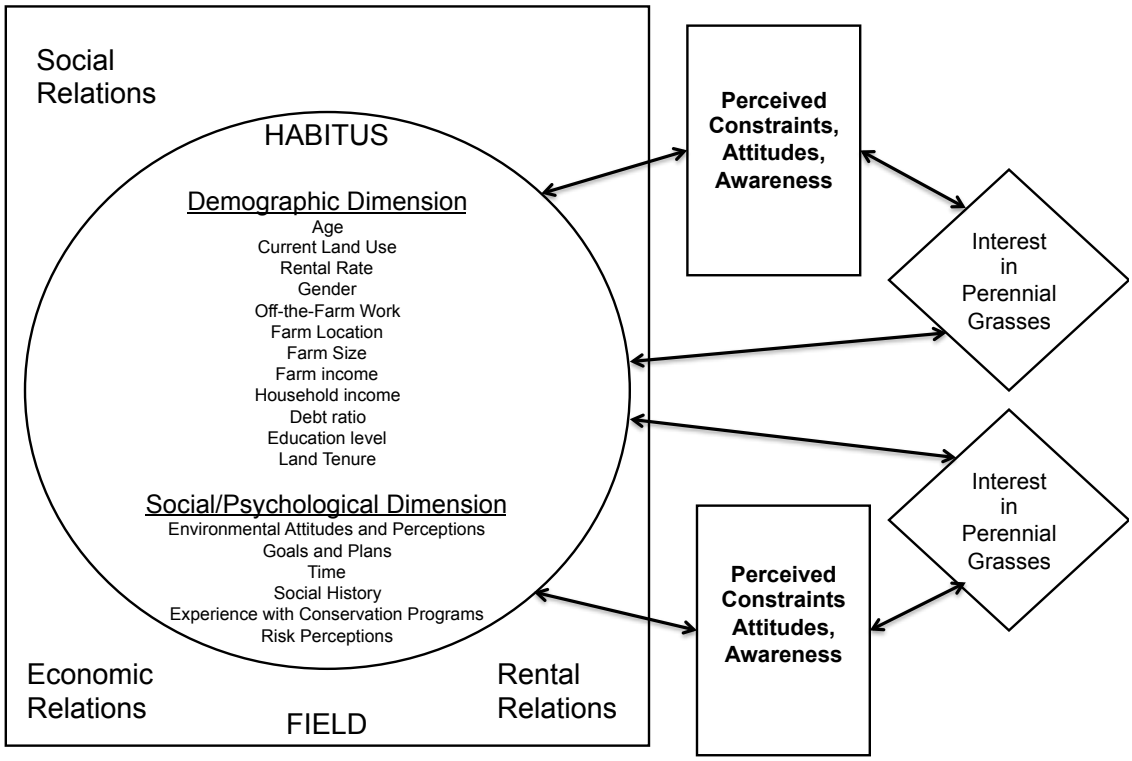
Conceptual Model:

The conceptual model I developed takes the concepts of field and habitus from practice theory and elements of Rogers' diffusion of innovations to explore the relationship between perennial energy crops and interest in adoption by Minnesota agricultural landowners. Habitus is split along two dimensions—demographic and social/psychological. The demographic dimension includes structural variables that are relatively stable such as age, gender, and income in a given period of time. The social-psychological dimension is more evaluative representing attitudes, opinions, plans, goals, feelings and memory of experience that have a variable expression, dependent on context. Within the current field of farming there is assumed to be a match between one's habitus and species of capital that allows landowners to participate in the field. When encountering a new practice, namely perennial energy crops, individual's attitudes and perceptions will be meditated by their habitus. Here, diffusions of innovations provide guidance to the ways in which an individual will evaluate a new practice, namely, through the lens of the practice's relative advantage and compatibility.

Bourdieu emphasized that habitus is not fixed and that individuals who perceive a practice as affording them a competitive advantage in the

field may consider adoption as a strategic move, one that will further their goals. It is important to note that interest and adoption will restructure the field of farming and individual habitus, varying on the types of individuals who pursue adoption. Hence, there is an inherent feedback loop between habitus, field and the new practice. There is also a relationship between individual attitudes and perception and interest, as interest may motivate landowners to seek out information to help them evaluate the fit between their habitus and the practice.

Table 2.1: Conceptual Model of Landowners' Interest in Perennial Energy Crops



Research Hypotheses

The hypotheses for this research were developed based upon the review of the literature and the conceptual model. They are tested both empirically using regression models and other statistical analyses (see Chapter III and IV).

Table 2.2: Research Hypotheses

General Hypothesis
H_a: The attitudinal and structural variables will have a significant effect on agricultural landowners' interest in perennial energy crops.
Stewardship
H_a: Agricultural landowners with a positive attitude towards stewardship are more likely to be interested in perennial energy crops.
Perennial Water
H_a: Agricultural landowners with a positive attitude towards the effect of perennial energy crops cultivation and water quality are more likely to be interested.
Recreation
H_a: Landowners who plan to use their land for recreation within the next ten years are more likely to be interested in perennial energy crops.
Time to learn new skills
H_a: Agricultural landowners who do not perceive having the time to learn new skills as a barrier are more likely to be interested in perennial energy crops.
Roots
H_a: Agricultural landowners who do not perceive having roots in tillable land as a barrier are more likely to be interested in trees.
Tree Equipment
H_a: Agricultural landowners who do not perceive having access to tree equipment as a barrier are more likely to be interested in trees.
Conservation Easements
H_a: Agricultural landowners who had or currently are participating in CRP or CRP-like programs are more likely to be interested in perennial energy crops.
Land Tenure
H_a: Landlords are more likely to be interested in perennial energy crops than owner operators.
Hay
H_a: Landowners who currently grow hay on their land will be more likely to be interested in perennial grasses.

Chapter III: *Methodology*

This research study was guided by a quantitative approach. The primary data collection tool was a self-administered mail survey. The survey was used to explore the relationship between landowners and interest in perennial energy crops, in a manner that is reliable, generalizable and useful to natural resource practitioners. This chapter provides direction to my methodological approach with a presentation of the population, sampling strategy, survey development, survey implementation, and the methods and procedures used in data analysis.

The Study Population and Sample

To model the effect habitus has on interest in perennial energy crops, a self-administered questionnaire was sent to agricultural landowners in nine southern Minnesota counties. These counties were Blue Earth, Brown, Carver, Le Sueur, Martin, Nicollet, Scott, Sibley and Watonwan. They were selected because of their proximity to potential bioenergy markets and the Minnesota River Valley, an ecologically impaired tributary of the Mississippi River. More specifically, there are two sources of potential demand, Koda Energy, a 12.5 MW all biomass burning power plant, and the Madelia project, a locally owned cooperative developing a bio-

refinery, both of whom are interested in the social availability of perennial feedstock.

The sampling frame comprised of individuals that owned 20 acres or more of land classified as agricultural for tax purposes. This information was gathered from county tax rolls obtained from county tax assessor's offices. We limited our sampling frame to include landowners with twenty acres or more to eliminate households who used their land for other purposes such as hobby farming and homesteading. Mailing address was a source of contact information and included agricultural landowners who lived both within, and outside of, the state of Minnesota. One drawback of only using county tax rolls records in the sample frame is it excludes individuals who farm but do not own the land. After aggregating the records and deleting duplicate addresses the final study population contained 13,850 unique addresses.

Mail Questionnaire

Design and Development

Our early survey drafts were solely based on a review of the agricultural adoption and economics literature. Natural resources professionals with survey design and implementation experience reviewed these first drafts. We considered their feedback, and made modifications when appropriate. We also convened two focus groups, one in Le Center,

Minnesota, and another in Saint Paul, Minnesota. Participants were recruited from Le Sueur County using county tax roll information and publicly listed phone numbers.

The focus groups were structured to follow Krueger and Casey (2000) and were co-facilitated by the author and a fellow graduate student (see Appendix I and II). Our primary goals were to gauge participant's understanding of the concepts presented in the questionnaire, determine the common perspectives of the target population, and ensure the questions were appropriately worded and sequenced. We reviewed the focus group transcripts and notes and made further adjustments to the questionnaire. The results of the focus groups further informed our survey design.

Next, 50 households were sampled and sent a draft survey as a pretest. Fifteen households responded and the appropriate modifications were made. The final survey was eight pages long with a minimum of 95 questions (see Appendix III). On average it took respondents 15 to 30 minutes to complete.

Response rate

Among the 1,000 surveys sent out only two were undeliverable. A total of 52 surveys were sent back completely blank. Five hundred and one

surveys were returned at least partially completed. The final response rate was 50.1 percent. This is comparable to Jolejole et al. (2009) study of Michigan's corn and soybean farmer's willingness to adopt environmental practices, which had a with a 56 percent response rate, and significantly higher than Jensen et al. (2007) and their survey of the willingness for Tennessee farmers to grow switchgrass, which had a 24 percent response rate.

Non-Response

A non-response bias check was conducted using analysis of variance (ANOVA) to determine whether there were significant differences in return rates based on mean parcel size and geographic location using. Non-response bias was analyzed further by comparing the differences between early respondents and late respondents (where late respondents are a proxy for non-respondents). The data was analyzed to reveal whether there were systemic patterns within the missing data, which would indicate the data is not missing at random. To address this problem, ANOVA was used to determine whether there were demographic differences between respondents who answered a survey question and those who did not answer the same question or responded "don't know". All of the above analyses were not found to be significant.

Survey Content

The survey included an informational section about perennial energy crops and four response-required sections: landowner and land use profile, attitudes and perceptions, land tenure, and landowner information.

The *landowner and land use profile* section asked for the number of acres owned, leased, rented and farmed; length of ownership; current uses of the land; average rental rate for cropland and pastureland; implementation of conservation practices; land use plans for the next ten years; and awareness of both perennial grasses and trees.

In between the first and second section was *information describing cultivation practices for perennial energy crops* and their potential benefits with respect to row crops. We strategically placed this information after the awareness question and before the interest and barrier questions. We reasoned that respondents would not be able to evaluate the potential barriers and their interest if they were unfamiliar with the practices. Furthermore, many of the respondents owned land, but did not actively farm or manage it, and therefore may have been less familiar with farming practices.

The *attitude and perception section* asked participants to rank their extent of agreement on a 4-point Likert type scale to: several general and specific attitude statements; interest in perennial energy crops; potential barriers to adoption of perennial energy crops; and four tree specific barriers. This section also included a question asking participants to rank their most preferred financial arrangement. Questions 13 and 14 were contingent valuation questions asking landowners their willingness to accept a randomly generated net income amount to grow perennials. If the respondent indicated yes, the survey asked the number of acres they would be willing to grow. The remaining questions in the section asked about the willingness to grow an invasive or noxious crop and potential area of establishment of perennial on their land. Note that questions 13-15 were specific considerations of the agricultural economist graduate student collaborating on the project and were not included in this report.

Interest was the designated dependent variable. Respondents were asked their level of interest in growing grasses and trees if financially competitive with their current land use on a 4-point Likert type scale with possible responses of: no interest, little interest, some interest and high interest.

The land tenure section targeted participants who either leased their land or had a sharecropping arrangement. The section asked about leasing arrangements; length of arrangement; familial ties; conservation practices; and landowner/tenant decision-making.

The final section asked landowners their gender; age; off-the-farm work status; farming status; land location; education; household income; farm income; and debt ratio.

For most questions, respondents had the ability to select "don't know".

Data Collection

Sampling Strategy

Once we finalized the survey's design we drew a statistically significant random sample from the sampling frame. Table 3.1 provides the equation used to obtain the minimum sample size. N_s is the complete sample size, N_p is the size of the population, p is the proportion of the population expected to choose one of the two response categories, B is the margin of error, C is the Z-score associated with the confidence level.

Table 3.1: Minimum Sample Size

$N_s = \frac{(N_p)p(1-p)}{(N_p-1)(B/C)^2 + p(1-p)}$	N_p	p	B	C
	13,850	0.50	+/- 5%	1.96 (95%)

Accordingly, the minimum sample size at a 95 percent confidence interval, with a 5 percent margin of error, was 375. Given that response rates can vary from 15-60 percent for our research population, we mailed surveys to 1,000 households.

We consulted Dillman and Smyth (2008) for survey implementation strategies. Implementation commenced in late 2010 and was completed by early 2011. The sample population received a pre-notice approximately one week prior to receiving the first survey. The first survey was mailed with a cover letter explaining the purpose of the study and confidentiality agreements (see Appendix III). A week afterward a reminder postcard was sent to non-respondents. Four weeks from the first mailing, the return rate slowed to 0-2 surveys per day. At this time a second survey was mailed to non-respondents. Final contact was made with another reminder postcard sent a week later.

Summary of methods

In summary, we mailed a total of 64 versions of our survey to 1,000 households with 20 acres or more of agricultural land in 9 southern Minnesota counties. The various versions differed on only two questions, question 13 and 14. The rest of the survey was identical. Prior to sending

off the questionnaire, two focus groups, and a pre-test were conducted to test assumptions made by the survey's designers.

Data Analysis

The data were coded and entered into Microsoft Excel 2007. Both IBM SPSS Statistical package and StataCorp's Stata Statistical Software were used to analyze the data.

Logistic Regression

I developed two probability models to examine the relationship between respondents' internal structure, attitudes, perceived constraints and interest in perennial energy crops. The response variable of interest in perennial grasses and trees was reduced from a 4-point Likert type scale to a binary dummy variable. In the circumstance where a predictor variable is binary ordinary least squares regression techniques are considered inappropriate. Ordinary least squares regression assumes that the relationship between the response variable and predictor variables is linear, and that the errors are normally distributed and constant across the entire range of data. With a binary response variable, neither of these assumptions is met. Instead, the relationship between a binary response variable and categorical and continuous predictor variables exhibits a

sigmodial distribution (Peng et al. 2001). An appropriate method for modeling such data is binary logistic regression.

Binary logistic regression predicts the natural log of the odds of an individual being in one category or another, and takes on this general form:

$$logit\ (Y_i) = natural\log(odds) = ln\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 \ldots \beta_n x_n + \varepsilon_i$$

Taking the antilog of both sides results in an equation that allows for prediction of the probability of Y_i occurring. The equation is as follows:

$$\pi = probability\ (Y_i) = \frac{e^{\beta_0+\beta_1 x_1+\beta_2 x_2 \ldots \beta_n x_n}}{1 + e^{\beta_0+\beta_1 x_1+\beta_2 x_2 \ldots \beta_n x_n}}$$

I developed two logistic regression models where the response variable took on two levels, interest (1) and no interest (0). To maintain the maximum degrees of freedom in the model and potentially include more predictor variables, I reduced 4-point Likert type scales to dummy variables of high (1) and low (0). Education was reduced from five categories into two, college (1) and no college (0), and household income, farm income and distance from land were converted into a continuous scale using the mean of each response category (see Appendix IV).

The data set contained a large number of potential predictor variables and a respectively small number of observations; therefore, a first step was to produce univariate logistic regressions with each predictor variable and response variable. Predictor variables with a p-value>0.25 were excluded from the multivariate model. Among the remaining predictor variables, I used a variance-co-variance matrix to investigate collinearity. If the covariance between two variables was greater than 0.8, the predictor variable with the lowest p-value in the univariate logit analysis was retained for further analysis.

To build the models an iterative process of backward selection using progressively lower p-value thresholds of 0.75, 0.5, 0.25 and 0.1 was used (Myers 1990, *for an example see*: Donovan et. al 2011). Once the model was established I reintroduced each predictor variable separately. If the reintroduced variable did not meet the p-value threshold of 0.15 it was not retained in the model. The natural log of the eight continuous predictor variables was taken to ensure that the variables were entered into the model in their correct functional form. I tested both the transformed score and the raw score; if the transformed scores did not improve the explanatory power of the model (the p-value did not decrease), then the raw score was used.

To make certain confounding variables were included in the final model I compared the distribution of the means using a student's *t*-test. For example, land tenure was split into its two respective groups, owner operator and landlord. A *t*-test was then performed to observe whether the groups had different demographic distributions, including: gender, farm income, age, number of acres owned, number of acres leased, number of acres rented, number of acres farmed, and length of ownership. If the *t*-test was significant ($p<0.05$), then the predictor variable was reintroduced into the model. If reintroduction caused an increase of 10 percent or greater in any coefficient then it was retained in the final model (Rothman et al. 2008). Chi-square was used to test over model fit.

Chapter IV: Empirical Results

Socioeconomic Characteristics

The socioeconomic and demographic characteristics of respondents are presented in Tables 4.1, 4.2, and 4.3. The results are expressed for all Minnesota landowners and by land tenure. The two land tenure categories presented are owner operators (individuals who own and farm the land, but do not have a rental or sharecropping arrangement with another party), and landlords (individuals who may themselves be farmers, but do have a rental or sharecropping arrangement with another party). A total of 312 respondents (or 65 percent of all respondents) were classified as landlords. The remaining 165 respondents (or 35 percent of all respondents) were classified as owner operators. The classification was based on question number 17, which discretely asked whether the respondent was an owner operator or landlord.

Table 4.1: Socioeconomic and demographic variables (continuous responses)

	Landlords (n=312)	**Owner Operators** (n=165)	**All Landowners** (n=477)
	Mean (SE)	Mean (SE)	Mean (SE)
Number of Acres Owned	**206** (20)	**279** (22)	**231** (15)
Ownership Length (years)	**58** (2)	**54** (3)	**56** (2)
Age (years)	**66** (1)	**56** (1)	**63** (1)
Average Yearly Crop Rental Rate (dollars/acre)	**170** (4)	**201** (7)	**180** (4)

The average number of acres owned for all landowners was 231 (± 15). For owner operators the average number of acres owned was 279 (± 22). This is higher than the 206 (± 20) average acres owned by landlords. The average length of ownership is not different between tenure, with an average of 56 (± 2) years for all landowners. The age of owner operators was lower, 56 (± 2) years, than landlords, who average 66 years (±1). The average age of all landowners was 63 years (±1). The average yearly crop rental rate for all respondents was $180 per acre (± $4). Owner operators' land was valued at $201 per acre (± $7), which was higher than landlords who averaged $170 (± $4) per acre. A student's *t* test of means revealed that the differences between number of acres owned ($p < 0.04$), crop rental rate ($p < 0.00$) and age ($p < 0.00$) to be significantly different between land tenure categories.

Table 4.2: Socioeconomic and demographic variables (categorical responses)

		Landlords	Owner Operators	All Landowners
		% (n)	% (n)	% (n)
Gender	Female	**26.2** (*80*)	**6.1** (10)	**19.2** (90)
	Male	**73.8** (*225*)	**93.9** (153)	**80.8** (378)
Work off-the-farm	No	**45.4** (*134*)	**38.3** (62)	**42.9** (196)
	Yes	**54.6** (*161*)	**61.7** (100)	**57.1** (261)
Land Location (miles from primary residence)	Located on Land	**52.4** (*161*)	**82.8** (135)	**63.0** (296)
	30 miles Away	**29.0** (*89*)	**16.0** (26)	**24.5** (115)
	31-150 miles Away	**8.8** (*27*)	**0.6** (1)	**6.0** (28)
	151 to 300 miles Away	**3.9** (*12*)	**0.6** (1)	**2.8** (13)
	More than 500 miles Away	**5.9** (*18*)	**0.0** (0)	**3.8** (18)
Annual Household Income Before Taxes (dollars)	Less than 25,000	**10.3** (*28*)	**6.6** (10)	**9.0** (39)
	25,001-50,000	**26.1** (*71*)	**18.5** (28)	**23.4** (99)
	50,001-75,000	**18.8** (*51*)	**25.2** (35)	**21.0** (89)
	75,001-100,000	**17.6** (*48*)	**16.6** (23)	**17.3** (73)
	100,001-150,000	**15.8** (*43*)	**15.2** (27)	**15.6** (66)
	More than 150,000	**11.4** (*31*)	**17.9** (12)	**13.7** (58)
Net Farm Income (dollars)	Less than 0	**4.7** (*13*)	**8.3** (12)	**6.0** (25)
	0-5,000	**14.9** (*41*)	**13.2** (19)	**14.3** (60)
	5,001-10,000	**17.0** (*47*)	**10.4** (15)	**14.8** (62)
	10,001-25,000	**35.9** (*99*)	**16.0** (23)	**29.0** (122)
	25,001-50,000	**16.3** (*45*)	**21.5** (31)	**18.1** (76)
	More than 50,000	**11.2** (*31*)	**30.6** (44)	**17.9** (25)
Highest Level of Formal Education	Some High School or Less	**8.6** (26)	**5.0** (8)	**7.3** (54)
	High School or GED	**31.3** (95)	**34.8** (56)	**32.5** (151)
	Some College	**15.1** (46)	**12.4** (20)	**14.2** (66)
	Technical or Community College	**14.5** (44)	**27.3** (47)	**18.9** (88)
	Bachelor's Degree	**17.1** (52)	**16.1** (26)	**16.8** (78)
	Graduate or Professional Degree	**13.5** (41)	**4.3** (7)	**10.3** (48)

The majority of respondents were males (81 percent, n=378). There were a greater percentage of female landlords (19 percent, n=90) than female owner operators (6 percent, n=10). Owner operators responded with a higher frequency to the question of whether someone in their family worked off-the-farm compared to landlords (62 vs. 55 percent). Fifty-seven percent of all respondents had a family member who worked

off-the-farm. Concerning land location, the vast majority of owner operators lived either on their land or within 30 miles of their farm. For landlords 52 percent lived on their land, 30 percent lived within 30 miles, and 10 percent lived more than 150 miles away. A student's *t*-test showed there to be a significance difference in gender ($p>0.00$) and land location ($p>0.00$) between land tenure. Significantly more landlords are females and are significantly more likely to live away from the farm.

Total household income varied by land tenure. Landlords' most frequent response was to the category that ranged from 25,001 to 50,000 dollars per year. For owner operators the most frequent response was to the category that ranged from 50,001 to 75,000 dollars per year. Owner operators received more money from their farm operations than landlords. Owner operators most frequently responded that they made more than 50,000 a year from their farming operations (31 percent), and just over half of owner operators made over 25,000 dollars from their farming operations. Landlords most frequently responded that they made between 10,000 and 25,000 dollars from their farm, and 72 percent of landlords made 25,000 dollars or less. A student's *t*-test revealed the differences in both household and farm income to be significant ($p>0.03$

and p>0.01, respectively), with owner operators having a higher mean household and farm income.

Regarding educational attainment the percentage of high school diplomas and bachelor's degrees held by respondents was similar across tenure. For all respondents 33 percent held a high school diploma and 14 percent held a bachelor's degree. However, significantly more landlords held a graduate or professional degree relative to owner operators (14 vs. 4 percent).

Table 4.3: Land use profile

	Landlord	Owner Operator	All Landowners
	% (n)	% (n)	% (n)
Corn	**88.1** (275)	**89.7** (148)	**82.2** (454)
Soybeans	**81.1** (253)	**83.0** (137)	**75.2** (415)
Wetland	**20.2** (63)	**15.8** (26)	**17.8** (98)
Wildlife	**19.9** (62)	**16.4** (27)	**17.8** (98)
Alfalfa	**12.8** (40)	**25.5** (42)	**16.1** (89)
Pasture	**9.9** (31)	**20.0** (33)	**12.6** (63)
Hay	**10.6** (33)	**17.6** (29)	**11.4** (63)
Recreation	**12.0** (38)	**8.5** (14)	**10.3** (57)
Wheat	**3.5** (11)	**21.2** (35)	**8.7** (48)
Confined Livestock	**3.8** (12)	**15.2** (25)	**6.9** (38)
Vegetables	**2.6** (8)	**9.1** (15)	**4.2** (23)
Sugar Beets	**1.6** (5)	**0.6** (1)	**1.1** (6)
Orchards	**1.9** (6)	**3.6** (6)	**2.2** (12)
Short Rotation Woody	**0.6** (2)	**1.2** (2)	**0.9** (5)
Native Prairie	**0.3** (1)	**0.0** (0)	**0.2** (1)

Table 4.3 displays the response rate for each land use option. The most common use of agricultural land in the study region was corn and soybean, at 82 percent and 75 percent, respectively, for all landowners. It

is important to note, that in the Midwest farmers frequently grow corn and soybean on a rotation. Landlords were more likely to have natural landscapes as part of their land use profile, as indicated by the higher prevalence of wetland (20 vs. 16 percent), wildlife habitat (20 vs. 16 percent), and recreation (12 vs. 9 percent) relative to owner operators. Both hay and pasture, which have similar cultivation practices to perennial grasses, were more common among owner operators than landlords. Notably, only one respondent indicated they used their land for native prairie and five indicated they used their land for short rotation woody crops.

Awareness and Interest

The level of awareness and interest in perennial energy crops was ascertained for both perennial grasses and short rotation woody crops (referred herein as trees).

Table 4.4: Awareness and interest in perennial energy crops

		Landlord	Owner Operator	All Landowners
		% (n)	% (n)	% (n)
Awareness of Perennial Grasses	No Awareness	**29.2** (82)	**18.8** (28)	**25.6** (110)
	Little Awareness	**21.7** (61)	**23.5** (35)	**22.3** (96)
	Some Awareness	**39.9** (112)	**50.3** (75)	**43.5** (187)
	High Awareness	**9.3** (26)	**7.4** (11)	**8.6** (37)
Interest in Growing Perennial Grasses	No Interest	**14.7** (41)	**10.8** (16)	**13.4** (57)
	Little Interest	**18.0** (50)	**27.0** (40)	**21.1** (90)
	Some Interest	**45.7** (127)	**44.6** (66)	**45.3** (193)
	High Interest	**21.6** (60)	**17.6** (26)	**20.2** (86)
Awareness of Trees	No Awareness	**36.7** (112)	**24.1** (38)	**32.4** (150)
	Little Awareness	**22.3** (68)	**31.0** (49)	**25.3** (117)
	Some Awareness	**31.8** (97)	**38.0** (60)	**33.9** (157)
	High Awareness	**9.2** (28)	**7.0** (11)	**8.4** (39)
Interest in Growing Trees	No Interest	**24.6** (72)	**29.2** (45)	**26.2** (117)
	Little Interest	**22.9** (67)	**32.5** (50)	**26.2**117)
	Some Interest	**36.9** (108)	**28.6** (44)	**34.0** (152)
	High Interest	**15.7** (46	**9.7** (15)	**13.6** (61)

Amongst all respondents 20 percent were highly interested in adopting perennial grasses for energy production with another 44 percent expressing some interest. Landowners were less interested in growing trees for energy production, with 14 percent stating they had a high interest and another 34 percent stating they had some interest. Landlords exhibited a slightly higher interest in adoption of both perennial grasses and trees. Landlords were also more likely to have no interest in perennial grasses compared to owner operators (15 vs. 11 percent).

Few respondents had high awareness about the use of perennial grasses (9 percent) and trees (8 percent) for bioenergy production.

Parsed out by land tenure, owner operators stated they had high awareness or some awareness at a higher frequency than landlords. There is no statistically significant difference in awareness for perennial grasses or trees between land tenure. A notable trend exhibited in Table 4.4, is the high degree of interest relative to landowners awareness about bioenergy crops and their cultivation practices.

Table 4.5: Mean interest in perennial energy crops

	Landlord	Owner Operator	All Landowners
	Mean (SE)	Mean (SE)	Mean (SE)
Interest in Growing Perennial Grasses	**2.7** (.06)	**2.7** (.07)	**2.7** (.05)
Interest in Growing Trees	**2.4** (.06)	**2.2** (.07)	**2.4** (.05)

Table 4.5 presents the mean scores for the 4-point Likert type scales used to assess interest. The average score for interest in perennial grasses for all landowners was 2.7 (± 0.6), for interest in growing trees, 2.4 (± 0.6). The result of a student's *t*-test shows that there is no significant difference between grass interest among land tenure ($p < 0.5$). A student's *t*-test also shows that landlords' interest in growing trees was significantly higher ($p < 0.02$) than owner operators' interest. Overall, the study population was more interested in perennial grasses than trees.

Land Use Plans and Behaviors

Respondents were asked about the ways they plan to use their land in the next ten years. Twenty-six percent of landlords stated that it was highly likely that their family would operate their land within the next 10 years, whereas 71 percent of owner operators stated the same. Fifty-two percent of all landowners stated that it was highly likely that their land would be rented in the next 10 years. Although, landlords indicated that they were more likely to rent their land compared to owner operators, 41 percent of owner operators stated that it was highly likely or somewhat likely that they might do so within the next 10 years. A slightly higher percentage of landlords indicated they would use their land for recreation or conservation compared to owner operators. Overall, 12 percent and 5 percent of landowners stated they would use their land for recreation or conservation, respectively. One hundred and three respondents or 26 percent of all landowners indicated that would grow a different crop within the 10 years. The result of a student *t*-test shows that owner operators are significantly more likely to have their land operated ($p< 0.00$) and inherited ($p< 0.03$) by their family. The test also showed that landlords are significantly more likely to sell their land for non-agricultural use ($p< 0.03$), rented ($p< 0.00$) and use for recreation ($p< 0.00$).

Table 4.6: Future land use

		Landlord	Owner Operator	All Landowners
		% (n)	% (n)	% (n)
Operated by Family	HU	**53.9** (153)	**7.1** (11)	**37.4** (166)
	SU	**9.9** (28)	**5.8** (9)	**8.4** (37)
	SL	**9.9** (28)	**16.2** (25)	**12.1** (53)
	HL	**26.4** (75)	**70.8** (109)	**42.0** (184)
Rented	HU	**11.5** (33)	**40.8** (60)	**21.4** (93)
	SU	**2.4** (7)	**18.4** (27)	**7.8** (34)
	SL	**13.9** (40)	**27.2** (40)	**18.4** (80)
	HL	**72.2** (208)	**13.6** (20)	**52.4** (225)
Used for Recreation	HU	**67.4** (184)	**80.4** (123)	**72.1** (307)
	SU	**6.2** (17)	**5.2** (8)	**5.9** (25)
	SL	**12.1** (33)	**5.9** (9)	**9.9** (42)
	HL	**14.3** (39)	**8.5** (13)	**12.2** (52)
Taken Out of Production for Conservation	HU	**73.2** (194)	**68.0** (102)	**71.3** (296)
	SU	**11.7** (31)	**22.7** (34)	**15.7** (65)
	SL	**9.8** (26)	**4.7** (7)	**8.0** (33)
	HL	**5.3** (14)	**4.7** (7)	**5.1** (21)
Different Crop will be Grown	HU	**54.7** (139)	**41.7** (60)	**50.0** (199)
	SU	**22.0** (56)	**28.5** (41)	**24.4** (97)
	SL	**14.6** (37)	**26.4** (35)	**18.8** (75)
	HL	**8.7** (22)	**3.5** (5)	**6.8** (27)

**HU=highly unlikely, SU=somewhat unlikely, SL=somewhat likely, HL=highly likely

The survey also asked landowners about their previous management actions. Table 4.7 shows the percentage of respondents who ever participated in the two formal government programs, CRP and CSP, or other governmental or non-governmental programs with similar incentives and regulations, or implemented soil conservation practices on their land such as no-till, low till or nutrient management. One hundred seventy-one respondents (39 percent) implemented CRP or a CRP-like program. A lesser number, 11 percent participated in CSP or a CSP-like

program. And 53 percent of respondents implemented some type of soil conservation practice on their land. There was significantly higher amount of owner operators (65 percent) who implemented soil conservation measures on their land compared to landlords (46 percent). According to a student's *t*-test owner operators are significantly more likely to have implemented soil conservation practices than landlords (p> 0.00).

Table 4.7: Conservation program participation

	Landlord	Owner Operator	All Landowners
	% (n)	% (n)	% (n)
Conservation Reserve Program (CRP)	**37.3** (*104*)	**42.1** (*67*)	**39** (*171*)
Conservation Security Program (CSP)	**10.1** (*25*)	**12.9** (*19*)	**11.1** (*44*)
Soil Conservation	**45.5** (*109*)	**64.9** (*100*)	**53** (*209*)

Attitudes and Perceptions

Respondents' evaluations of a series of attitude and perception statements are presented in Table 4.8. The majority of respondents (80 percent) were either highly concerned or somewhat concerned with the quality of their farm's soil. These results closely mirrored the percentage of respondents who were either highly concerned or somewhat concerned with water quality in their area. When asked whether it was important to provide wildlife habitat on their land 80 percent of all respondents either highly agreed or somewhat agreed. Notably, 46 percent of landlords

highly agreed with the statement, while 31 percent of owner operators highly agreed. Opinions diverged significantly between landlords and owner operators when asked whether they believed perennial crops would improve water quality in their area; 32 percent of landlords compared to 22 percent of owner operators highly agreed.

Table 4.8: Landowners' attitudes and perceptions

		Landlord	Owner Operator	All Landowners
		% (n)	% (n)	% (n)
I am concerned with the quality of my farm soil	SD	**11.1** (*32*)	**10.5** (17)	**10.9** (49)
	SWD	**6.6** (*19*)	**9.3** (15)	**7.6** (34)
	SWA	**24.7** (*71*)	**21.0** (34)	**23.4** (105)
	SA	**57.5** (*165*)	**59.3** (96)	**58.1** (261)
I am concerned with water quality in my area	SD	**9.8** (29)	**11.3** (18)	**10.4** (47)
	SWD	**7.5** (22)	**12.6** (20)	**9.3** (42)
	SWA	**31.9** (94)	**23.3** (37)	**28.9** (131)
	SA	**50.8** (150)	**52.8** (84)	**51.5** (234)
I believe it is important to provide habitat on my land	SD	**7.9** (23)	**8.8** (16)	**8.2** (37)
	SWD	**10.7** (31)	**13.8** (22)	**11.8** (53)
	SWA	**35.9** (104)	**45.9** (73)	**39.4** (172)
	SA	**45.5** (132)	**31.4** (50)	**40.5** (182)
Growing perennial energy crops could improve water quality in my area	SD	**6.4** (16)	**4.1** (6)	**5.6** (22)
	SWD	**13.5** (34)	**19.3** (28)	**15.7**(62)
	SWA	**48.6** (122)	**54.5** (79)	**50.8** (201)
	SA	**31.5** (79)	**22.1** (32)	**28.0** (111)
Growing perennial energy crops could provide wildlife habitat on my land	SD	**5.9** (16)	**1.3** (2)	**4.2** (18)
	SWD	**9.9** (27)	**14.0** (22)	**11.4** (49)
	SWA	**46.9** (128)	**54.1** (85)	**49.5** (213)
	SA	**37.4** (102)	**30.6** (48)	**34.9** (150)
Diversifying my production will reduce financial risk on my farm	SD	**16.8** (38)	**14.7** (21)	**16.0** (59)
	SWD	**31.9** (72)	**29.4** (42)	**30.9** (114)
	SWA	**37.2** (84)	**39.2** (56)	**37.9** (160)
	SA	**14.2** (32)	**16.8** (24)	**15.2** (56)
If I were to grow perennial energy crops I would be perceived as a land steward to my peers	SD	**8.6** (19)	**8.5** (11)	**8.6** (30)
	SWD	**20.8** (46)	**30.2** (39)	**24.3** (85)
	SWA	**53.4** (118)	**53.5** (69)	**53.4** (137)
	SA	**16.7** (37)	**7.8** (10)	**13.4** (47)
The United States should increase domestic sources of renewable energy	SD	**3.2** (9)	**2.6** (4)	**3.0** (13)
	SWD	**5.7** (16)	**7.8** (12)	**6.5** (28)
	SWA	**35.4** (99)	**37.9** (50)	**36.3** (157)
	SA	**55.7** (156)	**51.6** (79)	**54.3** (235)
Farmland should be used to increase the United States' energy independence	SD	**7.8** (21)	**6.3** (10)	**7.2** (31)
	SWD	**13.7** (37)	**11.3** (18)	**12.8** (58)
	SWA	**37.8** (102)	**43.8** (70)	**40.0** (172)
	SA	**40.7** (110)	**38.8** (62)	**40.0** (172)
I have the responsibility to conserve the land for use by future generations	SD	**1.0** (3)	**0.0** (0)	**0.7** (3)
	SWD	**1.3** (4)	**2.5** (4)	**1.7** (8)
	SWA	**21.9** (65)	**14.1** (23)	**19.**1(88)
	SA	**75.8** (225)	**83.4** (136)	**78.5** (361)

**SD=strongly disagree, SWD=somewhat disagree, SWA=somewhat agree, SA=strongly agree

When asked whether diversifying their production would reduce financial risk on the farm, a small percentage of respondents highly agreed with the statement, an additional 38 percent of respondents somewhat agreed. Concerning social norms a higher percentage of landlords (17 percent) compared to owner operators (8 percent) highly agree that by growing perennial crops they will be perceived as a land steward by their peers. An almost equal number of landlords and owner operators somewhat agreed with the statement (53 percent). The majority of respondents (79 percent) highly agreed that they had a responsibility to conserve the land for use by future generations; slightly more owner operators (84 percent) highly agreed with the statement compared to landlords (76 percent).

The results of a student *t*-test shows that landlords are significantly more likely ($p < 0.02$) to believe it is important to provide wildlife habitat on their land and that by growing perennial energy crops they would be perceived as a steward by their peers ($p < 0.02$).

Barriers to Adoption

We provided landowners a series of potential barriers to adoption and allowed them to respond on a four point Likert-type scale as to their

degree of limitation. These perceived barriers could be roughly divided between three sub-barrier categories: economic, institutional and social.

Among the economic barriers, the most limiting was a lapse in income till first harvest. For owner operators and landlords, lapse in income till first harvest was also the most important economic barrier. Both risk of unsuccessful establishment and risk involved with planting a new crop were found to be highly or moderately limiting for the majority of landowners.

Table 4.9: Perceived Barriers (Economic)

		Landlord	Owner Operator	All Landowners
		% (n)	% (n)	% (n)
A lapse in income till first harvest	HL	**48.2** (147)	**57.1** (92)	**51.3** (239)
	ML	**19.3** (59)	**24.2** (39)	**21.0** (98)
	SL	**14.4** (44)	**10.6** (17)	**13.1** (61)
	NL	**5.2** (16)	**3.7** (6)	**4.7** (22)
Risk of unsuccessful establishment	HL	**36.3** (110)	**39.9** (63)	**37.5** (173)
	ML	**30.7** (93)	**38.0** (60)	**33.2** (153)
	SL	**14.2** (43)	**13.9** (22)	**14.1** (65)
	NL	**4.6** (14)	**1.3** (2)	**3.5** (16)
Risk involved with a new crop	HL	**28.7** (87)	**31.1** (50)	**29.5** (137)
	ML	**35.6** (108)	**39.1** (63)	**36.9** (171)
	SL	**17.2** (52)	**23.6** (38)	**19.4** (90)
	NL	**6.6** (20)	**2.5** (4)	**5.2** (24)

**HL=highly limiting, ML=moderately limiting, SL=slightly limiting, NL=not limiting

Regarding institutional barriers, the most limiting factor was the lack of financial assistance followed by lack of renter or contract service provider. For the latter, this was more limiting for landlords, with 46 percent finding it to be highly limiting, compared to the 27 percent of owner

operators. The least limiting factor was the loss of base acreage eligible for government subsidies with 18 percent of all landowners stating that is was not a limiting factor. And fewer landlords found this to be a constraint than owner operators (21 vs. 14 percent, respectively).

Overall, respondents found signing a contract with government to be more limiting than signing a contract with an energy producer with 66 vs. 57 percent indicating it would be highly limiting or moderately limiting, respectively.

Table 4.10: Perceived Barriers (Institutional)

		Landlord	Owner Operator	All Landowners
		% (n)	% (n)	% (n)
Lack of access to proper equipment	HL	**42.6** (129)	**28.8** (46)	**37.8** (175)
	ML	**25.1** (76)	**32.5** (52)	**27.6** (128)
	SL	**13.9** (42)	**23.1** (37)	**17.1** (79)
	NL	**6.3** (19)	**9.4** (15)	**7.3** (34)
Lack of financial assistance	HL	**43.6** (132)	**31.1** (50)	**39.2** (182)
	ML	**24.4** (74)	**35.4** (57)	**38.2** (131)
	SL	**13.2** (40)	**18.0** (29)	**14.9** (69)
	NL	**5.6** (17)	**8.1** (13)	**6.5** (30)
Lack of information about growing crop	HL	**31.0** (95)	**30.0** (48)	**30.7** (143)
	ML	**31.0** (95)	**31.9** (51)	**31.3** (146)
	SL	**19.9** (61)	**23.8** (38)	**21.2** (99)
	NL	**4.6** (14)	**7.5** (12)	**5.6** (26)
Lack of renter or contract service provider	HL	**45.4** (138)	**26.9** (43)	**39.0** (181)
	ML	**20.4** (62)	**26.3** (42)	**22.4** (104)
	SL	**12.8** (39)	**20.0** (32)	**15.3** (71)
	NL	**4.6** (14)	**11.9** (19)	**7.1** (33)
Having to sign a contract with the government	HL	**36.2** (110)	**31.1** (50)	**29.5** (137)
	ML	**20.7** (63)	**39.1** (63)	**36.9** (171)
	SL	**16.8** (51)	**23.6** (38)	**19.4** (90)
	NL	**13.2** (40)	**2.5** (4)	**5.2** (24)
Having to sign a contract with an energy producer	HL	**30.1** (91)	**25.8** (41)	**28.6** (132)
	ML	**25.8** (78)	**32.1** (51)	**28.0** (129)
	SL	**17.9** (54)	**26.4** (42)	**20.8** (96)
	NL	**11.9** (36)	**6.9** (11)	**10.2** (47)
Having to complete the paperwork involved with the program	HL	**33.0** (100)	**23.0** (37)	**29.5** (137)
	ML	**23.1** (70)	**28.0** (45)	**24.8** (115)
	SL	**21.8** (66)	**25.5** (41)	**23.1** (107)
	NL	**11.2** (34)	**16.8** (27)	**13.1** (61)
Loss of base acreage eligible for government subsidies	HL	**32.3** (98)	**32.2** (52)	**32.3** (150)
	ML	**16.5** (50)	**26.8** (46)	**20.7**(96)
	SL	**12.9** (39)	**13.7** (22)	**13.1** (61)
	NL	**20.5** (62)	**14.3** (23)	**18.3** (85)

**HL=highly limiting, ML=moderately limiting, SL=slightly limiting, NL=not limiting

Lastly, among social barriers, the most limiting factor for landlords was lack of interest from current renter. For owner operators the most significant social constraint was also the lack of interest current renter. A

significant percentage of respondents indicated that the necessity to learn new skills (44 percent) to be highly or moderately limiting. The least significant potential barrier was the opinion of family and friends with 58 percent of all landlords indicating it was not limiting or slightly limiting.

The results of a student's *t*-test revealed that landlords were significantly less likely to find the lack of access to proper equipment ($p< 0.00$), the lack of financial assistance ($p< 0.01$), the lack of renter or contract service provider ($p< 0.00$), and the necessity to learn new skills ($p< 0.00$) limiting to adoption.

Table 4.11: Perceived Barriers (Social)

		Landlord	Owner Operator	All Landowners
		% (n)	% (n)	% (n)
The necessity to learn new skills	HL	**21.7** (66)	**12.4** (20)	**18.5** (86)
	ML	**25.7** (78)	**26.1** (42)	**25.8** (120)
	SL	**26.0** (79)	**27.3** (44)	**26.5** (123)
	NL	**12.5** (38)	**28.0** (45)	**17.8** (83)
Opinion of my family and friends	HL	**13.8** (42)	**9.9** (16)	**12.4** (58)
	ML	**19.7** (60)	**14.9** (24)	**18.0** (84)
	SL	**14.4** (44)	**29.8** (48)	**19.7** (92)
	NL	**37.0** (113)	**39.1** (63)	**37.8** (176)
Spending time to learn about a new system	HL	**16.1** (49)	**9.3** (15)	**13.8** (64)
	ML	**25.3** (77)	**20.5** (33)	**23.7** (110)
	SL	**26.0** (79)	**41.0** (66)	**31.2** (145)
	NL	**18.8** (57)	**23** (37)	**20.2** (94)
Current renter not interested	HL	**40.0** (122)	**15.0** (24)	**31.4** (146)
	ML	**14.1** (43)	**13.1** (18)	**13.1** (61)
	SL	**8.2** (25)	**10.6** (17)	**9.0** (42)
	NL	**8.9** (27)	**29.4** (47)	**15.9** (74)

**HL=highly limiting, ML=moderately limiting, SL=slightly limiting, NL=not limiting

Among the tree only barriers over 70 percent of respondents found a long delay till first harvest, having tree roots and stumps in tillable land and a long-term commitment for the land to be highly limiting. Owner operators found it more limiting to have tree roots and stumps in tillable land than landlords (79 vs. 72 percent). Owner operators also found it more limiting to have to make a long-term commitment for the land compared to landlords (76 vs. 69 percent). On the other hand, landlords found it more limiting to obtain access to equipment for harvesting relative to owner operators (66 vs. 57 percent) and overall, only 63 of respondents found getting access to equipment for harvesting highly limiting.

Table 4.12: Perceived Barriers (Trees)

		Landlord	Owner Operator	All Landowners
		% (n)	% (n)	% (n)
Long delay till first harvest (3-12 years)	HL	**73.5** (205)	**76.7** (122)	**74.7** (327)
	ML	**16.8** (47)	**16.4** (26)	**16.7** (73)
	SL	**6.1** (17)	**2.5** (4)	**4.8** (21)
	NL	**3.6** (10)	**4.4** (7)	**3.9** (17)
Access to equipment for harvesting	HL	**65.9** (178)	**56.9** (87)	**62.6** (265)
	ML	**20.7** (56)	**30.1** (46)	**24.1** (102)
	SL	**10.0** (27)	**9.2** (14)	**9.7** (41)
	NL	**3.3** (9)	**3.9** (6)	**3.5** (15)
Having tree roots and stumps in tillable land	HL	**72.2** (200)	**78.8** (123)	**74.6** (323)
	ML	**15.9** (44)	**16.7** (26)	**16.2** (70)
	SL	**7.9** (22)	**3.2** (5)	**6.2** (27)
	NL	**4.0** (11)	**1.3** (2)	**3.0** (13)
Long term commitment for the land (20-30 years)	HL	**69.1** (190)	**76.3** (119)	**71.7** (309)
	ML	**17.8** (49)	**17.3** (27)	**17.6** (76)
	SL	**8.0** (22)	**3.8** (6)	**6.5** (28)
	NL	**5.1** (14)	**2.6** (4)	**4.2** (18)

**HL=highly limiting, ML=moderately limiting, SL=slightly limiting, NL=not limiting

Land Suitability

Respondents were asked which land they would target for perennial crop establishment. As Table 4.13 shows the most suitable land would be land with poor quality soil followed by land with poorly drained soils. Notably, owner operators were more likely to target land with sandy soil compared to landlords (33 vs. 3 percent, respectively). Also noteworthy, landlords were more likely to target all of their land compared to owner operators (20 vs. 10, respectively).

Table 4.13: Farmland targeted for perennial crop establishment

	Landlord	Owner Operator	All Landowners
	% (n)	% (n)	% (n)
Sandy soil	**2.7** (2)	**33.3** (55)	**22.1** (122)
Poorly drained soils	**32.4** (101)	**36.4** (60)	**29.5** (163)
Land near a lake, river or stream	**28.5** (89)	**33.3** (55)	**26.4** (146)
Poor quality soil	**31.4** (98)	**43** (71)	**34.1** (188)
Sloped land	**29.2** (91)	**56.9** (87)	**29.7** (164)
Most productive land	**5.1** (16)	**8.5** (14)	**5.6** (31)
All my land	**19.6** (61)	**10.3** (17)	**14.1** (78)

Financial Incentives

Table 4.14 displays landowners ranking of a series of potential financial arrangements. Respondents either ranked all of the options against one another, in which they inserted a mutually exclusive response for each of the five options or ranked each individual option on a scale on 1-5. For clarity the for most frequent response was taken for each potential arrangement, based on a scale of 1-5 with 1 being the most preferred and 5 being the least preferred.

Table 4.14: Preferred financial incentive: Grasses

	Landlord	Owner Operator	All Landowners
	Ranking % (n)	Ranking % (n)	Ranking % (n)
1. **No financial assistance. Paid upon delivery of biomass.**	Fifth Choice 55.3 (121)	Fifth Choice 37 (54)	Fifth choice 35.7 (197)
2. **Financial assistance for planting. Annual payment for first 5 years. Paid upon delivery of biomass.**	Fourth Choice 29.2 (62)	Fourth Choice 25 (37)	Fourth choice 26.7 (108)
3. **10 year easement with annual payment. Paid upon delivery of biomass.**	Third Choice 36.4 (78)	Third Choice 43.2 (64)	Third choice 38.7 (157)
4. **10 year easement with annual payment. Harvest and maintenance conducted by contract service provider. Paid upon delivery of biomass.**	Second Choice 31 (66)	Second Choice 29.1 (43)	Second choice 30.1 (122)
5. **10 year or longer rental agreement. Harvest and maintenance conducted by contract service provider. Annual payment.**	First Choice 37.9 (81)	Fifth Choice 34.7 (51)	First choice 35.4 (143)

For perennial grasses just over 35 percent of respondents selected option 5 (10 year or longer rental agreement with a contact service provider) as their most preferred financial arrangement. Notably, 55 percent of landlords chose option 1 (no financial assistance) as their least preferred choice whereas owner operators chose option 1 and option 5 as their least preferred choice. The most preferred choice of landlords was option 5—a long-term rental agreement with a service provider and an annual payment. Among 29 percent of owner operators option 5 was also the most preferred choice. Both landlords and owner operators selected option 4 as their second most preferred choice.

Table 4.15: Preferred financial incentive: Trees

	Landlord	Owner Operator	All Landowners
	Ranking % (n)	Ranking % (n)	Ranking % (n)
1. **No financial assistance. Paid upon delivery of biomass.**	Fifth Choice 72.1 (147)	Fifth Choice 68.1 (92)	Fifth Choice 70.5 (60.8)
2. **Financial assistance for planting. Annual payment for first 5 years. Paid upon delivery of biomass.**	Fifth Choice 40 (82)	Fourth Choice 38 (52)	Fifth Choice 35 (134)
3. **10 year easement with annual payment. Paid upon delivery of biomass.**	Third Choice 32 (65)	Third Choice 48.9 (67)	Third Choice 38.7 (147)
4. **10 year easement with annual payment. Harvest and maintenance conducted by contract service provider. Paid upon delivery of biomass.**	Fifth Choice 36.1 (74)	Second Choice 39.7 (54)	Second Choice 33.3 (127)
5. **10 year or longer rental agreement. Harvest and maintenance conducted by contract service provider. Annual payment.**	Fifth Choice 35.1 (72)	First Choice 44.5 (61)	First Choice 40.2 (152)

For trees the majority of respondents chose option 1 (no financial assistance) as their least preferred choice and option 5 as their most preferred choice. Option 5 was the first choice of 35 percent of owner operators and 45 percent of landlords. Option 5 was also selected as the least preferred choice by 35 percent of landlords.

Land Tenure

The majority of landlord respondents (54 percent) indicated that they had a one year lease and received cash rent. Another 32 percent had a multiple year lease and received cash rent. Only 4 percent (n=13) of landlord respondents reported having a sharecropping arrangement.

Landlord respondents had their current renter or sharecropper for an average of 14 years. For the majority of landlord respondents (71 percent) their current renter or sharecropper was not an immediate or extended family member.

Table 4.16: Landlord management attitudes

		% (n)
The renter makes most of the decisions about the type of crops grown	Highly Disagree	**3.4** (*11*)
	Somewhat Disagree	**3.8** (*12*)
	Somewhat Agree	**14.1** (*45*)
	Highly Agree	**78.7** (*251*)
I make the decisions about conservation on my land	Highly Disagree	**23.1** (*70*)
	Somewhat Disagree	**13.5** (*41*)
	Somewhat Agree	**34.7** (*105*)
	Highly Agree	**28.7** (*87*)
My renter farms the land I want it to be farmed	Highly Disagree	**7.1** (*22*)
	Somewhat Disagree	**7.4** (*23*)
	Somewhat Agree	**28.2** (*88*)
	Highly Agree	**57.4** (*179*)
I can freely discuss the use of different practices with my renter	Highly Disagree	**7.1** (*22*)
	Somewhat Disagree	**4.9** (*15*)
	Somewhat Agree	**26.9** (*83*)
	Highly Agree	**61.0** (*188*)

Table 4.16 presents respondent's view about farm decision-making. The majority of landlords (79 percent) highly agreed with the statement: The renter makes most of the decisions about the type of crops grown. Sixty-three percent of landlord respondents highly agreed (29 percent) or somewhat agreed (35 percent) that they made conservation related decisions. Only 7 percent of landlords felt that their renter does not farm the land they way they want, with another 7 percent somewhat

disagreeing with the statement. Lastly, 88 percent of respondents either highly agreed or somewhat agreed with the statement: I can freely discuss the use of different practices with my renter.

Logistic Regression

The variables used to develop the logistic regression model are displayed in Appendix IV. The goal was to identify variables that effect interest in perennial grasses and trees adoption. Table 4.17 presents the list of variables included in the final model for perennial grasses. The statistical relationship between the predictor variables and the response variable were verified using a z-test for each coefficient (z=coefficient/standard error) where $p< 0.001$ is highly significant, $p< 0.05$ is significant and $p< 0.10$ is marginally significant. Overall model fit was assessed using the probability that null hypothesis (the predictor variables taken together have no effect on the response variable) is true. That was accomplished using the probability of the chi-square statistic for the log likelihood ratio.

A positive relationship exists between interest in perennial grass and the belief that by growing perennial crops they would be perceived as a land steward by their peers (STEWARD). These landowners were 26 percent more likely to be interested in perennial grasses than landowners who did not share the attitude. There was also a significant relationship

between interest in perennial grasses and the belief that growing perennial energy crops could improve water quality in the local area (PERRENIALWATER). Landowners who shared this attitude were 15 percent more likely to be interested than landowners who did not. Landowners who indicated they participated in the Conservation Reserve Program or a similar program were 21 percent more likely to be interested than other respondents (CRP). Finally, the only perceived barrier found significant in the final model was the necessity to spend time to learn a new system (TIME). Landowners who did not perceive TIME to be a constraint were 19 percent more likely to be interested in perennial grasses.

Both ACRES RENTED and GENDER were reintroduced after a *t*-test exhibited differing distributions when analyzed by land tenure, and had a 10 percent or greater change in the LANDTENURE and STEWARD coefficients.

Table 4.17: Logit Model: Grasses

	Coefficient	Std. Error	p-value	Marginal Effect
LANDTENURE	-.612	.525	.246	-
STEWARD	1.759	.514	.001	.262
PERENNIALWATER	1.018	.565	.071	.152
CRP	1.380	.530	.009	.206
TIME	1.265	.525	.016	.189
ACRES RENTED	-.001	.001	.324	-
GENDER	-.791	1.137	.487	-
Constant	-1.049	1.131	.354	
Log Likelihood	-56.584			
Model chi-square	44.76			
Number of observation	123			
Overall model significance	.000			

Table 4.18 displays the variables retained in the final tree model. Being an owner operator had a negative impact on interest in trees (p-value 0.21). Owner operators were 15 percent less likely to be interested in trees than landlords (LANDTENURE). Landowners who believed that by growing perennial crops they would be perceived as a land steward by their peers (STEWARD) were 15 percent more likely to be interested in trees than those who did not share the belief. Belief that growing perennial energy crops could improve water quality in the local area (PERRENIALWATER) was positively associated with interest in trees. These landowners were 14 more likely to be interested. Regarding landowners'

plans for the future, respondents who stated their land would be used for recreation within the next ten years were 16 percent more likely to be interested than those who did not plan to use their land for recreation.

Several barrier variables were found to be significant in the model (TIME, TREEEQUIP, ROOTS). Those who believed the necessity to spend time to learn a new system was not a barrier were 13 more likely to be interested in trees than those who found this not to be a barrier. A negative relationship exists between obtaining access to tree harvesting equipment and interest. Landowners who believed obtaining harvesting equipment a barrier were 19 percent less likely to be interested than those who did not perceive it be a barrier. Conversely a positive relationship existed between interest and the presence of roots in tillable land. Landowners were 26 percent more interested in trees if having roots and stumps in tillable land was not considered a barrier, than those who did not believe the same. Landowners who indicated they currently produced hay on some of their land were 16 percent more likely to be interested than those who did not cultivate hay (HAY). Although age was found to be insignificant, it was retained in the final model as its reintroduction significantly shifted the LAND TENURE coefficient.

Table 4.18: Logit model: Trees

	Coefficient	Std. Error	p-value	Marginal Effect
LANDTENURE	-.753	.325	.021	-.147
STEWARD	.768	.287	.015	.150
PERENNIALWATER	.726	.377	.054	.142
RECREATION	.841	.357	.018	.164
TIME	.660	.313	.035	.129
TREEEQUIP	-.997	.445	.025	-.194
ROOTS	1.33	.595	.026	.259
HAY	.826	.412	.045	.161
AGE	-.019	.012	.105	-
Constant	-.457	.794	.598	-
Log Likelihood	-151.572			
Model chi-square	63.92			
Number of observation	265			
Overall model significance	0.000			

Missing Data

For the model estimation, respondents who failed to answer any of the questions (which were turned into variables) in the model were deleted list wise (the entire record for that respondent was deleted if response to even one variable was missing).

Chapter V: Discussion of Results and Conclusions

The Habitus of Farming

Using Bourdieu's habitus provides a means to examine the field of farming as embodied and practiced by landowners. Bourdieu's theory infers that individual's attitudes, perceptions, goals and socioeconomic characteristics are acquired from participation in the farming field, and represent an "incorporated history, [that has] become [one's] nature" (Le Sens pratique, p. 94 in Costa 2006). Accordingly, one can say that respondents' evaluation of perennial energy crops is not drawn from a logical, rational appraisal of the problem situation, but from a sense of the game, its rules, and logic.

Landowner Habitus

The Midwestern landscape is replete with farms. The owners of them, as observed in this research study, mostly grow the traditional row crops of corn and soybean, are middle-aged, males, and have a high school education. On average their farms are small and bring in between $10,000 and $25,000 dollars in net annual income. The majority of landowners' household income is bolstered by off-the-farm work. Within this habitus, a portion of Minnesota landowners also reported using their land for wildlife, wetland, and recreation.

Concerning the social-psychological dimension of habitus, Minnesota landowners are concerned about water quality, wildlife habitat, energy independence, and the need to conserve the land for future generations. Many of them have experience with implementing conservation easements and soil conserving practices. For the future, the majority of landowners expect that someone in the family will operate the land, and the current suite of crops will continue to be grown.

As practice theory expounds, landowners have the potential to maintain or change the structure of farming by exploiting their capital and the opportunities presented to them. Regarding the practice of perennial energy crops, the majority of those in the research population expressed interest in pursuing perennial grasses, while a significant portion expressed interest in cultivating trees.

For those landowners who expressed interest in perennial grasses, several factors were found to be important including having implemented the Conservation Reserve Program, believing that by growing the crops they would be considered a land steward, believing that growing perennial crops would improve water quality in their local area and feeling as though they had enough time to learn the skills necessary to implement the practice.

The strongest predictor of interest in trees was landowners' ability not to see roots as a barrier to adoption. The problem of having roots in tillable land can be seen as a problem of spatial organization. Bourdieu posits that spatial organization is the result of social processes and that the resulting spatial arrangement mimics the values and identity of the individuals and groups that contribute to these arrangements (Bourdieu 1977). The way in which a farmer chooses to organize his land spatially depends on the economic, social, and rental relations that make farming possible and the motivations of the owner. While most agricultural land is dedicated for productive uses, portions of it are reserved for recreational activities. Thus, within this socially constructed space of the farm, landowners may be using different logic to govern their interest in trees. Indeed, many landowners know their ancestor's history of clearing the land of trees to make it suitable for cultivation and cannot see trees fitting within the farm space. Minnesota landowners who spatial relationship to the land did not differentiate between what could and could not be done on tillable were more likely to be interested as planting trees appears not to conflict with their habitus of farming.

Landowners who were classified as landlords, had positive attitudes about stewardship and the impact perennial crop would have on water

quality, and did not perceive allocating time to learn new skills as a barrier, were more likely to be interested in trees. Further, landowners who already grew hay and planned to use their land for recreation within the next ten years were more likely to be interested.

Both of the logistic regression models, which were built to understand interest in perennial energy crops, provide further evidence that social-psychological variables are equally important to economic variables when considering how landowners evaluate new practices. Like Valdivia and Poulos (2009) conclude in their study of agroforestry interest, attitudes matter.

Land Tenure and Habitus

One of the underlying assumptions of this study was that landowners of different tenure would hold different social positions and have differing lived experiences due to their relative closeness to rural culture. Specifically, landowners who are owner operators were expected to be deeply embedded in the rural lifestyle and industrial agriculture as they have more frequent interactions with the input industry, rural conservation agents, and fellow farmers. Realistically setting up such dichotomy would be problematic. Many of the values, preferences, and attitudes are shared between the two land tenure groups. And at one point in time,

many landlords shared the same social space as owner operators given that many landlords were once farmers. Further, many landlords live near or on their farms and remain connected to the community. The survey showed that within the landlord category 75 percent of respondents did not farm any of their land. Using a common definition of absentee landowner (someone who does not reside on his or her land), 52 percent of non-farming landlords are considered absentee landlords.

Owner Operator and Landlord Habitus

The habitus of owner operators and landlords were significantly different on several dimensions. Concerning demographics, owner operators were younger, owned more land and commanded more economic capital (higher household income, more income from farming operations, and higher average rental rate) than landlords. Landlords tended to be older, live further away from the farm and had a higher probability of being female than owner operators.

On the social-psychological dimension of habitus, attitudes varied between land tenure, with landlords more likely to believe that perennial crops will improve local water quality and make them appear as land stewards amongst their peers.

Forecast about future land use also varied between the groups. Owner operators' habitus is anchored by family, as revealed by their future land use—to have their land be inherited and operated by family. Landlords had a different vision for their land, being more likely to sell their land for non-agricultural use, rent it out, or use it for recreation within the next 10 years.

The land tenure groups' evaluation of grasses did not significantly differ although a higher percentage of landlords were highly interested in grasses than owner operators. However, interest in trees did differ, with landlords significantly more likely to be interested. Landlords were also less likely to find the lack of access to proper equipment, the lack of financial assistance, the lack of renter or contract service provider, and the necessity to learn new skills limiting to adoption.

As hypothesized in the outset of this research study, the habitus of owner operators and landlords appear to differ. While owner operators' habitus affords them greater economic capital, they are also more likely to conserve their current habitus of growing corn and soybean and transfer this onto their heir. Landlords' habitus, on the other hand, affords them a different vision, which includes using their land for recreation and

non-agricultural uses. Their habitus also affords them a more positive evaluation of perennial crops and their potential benefits.

Marginal land

Taking into consideration the economic and sociohistorical constraints to cultivating trees on productive farmland and political concerns about energy crops competing with food supplies, the literature often states that perennial energy crops can co-exist with traditional row crops if grown on marginal land (Schmer et al. 2008, Royal Society 2008). Economists define marginal land as land with low economic return or where cost-effective production is not possible. Ecologists consider land marginal because of its biophysical properties such as wetness, slope, or soil quality.

In a study of the social and political-economic valuation of marginal land, researchers found that farmers' perceived highly erodible land to be the most suitable for energy grass cultivation (Cope, McLafferty, and Roads 2011). Radeake at el. (2003) found a similar expression of land suitability. Their research revealed that although farmers did not view trees to be compatible with farming, farmers did view them as good fit for areas of their land with poor soil quality, on hillsides, or on marginal or idle land.

Our findings support Radeake's findings. Most landowners in our survey would target land with poor soil quality and poorly draining soil for perennial energy crops production, while only a small percentage of landowners were willing to dedicate their most productive land. Landlords were more likely than owner operators to target all their land, indicating that owner operators' habitus may be more spatial.

Economic Capital

In order to transform the field of farming landowners will need to have access to the sources of capital that allow them to be competitive. In industrial farming one the greatest assets is economic capital. Yet, despite this, economic factors were not found to be significant predictors of interest in our study. Nevertheless, Bourdieu claims that the logic of all practices is an economic logic, even when neither the capital nor the interests at stake are economic. So although economic capital was not found to be an important factor in interest, the position within the field of farming that a landowner can take is still intricately linked to his economic relations and access to economic capital (Costa 2006).

Policy Implications

Government policy is one tool that has been used to increase the adoption of new practices. Ultimately, the decision to adopt is a

household decision, and if these policies are not designed to meet the household's goal, obligations, and farming orientation, they may be ineffective and even cause social resistance (Dobbs and Pretty 2004). Further, government subsidies may bolster adoption by reducing risk (Gray et al. 2004), but only if there are strong prospects for the private market to develop and stand on its own.

We found that landowners were responsive to policy interventions with the majority preferring financial arrangements that reduced risk and provided certainty. For owner operators the most preferred arrangement was an easement with an annual payment. Landlords also preferred an easement to the more risker arrangements, but more would prefer to engage in a long-term rental agreement with a contract service provider. This option is similar to many cash-rent situations that landlords participate in wherein the risk of planting, harvesting, and marketing is left to the tenant. Landowner's willingness to accept easements speaks to the high participation rates among the population and the overall success of the easement programs, but also the long-term stability and steady income it provides to landowners.

In designing policy it is important that the appropriate group is targeted in order to increase the policy's effectiveness. Research on

tenant vs. landlord decision-making reveals the dissonance between the decision to adopt conservation programs and commodity crops. Most landlords in our survey area received cash rent from their tenant, and allowed the tenant to make decisions about which crops to grow. It is expected that renters will farm in a matter that allows them to meet this financial obligation. Further, many incentives strictly target the deed holders, such as the Conservation Reserve Program that call for a reduced amount of labor and a less active management style. If new programs are to be successful they must incentivize tenants as well as landlords and meet both parties' needs.

Potential Pathways for Social Change

Bourdieu's theory of practice suggests that fields are spaces continually in flux as social actors deploy strategies to either maintain or improve their position by exploiting or acquiring capital (Bourdieu 1984). In this research, we have explored Minnesota landowner's habitus within the field of agriculture, and some landowners habitus affords them capacity to see the potential for perennial crops. But, it what form will perennial cropping actually evolve, if at all? Raedake et al. (2003) suggest three pathways that are useful for speculation here: the practice is incorporated within

farming; the practice is a tool for transforming farming; a new field and habitus develops.

Alternative One: The practice is incorporated within farming

This first scenario would be both the least radical and easiest to pursue as it maintains the current distribution of power within farming and works within the prevailing practice of corn and soybean cultivation. For perennial farming practices this would mean targeting landowners who already have access to capital, and thus, have the means exploit new markets. More than likely this sort of social change would appeal to owner operators who could tweak their current practice of row cropping.

The advantage of this strategy is it would not challenge the sociocultural relations within farming and allow farmers to maintain their current lifestyle. Further, market developments for corn ethanol already have landowners pursuing strategies to supply the growing market, and experimenting with perennial crops, particularly grasses may not seem to deviate from the norm. Yet in order for this type of social transformation to occur perennials would need to be perceived as lifting the social actors status and power within the field. Further, the markets to support it would have to be developed. John and Watson (2007) suggest that current

markets for bioenergy feedstock are too low, and some type of payment would be necessary to stimulate adoption.

Alternative Two: The practice is a tool to transform farming

The second approach calls for a redistribution of power. Within the field of farming conflict arises when advocates of different types of farming disagree on how the field should be organized. Jordan and Warner (2010) characterize this conflict as the "inertia" of established production and management systems that innovations like multifunctional agriculture must overcome to became an established practice.

This type of transformation would allow for a reorganization of landowners position in the field as they capture new forms of economic capital. This new capital could be in the form of payments for environmental services such as wildlife habitat and carbon sequestration. For such capital to arise, cooperation must occur between multiple stakeholders, and provide a unified front for field reorganization. From this motion the points of conflict will become evident and at this point close attention must be paid to how landowners access to capital influences the practices development. For example, does perennial crop adoption lead to new markets, farmer cooperatives, and local, widespread benefit or is it still only capture by a few with commanding positions in the field?

Jordan and Warner (2010) offer a complementary model to conceive such a transformation.

Alternative Three: A new field and habitus develops

The last alternative would necessitate the development of a new field and habitus. In the context of perennial farming, landowners who participate in the practice would be adopting new technologies, building social, economic and possibly rental relations with new social actors, and new knowledge systems. The question is whether this practice simply integrates into the field of farming as orientated or if the practice forms a new separate field with its own set of rules, logic and taken-for-granted assumptions.

Future Research

There has been a call by researchers to segment the farming community and expose the more elusive psychosocial characteristics for each group (Brodt et al. 2004; Mesiti and Vanclay 2006). Countless studies have shown that demographic variables fail to capture landowners' interest in new practices, and this study finds further evidence to support this claim. Future research could focus on the farming context or style of different landowners, or in terms of Bourdieu, the fields and habitus of landowners. This could be accomplished for instance, by segmenting the population

by geographic areas and tenure and qualitatively assessing the group's goals, values, and long term plans. Such research could lead to typologies that allow sustainable agriculture advocates and extension to develop outreach techniques that are relevant to each group's unique position. For example, absentee landowners are much less likely to have contact with extension and local natural resource agency program and staff, and only one program in the country that has a program with a message tailored towards absentee landowners (Petrezlka 2011). A more pointed evaluation of farming styles and orientations within the heterogeneous field of agriculture could help advocates increase adoption and target interested landowners.

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Appendix I: Focus Group Recruitment Screener

- Hello can I speak with _____?
- My name is _____ with the University of Minnesota.
- How are you?
- I am calling you today because you own land in Le Sueur County Minnesota.
- As you may have heard, there is an interest in raising perennial crops for renewable energy. We are conducting some research here at the University and think your thoughts and opinions are important on this issue. We will be getting land owners in your area together to discuss potential barriers to growing these crops.
- Can I ask you, do you farm this land yourself or rent it out?
- What crops are you growing or what crops is your renter growing?
- Would you be interested in participating in a group discussion conducted in your area? We are offering a $25 gas card in recognition of your participation.
- Would have openings on Thursday, August 19th at 6:30 pm. Will this work for you?
- I'm glad to hear that you are willing to participate. You will contact you next week with the details about the meeting place
- Thank you for your time and we really appreciate your participation

Appendix II: Focus Group Discussion Guide

Introduction:
Good evening everyone and welcome to our group discussion! First, I want to thank you for taking time out of your busy schedules to attend. My name is _____ and I am a graduate student in the Natural Resources program at the University of Minnesota. Along with me is _____, who is also a graduate student at the in the Applied Economics program. The University of Minnesota and the Center for Integrated Natural Resources and Agricultural Management are interested in understanding what landowners such as your selves see as the challenges associated with adopting perennial energy crops and what conditions would be necessary to get landowners interested in adopting these crops.

You were invited here today because you've identified yourself as an owner of agricultural land in Minnesota and for many of you; you do not farm the land yourself but are instead have a renter. Some of you may have heard of or had experience with perennial plants and some of you may have never heard of them. This is not important. The fact that you own agricultural land and are capable of making decisions about that land is **all the expertise you need**. I want to remind you we are not trying to get you to adopt any new practice, but simply want to know your opinions on the issue.

We'll take about an hour and half today to go through all the questions. And I'd like this to be an open conversation, with people bouncing off each other's comments and thoughts. Dave and I role for today is just to make sure that everybody talks so we can get everybody's opinion.

Again, thank you for meeting with us today and for your willingness to participate in this conversation. You may have noticed the digital recorder. This session will be recorded to help out with our note taking and so that we don't miss anything you say. All the information you provide is completely voluntary and will be kept fully confidential; no names will be used on any of our reports.

Please take a moment to silence your cell phones. If you do need to take a call, please step outside the room. As a reminder the restrooms are located just down the hall to the left, and please feel free to help your selves to snacks & drinks during the conversation. Are there any questions before we start?

Well, let's go ahead and get started. To begin let's find out more about each other by going around the table with introductions. I'd like to hear three things from each person – first please tell us your name, second where you are from, and third something you want to do before summer ends."

Saint Paul Focus Group Questions

Opening Question

1. First please tell us your name, where you are from, and something you want to do before summer ends. (5)

Transition Questions

2. Many of you own land in different parts of Minnesota. So please tell us, where you own land, what the land is currently being used for, and whether you rent out the land or operate it yourself? (10)

Probe for absentee landowners

   a. What decisions are made by you and what decisions are made by your renter? Examples of decision types: conservation on land, tillage practices, crops grown, participation in government programs.

   b. How long have you had your renter? How does this relationship influence what decisions you make about your land?

3. As perennial energy crops are a new rather new to agriculture. Can you tell me that comes to mind when you think of perennial energy crops? (10)

Probe

   a. Do you know anyone who is growing perennial plants?

Key Questions

4. Based on what you already know, what would you rate your interest in perennial energy crops? (10)

Pass out perennial crop information pamphlet*

5. What do you think some of the benefits would be to growing perennial crops for energy? (10)

Probe

   a. environmental benefits, economics benefits, energy independence, benefits to the local, state, national economy, etc.

6. What would be some constraints that would prevent you from allowing perennial energy crops to be grown on your land? (15)

Probe

   a. If considering growing these crops or having a renter on your land that would grow them, what would be your constraints?
   b. Time lapse until income
   c. Lack of proper equipment
   d. Lack of financial assistance
   e. Lack of technical assistance
   f. Initial cost of establishment
   g. Opinion of family, friends, neighbors

h. Signing a contract with government energy producer
i. Change in government subsidy eligibility

Probe
Are these constraints different for grasses compared to trees?

7. Any additional thoughts about what would make you hesitate from producing perennial energy crops? (5)

8. As a landowner, what would it take for you to allow perennial crops to be grown on your land? (10)

Probe
a. What would be an ideal payment? What would be a realistic payment?
b. How would you describe the ideal conditions that would convince you to grow perennial crops?

Pass out sheet with different financial arrangements

9. After looking at these different types of financial arrangements, if you decided to grow perennials on your land which ones would you prefer? (10)

Probe
a. What do you like about that option?
b. Are there any other types of financial arrangements that you would prefer?

Final Questions

10. We've had some great discussion today, thank you! My notes from our conversation today include these key points _____. How well does that capture what was said here? (5)

11. Your input is very valuable in determining programs and policies that will encourage landowners to grow perennial crops for energy production. Is there anything you came wanting to say that you didn't get a chance to say? (5)

Additional probes to get people talking:

Would you explain that further?
Would you give me example of what you mean?
Tell us more.
Is there anything else?
I don't understand. Can you please describe what you mean?

Appendix III: Minnesota Agricultural Landowner Survey of Energy Crops

Dear Landowner,

The United States has set goals to significantly increase the amount of electricity, thermal energy, and biofuels made from renewable sources. One important source is perennial plants grown on farmland. The Center for Integrated Natural Resources and Agriculture at the University of Minnesota is collecting information from farm landowners regarding their attitudes and opinions towards perennial energy crops.

You do not need to have any expertise in farming, farm the land yourself or even have heard of perennial energy crops to successfully complete this survey.

The survey is intended for the **owner** of farmland in Minnesota. Your individual responses will be completely confidential and anonymous. No individual responses will be reported. The survey will take between 15-20 minutes to complete.

Please return the questionnaire in the enclosed, self-addressed, postage-paid envelope within 10 days of receipt. Once we have received your completed questionnaire, your name and any identifying information will be deleted from our database.

Survey # «Num»

If you have any questions or concerns, please contact me at (612) 624-4299 or email me at curre002@umn.edu. Thank you in advance for participating in this important project.

Sincerely,

Dean Current, Ph.D.
Project Leader

Landowner and Land Use Profile

1. What is the total acreage of farmland your household owns, leases and/or farms regardless of location or use?

	Total Acres
Land I Own	_____
Land I Lease/sharecrop **TO** others	**-** _____
Land I rent/sharecrop **FROM** others	**+** _____
Total Land I Farm	**=** _____

2. How long have you or your immediate family owned your farmland?

_____ Years

3. What current uses are made of the farmland that you OWN, regardless of whether or not you farm it? *Please indicate the total acreage. If you rotate crops please indicate average acreage per year.*

Acres	Acres
_____ Corn	_____ Confined livestock
_____ Soybeans	_____ Short rotation woody crops
_____ Wheat, oats, and other small grains	_____ Orchards
_____ Sugar beets	_____ Native prairie
_____ Alfalfa	_____ Wetland
_____ Hay—not including alfalfa	_____ Wildlife habitat

_____ Pasture livestock

_____ Recreation—such as hunting, bird watching

_____Vegetables

_____ Other_____

4. What is the average rental rate for land that you own? *If you don't rent out your land please estimate based on rental rates in your area.*

Cropland $_____ Acre/Year ___ Don't Know

Pastureland $_____ Acre/Year ___ Don't Know

5. Have you ever implemented any of the following programs or practices on your land? *Please circle the number corresponding to your answer.*

	Yes	No	Don't Know
Conservation easement such as Conservation Reserve Program (CRP)	1	2	9
Government conservation program that conserves natural resources while farming such as the Conservation Security Program (CSP)	1	2	9
Soil conservation practice such as no-till/low-till, direct seeding, nutrient management	1	2	9

6. Everyone has different plans for how their land will be used in the future. How likely are each of the following situations to occur <u>within the next ten years</u>? *Please circle the number that fits each situation the best.*

	Highly Unlikely	Some-what Unlikely	Somewhat Likely	Highly Likely	Don't Know
Land will be operated by family member(s)	1	2	3	4	9
Land will be inherited by family member(s)	1	2	3	4	9

Land will be sold for agricultural use	1	2	3	4	9
Land will be sold for a non-agricultural use	1	2	3	4	9
Land will be rented	1	2	3	4	9
Land will be used for recreation	1	2	3	4	9
Land will be taken out of production and used for conservation	1	2	3	4	9
I will diversify the current use(s) of my land	1	2	3	4	9
I will reduce the current use(s) of my land	1	2	3	4	9
I will maintain the current use(s) of my land	1	2	3	4	9
I will cease to use my land	1	2	3	4	9
I will grow a different crop	1	2	3	4	9

7. Which of the following best describes your awareness about the using <u>perennial crops</u> grown from farmland for energy production before receiving this survey?

	No Awareness	Little Awareness	Some Awareness	High Awareness
Perennial Grasses	1	2	3	4
Trees	1	2	3	4

Fast Facts about Perennial Grasses, Legumes and Forbs

- High yielding, drought tolerant, and requires lower fertilizer and herbicide quantities compared to row crops
- Once planted, needs to be re-planted only once every 10 years in early spring
- No-till practices can be used
- Harvested annually in late fall or early spring after nutrients have returned to the roots
- Less time to manage throughout plant's life cycle
- Harvested using conventional haying equipment

Fast Facts about Trees

- Requires lower fertilizer and herbicide quantities compared to row crops
- Harvested between 3 and 12 years after planting
- Once established, can be harvested for 20-30 years without any root disturbance or replanting
- Less time to manage throughout plant's life cycle
- Harvested using standard forestry equipment

What are the Benefits of Perennial Energy Crops?

- Adds organic matter to soils
- Reduces erosion
- Improves water quality
- Provides wildlife habitat
- Sequesters carbon from atmosphere

Attitudes and Perceptions

8. Please indicate the extent to which you agree or disagree with the following statements. *Circle the number that corresponds with your opinion.*

	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Don't Know
I am concerned with the quality of my farm soil	1	2	3	4	9
I am concerned with the effect my land has on water quality	1	2	3	4	9
I believe it is important to provide habitat for wildlife on my land	1	2	3	4	9
Growing perennial energy crops could improve water quality in my area	1	2	3	4	9
Growing perennial energy crops could provide wildlife habitat on my land	1	2	3	4	9
Diversifying my production will reduce financial risk on my farm	1	2	3	4	9
If I were to grow perennial energy crops I would be perceived as a land steward by my peers	1	2	3	4	9
The United States should increase domestic sources of renewable energy	1	2	3	4	9
Farmland should be used to increase the	1	2	3	4	9

United States' energy independence					
I have a responsibility to conserve the land for use by future generations	1	2	3	4	9

9. Assuming growing perennial crops for energy production was financially competitive with your current use, how would you rate your current level of interest?

	No Interest	Little Interest	Some Interest	High Interest
Perennial Grasses	1	2	3	4
Trees	1	2	3	4

10. Below is a list of potential barriers a landowner might encounter when considering growing <u>perennial crops</u>, both grasses and trees. To what degree would each of the following factors limit your willingness to grow perennial crops for energy? *Circle the number that corresponds with your opinion.*

Potential Barrier	Highly Limiting	Moderately Limiting	Slightly Limiting	Not Limiting	Don't Know
A lapse in income until first harvest	1	2	3	4	9
Risk of unsuccessful establishment	1	2	3	4	9
Lack of access to proper equipment	1	2	3	4	9
Risk involved with growing a new crop	1	2	3	4	9
Cost to establish	1	2	3	4	9

Lack of financial assistance	1	2	3	4	9
Lack of information about growing crop	1	2	3	4	9
Lack of renter or contract service provider	1	2	3	4	9
Necessity to learn new skills	1	2	3	4	9
Opinion of my family and friends	1	2	3	4	9
Spending time to learn about a different system	1	2	3	4	9
Having to sign a contract with the government	1	2	3	4	9
Having to sign a contract with an energy producer	1	2	3	4	9
Having to complete paperwork involved with program	1	2	3	4	9
Loss of base acreage eligible for government subsidies	1	2	3	4	9
Loss of bank loan eligibility for converted acres	1	2	3	4	9
Working with government technical assistance	1	2	3	4	9
Current renter not interested	1	2	3	4	9

11. Below is a list of potential barriers a landowner might encounter when considering growing <u>trees</u> specifically. To what degree would each of the

following factors limit your willingness to grow trees for energy? *Circle the number that corresponds with your opinion*

Potential Barrier	Highly Limiting	Moderately Limiting	Slightly Limiting	Not Limiting	Don't Know
Long delay till first harvest (3-12 years)	1	2	3	4	9
Access to equipment for harvesting	1	2	3	4	9
Having tree roots and stumps in tillable land	1	2	3	4	9
Long term commitment for the land (20-30 years)	1	2	3	4	9

12. If growing <u>perennial energy crops</u> was financially competitive with your current practice and there was an energy buyer, which financial arrangements you would prefer, assuming annual net farm income is the SAME under all arrangements? *Rank **all** of the following choices 1-5 with 1 being your top choice and 5 being your bottom choice. Rank perennial grasses and trees separately.*

	Grasses	Trees
A. Planting, maintenance, and harvest would be my own responsibility and I would be paid for biomass crop upon delivery.	_____	_____
B. A portion of the cost of planting would be covered; I would receive an **annual payment** for the **first 5 years**; maintenance and harvest would be my own responsibility; I would be paid for biomass crop upon delivery.	_____	_____
C. 10 year easement for which I would receive an **annual payment**; planting, maintenance, and harvest would be my responsibility; I would also be paid for biomass crop upon delivery.	_____	_____
D. 10 year easement for which I would receive an **annual payment**; planting, maintenance, and	_____	_____

harvest would be the responsibility of a **contract service provider** that I hire; I would be paid for biomass crop upon delivery.	_____	_____
E. 10 year or longer rental agreement with contract service provider; establishment, maintenance, and harvest would the responsibility of **contract service provider**; I would be paid an **annual rental payment**.	_____	_____

13. If your annual net farm income from growing <u>perennial grasses</u> was «g_amount» per acre «g_highlow» «g_as_than» your current annual net farm income per acre would you grow <u>perennial grasses</u> on at least some of your land? *Net farm income is total farm revenue minus all farm costs and expenses.*

☐ Yes ⟶ How many acres would you grow at this net farm income? _____ acres

☐ No

14. If your annual net farm income from growing <u>trees</u> was «t_amount» per acre «t_highlow» «t_as_than» your current annual net farm income per acre would you grow <u>trees</u> on at least some of your land? *Net farm income is total farm revenue minus all farm costs and expenses.*

☐ Yes ⟶ How many acres would you grow at this net farm income? _____acres

☐ No

15. If the particular perennial crop you were considering growing was known to be a noxious or invasive weed (causes or is likely to cause environmental harm) how would you answer question 13 and 14?

Question 13-Grasses

☐ Yes _____acres
☐ No

Question 14-Trees

☐ Yes _____acres
☐ No

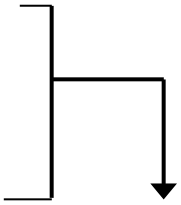
16. If you were to grow <u>perennial energy crops</u> which type of farmland would you target for establishment? *Please check all that apply.*

- ☐ Sandy soils
- ☐ Poorly drained soils
- ☐ Land near a lake, river or stream
- ☐ All my land
- ☐ Poor quality soil
- ☐ Sloped land
- ☐ Most productive land

Land Tenure

17. Which of the following best describes your farming operation? *Please check one*

- ☐ I own and operate my own land (***Please skip to question # 24***)
- ☐ I have a one year lease and receive cash rent
- ☐ I have a multiple year lease and receive cash rent
- ☐ I have a share cropping arrangement
- ☐ Other_____



If selected please answer questions 18 through 23

18. How long have you had your current renter/sharecropper?

_____ years

19. Is your current renter/sharecropper an immediate or extended family member?

☐ Yes ☐ No

20. Are conservation practices mentioned in your lease or lease supplement?

☐ Yes ☐ No (***Please skip to question # 21***)

Please check all below that apply.

- ☐ No-till
- ☐ Specific crop rotation
- ☐ Perennial crop
- ☐ Precision planting
- ☐ Planting or maintenance of buffers
- ☐ Cover crop_____

☐ Conservation drainage management_____
☐ Pasture
☐ Conservation Reserve Program
☐ Conservation Stewardship Program
☐ Environmental Quality Incentives Program
☐ Re-Invest in Minnesota
☐ Other: _____

21. Have you discussed conservation practices with your current renter?

☐ Yes Who initiated the discussion?

☐ No What is keeping you from initiating this conversation?

22. Would you like to incorporate conservation practices into your lease with your renter?

☐ Not Interested ☐ Little Interest ☐ Some Interest ☐ High Interest ☐ N/A

23. People have different approaches when making decisions about their land. How well do you agree with the following statements? *Please circle number that corresponds with your opinion.*

	Highly Disagree	Somewhat Disagree	Some what Agree	Highly Agree	Don't Know
The renter makes most of the decisions about the type of crops grown	1	2	3	4	9
The renter makes most of the decisions about tillage practices	1	2	3	4	9

I make the decisions about conservation on my land	1	2	3	4	9
My renter farms the land the way I want it to be farmed	1	2	3	4	9
I encourage my renter to utilize soil conserving practices	1	2	3	4	9
I can freely discuss the use of different practices with my renter	1	2	3	4	9
The type of relationship I have with the renter strongly influences decisions made about the farm	1	2	3	4	9
The length of my relationship with the current renter strongly influences decisions made about the farm	1	2	3	4	9
My renter's opinion significantly influences decision made about the farm	1	2	3	4	9

Landowner Information

24. Are you a

☐ Male ☐ Female

25. Your age

_____ years old

27. Does anyone in your household work off-the-farm?

☐ Yes ☐ No

26. Which of the following best describes your farming status? *Please check one.*

☐ I am a full-time farmer
☐ I am a part-time farmer
☐ I am a retired farmer
☐ I am a retired non-farmer
☐ I am a non-farmer
☐ Other_____

28. Is your permanent home located on your farmland?

☐ Yes, my home is located on my land
☐ No, I live within 30 miles from my land
☐ No, I live between 31 and 150 miles from my land
☐ No, I live between 151 and 300 miles from my land
☐ No, I live more than 300 miles from my land

30. What is highest level of formal education you have completed?

☐ Some High School or Less
☐ Technical/Community College Degree
☐ High School/GED
☐ Bachelor's Degree
☐ Some College
☐ Graduate/Professional Degree

31. What was your total annual household income from all sources, before taxes, in 2009?

☐ less than $25,000
☐ $75,001-$100,000
☐ $25,001-$50,000
☐ $100,001-$150,000
☐ $50,001-$75,000
☐ more than $150,000

32. What was your net cash farm income from farm operations in 2009, including rental income?

☐ Less than $0 (Net Loss)
☐ $10,001-$25,000
☐ $0-$5,000
☐ $25,001-$50,000
☐ $5,001-$10,000
☐ more than $50,000

33. What was your debt ratio (total debts divided by total assets) in 2009?

☐ 0-15%
☐ 15-30%
☐ 30-45%
☐ 45-60%
☐ 60-80%
☐ 80-100%

34. We will be conducting in-person and phone interviews with landowners to further understand their thoughts about perennial energy crops. Would you be interested in participating?

☐ Yes ☐ No

If **yes**, what is your:

phone number:_____

email:_____

Is there anything else you would like to share with us?

Thank you for taking the time to complete this questionnaire!
Please return this form using the prepaid, self-addressed envelope.
If you have any questions regarding the study, please feel free to contact us.

Dr. Dean Current
Center for Integrated Natural Resources and Agriculture, University of Minnesota
1530 Cleveland Ave. North, St. Paul, MN 55108-6112
curre002@umn.edu; (612) 624-4299

Appendix IV: Logistic Regression Model Variables

Variable	Original Scale	Model Scale
Dependent variables: INTERESTGRASS; INTERESTTREES	Interest in adoption: No interest (1) Little interest (2) Some interest (3) High interest (4)	High Interest and Some Interest (1) Little Interest and No Interest (0)
NUMACRES	Total amount of farmland owned (continuous acres)	Total amount of farmland owned (continuous acres)
LEASED	Amount of farmland leased to others (continuous acres)	Amount of farmland leased to others (continuous acres)
RENTED	Amount of farmland rented from others (continuous acres)	Amount of farmland rented from others (continuous acres)
CORN, SOYBEAN, WHEAT, SUGARBEETS, ALFALFA, HAY, PASTURE, VEGETABLES, CL, SRWC, ORCHARDS, NP, WETLAND, WILDLIFE, RECREATION	Amount of acres for each land use (continuous acres)	Yes (1) No (0)
CRP, CSP, SOILCONSERV	Implementation of program or practice Yes (1) No (0) Don't Know (9)	Yes (1) No (0)
LANDTENURE	Description of farming operation (Question 17) Own and operate (1) One year lease with renter (2) Multiple year lease with renter (3) Sharecropper (4) Other (5)	Own and operate (1) One year lease with renter; Multiple year lease with renter; and Sharecropper (0)
OPERATEDFAM, INHERITFAM, SOLDAG SOLDNONAG, RENTED, RECREATION, CONSERVATION, DIVERSIFY, REDUCE, MAINTAIN, CEASE, DIFFCROP	Future land use plans: Highly unlikely (1) Somewhat unlikely (2) Somewhat likely (3) Highly likely (4)	Highly Likely and Somewhat Likely (1) Highly Unlikely and Somewhat Unlikely (0)

AWAREGRASS, AWARETREES	Awareness No awareness (1) Little awareness (2) Some awareness (3) High awareness (4)	High awareness and Some awareness (1) Little Awareness and No Awareness (0)
SOILQUAL, CONCERNWATER, HABITAT, PERENNIALWATER, PERENNIALHAB, DIVERSIFYRISK, STEWARD, RENEWNRG, NRGINDEP, CONSERVEFUTURE	General and specific attitudes Strongly disagree (1) Somewhat disagree (2) Somewhat agree (3) Strongly agree (4) Don't know (9)	Strongly Agree and Somewhat Agree (1) Strongly Disagree and Somewhat Disagree (0)
LAPSEINCOME, RISKESTABLISH, LACKEQUIP, RISKNEWCROP, ESTABLISHCOST, FINANASSIST, INFOCROP, RENTERCONTRACT, NEWSKILLS, OPINIONFAM, TIME, GOVCONTRACT, CONTRACTNRG, PAPERWORK, BASEACREAGE, LOANELG, GOVTECH, CURRENTRENT, DELAY, TREEEQUIP, ROOTS, LONGTERMTREE	Perceived barriers Highly limiting (1) Moderately limiting (2) Slightly limiting (3) Not limiting (4) Don't know (9)	Highly limiting and Moderately Limiting (1) Slightly Limiting and Not Limiting (0)
Education Level EDUCATION	Some High School or Less (1) High School or GED (2) Some College Technical or Community College. Bachelor's Degree Graduate or Professional Degree	Some College; Technical or Community College; Bachelor's Degree; and Graduate or Professional Degree (1) (College) Some High School or Less; and High School or GRE (0) (No College)
Gender	Male (1) Female (0)	Male (1) Female (0)
AGE	Age (continuous years)	Age (continuous years)
WORKOFFFARM	Household member works off the farm Yes (1) No (0)	Yes (1) No (0)
LANDLOC	Location of Permanent Home Located on Land (1) 30 miles Away (2) 31-150 miles Away (3) 151 to 300 miles Away (4) More than 500 miles Away (5)	Location of primary residence (continuous miles): mean of each category used

HHINCOME	Household Income Less than 25,000 (1) 25,001-50,000 (2) 50,001-75,000 (3) 75,001-100,000 (4) 100,001-150,000 (5) More than 150,000 (6)	Total household income (continuous dollars): mean of each category used
FARMINCOME	Income from Farm Operations Less than 0 0-5,000 5,001-10,000 10,001-25,000 25,001-50,000 More than 50,000	Income from farm operations (continuous dollars): mean of each category used