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Producers Willingness to Adopt a Prescribed Grazing System East of the 100th Meridian

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To the Graduate Council:

I am submitting herewith a thesis written by Caroline Elizabeth Holt entitled "Producers Willingness to Adopt a Prescribed Grazing System East of the 100th Meridian." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

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PRODUCERS WILLINGNESS TO ADOPT A PRESCRIBED GRAZING SYSTEM EAST OF THE 100TH MERIDIAN

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Abstract

With the climate change concerns facing the United States, the contributions of the beef industry to greenhouse gasses are difficult to overlook. The agriculture industry is estimated to be the largest producer of methane emissions in the United States, and within agriculture, livestock are the largest contributor with cattle producing 73 percent of the methane emissions from all livestock (Johnson and Johnson 1995).

This thesis focuses on factors influencing beef cattle producers' east of the 100th meridian interest in adopting prescribed grazing; including how a government cost share system could enhance adoption. Information was obtained for the study through a mail survey conducted in early 2013. A total of 8,875 surveys were mailed to beef cattle producers, and 2,274 surveys were returned. The survey included questions regarding the cattle operation, grazing practices, attitudes of the respondent, and willingness to adopt or expand prescribed grazing. Producers were asked about their general interest in prescribed grazing. Interested producers were presented with a hypothetical program that would provide them an incentive payment to adopt prescribed grazing and asked if they would be willing to convert some acreage to prescribed grazing given the incentive payment. If interested, producers were then asked about how much acreage they would convert.

Responses were analyzed in three stages using an ordered probit model of interest level, a binary probit model of willingness to accept an incentive level, and linear regression model of acres that would be converted. These models provide a means to analyze the effects of factors influencing interest in adopting or expanding prescribed grazing, willingness to participate in an incentive program to adopt prescribed grazing, and acreage conversion levels. These results can

be used to better understand the willingness of beef cattle producers east of the 100th meridian to adopt of prescribed grazing and impacts of a prescribed grazing system.

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Chapter 1: Introduction and Objectives

Introduction

Nearly 765,000 farms are involved in raising beef cattle in some way, which is about 35 percent of the total number of farms in the US (McBride and Matthews 2011). In the United States, over 922 million acres are used for agriculture. Of these acres, about 409 million acres are used for pastureland, which means about 44.3 percent of the land used for agriculture in the US is used for grazing animals (2007 Census of Agriculture). While beef production has become more efficient, requiring fewer resources to produce the same quantity of beef than in the past (Capper 2011), the issue of the environmental impact of beef production has become of increased interest.

Greenhouse gas (GHG) emissions from agriculture are estimated to contribute about 6 percent of the total GHG emissions from the United States (United States Environmental Protection Agency (USEPA) 2010). In the United States, manure from domestic livestock is the largest contributor to methane emissions (USEPA 2008) while soil management in the agricultural sector is the largest contributor to nitrous oxide emissions due to the use of nitrogen fertilizer (Ribaudo 2011). The agriculture sector is estimated to be the largest producer of methane emissions, and within the sector, livestock are the largest contributor to those methane emissions with cattle producing 73 percent of the methane emissions from all livestock (Johnson and Johnson 1995).

Agricultural externalities, such as GHG emissions from beef cattle production are very difficult and costly to determine (Houston and Sun 1999). According to Fugile and Kasack, "Economic theory, however, suggests that producers will underinvest in natural resource conservation because they are unlikely to take into account costs that are external to the firm, such as environmental costs to water, resources, air quality, and wildlife" (Fugile and Kasack

2001: 387). Because ameliorating the GHG emissions from beef cattle production can be costly to farmers and the public, it is important to consider both the environment and economic costs in arriving at a solution (Houston and Sun 1999).

Best Management Practices (BMPs) can be adopted by farmers in order to reduce the effects of nonpoint pollution sources on water quality (Prokopy et al 2008). For example, grassed waterways, channels that are planted with grass in order to carry runoff water, improve water quality by filtering out suspended sediments and allow control over the water runoff so as to protect from flooding or erosion (Gillespie, Kim, and Paudel 2007). Increased forage growth can also create a carbon sink allowing carbon to be taken out of the atmosphere and be stored in the soil, and management of the forages cattle consume can reduce methane emissions from the cattle themselves (Johnson and Johnson 1995).

Prescribed grazing (Natural Resource Conservation Service (NRCS) Practice Code 528) is a BMP that may be utilized in cattle production. It is defined as the “controlled harvest of vegetation with grazing animals with the intent to achieve a specific objective” (NRCS Practice Code 528 2008). Some of the benefits of this practice include improving water use and access, maintaining or improving vegetation, helping prevent erosion of stream banks, keeping manure out of water sources, and helping to promote a plant community that is more diverse, stable, and suited to the land owner’s objectives (NRCS Practice Code 528 2008). Other practices that are commonly associated with using a prescribed grazing system include feed management, watering facilities, and pest management (NRCS Practice Code 528 2008). Additionally, there are different levels of prescribed grazing that a producer can choose to implement: basic, basic plus rotational feeding, high intensity, high intensity- stockpiling, and high intensity rotational

feeding according to the Environmental Quality Incentives Program (EQIP). Producers can select different plans to fit their production strategy.

With prescribed grazing, the producer divides up his pastures that are used to graze cattle into smaller sections to rotate the cattle throughout the grazing sections. These actions increase forage growth, control weeds, and maximize the potential of the land through increased stocking rates. Producers may perceive prescribed grazing as a highly involved practice that takes a lot of time, many also believe that the increase in time is worth the returns as it allows the pastures to grow more forages, contributes to the docility of the cattle as they are handled on a more regular basis, and allows the producer more flexibility when it comes to options for pasture management (Sleichter 2002). The producer will also see better quality forages and up to an estimated average 30 percent increase in stocking rates (Sollenberger et al 2011). Thus the adoption of prescribed grazing has the potential to benefit both the environment and individual producers.

BMPs and GHG Mitigation

Greenhouse gases can be offset by storage in the form of organic carbon, and with proper management that carbon will remain in the soil. As a purpose of prescribed grazing is to reduce soil erosion and maintain or improve soil quality (NRCS Practice Code 528 2008), the practice of prescribed grazing does include soil management. The grass itself can also be used to draw carbon from the atmosphere, and place it back in the soil (Briske et al 2013). Methane emissions are also expected to be lower from the cattle than with a traditional grazing system (Cottle, Nolan, and Wiedermann 2011). Some of the advantages for producers include an increase in carrying capacity of the land, better forage growth, an increase in the use of more diverse forage species, less forage wasted, and prevention of soil erosion. Potential disadvantages associated with a prescribed grazing system include a significant upfront cost and an increase in

management effort. Thus, the benefits to the producer of adopting prescribed grazing may not outweigh the costs (Lichtenberg and Smith-Ramirez 2011). Uncertainty among producers about the cost and management commitment can reduce willingness to adopt (Kim, Gillespie, and Paudel 2008).

The greatest impact for producers as well as the environment from prescribed grazing would be made if beef producers in the eastern half of the United States would be willing to adopt these practices. Adoption of these practices by dairy producers would not be as beneficial to themselves or the environment because of the management practices and housing of the cows on the farm (Bosch et al. 2008). In the western parts of the United States prescribed grazing would not be as beneficial to the producers or the environment because of the climate and limitations on forage growth that exist due to the land quality and the weather (Conant et al 2003).

Given the contribution of the beef industry to GHGs, practices in the industry can be investigated as a means to reduce GHG impact. Prescribed grazing can be used to mitigate the impacts of GHGs from animal operations (NRCS 2008). Thus, it is useful to understand the reasons why a producer would choose to adopt prescribed grazing or why they may choose not to adopt and how an incentive program might influence this adoption.

Objective

The objective of this study is to determine the factors influencing adoption or expansion of prescribed grazing on beef cattle farms, including the effects of a hypothetical incentive program on a producer's willingness to adopt or expand a prescribed grazing system. The effects of these hypothetical incentive levels, both on producer participation in the program and also

acreage conversion, are estimated. The study focuses on cattle production located east of the 100th meridian and use data from a mail survey conducted in early 2013.

A hypothetical incentive program with varying incentive levels is used in the survey to examine the degree of financial responsiveness by producers as prior studies have found adoption of practices related to conservation can be financially responsive (Lichtenberg 2004) This incentive program, along with other factors that affect a decision maker such as age, off farm income, and other farmer or farm characteristics (Knowler and Bradshaw 2007) are analyzed to better understand what affects a producer's willingness to adopt a prescribed grazing system. With this understanding of characteristics that affect adoption, as well as the influence of cost share levels, projections of the effects of cost share rates to obtain desired adoption behavior can be made. This information would also potentially be helpful in formulating environmental impacts.

The rest of the thesis will be organized as follows: Chapter 2 presents a review the results from previous studies focused on prescribed grazing as well as best management practices adoption behavior; Chapter 3 discusses data collection through the mail survey and economic modeling of the adoption decisions; and Chapter 4 shows the estimated models of adoption (ordered probit, binary probit, and OLS). Finally, Chapter 5 draws conclusions based on the results of the study.

Chapter 2: Review of Literature

Several studies examined factors influencing the adoption of Best Management Practices (BMPs) and provide useful insights into prescribed grazing. Some focused on prescribed grazing as a BMP for cattle producers (Briske et al 2013, Bosch et al 2008, and Allen 1993). Studies such as Cooper 2003 and Houston and Sun 1999 examine how a government cost share system influences adoption behavior. However, there is a much smaller body of work examining the adoption of prescribed grazing by beef cattle producers, and there are no studies that focus directly on the adoption of a prescribed grazing system while also looking at how a government cost share system influences producers willingness to adopt. This chapter will review previous studies on adoption of improved management practices, prescribed grazing, and the influence of a government cost share system on adoption of improved management practices.

Gillespie, Kim, and Paudel (2007) attempted to understand why producers chose not to adopt prescribed grazing and other BMPs. They cited several reasons for producers not adopting BMPs including producers deciding that the BMP was not relevant to their farm, lack of familiarity with the BMP, or preference of the producer. The study also looked at the difference between beef production and other program commodities such as corn, dairy, soybeans, and others. Because beef is not included in the program commodities, they have had less targeting from the federal government. The article also discusses how this attitude towards beef production is changing because it is becoming more apparent that the beef industry does significantly impact the environment.

Numerous studies have examined factors influencing adoption of improved management practices or new technologies (e.g. Daberkow and McBride 1998, Fugile and Kasack 2001, Jensen et al 2007, Kim, Gillespie, and Paudel 2005, Lambert et al. 2006, Norris and Batie 1987, and Qualls et al 2012). From these studies, several factors emerge as potential drivers of the

adoption of technology directed at natural resource conservation including farm size, farmer education, farmer age, farm tenure, and other characteristics of the farm operator (Fugile and Kasack 2001). These farm characteristics and farmer demographic factors can also be applied toward the likelihood that a producer would switch to a more conservation-compatible practice (Lambert et al 2006).

Adoption of new technologies or management practices can be influenced by a variety of attitudinal factors including the farmer's perceptions of risk and uncertainty (Houston and Sun 1999). Expectations about additional costs associated with a new practice may outweigh expected future returns and influence the adoption decision (Kim, Gillespie, and Paudel 2005). Furthermore, actual realized benefits and expected benefits might differ because of a lack of information about the technology, suggesting some role for public sector involvement to reconcile this difference (Feder and Umali 1993). One means of intervention to encourage adoption is a cost share system designed to increase utilization of conservation practices by increasing the benefits, both expected and realized to producers (Lichtenberg and Smith-Ramirez 2011).

Farmer Demographics

The demographics of farmers may influence their decision to adopt or not, as well as the rate at which a technology or practice is adopted. Findings regarding the effects of age on adoption of improved practices or technologies have been mixed. The effect of age of the famer on the adoption decision has been found to be negative as younger producers are typically more likely to adopt a new system because of a longer time horizon to amortize the costs of adopting as well as receive expected benefits (e.g. Daberkow and McBride 1998; Qualls et al 2012). However, in an analysis of the factors influencing BMP adoption in beef cattle production, it was

found that age had a positive effect on the adoption of BMPs, possibly due to the greater availability of time the older farmers may have due to retirement as well as the fact that most BMPs have been encouraged for many years (Kim, Gillespie, and Paudel 2005).

Higher education levels have been found to have a positive effect on improved management. The higher the education level of the decision maker, the more likely they are to adopt a new management practice (e.g. Daberkow and McBride 1998; Jensen et al 2007). Researchers have suggested that this finding is due to the increase in education, the greater their capacity to utilize the technologies as well as the increase in managerial responsibilities (Fernandez- Cornejo, Daberkow, and McBride 2001). However, in a meta-analysis of adoption literature by Baumgart-Getz, Prokopy, and Floress (2012), they found that formal education is not as significant as extension education in determining adoption behavior, which suggests that direct education about a topic can influence the adoption of that practice. Education from interactions with extension has also been found to positively effect adoption. In a study looking at the factors that affected farmer’s awareness of state programs, it was found that the number of extension workshops attended by the farmer or the use of extension pamphlets increased the farmer’s knowledge about these programs (Velandia et al 2012). These findings suggest both formal education and continuing education should be considered.

Findings from prior studies have suggested that farms at which income is generated from farming activities and where there is less reliance on off-farm income sources are more likely to participate in conservation oriented programs (Lambert, Sullivan, and Claassen 2007). As programs that provide financial compensation to farmers increase their income earned from the farm, Kim, Gillespie, and Paudel (2005) conclude that programs like Environmental Quality Incentives Program (EQIP) are useful to provide economic assistance to underserved or lower

income farmers to encourage them to switch to a new practice and continue using that practice over time.

Farm Characteristics

Characteristics of the farming operation also play a role in willingness to adopt. Total farm size was found to have a positive effect on adoption more frequently than a negative effect in an analysis of BMP adoption literature (Prokopy et al 2008). This finding could be due to the fact that with more available acres, the producer is able to spread their fixed cost out more than a producer who does not have the same amount of available acreage (Fernandez-Cornejo, Daberkow, and McBride 2001). However the amount of land that is leased can have a negative effect as the farmer does not necessarily have secure land tenure (Jensen et al 2007). Because adoption of a prescribed grazing system would require that the investment of the farmer be tied to the land, land ownership is likely to have a positive effect on the adoption of most BMPs for cattle production (Gillespie, Kim, and Paudel 2007). This can be attributed to the fact that these practices are very site specific and ownership of the land is the only way to ensure that the desired benefits are able to be enjoyed by the adopter. However, it has been noted that utilizing some of these BMPs are ways for tenants to improve relationships with landowners, which may provide a justification for adopting by tenants (Daberkow and McBride 1998).

Because the investment in prescribed grazing infrastructure is tied to the land, it is expected that plans for the respondent's family to take over the operation after the respondent is no longer in charge will also have a positive effect on adoption as long as the respondent is interested in maintaining or expanding their familial relationships (Kim, Gillespie, Paudel 2008). This can be attributed to the desire of the respondent to leave their business in the best situation for their family member to be successful.

It has also been found that the type of the business structure can influence has a positive effect on willingness to adopt. Past research has suggested that certain the business structures (i.e. partnerships, corporations), positively influence the adoption of a technology (Lee and Pennings 2002). The effect of the respondent having already participated in a government program is unknown due to the fact that depending on the program, either a positive or negative effect on adoption can be seen (Gillespie et al 2007).

Off-farm income can also play a role in adoption. According to Norris and Batie (1987), as off-farm income increases, adoption of conservation practices decreases. In a meta-analysis of BMP adoption literature, it was hypothesized that this could be attributed to the percent of the household income from farming being interpreted as a proxy for producer commitment to the operation (Baumgart-Getz et al 2012).

On-farm income has been found to have a positive effect on adoption as long as the income is greater than $75,000. Below that on-farm income has been found to have a negative effect in adoption decisions (Ellis 2006). It is also difficult to determine the effect of total income on the respondent's decision. While it has been found that higher income has a positive effect on adoption (Feder, Just, and Zilberman 1985), Kim, Gillespie, and Paudel (2005) point out that the amount of available income has a positive effect on adoption, and therefore the debt to asset ratio can be more important than the actual level of income in determining willingness to adopt.

Greater diversity of the farming operation, has been found to have a negative effect on adoption, likely because of fewer resources being available for the cattle operation (Kim, Gillespie, Paudel 2008). Previous adoption of pasture management and grazing practices has been found to have a positive effect on adoption of grazing practices in cattle production because it decreases the up-front cost (Kim, Gillespie, and Paudel 2008).

Farmer Attitudes

Farmer’s attitudes towards risk and environmental issues can also play roles in their decision to adopt improved management practices. It has been shown that producers who are risk averse, especially with regards to production and financial risks, are usually late or non-adopters of precision agricultural technologies (Daberkow and McBride 1998). In contrast, perceptions of increasing the profitability of their operations through the adoption of new technologies can have a positive effect on their willingness to adopt (Feder, Just, and Zilberman 1985). A farmer’s level of risk aversion can have either a positive or negative effect on adoption. Past research has found that individuals who identified themselves as risk averse were less likely to adopt BMPs regarding cattle production, specifically grazing practices (Gillespie, Kim, and Paudel 2007). In addition, the respondent’s attitudes towards environmental issues reflect the awareness they possess towards such issues. It has been shown that this awareness does positively influence adoption behavior. Without knowledge of an issue or how that issue could be resolved, it should not be expected that a farmer would adopt a practice that was designed to deal with the issue (Prokopy et al 2008).

Regional/Geographic Variables

Studies have been conducted which look at geographical variables as well as rainfall and soil erosion to determine their effects on improved management practices adoption. According to a synthesis of research regarding adoption of conservation agriculture by Knowler and Bradshaw (2006), these studies present mixed results and therefore it is difficult to hypothesize how regional or geography specific variables will affect adoption. Because of the diversity of ecosystems east of the 100^{th} meridian, even within geographical regions, it is difficult to know whether respondents in one region would be more likely to adopt than others.

Government Programs

In order to increase the adoption of agricultural technologies, the government has traditionally used two strategies. The first is providing information to farmers through avenues such as extension programs, and the second is providing financial support through subsidies or support programs (Feder and Umali 1993). However, the issue of the additional management duties that practices like prescribed grazing require can be an issue that affects adoption (Kim, Gillespie, and Paudel 2008). One means to encourage adoption of BMPs is through educational programs offered by Extension services. However, farmers in the beef industry do not always utilize these programs as the industry is characterized by a majority of producers being part-time hobby farmers (Kim, Gillespie, Paudel 2005). However when farmers use the assistance and information Extension services are able to provide, prior research has shown these services positively influence adoption of conservation agricultural practices (Baumgart-Getz, Prokopy, and Floress 2012, Knowler and Bradshaw 2007, Walton et al 2010).

A problem perceived by many regarding the adoption of a new technology is that there is not much information known about the technology and how it will perform in a real world situation or perhaps more importantly, on a producer's own farm. Therefore, early adopters can be key to providing that information and affecting the decisions of producers later on. Early adopters may experience greater risk because of the greater amount of uncertainty. A subsidy to encourage adoption can provide a means to correct for this difference (Feder and Umali 1993).

Payment programs can play a pivotal role in the adoption of new technology or practices in agriculture, especially those that promote environmental conservation (Cooper 2003). Policy can greatly influence the speed and extent to which these practices are diffused (Fugile and Kasack 2001), and can be used to decrease negative externalities associated with agriculture

while increasing resource conservation (Feder and Umali 1993). Two ways in which the government has traditionally encouraged adoption in the US are education or subsidies/support programs (Feder and Umali 1993). However, according to Houston and Sun (1999): “it is difficult for the government to find the appropriate levels of incentives”. It is also important for any policy to attempt to take into account the expected behavior of those that it affects (Harper and Eastman 1980). To reduce the chances of resource misallocation, careful study can help determine the policy option (Feder and Umali 1993). If the government offered a cost share, than producers would include that amount in their total revenue, which would influence their decision to adopt (Houston and Sun 1999). Information to potentially help lower government program costs is being able to understand factors that influence farmers’ adoption of new management practices (Cooper 2003).

While these studies provide meaningful insight into adoption behavior, there is little known about the behavior of beef cattle producers when given an opportunity to adopt a prescribed grazing system and how a government cost share system can affect those adoption behavior. The current study was performed in order to fill the knowledge gap as well as determine how a hypothetical incentive program influences the farmer’s willingness to adopt and the number of acres converted to prescribed grazing.

Chapter 3: Methods and Procedures

Data Collection and Survey

The survey conducted for this study used a random sample of beef cattle, cow/calf, and backgrounding/stockering operations from the eight Economic Research Service (ERS) Regions that are east of the 100th meridian. The sampling was limited to those operations with at least 20 head of cattle as reported by the 2007 Census of Agriculture in order to eliminate hobby farms. A total of 8,875 operations were randomly chosen from the available population of 267,413 in order to obtain a representative sample. 300 of the available farms received a pretest mailing, therefore 8,875 farms were included in the survey. The sample included in the survey represented three percent of the total available population. The margin of error was three percent at a 95 percent confidence interval. Post stratification weights were also obtained for the total available population using ERS regions as well as income class. 2,258 surveys were returned, providing a response rate of 26 percent. The geographical regions included are from the ERS and are based on commodity production, geographical specialization, and other characteristics. A map of these regions can be seen in Appendix 2.

The National Agricultural Statistics Service (NASS) pulled the sample of farms to be surveyed and performed a pretest as well as a series of three mailings. The pretest included 300 randomly selected cattle producers from the available population sample. Results from the pretest were used to modify the full field survey. The first mailing was an initial survey mailing of the full field survey and the 8,875 operations sampled received the survey, a cover letter, and a self-addressed, stamped envelope to return the survey. Approximately a week after receiving the first survey, the producers in the sample were sent a reminder post card. The fourth mailing was to the producers sampled in the first two mailings that did not return the survey from the first mailing, and included a cover letter and the survey. The surveys were returned to the UT

Forestry, Wildlife and Fisheries Human Dimensions Lab where the responses were coded and entered into datasets.

The survey was divided into three sections. The first section, entitled “Your Farming Operation”, focused on the characteristics of the producer and the operation they manage. Throughout the section, the producer was asked to answer questions such as the number of acres they own, rent, allocate to pasture, and allocate to hay. The section also included questions about the livestock that they have on their farm, and asked more in-depth questions about herd management and pasture management practices. The goal of this section was to understand and quantify the respondents’ farming operations, including their cattle operations, and how they manage them.

The next section, “Prescribed Grazing”, began by informing the respondent about what prescribed grazing is and how it may benefit them, as well as the environment. It also provided details on the actual management practices that together, comprise prescribed grazing. The survey then asked if they used any of the practices involved in prescribed grazing in the previous year and, if so, which ones. If they did use some of the management practices, they were asked about receiving government payment for these practices through federal programs such as EQIP. The respondents who had previously used these management practices and received government payments for them were then asked about a hypothetical program including an incentive level paid over a 10 year period as well as a 75 percent purchase and installation cost share to expand the number of acres managed with prescribed grazing. The respondents who had not received any government payments for prescribed grazing practices were asked about a hypothetical program that also included the 10 year incentive payment as well as the 75 percent purchase and installation cost share to encourage producers to adopt a prescribed grazing system.

"About You" is the last section of the survey. This section was designed to obtain information on the respondents' demographics and information about the factors that may influence their willingness to adopt or expand prescribed grazing. The survey included questions the respondents' age, education, income, and the percentage of income from their farming operation as well as their cattle operation. In this section, questions regarding the amount of hired labor, previous government program involvement, opinions on several statements about the future of farming, and the general plan for the future of their farm were asked.

There were five versions of the survey. Each version was the same in all respects, except for the hypothetical incentive level offered to adopt prescribed grazing. The incentive levels included were $10, $30, $50, $70, and $90. The hypothetical program offered to respondents included the incentive payment that was to be paid out to the respondent over 10 years, along with a 75 percent instillation cost share of regional cost estimates for prescribed grazing. These cost estimates were based on existing cost estimates from program payment structures, such as EQIP, that can be found for each state on the NRCS website (http://www.nrcs.usda.gov/wps/ portal/ nrcs/ detail/national/programs/financial/eqip/?cid=nrcs143_008223). The sample was randomly divided across the five versions of the survey. A copy of the survey can be found in Appendix 1.

Economic Modeling of the Adoption Decision

Producers are assumed to behave in an economically rational manner following the principle of utility maximization in their decision to adopt prescribed grazing, and therefore the decision can be modeled using a random utility model (RUM). Utility is a function of an individual's preferences for quantities of goods or services. Utility can include anything on which an individual places value (Nicholson 2005). Therefore, in order for a farmer to adopt a

new system, the utility that they get from adoption must be greater than or at least equal to their utility of not adopting. The incentive payment is included in the utility of adoption, however utility is not measurable because of unknown components, and therefore utility is a random variable (Cooper and Keim 1996).

An individual's RUM can be shown using the following equation:

$$U_i = \beta' X_i + \varepsilon_i \qquad (1)$$

where $\beta' X_i$ is the portion of utility that is observable, and ε_i, the error term, is the portion of utility that is determined by random components and cannot be measured. There are many factors that affect the expected utility of adoption represented by $\beta' X_i$. These factors include farm size, farmer education, farmer age, farm tenure, attitudes toward risk, and other characteristics of the farm operator (Fugile and Kasack 2001). The survey provides us with information about these factors through the questions it asks.

The decision of how much acreage to convert to prescribed grazing is divided into three decision points. The first decision is whether the farmer is interested in participating in a prescribed grazing program (INTEREST). Given interest in prescribed grazing, the second decision is whether interested producers would be willing to convert or expand acreage to prescribed grazing given the particular hypothetical incentive level offered (recalling that five incentive levels were offered) (ACCEPT). The third decision is how much acreage they would be willing to convert given they are interested and willing to accept the particular incentive level offered (ACRES).

For a producer to adopt a prescribed grazing system, the utility obtained from adopting must be higher than the utility that they were already receiving from their current system. This can be shown as:

$$U_i = U_i^A - U_i^{NA} \quad (2)$$

where U_i^A represents the utility an individual would expect to receive from adopting a prescribed grazing system, while U_i^{NA} represents the utility of not adopting, and U_i represents the difference between the two. As financial concerns can be included in an individual's RUM, incentive levels and cost share programs could influence the individual's utility of the adoption of a new technology or practice (Cooper 2003). Incentive programs can also influence the profit of an operation. By calculating the profit of the operation without adoption as well as with adoption, the difference between the two can be seen as the farmer's risk premium. In order for a farmer to adopt a new technology, the incentive level should be higher than the risk premium. However, as the farmer's decision is a function of their utility, the risk premium can be offset by the other factors that affect the farmer's utility (Cooper and Signorello 2008). It can be expected that the farmer will adopt prescribed grazing if $U_i > 0$, and not adopt if $U_i < 0$ (Walton et al 2010).

The first decision stage modeling interest in prescribed grazing is modeled with an ordered probit. After that a Heckman two-stage estimation was used to determine if the second and third decisions could be estimated independently. Following this is a binary probit for the decision of whether to accept the incentive offered, and the third stage is a linear regression of the acres the farmer would convert. Each of these models will be discussed in the following sections.

Interest in Prescribed Grazing

In the survey, respondents were given three options to choose from to express their interest in adoption of prescribed grazing. These choices were as follows: (1) I would not adopt or expand prescribed grazing even if it was profitable to do so, (2) I would adopt or expand prescribed grazing only if it was profitable to do so, and (3) I would adopt or expand prescribed

grazing even if it was not profitable to do so. As this decision to adopt or not is divided into three separate choices that can be logically ordered in a progression, using an ordered probit model for estimation allows the ranked nature of the dependent variable to be exploited.

Using the ordered probit, the probabilities that a respondent would choose INTEREST=1, 2, or 3 as an interest level in prescribed grazing are as follows:

$$Prob\ (\text{INTEREST} = 1) = \Phi(-\boldsymbol{\beta}'\boldsymbol{X}_i^{\boldsymbol{INTEREST}}) \quad (3)$$

$$Prob\ (\text{INTEREST} = 2) = \Phi\left(\mu_1 - \boldsymbol{\beta}'\boldsymbol{X}_i^{\boldsymbol{INTEREST}}\right) - \Phi(-\boldsymbol{\beta}'\boldsymbol{X}_i^{\boldsymbol{INTEREST}})$$

$$Prob\ (\text{INTEREST} = 3) = \Phi\left(\mu_2 - \boldsymbol{\beta}'\boldsymbol{X}_i^{\boldsymbol{INTEREST}}\right) - \Phi\left(\mu_1 - \boldsymbol{\beta}'\boldsymbol{X}_i^{\boldsymbol{INTEREST}}\right)$$

(Greene 2011). It can be expected that individuals with a greater U_i^{NA} than U_i^{A} would choose INTREST=1, while those that obtain a higher U_i^{A} than U_i^{NA} would choose INTEREST=3, and those that choose INTEREST=2 would be influenced by the incentive level and therefore their risk premium could play a significant role in their willingness to adopt. The log-likelihood function for the *ith* individual can then be expressed as:

$$\text{LogL} = \sum_{i=1}^{n}\sum_{J=0}^{j} m_{ij} log\ [\Phi\left(\mu_j - \boldsymbol{\beta}'\boldsymbol{X}_i^{\boldsymbol{INTEREST}}\right) - \Phi\left(\mu_{j-1} - \boldsymbol{\beta}'\boldsymbol{X}_i^{\boldsymbol{INTEREST}}\right)] \quad (4)$$

(Greene and Hensher 2009). The variables in the $\boldsymbol{X}^{\boldsymbol{INTEREST}}$ matrix are described in Table 1 and discussed later in this chapter. The $\boldsymbol{\beta}$ represents a vector of parameters to be estimated and Φ is the standard normal probability function.

With respect to a given explanatory variable, the estimated coefficients cannot be interpreted directly as slopes of INTEREST. The marginal effects for continuous variables are calculated as:

$$\frac{\partial \Pr\ (INTEREST = j)}{\partial X_i^{INTEREST}} = \left[\phi\left(\mu_{j-1} - \boldsymbol{\gamma}'\overline{\boldsymbol{X}}_i^{\boldsymbol{INTEREST}}\right) - \phi\left(\mu_j - \boldsymbol{\gamma}'\overline{\boldsymbol{X}}_i^{\boldsymbol{INTEREST}}\right)\right]\boldsymbol{\beta}. \quad (5)$$

To calculate the effects of a binary or dummy variable, D, on the probability of a given interest level:

$$(D) = [\Phi\big(\mu_j - \boldsymbol{\gamma_1}\overline{\boldsymbol{X}}_{\mathbf{1}}^{\boldsymbol{INTEREST}} - \ldots - \boldsymbol{\gamma_{j\neq k}}\overline{\boldsymbol{X}}_{\mathbf{j\neq k}}^{\boldsymbol{INTEREST}} + \gamma_k\big) - \Phi\big(\mu_{j-1} - \boldsymbol{\gamma_1}\overline{\boldsymbol{X}}_{\mathbf{1}}^{\boldsymbol{INTEREST}} - \ldots - \boldsymbol{\gamma_{j\neq k}}\overline{\boldsymbol{X}}_{\mathbf{j\neq k}}^{\boldsymbol{INTEREST}} + \gamma_k\big)] - [\Phi\big(\mu_j - \boldsymbol{\gamma_1}\overline{\boldsymbol{X}}_{\mathbf{1}}^{\boldsymbol{INTEREST}} - \ldots - \boldsymbol{\gamma_{j\neq k}}\overline{\boldsymbol{X}}_{\mathbf{j\neq k}}^{\boldsymbol{INTEREST}} + 0\big) - \Phi\big(\mu_{j-1} - \boldsymbol{\gamma_1}\overline{\boldsymbol{X}}_{\mathbf{1}}^{\boldsymbol{INTEREST}} - \overline{\boldsymbol{X}}_{\mathbf{j\neq k}}^{\boldsymbol{INTEREST}} + 0\big)] \quad (6)$$

(Greene and Hensher 2009).

Table 1: Variables for the Interest in Adoption Ordered Probit Model

Variable Name	Description	Mean
Dependent Variable:		
INTEREST	1 I would not adopt or expand prescribed grazing even if it was profitable to do so 2 I would adopt or expand prescribed grazing even if it was not profitable to do so 3 I would adopt or expand prescribed grazing only if it was profitable to do so	1.79
Explanatory Variables:		
AGE	Age	61.38
AGE^2	Age^2	3916.09
INCL30	Household Income less than $30,000 *Omitted	
INC3049	0,1 Household Income $30,000-$49,999	0.19
INC5099	0,1 Household Income $50,000-$99,999	0.41
INC100149	0,1 Household Income $100,000-$149,999	0.12
INCG150	0,1 Household Income greater than $150,000	0.15
COLLEGE	1 if attended any college at all, 0 if otherwise	0.61
EXTWKSHP	Number of Extension or other educational workshops attended in 2012	0.95
RENT	1 if any land rented, 0 if otherwise	0.53
PASTURE	Number of acres used for pasture	413.74
INPUTMGT	1 if any input pasture management practices (applied manure for fertilizer, use of N, P, or K for fertilizer, etc.), 0 if otherwise	0.84
STRUCTURALMGT	1 if any structural pasture management practices (improved stream crossings, use of geotextile fabrics, etc.), 0 if otherwise	0.84
FEEDINGMGT	1 if any feeding-based grazing practices used (balanced livestock consumption and forage production, limit hay to no more than 50% of livestock diet, etc.), 0 if otherwise	0.50
GRASSMGT	1 if any grass based grazing practices (pasture weed control plan, use at least 5 paddocks for grazing, etc.), 0 if none	0.52
HEARTLAND	0,1 ERS Region	0.23

Table 1 Continued

Variable Name	Description	Mean
NORTHERNGREATPLAINS	0,1 ERS Region	0.03
PRARIEGETAWAY	0,1 ERS Region	0.16
EASTERNUPLANDS	0,1 ERS Region	0.29
SOUTHERNSEABOARD	0,1 ERS Region	0.13
FRUITFULRIM	0,1 ERS Region	0.03
MISSISSIPPIPORTAL	0,1 ERS Region	0.07
NORTHERNCRESCENT	ERS Region *Omitted	
PRESCGRAZCOST	The cost, by region, of prescribed grazing	30.03
STKRATE	Stocking Rate: (.92*cows+ .08* calves+ 1.35* bulls+ .6*backgrounder calves+ .6*stocker calves+ .92*dairy cows+ .8*replacement heifers +.8*miscellaneous cattle)/ total number of pasture acres farmed	0.52
OTHLIV	1 if other livestock present on the farm in 2012, 0 if otherwise	0.28
FEDPRGM	1 if participated in any federal programs, 0 if otherwise	0.25
LIFE	1 Strongly Agree-5 Strongly Disagree: For me, farming is not only a business it is a way of life.	4.43
WAIT	1…-5…: I tend to wait until others have adopted new technologies or practices before I adopt them.	2.86
CLIMATE	1…-5…: I am concerned that climate change will negatively impact the yield of my product.	3.18
STEWARD	1…-5…:As a farmer, I am a steward of the land I farm and it is my obligation to protect it for use by future generations.	4.64
FAMTKOVER	1,0 Your children/grandchildren will farm your land after you cease farming	0.62
INTERNET	Do you use internet to make farm purchases or farm management decisions?	0.45
PROPRIATOR	1 if Farming Business is Sole Proprietorship, 0 if not	0.82
OFFFARMWORK	1 if any reported hours working off farm, 0 if none	0.53

N= 1341

[1] Stocking Rate formula was derived from Colorado State's Extension service at http://www.range.colostate.edu/calculators.shtml by using their stocking rate multipliers given to each category of cattle

Relationship between models for ACCEPT and ACRES

To test whether the decision to accept a given incentive level (ACCEPT) and decision of how many acres to covert given incentive acceptance (ACRES) were related, the Heckman two-stage estimation was used. This model provides the inverse Mill's ratio, which if significant shows that the two models are related (Kennedy 1998). The Heckman two-step estimation proceeds as follows:

Stage 1: Obtain estimates of $\hat{\lambda}_i$ by estimating the probit model by maximum likelihood estimation for equation (6):

$$\hat{\lambda}_i = \frac{(\phi(\boldsymbol{\gamma}'\boldsymbol{Z_i})}{\Phi(\boldsymbol{\gamma}'\boldsymbol{Z_i})} \tag{14}$$

where ϕ is the standard normal density at $\boldsymbol{\gamma}'\boldsymbol{Z_i}$ and Φ is the standard normal distribution at $\boldsymbol{\gamma}'\boldsymbol{Z_i}$.

Stage 2: Perform an OLS regression of ACRES on $\mathbf{Y}$ and $\hat{\lambda}$ to estimate $\boldsymbol{\eta}$ and $\boldsymbol{\eta}_\lambda = \rho\sigma_\varepsilon$ (Greene 1993). For observations where ACCEPT=1, the expected value of ACRES is then

$$E[ACRES_i^*|ACCEPT_i = 1] = \boldsymbol{\eta}'\boldsymbol{Y_i} + \boldsymbol{\eta}_\lambda\lambda_i. \tag{15}$$

The null hypothesis is that $\boldsymbol{\eta}_\lambda = 0$, or that the two models are independent. If the t test of the significance of $\boldsymbol{\eta}_\lambda$ indicates that it is significantly different from zero, then the two models cannot be considered independent.

Incentive Acceptance

The decision of whether to accept the incentive level offered is captured as a binary dependent variable, and hence is modeled using a probit model (Kennedy 1998). Included in this model are the respondents that expressed a willingness to participate in prescribed grazing by selecting 2 or 3 for INTEREST. Intuitively, in order to determine how a hypothetical incentive program would affect the acceptance levels, only those individuals who are willing to participate would be affected by the changes in incentive level. Individuals who are not interested in

participating regardless of incentive level would not be affected by the changes in incentive level. It can be expected that if the utility of accepting the incentive and adopting is greater than the incentive of not accepting the incentive and staying with their current program, than they would accept the incentive level offered.

Letting ACCEPT=1 if producers are willing to accept the incentive level offered and participate in prescribed grazing (utility of accepting the incentive and adopting is greater than the incentive of not accepting the incentive and staying with their current program), then the probability of acceptance can be represented as:

$$Pr(\text{ACCEPT} = 1|\text{INTEREST} > 1) = Pr(U^{A} > U^{NA}) \quad (7)$$
$$= \Pr(\boldsymbol{\gamma}'\boldsymbol{X}^{\boldsymbol{ACCEPT}} > \varepsilon\,|\boldsymbol{X}^{\boldsymbol{ACCEPT}})$$
$$= \Phi(\boldsymbol{\gamma}'\boldsymbol{X}_{\mathbf{i}}^{\mathbf{ACCEPT}})$$

where $\boldsymbol{\Phi}$ is the standard normal distribution at $\boldsymbol{\gamma}'\boldsymbol{X}_{\mathbf{i}}^{\mathbf{ACCEPT}}$ given use of the probit model. The variables in the $\boldsymbol{X}^{\mathbf{ACCEPT}}$ matrix are shown in Table 2 and the $\boldsymbol{\gamma}$ represents a vector of parameters to be estimated. The log-likelihood function for the *ith* individual can then be expressed as:

$$\text{Log L} =$$
$$\sum_{\mathrm{i}=1}^{\mathrm{n}} \{\text{ACCEPT}_{\mathrm{i}} \log \Phi\big(\boldsymbol{\gamma}'\boldsymbol{X}_{\mathbf{i}}^{\mathbf{ACCEPT}}\big) + (1 - \text{ACCEPT}_{\mathrm{i}}) \log\,[1 - \log \Phi\big(\boldsymbol{\gamma}'\boldsymbol{X}_{\mathbf{i}}^{\mathbf{ACCEPT}}\big)]\}\,. \quad (8)$$

The marginal effects for continuous variables in the probit model of incentive level acceptance (ACCEPT) were determined using the equation:

$$\frac{\partial \Pr\,(ACCEPT_{i}=1)}{\partial X_{\mathbf{i}}^{\mathbf{ACCEPT}}} = [\phi\big(\boldsymbol{\gamma}'\overline{\boldsymbol{X}}_{\mathbf{i}}^{\mathbf{ACCEPT}}\big)]\boldsymbol{\beta} \quad (9)$$

where ϕ is the standard normal probability density function at $\boldsymbol{\gamma}'\overline{\boldsymbol{X}}_{\mathbf{i}}^{\mathbf{ACCEPT}}$, with all the $\boldsymbol{X}^{\mathbf{ACCEPT}}$ variables held at their means. The marginal effects of binary variables probability of acceptance were calculated by holding all other variables than that of interest at their means and letting the

variable of interest, $\boldsymbol{X}_{\boldsymbol{k}}^{\mathbf{ACCEPT}}$, be set at 0 then 1 and calculating the probability for each level.

The difference between these two calculated probabilities is then the marginal effect.

$$Pr(\text{ACCEPT} = 1|\boldsymbol{X}_{\boldsymbol{k}}^{\mathbf{ACCEPT}} = 1) - Pr(\text{ACCEPT} = 1|\boldsymbol{X}_{\boldsymbol{k}}^{\mathbf{ACCEPT}} = 0) = \Phi(\gamma_0 + \boldsymbol{\gamma_1}\overline{\boldsymbol{X}}_{\mathbf{1}}^{\mathbf{ACCEPT}} + \ldots + \boldsymbol{\gamma_{j\neq k}}\overline{\boldsymbol{X}}_{\mathbf{j\neq k}}^{\mathbf{ACCEPT}} + \gamma_k 1) - \Phi(\gamma_0 + \boldsymbol{\gamma_1}\overline{\boldsymbol{X}}_{\mathbf{1}}^{\mathbf{ACCEPT}} + \ldots + \boldsymbol{\gamma_{j\neq k}}\overline{\boldsymbol{X}}_{\mathbf{j\neq k}}^{\mathbf{ACCEPT}} + \gamma_k 0) \quad (10)$$

Table 2: Variables for the Adoption at the Given Incentive Level Probit Model[1]

Variable Name	Description	Mean
Dependent Variable:		
ACCEPT	1 Yes I would adopt prescribed grazing at the incentive level, 0 if not	0.74
Explanatory Variables:		
INCENT	Incentive level offered to the respondent by the survey	50.18
AGE	Age	60.04
AGE^2	Age^2	3742.0
INCL30	Household Income less than $30,000 *Omitted	
INC3049	0,1 Household Income $30,000-$49,999	0.15
INC5099	0,1 Household Income $50,000-$99,999	0.43
INC100149	0,1 Household Income $100,000-$149,999	0.14
INCG150	0,1 Household Income greater than $150,000	0.17
COLLEGE	1 if attended any college at all, 0 if otherwise	0.68
EXTWKSHP	Number of Extension or other educational workshops attended in 2012	1.15
RENT	1 if any land rented, 0 if otherwise	0.56
PASTURE	Number of acres used for pasture	448.15
INPUTMGT	1 if any input pasture management practices (applied manure for fertilizer, use of N, P, or K for fertilizer, etc.), 0 if otherwise	0.89
STRUCTURALMGT	1 if any structural pasture management practices (improved stream crossings, use of geotextile fabrics, etc.), 0 if otherwise	0.89
FEEDINGMGT	1 if any feeding-based grazing practices used (balanced livestock consumption and forage production, limit hay to no more than 50% of livestock diet, etc.), 0 if otherwise	0.61
GRASSMGT	1 if any grass based grazing practices (pasture weed control plan, use at least 5 paddocks for grazing, etc.), 0 if none	0.63

Table 2 Continued

Variable Name	Description	Mean
HEARTLAND	0,1 ERS Region	0.22
NORTHERNGREATPLAINS	0,1 ERS Region	0.04
PRARIEGETAWAY	0,1 ERS Region	0.17
EASTERNUPLANDS	0,1 ERS Region	0.27
SOUTHERNSEABOARD	0,1 ERS Region	0.12
FRUITFULRIM	0,1 ERS Region	0.03
MISSISSIPPIPORTAL	0,1 ERS Region	0.07
NORTHERNCRESCENT	ERS Region *Omitted	
PRESCGRAZCOST	The cost, by region, of prescribed grazing	29.99
STKRATE	Stocking Rate: (.92*cows+ .08* calves+ 1.35* bulls+ .6*backgrounder calves+ .6*stocker calves+ .92*dairy cows+ .8*replacement heifers +.8*miscellaneous cattle)/ total number of pasture acres farmed	0.51
OTHLIV	1 if other livestock present on the farm in 2012, 0 if otherwise	0.31
FEDPRGM	1 if participated in any federal programs, 0 if otherwise	0.28
LIFE	1 Strongly Agree-5 Strongly Disagree: For me, farming is not only a business it is a way of life.	4.48
WAIT	1…-5…: I tend to wait until others have adopted new technologies or practices before I adopt them.	2.72
CLIMATE	1…-5…: I am concerned that climate change will negatively impact the yield of my product.	3.21
STEWARD	1…-5…:As a farmer, I am a steward of the land I farm and it is my obligation to protect it for use by future generations.	4.71
FAMTKOVER	1,0 Your children/grandchildren will farm your land after you cease farming	0.63
FAMTKOVER	1,0 Your children/grandchildren will farm your land after you cease farming	0.63
INTERNET	Do you use internet to make farm purchases or farm management decisions?	0.54
PROPRIATOR	1 if Farming Business is Sole Proprietorship, 0 if not	0.80
OFFFARMWORK	1 if any reported hours working off farm, 0 if none	0.57
N= 875		

[1] Stocking Rate formula was derived from Colorado State's Extension service at http://www.range.colostate.edu/calculators.shtml by using their stocking rate multipliers given to each category of cattle

Acres to be Converted

The third decision point, the number of acres to be converted by producers if interested in participating and accepting the incentive level offered, can be modeled with a linear regression using Ordinary Least Squares (OLS) estimation. By using OLS, we are able to determine how the explanatory variables influence the dependent variable (Wooldridge 2009). In order to meet the assumptions for the estimates of OLS to be the best linear unbiased estimates, or BLUE, as the Gauss- Markov Theorem proves, the model must be linear, there must be random sampling, there must be variation in the explanatory variables, zero conditional mean, and homoscedasticity (Wooldridge 2009). The linear regression is shown in the equation:

$$\text{ACRES}_i|\text{INTEREST}_i > 1 \ \& \ \text{ACCEPT}_i = 1 = \boldsymbol{\eta}'\boldsymbol{X}_i^{\boldsymbol{ACRES}} \quad (11)$$

The variables, $\boldsymbol{X}^{\boldsymbol{ACRES}}$, used in the estimation are shown in Table 3 and $\boldsymbol{\eta}$ represents a vector of parameters to be estimated.

Table 3: Variables for the Acreage Conversion Linear Regression

Variable Name	Description	Mean
Dependent Variable:		
ACONVERT	Number of acres respondent chooses to convert to prescribed grazing	256.25
Explanatory Variables:		
INCENT	Incentive level offered to the respondent by the survey	51.97
TOTACFARM	Total number of acres the respondent farms	572.87
TOTAFINCENT	Incentive level x Total acres farmed	33149.44
N= 618		

Tests of Model Significance and Measures of Performance

The overall significance of the models was determined using a Likelihood Ratio (LR) test for the first and second models, and an F test for the third. The LR test allows all of the variables to be tested for significance and concludes if the model is significant. The equation for the LR test is:

$$LR = 2(L_u - L_r) \tag{12}$$

where L_u is the log-likelihood of the unrestricted model and L_r is the log-likelihood of the restricted model (Woolridge 2009). The F test for overall significance of the model works similarly to the LR test, in hypothesizing that none of the explanatory variables has an effect on the dependent variable and testing that hypothesis. This is represented in the equation:

$$F = \frac{R^2/k}{(1-R^2)(n-k-1)} \tag{13}$$

where R^2 is the coefficient of determination from the model, *n* represents the sample size, and *k* represents the number of explanatory variables (Wooldridge 2009). Measures of the explanatory power of the models include the R^2 for the OLS model and the Pseudo R^2 for the probit and ordered probit models. The Pseudo R^2 is equal to $1 - (\ln L / \ln L_0)$, where $\ln L_0$ is the log likelihood of an intercept only model. Of additional importance is how well each model correctly classifies the observations. Therefore, the percent of observations correctly classified is calculated for each model (100*number of observations correctly classified by the model/total number of observations used in model).

Weighted Regressions

These three decision stages were also run as weighted models. These weights are post-stratification weights that attempt to project the results from those chosen to take the survey, over the entire population that could have been sampled. The sampling weights are defined by Lohr (1999) as the reciprocal of the probability that the unit is included in the sample. The sampling weights used in the analysis are based on household income level as well as ERS (Economic Research Service) region. Using these weights allows us to approximate the number of farms that would be in the same income and regional categories according to the 2007 Agricultural

Census. Therefore the farms that fall into the same categories are weighted the same. This allows us to see how the responses may change when projected out over the entire sample.

Hypothesized Effects

While the variables considered in the decision to express interest in adoption (INTEREST) and in the decision to adopt at the given incentive level (ACCEPT) are the same except for the inclusion of INCENT in the second decision, the variables included in the decision determining the number of acres converted (ACRES) are different. The first two decisions focus largely on characteristics of the farm, farm operator, and attitudes the respondent may have. The third decision is very limited by the number of acres the respondent has available to convert to a prescribed grazing system, and also relies very heavily on the incentive level offered. The discussion of the farmer demographics, farm characteristics, and attitudes hypothesized to influence INTEREST and ACCEPT will be presented first. This discussion will be followed by a discussion of the influence of the variables in ACRES.

Farmer Demographics

Several studies discuss the effects of certain characteristics of a farm or farm operator that affect willingness to adopt. From these studies, we can hypothesize about the effects of each demographic variable on the overall willingness of the producer to adopt or convert additional acres to a prescribed grazing system.

The effect of age of the respondent (AGE) on adoption rates has been found to be a negative one (e.g. Daberkow and McBride 1998; Qualls et al 2012), and therefore it can by hypothesized that it will negatively impact willingness to adopt. Intuitively, it can be hypothesized that age does not have a linear relationship with adoption behavior as individuals may be willing to participate up to a certain point and then there willingness may decline because

of a shortened planning horizon or additional management requirements, and therefore the quadratic term (AGE^2) is included. Education (COLLEGE) has been found to have a positive effect on new technology or improved management adoption rates and therefore it can be expected to positively influence the respondents' willingness to adopt. The higher the education level of the decision maker, the more likely they are to adopt a new management practice (e.g. Daberkow and McBride 1998; Jensen et al 2007). Following the same thought process, it can be expected that the number of educational workshops attended by the producer (EXTWKSHP) might also have a positive effect on the adoption rates. Since producers who use the internet for their farming operation have a very large body of educational resources at their fingertips, the use of the internet (INTERNET) could also be expected to have a positive effect.

Prior studies have found that income (INC) can also play roles in adoption. However, as the results of these prior studies present mixed findings, it is difficult to hypothesize about the effects of income on adoption decisions. According to Norris and Batie (1987), as off-farm income increases, adoption rates decrease. On-farm income has been found to have a positive effect on adoption rates as long as it is greater than $75,000. Below that it has been found to have a negative effect (Ellis 2006). However, it is difficult to determine the effect of total income on the respondent's decision. While it has been found that higher income is expected to have a positive effect on adoption rates, however the importance of debt on the decision to adopt has also been noted (Feder, Just, and Zilberman 1985). Kim, Gillespie, and Paudel (2005) point out that the amount of available income has a positive effect on adoption rates, and therefore the debt to asset ratio is more important than the actual level of income in determining willingness to adopt.

Farm Characteristics

Total farm size (TOTACF, PASTURE) has been found to have a positive effect on adoption the adoption of conservation practices (Knowler and Bradshaw 2007, Prokopy et al 2008); however the amount of land that is leased (RENT) has been found to have a negative effect on the adoption of new technology as the farmer does not necessarily have future interest in the land (Jensen et al 2007). In this instance, since the adoption of a prescribed grazing system would lead to the investment being tied to the land, land ownership is likely to have a positive effect on adoption rates (Daberkow and McBride 1998). Also, since the investment is tied to the land, it is expected that plans for the respondent's family to take over the operation after the respondent is no longer in charge (FAMTKOVER) will also have a positive effect on adoption (Kim, Gillespie, Paudel 2008). It has also been found that the size of the business itself has a positive effect on adoption rates. According to Lee and Pennings 2002, the larger the business structure is, the more likely they are to adopt. Therefore it can be hypothesized that a sole proprietorship (PROPRIETOR) will have a negative effect on adoption rates. The effect of the respondent having already participated in a government program (FEDPRGM) is unknown due to the fact that depending on the program, it can have either a positive or negative effect on adoption (Gillespie et al 2007). Therefore the expected effect on adoption is unknown as

Increased diversity in the farming operation, in this case the livestock present on the farm (OTHERLIV), is expected to have a negative effect on adoption because of fewer resources available for the cattle operation (Kim, Gillespie, Paudel 2008). Previous use of pasture management (INPUTMGT, STRUCTURALMGT) such as the use of fertilizers and prescribed grazing practices (FEEDMGT, GRASSMGT) such as having at least 5 paddocks for grazing cattle would additionally be expected to have a positive effect on adoption. Previous adoption of

pasture management and grazing practices can be expected to have a positive effect on adoption rates because having some of these practices already in place decreases up-front costs of fencing, forage management, input time, etc. (Kim, Gillespie, and Paudel 2008).

Farmer Attitudes

Prior research has indicated that opinions of the respondent also affect their willingness to adopt a new technology or management system, such as prescribed grazing. If the producer's has a negative opinion of the time it would take to implement and carry out a prescribed grazing system and the total investment cost (PRESCGRZCOST) will likely have a negative effect on their willingness to adopt. Both of these factors increase the risk that the producer is taking by adopting. It has been shown that producers who perceive a large amount of risk, especially production and financial, with adopting a new system are usually late or non-adopters (Daberkow and McBride 1998). In contrast, the perceived opinion of the respondents as to if adopting the new system will increase the profitability of their operations will have a positive effect on their willingness to adopt (Feder, Just, and Zilberman 1985). The respondent's tendencies to wait until others have adopted (WAIT) can also have a negative effect on their decision. As they are less willing to adopt and assume risk in general terms, they will be less willing to adopt in this situation (Qualls 2011). However, respondent's attitudes about their role as a farmer to be a steward of the land, how they view their way of life (STEWARD, LIFE), and the how the changing climate will affect their production (CLIMATE) can have a positive effect on adoption rates. Awareness has previously been associated with a positive effect on adoption rates (Prokopy, Klotthor-Weinkauf, and Baumgart-Getz 2008), and these attitude variables are ways of highlighting the respondent's awareness of environmental issues as well as their role in these issues.

According to a synthesis of research looking at the effects of geographical variables on the adoption of conservation agriculture by Knowler and Bradshaw (2006), these studies present mixed results and therefore it is difficult to hypothesize how regional or geography specific variables will affect adoption rates. Because of the diversity of ecosystems east of the 100^{th} meridian, even within geographical regions, it is difficult to know whether respondents in one region would be more likely to adopt than others.

The incentive level (INCENT) offered to the respondent is expected to positively influence the farmer's willingness to adopt as well as the number of acres converted to prescribed grazing as it increases (Houston and Sun 1999). It is unknown how the interaction between the incentive level and the number of acres farmed (TOTAFINCENT) will influence the number of acres converted as there may or may not be an amount of acres the farmer chose to convert that would no longer be profitable.

Chapter 4: Results and Discussion

Results

The results from this study suggest that about 52 percent of producers stated that they are already using some form of prescribed grazing. In terms of interest in adopting or increasing prescribed grazing, 48 percent were interested if it was profitable, and 11 percent were interested even if it was not profitable. Thus, a total of 59 percent of the respondents were interested, while 11 percent of the respondents may see greater value in the environmental benefits from prescribed grazing than the other farmers. About 68.5 percent of those farmers who were interested would accept the bid offered. Among the respondents that were interested in adoption, 62 percent chose to adopt at the $10 incentive level, 62.5 percent at $30, 69 percent at an incentive level of $50, 73 percent at $70, and 76 percent at the $90 incentive level. Out of the total number of respondents, 40 percent were willing to convert an average of 256 acres to prescribed grazing at an average incentive level of $51.

The results are presented in this chapter for each model of the adoption decision process. These decisions are the level of interest in adopting a prescribed grazing system (INTEREST), whether or not the respondent is willing to adopt prescribed grazing at a given incentive level (ACCEPT), and how many acres they would convert at that incentive level (ACRES). The first decision is estimated as an ordered probit, the second decision is modeled as a binary probit, and the third is a linear regression estimated with an OLS model. The estimates for each model are presented along with the estimated marginal effect. In addition to presenting the results of each model, a test of independence of the second and third models, ACCEPT and ACRES, is also presented.

Interest in Adopting Prescribed Grazing

The estimated coefficients for the ordered probit model of interest in prescribed grazing can be seen in Table 4a. The marginal effects were estimated in order to show the magnitude of the effect of the explanatory variables on INTEREST and can be seen in Table 4b.

The overall significance of the model is determined using an LR test, which gives a value of 330.21, and therefore the model is significant overall at the 95 percent confidence level. The Pseudo R^2 was 0.1243. Of the 1,341 respondents, the model correctly predicted 64 percent of responses regarding interest level. Out of that 1,341, 440 of the respondents said that they would not adopt prescribed grazing even if it was profitable to do so, and the model correctly predicted 75 percent of these responses. Of the respondents, 742 indicated that they would adopt prescribed grazing only if it was profitable to do so, and the model correctly predicted these responses 64.5 percent of the time. Of the 159 respondents who would adopt prescribed grazing even if it was not profitable to do so, the model correctly predicted 88 percent of their responses. Overall 59 percent of the respondents were interested in adopting prescribed grazing if it would be profitable (48 percent) or even if it would not be profitable (11 percent).

The model exhibited 16 statistically significant variables influencing the decision of INTEREST. Of these variables, 11 had the hypothesized effect. However, AGE and OTHERLIV positively influenced adoption, while it was hypothesized that they would have a negative influence. Respondents who attended at least some college (COLLEGE) and the number of extension workshops (EXTWKSHP) the respondents attended play a significantly positive role in interest in adoption, as well as the respondents who use the internet for their farm business (INTERNET). These findings support previous findings suggestion that education and information influence the adoption of conservation practices. In addition, respondents that have

other livestock present on their farm (OTHERLIV) are positively influenced rather than negatively influenced as the literature suggests. This finding could potentially be explained by the need to increase the productivity of the respondent's land, which would decrease the amount of land needed for the current cattle population since there is more than one species utilizing the available land. The respondents who were already using pasture management practices (INPUTMGT, STRUCTURALMGT) and prescribed grazing practices (FEEDINGMGT, GRASSMGT) also showed a positive, significant effect on the decision to be interested in adopting a prescribed grazing system. This could be attributed to the fact that the more of these practices already in place, the less of an investment it would be to adopt prescribed grazing, therefore reducing their cost.

It was uncertain how the income and regional variables would likely influence interest in adoption. Producers with an income between $100,000 and $149,000 (INC100149) positively influenced adoption relative to the omitted category, income less than $30,000 (INCL30). Respondents in the EASTERNUPLANDS were less likely to be interested in prescribed grazing than producers in the base region that was omitted, NORTHERNCRESCENT. The income could have a positive influence because that is an income range where people have more financial flexibility than those in lesser income categories, so they may be able to take more risks. At income levels above $150,000, the opportunity cost of adoption could be much higher than at lower income levels. EASTERNUPLANDS may have negatively influenced adoption because of the regional characteristics, such as small farms and part-time cattle farms (ERS 2010).

As seen in Table 4b, INCG150 has a positive marginal effect on choosing Outcome 2, while it was not statistically significant in the overall decision, or when determining Outcomes 1 or 3. This could be attributed to some respondents in that income category choosing to adopt if

the incentive level will allow them to be profitable, while the other respondents in INCG150 show no interest in adoption. INC100149 also loses significance in its effect on Outcome 3, while it is statistically significant to the model as well as Outcomes 1 and 2, but increases in significance in Outcome 2 as compared with Outcome 1 . As Outcome 3 is not based on monetary issues as the respondent is choosing to adopt even if not profitable, the income level losing significance for Outcome 3 is not surprising. As profit does not matter to the respondents who chose Outcome 3, their income level would play no role in their decision as well. COLLEGE also gains significance in Outcome 1, showing that respondents who did not attend college are much more likely not to adopt, and STRUCTURALMGT in Outcome 3 possibly because the respondents who chose Outcome 3 are already much more likely to have several pasture management practices already in place.

Table 4a: Estimated Ordered Probit Model for the Interest in Adoption Decision (INTEREST)[a]

Variable	Est. Coeff	Std. Error	Z
AGE	0.042	0.018	2.290 **
AGE^2	-0.000	0.000	-2.620***
INC3049	0.024	0.118	0.200
INC5099	0.107	0.108	0.990
INC100149	0.223	0.136	1.640*
INCG150	0.181	0.129	1.400
COLLEGE	0.141	0.073	1.930**
EXTWKSHP	0.040	0.018	2.250**
RENT	-0.134	0.068	-1.970**
PASTURE	0.000	0.000	-0.500
INPUTMGT	0.349	0.101	3.450***
STRUCTURALMGT	0.232	0.100	2.320**
PRARIEGETAWAY	-0.057	0.165	-0.340
EASTERNUPLANDS	-0.243	0.149	-1.640*
SOUTHERNSEABOARD	-0.191	0.165	-1.160
FRUITFULRIM	-0.180	0.231	-0.780
MISSISSIPPIPORTAL	0.017	0.187	0.090
PRESCGRAZCOST	-0.002	0.006	-0.380
STKRATE	0.011	0.033	0.330
OTHLIV	0.192	0.073	2.630***
FEDPRGM	0.167	0.076	2.190**
LIFE	-0.009	0.042	-0.220
WAIT	-0.092	0.029	-3.160***
CLIMATE	0.050	0.025	1.960**
STEWARD	0.066	0.048	1.390
FAMTKOVER	0.041	0.069	0.600
INTERNET	0.227	0.075	3.010***
PROPRIETOR	-0.166	0.085	-1.940**
OFFFARMWORK	0.068	0.074	0.930
μ_1	1.517	0.630	2.407**
μ_2	3.399	0.635	5.357***

N=1404 LLR Test Wald $\chi^2(33)$= 330.21*** Pseudo R^2= 0.1243

[a] *** indicates significance at α=.01, ** indicates significance at α=.05, and * indicates significance at α=.10.

Table 4b: Marginal Effects for Interest in Adoption Decision (INTEREST)[a]

Outcome 1 (Not Interested in Prescribed Grazing)

Variable	Marg. Effect	Std. Error	Z
AGE	-0.015	0.006	-2.410**
AGE^2	0.000	0.000	2.780***
INC3049	-0.002	0.040	-0.060
INC5099	-0.026	0.037	-0.720
INC100149	-0.070	0.042	-1.650*
INCG150	-0.059	0.041	-1.450
COLLEGE	-0.046	0.025	-1.830**
EXTWKSHP	-0.014	0.006	-2.330**
RENT	0.045	0.023	1.950**
PASTURE	0.000	0.000	0.450
FEEDINGMGT	-0.075	0.034	-2.190**
GRASSMGT	-0.140	0.034	-4.080***
HEARTLAND	0.049	0.057	0.860
NORTHERNGREATPLAINS	-0.045	0.072	-0.620
PRARIEGETAWAY	0.000	0.056	-0.010
EASTERNUPLANDS	0.077	0.053	1.470
SOUTHERNSEABOARD	0.073	0.060	1.220
FRUITFULRIM	0.062	0.084	0.740
MISSISSIPPIPORTAL	-0.015	0.063	-0.230
PRESCGRAZCOST	0.001	0.002	0.530
STKRATE	-0.004	0.012	-0.310
OTHLIV	-0.066	0.024	-2.790***
FEDPRGM	-0.056	0.025	-2.250**
LIFE	0.004	0.014	0.280
WAIT	0.030	0.010	3.080***
CLIMATE	-0.018	0.009	-2.130**
STEWARD	-0.021	0.016	-1.270
FAMTKOVER	-0.018	0.024	-0.750
INTERNET	-0.078	0.025	-3.070***
PROPRIETOR	0.063	0.027	2.350**
OFFFARMWORK	-0.021	0.025	-0.820

Table 4b. Continued.

Outcome 2 (Interested in Prescribed Grazing if Profitable)			
Variable	Marg. Effect	Std. Error	Z
AGE	0.009	0.004	2.370**
AGE^2	0.000	0.000	-2.720***
INC3049	0.001	0.022	0.060
INC5099	0.015	0.020	0.720
INC100149	0.034	0.017	1.960**
INCG150	0.030	0.018	1.640*
COLLEGE	0.027	0.015	1.780*
EXTWKSHP	0.008	0.003	2.300**
RENT	-0.025	0.013	-1.950**
PASTURE	0.000	0.000	-0.450
INPUTMGT	0.084	0.027	3.070***
STRUCTURALMGT	0.055	0.025	2.180**
FEEDINGMGT	0.041	0.019	2.170**
GRASSMGT	0.079	0.020	3.920***
HEARTLAND	-0.029	0.035	-0.820
NORTHERNGREATPLAINS	0.023	0.032	0.710
PRARIEGETAWAY	0.000	0.031	0.010
EASTERNUPLANDS	-0.046	0.033	-1.390
SOUTHERNSEABOARD	-0.045	0.040	-1.120
FRUITFULRIM	-0.038	0.057	-0.680
MISSISSIPPIPORTAL	0.008	0.033	0.240
PRESCGRAZCOST	-0.001	0.001	-0.530
STKRATE	0.002	0.006	0.310
OTHLIV	0.035	0.012	2.940***
FEDPRGM	0.029	0.012	2.390**
LIFE	-0.002	0.008	-0.280
WAIT	-0.017	0.006	-3.000***
CLIMATE	0.010	0.005	2.110**
STEWARD	0.012	0.009	1.260
FAMTKOVER	0.010	0.013	0.750
INTERNET	0.043	0.014	3.050***
PROPRIETOR	-0.032	0.012	-2.580**
OFFFARMWORK	0.012	0.014	0.820

Table 4b. Continued.

Outcome 3 (Interested in Prescribed Grazing Even if Not Profitable)			
Variable	Marg. Effect	Std. Error	Z
AGE	0.007	0.003	2.400**
AGE^2	0.000	0.000	-2.760***
INC3049	0.001	0.018	0.060
INC5099	0.012	0.017	0.710
INC100149	0.036	0.025	1.420
INCG150	0.030	0.023	1.290
COLLEGE	0.020	0.011	1.870*
EXTWKSHP	0.006	0.003	2.320**
RENT	-0.020	0.010	-1.930**
PASTURE	0.000	0.000	-0.450
INPUTMGT	0.046	0.011	4.150***
STRUCTURALMGT	0.034	0.012	2.770***
FEEDINGMGT	0.033	0.015	2.160**
GRASSMGT	0.061	0.015	3.990***
HEARTLAND	-0.020	0.022	-0.930
NORTHERNGREATPLAINS	0.022	0.040	0.560
PRARIEGETAWAY	0.000	0.025	0.010
EASTERNUPLANDS	-0.032	0.020	-1.590
SOUTHERNSEABOARD	-0.028	0.020	-1.400
FRUITFULRIM	-0.024	0.028	-0.860
MISSISSIPPIPORTAL	0.007	0.030	0.230
PRESCGRAZCOST	0.000	0.001	-0.530
STKRATE	0.002	0.005	0.310
OTHLIV	0.032	0.012	2.560***
FEDPRGM	0.027	0.013	2.070**
LIFE	-0.002	0.006	-0.280
WAIT	-0.013	0.004	-3.050***
CLIMATE	0.008	0.004	2.120**
STEWARD	0.009	0.007	1.270
FAMTKOVER	0.008	0.010	0.760
INTERNET	0.035	0.012	2.970***
PROPRIETOR	-0.031	0.015	-2.100**
OFFFARMWORK	0.009	0.011	0.820

[a] *** indicates significance at α=.01, ** indicates significance at α=.05, and * indicates significance at α=.10.

Interest in Accepting the Given Incentive Level

Producers who indicated interest in prescribed grazing (i.e. ACCEPT>1) were then asked to indicate whether they would convert some acreage to prescribed grazing at a given incentive level (ACCEPT). The estimated probit model for ACCEPT, as well as the marginal effects are displayed in Table 5.

The overall significance of the model was estimated using an LR test for exclusion. This allows for the restricted and unrestricted models to be compared, and determine if they are significantly different from one another. The LR test provided a value of 110.41, which is statistically significant and therefore the use of the model is justified, and the model is statistically significant. The model also has a Pseudo R^2 of 0.11. Of the 875 responses used in the model, 647 were to adopt (68.5 percent) and 228 were to not adopt (31.3 percent). The model correctly predicted 74.97 percent of these responses.

Nine variables were statistically significant variables in the model. Of these nine, only COLLEGE, EASTERNUPLANDS, FEDPRGM, INTERNET, and PROPRIETOR were significant in the first model as well. These variables influence the respondent's willingness to adopt as well as their willingness to accept the incentive level offered, therefore they could potentially play an important role in determining adoption behavior. Of the nine significant variables, seven had the hypothesized effect. INCG150 was found to have a negative effect on adopting at the incentive level possibly because of the higher opportunity cost of adoption. EASTERNUPLANDS, while having a negative effect on ADOPT, was found to have a positive effect on ACCEPT as compared to NORTHERNCRESCENT. This could be attributed to the hypothesis that many of the respondents in the EASTERNUPLANDS were not interested in adopting a prescribed grazing system, however the ones that were interested were very much

influenced by the incentive level and chose to adopt if it would be profitable. The incentive level offered to the respondent (INCENT) was also significant and positively influenced the acceptance of the program.

Table 5: Estimated Probit Model and Marginal Effects for the Adoption at the Incentive Level Decision (ACCEPT)[a]

Variable	Est. Coeff	Std. Error	Z	Marg. Effect	Std. Error	Z
INCENT	0.005	0.002	2.880***	0.002	0.001	2.890***
AGE	0.020	0.030	0.660	0.006	0.009	0.660
AGE^2	0.000	0.000	-1.080	0.000	0.000	-1.080
INC3049	-0.247	0.189	-1.310	-0.081	0.065	-1.240
INC5099	-0.208	0.169	-1.230	-0.065	0.053	-1.220
INC100149	-0.172	0.205	-0.840	-0.055	0.068	-0.810
INCG150	-0.395	0.195	-2.030**	-0.132	0.070	-1.900*
COLLEGE	0.269	0.109	2.460***	0.086	0.036	2.390**
EXTWKSHP	0.021	0.027	0.780	0.007	0.008	0.780
RENT	0.043	0.102	0.420	0.013	0.031	0.420
PASTURE	0.000	0.000	-0.990	0.000	0.000	-0.990
INPUTMGT	-0.023	0.165	-0.140	-0.007	0.050	-0.140
STRUCTURALMGT	0.186	0.158	1.180	0.060	0.053	1.130
FEEDINGMGT	0.026	0.146	0.180	0.008	0.045	0.180
GRASSMGT	0.044	0.148	0.300	0.014	0.046	0.300
HEARTLAND	0.019	0.236	0.080	0.006	0.072	0.080
NORTHERNGREATPLAIN	0.118	0.338	0.350	0.035	0.096	0.360
PRARIEGETAWAY	-0.210	0.233	-0.900	-0.068	0.078	-0.860
EASTERNUPLANDS	0.356	0.215	1.660*	0.103	0.058	1.780*
SOUTHERNSEABOARD	-0.149	0.238	-0.630	-0.048	0.079	-0.610
FRUITFULRIM	-0.115	0.333	-0.350	-0.037	0.110	-0.340
MISSISSIPPIPORTAL	0.394	0.276	1.430	0.106	0.063	1.680*
PRESCGRAZCOST	-0.003	0.009	-0.380	-0.001	0.003	-0.380
STKRATE	-0.070	0.046	-1.540	-0.022	0.014	-1.530
OTHLIV	0.110	0.110	1.000	0.033	0.033	1.020
FEDPRGM	0.255	0.115	2.210**	0.075	0.032	2.330**
LIFE	0.082	0.063	1.310	0.025	0.019	1.310
WAIT	-0.055	0.043	-1.280	-0.017	0.013	-1.280
CLIMATE	-0.020	0.037	-0.530	-0.006	0.012	-0.530
STEWARD	0.156	0.072	2.160**	0.048	0.022	2.150**
FAMTKOVER	0.193	0.102	1.890*	0.060	0.032	1.860*
INTERNET	0.295	0.111	2.670***	0.091	0.034	2.670***
PROPRIETOR	-0.234	0.132	-1.770**	-0.068	0.036	-1.880*

Table 5 Continued

Variable	Est. Coeff	Std. Error	Z	Marg. Effect	Std. Error	Z
OFFFARMWORK	0.039	0.111	0.350	0.012	0.034	0.350
Intercept	-0.947	1.043	-0.910			
N= 875	LLR Test Wald $\chi^2(34)$= 110.41***		Pseudo R^2= 0.1100			

[a] *** indicates significance at α=.01, ** indicates significance at α=.05, and * indicates significance at α=.10.

Independence of the Models for ACCEPT and ACRES

As discussed earlier, in order to determine if the second and third stage models were related, a Heckman two-step model was used. The inverse Mill's ratio was calculated using estimates from the probit model presented in Table 5 and the inverse mills was added into the regression model presented in Table 6. The resulting estimated coefficient on the inverse Mill's ratio was -108.97 with a standard error of 138.82 and a Z statistic of -0.78. Hence the coefficient on the inverse Mills ratio was not significantly different from zero at the 95 percent confidence level. Therefore, the two models for ACCEPT and ACRES can be estimated separately.

Acreage Conversion

Of the respondents who were interested in prescribed grazing and would accept the incentive level offered 618 provided an amount for the number of acres that they would consider converting. The average number of acres converted was 227, the mean was 100, and the range was from two to 4,000 acres. The average number of acres the 618 respondents farmed was 573, so on average 40 percent of the number of acres the respondents farmed would be converted to prescribed grazing. At the $10 incentive level 20,477.5 acres were converted, at $30 27,623.9 acres, at $50 41,104 acres, at $70 23,091.9, and at $90 27,812 acres were converted to prescribed grazing.

A linear model using OLS estimation was utilized to determine the effects of the incentive level (INCENT), the number of acres farmed (TOTACFARM), and the interaction between these two variables (TOTAFINCENT) on the number of acres the respondent was willing to convert. These results are provided in Table 6.

In order to test for the overall significance of the model, an F Test was performed. The null hypothesis that the variables included in the model were not associated with acres supplied was rejected at the 1 percent level of significance and had an R^2 value of 30.28.

Of the three explanatory variables used, all were found to be highly significant. For each additional dollar of incentive, these farmers would add nearly 8.6 acres of prescribed grazing land. The amount of land they farmed had a positive effect as expected. The incentive and acres farmed interaction had a negative sign. This suggests that a larger number of acres has a decreasing effect at higher incentive levels or in other words, smaller farms are more responsive to an increase in the incentive than larger farms.

Table 6: Estimated Linear Regression for the Acreage Conversion Decision (ACRES)[a]

Variable	Est. Coeff	Std. Error	Z
INCENT	8.586	1.305	6.580***
TOTACFARM	1.585	0.100	15.910***
TOTAFINCENT	-0.022	0.001	-14.840***
Intercept	-425.358	80.541	-5.280***
N=618 F Test (3, 614)= 91.20*** R^2= 30.82			

[a] *** indicates significance at α=.01, ** indicates significance at α=.05, and * indicates significance at α=.10.

Weighted Models

The results of the analysis using post-stratification weights, which can be seen in Appendix 3 Tables 7, 8, and 9, are much more conservative than the non-weighted results. This is because the expansion factors adjust the estimates to reflect the entire population from which

the survey was taken, rather than just the responses. This is attempting to correct for response bias as well as sampling bias. Because of this, it is expected that the coefficients as well as the marginal effects of these weighted models are decreased compared with the effects of those that are not weighted.

In the decision to be interested in adoption or not, several variables are no longer significant. These variables include AGE, RENT, FEEDINGMGT, FEDPRGM, and FAMTKOVER. Variables that decreased in significance were AGE^2, COLLEGE, STRUCTURALMGT, OTHERLIV, and PROPRIETOR. While these variables saw a decrease in significance, there were several variables that were not significant in the non-weighted model, but gained significance with the use of the weights. NORTHERNGREATPLAINS and STEWARD both become significant with the use of the post-stratification weights. These changes in significance could be attributed to an overrepresentation or underrepresentation of a particular group of people within the survey sample as compared to the entire survey population. The weighted model shows some variation on overall predicting abilities as compared with the non-weighted ordered probit. The weighted model correctly predicted 63 percent of the overall respondents, 74 percent of those that chose no interest in adoption, 64 percent of those that chose to adopt only if profitable, and 88 percent of those that chose to adopt even if not profitable.

In the modeling of the decision to adopt at the given incentive level, a similar phenomenon can be seen. In the weighted model we see that many variables gain significance as compared with the non-weighted model. EXTWKSHP, PASTURE, MISSISSIPPIPORTAL, and LIFE were all insignificant in the original model, but become significant with the weights. We also see that FAMTKOVER and PROPRIETOR increase in significance between the two models. However we did still see that INCENT, INCG150, and COLLEGE did decrease in their

significance from one model to the other. Once again this is to be expected because the expansion factors are adjusting the estimates.

In the third decision, the number of acres to be converted to a prescribed grazing system, it is apparent that all of the variables decrease in their significance to the model. However they all remain significant and continue to influence the model in the same direction. Using the weighted model, an additional 5.9 acres are converted to prescribed grazing with each additional dollar of incentive.

Discussion

The results of the study suggest that there are many factors likely to influence a producer's decision to be interested in adoption or a prescribed grazing system. However, less factors influence their decision to adopt at the given incentive level, the incentive level being a significant positive influence on willingness to accept that particular incentive level. Acreage and incentive levels are important influences on how many acres to convert at a given incentive level.

The results suggest that the first decision is based more on the respondent's attitudes, farming situation, farming methods, and business structure. The first decision is a question of "interest" and appears to not rely as heavily on farm characteristics as it does on farmer characteristics and attitudes. However, a positive effect on the interest in adoption and willingness to accept the incentive from COLLEGE, EXTWKSHP, and INTERNET is seen, which suggests that the more educated and informed respondents are, the more likely they are to adopt to have an interest and accept an incentive for prescribed grazing. A total of 59 percent of respondents were interested in adopting.

While the decision to adopt at the given incentive level shares several significant variables with the first decision, the addition of the INCENT variable highlights how important

the incentive level is to the decision to adopt. As the majority of respondents from the first decision stated that they would adopt only if it was profitable to do so, it could be expected that the incentive level would be a determining factor for them. However it is important to note that estimated regional differences in the cost of implementing a prescribed grazing system (PRESCGRAZCOST) are not statistically significant. It is also important to note that while all of the other income variables are insignificant, INCG150 has a negative effect on ACCEPT, showing that respondents in the income category greater than $150,000 are less inclined to adopt at the given incentive level. This could be due to the fact that it would not be economically beneficial for them to change their production methods as they are already generating a high income from their current situation. Over 68 percent of the respondents that indicated an interest in adopting a prescribed system accepted the incentive level offered.

The decision of how many acres to convert at the given incentive level then becomes an issue of money and acres. The respondents are only able to control acres that they own, and the incentive level directly impacts the profitability of their adoption. From the model, we see that the incentive level (INCENT) as well as the total number of acres farmed (TOTACFARM) have a positive effect on the number of acres converted. However, their interaction term (TOTAFINCENT) has a negative effect. This suggests that there is point where converting acres to a prescribed grazing system no longer becomes beneficial at any incentive level. The average number of acres respondents would convert to prescribed grazing of those that accepted the incentive level offered was 256 acres.

The weighted estimates allow us to develop a better understanding of what the adoption rates would look like when an incentive program such as this is expanded over the entire target population. While the estimates are more conservative, they offer a more accurate picture of how

the population would approach these decisions and how the incentive levels would influence adoption.

Chapter 5: Conclusion

This study examined producers' willingness to adopt and convert acreage to prescribed grazing through a hypothetical incentive program. The data for the study were obtained from a survey of cattle producers east of the 100th meridian in the U.S.. 8,875 surveys were sent out, and 2,274 surveys were returned. The results from this study suggest that about 52 percent of producers stated that they are already using some form of prescribed grazing. In terms of interest in adopting or increasing prescribed grazing, 48 percent were interested if it was profitable, and 11 percent were interested even if it was not profitable. A total of 59 percent of the respondents were interested, while 11 percent of the respondents may see greater value in the environmental benefits from prescribed grazing than the other farmers. About 68.5 percent of those farmers who were interested would accept the bid offered. Among the respondents that were interested in adoption, 62 percent chose to adopt at the $10 incentive level, 62.5 percent at $30, 69 percent at an incentive level of $50, 73 percent at $70, and 76 percent at the $90 incentive level. Out of the total number of respondents, 40 percent were willing to convert an average of 256 acres to prescribed grazing at an average incentive level of $51.

Several variables appear to be important in influencing the decision to adopt. Education and obtaining information through workshops and the internet were each important in determining interest levels and willingness to accept the incentive level. The respondents who completed some college were much more likely to adopt, as well as those who attended extension or other educational workshops. The use of the internet was also extremely influential on their decision to adopt. These results suggest that educational programs to explain the benefits of prescribed grazing can be influential on farmers' decisions to participate. Furthermore, information provided through workshops and the internet could be helpful to farmers in making the decision of whether to adopt.

Among those farmers who were interested and willing to accept the incentive, the amount of acres to be converted is strongly influenced by the number of acres available to the farmer. However, the incentive level also plays a role in acreage conversion, with each dollar increase in incentive level providing about an 8.5 increase in acres to be converted, and a 5.9 increase in acres using the weighted model. These results indicate that farmers are willing to respond to incentive programs by converting acreage to prescribed grazing given the acreage resources they have. The weighted results can also be used to explore a more conservative look at the influence of these variables on adoption and the number of acres willing to be converted.

While this study does answer many questions about the adoption of prescribed grazing in beef cattle producers, there are many opportunities for future research based on these findings. One area that could be of interest is how physical characteristics affect adoption rather than geographical regions. Since prescribed grazing utilizes fences and increases the need for water availability, it would be interesting to note if elevation, rainfall, proximity to flood plains, etc. play a role in adoption. Another area that possesses interest would be if there is a connection between the respondent's decision to express interest in adopting a prescribed grazing system and the decision to adopt at the given incentive level. With these potential research opportunities being explored, it will further the knowledge that we possess about the adoption of a prescribed grazing system and will allow policy makers the opportunity to understand how their decisions will impact the industry in a concrete way.

With these results, it can be determined how a government implemented incentive program would impact the number of acres put into a prescribed grazing program. The information obtained in this study could be combined with regional data to project number of acres converted to prescribed grazing all across the eastern half of the United States. This would

allow policy makers to determine the total number of acres that would be converted to prescribed grazing at a given incentive level, and how that number of acres would change with a change in incentive levels. Using this information, it would be possible to quantify the impact the prescribed grazing systems put in place would have on the GHG issue that the United States, and more specifically the livestock industry, faces.

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Appendices

Appendix 1

Cattle Grazing Management Survey

Dear Agricultural Producer:

The U.S. Department of Agriculture estimates there are about 922 million acres of farmland in the U.S. About 575 million of those acres are grazed by livestock. The grazing and land management practices used on America's farms have important effects on farm profits and on the environment. The University of Tennessee Institute of Agriculture is attempting to gather information on agricultural producers' views of ***prescribed grazing***.

We ask that you complete the enclosed survey, place it in the enclosed postage-paid envelope, and return it to us by mail. The survey should take about 10-15 minutes to complete. Responding to this survey gives <u>you</u> an opportunity to let policymakers know about your views of and experiences with this management practice along with your willingness to voluntarily adopt ***prescribed grazing*** if you were to receive a payment to do so.

You can be assured of confidentiality. Your name or other identifying information will not be linked with your responses. University of Tennessee research protocols prohibit the release of your name or personal information to any other agency or individual. The list of those invited to participate in the study will be destroyed after responses are collected. Finally, only summary results from the survey will be publicly reported.

Please do not hesitate to contact us if you have any questions or concerns. Thank you for taking time out of your busy schedule to help us out! If you are interested, a summary of the survey results will be available at <u>www.beag.ag.utk.edu</u> once we have collected and summarized the data.

Sincerely,

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Please indicate if you are no longer farming at the top of the blank survey and return it to us. Thanks!

We ask that the primary farm/ranch decision maker complete this survey. If you are NOT the primary decision maker please forward the survey to that person. Your expert knowledge and participation are much appreciated. Please answer the following questions to the best of your ability. All responses are voluntary. No individual information will be released. This survey will take about 10-15 minutes to complete. Thank you for your help!

Your Farming Operation

Q1. Did you own farm land OR raise cattle in 2012? Check one.

Yes ☐ → *Continue to* **Q2**   No ☐ → *Skip to* ***Q25*** *on* ***page 7***

Q2. How many total acres did you farm in 2012 and how many of these acres were rented from someone else?

	Total Acres Farmed	Acres Rented
Pasture		
Hay		
Harvested Cropland		
Woodland (grazed)		
Woodland (not grazed)		
Other (Please specify:)		
Totals		

Q3. If you rented land from others in 2012, how long were the rental terms? ____ **Years**

Q4. How much farmland and woodland did you own, but rent to others in 2012? ____ **Acres**

Q5. Did you have any of the following types of livestock on your farm in 2012? Check all that apply.

Hogs ☐ Poultry ☐ Cattle ☐ ⇨ *If you did not have cattle in 2012, skip to* ***Q25*** *on* ***page 7***.

Goats/Sheep ☐ Horses ☐

Q6. How many of the following types of cattle were in your care on January 1, 2013?

Brood Cows ____ Backgrounded Calves ____ Stockers ____

Replacement Heifers ____ Bulls ____ Dairy Cows ____

Other ____ (Please describe:)

Q7. Did your cattle graze on pasture owned or rented by you in 2012? Yes ☐ No ☐

Q8. About how many days per year do you graze your cattle? ____ **Days per year**

Q9. Which of the following <u>pasture management</u> practices do you use? Check all that apply.

Apply manure as fertilizer to pastures	☐
Apply N,P, or K fertilizer (DAP, urea, LAN, etc.) to pastures	☐
Water cattle at site other than a stream or pond	☐
Have buffer strips of woody or grassy vegetation along waterways	☐
Have shade structures, scratching posts, and feed supplements placed away from streams	☐
Have improved stream crossings	☐
Control livestock access to streams	☐
Protect heavy use areas with geotextiles	☐
Replant bare pasture with legumes or native grasses	☐
Periodically test soil	☐

Prescribed Grazing

The next section asks you some questions about prescribed grazing. Before answering these questions, we ask that you read the following to ensure that you understand how prescribed grazing is defined in this survey.

What is **prescribed grazing?**

- Prescribed grazing is the *controlled harvest* of vegetation by grazing animals.
- Controlled harvest means managing the duration, intensity, distribution, frequency, and season animals graze on a pasture.
- Management practices include:
  - Rotating cattle around a number of paddocks (fenced fields) in an ordered sequence;
  - Monitoring forage stubble height for the best grazing start and stop times; and
  - Removing cattle from grazing areas to allow forage recovery.

Photo: NRCS.

How would prescribed grazing **benefit you**?

- Grow more and better quality forage;
- Allow higher stocking rates (estimates are up to 40% increases); and
- Increase use of forage from pastures.

How would prescribed grazing **affect the environment**?

- Increased yields and efficiency per unit of land means less pollution; and
- Concentrating livestock in paddocks for days at a time lets animals graze lightly but evenly, encouraging roots to grow deeper into the soil, storing more organic matter (carbon).

What would you need to do to practice prescribed grazing?

Manage forage by:
- Balancing livestock consumption and forage production;
- Adjusting livestock numbers, fertilizer rates, or purchased feed to meet livestock forage needs;
- Limiting feed (hay, silage, gluten, hulls, grain, etc.) to no more than 50% of total livestock diet; and
- Creating a weed control plan and controlling weeds in pastures by clipping, spraying, high density grazing, mixed species grazing and/or weed wiping as needed.

Rotate livestock by:
- Using at least 5 different paddocks or fields for grazing;
- Grazing livestock for no more than 14 continuous days on any paddock or field (except during extreme weather conditions);
- Buffering sensitive areas like wells, depressions, sinkholes, and all water areas in paddocks;
- Developing a conservation plan that includes a grazing component with a technical consultant; and
- Not grazing more than 20% of the pasture to less than minimum grazing heights of:
  - 2” for bermudagrass, ryegrass;
  - 3” for cool season grasses (e.g. tall fescue, orchardgrass, cereal grains); and
  - 6” for tall upright grasses (e.g. native grass, millet, sorghums).

Recordkeeping:
- Keep records to show continued use of prescribed grazing practices.

Q10. In 2012, did you use any of the prescribed grazing practices described above?

Yes ☐ → *Continue to **Q11*** No ☐ →*Skip to **Q12** on **page 5***

Q11. Which prescribed grazing practices did you use during 2012? Check all that apply.

Balanced livestock consumption and forage production	☐
Adjusted livestock numbers, fertilizer rates, or purchased feed to meet livestock forage needs	☐
Limited feed (hay, silage, gluten, hulls, grain etc.) to no more than 50% of total livestock diet	☐
Created and used a pasture weed control plan	☐
Used at least 5 different paddocks or fields for grazing	☐
Grazed livestock for no more than 14 continuous days on any paddock or field	☐
Buffered sensitive areas like wells, depressions, sinkholes, and all water areas in paddocks	☐
Developed or followed a conservation plan that included a grazing component	☐
Grazed no more than 20% of pasture to less than minimum grazing heights, as described above	☐

Q12. The following table provides cost estimates (by region) for the components needed to adopt or expand prescribed grazing. Please review the cost estimates for your region before answering the questions below. We realize that these costs will vary depending on where you purchase the materials.

Region*	Prescribed grazing ($/AC)	Fence ($/Strand Foot)	Watering facility ($/Gallon)	Heavy use area ($/Sq Ft)
Northeast	34.86	1.86	2.34	1.76
Lake States	36.09	1.34	1.31	1.16
Corn Belt	23.38	1.12	1.80	1.21
Northern Plains	24.96	1.36	1.72	1.72
Appalachia	31.07	1.49	2.43	1.18
Southeast	21.35	1.09	1.14	1.23
Delta	48.26	1.42	0.61	1.20
Southern Plains	28.82	1.38	1.72	1.35

*__Northeast:__ CT, DE, ME, MD, MA, NH, NJ, NY, PA; **Lake States**: MN, WI, MI; **Corn Belt:** IL, IN, IA, MO, OH; **Northern Plains**: KS, NE, ND, SD; **Appalachia:** KY, NC, TN, VA, WV; **Southeast:** AL, FL, GA, SC; **Delta:** AR, LA, MS; **Southern Plains:** OK, TX

Which of the following best describes whether you would adopt or expand prescribed grazing? Check one answer.

I would not adopt or expand prescribed grazing even if it was profitable to do so. ☐ → *Skip to **Q23** on **page 6***

I would adopt or expand prescribed grazing even if it was not profitable to do so. ☐ → *Continue **to Q13***

I would adopt or expand prescribed grazing only if it was profitable to do so. ☐ → *Continue **to Q13***

Q13. We now ask you about a HYPOTHETICAL PROGRAM to encourage farmers and ranchers to adopt or expand prescribed grazing. Assume the program would:

- **Pay 75% of the costs of purchasing and installing the components needed to adopt or expand prescribed grazing on your farm or ranch;**
- **Pay you continuing annual payments for 10 years if you follow all of the practices described on page 4 and document these practices each season;**
- **Not limit the number of acres you can enroll; and**
- **Be limited to acres not enrolled in another conservation program.**

Would you be willing to convert pasture acres on your farm to prescribed grazing for a 10 year period if you were offered a) the 75% installation cost share described above and b) an ANNUAL payment of $50 per acre for each of the 10 years you practice prescribed grazing?

Yes, I would adopt or expand prescribed grazing ☐ → *Continue to **Q14***

No, I would not adopt or expand prescribed grazing ☐ → *Skip to **Q23** on **page 6***

Q14. If yes, how many pasture acres would you convert to prescribed grazing? ________ **Acres**

Q15. After adopting or expanding prescribed grazing, how would the number of cattle change on your farm?

☐ **Decrease by** ________ %

☐ ***No Change***

☐ ***Increase by*** ________ %

Q16. In 2012, did you receive payments for practicing prescribed grazing through a government program, such as the Environmental Quality Incentives Program (EQIP) or the Conservation Stewardship Program (CSP)?

Yes ☐ → *Continue to **Q17*** No ☐ → *Skip to **Q23** below*

<u>Answer Q17 – Q22 Only if You Have Received Payments for Prescribed Grazing…</u>

Q17. How many acres did you manage with prescribed grazing under this program in 2012? ______ **Acres**

Q18. Did you receive a per acre annual payment in 2012 to continue practicing prescribed grazing?

Yes ☐ → *Continue to **Q19*** No ☐ → *Skip to **Q20 below***

Q19. What <u>per acre</u> annual payment did you receive in 2012? ______ **$/acre**

Q20. Did you receive any cost share for expenses you incurred to start prescribed grazing?

Yes ☐ → *Continue to **Q21*** No ☐ → *Skip to **Q23 below***

Q21. Approximately how much did you receive as a cost share for adopting prescribed grazing? **$** ______

Q22. In what year did you receive the cost share? ______ **Year**

If you graze cattle answer Q23 – Q37…

Q23. How important were the following in determining your decision about the prescribed grazing program?

	Not at all Important	Somewhat Unimportant	Not Sure	Somewhat Important	Extremely Important
Amount of time/labor required to implement and practice prescribed grazing.	☐	☐	☐	☐	☐
Attitudes of friends and other farmers toward prescribed grazing.	☐	☐	☐	☐	☐
Availability of Extension or other educational resources related to prescribed grazing.	☐	☐	☐	☐	☐
Investment cost of implementing prescribed grazing.	☐	☐	☐	☐	☐
Amount of paperwork required to participate in the program.	☐	☐	☐	☐	☐
Effect on your farm's ability to offset carbon emissions.	☐	☐	☐	☐	☐
The level of program payment offered per acre for converting land to prescribed grazing.	☐	☐	☐	☐	☐
Potential for damage to paddocked pastures during wet periods.	☐	☐	☐	☐	☐
Impact of adopting prescribed grazing on the environment.	☐	☐	☐	☐	☐
Your level of knowledge about prescribed grazing practices.	☐	☐	☐	☐	☐

Q24. How likely do you believe participating in the prescribed grazing program would be to:

	Highly Unlikely	Somewhat Unlikely	Not Sure	Somewhat Likely	Highly Likely
Increase the profitability of your farming operation.	☐	☐	☐	☐	☐
Reduce soil erosion on your farm.	☐	☐	☐	☐	☐
Improve cattle health.	☐	☐	☐	☐	☐
Improve water quality in the streams on or near your farm.	☐	☐	☐	☐	☐
Allow you to increase herd size.	☐	☐	☐	☐	☐
Free up land for other agricultural uses.	☐	☐	☐	☐	☐
Improve the quality and amount of forage produced on your farm.	☐	☐	☐	☐	☐
Increase your supplemental feed costs to support more cattle.	☐	☐	☐	☐	☐

About You

Q25. Years as primary farm business decision maker? ______ **Years** **Age in Years?** ______ **Years**

Q26. Which of the following best describes your farming business?

Sole Proprietorship ☐ Partnership ☐ Corporation ☐ Other (Please describe: ____________________________ ____)

Q27. What is your highest level of education?

Less than High School ☐ Some College ☐
High School Graduate ☐ College Degree or Higher ☐

Q28. Which category best reflects your total taxable household income from <u>both farm and non-farm sources</u> for 2012? ***Check one answer. Please know that laws prohibit us from sharing your personal information.***

Less than $10,000 ☐ $50,000 to $99,999 ☐ $200,000 to $499,999 ☐
$10,000 to $29,999 ☐ $100,000 to $149,999 ☐ $500,000 or more ☐
$30,000 to $49,999 ☐ $150,000 to $199,999 ☐

Q29. What percent of your total taxable household income (both farm and non-farm sources) for 2012 do you estimate came from farming? ______ **%**

Q30. What percent of your 2012 farm income do you estimate came from your cattle operation? ______ **%**

Q31. On average, how many hours a week do you spend working: **on your farm?** ______ **Hrs/week**
off your farm? ______ **Hrs/week**

Q32. How many hours of hired labor do you usually use on your farm in a week? ______ **Hrs/week**

Q33. Have you participated in any of the following government programs? Check all that apply.

Conservation Reserve Program (CRP) ☐

Grassland Reserve Program (GRP) ☐

State Programs (ex: state conservation or agricultural enhancement programs) ☐

Other (Please describe: ______) ☐

Q34. How many Extension or other educational workshops did you attend in 2012? ______ **Workshops**

Q35. Please indicate the extent to which you disagree or agree with each of the following statements.

	Strongly Disagree	Somewhat Disagree	No Opinion	Somewhat Agree	Strongly Agree
For me, farming is not only a business it is a way of life.	☐	☐	☐	☐	☐
I tend to wait until others have adopted new technologies or practices before I adopt them.	☐	☐	☐	☐	☐
The government should offer incentives to farmers to adopt conservation practices.	☐	☐	☐	☐	☐
I am concerned that climate change will negatively impact the yield of my product.	☐	☐	☐	☐	☐
As a farmer, I am a steward of the land I farm and it is my obligation to protect it for use by future generations.	☐	☐	☐	☐	☐

Q36. Which of the following best describes your plans for your farming operation?

Your children/grandchildren will farm your land after you cease farming. ☐

Your land will be sold or leased to another farmer after you cease farming. ☐

Your land will be sold for development after you cease farming. ☐

Other ☐ (Please describe: ____

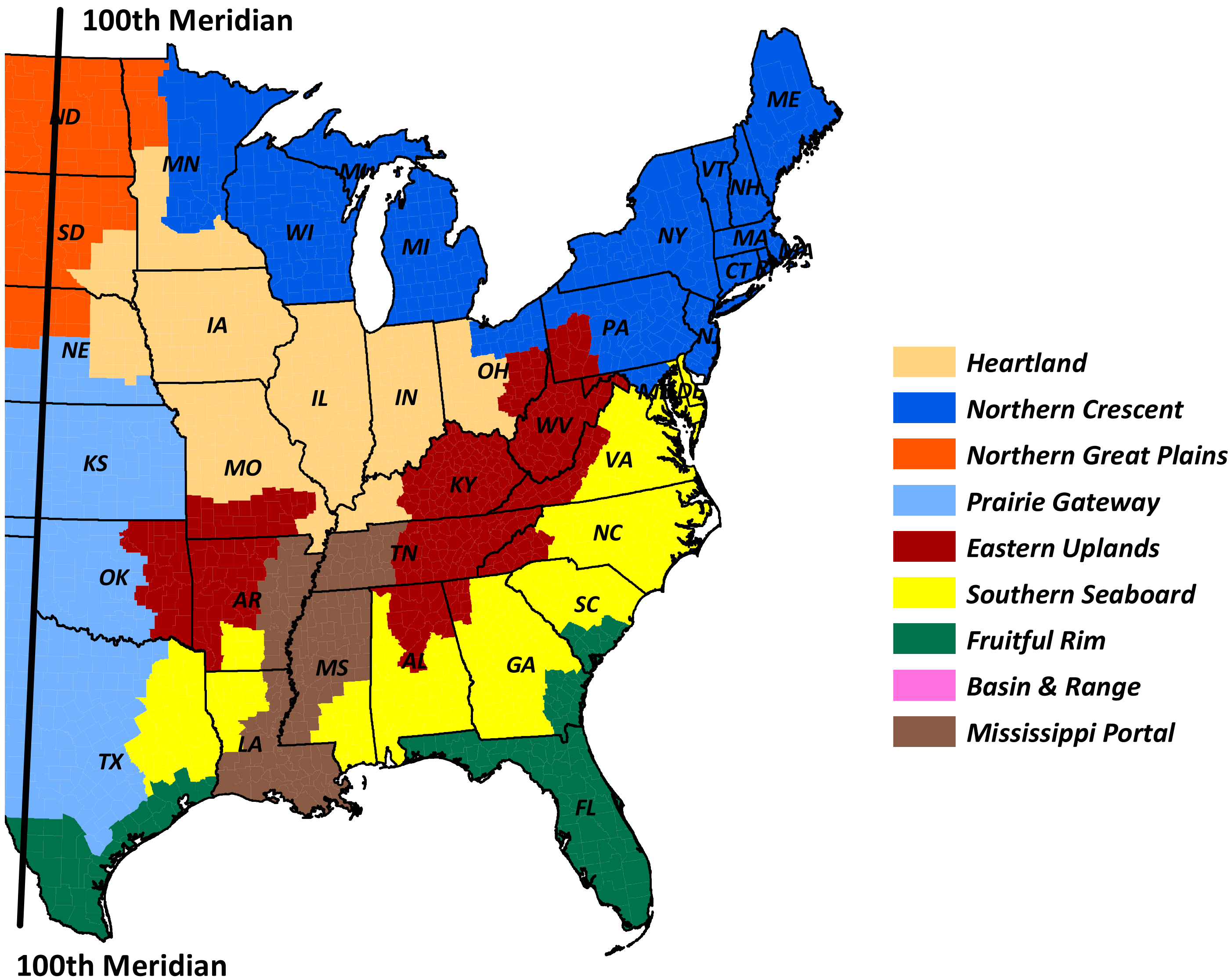
____)

Q37. Do you use the Internet to make farm purchases or farm management decisions? Yes ☐ No ☐

Please return the completed survey to us in the enclosed, postage-paid envelope.

Thank you for participating in this study. If you are interested, please check the following website, http://beag.ag.utk.edu/, for a summary of results in the coming months.

Appendix 2


100th Meridian
ND
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VT
NH
ME
MA
CT
NJ
DE
KS
MO
KY
WV
VA
NC
TN
OK
AR
SC
MS
AL
GA
TX
LA
FL
100th Meridian
Heartland
Northern Crescent
Northern Great Plains
Prairie Gateway
Eastern Uplands
Southern Seaboard
Fruitful Rim
Basin & Range
Mississippi Portal

Appendix 3

Table7a: Estimated Weighted Ordered Probit Model for the Interest in Adoption Decision (INTEREST)[a]

Variable	Est. Coeff.	Std. Error	Z
AGE	0.027	0.018	1.480
AGE^2	0.000	0.000	-1.690*
INC3049	-0.015	0.119	-0.120
INC5099	0.085	0.104	0.810
INC100149	0.198	0.131	1.510*
INCG150	0.222	0.140	1.590
COLLEGE	0.143	0.082	1.750*
EXTWKSHP	0.041	0.018	2.280**
RENT	-0.099	0.078	-1.280
PASTURE	0.000	0.000	-0.520
INPUTMGT	0.358	0.115	3.110***
STRUCTURALMGT	0.182	0.108	1.680*
FEEDINGMGT	0.142	0.120	1.180
GRASSMGT	0.401	0.117	3.420***
HEARTLAND	0.042	0.180	0.230
NORTHERNGREATPLAINS	0.442	0.228	1.940**
PRARIEGETAWAY	0.162	0.180	0.900
EASTERNUPLANDS	-0.110	0.163	-0.680
SOUTHERNSEABOARD	-0.049	0.188	-0.260
FRUITFULRIM	0.095	0.240	0.400
MISSISSIPPIPORTAL	0.187	0.212	0.880
PRESCGRAZCOST	0.005	0.006	0.720
STKRATE	0.026	0.044	0.600
OTHLIV	0.170	0.079	2.140**
FEDPRGM	0.120	0.090	1.330
LIFE	0.020	0.045	0.450
WAIT	-0.107	0.032	-3.360***
CLIMATE	0.041	0.028	1.460
STEWARD	0.085	0.051	1.650*
FAMTKOVER	0.036	0.075	0.480
INTERNET	0.241	0.082	2.920***
PROPRIETOR	-0.153	0.093	-1.650*
OFFFARMWORK	0.077	0.081	0.950
μ_1	1.517	0.630	2.407
μ_2	1.517	0.630	2.407**

N=1338 LLR Test Wald $\chi^2(33)$= 224.75*** Pseudo R^2= 0.1216

[a] *** indicates significance at α=.01, ** indicates significance at α=.05, and * indicates

significance at α=.10.

Table 7b: Marginal Effects for Weighted Interest in Adoption Decision (INTEREST)[a]

Outcome 1 (Not Interested in Prescribed Grazing)			
Variable	Marg. Effect	Std. Error	Z
AGE	-0.010	0.006	-1.490
AGE^2	0.000	0.000	1.690*
INC3049	0.005	0.043	0.120
INC5099	-0.030	0.037	-0.820
INC100149	-0.069	0.044	-1.570
INCG150	-0.077	0.046	-1.660*
COLLEGE	-0.052	0.030	-1.740*
EXTWKSHP	-0.015	0.006	-2.270**
RENT	0.036	0.028	1.280
PASTURE	0.000	0.000	0.530
INPUTMGT	-0.135	0.045	-3.030***
STRUCTURALMGT	-0.068	0.041	-1.650*
FEEDINGMGT	-0.051	0.043	-1.180
GRASSMGT	-0.144	0.042	-3.450***
HEARTLAND	-0.015	0.065	-0.230
NORTHERNGREATPLAINS	-0.142	0.064	-2.240**
PRARIEGETAWAY	-0.057	0.062	-0.930
EASTERNUPLANDS	0.040	0.060	0.670
SOUTHERNSEABOARD	0.018	0.069	0.260
FRUITFULRIM	-0.034	0.083	-0.410
MISSISSIPPIPORTAL	-0.065	0.070	-0.920
PRESCGRAZCOST	-0.002	0.002	-0.720
STKRATE	-0.010	0.016	-0.600
OTHLIV	-0.060	0.028	-2.180**
FEDPRGM	-0.043	0.032	-1.360
LIFE	-0.007	0.016	-0.450
WAIT	0.039	0.012	3.360***
CLIMATE	-0.015	0.010	-1.460
STEWARD	-0.031	0.019	-1.650*
FAMTKOVER	-0.013	0.027	-0.480
INTERNET	-0.086	0.029	-2.970***
PROPRIETOR	0.054	0.032	1.690*
OFFFARMWORK	-0.028	0.029	-0.950

Table 7b. Continued.

Outcome 2 (Interested in Prescribed Grazing if Profitable)			
Variable	Marg. Effect	Std. Error	Z
AGE	0.006	0.004	1.470
AGE^2	0.000	0.000	-1.670*
INC3049	-0.003	0.025	-0.120
INC5099	0.017	0.021	0.830
INC100149	0.036	0.020	1.750*
INCG150	0.039	0.020	1.930**
COLLEGE	0.031	0.018	1.690*
EXTWKSHP	0.009	0.004	2.220**
RENT	-0.021	0.016	-1.280
PASTURE	0.000	0.000	-0.530
INPUTMGT	0.088	0.033	2.700***
STRUCTURALMGT	0.042	0.028	1.530
FEEDINGMGT	0.030	0.025	1.180
GRASSMGT	0.083	0.025	3.380***
HEARTLAND	0.009	0.036	0.240
NORTHERNGREATPLAINS	0.055	0.011	5.160***
PRARIEGETAWAY	0.031	0.030	1.010
EASTERNUPLANDS	-0.024	0.037	-0.650
SOUTHERNSEABOARD	-0.011	0.042	-0.250
FRUITFULRIM	0.018	0.042	0.440
MISSISSIPPIPORTAL	0.033	0.030	1.090
PRESCGRAZCOST	0.001	0.001	0.720
STKRATE	0.006	0.009	0.600
OTHLIV	0.033	0.015	2.270**
FEDPRGM	0.024	0.017	1.420
LIFE	0.004	0.009	0.450
WAIT	-0.023	0.007	-3.240***
CLIMATE	0.009	0.006	1.450
STEWARD	0.018	0.011	1.640*
FAMTKOVER	0.008	0.016	0.480
INTERNET	0.048	0.016	3.000***
PROPRIETOR	-0.029	0.016	-1.810**
OFFFARMWORK	0.016	0.017	0.950

Table 7b. Continued.

Outcome 3 (Interested in Prescribed Grazing Even if Not Profitable)			
Variable	Marg. Effect	Std. Error	Z
AGE	0.004	0.003	1.480
AGE^2	0.000	0.000	-1.690*
INC3049	-0.002	0.018	-0.120
INC5099	0.013	0.017	0.800
INC100149	0.033	0.024	1.380
INCG150	0.038	0.027	1.430
COLLEGE	0.021	0.012	1.780*
EXTWKSHP	0.006	0.003	2.260**
RENT	-0.015	0.012	-1.270
PASTURE	0.000	0.000	-0.520
INPUTMGT	0.046	0.013	3.630***
STRUCTURALMGT	0.025	0.014	1.850**
FEEDINGMGT	0.022	0.018	1.180
GRASSMGT	0.061	0.019	3.300***
HEARTLAND	0.006	0.028	0.230
NORTHERNGREATPLAINS	0.087	0.056	1.550
PRARIEGETAWAY	0.026	0.032	0.840
EASTERNUPLANDS	-0.016	0.023	-0.700
SOUTHERNSEABOARD	-0.007	0.027	-0.270
FRUITFULRIM	0.015	0.041	0.370
MISSISSIPPIPORTAL	0.032	0.040	0.790
PRESCGRAZCOST	0.001	0.001	0.710
STKRATE	0.004	0.007	0.600
OTHLIV	0.027	0.013	2.030**
FEDPRGM	0.019	0.015	1.270
LIFE	0.003	0.007	0.450
WAIT	-0.016	0.005	-3.290***
CLIMATE	0.006	0.004	1.460
STEWARD	0.013	0.008	1.640*
FAMTKOVER	0.005	0.011	0.480
INTERNET	0.038	0.014	2.780***
PROPRIETOR	-0.025	0.016	-1.550
OFFFARMWORK	0.012	0.012	0.940

[a] *** indicates significance at α=.01, ** indicates significance at α=.05, and * indicates significance at α=.10.

Table 8: Estimated Weighted Probit Model and Marginal Effects for the Adoption at the Incentive Level Decision (ACCEPT)[a]

Variable	Est. Coeff	Std. Error	Z	Marg. Effect	Std. Error	Z
INCENT	0.005	0.002	2.330**	0.001	0.001	2.340**
AGE	0.033	0.031	1.050	0.010	0.010	1.050
AGE^2	0.000	0.000	-1.440	0.000	0.000	-1.440
INC3049	-0.209	0.184	-1.140	-0.068	0.062	-1.110
INC5099	-0.216	0.169	-1.280	-0.070	0.056	-1.260
INC100149	-0.175	0.202	-0.870	-0.057	0.068	-0.840
INCG150	-0.344	0.206	-1.670*	-0.116	0.073	-1.580
COLLEGE	0.275	0.122	2.260**	0.089	0.040	2.210**
EXTWKSHP	0.016	0.030	0.520*	0.005	0.009	0.520*
RENT	0.026	0.111	0.230	0.008	0.035	0.230
PASTURE	0.000	0.000	-2.110**	0.000	0.000	-2.120**
INPUTMGT	0.055	0.172	0.320	0.018	0.055	0.320
STRUCTURALMGT	0.177	0.165	1.070	0.058	0.056	1.030
FEEDINGMGT	0.104	0.162	0.640	0.033	0.052	0.640
GRASSMGT	0.057	0.164	0.350	0.018	0.052	0.350
HEARTLAND	0.101	0.247	0.410	0.031	0.075	0.420
NORTHERNGREATPLAIN	0.459	0.375	1.230	0.123	0.081	1.510
PRARIEGETAWAY	0.012	0.243	0.050	0.004	0.076	0.050
EASTERNUPLANDS	0.380	0.225	1.690*	0.110	0.060	1.850*
SOUTHERNSEABOARD	-0.224	0.245	-0.910	-0.074	0.086	-0.870
FRUITFULRIM	-0.180	0.383	-0.470	-0.060	0.133	-0.450
MISSISSIPPIPORTAL	0.489	0.293	1.670*	0.130	0.063	2.060**
PRESCGRAZCOST	-0.001	0.010	-0.050	0.000	0.003	-0.050
STKRATE	-0.064	0.046	-1.390	-0.020	0.015	-1.390
OTHLIV	0.073	0.117	0.630	0.023	0.036	0.630
FEDPRGM	0.254	0.126	2.010**	0.077	0.036	2.100**
LIFE	0.112	0.067	1.670*	0.035	0.021	1.670*
WAIT	-0.044	0.047	-0.930	-0.014	0.015	-0.930
CLIMATE	-0.046	0.042	-1.100	-0.015	0.013	-1.100
STEWARD	0.174	0.079	2.200**	0.055	0.025	2.200**
FAMTKOVER	0.255	0.111	2.290**	0.082	0.036	2.260**
INTERNET	0.251	0.119	2.110**	0.079	0.037	2.110**
PROPRIETOR	-0.413	0.134	-3.090***	-0.118	0.035	-3.410***
OFFFARMWORK	0.090	0.124	0.730	0.028	0.039	0.730
Intercept	-1.631	1.119	-1.460			

N= 872 LLR Test Wald $\chi^2(34)$= 99.11*** Pseudo R^2= 0.1209

[a] *** indicates significance at α=.01, ** indicates significance at α=.05, and * indicates significance at α=.10.

Table 9: Estimated Weighted Linear Regression for the Acreage Conversion Decision (ACRES)[a]

Variable	Est. Coeff	Std. Error	Z
INCENT	5.898699	3.22281	1.83*
TOTACFARM	1.20945	0.58303	2.07**
TOTAFINCENT	-0.01454	0.0085	-1.71*
Intercept	-290.938	218.291	-1.33
N=618 F Test (3, 612)= 5.36*** R^2= 0.2898			

[a] *** indicates significance at α=.01, ** indicates significance at α=.05, and * indicates significance at α=.10.

Vita

Caroline was born in Chattanooga, TN to Stuart and Laura Ellis. After graduating from Chattanooga Christian School, she went on to attend and graduate from the University of Tennessee in Knoxville, TN. She currently holds a B.S. in Animal Science and a B.A. in Food and Agricultural Business. She obtained a M.S. degree in Agricultural Economics in 2013 from the University of Tennessee in Knoxville as well. She would like to thank her husband, family, and friends for their continued support and encouragement throughout her academic career.