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Investigating Grassland and Cropland Conversion Decisions in the Dakotas, 2015 Producers Survey and Analysis

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INVESTIGATING GRASSLAND AND CROPLAND CONVERSION DECISIONS IN THE DAKOTAS, 2015 PRODUCERS SURVEY AND ANALYSIS

BY

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This thesis is approved as a credible and independent investigation by a candidate for the Master of Science degree and is acceptable for meeting the thesis requirements for the degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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ABSTRACT

INVESTIGATING GRASSLAND AND CROPLAND CONVERSION DECISIONS IN THE DAKOTAS, 2015 PRODUCERS SURVEY AND ANALYSIS

MD NIAZ MURSHED CHOWDHURY

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This study investigates grassland and cropland conversion decisions in the Dakotas. Data from a 2015 survey completed by 1,026 producers located in 57 counties of the Prairie Pothole Region (PPR) were used to evaluate land conversions. This thesis attempts to identify the land use conversion incidence and rate (grass to crop and crop to grass); the link between past and projected land use conversion decisions in the Dakotas, and determinants of land use conversion using different statistical tools, including logistic regression methods. A regional analysis of converted acres reveals that the grass to crop conversion rates (as percent of 2014 cropland acres operated) was 7.2% in both states, with more CRP grass conversion in North Dakota and tame/native grass conversion in South Dakota. Grassland to cropland conversion is more active in the central regions of both states compared to the eastern regions. The study also reports that economic price/cost/selected technology factors (ECT) had the highest average impacts and greatest difference by operator characteristics. The binary logit regression analysis confirms that farmland acres, farm/ranch sales, expansion of past farmland acres and region are related to almost all of the land use conversion decisions. Grassland (including CRP) to cropland use conversion is less likely to occur in East Central SD and East ND than in other regions. Cropland to grassland use conversion is less likely to occur in East North Dakota compared to other regions.

Chapter One
Problem Identification and Research Objectives

1.1 Introduction

The Prairie Pothole Region (PPR) is an area of the northern Great Plains with mid-grass and tall-grass prairies that contains thousands of shallow wetlands known as potholes. The region covers an area of about 715,000 km^2 (276,000 sq mi), including parts of three Canadian provinces (Saskatchewan, Manitoba, and Alberta) and five U.S. states (Minnesota, Iowa, North and South Dakota, and Montana), (Wikipidea, 2015). The Prairie Pothole Region (PPR) is the core of what was once the largest expanse of grassland in the world, the Great Plains of North America; and it provides breeding and nesting habitat for about 50% of the nation's migratory birds and it is home to rich soils, lakes and marshes (Ducks Unlimited, 2010).

North Dakota (ND) and South Dakota (SD) are among the most farm-dependent states in the United States, and grasslands in North Dakota and South Dakota are a major component of local ecosystems. In North Dakota and South Dakota (referred to as the Dakotas), the vast majority of cropped land is found in the eastern third of the two states, with cropping mixes, hay and pasture toward the center of each state. The west is dominated by ranching and hay production. The eastern and central parts of the two states are the focus of this thesis and also constitute the Corn Belt's northwest edge (Luri, 2015).

This study examines the relationship between land use conversion decisions and farm/business operator characteristics of producers in South Dakota and North Dakota. It uses data collected from a survey designed to determine land use conversion decisions. This study includes farmers' assessment of the relative importance of the driving forces behind land use changes and land use conversion rate across the region/state in the past 10 years. In addition, this study attempts to estimate projected land use conversion, and the link between past and future land use conversion.

1.2. Problem Identification

Land use change between crop and grass cover has been prominent in the Prairie Pothole region of the Dakotas for many decades. The increase in demand for and price of corn and soybeans within the Prairie Pothole Region (PPR) of the United States have been identified to be the primary drivers of producer decisions respecting participation in the Conservation Reserve Program (CRP) in the area (Stubbs, 2007; Rashford, Walker and Bastian, 2010). In recent times, Feng, Hennessy, & Miao (2013) reported that between 2007 and 2011, cropland enrolled in CRP decreased from 5 million acres to 3.8 million in South Dakota and North Dakota. It is assumed that most of these post-CRP acres were converted to cropland use.

Claassen et al. (2011) and Stephens et al. (2008) found that native grassland to cropland conversion continued to rise during the same period. Luri (2015) reported that grasslands (excluding CRP) were converted to cropland over the last decade (between 2004 and 2014). A set of recent studies reported a net decline of grass-dominated cover in the Dakota and grassland use shifted towards corn, soybean, and small grains (Decisions Innovations Solutions, 2013; Wright & Wimberly, 2013). Reduction in CRP acres and conversion of most post-CRP contracts acres from grassland to cropland is a portion of the grassland reduction. Thus, grassland loss is responsible for habitat loss and is a possible threat for the sustainable development and ecosystem. All of these studies confirm that grassland to cropland conversion has occurred over the last few decades and the rates of grass to cropland conversion may be substantial.

Most of the previous studies used different methods such as transition probability models, multivariate statistical modeling, spatial statistical (GIS-based) models, behavioral models and dynamic simulation models to estimate land conversion. Luri (2015) used a survey data set of producers located in the PPR of the Dakota, where corn and soybeans are more important than wheat or any small grain from an acreage standpoint. Luri's study mainly conducts a general assessment of the main drivers of the land use changes recent and projected land use patterns, and evaluation of agriculture in the Dakotas. He examined the whole survey data set at a less intensive level instead of focusing on the specific sections related to land conversion.

In this study, we have used the same data set that Luri (2015) used, but the research focus in this thesis is on land use conversion decisions and factors that may explain conversion decisions. Previous literature confirmed that no studies have been conducted that simultaneously studied the relationship between land use conversion decisions and farm business operator characteristics. This study employs a logistic regression model as well as different statistical tools including chi-square tests and t-tests using survey data to investigate the research objectives proposed in the thesis.

1.3 Research Objectives and Research Questions

The primary objective of this research is to conduct general assessments of the following in the Dakotas: land use conversion (grass to crop/crop to grass); the link between past and projected land use conversion decisions in the area, and determinants of land use conversion using survey data. Past land use conversion is estimated for the 10-year period of 2004 to 2014, while projected land use conversion is for the next 10 years.

1.3.1 Secondary Objectives

This objective will be achieved through these specific objectives.

1. To examine past agricultural land use conversion in the Dakotas based on regional distribution and farm operator / farm business characteristics.
2. To analyze projected agricultural land use conversion, and the link between past and projected land use conversion decisions.
3. To examine determinants of land use conversion decisions in the Dakotas by investigating the relationship of selected farm operator/farm business characteristics to specific land use conversion decisions.

1.3.2 Research Questions

The following research questions are answered by the study:

1. What are the land use conversion rate (grass to crop and crop to grass) and drivers of land use conversion?
2. What is the link between past and projected land use conversion decisions?
3. What are the determinants of land use conversion decisions?

1.4 Justification

The primary beneficiaries of this research are the farm/business operators, policy makers, and the communities of the Prairie Pothole Region. Research concerning land use conversion would serve as a source of information to farmland owners, renters, appraisers, lenders, buyers and decision makers. Findings and output from this research are expected to be useful in several ways.

First, this research could help land users (owners or renters) by providing information about land conversion decisions. It also provides information on how land conversion has occurred during the last decade; and which driving forces significantly affect the land use conversion decision. So, this study may serve as a source of information for the policy makers and land use conversion participants; past and prospective.

Secondly, the study will serve as source of information for policy decisions on long-term improvement in the sustainable development of agricultural and food production systems in the study area. In addition, this study attempts to identify the comparative usefulness of factors responsible for land use conversion decisions plus stakeholder perspectives. All of these findings can be used to understand the dynamics of land use conversion decisions.

Furthermore, this study provides an assessment of the relationship between farm operator and farm business characteristics and land use conversion decisions. Previous studies have not considered simultaneously studying the relationship between land use conversion decisions and farm business operator characteristics. Besides, no formal work has considered the likely importance of comprehending rapid land use conversion in the study area.

Finally, the study will provide information about projected land use conversion decision, and link between past and projected land use conversion decision. Based on this study, one can learn about the respondents' perception about future land use conversions, and they can also get information on how farmers are thinking about it. This information could help farmers make decisions about future land use conversion.

1.5 Organization of the Study

This study is organized in six main chapters. The first chapter contains the introduction of the study including the statement of the problem of the study, research objectives, questions and significance of the study.

Chapter two includes a review of theoretical and empirical literature on land use change. This chapter is divided into four sections. The first section contains definition of some key concepts used to analyze this data. The second section deals with past and present land use conversion scenarios in the Dakotas as well as the United States. The third section presents the projected land use conversion overview in the Prairie Pothole Region (which includes South and North Dakota) and the U.S. Finally, the last section is a discussion of models used in previous studies related to land use conversion.

Chapter three discusses the research design, data sources, and analysis methods adopted in this research. This chapter is arranged in the following ways, geographical research area, the sample frame, the sample and questionnaire design, data collection procedures, response rate and comparison of respondents/non respondents. Finally, data analysis procedures and analysis methods are presented in this chapter.

Chapter four contains a discussion of findings of the first two objectives of this research. The presentation and discussion of these results cover all objectives of this study. This chapter initially discusses the regional distribution by farm operator and business characteristics, farm household and operator demographic information. Thus, land uses conversion decision contains a two-fold discussion of conversion from cropland to grassland and conversion of grassland to cropland. In addition, the reasons for land use conversion are examined in this section. Finally, this chapter contains a discussion of projected land use conversion decisions and the linkage between their past decisions versus projected land use conversion decisions in the Dakotas.

Chapter five contains the investigation of determinants of land use conversion in Dakotas. This chapter provides a discussion of the modeling procedures, using logistic regression methods. Results from seven different land conversion logistic regression models are reported in this section, including grassland to cropland conversion models, cropland to grassland conversion models, and CRP use decision models. The final section of this chapter provides the key findings of this modeling based research. Finally, chapter six covers the summary, limitations, conclusions and recommendations of the study.

Chapter Two
Literature Review

2.1 Introduction

This chapter is a literature review focused on agriculture land conversion and major reasons for land conversion discussions. This chapter is divided into four sections. The first section contains definitions of key concepts used to analyze this study. The second deals with past and present agricultural land use conversion scenarios in the Dakotas and the United States. The third section presents the projected land use conversion overview in Prairie Pothole Region (which includes South and North Dakota) and for the United States. Finally, the last section discusses models that are used in different previous studies related to land use conversion.

2.2 Key Concepts

It is important to define some key concepts that are used in this study to clarify to the readers. These concepts related to land use or land cover. Those key concepts are defined in the following manner:

Land Use/Cover

Land-use denotes how humans use the biophysical or ecological properties of land. Land-uses include the modification and/or management of land for agriculture, settlements, forestry and other uses that excludes humans from land, as in the designation of nature reserves for conservation. Natural Scientists define land use in terms of syndromes of human activities. Social scientists and land managers define land use more broadly to include the social and economic purposes and contexts for and within which lands are managed (or left unmanaged), such as subsistence versus commercial agriculture, rented vs. owned, or private vs. public land (Ell10). Finally, Food and Agricultural Organization (FAO, 1999) states that land use is characterized by the arrangements activities and inputs people undertake in a certain land cover type to produce or maintain it. There is a difference between land cover and land use; land cover data documents how much of a region is covered by forests, wetlands, impervious surfaces, agriculture, and other land use types. However, land use shows how people use the landscape, whether for development, conservation, or mixed uses. Land cover can be determined by analyzing satellite and aerial imagery. Land use cannot be determined from satellite imagery. Land cover maps provide information to help managers best understand the current landscape. To see change overtime, land cover maps for several different years are needed. It is often impossible to observe land-use by examining only land-cover by remote sensing.

Land Use Change/Conversion

Land use change is “a process by which human activities transform the landscape”. Land use change is divided into two broad categories: conversion and modification (Stott & Haines, 1996; Alun & Clark, 1997; Baulies & Szejwach, 1997), where conversion refers to a change from one cover or use category to another (e.g. from cropland to grassland or grassland to cropland). Modification represents a change within one land use or land cover category due to changes in its physical or functional attributes (European Commission, 2011).

Cropland

Cropland denotes a land cover/use category that includes areas used for the production of adapted crops for harvest. Two subcategories of cropland are recognized: cultivated and non-cultivated. Cultivated cropland comprises land in row crops or close-grown crops and also other cultivated cropland like hay-land or pastureland that is in a rotation with row or close-grown crops. Non-cultivated cropland includes permanent hay-land and horticultural cropland (NRCS, National Resource Inventory).

CRP Land

The Conservation Reserve Program (CRP) pays an annual rental payment in exchange for farmers removing environmentally sensitive land from agricultural production and for planting species that will improve environmental quality (USDA, 2012). Through the Conservation Reserve Program (CRP), the federal government pays farmers to retire their land from active production and keep it in permanent vegetation grass in most cases (Feng, Hennessy, & Miao, 2013). The CRP contacts are 10 to 15 years in length.

Grasslands

Grassland is vegetation dominated by grasses and forbs, containing less than 10% woody plant cover (shrubs or trees). The term of grassland may evoke an image of a flat treeless expanse covered by a canopy of wispy plants. There is a duality in how we define grasslands, either as type of lands covered by specific forms of vegetation, or as a use of land by humans (Barnes and Nelson, 2003). Grassland as an ecological land type is defined as “land on which the vegetation is dominated by grasses” (Forage and Grazing Terminology Committee, 1991). Grasslands typically have minimal tree and shrub cover, though wooded grasslands may have up to 40% tree and shrub cover (FAO, 2012). According to definition “grasslands encompass not only non-woody grasslands but also savannas, woodlands, shrub lands, and tundra” (World Resource Institute, 2012). Many types of grassland occur as openings or as large islands called meadows within forested areas (Keller-Wolf et al., (2007).

Native Grassland

Native grasslands are “grassland” where >50% of the vegetation ground cover is composed of indigenous species of grasses and forbs (native to the area before European settlement), >50% of the number of species are native, and where the minimum standing vegetation ground cover, alive or dead, exceeds 10%. Prairie plants are adapted to grazing and native grazers such as bison helped maintain diverse prairie habitats by altering the vegetation height and density. These animals grazed at different intensities and frequencies, creating patches of heavily to lightly grazed prairie. This patchiness provided different habitats for various plant and animal species. Currently, most native grasslands are used for annual grazing with only modest improvements for fencing and livestock water (Ducks Unlimited, 2010).

Tame Grassland

Tame seeded grass is a parcel of land that has been seeded by the rancher with either native or introduced species of grass commonly mixed with a legume species such as clover, alfalfa or milk vetch.

Rangeland

Rangelands are grasslands, shrub-lands, woodlands, wetlands, and deserts that are grazed by domestic livestock or wild animals. Types of rangelands include tall-grass and short-grass prairies, deserts grasslands and shrub-lands, savannas, chaparrals, steppes, and tundras. Rangelands do not include forests lacking grazeable understory vegetation, barren desert, farmland, or land covered by solid rock, concrete and/or glaciers (Wikipedia, 2016). Most of the rangelands in the United States are to the west of an irregular North/South line that cuts through the Dakotas, Nebraska, Kansas, Oklahoma, and Texas (Source: A Land Use and Land Cover Classification System for Use with Remote Sensing Data). The land consists of principally native grasses, grass like plants, forbs or shrubs suitable for grazing and browsing (NRCS, 2011). A land cover/use category on which the climax or potential plant cover is composed principally of native grasses, grass-like plants, forbs or shrubs suitable for grazing and browsing, and introduced forage species that are managed like rangeland (NRCS, National Resources Inventory).

Pastureland

Pasture (from the Latin pastus, past participle of pascere, "to feed") is land used for grazing. Pasturelands in the narrow sense are enclosed tracts of farmland, grazed by domesticated livestock, such as horses, cattle, sheep or swine. The vegetation of tended pasture, forage, consists mainly of grasses, with an interspersion of legumes and other forbs (non-grass herbaceous plants). A field covered with grass or herbage and suitable for grazing by livestock Pastureland cover may consist of a single species in a pure stand, a grass mixture, or a grass- legume mixture rangeland (NRCS, National Resources Inventory).

Pasture/ Hay

A Pasture/Hay land includes areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation (National Land Cover Database).

Grassland Easement

A grassland easement is a legal agreement signed with the US federal government, through the U.S. Fish and Wildlife Service (Service) that pays landowners to permanently keep your land in grass. Many landowners never plan on putting their land into crop production and can benefit from the added cash incentive of a grassland easement. Land covered by a grassland easement may not be cultivated. Mowing, haying, and grass seed harvesting must be delayed until after July 15 each year. This restriction is to help grassland-nesting species, such as ducks and pheasants, complete their nesting before the grass is disturbed. (U.S. Fish and Wildlife Service; Divison of Reality, 2010)

2.3. Past and Present Land Use Conversion Scenario

2.3.1 Factors Responsible for Conversion towards Crop Production

Conversion of land towards crop production is driven by many factors. According to the most recent study conducted by Luri (2015), changing crop prices, changing prices in input markets, improved crop yields, development of more efficient cropping equipment, and changing climate and weather patterns have the greatest impacts on land use decisions. Clay et al. (2014) also reported high grain prices, rising food demand, and the development of more drought resistant maize cultivars as factors favoring crop production. Agricultural prices have increased over the last three decades and the U.S. total gross value/total costs ratio for maize, soybeans, and wheat were 1.24, 1.34, and 1.07, respectively in 2012 (Clay, et al. 2014). According to Faber, et.al (2012) high crop prices and crop insurance subsidies are primarily responsible for the loss of more than 23 million acres of grassland, shrub land and wetlands in the United States from 2008 to 2011; and of the 23.7 million acres, more than 8.4 million were converted to raise corn, more than 5.6 million to raise soybeans and nearly 5.2 million to grow winter wheat.

Crop prices, government payments and climate change are the major factor for the conversion of these grasslands in the Northern Great Plains (which includes the Dakotas). Other factors contributing to the reduction in grassland acre including the greater availability of crop production technologies, farm program payments and subsidies, including those for crop insurance inviting row cropping of soybeans and corn an marginal high risk land, and demand for agricultural land as a safe haven for stability (Lesch & Wachenheim, 2014).

Recent years have witnessed a dramatic increase in commodity prices due to rising demand. Stubbs (2012) & Rashford, Walker and Bastian (2010) reported current upward shifts in demand and price for corn as the primary drivers of producer decisions regarding participation in the Conservation Reserve Program (CRP) in the PPR. Wright & Wimberley (2013) found almost the same results; they concluded that in the U.S. Corn Belt, a recent doubling of commodity prices has created incentives for landowners to convert grassland to corn and soybean production. The upward demand of commodities around the globe has resulted in crop price increases in both local and international markets and is responsible for land use conversion as well. The rapid rise in commodity prices and its resultant effect on opportunity cost of land which otherwise is or might be devoted to conservation. Stubbs (2012) and Rashford, Walker and Bastian (2010) reported the downward shift in CRP enrollment in response to increasing commodity prices.

Several studies have investigated the impacts of government payments on land use decisions, and some studies specifically focused on the role of federal crop insurance programs, such as Young, Vandeveer & Schnepf (2001); Goodwin, Vandeveer, & Deal (2004); Lubowski et al. (2006); U.S. GAO (2007); and Claassen et al. 2011. Grassland to cropland conversion has also been heavily influenced by government payments such as crop insurance and disaster payments, which impact landowner decisions (Rashford, Walker & Schrag, 2013). In addition, Bauman, et al. (2014) found that government supports with crop insurance subsidies have statistically significant and positive effects on cropland acreage, but have negative effects on the acreage of land offered for CRP enrollment consideration.

Grassland conversion in the Dakotas initially took place east of the Missouri River in Minnesota and the Dakotas seeking higher rates of return from high-quality pasture by converting those lands to crop production (Wright & Wimberly, 2013). Rashford, Walker & Bastain (2011) and Stephens et al. (2008) are other examples of recent studies that grasslands in area with high quality soils are more likely to be converted to cropland than grassland on low-quality soils in the Prairie Pothole Region.

Technological innovation is another important factor responsible for land use conversion. Crops, seed and chemical market innovations have reduced some production costs, especially for corn and soybeans. Advanced technology can reduce production costs that subsequently increase the demand of cropland. A considerable number of studies reported technological innovation induced conversion decision in favor of cropland due to rapid adoption of genetically modified, herbicide tolerant and pest-resistant corn and soybeans varieties that have cut down on chemical use (Claassen, et.al. 2011; Yu & Babcock 2010; Tollefson 2011).

2.3.2 Overall Grassland to Cropland/ Cropland to Grassland Conversion Statistics

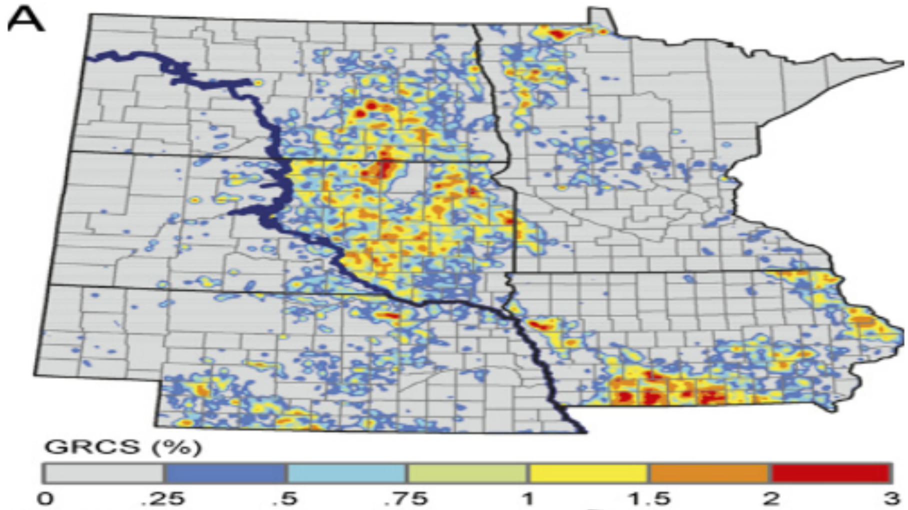
Grassland to cropland conversion varied by grassland type and region during the period between 1997 and 2007. Producers in the Northern Plains were more likely to convert grassland to cropland or retain land in crops rather than returning it to grass compared to other regions (Claassen et al., 2011). The Northern Plains accounted for 57% of rangeland to cropland conversion. In 2012, as compared to 2008, 2% less of the U.S. Northern Great Plains was grassland, due to the expansion of cropland. This equates to 2,708,275 acres (Olimb, 2013). A recent study conducted by Luri (2015) reported that farmers in Dakota's operated more acres of cropland and less acres of pasture/rangeland in 2014 than they did ten years before. All of these studies indicate conversion towards cropland is increasing over time and grasslands are reducing in acreage. Wright & Wimberly, (2013) also reported that grass-dominated land cover in the Western Corn Belt ranges from native prairie to modified grassland types like grass pasture and hay lands with cropland converted to perennial grasses through the Conservation Reserve Program (CRP).

2.3.3 Land Use Conversion Rate

Luri (2015) reported that the proportions of grassland (excluding CRP) converted to cropland acres between 2004 and 2014 to total cropland operated in 2014 were 1.06% and 3.83% for North Dakota (ND) and South Dakota (SD), respectively. The amounts of grassland (including CRP grassland) converted to cropland acres between 2004 and 2014, as a proportion of cropland acres operated in 2014 were 6.81% in ND and 7.08% in SD. For the subset of producers who converted grassland (excluding CRP) to cropland between 2004 and 2014, the conversion rate over the period was 4.55% for ND and 6.93% for SD. The majority of grassland acreage conversion was from CRP grassland to cropland conversion in ND, while most of the grassland acreage conversion in SD was from native grassland or tame grassland not enrolled in CRP contracts (Luri, 2015).

Johnston (2013), using remotely sensed National Land Cover Cropland Data Layer (NLCCDL) across the part of the PPR within the Dakotas, found that 4,840 square miles of grassland (native or not) between 2001 and 2010 had been converted to cropping. Another study by Reitsma, et al., (2014) using USDA-NRI (Natural Resource Inventory) data from 2006 to 2012 had even higher conversion estimates for South Dakota. Wright & Wimberly (2013) confirm that grassland conversion in the Western Corn Belt between 2006 and 2011 was mostly concentrated in North Dakota and South Dakota, east of the Missouri river (see Figure 2.2.1 below).

Figure 2.2.1: Map Showing Absolute Change Rate from Grassland in 2006 to Corn or Soybean in 2011.



Source: (Wright & Wimberly, 2013).

2.3.4 Regional Distribution of Land Use Conversion

Grassland to cropland conversion is more active in the central regions of both ND and SD than in the eastern regions (Luri, 2015). The majority of the change in corn and soybean production is happening along the eastern edge of the ecoregion, while wheat production is dominating in eastern and central Montana (Olimb, 2013). Wright & Wimberly (2013) evaluated the magnitude of grassland loss attributed to conversion to crop production in the Western Corn Belt (WCB) South and North Dakota during the period between 2006 and 2011. They reported the rate of grassland conversion to crops during this recent period was similar to the peak rates documented during the 1920's and 30's. In addition, Wright & Wimberly (2013) found a net decline in grass-dominated land cover in the WCB between 2006 and 2011 totaling 530,000 ha (>1.3 million acres) and a net decline in North Dakota and South Dakota totaled nearly 271,000 ha (>671, 000 acres).

Table 2.3.1 Area of Land Cover/Land Use Change from 2006 to 2011

Area, ha*10^3

State	**Grassland to Corn/Soy**	**Corn/Soy to grassland**	**Grassland net loss**
North Dakota	129(320)	40(100)	89(220)
South Dakota	256(632)	73(181)	182(451)
Minnesota	92(228)	13(31)	80(196)
Iowa	195(481)	42(104)	152(376)
Nebraska	125(309)	100(247)	25(62)
Sum (ND+SD)	385(952)	113(281)	271(671)
Sum	797(1969)	268(663)	528(1306)

Source: (Wright & Wimberly, 2013).

2.3.5 Native Grassland to Cropland Conversion

In recent times, conversion of native grassland to crop production land has become a critical issue in the United States (Claassen et.al., 2011). Evidence suggests that the rate of native grassland conversion has increased markedly since the 1990s. Some recent studies such as Stephens, et al. (2008), Claassen, et al., (2011) and Feng, Hennessy & Miao (2013), reported that native grassland to cropland conversion has been increasing continuously. A survey conducted by the NRCS in the four states reported that the Sodbuster program is of little assistance in limiting the conversion of native grassland to cropland. These findings suggest that native grassland to cropland conversion has been increasing in recent times.

2.3.6 Decline in Conservation Reserve Program (CRP) Land

Feng, Hennessy, & Miao, (2012) reported that between 2007 and 2011, the amount of cropland enrolled in CRP decreased from 5 million acres to 3.8 million. Luri (2015) found that more CRP lands were converted to cropland acres over the last decade in the Dakotas compared to tame and native grasslands converted outside of CRP.

2.3.7 Decline in Grassy Habitats

Decisions Innovations Solutions (2013) found that between 2007 and 2011, a considerable amount of land used for grassy habitat in SD was moved toward corn, soybeans and small grains. Luri (2015) found that grassland acres decreased by at least 5% whereas the number of corn and soybean acres increased by at least 5% with in 5 miles of their farm operation. Nearly 2 million acres of grassland had been converted to corn and soybean production in the western Corn Belt during 2006-2011 (Wright & Wimberly, 2013). Luri, (2015) also quoted the net loss of this area would be less (around 1.3 million acres) if conversion from cropland to grassland is taken into account during the same time period.

2.3.8 Conversion of Wetlands to Cropland

Recently, researchers have focused on the extent of wetland conversion towards cropland (Wright & Wimberly, 2013; Johnston, 2013; and Gleason et al., 2008). Wright & Wimberly (2013) found that between 2006 and 2011 wetlands have increasingly been converted to cropland in the Dakotas. In the PPR of North Dakota and South Dakota, increasing crop production is the greatest source of wetland loss (Johnston, 2013). Johnson (2013) found that National Wetlands Inventory wetland loss rate was 0.28% per year (−5,203 ha/yr) and the National Land Cover Database wetland loss rate was 0.35% per year (−6,223 ha/yr). Within this region, CRP and the Wetlands Reserve Program (WRP) have restored approximately 5.4 million acres of wetland and grassland habitats

(Gleason et al., 2008). Increased acreage devoted to agricultural production challenges these wildlife habitat gains throughout this unique geological and bio-diverse landscape.

2.4 Projected Land Use Conversion Overview

Rashford, Walker & Schrag (2013) investigated the impacts of changes in crop prices, government payments and climate on the likelihood of grassland being converted to cropland across the U.S. portion of the Northern Great Plains. They also reported that crop returns are expected to increase as much as 75% by 2030. A 10% increase in crop returns leads to a 0.3% increase, and a 25% increase in crop returns leads to a 1% increase of grassland being converted to cropland. A 10% increase in returns to cropland can lead to a 4-10% increase of grassland being converted to cropland for the high-quality soils. On relatively low soil quality, it will take a doubling of crop returns to lead to conversion of grasslands (Rashford, Walker & Schrag, 2013). They also reported North and South Dakota are likely to see an increase in cropland by 3 million acres if crop prices increase linearly until 2030, but grassland acres in Montana, Wyoming and Nebraska will remain relatively constant during the same period of time. An additional 700,000 acres of grassland may be lost in North and South Dakota, and 370,000 acres may be lost in Montana, Wyoming and Nebraska by 2060 (Rashford, Walker & Schrag (2013).

An increase in crop prices will lead to a rise in the number of parcels converted to cropland on all but those areas with the poorest soil quality (Schrag, Copeland & Rashford, 2013). The same study recorded a 10% increase in crop returns leads to a 0.3% increase, on average, in the likelihood of grassland being converted to cropland, while a 25% increase in crop returns leads to a 1% increase, on average, in the likelihood of grassland being converted to cropland across the US portion of the NGP ecoregion. However, an increase in crop prices of 10% leads to an increase in the probability of conversion of 4% to 10% depending on the soil quality (Schrag, Copeland & Rashford, 2013).

2.5. Data and Modeling of Previous Land Use Conversion Studies

Stephen et al. (2008) estimated the probability of native grassland loss during 1989-2003 with satellite data and logistic regressions. In addition, Rashford, Walker & Bastian (2011) used logit analysis of site specific (Natural Resource Inventory) data to examine grassland conversion between 1979 and 1997 in the Prairie Pothole region. Claassen, et al. (2011) investigated grassland loss across 77 Dakota counties in the PPR with simulation and econometric analyses based on 1998-2007 National Resource Inventory data. Johnston (2013) and Johnston (2014) estimate the land use change via NASS CDL data from 2006 to 2012, National Wetlands Inventory (NWI), and U.S Geological Survey National Land Cover Database (NLCD) for wetland use change for the Dakota Prairie Pothole Region of North Dakota and South Dakota. The studies combine all grassland/herbaceous, pasture, and hay cover by merging them into a single ‘grassland’ layer excluding alfalfa.

A recent study on land use change used survey data and logistic regression model (Luri, 2015). Data were collected from the sampled counties via a survey questionnaire of producers. Miao, Hennessy, & Feng (2013) used field level yield data up to 2006 and price data over 2005–2008 to their analysis. Diaz, et al. (2013) used the NLCD dataset between 2001 and 2006 for grassland and shrub land covers to cropland. Stott & Haines

(1996) estimated the probability of conversion of native grassland to cropland with satellite imagery and logistic regression models.

Turner et al. (2013) investigated grassland to cropland conversion in the Northern Great Plains Using Systems Dynamics via triangulation of qualitative and quantitative data. Feng, Hennessy & Miao (2013) generated a real options model of the irreversible native grassland conversion decision. Schrag, Copeland, & Rashford (2013) developed a predictive model to describe the potential for converting grassland to cropland. Wright & Whimberly (2013) conducted research using satellite imagery data. Another study conducted by Reitsma, et al., (2014) using USDA - NRI (Natural Resource Inventory) data focusing on estimation South Dakota Land Use change from 2006 to 2012. Most of the previous studies focused on transition probability models, multivariate statistical modeling, spatial statistical (GIS-based) models, behavioral models and dynamic simulation models.

2.6. Conclusion

This section of the literature review identified factors responsible for land use conversion practices in the United States and Prairie Pothole Region. Overall, there is agreement in the literature that high crop prices, increasing food demand, increasing drought resistant cultivars, improvement of equipment and other technological advancements, improved crop yields, high quality soil, government support and subsidies, crop insurance, and high climate variability have the greatest impacts on land use decisions.

The literature confirmed that grassland conversion towards cropland increased over the last few decades, with decreased amounts of grassland such as CRP land, native grassland and other grassy habitats. Wetlands have become an increasing source of conversion to cropland in the Dakotas where increasing crop production is the greatest source of wetland loss. The literature suggests that a considerable amount of grassland/CRP land acres was converted to cropland. Also, some cropland was converted to grassland, though the rate is much lower. We have not seen studies which focused simultaneous studying on land use conversion and farm operator characteristics. In this study, we trying to connect land use conversion and farm/business operator characteristics. This study also investigates the conversion rate of grass to crop and crop to grassland, and impact of various reasons for making land use decisions.

Chapter Three
Methodology

3.1 Introduction

The producer survey titled Farmland Use Decisions in the Dakotas was used to obtain the primary data needs to complete each objective. Quantitative and qualitative approaches were used to reach the research goals framework in Chapter 1. This chapter describes the methodological approach and procedures used in this thesis and it is divided into several parts. The methodology discussion begins with a description of the geographical area, sample selection, questionnaire design, and data collection procedures. Response rates and comparison of selected characteristics of respondents and non-respondents are presented and discussed. The remainder of this chapter includes a detailed discussion of data analysis procedures used to achieve each of the three major objectives.

3.2 Geographical Area Considered in this Research

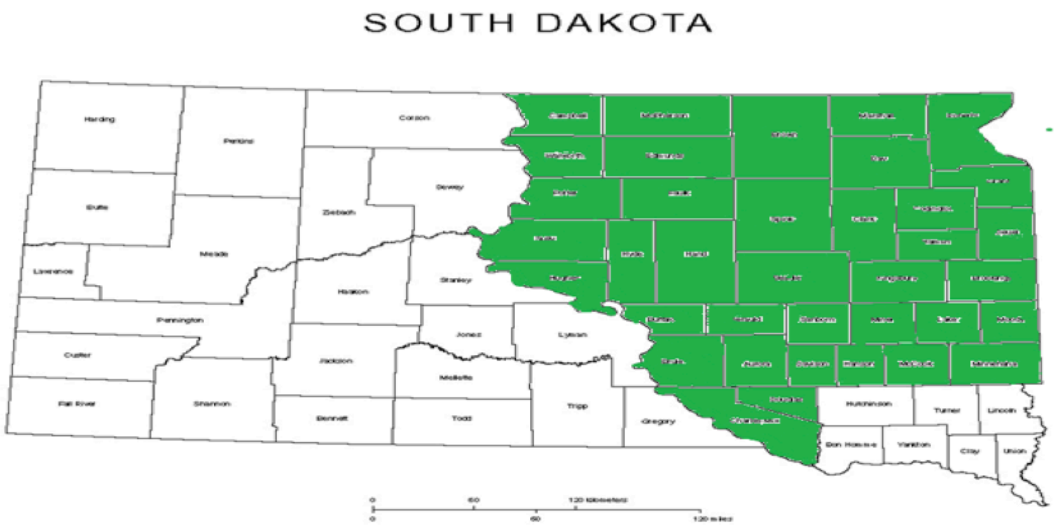
The survey project from which data were collected for this study was designed to be representative of crop farmers in a specific area in the eastern and central Dakotas, including 37 counties in South Dakota and 20 counties in North Dakota. These counties are located in the Prairie Pothole Regions (PPR) of both states and are located where corn or soybeans is more important than wheat or any small grains from an acreage standpoint. The geographic locations of the selected counties in North Dakota and South Dakota, along with the location of the PPR are shown in the following maps, and a complete listing of the 57 counties distributed by state is presented in Table 3.3.1 and by agricultural region in Table 3.3.2.

The agricultural regions followed USDA Ag Statistic Districts (ASD) in South Dakota except for the addition of Charles Mix and Douglas counties to the Central SD region. The two North Dakota regions did not follow ASD lines. The Central ND region consists of counties that were directly north of the North Central SD region, while the East ND regions consist of counties directly north of the Northeast SD region.

Figure 3.2.1a Map of North Dakota Showing Locations of Sampled Counties

Source: (Luri, 2015).

Figure 3.2.2a Map of South Dakota Showing Locations of Sampled Counties



Source: (Luri, 2015).

Table 3.2.1 List of 57 Sampled Counties by State

South Dakota Counties		North Dakota Counties
Brookings	Brown	Barnes
Clark	Brule	Burleigh
Codington	Buffalo	Cass
Davison	Campbell	Dickey
Day	Charles	Eddy
Deuel	Mix	Emmons
Grant	Douglas	Foster
Hamlin	Edmunds	Griggs
Hanson	Faulk	Kidder
Kingsbury	Hand	LaMoure
Lake	Hughes	Logan
Marshall	Hyde	McIntosh
McCook	Jerauld	Ransom
Miner	McPherson	Richland
Minnehaha	Potter	Sargent
Roberts	Spink	Sheridan
	Sully	Steele
	Walworth	Stutsman
		Traill
		Wells

Table 3.2.2 List of Sampled Counties by Agricultural Region	
Agricultural Region	**County or County Cluster**
North Central South Dakota	Brown, Campbell, Edmunds, Faulk, McPherson, Potter, Spink and Walworth
Central South Dakota	Aurora, Beadle, Brule, Buffalo, Charles, Mix, Douglas, Hand, Hughes, Hyde, Jerauld and Sully
North East South Dakota	Clark, Codington, Day, Deuel, Grant, Hamlin, Marshall and Roberts
East Central South Dakota	Brookings, Davison, Hanson, Kingsbury, Lake, McCook, Miner, Minnehaha, Moody and Sanborn
Central North Dakota	Burleigh, Dickey, Eddy, Emmons, Foster, Kidder, LaMoure, Logan, McIntosh, Sheridan, Stutsman and Wells
East North Dakota	Barnes, Cass, Griggs, Ransom, Richland, Sargent, Steele and Traill

3.3 Sample List Selection and Questionnaire Design

To be included in the sample, farmers were required to operate a minimum of 100 acres and to raise at least some wheat, corn, soybeans, or grass/hay. The sample was purchased from Survey Sampling International (SSI), and was obtained from their highest quality farm-sampling frame, which is based primarily on government reporting and other voluntarily provided land and crop ownership information. It was selected by SSI to be proportional by county, so that counties with more eligible farms would have more farmers in the sample than counties with fewer eligible farms. The sample included 3,000 names and mailing addresses with county, latitude and longitude of the primary farm location, primary crops, and estimated crop acreage for each farm. SSI billed SDSU directly for the sample cost.

Eligible participants included farm owners/operators involved in making decisions about land use. The level of farm involvement was not absolutely identifiable through the sample but was addressed in the cover letter and survey. Farmers who technically retired but who still made land use decisions were eligible for the study, while retired farmers who rented out their agricultural land and were not involved in land use decision making were ineligible.

The questionnaire called Farmland Decision Survey (FDSD) in the Dakotas, 2015 was primarily developed during the June – September 2014 time period by the principal investigators: Dr. Janssen and Moses Luri from the Economics Department along with Dr. Hennessy and Dr. Feng of Iowa State University. In addition, Mr. Carter Anderson from the USDA –NASS (National Agricultural Statistical Service) office in Sioux Falls, SD provided considerable assistance during this same period. Later assistance (December 2014 and January 2015) was provided by Dr. Janice Larson, Iowa State University, Survey Research & Behavioral Research Center (SRBR) in Ames, Iowa.

The final survey instrument consisted of an 8-page booklet with approximately 100 questions. The survey included questions related to the farmer's current land use, such as the number of acres planted in wheat, corn, soybeans, and alfalfa. It addressed recent changes in the use of grassland, cropland, and CRP land as well as opinions about the causes of land use changes in the respondent's farm operation and in his/her local area. Additional questions were focused on the future of agriculture in the next 10 years. Selected farmer demographic questions were also included. Appendix I contains a copy of the survey instrument.

A summary of the questionnaire design components is shown in Table 3.3.1. Section-1 asked the respondent about the farm operator and operation, and section-2 contains the questions related to their cropping system. Section-3 is related to their land use decisions and cropping decisions. In addition, section-4 obtained the respondents views on the adequacy of market outlets and infrastructure for crop and livestock production. Section 5 questions are focused on local area changes in land use patterns, while section-6 obtains their response to questions on weather patterns adversity. Finally, section-7 goes into farm operator and business characteristics. The analysis conducted in this thesis is mostly focused on content in sections 1, 3, and 7 (Table 3.3.1). Selected farm operator and business characteristics from sections one and three are included in the examination of land use decisions and land conversion decisions.

Table 3.3.1 Farmland Use Decisions in the Dakotas, 2015: Questionnaire Design

Section No.	Description
Section-1	Farm operator and operation
Section-2	Crop system
Section-3	Land use and cropping decisions
Section-4	Market outlets and infrastructure
Section-5	Local changes in land use patterns
Section-6	Weather patterns / adversity
Section-7	Farm business or operator characteristics

3.4 Data Collection Procedures

The Iowa State University's Survey & Behavioral Research Services (SBRS) unit collected data for this research. The principal investigators from SDSU and Iowa State University developed the questionnaire. SBRS staff converted the questionnaire into an

8-page booklet, drafted a cover letter and reminder postcard in collaboration with the principal investigators. The letter was printed on South Dakota State University letterhead and signed by both Dr. Larry Janssen and Dr. David Hennessy. It explained the purpose of the study, requested the farmer's participation, and assured complete confidentiality of all information provided. The SBRS toll-free phone number was also included so that sampled farmers could call to ask questions or express concerns about the project. The required approval of the Iowa State University Institutional Review Board was obtained by SBRS on February 27, 2015.

It was assumed that envelopes with the South Dakota State University logo and mailing address would be more likely opened by Dakota farmers than envelopes with an Iowa State University address, so the outgoing envelopes were printed and provided to SBRS by South Dakota State University. Other project materials, including the surveys, were printed and the survey packets prepared for mailing by SBRS. Return envelopes were addressed to Iowa State University to expedite the processing of completed surveys.

The first survey mailing was sent to the 3,000 sampled farmers on March 2, 2015. Each survey packet contained a cover letter, the survey booklet, a $2 bill cash incentive, and a postage paid return envelope. A reminder postcard with a small replica of the survey's cover picture was sent to the full sample about 8 days later, and a second complete mailing of the survey was sent to 2,108 non-responders on March 24. There were no cash incentives included with the survey re-mail.

A total of 1,050 completed surveys were received during the data collection period, from March 6 through May 11. Most of these surveys were useable for analysis purposes.

SBRS staff monitored and recorded the receipt of completed surveys. The U.S. Post Office returned to SDSU surveys that were marked as undeliverable or whose intended recipients were temporarily away, based on the return address on the mailing envelopes. SDSU staff notified SBRS of the undeliverable returned packets so that records could be updated. “Temporarily away” was an unfamiliar classification for SBRS. An investigation indicated that individuals at those addresses were away for an extended period and, even though the survey packets were sent first class, the local Post Offices did not think the project envelopes warranted forwarding. As a result, SBRS kept those cases in the active sample and sent a second survey packet in the event that the farmer would have returned home.

When the data collection window ended, SDSU shipped the undeliverable packets to Iowa State University so SBRS could remove the $2 bills and reconcile the incentive account. Completed surveys were edited and coded by SBRS staff. Coded surveys were key entered using a double entry verification system, and the resulting data set was checked for errors and cleaned. Open-ended text was entered into a separate worksheet for delivery. The final Excel spreadsheet was then acquired and analyzed using SAS programing.

3.5 Response Rates and Comparison of Selected Characteristics of Respondents and Non-Respondents.

The survey response rate and outcome distribution are shown in Table 3.5.1 below. The original sample list consisted of 3,000 farm households. A total of 96 cases (3.2% of 3,000) were classified as Not Eligible based on information received primarily from phone calls or blank surveys returned with notes. Cases with survey packets marked as "deceased" were also classified as ineligible. In addition, there were 107 cases (3.6% or original sample) with survey packets returned to SBRS by the U.S. Postal Service that were marked as "temporarily away" or "return to sender". These households were not considered eligible because these persons could not complete the survey during the data collection period.

This resulted in an eligible sample list of 2,797 farm households or 93.2% of the original sample. Refusals were received from 50 people (1.8% of the eligible sample), either by phone calls or blank surveys returned with notes. The largest portion of the eligible sample list, 1,690, did not respond at all. Non-responders comprise 60.4% of the eligible sample (1,690/2,797). In addition, there were 31 farmers (1.1% of the eligible sample) who returned their surveys with just a small number of questions completed or whose farm operation were now located outside of the study region, primarily in Iowa and Minnesota. These survey responses were not included in the completed survey file.

Overall, a total of 1,026 completed and useable surveys were received, with 342 from North Dakota and 684 from South Dakota. The overall response rate is 36.7%, with a 31.4% response rate from North Dakota and 40.0% from South Dakota (Table 3.5.1). The completed responses included eight producers whose farm headquarters were in an adjacent county but also operated farmland in the study region.

Table 3.5.1 Number of Sampled Cases by Outcome Disposition and Response Rates.

	North Dakota (20 Counties)	South Dakota (37 Counties)	Total
A. Original Sample List	1,182	1,818	3,000
Not Eligible	38	58	96
Returned by USPS	55	52	107
B. Eligible Sample	1,089	1,708	2,797
Refused	16	34	50
No Response	717	973	1690
Partial and unusable	14	17	31
C. Completed Surveys	342	684	1,026
Response Rates (C/B)	31.4%	40.0%	36.7%

The tabulation of number of responses / non responses by state and region is shown in Table 3.5.2: Response rates were lowest (30.1%) in Central ND, moderate (35+%) in East ND and North Central SD regions, and highest (40% to 43.7%%) in the Central, East Central and Northeast regions of South Dakota. The response rate across the three central regions (Central ND, North Central SD, and Central SD) for this study was 35% with variation from 30.1% to 40%. The overall response rate across the three eastern regions was 40% with variation from 35.2% to 43.7%.

Table 3.5.2 Distribution of Survey Responses /Non Respondents

State	Region	Complete	Not used	Response Rate
North Dakota	East ND	164	318	35.2%
	Central ND	178	418	30.1%
	Subtotal: ND regions	342	747	31.4%
South Dakota	Central SD	164	249	40.0%
	North Central SD	119	229	35.5%
	East Central SD	219	307	42.4%
	North East SD	182	228	43.7%
	Subtotal: SD regions	684	1024	40.0%
Subtotal Both States	Subtotal All Regions	1026	1771	36.7%

Selected farm size and cropping pattern characteristics were compared for respondent and non-respondent farm operators included in the 2,797 households in the eligible sample list. Based on data provided by SSI from their summary of federal reports, 97% to 99% of producers in the sample list grew corn or soybeans, about 91% reported some hay acres and 75% reported wheat acres. Slightly over half reported having beef cows.

The following items were examined for t-test comparisons of means ($p<=0.05$ level of significance) between "Complete" responses and "Not Used" at the overall (both states), state, and regional level (Table 3.5.3).

Table 3.5.3. Selected Items and Various Geographical Regions Used for T-Tests

Item selected to examine for t-test	**Various levels of geographic aggregation for t-test**		
Planted Acres		State	Region
Corn acres		North Dakota	Central ND
Soybean Acres			East ND
Hay Acres		South Dakota	North Central SD
Wheat Acres			Central SD
			Northeast SD
Beef Cow Herd (number of cows)			East Central SD

Overall, the means for planted acres, corn acres, soybean acres and wheat acres were slightly higher to significantly higher for the "Not Used" sample list compared to the "Complete" responses. Table 3.5.4 contains a summary of the key results for each item by geographic region. Only statistically significant items ($p<=0.05$) are emphasized.

Table 3.5.4 Comparison of Non-Respondent versus Respondent Characteristics of Sample Frame

Acres Operated	Summary Result
Planted acres	Significantly higher means for Not Used vs. Complete responses: Both states, South Dakota and East Central South Dakota with p=0.04 to p=0.06 for Central South Dakota and North Central South Dakota.
Corn Acres	Significantly higher means for Not Used vs. Complete responses for: Both States, South Dakota and Central Dakota, Central South Dakota and North Central South Dakota (p=0.05)
Soybean Acres	Significantly higher means for Not Used vs. Complete responses for: Both states, South Dakota and East Central South Dakota (p=0.05).
Hay Acres	Significantly higher means for Not Used vs. Complete responses for South Dakota and North Dakota but not significant differences in any region.
Wheat Acres and Beef Cows.	No significant differences for means of Wheat Acres or Beef Cows between Not Used vs. Complete at any geographic level: both states, six regions, or individual states.

The most important findings were:

1. Responding farms planted crop acres, corn acres & soybean acres averaged 10-15% lower than on non-respondent farms.
2. The means of all farm-size related variables of planted acres, specific crop acres, and beef cow numbers were slightly higher to significantly higher for Not Used (did not respond to survey) than for Complete respondents.

3. The main geographic differences in means were for Planted Acres and Corn Acres based on t-tests results for both states, for South Dakota, and for several regions. There were some significant differences in means for Soybean Acres and Hay Acres. There were no significant differences in means for Wheat Acres and Beef Cow numbers at any geographic level examined.

We conducted an unusual method of checking for nonresponse bias. Essentially, the data per observation in the sample list compared selected non-surveyed characteristics of respondents vs. non-respondents in the sample list. Thus the findings provide considerable insight on how similar respondents are to non-respondents in the sample list and indicate how representative the respondents are of the entire sample frame.

This analysis can also be used to make some comparisons to the farm operator characteristics in the Census of Agriculture 2012. In general, respondent characteristics are most representative of farm operations in the low medium to larger farm operations with >$100,000 sales, more than 260 acres operated, and farm operators declaring that farming is his/her major occupation (not retired or primarily working off-farm). In South Dakota this subset of farmers operates more than 85% of farmland acres in the State.

3.6 Data Analysis Procedures

In this section, the methods and procedures used in analyzing the collected survey data are discussed. The discussion is presented in four sub-sections.

3.6.1 Analysis Procedures of the First Research Objective

The first objective of this study was to examine the past land use conversion in the Dakotas based on geographical regional distribution and farm operators' and business characteristics. Table 3.6.1a below provides the list of survey question numbers related to farm operator and business characteristics of the survey respondents, and Table 3.6.2 shows the specific questions in the survey questionnaire used to achieve this objective

Table 3.6.1a Selected Farm Operators and Business Characteristics

Variable	**Question number in survey questionnaire**
Time as farm operator on current farm/ranch	Q1
Total operated farmland acres in 2014	Q3a
Ownership Status of land operated in 2014	Q4
Age	Q19
Gender	Q20
Highest level of education completed	Q21
Principal Occupation	Q22
Gross farm/ranch sales in a typical year	Q23

Table 3.6.1b Survey Questions Used for Analysis of Research Objective One

Brief description of question	**Question number in survey questionnaire.**
If respondent converted native grassland to cropland in the past ten years.	Q9AYN
If respondent converted tame grassland to cropland in the past ten years.	Q9BYN
If respondent converted CRP land to cropland in the last ten years.	Q9CYN
If respondent converted CRP land to pasture/hay in the last ten years.	Q9DYN
If respondent enrollment of farmland acres into CRP in the last ten years.	Q9EYN
If respondent enrollment of land into WRP (Wetland reserve) or grass easement program in the last ten years.	Q9FYN
If respondent made a grass/CRP conversion to cropland decision in the last ten year.	GRASCROP (Q9AYN, Q9BYN, Q9CYN)
If respondent made a cropland conversion decision to grass in the last ten year.	CROPGRAS (Q9DYN, Q9EYN, Q9FYN)
If respondent made some changes in CRP use decision vs. no changes in the last ten year.	CRPUSE (Q9CYN, Q9DYN, Q9EYN)
Acres of native, tame and CRP land converted to cropland over the last decade	Q9 Acres (Q9AAC, Q9BAC, Q9CAC)
Acres converted CRP land to pasture/hay, enrollment of farmland acres into CRP and Enrollment of land into WRP	Q9 Acres (Q9DAC, Q9EAC, Q9FAC)
If the farm operator has expanded in terms of acres operated during the past 10 years based on Q5.	EXPAND
Farm-related issue with the greatest impact on producers' own land use.	Q10B (10 items)
How much the farm-related issue impacts on producers' own land use.	Q10A (10 items)

To analyze the first objective, different summary statistics including t-tests and crosstabs with associated chi-square tests were performed. The farm operator and business characteristics are based on questions Q19 through Q23 in the survey as well as questions Q1 (year involved as farm operator) Q3A (total farmland acres operated), and Q4 (Ownership status). We also developed an additional farm operator and business characteristic variable called EXPAND. We also developed three new composite variables GRASCROP, CROPGRAS, and CRPUSE, which are various combinations of land conversion decisions. These variables are explained in more detail in section 3.6.3.

The following steps were completed to analyze objective one.

1. Number and percent of respondents by specific land use conversion decision and combinations of land use conversion decisions in past 10 years.
2. The number of acres converted by specific decision and as a percent of cropland operated in 2014. Overall land use conversion rates are calculated including and excluding CRP land conversion (Table 3.6.1c).
3. To show relationship of individual respondent farm operator/ farm business characteristics to participation in land use conversion (chi-square or t-tests).
4. The determine reasons for land use conversion decisions.
5. The main purpose of these four steps (1 to 4) is to investigate the incidence of conversion decisions and to compare individual characteristics of participants / non-participants in land conversion.

Table 3.6.1c Land Use Conversion Rate Definitions

Conversion rate Definitions (Percent of Acres Converted 2004 to 2014/Cropland Acres Operated in 2014)
Percent of total cropland acres that are converted grassland acres (exclude CRP)
Percent of total cropland acres that are converted grassland acres (include CRP)
Percent of total cropland acres converted to grass (include post-CRP)

Land use conversion statistics were summarized at the state and regional level, which allows for examination of possible differences in conversion rates by state or region. Several different cross-tabulations were used to show the relationship between farm operator business characteristics and land use conversion decisions.

We also examined respondents' reasons for land use conversion decisions and compared the mean values of each reason for respondents that did or did not make convert any acres of grassland to cropland. We also compared the mean of each farm-related issues (Q10A) to the order of responses for Q10B (which asked each respondent to indicate the single most important item). We further examined each Q10A item mean or frequency distribution by selected farm operator/business characteristics.

3.6.2 Analysis Procedures of the Second Research Objective

The second objective of this work is to examine projected agricultural land use conversion, and the link (if any) between past and projected land use conversion decisions in the Dakotas. The following items were examined in this objective.

i. Relationship between region/state location and operator/farm business characteristics to future land use conversion decision.

ii. Farm-related issues that significantly affect producers' plan about future land use conversion decisions.

iii. The association between producers' responses on past and future land use conversion decisions.

Table 3.6.2 Survey Question Related to future land Use Conversion Decisions.

Brief Description of Question	Question Number in Survey Questionnaire.
If respondent plans to convert some native grassland to cropland in the next ten years.	Q11a
If respondent plans to convert some tame grassland to cropland in the next ten years.	Q11b
If respondent plans to convert some cropland to grassland in the next ten years.	Q11c

To analyze the objectives, we used many of the same procedures used to accomplish the first objective. In addition, we tried to determine which farm-related issues significantly affect future land use conversion decisions. To do this, we used different cross tabs with chi square test between farms related issues (Q10A) and future land use conversion intention (Q11). Finally, we provided the association between past and future land use conversion decisions, where we compared each respondent's past decisions with his/her projected land use conversion decisions.

3.6.3 Analysis Procedures for Analyzing the Third Research Objective

The third objective of this study was to examine the determinants of land use conversion decisions in the Dakotas by investigating the relationship of selected farm operator/farm business characteristics to specific land use conversion decisions.

To analyze the third objective, we tried to get the state and regional distribution of acres converted for all six-conversion decisions (Q9 variables). Then, a two-way frequency analysis with chi-square test was run on question Q9 and selected farm/business operator characteristics. This approach allows one to understand the relationship between each farm operator and farm business characteristics to land use conversion decisions.

First, we tried to figure out the number of respondents who made any land use conversion decision and what is the pattern of land use decisions that were made (in other words, whether the respondents made more than one type of land use decision). Following, we compared farm operator / business characteristics for those respondents that made a land use conversion decisions vs. those who did not make this decision – an overall YES / NO decision. Initially, we examined by cross-tabs and associated chi-square tests or t-test difference of means (for continuous variables). Next, we developed several logit regression model(s) of the YES / NO land use conversion decision as a function of several explanatory variables including some farm business / operator characteristics and regional location From the chi-square test results, seven logistic regression models were built based on statistically significant relationships discovered. The logistic regression was aimed at further investigating the combined relationships of selected farm operator/farm business characteristics to specific land use conversion decisions. Tables' 3.6.3a and 3.6.3b show the list of dependent and independent variables included in various logistic regressions.

Table 3.6.3a List of Dependent Variables

Variable Description	Representation
If respondent converted native grassland to cropland in the past ten years.	NGLCL
If respondent converted tame grassland to cropland in the last ten years.	TGLCL
If respondent converted CRP land to cropland in the last ten years.	CRPCL
If respondent converted CRP land to pasture/hay in the last ten years.	CRPLP
If respondent made a grass/CRP conversion to cropland decision in the last ten years.	GRASCROP
If respondent made a cropland conversion decision to grass land in the last ten years.	CROPGRAS
If respondent made some changes in their use CRP use in the last ten years.	CRPUSE

3.6.3.1 Explanation of Dependent Variables

For each dependent variable listed below, a conversion decision was coded as 1 or 0, with YES=1 and NO=0

1. **Native Grassland to Cropland (NGLCL):** Respondents were asked about native grassland to cropland conversion decision in the last 10 years (see appendices)

2. **Tame Grassland to Cropland (TGLCL):** Respondents were asked about tame grassland to cropland conversion decision in the last 10 years (see appendices)

3. **CRP land to Cropland (CRPCL):** Respondents were asked about post-CRP land to cropland conversion decision in the last 10 years (see appendices)

4. **CRP land to Pasture/Hay (CRPLP):** Respondents were asked about post-CRP land to pasture/hay land conversion decision in the last 10 years.

5. Made a Grass/CRP Conversion to Cropland Decision (GRASCROP): We developed a composite variable GRASCROP to include any respondent that made a grass/CRP conversion to cropland decision:

YES=1 if respondent converted native grass to cropland or converted tame grassland to cropland or converted CRP to cropland.

NO =0 if respondent answered "no" to all of these conversion decisions.

The GRASCROP variable YES represents all respondents who made a land use conversion of grass/CRP grass to cropland use decision in the past 10 years, compared to those who made no grass to cropland use decisions.

6. **Made Some Changes in their Use CRP Use (CRPUSE):** We developed a composite variable CRPUSE to include any respondent who made some changes in their use of CRP (Feng, Hennessy, & Miao, 2013) use decision:

YES=if the respondent converted CRP to crop or converted CRP to grass/hay or enrolled farmland acres into CRP.

NO= if there was no CRP conversion/enrollment activity

This variable CRPUSE represents all respondents that made some changes in their use of CRP during the past 10 years vs. those that made no changes in CRP use.

7. Made a cropland conversion decision to grass land (CROPGRAS): The composite **v**ariable CROPGRAS represents respondents who made a cropland conversion decision to grass in the last ten years.

YES=if the respondent converted CRP to grass/hay or enrolled farmland acres into CRP or enrollment of land in WRP.

NO= if there was no CRP conversion/enrollment activity

Table 3.6.3b List of Independent Variables

Variable Description	Representation
Respondents age	AGE
Gross farm/ranch sales	GFRSALES
Farmland acres operated in 2014	FARMLAO
If the farm operator has expanded in terms of acres operated during the past 10 years.	EXPAND
Region	REGION

3.6.3.2 Explanation of Independent (Explanatory) Variables:

a. AGE:

In our original survey dataset AGE is classified into five categories. For the models we reclassified AGE into three categories: 1= Young respondents less than 50 years old, 2= middle age respondents from 50 – 59 years old, and 3= Older respondents at least 60 years old.

b. Gross Farm/Ranch Sales (GFRSALES):

Gross farm/ranch sales was reclassified from six annual sale volume categories to three categories, which are defined as less than $99,999; from $100,000 to $499,999 and $500,000 or more.

c. Total Farmland Acres Operated in 2014 (FARMLAO):

We categorized the variable FARMLAO in following way; ' 1 to 499 acres', ' 500 to 999 acres', '1000 to 1999 acres' and '2000 and above '.

d. EXPAND:

To obtain the variable "EXPAND", we used Q5a and Q5b to develop a composite variable ACRECHG to indicate if the operator had changed his/her number of acres operated by more than 10% from 10 years earlier. Question 5 on trends in cropland acres operated and pasture/rangeland acres operated can help answer the question of whether the farm operator expanded, downsized or remained about the same in terms of acres operated during the past 10 years. We can classify farm operation and total acres into EXPAND, DOWNSIZE, SAME and UNSURE category. Sizeq5= (q5a*10) + q5b) where q5a and q5b are each equal to 1,2, or 3. We can categorize sizeq5 variable in the following way (table 3.6.3c).

Table 3.6.3c Relationship between ACRECHG and EXPAND

Categorized of size5 variable	**Description of the Variable**
ACRECHG = EXPAND	if sizeq5 is equal to 33,32, 23, 31, 30 or 3
ACRECHG= SAME	if sizeq5 is equal to 22,20 or 2
ACRECHG= DOWNSIZE	if sizeq5 is equal to 11, 12, 21, 10 or 1
ACRECHG= UNSURE	if sizeq5 is equal to 13

3.6.3.3 Specification of the Models:

Several criteria were used, including chi-square tests, to decide on the final set of dependent and independent variables. If π is the probability of a respondent answering yes to a question on the dependent variable list, the odds in favor of a 'yes' are $\pi/(1-\pi)$.

Logistic regression models describe the linear relationship between the logit, which is the log of odds, and the set of predictors. Seven logistic regressions were performed in this research as specified below and all seven models have the same set of explanatory variables.

$$\mathbf{Model1.\ Logit(\pi) = \log\left(\pi/_{(1-\pi)}\right) = NGLCL = \ \beta_0 + \beta_1 AGE + \beta_2 GFRSALES + \beta_3 FARMLAO + \beta_4 EXPAND + \beta_5 REGION + \mathit{e}_1}$$

$$\mathbf{probability\ modeled\ is\ CNGCLP = yes(1)}$$

All of the six other logit models have the same format and list of independent (explanatory variables; only the dependent variable (land conversion decision) is changed. The dependent variable for the other six models are: TGLCL, CRPCL, CRPLP, GRASCROP, CRPUSE and CROPGRAS.

Both multiple linear regression models and logistic regression models produce beta values or coefficients for the predictor or independent variables. However, the interpretation of logistic regression coefficients is considerably different from that of multiple regression coefficients. Interpretation of logistic regression coefficients considerably depends on the understanding of the concept of odds ratios. An odds ratio (OR) is a measure of association between an exposure and an outcome. The odds ratio represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure. In other words, the odds ratio of an event is the probability of that event occurring divided by the probability of its failure. For instance, if G is an event whose outcome is dichotomous with a yes/no response and if P(G) is the probability of a "yes" response to G, then the odds of G are given by $odds = P(G)/1-P(G)$.

OR<1 the odds of the target event is less likely than the other event or exposure associated with lower odds of outcome.

OR>1 the odds of the target event is more likely than the other event or exposure associated with higher odds of outcome.

OR=1 both events are likely or exposure does not affect odds of outcome.

The logistic regression output used in this research is the max rescaled R-square, concordance percentage, likelihood ratio test, the type 3 analyses of effects and the odds ratio estimates. Details of the seven models and the various outputs are discussed in chapter five.

Chapter Four
Analysis and Discussion of Results for Objectives 1 and 2

4.1 Introduction

This chapter presents the findings in line with the objectives and methodology discussed in the first three chapters. Results from the first two objectives are presented and discussed in this chapter, while chapter 5 is devoted to the third objective. This chapter contains three parts:

1) Farm household operator demographic and farm business characteristics (sections 4.2 and 4.3) are included as essential background information for all three objectives;
2) Section 4.4 is mainly devoted to findings related to objective one, which includes a detailed investigation of land use conversion decisions, both grass to crop and crop to grass conversion, by number of acres, incidence by types of decisions, conversion rates as percent of cropland acres and other land use conversion dynamics. Most findings are reported at both the state and regional levels. Also included is an investigation of the relative importance of major reasons for land use conversion decisions. Finally, this study reports, using chi-square analysis, the relationship between various reasons for decisions and operator / farm business characteristics.
3) Section 4.5 is devoted to investigating of the second objective and is divided into four subsections. In subsection 4.5.1 the relationship of region/state location and operator/farm business characteristics to future land use conversion decision is

investigated. The next subsection, 4.5.2, shows the relationship between farm-related issues that are possible reasons for land use decision making and projected land use conversion decisions. Subsection 4.5.3 emphasizes discussion of the association between producers' responses on past and future land use conversion decisions. Finally, this study reports the comparison of past and projected land use conversion decisions.

4.2 Farm Household and Operator Demographics

Table 4.2.1 contains frequencies and percentages on six demographic variables presented by state. A total of 1,026 usable responses were analyzed of which 342 (33.3%) are from North Dakota and 684 (66.7%) from South Dakota. Major similarities exist between the distributions of characteristics of operators in the two states. Gender distribution is heavily skewed towards males for both states. The median age class in both states is 50-59 years, which probably reflects a group that has lots of experience in farming/ranching. Over 60% of respondents in each state report at least 30 years of experience in farming/ranching and nearly 87% of respondents in each state list farming as their principal occupation. More respondents in North Dakota completed some post high school education compared to their South Dakota counterparts. However, the difference in the distribution of educational attainment of respondents between the two states is probably not large enough to create major differences in the understanding and responses to the survey. Finally, the distribution of responses on gross farm/ranch sales in a typical year is normal for each of the two states with a median sales range of $250,000 to $499,999. Nearly two-thirds of the respondents reported gross farm sales between $100,000 and $ 999,999.

4.2.1 Farm/Ranch Operator Demographic Information

	SD		ND		Both States	
Gender	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
Male	664	97.36	336	98.25	1000	97.66
Female	18	2.64	6	1.75	24	2.34
Age						
19-34 years	26	3.83	26	7.69	52	5.11
35-49 years	127	18.70	56	16.57	183	17.99
50-59 years	216	31.81	122	36.09	338	33.24
60-69 year	193	29.59	100	28.42	293	28.81
70 years and over	117	17.23	34	10.06	151	14.85
Highest education completed						
Less than High school	22	3.22	7	2.05	29	2.83
High School	239	34.94	82	24.05	321	31.32
Some College/ technical School	246	35.96	146	42.82	392	38.24
4 year college degree	155	22.66	88	25.81	243	23.71
Advanced Degree (Masters, etc.)	22	3.22	18	5.28	40	3.90
Principal Occupation						
Farming or Ranching	601	88.12	298	87.13	899	87.79
Employment in off-farm job	35	5.13	22	6.43	57	5.57
Own/operate a non-farm business	20	2.93	8	2.34	28	2.73
Retired	26	3.81	14	4.09	40	3.91
Time spent as farm operator on current farm/ranch						
Less than 10 years	34	5.72	25	8.65	59	6.68
10 to 19 years	72	12.12	32	11.07	104	11.78
20 to 29 years	94	15.82	49	16.96	143	16.19
30 years or more	394	66.33	183	63.32	577	65.35
Gross farm/ranch sales in a typical year						
Less than $99,999	108	16.56	61	18.65	169	17.26
From $100,000 up to $249,999	177	27.15	74	22.63	251	25.64
From $250,000 up to $499,999	175	26.84	83	25.38	258	26.35
From $500,000 up to $999,999	120	18.40	68	20.80	188	19.20
$1 million or more	72	11.04	41	12.54	113	11.54

Table 4.2.2 shows the proportion of farm sales by operator age and sales class in 2014. Young operators (less than 35 years) make up a small percentage of all farm sales in both states. Old-age operators (60 years or over) have the largest proportion of farm operators by age category in the Dakotas, accounting for 38.70% of ND respondents and 45.13% of SD responses. These older farmers account for the largest proportion of small and middle size farms, while middle age operators (35 to 59 years old) are generally operators of middle and large sales class farms. This is evidence of the proposition that older operators generally operate small and medium scale farm operations, while middle-aged farmers run the large-scale farm operations in both states.

Table 4.2.2 Distribution by Sales Class and Age of Principal Farm Operator in the Dakotas

	Less than $99,999	From $100,000 up to $499,999	$500,000 or more	Total
		North Dakota		
Young	13 (22.03)	32 (20.65)	36 (33.03)	81 (25.08)
Middle Age	20 (33.90)	50 (32.26)	47 (43.12)	117 (36.22)
Old	26 (44.07)	73 (47.10)	26 (23.85)	125 (38.70)
Total	59 (18.27)	155 (47.99)	109 (33.75)	323 (100.00)
		South Dakota		
Young	31 (29.25)	63 (18.05)	56 (29.17)	150 (23.18)
Middle Age	23 (21.70)	108 (30.95)	74 (38.54)	205 (31.68)
Old	52 (49.06)	178 (51.00)	62 (32.29)	292 (45.13)
Total	106 (16.38)	349 (53.94)	192 (29.68)	647 (100.00)

Note: Figure parentheses are percentage, in which column % for "individual categories" and row % for "total".

4.3 Farmland Acres Statistics and Ownership Status of the Land in Dakotas

In this section, results are presented and discussed on the following: (1) a series of summary tables on farmland acres operated in 2014 overall, by state and by region, (2) summary statistics on ownership status of land operated in 2014 by state and region, and (3) summary statistics and frequency distribution of farm land acres currently operated by farmers, compared to the number of acres operated in 10 years ago**.**

Table 4.3.1 shows reported acres based on the survey of producers in the Dakotas. There is more land reported for cropland in both states than there are for CRP and for pasture or rangeland. CRP acres reported are relatively greater in ND compared to SD based on total farmland acres reported. Average farm size (acres) and distribution of acre sizes are larger in ND (2022 acres) compared to SD (1518 acres). Based on data reported in Table 4.3.1, the proportion of cropland acres to total farmland acres is about 78% for ND and 66% for SD. The proportion of cropland acres in both states is greater than the Census of Agriculture reports, because sampled counties are located in more cropland-intensive Prairie Pothole regions of each state.

Table 4.3.1 Reported Farmland Acres Operated in 2014 by State

State	Farmland*		Cropland Excluding CRP acres	CRP acres	Pasture or rangeland acres
	N	Total Acres			
ND	332	671,154	525,569	13,424	123,591
SD	664	1,008,133	666,197	15,186	350,408
Total	996	1,679,287	1,191,766	28,610	473,999

***Total farmland acres reported are slightly different than the sum of cropland, CRP and pasture / rangeland acres at the state and regional level, but are based on survey responses.**

Data in Table 4.3.2 shows the regional distribution of farmland acres operated by respondents. The largest total number of farmland acres was from the Central ND region while the least total number of farmland acres was from the Northeast SD region. The 1st and 2nd largest proportion of cropland acres to total farmland acres is about 89.7% for East ND and 76.1% for North East SD. The 3rd largest proportion of cropland acres to farmland acres is about 69.3% for East Central SD. The least percentage (57.8%) of cropland to total farmland acres is in Central SD.

Table 4.3.2 Reported Farmland Acres Operated in 2014 by Region

State	Farmland		Cropland Excluding CRP acres	CRP acres	Pasture or rangeland acres
	N	Total acres			
Central ND	171	373,778	258,902	8,345	101,480
Central SD	160	264,390	151,111	2,211	144,894
East Central SD	213	270,596	175,786	2,655	69,231
East ND	161	297,376	266,667	5,079	22,111
North Central SD	113	269,114	181,812	4,555	93,180
North East SD	178	207,033	157,488	5,765	43,103
Total	996	1,679,287	1,191,766	28,610	473,999

Data reported in Table 4.3.3 reveal substantial regional differences in the average number of all land, cropland, CRP and pasture / rangeland acres operated along with the variability of acres operated per respondent in each region.

The greatest mean number for farmland acres is 2,350.6 was reported in North Central SD with a standard deviation of 2509.3 acres. The lowest average (mean) cropland acres (878.9 acres) was recorded in East Central SD with variability (standard deviation) of 1,514.6 acres. This suggests there was more relative variability in the number of acres of cropland reported by producers in East Central SD than in any other region. Also, notice the high variability in CRP acres in the North Central region of South Dakota and the Central region of North Dakota. In addition, it is observed that there is high variability in pasture/rangeland acres in the North Central and Central regions of SD.

Table 4.3.3 Summary Statistics on Number of Farmland Acres Operated in 2014 by Region.

REGION	N Obs.	Label	Mean	Std. Dev.
Central ND	171	Farmland Acres	2,185.8	1,861.5
		Cropland Acres	1, 514.0	1, 419.1
		CRP Acres	47.7	117.3
		Pasture/rangeland Acres	579.9	951.7
Central SD	160	Farmland Acres	1,654.4	1,682.4
		Cropland Acres	981.2	1, 335.3
		CRP Acres	14.5	34.9
		Pasture/rangeland Acres	917.1	1,600.2
East Central SD	213	Farmland Acres	1,270.4	2,414.1
		Cropland Acres	878.9	1, 514.6
		CRP Acres	12.9	35.9
		Pasture/rangeland Acres	329.7	1,200.0
East ND	161	Farmland Acres	1,847.1	1,506.5
		Cropland Acres	1, 677.2	1, 483.8
		CRP Acres	31.7	78.2
		Pasture/rangeland Acres	137.3	338.0
North Central SD	113	Farmland Acres	2,340.1	2,494.9
		Cropland Acres	1, 581.1	1, 717.3
		CRP Acres	38.3	128.4
		Pasture/rangeland Acres	796.4	1,664.3
North East SD	178	Farmland Acres	1,163.1	1,092.4
		Cropland Acres	910.3	989.5
		CRP Acres	33.1	72.2
		Pasture/rangeland Acres	242.2	506.6

Note: Cropland acres exclude CRP acres.

Table 4.3.4 provides a distributional summary of the proportions of agricultural land operated in 2014 that were owned or rented by farm operators by state. According to data Table 4.3.4, both states contain almost the same percentage of respondents who owned all acres farmed in 2014. We observe in both states a large percentage of farm operators (47.5%) owned all or most of their farmland acres operated. However, nearly 45.3% of respondents rented half or most of their farmland acres. Very few (7.2%) respondents rented all of their farmland operated in 2014. This land tenure distribution clearly shows that three fourths of respondents are part-owner operators, which is a much higher proportion of farmers (40%) than that reported in the 2012 South Dakota Census of Agriculture. However, further analysis of Census of Agriculture data reveals that part-owner-operators have much larger average farm size based on acres operated or gross farm sales than full-owner operators or full-tenants. These findings provide added evidence that respondent farmers are representative of commercial family farms in the sampled counties of both states.

Table 4.3.4 Ownership Status of Land Operator in 2014 by State

	North Dakota Freq. (%)	South Dakota Freq. (%)	Total Freq. (%)
Own all acres farmed	53 (15.87)	123 (18.44)	176 (17.58)
Own most acres farmed, rented the remainder	87 (26.05)	212 (31.78)	299 (29.87)
Own and rent roughly equal number of farmland acres	72 (21.56)	123 (18.44)	195 (19.48)
Rented most of the acres farmed, owned the remainder	94 (28.14)	165 (24.74)	259 (25.87)
Rented all acres farmland	28 (8.38)	44 (6.60)	72 (7.19)
Total	334 (33.3)	667 (66.67)	1001 (100.00)

Note: Figure parentheses are percentage, in which column % for "individual categories" and row % for "total".

We discussed the ACRECHG variable in detail in Chapter 3. The ACRECHG variable classifies respondent operation in the context of farmers expanding, downsizing or remaining the same size (in terms of acres operated) during the past 10 years. Overall, one third of respondents had expanded their farm operation by 10% or more in the past 10 years, and control 51% to 52% of farmland and cropland acres operated by all respondents. Nearly 43% of respondents operated a similar number of farmland acres in 2004 and 2014, while 23% had downsized their farming operation in terms of acres operated. These two-thirds of respondents operated about 48% of farmland acres in 2014. An important issue that is further investigated is whether land conversion decisions during this same time period were concentrated in the EXPAND, SAME or DOWNSIZE group of respondents.

Table 4.3.5 Distribution of Respondents and Acres Operated (Farmland and Cropland) by ACRECHG Category (EXPAND, SAME, DOWNSIZE)

ACRECHG, number and % of responses	Number of obs. N	Percent (%) of N	Total farmland Acres	Percent of total acres	Cropland acres	Percent of crop acres
Expand	333	33.7%	847,095	51.7%	596,704	51.1%
Same	425	42.9%	530,783	32.4%	382,515	32.8%
Downsize	231	23.4%	260,275	15.9%	187,636	16.1%
Total	989	100.00%	1,638,153	100.00%	1,166,855	100.00%

4.4 Results Obtained From Objective 1

Recall from Chapter one that objective 1 is: "to examine past agricultural land use conversion in the Dakota based on geographic (regional) distribution and farm operator / farm business characteristics." Thus, prior analysis reported in Sections 4.2 and 4.3 is essential in achieving objective 1. In this section all types of land conversion decisions made by respondents are presented and discussed in terms of acres and percent of land converted, incidence of respondents involved in land conversion decisions and statistical relationships, mostly chi-square analysis, between specific operator and farm business characteristics and specific land use conversion decisions.

4.4.1 State and Regional Description of Land Use Conversion Decisions

4.4.1.1 Conversion of Grassland to Cropland: Conversion from grass to crop use mainly occurs from conversion of native grasses or tame grasses to crop use or from CRP grass use to crop use after their CRP contract expires. The long-term consequences differ from converting native grassland to cropland use, compared to tame grass pasture or CRP grass use. Cropland is the prior use of CRP acres enrolled and is a likely prior use of tame pastureland. The distribution of grassland to cropland conversion decisions by state and region are shown in Tables' 4.4.1a and 4.4.1b. Additional data are available in appendix 2 and 3.

Native Grassland to Cropland Conversion: In SD, 17.9% of respondents converted native grassland to cropland compared to 7.6% of ND respondents. The average number of native grassland acres converted was 126 in SD and 81 in ND. At the regional level, the conversion of native grassland to cropland was much more likely in North Central and Central SD compared to other regions. More than 20% of respondents in both regions converted some native grassland to cropland compared to less than 4% in East ND.

Tame Grassland to Cropland Conversion: In SD, 18.4% of respondents converted tame grassland to cropland compared to 9.7% of ND respondents. The average number of tame grassland acres converted was 97.4 acres in SD and 121.9 acres in ND. At the regional level, the conversion of tame grassland to cropland is much more likely in North

Central and Central SD compared to other regions. More than 17% of respondents in both regions converted some tame grassland to cropland compared to less than 5% in East ND.

Conservation Reserve Program (CRP) Land to Cropland Conversion: CRP land to cropland conversion was much more common in North Dakota (32.12% of responses) than South Dakota (18.85% of responses) with 1 to 179 acres as the most common category amount in both States. At the regional level, the conversion of CRP land to cropland was much more likely in Central ND, East ND and North Central SD compared to other regions. More than 25% of respondents in all of these regions converted some CRP land to cropland compared to less than 14% of respondents in Central and East Central SD.

Table 4.4.1a Grassland to Cropland Conversion During Past 10 Years by State: 2014

Conversion		North Dakota		South Dakota		Both States
	N	No. of acres	N	No. of acres	N	No. of acres
Convert native grass to cropland use	25	2,042	115	14,275	140	16,317
Convert tame grass to cropland use	35	3,901	122	11,496	157	15,397
Convert CRP to cropland use	112	32,403	129	21,876	241	54,279
Total grass acres converted to crops		38,346		47,647		85,933

Note: N indicates Number of respondents

Table 4.4.1b Grassland to Cropland Conversion During Past 10 Years by Region: 2014

Conversion	Central ND	Central SD	East Central SD	East ND	North Central SD	North East SD	Both State
	Number of acres & Number of respondents						
Convert native grass to cropland use	1905	7231	1451	137	4051	1542	16,317
	(19)	(39)	(27)	(6)	(24)	(25)	
Convert tame grass to cropland use	3252	4442	1700	649	3046	2308	15,397
	(27)	(34)	(39)	(8)	(21)	(28)	
Convert CRP to cropland use	23754	1484	3772	8649	9596	7024	54,279
	(72)	(14)	(31)	(40)	(33)	(51)	
Total grass acres converted to crops	28911	13157	6923	9435	16693	10874	85,933

Note: Parentheses indicate numbers of observations.

4.4.1.2 Conversion of Cropland to Grassland: Conversion of cropland to grass use can occur through enrollment of cropland in CRP or WRP or from maintaining post-CRP land in grass for hay or grazing use. In addition, grass easement programs can be used. During the same period from 2004 to 2014, conversion of cropland to grassland use also occurred, but the acreage amount and incidence of operator was considerably lower than conversion of grassland to cropland use. The distribution of cropland to grass conversion is reported for both states and by region in tables' 4.4.1c and 4.4.1d. Additional data is provided in appendix 2 and 3.

Conversion of CRP Land to Pasture/Hay: As a comparison between the states, the conversion of CRP land to grass/hay use was more common in North Dakota than in

South Dakota, 10.3% vs. 5.6% of responses. At the regional level, almost all CRP land to grassland/hay land use averaged less than 100 acres per farm and was most likely to occur in Central ND and North Central SD. CRP land conversion acres averages 85% toward cropland and 15% toward grass/hay use. The conversions from CRP to cropland acres were greater than 90% of converted CRP land acres in East ND.

Enrollment of Farmland Acres into CRP Land: Enrollment in CRP was more common in South Dakota than North Dakota (19.31% vs. 15.45% of respondents) and most enrollments are less than 100 acres. Incidence of enrollment into CRP was not different across regions.

Enrollment of Land into WRP (Wetland Reserve Program) or Grass Easement program: WRP enrollment was not significantly different between states and only a total of 5.5% of respondents enrolled some cropland into WRP. Enrollment into WRP was more likely in North Central SD and North East SD, but minimum in other regions.

Table 4.4.1c Cropland to Grassland Converted Acres During the Past 10 Years by State: 2014

Conversion	North Dakota		South Dakota		Total grass acres	
	N	No. of acres	N	No. of acres	N	No. of acres
Convert CRP to grass / hay use	34	5,278	48	3,172	82	8,450
Enroll cropland into CRP	57	4,617	136	5,862	193	10,479
Enroll farmland into WRP / grass easement	14	1,924	45	7,254	59	9,178
Total grass acres		11,639		16,468		28,107

Table 4.4.1d Cropland to Grassland Conversion by Region

Conversion	Central ND	Central SD	East Central SD	East ND	North Central SD	North East SD	Total grass acres
	Number of acres, and Number of respondents						
Convert CRP to grass / hay use	5,048	405	496	230	1,387	884	8,450
	(26)	(8)	(11)	(8)	(15)	(14)	
Enroll cropland into CRP	2,555	964	1,291	2,062	1673	1,934	10,479
	(24)	(32)	(39)	(33)	(21)	(44)	
Enrollment of land into WRP / grass easement program	1310	2559	820	614	2037	1838	9178
	(5)	(11)	(7)	(9)	(10)	(17)	
Total grass acres	8913	3928	2607	2906	5097	4656	28,107

Note: Parenthesis indicate numbers of observation.

4.4.2 Land Use Conversion Incidence Patterns

Data in Table 4.4.2 provide a summary of the number and percent of respondents making grass to cropland conversion decisions and/or cropland to grass conversion decisions or were not involved in any land use conversion decision. More than one-half (53.6%) of respondents were involved in one or more land use conversions decisions implemented from 2004 to 2014. Nearly 14.5% of respondents were involved in both conversion of cropland to grassland and conversion of cropland to grassland cover. Another 13.9% were only involved in converting cropland to grassland cover, primarily new CRP enrollment. Finally, 25.2% of respondents were only involved in converting grassland to cropland during the same 10-year period (table 4.4.2).

Table 4.4.2 Conversion of Grassland to Cropland by Cropland to Grassland Use Decisions for North Dakota and South Dakota.

GRASCROP (CONVERSION of grassland to cropland)		CROPGRAS (CONVERSION of cropland to grassland over the last 10 years) Yes	No	Total
Yes	Frequency Percent Row Percent Col Percent	142 14.49 36.50 51.08	247 25.20 63.50 35.19	389 39.69*
No	Frequency Percent Row Percent Col Percent	136 13.88 23.01 48.92	455 46.43 76.99 64.81	591 60.31*
Total	Frequency Column Percent	278 28.37	702 71.63	980 100.00
Frequency Missing = 46				

Note: * indicates column percentage of respondents

Results from the tables in section 4.4.1 combined with table 4.4.2 suggest that many farmers were involved in multiple land conversion decisions. Overall, the percent of respondent farmers that made specific grassland to cropland conversion decisions are:

1.Native grass to cropland conversion 14.4%,

2. Tame grass to cropland conversion 16.2%,

3. CRP to cropland use conversion 24.8% and

4. CONVERT grass to crop 39.7% (by using any combination of methods)

The percent of respondent farmers that made specific conversion decisions to grassland are:

1. CRP land to grass / hay use 8.4%

2. Enroll in new CRP contract 19.9%

3. Enroll in WRP / easement 6.1% and

4. Convert crop to grass 28.4% (by using any combination of methods)

4.4.3 Land Use Conversion Decision Incidence by State/Region and Selected Farm Operator Characteristics: To analyze this part, we used data in Table 4.4.3a and 4.4.3b below. Most of the land use conversion decision factors were significantly related to state and region. Enrollment of farmland acres into CRP was not related to the regional level but significantly related to the state level (see table 4.4.3a). Most of the land use conversion decisions were not related to years farming, education level, occupation or gender. The exceptions were enrollment of land into WRP for the year of farming and the relationship of principal occupation to conversion of CRP land to pasture/hay. No operator characteristics were related to enrollment of land into WRP or grass easement program, except for year of farming (see table 4.4.3b).

The incidence of land use conversion for native grassland to cropland, tame grassland to cropland, CRP land to cropland, or CRP land to grass/hay was much more likely to occur on farms of 2000+ acres operated, with average incidence for 1000 to 1999 acres farms and much lower incidence for farms of less than 500 acres. This finding is closely related to regional incidence patterns, as farms size is considerably larger in regions with greater conversion and greater proportion of pasture. There is no farm size pattern for enrollment into CRP or enrollment into WRP/grass easements.

Table 4.4.3a Probability Results Land Use Conversion Decisions by Location (State and Region)

		State	Region
Land use conversion decisions			
Native grass to cropland		<0.0001**	<0.0001**
Tame grass to cropland		0.0003**	0.0015**
CRP land to cropland		<0.0001**	<0.0001**
CRP to pasture/hay		0.0287*	0.0011**
Enrollment of farmland acres into CRP		0.0273*	0.1369
Enrollment of WRP etc.		0.0290*	0.0324*

Note: ** indicates 1% level of significance, * indicates 5% level of significance.

Age of operator was significantly related to converting CRP to cropland with farmers younger than 50 years of age most likely to convert CRP land to cropland compared to any other age categories. In addition, gross farm sales were related to all conversion and enrollment decision (except WRP). The general pattern was farms with annual gross farm sales above $500,000 were more likely to make a conversion decision, while farms with annual gross farm sales lower than $250,000 were least likely to make a conversion or enrollment decisions. Land ownership/tenure was significantly related to enrollment of farmland acres into CRP and conversion of native grassland to cropland and CRP land to crop conversion decisions. However, land ownership/tenure patterns were also closely related to operator age and farm size variables (See Table 4.4.3b.

Table 4.4.3b Probability Results of Land use Conversion Decision by Selected Farm Operator and Business Characteristics

Land use conversion Decisions	Farm Acres	Gross Sales	Age of Operator	Land Tenure	Years of Farming	Education Level	Principal Occupation	Gender	Expand
Native grass to cropland	.0231*	.0457*	0.8213	0.0206*	0.3991	0.7501	.1520	0.1713	<. 0001**
Tame grass to cropland	.0186**	0.0546*	0.8090	0.1243	0.1084	0.1448	.6926	0.8295	0.0014**
CRP land to cropland	<0.0001**	<0.0001**	.0011**	.0029**	0.1757	0.0283*	.7680	0.2030	<. 0001**
CRP to pasture/hay	<0.0001**	.0032**	.7110	0.4665	0.7232	0.9370	.0432*	0.9385	0.0007**
Enrollment of into CRP	.3960	.0315*	.9443	.0144**	0.5468	0.0704	.2864	0.7967	<. 0001**
Enrollment of WRP etc.	.3844	.3680	.5330	0.0970	.0186*	0.7511	.6340	0.7533	0.0014**

Note: ** indicates 1% level of significance, * indicates 5% level of significance.

4.4.4 Conversion Rates as Percent of Cropland Acres:

Conversion rates were calculated as a percent of cropland acres operated in 2014. In other words, a grass to cropland conversion for example 10%, indicates that 10% of cropland operated in 2014 consists of former grassland acres that were converted to cropland within the past 10 years. Gross conversion rates are calculated from the total amount of grassland converted to cropland, while net conversion rates subtract the percent of acres converted from crop to grass from the gross conversion rate.

The overall gross conversion from grass/CRP to cropland use conversion was 7.22% of all respondents' cropland acres in 2014. The net conversion rate to cropland was 4.87%. Gross and net conversion rate were similar across states, but varied greatly by regions. The highest conversion rates (gross or net) were in Central North Dakota, North Central South Dakota, and Central South Dakota. The lowest conversion rates were in East North Dakota (Table 4.4.4a, and Table 4.4.4b)..

Conversion of grassland/CRP acres to cropland was the highest number of acres in Central SD. Also the proportion of current cropland acres from converted grass/CRP to cropland was highest in these three regions: 10.3% in Central ND, 9.3% in North Central SD and 8.6% in Central SD. The lowest conversion acres and percent of cropland occurred in East Central SD and East ND with less than 4% conversion to grass uses via CRP conversion or enrollment of new acres into CRP or WRP (Table 4.4.4b).

Table 4.4.4a Grass to Crop/Crop to Grass Conversion by State (with Net Conversion)

	North Dakota	South Dakota	Both States
Conversion of grass or CRP to cropland			
No. of acres	38346	47647	85993
% Cropland	7.30%	7.15%	7.22%
N	133	260	393
% of total N	40.30%	40.50%	40.43%
CRP Conversion Hay or Enroll in CRP or WRP			
No. of acres	11639	16468	28107
% Cropland	2.21%	2.47%	2.36%
N	90	194	284
% of total N	27.3%	30.21%	29.21%
Net Conversion to Cropland= Cropland minus pasture/hay/grass			
No. of acres	26707	31179	57886
% Cropland	5.08%	4.68%	4.86%

Table 4.4.4b Grass to Crop/Crop to Grass Conversion by Region (with Net Conversion)

	Central ND	Central SD	East Central SD	East ND	North Central SD	North East SD	All regions
Conversion of Grass or CRP to Cropland							
No. of acres	28911.0	13157.0	6923.0	9435.0	16693.0	10874.0	85993
% Cropland	11.17%	8.71%	3.94%	3.54%	9.18%	6.90%	7.22%
N	90	63	69	43	52	76	393
% of total N	52.63%	40.91%	32.39%	27.04%	46.02%	42.70%	40.43%
CRP Conversion hay or enroll in CRP or WRP							
No. of acres	8913	3928	2607	2906	5097	4656	28107
% Cropland	3.44%	2.60%	1.48%	1.09%	2.80%	2.96%	2.36%
N	46	43	52	44	38	61	284
% of total N	26.9%	27.56%	26%	27.67%	33.63%	35.26%	29.21%
Net conversion = Crop minus pasture/Hay/Grass							
Number of acres	19998.0	9229.0	4316.0	6529.0	11596.0	6218.0	57886
% Cropland	7.72%	6.11%	2.46%	2.45%	6.38%	3.95%	4.86%

Overall, about five-eighths of the nearly 86,000 acres converted by 393 respondents were converted from CRP grassland to cropland use after the CRP contacts expired. Crop to grass conversion by 284 respondents totaled nearly 28,000 acres, was about one-third of the acres of grassland converted to cropland.

Two-fifths of responding farmers in each state converted some of their grassland to cropland. Among these respondents, an average of 14% to 15% of their cropland acres in 2014 are from acres that were converted from grass to crop use over the prior 10 years. Based on survey results, land use conversion decisions in the study region are more likely to be made by respondents with one or more of the following characteristics:

- Farmers operating 2000 or more acres
- Farmers with annual gross farm sales exceeding $500,000
- Farmers less than 50 years old (especially for CRP conversion decisions)
- Farmers that expanded their land operation, in terms of acres operated, during the past 10 years, from 2004 to 2014.

Land use conversions decisions during this 10 year time period were much less likely to have been made by farms of less than 500 acres, older farmers (>60 years old), and those farmers that had downsized their operation in terms of acres operated within the past 10 years.

4.4.5: Reasons for Land Use Conversion Decisions (Main Drivers)

In this section, we examine the main reasons for land use conversion decisions. We report the overall, state and regional ranking of farm related issues that may influence land use decisions based on mean value. To analyze this section, we ran different summary statistics and later we used mean value to rank the reasons for land use conversion decision.

The relative ranking of each decision factor was based on comparing mean impact values using a 1 to 5 scale with 1=no impact, 3=some impact and 5=great impact. From Table 4.4.5a, changing crop price (3.52), changing price of input (3.29) and improved crop yields were the 1st, 2nd and 3rd most influential impact factors for the ND respondents. However, changing crop price, improved crop yields and changing price of inputs were the 1st, 2nd and 3rd most influential impact factors for the SD respondents. From Table 4.4.5b a majority 50.3% of the producers in the survey indicated changing crop prices as the single factor with the greatest impact on their own land use decisions over the last decade. This simple result confirmed the findings by Wright & Wimberly (2013) in which the authors reported cropland acre increased in the Dakotas in recent years because of the increasing trend in crop prices.

Changing prices in input markets was listed as the second driving force affecting producers' land use decisions in both states, which confirmed price motives as the biggest forces driving land use decisions in the Dakotas over the last 10 years. In addition, improved crop yields, changing weather patterns, and the developing of more efficient cropping equipment were ranked 3rd, 4th and 5th, respectively. Both improved crop yields and development of more efficient cropping are results of technological improvement, thus the effect of technological advances on land use decision in the Dakotas is great (Luri 2015). This result corroborates the findings of Claassen, et al. (2011); Yu and Babcock (2010); Tollefson (2011) reports that development in new technology has made crop production more efficient and profitable in the U.S. in recent years.

Finally, the mean values of decision factors were compared for all respondents vs. those 39.7% of respondents who had converted some grassland to crop production. This analysis was performed to find out if there were differences in the ranking of decision factors between all respondents and those implementing conversion decisions and also to determine if there were statistically significant differences in mean values. Results from Table 4.4.5c indicate respondents that actually converted some grass to cropland (GRASCROP) respondents gave higher than average impact ratings to all 10 factors, compared to all respondents. However, the relative ranking of each factor based on comparing mean impact values was the same for all respondents and for the GRASCROP respondents. In other words, the impact intensity was higher for those that made an active conversion decision, but the ranking was still the same.

Table 4.4.5a Mean value Ranking of Farm Related Decisions Factors by State

STATE	N Obs.	Label	Mean	Rank
North Dakota	342	Changing crop prices	3.52	1st
		Changing prices of input	3.29	2nd
		Availability of insurance	2.71	5th
		drought-tolerant seed	2.18	9th
		Developments pest management practice	2.59	7th
		Improved crop yields	3.14	3rd
		Development cropping equipment	2.99	4th
		Labor availability problems	2.36	8th
		Improving wildlife habitat	1.92	10th
		Changing weather patterns	2.67	6th
South Dakota	684	Changing crop prices	3.10	1st
		Changing prices of input	2.98	3rd
		Availability of insurance	2.53	6th
		drought-tolerant seed	2.38	8th
		Development of pest management practices	2.74	5th
		Improved crop yields	3.03	2nd
		Development of cropping equipment	2.75	4th
		Labor availability problems	2.01	9th
		Improving wildlife habitat	2.03	10th
		Changing weather patterns	2.49	7th

Note: Rankings indicate farm-related issues with greatest impact on farm operators' land use change in the past 10 years (on a 1 to 5 scale with 1=no impact, 3=some impact and 5=great impact).

Table 4.4.5b Percent of Respondents Indicating a Decision Factor as their Most Important Reason.

Label	Rank	Percent of Reponses
Changing crop prices	1st	50.3 %
Changing prices of input	2nd	15.2%
Improved crop yields	3rd	10.8%
Changing weather patterns	4th	6.9%
Development of cropping equipment	5th	5.9%
Availability of insurance	6th	3.7%
Development of pest management seed	7th	2.9%
Labor availability problems	8th	2.6%
Improving wildlife habitat	9th	1.9%
Drought-tolerant seed	10th	1.8%

Note: Ranking in this table follow the distribution of farm operator including as specific decisions factor as the most important factor.

Table 4.4.5c Relative impact (1-5 scale) of Decision Factors for All Farmers vs. GRASCROP Respondents

Decisions Factors	Rank	All-farmers mean value	GRASCROP farmer mean value
Changing crop prices	1st	3.24	3.47
Improved crop yields	2nd	3.09	3.22
Changing prices of input	3rd	3.08	3.17
Development of cropping equipment	4th	2.83	3.09
Development of pest management seed	5th	2.69	2.75
Availability of insurance	6th	2.59	2.67
Changing weather patterns	7th	2.55	2.57

Note: Rankings indicate farm-related issues with greatest impact on farm operators' land use change in the past 10 years (on a 1 to 5 scale with 1=no impact, 3=some impact and 5=great impact). GRASCROP farmers are those respondents that actually converted some grassland to cropland

4.4.6 Investigation of Key Chi-Square Cross Tabs of Reasons for Decision and Operator Characteristics

To analyze this section, we used different crosstabs between state/region/selected farm operator and business characteristics and farm related decision issues. Chi-square tests of probability were used to determine statistical significance.

Table 4.4.6a shows the probability results based on chi-square test of decision factors at the state and regional level. Key findings indicate that several economic and technology factors are significantly different at the state and regional level including changing crop prices, changing input prices, efficient equipment, and labor availability. The impact values for drought tolerant seeds and pest management practices were significantly different at the state level, but not at the regional level. The weather /

climate factor was significant at the regional level. The mean values of other decision factors were not significantly different at either the state or regional level.

Table 4.4.6b shows the chi-square probability result based on different cross tabs between farms related decision issues and selected farm operator and business characteristics. Operator age was significantly related to most land use decision reasons. However, age of operator was not related to drought tolerant seed, efficient crop equipment and labor availability. It is also observed that the impact value was higher for younger farmers, less than 50 years old, compared to older farmers.

Based on results reported in Table 4.4.6b, the gender and occupation categories were not related to any land use decision reason except drought tolerant seeds, efficient crop equipment and wildlife habitat, Gender is related to drought tolerant seeds, and principal occupation is related to efficient crop equipment and wildlife habitats. In terms of impact factors based on mean value, female respondents have the overall highest impact value compared to males. We also found that impact value was higher for changing crop price and changing price of inputs in all levels of reported principal occupation. Years involved in farming were only related to crop price and input price impacts. Education level was related to weather/climate and efficient crop equipment and labor availability and increased crop yield impacts.

Land ownership tenure is related to several key decisions with part-owner operator respondents most likely to rate higher impact of key decision variables, compared to full owner operator and full tenants. Farmland acres and gross sales were significantly related to almost all decision factors. In general, farms larger than 2,000 acres and greater than $500,000 in gross farm sales were most like to rate higher impact factors, farms of less than 500 acres and farms of less than $250,000 of gross farm sales were most like to rate low impact factors, while midsize farms were close to the overall sample average.

In general, the economic price/cost/selected technology factors (ECT) had the highest average impacts and greatest difference by operator characteristics. These ECT factors were more likely to have higher rated impact for larger farms.

Table 4.4.6a Probability Results (Chi-square) of Reasons of Decisions by State/Region

		State	Region
Reason for decisions			
Changing crop price		<0.0001**	0.0026**
Changing Input price		0.0039**	0.0128**
Availability of Crop Insurance Policies		0.1344	0.2525
Drought tolerant seeds		0.0399*	0.3074
Pest management practices		0.0244*	0.0836
Increased crop yield		0.5786	0.6840
Efficient crop equipment		0.0193*	0.0449*
Labor availability		<0.0001**	<0.0001**
Wildlife habitat		0.1074	0.4511
Weather / climate		0.1271	0.0340*

Note: ** indicates 1% level of significance, * indicates 5% level of significance.

Table 4.4.6b Probability Results (Chi-Square) of Reasons of Decisions (Q10a) by Selected Farm Operator/Business Characteristic Categories

Reason for decision	Farm Acres	Gross Sales	Age of Operator	Land Tenure	Years of Farming	Education Level	Principal Occupation	Gender
Crop price	.0008**	.0358*	.0014**	.0137**	.0052**	0.05605	.9173	0.1998
Input price	.0029**	.0020**	.0003**	.0001**	.0024**	0.1492	.1738	0.5744
Crop insurance	.0028**	.0023**	.0023**	.0509*	.2068	0.6146	.8169	0.1489
Drought tolerant seeds	.8168	.1755	.2706	.2145	.0541	0.1431	.9971	0.0469*
Pest management practices	.0291*	.0002**	.0027**	.0496*	.0798	0.7977	.0654	0.5326
Increased crop yield	<.0001**	.0008**	.0141**	.0661	.2971	0.0218*	.1167	0.1720
Efficient crop equipment	<.0001**	<. 0001**	.0748	.0023**	.5448	0.0028**	.0123**	0.3225
Labor availability	<.0001**	<.0001**	.0877	<.0001**	.4277	0.0027**	.8851	0.4221
Wildlife habitat	.0529*	.4798	.0001**	.3659	.2218	0.0115**	.0168*	0.4444
Weather / climate	.1019	.0082	.1886	.0175*	.7896	0.0247*	.3407	0.4607

Note: ** indicates 1% level of significance, * indicates 5% level of significance.

4.5 Findings of Objective 2

The second objective of this thesis is to examine projected agricultural land use conversion in the next 10 years, and the link between past and projected land use conversion decisions in the Dakotas. First, the incidence of projected future land use conversion is reported along with the relationship by state / regional location and operator / farm business characteristics. Second, the relationship between 10 past reasons for land use decisions (Q10a) and future projected a land use conversion decision is examined. Finally, the linkage between past conversion decisions and future intentions is explored.

4.5.1 Projected Land Use Conversion Decisions

The incidence of three projected land use conversion decisions in the next 10 years is reported in Table 4.5.1. Comparatively few respondents (2.7%) reported their expectation to convert any native grassland to cropland in the next 10 years, while only 6.5% of respondents indicate intentions to convert some tame grassland to cropland in the same time period. Most respondents (over 80%) had no intention to convert any grassland to cropland in the next 10 years, with the remainder indicating, "don't know". If these intentions are realized, a much lower percent of producers will be involved in converting any grassland to cropland in the next 10 years compared to the previous 10 years. The expected number of converted grassland acres was not asked in this survey; however, the respondents expecting to convert more grassland acres to cropland already operated more farmland acres than those not expecting to convert any grassland.

Finally, over one-eighth of respondents (12.7%) expected to convert some cropland to grassland in the next 10 years and another 20% of respondents answered "don't know" to this question. Thus a higher proportion of respondents expected to convert some cropland to grass than plan to convert some grassland to cropland. If realized, this would be a considerable reversal from actual conversion decisions during the 2004 to 2014 period.

Table 4.5.1 Summary Statistics of Projected Land Use Conversion Decisions.

Future land use conversion		Yes	Don't Know	No	Total
Convert native grassland to cropland	N	27	94	884	1005
	%	2.7%	9.3%	88.0%	100%
Convert tame grassland to cropland	N	66	126	816	1008
	%	6.5%	12.5%	81.0%	100%
Convert some cropland to grassland	N	128	202	681	1011
	%	12.7%	20%	67.3%	100%

Note: N= Number of respondents and % is the percentage of respondents by category

4.5.2 Relationship of Region/State Location and Operator/Farm Business Characteristics to Future Land Use Conversion Decisions

Based on results in Table 4.5.2a, there were no significant differences in future land use conversion intentions by state, but projected land use conversion was significantly related to region. The regional chi-square were significant at 0.01 probability level primarily by a high incidence of " don't know" responses in the North Central region of South Dakota. In addition, Central ND, North Central SD and Central SD usually had significantly higher incidence of projected conversion (all three types) than the eastern regions.

Table 4.5.2a Projected Land Use Conversion Decisions by Location

Item of Q11 by location (Chi-Square Probability Results)			
		State	Region
Projected Land use conversion decisions			
Native grassland to cropland		0.2871	0.0001**
Tame grassland to cropland		0.3157	0.0010**
Some cropland to grassland conversion		0.0978	0.0405 *

Note: ** indicates 1% level of significance, * indicates 5% level of significance.

According to Table 4.5.2b, ACRECHG is significantly related to the native grassland to cropland conversion decisions. A higher percent (5.17%) of EXPAND respondents have future plans to convert nature grassland to cropland compared to SAME (1.2%) and DOWNSIZE (1.76%) respondents in which conversion percentage are similar). In another words, "EXPAND" is related to higher percentage of respondent converting native grassland to cropland, but not significantly higher for tame grassland to cropland or converting cropland to grassland.

Table 4.5.2b Projected Land Use Conversion Decisions by ACRECHG

Item of Q11 by ACRECHG (Chi-Square Probability Results)		
		ACRECHG
Projected Land use conversion decisions		
Native grass land to cropland		0.0069**
Tame grassland to cropland		0.7963
Some cropland to grassland conversion		0.1494

Note: ** indicates 1% level of significance.

Table 4.5.2c Chi-square Probability Values of Future Land Use Conversion Intention by Selected Farm Operator Business Characteristics.

	Farm Acres	Gross Sales	Age of Operator	Land Tenure	Years of Farming	Education Level	Principal Occupation	Gender
Projected land use conversion Decisions								
Native grass to cropland	0.3119	0.1993	0.0368*	0.6875	0.2061	0.3245	0.0596	0.2775
Tame grass to cropland	0.4286	0.9068	0.3167	0.5297	0.2494	0.9590	0.0124*	0.6870
CRP land to cropland	0.1148	0.7244	0.2739	0.0439*	0.1848	0.7803	0.2260	0.6561

Note: ** indicates 1% level of significance, * indicates 5% level of significance.

Results in Table 4.5.2c suggests that future land use conversion does not differ at the 0.01 probability level for any farm operator or farm business characteristics. In addition, there were few farm operator or business characteristics related to projected land use conversion decisions at the 0.05 probability level.

Table 4.5.2d shows almost no reasons for past decisions are significantly related to future land use conversion plans, but with one exception. Respondents indicating "improved wildlife habitat" is important to them were the most likely to project future conversion of cropland to grassland.

Table 4.5.2d Chi-square Probability Values of Future Land Use Conversion Intention by Past Reasons for Decisions.

Item of Q10a by projected land use conversion decisions			
	Native Grassland to Cropland	**Tame Grassland to Cropland**	**Some Cropland to Grasslands**
Reason for decision			
Changing Crop price	0.2170	0.8765	0.1602
Changing Input price	0.7353	0.4450	0.3620
Availability of Crop insurance	0.4989	0.8330	0.8574
Drought tolerant seeds	0.8678	0.4391	0.2779
Pest management practices	0.0833	0.5129	0.3945
Increased crop yield	0.4095	0.7402	0.7906
Efficient crop equipment	0.1129	0.9773	0.9781
Labor availability	0.4747	0.5145	0.4067
Wildlife habitat	0.7648	0.6936	<. 0001**
Weather / climate	0.9716	0.4542	0.4524

Note: ** indicates 1% level of significance.

4.5.3: Association Between Past and Projected Land Use Conversion Decisions

Only 6.7% of respondents plan to convert some tame grassland to cropland in the next 10 years (Table 4.5.3b). However, over 16% of respondent reporting past tame grass conversions plan to convert more tame grass to cropland and only 4% to 5% of respondents that did not convert tame grassland in the past 10 years plan to convert some tame grass to cropland. Projected conversion percent of respondents is higher in ND than SD. By region, conversion percent of responses are highest in Central SD and North Central SD. At the regional level, conversion actually is projected higher in the central regions. In general, respondents with prior conversion of tame grassland were more likely to continue this conversion in the future.

Table 4.5.3a Respondents Linkage Between Past and Future Native Grassland to Cropland Conversion Decisions

		Future Native Grass to Cropland Conversion decisions			
		Yes	No	Don't know	Total
Past Native Grass to Cropland Conversion decisions	Yes	12 8.7%*	108 78.3%*	18 13%*	138 14.2%**
	No	15 1.8%*	750 89.8%*	70 8.4%*	835 85.8%**
	Total	27 2.8%**	858 88.2%**	88 9%**	973 100%**

Note: * indicates row percentage and ** indicates column percentage of respondents

Table 4.5.3b Respondents' Linkage Between Past and Future Tame Grassland to Cropland Conversion Decisions

		Future Tame Grass to Cropland Conversion decisions			
		Yes	No	Don't know	Total
Past tame Grass to Cropland Conversion decisions	Yes	25 16%*	97 62.2%*	34 21.8%*	156 16%**
	No	40 4.9%*	695 84.7%*	86 10.9%*	821 84%**
	Total	65 6.7%**	792 81%**	120 12.3%**	977 100%**

Note: * indicates row percentage and ** indicates column percentage of respondents

Future cropland to grassland conversion is related to past conversion decisions. Over 21.7% of respondent reporting past cropland conversion plan to convert more cropland to grassland and only 9% of respondents that did not convert cropland in the past 10 years plan to convert some cropland to grassland. Projected conversion percent of respondents is almost the same in both ND and SD. At the regional level, conversion percent of responses are highest in the Central region of SD (32.6%) and in Central ND (26.7%)

Table 4.5.3c Respondents Linkage Between Past and Future Cropland to Grassland Conversion Decisions

		Future Some Cropland to Grassland decisions			
		Yes	No	Don't know	Total
Past Cropland to Grassland decisions	Yes	61 21.8%*	163 58%*	57 20.9%*	281 28.8%**
	No	63 9.1%*	497 71.4%*	136 19.5%*	696 71.2%**
	Total	124 12.7%**	660 67.6%**	193 19.8%**	977 100%**

Note: * indicates row percentage and ** indicates column percentage of respondents

The chi-square test results in Table 4.5.3d measures the statistical significance of the association between producers' responses on past and future land use conversion decisions. Clearly, all three tests are statistically significant at the 1% probability level , meaning there was significant consistency in the producers' responses for past and future land use conversion. More importantly, a considerably higher proportion of respondents in both states indicated they did not know their future land use conversion plans. To ensure that the chi-square test results are not affected by the big shift in the proportion of "don't know" responses between the past and future, a separate chi-square test was performed with the "don't know" responses excluded. All three tests were significant, thus indicating the robustness of the results.

Table 4.5.3d Chi-Square Tests for Response Associations Between Past and Future Land Use Conversion Decisions

	North Dakota		**South Dakota**		**Both States**	
	Chi-square value	P-value	Chi-square value	P-value	Chi-square value	P-value
Past Native Grassland to Cropland conversion vs. Projected Native Grassland to Cropland conversion	21.6700	<.0001	8.9939	0.0027	22.6653	<. 0001
Past Tame Grassland to Cropland conversion vs. Projected Tame Grassland to Cropland conversion	8.6468	0.0033	26.6841	<.0001	33.8097	<.0001
Past Cropland to Grassland conversions vs. Projected Cropland to Grassland conversion.	10.3171	0.0013	20.9453	<.0001	30.6942	<.0001

Note: Significant at 0.05 Probability Level.

Chapter 5
Model Specification and Interpretation of Results

5.1 Determinants of Land Use Conversion Decisions

This chapter reports empirical results for objective 3. We used binary logistic regression modeling to analyze the determinants of land use conversion decisions. Seven different model specifications were examined and all were related to different types of land use conversion decisions (Table 5.1.1a). The list of definition and specification of variables for each section were reported in chapter three. Based on results in Table 5.1.1a, most of the land use conversion decisions were significantly related to both state and region. In all logistic regression models, regional location, instead of state location, was used as one set of explanatory variables.

Table 5.1.1a Probability Results of (Chi-Square) Land Use Conversion Decisions, GRASCRP, CROPGRAS and CRPUSE by Location (State and Region)

Item of Q9 by location (Chi-Square Probability Results)			
		State	**Region**
Land use conversion decisions over the last decade			
Native grass to cropland		<0.0001**	<0.0001**
Tame grass to cropland		0.0003**	0.0015**
CRP land to cropland		<0.0001**	<0.0001**
CRP land to pasture/hay		0.0287*	0.0011**
GRASCROP		0.0544*	<. 0001 **
CROPGRAS		0.0416 *	0.1770
CRPUSE		0.0022 **	<. 0001**

Note: ** indicates % level of significance, indicates * 5% level of significance probability

The chi-square probability relationship of all other farm operator and farm business characteristics to each land use conversion decision is reported in Table 5.1.1b. Almost all of the land use conversion decisions were significantly related to respondent farmland acres, annual gross farm sales, and past farmland expansion (EXPAND) decisions at the 0.01 probability level of significance. Operator age and land tenure were also significantly related to three land use conversion decisions at the 0.01 probability level. All other operator characteristics, including years of farming, education level, principal occupation, and gender were not related to any land use conversion decision at the 0.01 probability level of significance.

After examination of these two-way results, all logistic regression models included EXPAND, farmland acres, gross farm sales, age of operator and regional location as explanatory variables. Land tenure was excluded from the final set of explanatory variables because of its inter-relationship with operator age and farm size variables in the regression models.

Table 5.1.1b Probability results(Chi-square) of Land use Conversion Decision by Selected Farm Operator and Business Characteristics

Land use conversion Decisions	**Farm Acres**	**Gross Sales**	**Age of Operator**	**Land Tenure**	**Years of Farming**	**Education Level**	**Principal Occupation**	**Gender**	**EXPAND**
Native grass to cropland	0.0231*	.0457*	0.8213	.0206*	.3991	0.7501	.1520	0.1713	<. 0001**
Tame grass to cropland	0.0186**	0.0546*	0.8090	.1243	.1084	0.1448	.6926	0.8295	0.0014**
CRP land to cropland	<0.0001**	<0.0001**	.0011**	.0029**	.1757	0.0283*	.7680	0.2030	<. 0001**
CRP to pasture/hay	<0.0001**	.0032**	.7110	.4665	.7232	0.9370	.0432*	0.9385	0.0007**
GRASCROP	<. 0001**	<.0001**	0.0084**	0.0026**	0.3423	0.1287	0.5330	0.3493	<. 0001**
CRPUSE	<.0001**	<.0001**	0.0063**	0.0073**	0.2386	0.0522*	0.7478	0.1670	<. 0001**
CROPGRAS	0.0096**	0.0020**	0.6409	0.2170	0.2895	0.3621	0.4401	0.7791	0.0064**

5.2 Grassland to Cropland Conversion Decisions Related Models

In this section, results of four models are reported in Table 5.2.1a and each model contains the same set of explanatory variables. Models 1, 2 and 3 are results for individual land use conversion decisions (native grass to cropland, tame grass to cropland, and post-CRP land to cropland), while model 5 is the overall grassland to cropland conversion model. Table 5.2.1a provides the results of overall model statistics and type 3 analysis of effects for models 1, 2, 3 and 5. Before going through each model result, an overall statistical comparison of the four grassland-to-cropland models is provided.

The relative performance of the four models can be compared by examining their R-square values and percent concordance. Model 3, post-CRP conversion to cropland, has the highest max-rescaled R-square (26.9%) and highest percent concordance (77.9%). These results indicate Model 3 explains nearly 27% of variation and correctly predicts the actual conversion result nearly 78% of the time. All of the explanatory variables, except age of operator, are statistically significant at the 0.01 probability level. Model 5, GRASCROP, also has the same set of statistically significant explanatory variables, but its maximum rescaled R-square value and percent concordance is somewhat lower. The other two models (1 and 2) have considerably lower R-square, lower percent concordances and fewer statistically significant explanatory variables than the other two models reported in Table 5.2.1a. Overall, region is the only explanatory variable that is statistically significant in all four models, while age of operator is not statistically significant in any of the four models. All of these coefficients confirm that Model 2 is the weakest and model 3 is the strongest of the four models discussed in this section.

Table 5.2.1a Type 3 Analysis of Effect for Model 1,2,3 and 5 and Overall Statistics

Type 3 analysis of effects								
	Conversion of Native grassland to Cropland (NGLCL), Model-1		**Conversion of tame grassland to cropland (TGLCL), Model-2**		**Conversion of CRP acres to cropland (CRPCL), Model-3**		**Conversion of grassland (including CRP) to cropland (GRASCROP), Model-5**	
	Wald chi-Square	Pr.>Chi-square	Wald chi-Square	Pr.>Chi-square	Wald chi-Square	Pr.>Chi-square	Wald chi-Square	Pr.>Chi-square
AGE	1.08	0.583	0.0118	0.9941	1.2201	0.5433	0.6517	0.0853
GFRSALES	1.2954	0.5232	2.7422	0.2538	12.5844	0.0019**	4.9231	0.0004**
FARMLAO	1.6856	0.6401	13.4243	0.0038**	14.8964	0.0019**	19.6827	0.0002**
EXPAND	13.0088	0.0003**	2.8226	0.0929	22.3447	<. 0001**	17.8626	<. 0001**
REGION	28.1453	<. 0001**	19.4924	0.0016**	43.5097	<. 0001**	25.8772	<. 0001**
Overall Model Statistics								
Max rescaled R-Square	0.1200		0.0817		0.2687		0.1732	
Percent Concordant	70.3		65.4		77.9		70.4	
Number of observations read	1026		1026		1026		1026	
Number of observations used	900		902		904		896	

**** Indicates 1% level of significance * Indicates 5% level of significance.**

$$\textbf{Model 1: } \mathrm{Logit}(\pi) = \log\left(\pi/(1-\pi)\right) = \mathrm{NGLCL} = \beta_0 + \beta_1\mathrm{AGE} + \beta_2\mathrm{GFRSALES} + \beta_3\mathrm{FARMLAO} + \beta_4\mathrm{EXPAND} + \beta_5\mathrm{REGION} + e_1$$

$$\textbf{probability modeled is } \mathrm{NGLCL} = \mathrm{yes}(1)$$

Overall model fitness— The likelihood ratio for model 1 **(** χ^2 = 62.4396, df=13, p<. 0001) suggests that the entire model is statistically significant with an adjusted R^2 of 0.1200. Model 1 contains a high percentage of concordance (70.3%), which indicates the model is statistically reliable. Further results from Table 5.2.1a shows that past farmland expansion decision (EXPAND) and region are reliable predictors of producers' response to native grassland conversion to cropland (NGLCL). However, respondents' age, gross farm/ranch sales and farmland acres operated in 2014 were not reliable predictors of producers' response to NGLCL.

Table 5.2.1b shows that the intercept term of Model 1 is negative and statistically significant. The negative intercept term indicates the baseline of young farmers, gross farm sales less than $100,000, farmland acres between 500 and 999, and located in Northeast SD are less likely to be involved in native grass to cropland conversion than farms with some other characteristics included in the model. None of the age, gross farm sales and farmland acres categories were significantly different from the baseline condition. However, farmland expansion and the regional variable of Central SD and East Central SD were statistically significant predictors (0.01 probability level) of native grass to cropland conversion.

Table 5.2.1c contains the odds ratio estimate for model 1. The point estimate of 0.997 indicates that the odds of a producer giving a 'yes' response to 'NGLCL' are increased by 0.997 if the respondents are middle age vs. young. Similarly, the point estimate of 1.843 would mean that the odds of responding a 'yes' to NGLCL are increased by 1.843 if a respondent is from Central South Dakota vs. North East South Dakota. The ratios for region and region are also statistically significant since their 95% Wald confidence limit do not include 1, meaning the odds of answering 'yes' to NGLCL are increased if the respondents made conversion decisions (yes, native grassland to cropland) with Central ND, Central SD, East Central SD and North Central SD versus North East SD. However, most of these ratios are not statistically significant because their 95% Wald confidence limits include 1 except for East North Dakota versus North East SD.

Model 2: $\mathbf{TGLCL = \beta_0 + \beta_1 AGE + \beta_2 GFRSALES + \beta_3 FARMLAO + \beta_4 EXPAND + \beta_5 REGION + \mathit{e}_2}$

probability modeled is $\mathbf{TGLCL = yes\ (1)}$

Overall model fitness—The likelihood ratio for model 2 (χ^2 = 44.4585, df=13, p<. 0001) suggests that the entire model is statistically significant with an adjusted R^2 of 0.0817. Model 2 contains a fairly high percentage of concordance (65.4%), which indicates the model is statistically reliable. Further results from Table 5.2.1a show that farmland acres operated (FARMLAO) as well as the region are reliable predictors of producers' response to tame grassland to cropland (TGLCL). However, respondents' age, past farmland expansion decision (EXPAND), and gross farm/ranch sales were not statistically significant predictors of producers' response to TGLCL.

As shown in Table 5.2.1b, the intercept term of model 1 is negative and statistically significant. None of the age, gross farm sales and past expansion decisions were significantly different from the baseline condition. However, farmland acres within the '2000 and above' category and the regional variable of East North Dakota were statistically significant predictors (0.01 probability level) of tame grassland to cropland conversion.

Table 5.2.1c contains the odds ratio estimate for model 2. The ratios for region are also statistically significant since their 95% Wald confidence limit do not include 1, meaning the odds of answering a yes to TGLCL are increased if the respondents took conversion decisions (yes, tame grassland to cropland) with central North Dakota, Central South Dakota, East Central South Dakota and North Central South Dakota versus North East South Dakota, however most of these ratios are not statistically significant because their 95% Wald confidence limits include 1 except East North Dakota versus North East South Dakota.

Model 3: $\mathbf{CRPCL = \beta_0 + \beta_1 AGE + \beta_2 GFRSALES + \beta_3 FARMLAO + \beta_4 EXPAND + \beta_5 REGION} + \boldsymbol{e_3}$

$\mathbf{probability\ modeled\ is\ CRPCL = yes(1).}$

The likelihood ratio for model 3 (χ^2 = **178.2773**, df=13, P <. 0001) suggests that the overall model is statistically significant. This model contains the highest adjusted R-square (0.2687), which indicates this model is highly reliable compared to other models. Based on a 77.9% percent concordance, we can report Model 3 is statistically reliable as nearly 78% of conversion decisions are correctly predicted. From Table 5.2.1a, it can be reported that almost all the variables are statistically significant except respondent age. Based on Table 5.2.1b, the intercept term of model 3 is negative and statistically significant. Some parts of all other explanatory variables are statistically significant except age.

Model 5: $\mathbf{GRASCROP = \beta_0 + \beta_1 AGE + \beta_2 GFRSALES + \beta_3 FARMLAO + \beta_4 EXPAND +}$

$\mathbf{\beta_5 REGION} + \boldsymbol{e_5}$

$\mathbf{probability\ modeled\ is\ GRASCROP = yes(1)}$

The likelihood ratio test for model 5 (χ^2 = 122.8050, df=13, p<. 0001) and Nagelkerke R^2 is 0.1732. The Likelihood Ratio test for model 2 suggests that the model as a whole is significant. Table 5.2.1a also shows all of the explanatory variables, except operator age, are statistically significant at the 0.01 probability level). This model can explain about 17.3% of shared variation in GRASCROP and the concordant percentage of 70.4% indicates this model is statistically reliable. The intercept is not statistically significant in this model. The p-values indicate that Central ND, Central SD and North Central SD are not statistically significant relative to the base region of North East SD. However, the East Central SD and East ND regions are statistically significant. A quick glance at the results on Table 5.2.1c (model 5) should reveal that region ('East Central SD vs. North East SD' and East ND vs. North East SD') part of farmland acres operated show statistically significant odds ratios based on their 95% Wald confidence limits. The odds ratio for AGE and GFRSALES are not statistically significant. However, EXPAND appears to be highly significant.

Table 5.2.1b Analysis of Maximum Likelihood Estimates for Model 1,2,3 and 5

Analysis of Maximum Likelihood estimates				
	Conversion of Native grassland to Cropland (NGLCL)	**Conversion of tame grassland to cropland (TGLCL)**	**Conversion of CRP to cropland (CRPCL)**	**Conversion of grassland (including CRP) to cropland (GRASCROP)**
Intercept	-2.2585 ** 0.4510	-1.8120 ** 0.4055	-1.3580 ** 0.3813	-0.5664 0.3122
Middle Age	-0.00269 0.2698	-0.0183 0.2509	0.0346 0.2231	0.0744 0.1995
Old	-0.2206 0.2671	-0.0273 0.2513	-0.1888 0.2333	-0.0654 0.2003
From $100,000 up to $499,999	0.0510 0.3392	-0.0165 0.2925	0.1101 0.3064	0.0977 0.2309
$500,000 or more	0.3313 0.3842	-0.4134 0.3434	0.8604 ** 0.3365	0.4942 0.2701
1 to 499 acres	-0.3923 0.3789	-0.2715 0.3440	-1.3733 ** 0.4424	-0.7775 ** 0.2685
1000 to 1999 acres	-0.0107 0.2906	0.3584 0.2735	-0.1846 0.2518	0.00647 0.2041
2000 and above	0.1348 0.3350	0.9532 ** 0.3116	0.3092 0.2846	0.4972 * 0.2408
Expansion	0.8175** 0.2266	0.3616 0.2152	0.9163 ** 0.1938	0.7155 ** 0.1693
Central ND	-0.5377 0.3655	-0.3420 0.3207	0.3939 0.2750	0.0744 0.2497
Central SD	0.6116 * 0.3120	0.2029 0.3041	-1.5406 ** 0.3580	-0.2757 0.2525
East Central SD	-0.1075** 0.3190	0.1438 0.2876	-0.9633 ** 0.2955	-0.5192 * 0.2375
East ND	-1.5318 0.4841	-1.5111** 0.4306	-0.4932 0.2863	-1.0907 ** 0.2634
North Central SD	0.2938 0.3456	-0.1328 0.3417	-0.5156 0.3179	-0.3436 0.2776

Note: Coefficients are estimates and under the coefficient is std. error.
*** indicates 5% level of significance ** indicates 1% level of significance.**

Table 5.2.1.c Odds Ratio Estimates for Model I, 2, 3 and 5

Odds ratio estimates				
	Conversion of Native grassland to Cropland (NGLCL)	**Conversion of tame grassland to cropland (TGLCL)**	**Conversion of Cropland to cropland (CRPCL)**	**Conversion of grassland (including CRP) to cropland (GRASCROP)**
AGE Middle Age vs. Young	0.997 (0.588-1.692)	0.982 (0.601-1.605)	1.035 (0.669-1.603)	1.077 (0.729-1.593)
AGE Old vs. Young	1.247 (0.739 -2.104)	0.973 (0.595-1.593)	0.828 (0.524-1.308)	0.937 (0.633-1.387)
GFRSALES From \$100,000 up to \$499,999 vs. Less than \$99,999	1.052 (0.541-2.046)	0.984 (0.554-1.745)	1.116 (0.612-2.035)	1.103 (0.701-1.734)
GFRSALES From \$500,000 or more vs. Less than \$99,999	1.393 (0.656 -2.957)	0.661 (0.337-1.297)	2.364 (1.222-4.572)	1.639 (0.965-2.783)
FARMLAO 1 to 499 acres vs. 500 to 999 acres	0.676 (0.321-1.420)	0.762 (0.388 -1.496)	0.253 (0.106-0.603)	0.460 (0.271-0.778)
FARMLAO 1000 to 1999 acres vs. 500 to 999 acres	0.989 (0.560-1.749)	1.431 (0.837-2.446)	0.831 (0.508-1.362)	1.006 (0.675-1.502)
FARMLAO 2000 and above vs. 500 to 999 acres	1.144 (0.593-2.207)	2.594 (1.408-4.778)	1.362 (0.780-2.380)	1.644 (1.026-2.636)
EXPAND Expansion vs. OTHERS decision	2.265 (1.452-3.531)	1.436 (0.942-2.189)	2.500 (1.710-3.656)	2.045 (1.468-2.850)
REGION Central ND vs. North East SD	0.584 (0.285 -1.196)	0.710 (0.379-1.332)	1.483 (0.865-2.542)	1.077 (0.660-1.757)
REGION Central SD vs. North East SD	1.843 (1.000 -3.398)	1.225 (0.675-2.223)	0.214 (0.106-0.432)	0.759 (0.463-1.245)
REGION East Central SD vs. North East SD	0.898 (0.481-1.678)	1.155 (0.657-2.029)	0.382 (0.214-0.681)	0.595 (0.374-0.948)
REGION East ND vs. North East SD	0.216 (0.084-0.558)	0.221 (0.095-0.513)	0.611 (0.348-1.070)	0.336 (0.200-0.563)
REGION North Central SD vs. North East SD	1.342 (0.681-2.641)	0.876 (0.448-1.711)	0.597 (0.320-1.113)	0.709 (0.412-1.222)

Note: The Values are Point estimate and parenthesis below are the 95% Wald confidence interval or limit.

5.3 CRP Use Decisions and Cropland to Grassland Conversion Models

Results from three logistic regression models are reported in Table 5.3.1a and each contains the same set of explanatory variables. Model 4 attempts to explain the conversion of CRP land to pasture/hay over the last decade using explanatory variables of selected farm operator and business characteristics. Model 6, CRPUSE, is concerned with using CRP to make various land use conversion decisions. Finally, model 7 is an overall cropland to grassland use conversion decisions model. The same structure of data reporting as is used in Section 5.2 is used in this section.

The relative performance of these three models can be compared by examining their R-square values and percent concordance. Models 4 and 6 have similar R-square (16.5% vs. 15.1%) values, which are much higher than reported for model 7, which has an adjusted R-square of only 3.9%. The percent concordance is highest (75.8%) for model 4 and lowest for model 7 (60.2%).

In terms of a large number of statistical significant variables, we can state that model 6 is the best performing model, followed by model 4. Model 7 has low adjusted R-square value, low percent of concordance, low Wald chi-square value and no statistical significant variable. Considering all of these parameters we concluded that model 7 is not statistically reliable.

Table 5.3.1a Type 3 Analysis of Effects for Model 4, 6 &7 and Overall Statistics

Type 3 Analysis of Effects						
	Model 4		**Model 6**		**Model 7**	
	Conversion of CRP land to pasture/hay land (CRPLP)		**Some change in their use of CRP (CRPUSE)**		**Conversion of cropland to grassland (CROPGRAS)**	
	Wald chi-Square	**Pr.>Chisq.**	**Wald chi-Square**	**Pr>Chisq**	**Wald chi-Square**	**Pr.>Chisq**
AGE	0.1351	0.9347	1.0617	0.5881	0.1785	0.9146
GFRSALES	7.9566	0.0187*	11.6465	0.0030 **	3.4513	0.1781
FARMLAO	19.827	0.0002**	9.9432	0.0191*	3.0577	0.3828
EXPAND	0.0002	0.0963	9.2074	0.0024 **	1.1970	0.2739
REGION	11.6999	0.0391*	16.4615	0.0056**	5.5377	0.3538
Overall Model Statistics						
Max rescaled R-Square	0.1653		0.1513		0.0392	
Percent Concordant	75.8		69.0		60.2	
Number of observations read	1026		1026		1026	
Number of observations used	905		901		899	

**** Indicates 1% level of significance * Indicates 5% level of significance**

Model 4: $\mathbf{CRPLP = \beta_0 + \beta_1 AGE + \beta_2 GFRSALES + \beta_3 FARMLAO + \beta_4 EXPAND + \beta_5 REGION} + e_4$

probability modeled is CRPLP = Yes(1)

Overall model fitness— the likelihood Ratio test for model 4 (χ^2= 66.5995, df=13, p<. 0001) suggests that the entire model is statistically significant with an adjusted R^2 of 0.1653. This model contains high percentage of concordant (75.8%) that indicates this model is statistically reliable. The result in table 5.3.1a shows that gross farm/ranch sales, farmland acres operated (FARMLAO) and region are reliable predictors of producers' response to CRPLP. Respondents' age and past farmland decisions (EXPAND) are not reliable predictor of producers' response to CRPLP.

Model 6. $\mathbf{CRPUSE = \beta_0 + \beta_1 AGE + \beta_2 GFRSALES + \beta_3 FARMLAO + \beta_4 EXPAND + \beta_5 REGION} + e_6$

probability modeled is $\mathbf{CRPUSE = yes(1)}$

Overall model fitness— the Likelihood ratio test for model 5 (χ^2 = 106.9846, df=13, p<. 0001) and Nagelkerke R^2 is 0.1513 suggests that the model as a whole is significant. The model however only explains about 15.13% of shared variation in CRPUSE. The percent concordant (69%) indicates model is reliable statistically. The result in Table 5.2.1a shows that all of the variables are statistically significant except respondents' age.

Table 5.2.1b shows that the intercept term of model 6 is negative and statistically significant. GFRSALES, part of FARMLAO and EXPAND of this model is statistically significant. The p-values indicate that Central North Dakota and North Central South Dakota are not statistically significant. This indicates that these regions are not significantly different than the base region. However, the East Central South Dakota, Central South Dakota and East North Dakota are statistically significant predictors of CRP use change related decisions. Results from Table 5.2.1c (model 6) should reveal that the region shows statistically significant odd ratios of 95% Wald confidence limits.

Model 7. $\mathbf{CROPGRAS = \beta_0 + \beta_1 AGE + \beta_2 GFRSALES + \beta_3 FARMLAO + \beta_4 EXPAND + \beta_5 REGION} + e_7$

$\mathbf{probability\ modeled\ is\ CROPGRAS = yes(1)}$

Overall model fitness— the Likelihood Ratio test for model **7 (** χ^2 = 249882, df=13, p=0.0232) suggests that the model is statistically significant. However, the model only explains about 3.92% of shared variation in CROPGRAS based on max-rescaled R^2. This model is extremely weak based on its low R^2 value. In addition, this model contains a moderate percent of concordance of 60.2%. The result in Table 5.2.1a shows that no variable is statistically significant but percent of concordant confirms this model is statistically reliable.

Table 5.2.1b suggests that the intercept of this model is statistically significant and negative. The p values indicate that rest of the variables are statistically insignificant at 1% and 5% level but some of part of the variable region are statistically significant at the 5% significance level. A quick glance at the results on table 5.3.1c (model 7) should reveal that none of the variables show statistically significant odds ratios based on their 95% Wald confidence limits. The odds ratio for AGE, GFRSALES, FARMLAO, region and EXAPND are not statistically very reliable.

Table 5.3.1b Maximum Likelihood estimates for Model 4, 6 and 7

Analysis of Maximum Likelihood Estimates			
	Model 4	**Model 6**	**Model 7**
	Conversion of CRP land to pasture/hay land	**Some change in their use of CRP**	**Conversion of cropland to grassland (overall)**
Intercept	-5.5713 ** 1.1326	-0.6191* 0.3097	-1.0685 ** 0.3287
Middle Age	0.0491 0.3356	0.0224 0.1960	-0.0758 0.2019
Old	0.1239 0.3469	-0.1437 0.1970	-0.0783 0.2039
From $100,000 up to $499,999	2.4968 1.0290 **	0.1757 0.2295	0.3526 0.2480
$500,000 or more	1.9719 1.0514	0.7667 ** 0.2685	0.5361 0.2888
1 to 499 acres	0.4135 0.6088	-0.4408 0.2606	-0.1243 0.2663
1000 to 1999 acres	0.6491 0.4682	0.0953 0.2034	0.1264 0.2164
2000 and above	1.8476 ** 0.4874	0.4804 * 0.2394	0.3092 0.2846
Expansion	0.4850 0.2916	0.5085 ** 0.1676	0.1913 0.1748
Central ND	0.2987 0.4023	0.0303 0.2481	-0.4807 0.2599
Central SD	-0.7625 0.4975	-0.6290 ** 0.2556	-0.2963 0.2575
East Central SD	-0.4892 0.4549	-0.6956 ** 0.2369	-0.4319 0.2395
East ND	-0.9676 0.5096	-0.4976 * 0.2489	-0.5144 * 0.2589
North Central SD	-0.1646 0.4540	-0.4226 0.2769	-0.3411 0.2839

Note: Coefficient are estimates and under the coefficient are std. error
*** indicates 5% level of significance ** indicates 1% level of significance**

Table 5.3.1c Odds Ratio Estimates for Model 4,6 &7

Odds Ratio estimates			
	Model 4	**Model 6**	**Model 7**
	Conversion of CRP land to pasture /hay land	**Some change in their use of CRP**	**Conversion of cropland to grassland (overall)**
AGE Middle Age vs. Young	1.050 (0.544 -2.027)	1.023 (0.589-1.274)	10.927 (0.624-1.377)
AGE Old vs. Young	1.132 (0.574 -2.234)	0.866 (0.524-1.308)	0.925 (0.620 -1.379)
GFRSALES From $100,000 up to $499,999 vs. Less than $99,999	12.144 (1.616 -91.246)	1.192 (0.760-1.869)	1.423 (0.875-2.313)
GFRSALES From $500,000 or more vs. Less than $99,999	7.184 (0.915-56.407)	2.153 (1.272-3.643)	1.709 (0.970-3.011)
FARMLAO 1 to 499 acres vs. 500 to 999 acres	1.512 (0.459-4.986)	0.644 (0.386-1.072)	0.883 (0.524 -1.488)
FARMLAO 1000 to 1999 acres vs. 500 to 999 acres	1.914 (0.764-4.791)	1.100 (0.738-1.639)	1.135 (0.743-1.734)
FARMLAO 2000 and above vs. 500 to 999 acres	6.344 (2.441-16.493)	1.617 (1.011-2.585)	1.443 (0.878-2.372)
EXPAND Expansion vs. OTHERS decision	1.624 (0.917-2.876)	1.663 (1.197-2.309)	1.211 (0.860-1.706)
REGION Central ND vs. North East SD	1.348 (0.613-2.966)	1.031 (0.634-1.676)	0.618 (0.372-1.029)
REGION Central SD vs. North East SD	0.466 (0.176-1.237)	0.533 (0.323-0.880)	0.744 (0.449-1.232)
REGION East Central SD vs. North East SD	0.613 (0.251-1.496)	0.499 (0.106-0.432)	0.649 (0.406-1.038)
REGION East North ND vs. North East SD	0.380 (0.140-1.032)	0.608 (0.373-0.990)	0.598 (0.360-0.993)
REGION North Central SD vs. North East SD	0.848 (0.348-2.065)	0.655 (0.381-1.128)	0.711 (0.408-1.240)

Note: values are point estimate and parenthesis below is 95% Wald confidence limit.

5.4 Key Findings of Grassland to Cropland and Cropland to Grassland conversion

Grassland to cropland and cropland to grassland use conversion related models were discussed in the prior sections of this chapter. Based on the discussion, we are able to state the following conclusions.

Key Findings:

1. Respondents age is not related to any kind of land use conversion decision. However, middle age respondents are more likely to be involved in land use conversion decisions compared to other age groups.
2. Gross farm/ranch sales are significantly related to CRP land conversion decisions of various types. But, it does not effect the land use conversion decisions of native grassland to cropland and tame grassland to cropland.
3. Farmland acres operated in 2014 is related to almost all conversion decisions except native grassland to cropland and overall cropland to grassland use conversion decisions. In addition, large farmers (who have 2000 or more farmland acres) are more likely to engage in land use conversion practices compared to small and mid-size farmers.
4. Past farmland acres expansion over the last decade is highly related to almost all conversion decisions except tame grassland to cropland and cropland (overall) to grassland use conversion decisions. In general, respondents who made farmland expansion decisions over the last decade were much more likely to be involved in land conversion decisions, especially those involving CRP land conversions.
5. Region is strongly related to all land use conversion decisions except cropland (overall) to grassland use conversion decision over the last decade. Native

grassland to cropland and CRP land to cropland use conversion most likely occurred in Central South Dakota and East Central South Dakota. Grassland (including CRP) to cropland use conversion is less likely to occur in East Central SD and East ND than in other regions. Cropland to grassland use conversion is less likely to have occurred in East North Dakota compared to other regions.

Chapter Six
Summary, Conclusion and Recommendations

6.1 Introduction

Investigating the grassland and cropland conversion in the Dakotas is of interest to producers and policy makers. The increasing trend of crop price has boosted the amount of grassland to cropland conversion over the last few decades. High crop prices and crop insurance subsidies contributed to the loss of grassland and wetland in the Dakotas and the entire U.S. More than 23 million acres of grassland, shrub land and wetlands between 2008 and 2011 were converted in the United States (Faber, et al. 2012). This final chapter provides summary and conclusions of the study. Some recommendations are also made in this chapter based on the major findings of the research. The suggested area for further studies is also discussed in this final chapter.

6.2 Summary of Findings and Conclusion

This thesis used producer survey data and focused on the following in the Dakotas: land use conversion (grass to crop and crop to grass); link between past and projected land use conversion decisions in the area, and determinants of land use conversion. Specific objectives include: to examine the past agricultural land use conversion in the Dakotas based on geographic regional distribution and farm operator/ farm business characteristics; to analyze projected agricultural land use conversion, and link between past and projected land use conversion decisions; and to examine determinants of land use conversion decisions in the Dakotas by investigating the relationship of selected farm operator/farm business characteristics to specific land use conversion decisions.

We employed different statistical tools with logistic regression methods and a 2015 producers survey dataset to evaluate land use conversion in 57 counties within South Dakota (37 counties) and North Dakota (20 Counties) portion of the Prairie Pothole Region (PPR). The data were collected from 1,026 producer respondents, yielding a response rate of 36.7%, with a 31.4% response rate from North Dakota and 40.0% from South Dakota.

The survey data were analyzed both quantitatively and qualitatively using descriptive statistics, chi-square test, t-test and logistic regression. SAS programing and MS Excel, 2012 edition were the statistical packages used in the data analysis. Major findings of the research are summarized below in three parts as follows: 1) findings on land use conversion and dynamics; 2) past vs. projected land use conversion decisions; and 3) determinants of land use conversions in Dakotas.

Objective 1: To Examine the Past Agricultural Land Use Conversion in the Dakotas Based on Geographical Regional Distribution and Farm Operator/Farm Business Characteristics

Respondents' Percentage of Land Use Conversion

In order to obtain information on the respondents' response to grassland to cropland and cropland to grassland conversion decisions, different cross tabs with chi-squares were used in this analysis. Overall, 14.4% of the respondents converted some native grass to cropland, 16.2% of the respondents converted tame grassland and 24.8% of the respondents converted post-CRP contract grasses to cropland use during the last decade (2004-2014). A lower proportion of producers converted some cropland to grassland during the same time period. Enrollment in new CRP contracts (where tame or native grasses are seeded) was used by 19.9% of respondents during this period, while 8.4% kept their post-CRP contract land in grass for hay, grazing or wildlife habitat use. In addition, 6.1% of the responding farmers enrolled cropland into the Wetland Reserve Program between 2004 and 2014.

Overall, two-fifths (39.7%) of the responding farmers converted some grassland to cropland during the 2004 to 2014 period. However, 28.4% of respondent farmers converted some cropland to grassland acres during the same period of time. The dynamics of land conversion is really shown by examining the extent of producer participation. More than half (53.6%) of respondents were involved in one or more land use conversion decisions implemented in the past 10 years. Nearly 14.5% of respondents were involved in both conversion of grass to cropland and conversion of cropland to grassland cover. Another 13.9% were only involved in converting cropland to grass cover, primarily new CRP enrollment. Finally, 25.2% of respondents were only involved in converting grass to cropland during the previous 10-year period.

Land Use Conversion Patterns

A regional analysis of converted acres revealed that the grass to crop conversion rates (as percent of 2014 cropland acres operated) was 7.2% in both states, with more CRP grass conversion in North Dakota and tame/native grass conversion in South Dakota. Grassland to cropland conversion is more active in the central regions of both states, compared to the eastern regions. The average gross conversion rate from grass to cropland varied from 11.2% of cropland acres in Central ND to less than 4% in East ND and East Central SD region. The net conversion rate (grass to crop minus crop to grass conversion) varied from about 7% to less than 2% across the same regions. The overall net conversion rate was 4.9% across both states.

Land Use Conversion Decision Incidence by State/Region and Selected Farm Operator Characteristics

Most of the land use conversion decision factors were significantly related to state and region. Enrollment of farmland acres into CRP was not related to region level but significantly related to state level. Most of the land use conversion decisions were not related to years farming, education level, occupation or gender. The exceptions were enrollment of land into WRP for the year of farming and the relationship of principal occupation to conversion of CRP land to pasture / hay. No operator characteristics were related to enrollment of land into WRP or grass easement program, except for years of farming.

Many farmers used various combinations of converting from CRP grass, to tame grass or native grassland. For these respondents an average of 14% to 15% of their cropland acres in 2014 are from acres that were converted from grass to crop use over the prior 10 years. Based on survey results, land use conversion decisions in the study region are more likely to be made by respondents with one or more of the following characteristics:

a) Farmers operating 2000 or more acres

b) Farmers with annual gross farm sales exceeding $500,000

c) Farmers less than 50 years old (especially for CRP conversion decisions)

d) Farmers who expanded their land operation, in terms of acres operated from 2004 to 2014.

Land use conversions decisions during this 10 year time period were least likely to have been made by smaller farms of less than 500 acres, older farmers (>60 years old), and those farmers that had downsized their operation in terms of acres operated within the past 10 years.

Investigations of key chi-square cross tabs of reasons for decision and operator characteristics:

In this study, respondents were asked to rate the relative impact (on a 1 to 5 scale with 1=no impact, 3=some impact and 5=great impact) of 10 possible reasons for making various land use decision during the past 10 years with emphasis on land use patterns and land use conversion decisions. Respondents' age, level of education, principal occupation, gross farm/ranch sales, gender, year of farming, land tenure and farmland acres were considered as farm operator characteristics. Chi-square tests of probability and mean value were used to determine the statistical significance. We found several economic and technology factors are significantly different at the state and regional level including changing crop prices, changing input prices, efficient equipment, and labor availability. It is revealed that impact values for drought tolerant seeds and pest management practices were significantly different at the state level. The weather / climate factor was significant at the regional level. ND has slightly higher impact for weather/climate than SD.

Operator age was significantly related to most land use decision reasons. Respondents' gender was related to drought tolerant seeds, and principal occupation is related to efficient crop equipment and wildlife habitats. We also found that impact value was higher for changing crop price and changing price of inputs in all levels of reported principal occupation. Years of farming were related to crop price and input price impacts. Education level was related to weather/climate and efficient crop equipment and labor availability and increase yield impact. Farmland acres and gross farm sales were clearly related to land use decisions factors. We also observed region and state were also closely related to different impacts for most of the land use decisions.

In general, the economic price/cost/selected technology factors (ECT) had the highest average impacts and greatest difference by operator characteristics. These ECT factors were more likely to have higher rated impact for larger farms.

Main drivers of land use change in the Dakotas:

Several different factors have the greatest impact on farmers' decisions regarding their own land use. The top five important driving forces are changing crop prices, changing input prices, increased crop yields, changing weather and climate and more efficient crop equipment. Wright & Wimberly, (2013; Hennessy, (2013) and Luri, (2015) indicate that these are the farm related factors which are responsible for land use conversion decisions during the last 10-year period from 2004 to 2014 in the Prairie Pothole Regions (PPR) in the Dakotas. However, we found slightly different results when we examined producer responses to the relative importance of each driving force in their land use decisions making, using a 1 to 5 scale, in this cases we found changing crop price, improved crop yields, changing price of input, development of cropping equipment and developments pest management seeds were the top five farm-related reason for all famer respondent and for those respondents that converted some grassland to cropland (GRASCROP). There is an exception in this study that is "improving wildlife habitat" was strongly associated with decisions to convert CRP to pasture/hay, to enroll crop acres into CRP and enroll in WRP/grass.

Objective 2: To Analyze Projected Agricultural Land Use Conversion, and Link Between Past and Projected Land Use Conversion Decisions.

Respondents were asked about their future land use conversion plans in the next 10 years. We found comparatively few producers have plans to convert land use from grass to crop use or from crop to grass use in the next 10 years. For example, very few respondents (only 2.7%) plan to convert some native grassland to cropland use, while only 6.5% plan to convert tame grassland to cropland use in the next 10 years. Finally, about one-eighth (12.7%) of the respondents had plans to convert some cropland to pasture / grassland in the next 10 years. Another 20% of respondents indicated that they "don't know" about their future land use conversion plans at this time.

We reported that there were no significant differences in future land use conversion intention by state, but projected land use conversion was significantly related to region. We observed Central ND, North Central SD and Central SD had significantly higher projected conversion rates (all three types) than the eastern regions. We also found that future land use conversion does not differ at the 0.01 probability level for almost any operator or farm business characteristics.

The last set of major findings in this study was in line with producers' opinions and perceptions about past and future land use conversion decisions. Past and projected land use conversion decisions were statistically significant at the 5% probability level of significance, meaning there was substantial consistency in the producers' responses for past and future land use conversion.

Objective 3: To examine determinants of land use conversion decisions in the Dakotas by investigating relationship of selected farm operator/farm business characteristics to specific land use conversion decisions.

Logistic regression models were used to examine seven different land use conversion decisions by farm/business operator characteristics. The explanatory variables selected were based on earlier chi-square test results. We observed that respondents' age is not related to any kind of land use conversion decision. However, middle age respondents are more likely to be involved in land use conversion decisions than other age groups. Gross farm/ranch sales are significantly related to CRP land conversion decisions of various types, but it does not affect the land use conversion decisions of native grassland to cropland and tame grassland to cropland.

Farmland acres operated in 2014 is related to almost all the conversion decisions except native grassland to cropland and overall cropland to grassland use conversion decisions. In addition, large farmers (who have or 2,000 more farmland acres) are more likely to engage in conversion practices compared to small and mid-size farmers. Past farmland acre expansion over the last decade is highly related to almost all conversion decision except tame grassland to cropland and cropland (overall) to grassland use conversion decisions. In general, respondents who made farmland expansion decisions over the last decade were much more likely to be involved in land conversion decisions, especially those involving CRP land conversions.

Regional differences were observed in the effect of land use conversion decisions and selected farm operator and business characteristics. Region is strongly related to all land use conversion decisions except cropland (overall) to grassland use conversion decision over the last decade. Native grassland to cropland and CRP land to cropland use conversion were most likely to occur in Central SD and East Central SD. In addition, grassland (including CRP) to cropland use conversion is less likely to occur in East Central SD and East ND than in other regions. Cropland to grassland use conversion is less likely to occur in East ND compared to other regions.

6.3 Limitations for the Study

This study focused on a specific section of the entire data set. Another limitation is the study relied solely on responses to close-ended questions in order to explain opinions on perceptions of respondents. The other limitation is due to time period of study when higher crop prices were the major driving force behind numerous farm level decisions.

6.4 Recommendations for the further study

I would like to recommend two-fold suggestions based on the finding of this research. One is how to improve existing farmland use decisions survey questionnaire, and provide information about how more research could be done from this survey data.

Recommendation from Existing Survey Data: The first recommendation would be to use the same modeling approach by including state instead of region. One could also re-examine the same modeling approach by using relatively short or long period of data. Based on earlier studies, researchers could justify using these potential model options.

One could also examine the determinants of land use conversion decisions reasons in the Dakotas by investigating the relationship of selected farm operator/farm business characteristics to specific land use conversion decisions. In our study, we found changing crop prices, improved crop yields, changing price of input, development of cropping equipment, and developments pest management seeds were the top five farm-related reasons for all the famers and respondents who converted grassland to cropland (GRASCROP). One could use these five land use conversion decision reasons as dependent variables and selected farm operator and business characteristics as independent variables.

Further analysis could be done with this information, where one could use grass to cropland (GRASCROP) conversion, some CRP land use change (CRPUSE) and cropland to grassland (CROPGRAS) conversion as dependent variables, and the top five greatest influential farm related issues as independent variable. This approach allows researchers to investigate main the drivers of land use change in different ways.

Finally, we could also check the effect of producers' perceptions about past and future changes in the amount of grassland and cropland acres in their locality on changes made to their own grassland and cropland acres.

Improvement of Survey Questionnaire: Results of this study are based on dataset of the 10-year period (2004-2014) obtained by SRBR of ISU and SDSU. Further study could be done using the dataset for a relatively shorter period of time. Literature suggests that, much past research used relatively shorter period of data set such as 4-5 years of data. By so doing, we could get more recent land use conversion decision scenarios.

In addition, we could include successful transition of the farm assets to the next generation as a farm operator and business characteristic. The reason the successor status is important is because it provides an incentive to expand the farm, to invest in capital, and to increase the output over longer periods (Mieke & Huylenbroeck, 2008).

We found changing crop was the top most influential driver for the land use conversion. In agriculture, crop price frequently changes because of changing global food demand and other factors. We could also conduct a sensitivity analysis, for example, how much land use conversion decisions are sensitive to increasing demand of food subsequently crop price in recent times. Along with this, one should also look at how crop price have affected land use conversion decisions such as native and tame grass to cropland and CRP to cropland or cropland to grassland.

Finally, this research could be improved by collecting quantitative data to conduct a cost benefit analysis of land use conversion decisions. Additional data linking certain benefits of land use conversion decisions in monetary terms in needed to present a more complete empirical assessment. We could also examine net benefit from own land use conversion decisions and what is the net effect of future generation to their own land use conversion decisions that information could be enhanced the sustainable development of agricultural land.

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Appendix I
FARMLAND USE DECISIONS IN THE DAKOTAS

2015

Thank you for your interest in *Farmland Use Decisions in the Dakotas*. The questions in this survey focus on your current farm operation as well as possible changes that may have occurred in the past 10 years (since 2004). If you have operated a farm less than ten years, please respond to the changes made since you started. For each question, please circle the number or enter the information that best represents your opinions and experiences.

PART A: FARM OPERATOR and OPERATION

1. How long have you been a farm operator on any part of your current farm/ranch?

 1 = Have never been a farm operator → *If you have **never** operated a farm, please stop here. Return the survey in the envelope provided. Thank you.*
 2 = Less than 10 years as a farm operator
 3 = 10 to 19 years as a farm operator
 4 = 20 to 29 years as a farm operator
 5 = 30 years or more as a farm operator

2. In what county is the majority of the agricultural land that you operate (including owned and rented) located?
_____________________________ county

3. Please enter the number of your farmland acres in the following categories.

	Acres
a. Total farmland acres you operated in 2014:	_________
b. Cropland (excluding CRP) acres you operated in 2014:	_________
c. Your CRP acres (if any) in 2014:	_________
d. Your pasture or rangeland acres in 2014:	_________

4. Which of the following best describes the ownership status of the land that you farmed in 2014?

 1 = Own all the acres farmed in 2014
 2 = Own most of the acres farmed, and rent the remainder
 3 = Own and rent roughly equal number of farmland acres
 4 = Rent most of the acres farmed, and own the remainder
 5 = Rent all the acres farmed
 6 = Professional farm manager
 7 = Other – Please explain: ____

4. Which of the following best describes the ownership status of the land that you farmed in 2014?

1 = Own all the acres farmed in 2014

2 = Own most of the acres farmed, and rent the remainder

3 = Own and rent roughly equal number of farmland acres

4 = Rent most of the acres farmed, and own the remainder

5 = Rent all the acres farmed

6 = Professional farm manager

7 = Other – Please explain: ____

5. How does the number of farmland acres you **currently operate** compare to the number of acres you operated 10 years ago?

	Fewer acres than 10 years ago (by over 10%)	**No change or a minor change**	**More acres than 10 years ago (by over 10%)**
a. Cropland acres operated	1	2	3
b. Pasture/rangeland acres operated	1	2	3

PART B: CROP SYSTEM

6. Please enter your acres harvested and yield on non-irrigated land. (*Use approximate yield if necessary. Enter 0 acres if none was harvested.)*

CROP	**Acres harvested in 2014**	**Yield in 2014 on dry land (not irrigated)**
Corn	________ acres	________ Bu/acre
Soybeans	________ acres	________ Bu/acre
Wheat	________ acres	________ Bu/acre
Alfalfa	________ acres	________ Tons/acre

		Yes	**No**
7a.	In 2014, did you harvest any **other** grain or oilseed crops (not including corn, soybeans, or wheat)?	1	2
7b.	In 2014, did you harvest any other hay crop (not including alfalfa)?	1	2

PART C: LAND USE AND CROPPING DECISIONS

8. During the past 10 years, have you done any of the following?

		Yes	No
a.	Grown corn and/or soybeans each year?	1	2
b.	Increased the proportion of your corn and/or soybean acres compared to other crops?	1	2
c.	Grown wheat each year?	1	2
d.	Increased the proportion of your wheat acres compared to other crops?	1	2
e.	Grown any other grains or oilseed crops each year?	1	2
f.	Grown alfalfa or other hay crops each year?	1	2
g.	Adopted or increased your use of tile drainage on cropland acres?	1	2
h.	Adopted or increased your use of no-till crop systems?	1	2

9. Which of the following changes in land use has occurred on your farm operation in the past 10 years?

Agricultural land use changes:	Occurred in the past 10 years?	IF YES: About how many acres are involved?	IF YES: What crop is grown on this land?
Conversion of native grassland to cropland?	1 = Yes 2 = No	________Acres	1 = Corn 2 = Soybeans 3 = Wheat
Conversion of tame grassland to cropland?	1 = Yes 2 = No	________Acres	1 = Corn 2 = Soybeans 3 = Wheat
Conversion of CRP land to cropland?	1 = Yes 2 = No	________Acres	1 = Corn 2 = Soybeans 3 = Wheat
Conversion of CRP land to pasture/hay?	1 = Yes 2 = No	________Acres	
Enrollment of farmland acres into CRP?	1 = Yes 2 = No	________Acres	
Enrollment of land into WRP (wetland reserve) or grass easement program?	1 = Yes 2 = No	________Acres	

10a. How much impact has each of the following farm-related issues had on changes you have made in the way you use your agricultural land?

FARM-RELATED ISSUES:	IMPACT ON YOUR OWN LAND USE CHANGES				
	No Impact	Slight Impact	Some Impact	Quite a Bit of Impact	Great Impact
Changing crop prices	1	2	3	4	5
Changing prices in input markets (seed, fertilizer, chemicals, etc.)	1	2	3	4	5
Availability of crop and revenue insurance policies	1	2	3	4	5
Availability of drought-tolerant seed	1	2	3	4	5
Developments in pest management practices, including pest management seed traits	1	2	3	4	5
Improved crop yields (other than seed related traits)	1	2	3	4	5
Development of more efficient cropping equipment	1	2	3	4	5
Labor availability problems	1	2	3	4	5
Improving wildlife habitat	1	2	3	4	5
Changing weather /climate patterns	1	2	3	4	5

10b. Which **one** of the issues in the previous table, listed below, would you say has had the greatest impact on changes in your own land use? Please circle the **one issue with the greatest impact**.

1 = Changing crop prices

2 = Changing prices in input markets (seed, fertilizer, chemicals, etc.)

3 = Availability of crop and revenue insurance policies

4 = Availability of drought-tolerant seed

5 = Developments in pest management practices, including pest management seed traits

6 = Improved crop yields (other than seed related traits)

7 = Development of more efficient cropping equipment

8 = Labor availability problems

9 = Improving wildlife habitat

10 = Changing weather /climate patterns

11. During the next 10 years, do you plan to make any of the following land use changes on your farm?

Future changes in your land use:	Yes	No	Don't Know
Convert some native grassland to cropland	1	2	3
Convert some tame grassland to cropland	1	2	3
Convert some cropland to grassland	1	2	3

PART D: MARKET OUTLETS and INFRASTRUCTURE.

12. How many miles, by road, is your farm operation from . . .

a. an ethanol plant? __________ miles

b. a grain elevator that accepts wheat? __________ miles

c. a grain elevator that accepts corn? __________ miles

d. a grain elevator that accepts soybeans? __________ miles

13. For each item below, please circle the number that best shows how you think the infrastructure to support that type of production has changed in your local area, when compared to 10 years ago. *(Infrastructure includes transportation, market outlets, and equipment and agronomic services.)*

Changes in infrastructure supporting:	**Much Worse**	**Somewhat Worse**	**Stayed about the same**	**Somewhat Better**	**Much Better**
a. Cattle production	1	2	3	4	5
b. Wheat production	1	2	3	4	5
c. Corn production	1	2	3	4	5
d. Soybean production	1	2	3	4	5

PART E: LOCAL CHANGES IN AGRICULTURAL LAND USE PATTERNS

Please answer the following questions about changes in land use patterns in your local area.

14a. How do you think the amount of the following types of grassland and cropland, within 5 miles of your farm operation base, has changed over the **past** 10 years?

	Decreased Markedly (over 10%)	**Decreased Somewhat (5-10%)**	**Stayed about the same (less than 5%)**	**Increased Somewhat (5-10%)**	**Increased Markedly (over 10%)**
Grassland acres, any type	1	2	3	4	5
Native Grassland acres only	1	2	3	4	5
Soybean or Corn acres	1	2	3	4	5

14b. How do you think the amount of the following types of grassland and cropland, within 5 miles of your farm operation base, will probably change in the **next** 10 years?

	Decrease Markedly (over 10%)	**Decrease Somewhat (5-10%)**	**Stay about the same (less than 5%)**	**Increase Somewhat (5-10%)**	**Increase Markedly (over 10%)**
Grassland acres, any type	1	2	3	4	5
Native Grassland acres only	1	2	3	4	5
Soybean or Corn acres	1	2	3	4	5

15a. How much impact has each of the following farm-related issues had on changing agricultural land use in your local area during the past 10 years?

☐ *Check this box if you would say there have been **no changes in agricultural land use** in your local area during the past 10 years. Then go to Question 16.*

FARM-RELATED ISSUES:	IMPACT ON LAND USE CHANGES IN YOUR LOCAL AREA				
	No Impact	Slight Impact	Some Impact	Quite a Bit of Impact	Great Impact
Changing crop prices	1	2	3	4	5
Changing prices in input markets (seed, fertilizer, chemicals, etc.)	1	2	3	4	5
Availability of crop and revenue insurance policies	1	2	3	4	5
Availability of drought-tolerant seed	1	2	3	4	5
Developments in pest management practices, including pest management seed traits	1	2	3	4	5
Improved crop yields (other than seed related traits)	1	2	3	4	5
Development of more efficient cropping equipment	1	2	3	4	5
Labor availability problems	1	2	3	4	5
Improving wildlife habitat	1	2	3	4	5
Changing weather /climate patterns	1	2	3	4	5

15b. Which **one** of the issues in the previous table, listed below, would you say has had the greatest impact on causing changes in land use in your local area? Please circle the **one issue with the greatest impact**.

1 = Changing crop prices

2 = Changing prices in input markets (seed, fertilizer, chemicals, etc.)

3 = Availability of crop and revenue insurance policies

4 = Availability of drought-tolerant seed

5 = Developments in pest management practices, including pest management seed traits

6 = Improved crop yields (other than seed related traits)

7 = Development of more efficient cropping equipment

8 = Labor availability problems

9 = Improving wildlife habitat

10 = Changing weather /climate patterns

PART F: WEATHER PATTERNS / ADVERSITY

16. For each item below, circle the number that best describes the **current** weather patterns in your local area compared to 10 years ago.

a. Temperature	b. Precipitation	c. Drought	d. Flooding
1 = Warmer weather	1 = More precipitation	1 = More drought	1 = More flooding
2 = About the same	2 = About the same	2 = About the same	2 = About the same
3 = Cooler weather	3 = Less precipitation	3 = Less drought	3 = Less flooding
6 = Don't Know	6 = Don't Know	6 = Don't Know	6 = Don't Know

17. For each item below, circle the number that best describes what you think weather patterns in your local area **will be** 10 years from now.

a. Temperature	b. Precipitation	c. Drought	d. Flooding
1 = Warmer weather	1 = More precipitation	1 = More drought	1 = More flooding
2 = About the same	2 = About the same	2 = About the same	2 = About the same
3 = Cooler weather	3 = Less precipitation	3 = Less drought	3 = Less flooding
6 = Don't Know	6 = Don't Know	6 = Don't Know	6 = Don't Know

18. In 2014, about what percentage of the land you planted in crops had the following characteristics? *(If none, please write "0". Numbers do not need to add up to 100%.)*

	Percent of your 2014 crop ground
a. Highly erodible land (HEL)	%
b. Heavy soil	%
c. Slow draining soil (predominantly clay)	%
d. Sandy soil	%

PART G: FARM BUSINESS OR OPERATOR CHARACTERISTICS

Please record the following background information about you and your farm operation.

19. What is your current age category?

1 = 19 to 34
2 = 35 to 49
3 = 50 to 59
4 = 60 to 69
5 = 70 or over

20. What is your Gender?

1 = Male
2 = Female

21. What is the highest level of education that you have completed?

1 = Less than high school
2 = High school
3 = Some college/technical school
4 = 4-year college degree
5 = Advanced degree (Masters, etc.)

22. What do you consider to be your principal occupation?

1 = Farming or Ranching
2 = Employment in off-farm job
3 = Own/operate a non-farm business
4 = Retired
5 = Other - Please explain: ___________________________________

23. Please indicate the level of your gross farm/ranch sales in a typical year.

1 = Less than $50,000
2 = From $50,000 up to $99,999
3 = From $100,000 up to $249,999
4 = From $250,000 up to $499,999
5 = From $500,000 up to $999,999
6 = $1 million or more

24. Please record any comments you have regarding changes in farmland use in North and South Dakota.

Thank you for completing this survey! We appreciate your help. Please place the survey in the postage-paid return envelope provided and mail it as soon as you are able.

Appendix II
Grassland and cropland conversion decisions by State

	North Dakota	South Dakota
Cropland acres	525569	666197
No. of responses	330	658
Average acres	1592.6	1012.5
Conversion of native grass to cropland		
Number of acres	2042	14275
N =	25	113
Average acres	81.7	126.3
% of response	7.58%	17.17%
Conversion of tame grass to cropland		
Number of acres	3901	11496
N =	32	118
Average acres	121.9	97.4
% of response	9.70%	17.93%
Conversion of CRP land to cropland		
Number of acres	32403	21876
N =	106	121
Average acres	305.7	180.8
% of response	32.12%	18.39%
Conversion of CRP to pasture/hay		
Number of acres	5278	3172
N =	34	36
Average acres	155.2	88.1
% of response	10.30%	5.47%
Enrollment of farmland acres into CRP		
Enroll in CRP	4437	6042
N =	51	124
Average acres	87.0	48.7
% of response	15.45%	18.84%
Enrollment of land into WRP or grass easement program		
Number of acres	1924	7254
N =	12	43
Average acres	160.3	168.7
% of response	3.64%	6.53%

Appendix III
Grassland and Cropland Conversion Decisions by Region and Overall (Part-1)

Land Use Conversion	**Regional description**						
	Central	**Central**	**East Central**	**East**	**North Central**	**Northeas t**	**Both states**
	ND	SD	SD	ND	SD	SD	
Cropland acres	258902	151111	175786	266667	181812	157488	1191766
No. of responses	171	154	213	159	113	178	988
Average acres	1514.0	981.2	825.3	1677.2	1609.0	884.8	1206.2
Native grass land to cropland							
Native grass to crop	1905	7231	1451	137	4051	1542	16317
N =	19	39	25	6	24	25	138
Average acres	100.3	185.4	58.0	22.8	168.8	61.7	118.2
% of response	11.11%	25.32%	11.74%	3.77%	21.24%	14.04%	13.97%
Tame grassland to cropland							
Number of acres	3252	4442	1700	649	3046	2308	15397
N =	25	32	38	7	20	28	150
Average acres	130.1	138.8	44.7	92.7	152.3	82.4	102.6
% of response	14.62%	20.78%	17.84%	4.40%	17.70%	15.73%	15.18%

Appendix IV
Grassland and Cropland Conversion Decisions by Region and Overall (Part 2)

CRP land to cropland							
Number of acres	23754	1484	3772	8649	9596	7024	54279
N =	66	13	28	40	32	48	227
Average acres	359.9	114.2	134.7	216.2	299.9	146.3	239.1
% of response	38.60%	8.44%	13.15%	25.16%	28.32%	26.97%	22.98%
CRP land to pasture/hay							
CRP to grass/hay	5048	405	496	230	1387	884	8450
N =	26	4	9	8	14	9	70
Average acres	194.2	101.3	55.1	28.8	99.1	98.2	120.7
% of response	15.20%	2.60%	4.23%	5.03%	12.39%	5.06%	7.09%
Enrollment of farmland acres into CRP							
Number of acres	2555	964	1291	2062	1673	1934	10479
N =	21	26	37	31	20	40	175
Average acres	121.7	37.1	34.9	66.5	83.7	48.4	59.9
% of response	12.28%	16.88%	17.37%	19.50%	17.70%	22.47%	17.71%
Enrollment of land into WRP or grass easement program							
Number of acres	1310	2559	820	614	2037	1838	9178
N =	4	10	6	8	10	17	55
Average acres	327.5	255.9	136.7	76.8	203.7	108.1	166.9
% of response	2.34%	6.49%	2.82%	5.03%	8.85%	9.55%	5.57%

Appendix V
Chi-square tests of association between grassland to cropland conversion decisions, and selected farm operator and business characteristics by region

	Central ND	Central SD	East Central SD	East ND	North Central SD	North East SD	Both State
NGLCL vs. AGE	7.6946 0.0213*	1.3043 0.5209	3.1960 0.2023	0.8286 0.6608	0.1131 0.9450	2.8135 0.2449	1.1987 0.5492
NGLCL vs. GFRSALES	4.8868 0.0869	0.9206 0.6311	4.9694 0.0834	1.2416 0.5375	5.7742 0.0557	2.7806 0.2490	9.6280 0.0081**
NGLCL vs. FARMLAO	1.4594 0.6917	3.0217 0.3883	4.3279 0.2282	3.9789 0.2638	2.1108 0.5497	9.6367 0.0219*	11.3456 0.0100**
NGLCL vs. EXAPND	11.4127 0.0007**	8.7358 0.0031*	3.4430 0.0635	0.9471 0.3305	5.0903 0.0241*	0.2360 0.6271	25.6607 <.0001**
TGLCL vs AGE	0.5488 0.7600	0.5459 0.7611	0.9317 0.6276	0.6132 0.7360	1.9461 0.3779	2.2538 0.3240	1.1501 0.5627
TGLCL vs. GFRSALES	1.2497 0.5353	1.2473 0.5360	1.6072 0.4477	5.2470 0.0725	3.2465 0.1973	0.3167 0.8536	1.9807 0.3714
TGLCL vs. FARMLAO	3.9277 0.2694	4.8987 0.1794	4.5264 0.2099	6.1871 0.1029	2.3556 0.5019	5.9756 0.1128	13.5436 0.0036**
TGLCL vs. EXAPND	0.3589 0.5491	3.3293 0.0681	5.8381 0.0157*	1.2106 0.2712	2.3338 0.1266	0.0143 0.9048	10.2415 0.0014**
CRPCL vs. AGE	9.5957 0.0082**	1.8022 0.4061	0.2401 0.8869	6.1010 0.0473*	3.0339 0.2194	7.9971 0.0183*	16.8256 0.0002**
CRPCL vs. GFRSALES	22.8785 <.0001**	7.7636 0.0206*	23.6234 <.0001**	5.7670 0.0559*	12.7382 .0017**	6.6702 0.0356*	63.5444 <.0001
CRPCL vs. FARMLAO	23.1044 <.0001**	1.6962 0.6378	18.3478 0.0004**	13.958 .0030**	15.870 .0012**	13.5127 0.0036**	81.3995 <.0001**
CRPCL vs. EXAPND	29.3790 <.0001**	1.6571 0.1980	7.3975 0.0065**	7.6948 .0055**	11.2776 .0008**	11.9273 .0006**	63.4805 .0001**
GRASCROP vs. AGE	8.4661 0.0145*	2.5965 0.2730	2.2925 0.3178	5.9327 0.0515*	1.0810 0.5825	4.7414 0.0934*	11.0598 0.0040 *
GRASCROP vs. GFRSALES	16.3083 0.0003**	2.0631 0.3565	13.4966 0.0012	5.5078 0.0637	13.6475 .0011**	5.5509 0.0623*	40.1901 <.0001**
GRASCROP vs. FARMLAO	17.4839 0.0006**	1.8630 0.6013	14.3620 0.0025**	13.991 .0029**	10.5966 .0141**	18.3022 .0004**	63.6456 <.0001**
GRASCROP vs. EXAPND	24.8548 <.0001	6.9255 0.0085**	9.9849 .0016**	5.8674 0.0154*	7.0694 .0078**	4.3290 0.0375*	55.1026 <.0001**

Appendix VI
Chi-square tests of association between cropland to grassland conversion decisions, and selected farm operator and business characteristics by region

	Central ND	**Central SD**	**East Central SD**	**East ND**	**North Central SD**	**North East SD**	**Both State**
CRPLP vs. AGE	2.0989 0.3501	0.3389 0.8441	30.5452 0.7614	1.1312 0.5680	0.1131 0.9450	1.0277 0.5982	1.1987 0.5492
CRPUSE vs. AGE	5.5874 0.0612	0.6855 0.7098	0.0155 0.9923	8.5202 0.0141*	5.7742 0.0557*	3.6554 0.1608	9.6280 0.0081**
CROPGRASS vs. AGE	0.7616 0.6833	2.1526 0.3409	1.8023 0.4061	1.3454 0.5103	2.1108 0.5497	2.8419 0.2415	11.3456 0.0100**
CRPLP vs. GFRSALES	9.3979 0.0091**	1.6325 0.4421	13.2734 .0013**	2.9086 0.2336	5.0903 0.0241*	0.2360 0.6271	13.9435 0.0009**
CRPUSE vs. GFRSALES	14.3168 0.0008**	6.0328 0.0490*	9.2567 .0098**	0.6132 0.7360	1.9461 0.3779	2.2538 0.3240	54.0808 <.0001**
CROPGRASS vs. GFRSALES	4.9445 0.0844	5.8408 0.0539*	1.2251 0.5420	5.2470 0.0725	3.2465 0.1973	0.3167 0.8536	12.8926 0.0016**
CRPLP vs. FARMLAO	26.3128 <.0001 **	6.0077 0.1112	9.5112 0.0232*	6.1871 0.1029	2.3556 0.5019	5.9756 0.1128	46.1430 <.0001**
CRPUSE vs. FARMLAO	27.2020 <.0001**	1.2095 0.7507	15.0724 .0018**	1.2106 0.2712	2.3338 0.1266	13.0543 .0045**	10.2415 0.0014**
CROPGRASS vs. FARMLAO	8.6276 0.0347	1.2945 0.7304	9.9460 0.0190*	6.1010 0.0473*	3.0339 0.2194	7.9971 0.0183*	14.0680 0.0028**
CRPLP vs. EXAPND	13.1457 0.0003**	0.0356 0.8504	5.1791 0.0229*	5.7670 .0559*	12.7382 .0017**	3.8108 0.0509*	11.4008 <.0007**
CRPUSE vs. EXPAND	22.6979 <.0001**	0.0310 0.8603	6.9494 .0084**	13.959 .0030**	15.8700 .0012**	7.9444 .0048**	35.8483 .0001**
CROPGRASS vs. EXPAND	4.9935 0.0254*	0.5133 0.4737	4.4323 0.0353*	7.6948 .0055**	11.2776 .0008**	0.7435 0.0385*	7.4372 .0064**

Appendix VII
Statistically Significant Chi-square Test Results for Association Between Land Use Conversion Decisions (Grass to Cropland) Over the Past Ten Years and Selected farm/business operator characteristics by state

	ND		SD		Both States	
	Chi-squ value	P-value	Chi-squ value	P-value	Chi-squ value	P-value
NGLCL vs AGE	2.4405	0.2952	0.8664	0.6484	1.1987	0.5492
TGLCL vs. AGE	0.7361	0.6921	1.3685	0.5045	1.1501	0.5627
CRPCP vs. AGE	14.3338	0.0008**	2.9571	0.2280	16.8256	0.0002 **
GRASCROP vs. AGE	12.6583	0.0018 **	2.5242	0.2831	11.0598	0.0040 **
NGCL vs. GFRSALES	3.7646	0.1522	7.5603	0.0228*	9.6280	0.0081 **
TGLCL vs. GFRSALES	2.3807	0.3041	4.2729	0.1181	1.9807	0.3714
CRPCL vs. GFRSALES	23.0748	<. 0001**	41.4804	<. 0001 **	63.5444	<. 0001 **
GRASCROP vs. GFRSALES	16.1774	0.0003 **	28.2862	<.0001 **	40.1901	<. 0001**
NGLCL vs. FARMLAO	4.1583	0.2449	16.7717	0.0008 **	11.3456	0.0100 **
TGLCL vs. FARMLAO	8.1023	0.0439 *	13.2116	0.0042 **	13.5436	0.0036 **
CRPCL vs. FARMLAO	37.8373	<.0001 **	34.6460	<. 0001 **	81.3995	<.0001 **
GRASCROP vs. FARMLAO	31.9580	<.0001**	37.6616	<.0001 **	63.6456	<.0001 **
NGLCL vs. EXPAND	12.2715	0.0005**	16.1143	<.0001 **	25.6607	<.0001**
TGLCL vs. EXPAND	1.3553	0.2444	9.4212	0.0021 **	10.2415	0.0014**
CRPCL vs. EXPAND	35.8584	<.0001 **	29.3513	<.0001 **	63.4805	<.0001 **
GRASCROP vs. EXPAND	29.1686	<.0001 **	27.7031	<.0001 **	55.1026	<.0001 **

Appendix VIII

Statistically significant chi-square test results for association between land use conversion decisions (cropland to grassland) over the past ten years and selected farm/business operator characteristics by state.

	ND		SD		Both State	
	Chi-squ value	P-value	Chi-squ value	P-value	Chi-squ value	P-value
CRPLP vs. AGE	0.2508	0.8821	0.5934	0.7433	0.9926	0.6088
CROPGRASS vs. AGE	1.7882	0.4090	1.5960	0.4502	1.2713	0.5296
CRPUSE vs. AGE	14.3338	0.0008 **	2.5910	0.2738	12.6819	0.0018 **
CRPLP vs. GFRSALES	13.1974	0.0014 **	11.0867	0.0039 **	13.9435	0.0009 **
CROPGRASS vs. GFRSALES	4.4140	0.1100	12.3619	0.0021 **	12.8926	0.0016 **
CRPUSE vs. GFRSALES	17.4228	0.0002**	36.0943	<.0001 **	54.0808	<.0001 **
CRPLPH vs. FARMLAO	27.2383	<.0001 **	17.5256	0.0006 **	46.1430	<. 0001 **
CROPGRASS vs. FARMLAO	6.4515	0.0916 *	12.8036	0.0051 **	14.0680	0.0028 **
CRPUSE vs. FARMLAO	34.3012	<.0001 **	29.9896	<.0001**	62.9268	<.0001 **
CRPLPH vs. EXPAND	6.7886	0.0092 ***	4.9214	0.0265 *	11.4008	0.0007 **
CROPGRASS vs. EXPAND	5.4104	0.0200 *	2.9381	0.0865	7.4372	0.0064 **
CRPUSE vs. EXPAND	25.4102	<.0001 **	13.7985	0.0002 **	35.8483	<.0001 **