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The impact of ownership on Iowa land owners' decisions to adopt conservation practices

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The impact of ownership on Iowa land owners' decisions to adopt conservation practices

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TABLE OF CONTENTS

LIST OF FIGURES iv

LIST OF TABLES v

ABSTRACT vi

CHAPTER I. BACKGROUND AND OBJECTIVES 1
- Introduction 1
- Landowners and Agricultural Production 2
- Landowners and Conservation 3
- Problem Statement 4
- Objective 6
- Organization 7

CHAPTER II. LITERATURE REVIEW 8
- Introduction 8
- Economic Motivation and Definition of Conservation Technology Adoption 8
- Previous Empirical Studies on Technology Adoption in Agriculture 10
- Importance of Land Ownership 14
- Recent Environmental Policy, Agriculture and Conservation Programs 16
- Land Ownership and Conservation Practices and programs 20
- Summary 32

CHAPTER III. RANDOM UTILITY MODEL AND ADOPTION OF CONSERVATION PRACTICES 34
- Introduction 34
- Utility Maximization and Technology Adoption 34
- Probability Models and Estimation 38
- Hypothesis Testing 41
- Model Specification 41

CHAPTER IV. SURVEY INSTRUMENT AND DATA 44
- Introduction 44
- Survey Instrument and Sample: Overview 44
- Background Information about the Survey Area 49
- Description of Survey Data 53
- Data Definition, Measurement and Descriptive Statistics 56
- Descriptive Statistics 68

CHAPTER V. EMPIRICAL RESULTS AND ANALYSIS 85
- Introduction 85
- Empirical Logit Model Results and Analysis of Adoption of Technology 85

Empirical Results 87
Model 1: Adopting Conservation Practices and Program: Adopting at least one of more CP 87
Model 2: Adopting Expensive Conservation Practices 91
Model 3: Adopting Inexpensive Conservation Practices....95
Model 4: Adopting Conservation Tillage 98
Model 5: Have a Land Enrolled in Conservation Programs....100

CHAPTER VI. SUMMARY, POLICY IMPLICATIONS AND CONCLUSION 103
Summary....103
Major Conclusions, Based on Hypotheses....105
Policy Implications 114
Limitations of this Analysis and Suggested Further Research 115

APPENDIX A. THE SURVEY INSTRUMENT 118

APPENDIX B. DEFINITION OF DIFFERENT TYPES OF OWNERSHIP....124

APPENDIX C. THE CHARACTERISTICS OF THE EIGHT COUNTIES SELECTED FOR THIS STUDY 126

APPENDIX D. RANDOM UTILITY MODEL 141

APPENDIX E. PROBABILITY MODEL 145

REFERENCES 146

ACKNOWLEDGMENTS 158

LIST OF FIGURES

Figure 4.1 The Selected Counties for the Survey 45
Figure 4.2 Time of Land Acquisition among Land Owners 55

LIST OF TABLES

Table 2.1 Adoption and Cost of Conservation Practices in Iowa 30
Table 4.1 Total acreage Surveyed in each County..46
Table 4.2 Response Rate, by County 47
Table 4.3 Common Conservation Practices Area in the Eight Surveyed Counties in Iowa in 1997 as a Proportion of the Total...53
Table 4.4 Land Owned by Absentee Owners and Owner Operators, by County 54
Table 4.5 Expected Signs Based on the Previous Studies for the Estimated Regression Coefficients for the Explanatory Variables..66
Table 4.6 Percentage of Land Owner Characteristic between Absentee Owners and Owner Operators in Eight Iowa Counties—with tau-b Test Results..................71
Table 4.7 Measure of Association among the Independent Variables: (Upper right) tau-b and Z (Lower left) Statistics 75
Table 4.8 Kendall's tau-b Test Results as a Measure of Association among the Dependent Variables...77
Table 4.9 Definition of Variables Used in Modeling the Decision of Adopting Conservation Technology Model(s) 78
Table 4.10 Percent of Absentee Owners and Owner Operators by Responses 81
Table 5.1 Impact of Land Ownership on Adopting Conservation practices or Program: Adopting at least One or More C P (C_1)...89
Table 5.2 Impact of Land Ownership on Adopting Expensive Conservation Practices (C_2)..94
Table 5.3 Impact of Land Ownership on Adopting Inexpensive Conservation Practices (C_3) 97
Table 5.4 Impact of Land Ownership on Adopting Conservation Tillage (C_4)..99
Table 5.5 Impact of Land Ownership on Having Land Enrolled in Conservation Programs (C_5)...101

ABSTRACT

The structure of land ownership in Iowa is rapidly changing. More than half of the state's land is rented. The average age of land owners has increased over time. This study examines the differences in adoption of conservation practices between absentee owners and owner operators. Specifically, this study investigates hitherto unexplored differences between absentee owners and owner operators found in previous studies (e.g., absentee owners, sole ownership, proximity of habitation to farm and reasons for owning land) regarding decisions to conserve land.

This study's 2006 survey data were analyzed using the non-parametric method (tau-b) and a parametric regression framework (logistic regressions). The results suggested that all conservation practices were not considered to be equal by landowners. Being an owner operator or absentee owner impacted the decision to use certain types of conservation practices. Absentee owners tend to adopt the structural (expensive) conservation practices more than owner operators, whereas both types of owners equally adopt inexpensive conservation practices. Being an absentee owner or owner operator does not impact the probability of having land enrolled in a government conservation program. Age, education, place of residence, owned agricultural land and reasons for owning land seem to affect the adoption of each practice individually. However, knowledge about the cost-share program does have a positive impact on adoption, regardless of the type of conservation practices.

Ultimately, there is a need for more investigation to increase our knowledge of absentee owners, the reasons land owners choose to be absentee owners and their motivations to conserve land. This study found that landowners rarely used the internet for management

information regarding their land. Similarly a very low percentage of landowners said the internet was their preferred way to receive such information. Reasons why the internet was not more widely used should be explored. Finally, policy makers should consider absentee owners as being strategically different from owner operators when creating conservation policies.

The Impact of Ownership on Iowa Land Owners' Decisions to Adopt Conservation Practices

CHAPTER I. BACKGROUND AND OBJECTIVES

I.1 Introduction

Land owner decisions on how to cultivate or use agricultural land is affected by two major factors in Iowa: (1) land owners can adopt intensive production practices to increase productivity and farm profits; or (2) they can adopt conservation measures that may improve resource quality, yields, profits and long term sustainability, but which incur additional costs. There are interesting variations regarding how production and conservation practices are chosen by different types of land owners. The Owner Operator (or "OO") — who owns and operates his (or her) own land — decides personally which practices to adopt for the fields; while the Absentee Owner (or "AO") — who owns land but rents it out to others — has to make the decision while involving another party. However, once the final decision for land use is reached, it falls along a continuum of 'intensive production without any conservation measures' at one end, and land being 'fully retired from production' at the other. The gradient between these two extremes is determined by the degree to which land owners implement 'a combination of production and conservation' practices.

The decisions are affected by land owner preferences, personal characteristics and type of environmental problem(s) they have. It is important, then, to answer the following questions: 1) how do these factors affect the adoption decision of 'production' and 'conservation' practices? 2) Does land ownership in Iowa influence conservation practice use or adoption of new practices?

These questions become even more relevant for two reasons: first, there is a growing demand for biomass (grains, agricultural residues and energy crops) for food, fuel and fiber that fuels the ‘production’ trend—these products exacerbate certain environmental problems associated with intensive production; second, adoption of conservation practices can reduce these negative impacts, and have the potential to increase yields and farm profits in the long run [De la Torre Ugarte, D. and Hellwinckel, C. (2007)].

I.2 Land Owners and Agricultural Production

The question of adopting appropriate production practices has been analyzed in the literature. The decision making process is traditionally modeled as a profit-maximizing problem. Even though a land owner owns land, he/she does not have to farm it if economic returns are not sufficient. Some owners decide to rent all or part of their land and become absentee owners.

There are many potential reasons for land owners to hold land in spite of fluctuating farm returns. The increase in Iowa farm land real estate value could be a reason why some absentee owners choose not to sell their lands [Iowa State University Extension (2007)]. Land owners, then, will maintain ownership of their land as an accumulation of wealth, even if they choose not to farm it themselves. This brings up an interesting question: Does land owner status as OO or AO affect decisions on what to produce and, implicitly, how to conserve land? This study, therefore, focuses on the impact of land owners’ status on adoption of conservation practices.

In spite of the numerous challenges in the production-conservation regime, modified production practices can contribute to conservation (e.g., conservation tillage increases carbon sequestration in soils) [Chicago Climate Exchange (2007)]. There has been increasing allocation of land between two major crops (corn and soybeans) in the US and Iowa, due to increases in biomass demand and consequent increase in their relative price levels in recent times.[1] The effect of rising bio-energy demand, changing cropping patterns and personal characteristics of the land owners on the decision of conserving the farm land is an issue that is minimally explored in the literature.

I.3 Land Owners and Conservation

Agriculture-related environmental problems are the result of production decisions of land owners', including large scale application of fertilizers, fuels and chemicals, aggravating soil quality and contributing to ground water contamination [Manning, J. (2001)]. Higher returns from production in recent times have prompted land owners to bring conserved lands back into production. For example, the USDA reported that land owners have pled for early release of land that was set aside under Conservation Reserve Program (CRP) to grow grain crops, due to high prices. The net decrease in CRP land as of February 2008 was 2.2 million acres [USDA. 1(2008)]—this decrease in overall enrollment in CRP was to increase biomass production. However, there is evidence that if land owners decide not to follow conservation practices (such as no till, mulch or reduced till), then excessive emissions of greenhouse gas from soil by stimulating the activity of microbes in the soil can result [Charles, D. (2007)]—a new type of environmental problem associated with climate change [Laird, D. (n.d)]. Removal of biomass (agricultural residues corn cobs, straw and leaves) for bio-energy purposes is also found to negatively affect the soil exchange capacity, nitrogen leaching and

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[1] Corn prices fluctuated between $2 in 2005 and $5.00 in 2007 per bushel, and soybeans prices fluctuated between $5.66 in 2005 and $10.10 per bushel in 2007–October 2009. (ERS-Data USDA).

soil organic carbon content (ibid). Hence, production and conservation practices have direct impacts on environmental stability and long-term agricultural sustainability.

The problems of greenhouse gas emissions, reduction in soil exchange capacity, nitrogen leaching and reduction in organic carbon content are common at the national level in the US, and still more pronounced in the heartland states, such as Iowa and Illinois. Production and conservation might have been treated by land owners as being mutually exclusive. Adoption of conservation practices in farm lands currently under production has a broad scope, since around 90 percent of all Iowa farm land is cultivated. Achieving the goal of aligning production with conservation—in the case of a need to conserve—depends on various factors: costs and incentives available for different conservation measures or methods, nature of soil properties, impact of energy prices on farm profitability, farmers' characteristics and attitudes, demographic changes, type and amount of biomass requirements in the future and the emerging role of agriculture in natural resource conservation. All of these concerns comprise the costs and benefits of sustainable agricultural production as land owners consider conservation practices.

I.4 Problem Statement

Since land owners are the final decision-making authority on whether to adopt conservation practices, it is important to understand both how they make production and conservation decisions and the factors that influence their choices. The utility (benefits) derived from the same conservation practices or program can differ markedly among farmers. To illustrate, consider the evolving age dynamics of farmers in Iowa: Duffy's 2007 land tenure survey in Iowa found that over half (55 percent) of Iowa farm land was owned by owners over 65 years old, and 27 percent of farm land was owned by owners over 74 years old [Duffy, M. and Smith, D. (2007)]. A high proportion of land with older land owners might differ from young land owners in: (1) the production and conservation decisions adopted; and (2) the associated benefits (utility). Older owners may have owned their land for long time, and might be more inclined to adopt (or not adopt) certain conservation practices, like terraces (to save the land with high value). In contrast, younger land owners' incentives might be different (e.g., profit), due to age and purpose for holding the land (more income, sentimental reason or hobby). Similarly education level, residency area and other factors can impact the decision to adopt conservation practices. So investigating the difference(s) between AOs and OOs characteristics –age, education, etc.. – is important because of the latter's impact on the decision to adopt conservation practices.

Also, it is important to distinguish between OOs and AOs, because of the growing importance of the latter type. During 1880 to 1920, absentee landlords increased from 20 to 42 percent of farm land in Iowa [Rasmussen, C. (1999)], and by 2007, absentee ownership had grown to 60 percent of farmer operated land [Duffy, M. and Smith, D. (2007)]. Since the majority of farm land is owned by absentee landlords, the distinction between OOs and AOs becomes important, especially regarding the production and conservation practices they adopt. Moreover, the utility from adopting conservation practices or retiring land under CRP is likely to be different for OOs and AOs. In other words, the decision making process and the factors that govern it with regard to production and conservation in a piece of land owned by an owner operator might be different—due to different purposes of owning the land—from that of an absentee owner who has tenants' interests to consider, as well.

There is general evidence that absentee owners whose lands or part of his/her land are rented out are less likely to adopt conservation measures than owner operators [Soule, M.J., Tegene, A. and Wiebe, K.D. (1999), (2000)]. The existing literature has identified the general socio-economic characteristics, such as land owners' age, gender, education and the location of residence [Norris, P.E. and Batie, S.S. (1987) and Onianwa, O., Wheelock, G. and Hendrix S. (1999)], to be key factors; other studies have proven that income and other economic factors (like off-farm income and access to credit) significantly affect the decision to adopt conservation technology. But there is a gap in understanding how a variety of land ownership characteristics affect the adoption decision of conservation practices. These characteristics include being absentee owners or owner operators, living on a farm or in a nearby town or city, being sole or joint owner and planning the future uses of the land. All of these factors influence the decision to adopt conservation measures—practices or programs—yet, previous studies fail to address them. The aim of this study is to understand the nature of the influence these factors exert on conservation adoption decisions.

I.5 Objectives

Although CRP programs are important, their benefits accrue from only about 2 million acres in Iowa, or about 10 percent of Iowa crop land [Licht, M. and Johnson S. (2006)]. Thus, the benefits from adopting conservation practices (e.g., terraces and seeded downstream banks) can potentially be realized in the remaining 90 percent of Iowa farm land currently being used for farming purposes. Some of the established problems of converting CRP land into production (for bio-energy needs) possibly can be alleviated through the adoption of on-field conservation practices. The differences in ownership type might be reflected in differing farm decisions (e.g., production or conservation practices). This study's objective is to investigate, first, whether there is a difference between land ownership type (i.e., OO, AO) and the adoption of conservation technology; second, if the economic returns from land use support the decision to conserve or not; third, the factors that might differentiate owner operators from absentee owners (e.g., age, education, and so on) in adopting conservation practices and programs; fourth, if OOs and AOs favor adopting different conservation practices due to differences in the adoption expenses or range of scope (e.g., terraces, grassed water way); finally, if the characteristics of land owners, such as demographic, behavior or attitude, will support the decision to conserve, and ultimately sustain the agricultural land in Iowa.

The specific hypotheses of this study are identified at the end of Chapter II.

I.6 Organization

Chapter II presents a literature review, including a definition of the adoption of conservation technology, previous empirical studies on technology adoption in agriculture and land ownership (type, characteristics in Iowa). It states specific hypotheses about land ownership and conservation technology adoption. Chapter III describes the survey data used in this study. Chapter IV discusses the theoretical random utility model and statistical technique (logistic regression) used in this analysis to model land owners' decisions to adopt conservation practices. Chapter V discusses the results. Chapter VI presents conclusions, implications and the limitations of this study.

CHAPTER II. LITERATURE REVIEW

II.1 Introduction

This chapter provides a review of literature on land ownership and the adoption of conservation practices in Iowa. It is organized into four sections. Section II.2 conceptualizes the key question of this thesis as a technology adoption problem, and identifies suitable methods to analyze it. Section II.3 discusses the importance of land ownership in USA. The recent agricultural and environmental acts and conservation programs issued to help land owners are discussed in Section II.4. Section II.5 reviews the links between land owner characteristics and adoption of conservation practices, and further discusses the development not only of the hypotheses based on the literature review, but also land ownership characteristics, environmental problems, conservation practices and programs in Iowa.

II.2 Economic Motivation and Definition of Conservation Technology Adoption

To improve farm profitability and financial solvency, farmers often adopt improved crop varieties (hybrids, genetically modified seeds), use chemicals and follow certain cultivation practices. Farm profits translate into direct economic benefits and improvement in the quality of life (utility) enjoyed by the farmer. Changes in cultivation practices and adoption of new crop varieties, products or practices are motivated either by the achievement of higher utility for the farmer or achieving higher economic welfare level. [Dlamini, D. (2005)].

When farmers accrue monetary benefits from the adoption of technologies, regional impacts may result from aggregate adoption [Just, R., Ziberman, D. and Rauser G. (1980)]. When sustainable agricultural practices (SAP) have potential impact for a specific region, they may be promoted across the region for aggregate adoption. For instance, biological pest control is only effective if adopted over a large area.

Examples of SAP include Integrated Pest Management (IPM) practices, conservation tillage practices to reduce soil erosion, adoption of conservation practices such as terrace placement on steeper slopes, and grassed waterways. These practices affect not only farm profitability, but also the quality of soil and water resources. In fact, one primary reason to adopt a conservation practice is possible improvement in resource quality and land value. Many times, adoption decisions have to be made under uncertain information (and are therefore subject to farmers' predispositions toward the conservation technology). By definition, new technology adoption involves a broader "mental process", referring to the utility derived by the farmer who "passes from first hearing about the innovation to final adoption" [Rogers, E.M. (1962, p 17)]. Sustained productivity growth depends on rapid diffusion of new technologies [Huffman, W.E. and Evenson, R.E. (1993) and Ball, V.E., Bureau, J.C., Nehring R. and Somwaru, A. (1997)]. Hence, sustainable agriculture depends directly on the adoption of new technologies, and both have implications for resource quality and farm economics in the long run [Rahm, M.R. and Huffman, W.E. (1984)]. Farm productivity and profitability, and water, soil and land quality are also key factors in promoting sustainable agriculture. Therefore, understanding farmer characteristics that affect adoption of new technologies would be highly beneficial for promoting sustainable agricultural practices in Iowa.

II.3 Previous Empirical Studies on Technology Adoption in Agriculture

Past studies have identified an array of factors that can influence farmers' decision to adopt conservation technology. Each study highlights different sets of factors that determine technology adoption, with various findings partly influenced by differences in the study area and circumstances under which these studies were conducted. These differences reflect the variation in agro-ecological, socio-economic and institutional factors among countries and regions.

Studies that used utility and profit maximization theoretical framework

Motivations for adopting conservation technology were modeled in some empirical studies using, and at times combining, two economic theories: random utility and profit maximization. Each of these studies is location-specific, and acknowledges that farmers' circumstances and needs are diverse [Dlamini, D. (2005)]. So, it is difficult to draw reasonable generalizations due to differences in agro-ecological, socio economic and institutional factors in each region of the study area.

However, most of the previous studies used these two economic theories to conduct quantitative analyses. For example, Rahm and Huffman (1984) used the utility maximization model, where utility depends on the distribution of net returns (profits) and other characteristics of conservation technology, to study the adoption behavior of conservation tillage in Iowa. The relationship between the dependent variable (conservation practice adoption) and explanatory variables (such as age and education) was assumed to be linear. Since actual returns for each individual technology was not directly observable or available, they assumed that if farmers' utility increased after adopting the new technology, then farmers will adopt that technology. They used the following explanatory variables: corn acreage, acreage ratio of soybeans to corn area and 19 soil association dummy variables representing the different types of available soils. An efficiency index was created using the estimated probability of their adoption model. This efficiency index was then linked to other variables such as education, experience and sources of information. Their results suggest that the latter variables were positively and significantly related to the efficiency index.

Other studies, such as Purvis, A., Hoehn, J.P., Sorenson, V.L. and Piercie, F.J. (1989), also used a utility maximization approach to explain the conservation behavior of farmers. They investigated farmers' willingness to participate in a filter strip program. They analyzed whether farmers accepted a yearly payment to participate in a ten-year filter strip program and how they differed based on their preferences, characteristics and constraints, using utility maximization theory. Their results suggest that yearly payments, household income and concern about environment positively impacted the decision to adopt the program; however, the length of the program and the average yield on the filter strip land weighed in negatively on the adoption decision.

Concurrent with Purvis et al.'s (1989) study to understand farmers' attitudes toward adoption of conservation practices, Lynne, G.D., Shonkwiler, J.S and Rola, L.R. (1988) built a utility model where farmers' utility is designated as a function of farmer's income, conservation cost, farmers' attitude and farm characteristics. They focused on farmer's attitudes and awareness toward agriculture and environment, future plans, land tenure, income, financial constraints and erosion potential. To capture the amount of effort with which farmers tackled the resource quality problem, the dependent variable was identified as the number of conservation practices adopted by farmers. The results concluded that farmers' perception (of the soil erosion problem) and their ability to bear the conservation costs were the most important factors that affected adoption decisions. The study also found evidence that profit maximization (without regard to resource quality) had relatively less impact on farmers' adoption decisions. This conclusion suggests that utility maximization is as important as profit maximization. This same result was attained subsequently by Norton, N.A. (1994) and Dlamini, D. (2005). They showed how farmers' behavior in conservation technology adoption can be modeled as a utility maximization problem that ensures maximization of farm profits (further explained in chapter III). Utility maximization framework can be used to derive the demand for conservation practices (to enhance and maintain soil and water quality), and the profit maximization framework can similarly be used to generate the derived demand for conservation practices. The conceptual and empirical model in this study will be built based on Norton, N.A.'s (1994) and Dlamini, D.'s (2005) studies using utility (and profit) maximization of land owners.

Studies that utilized other approaches

Other studies have used different methods to analyze farmers' adoption of conservation practices. For example, Nielsen, E.G., Miranowski, J.A. and Morehart, M.J. (1989) looked at farmer investments in soil conservation technology using time-series data at the regional level. They hypothesized that soil conservation investment is affected by expected income, land retired under CRP, ratio of land improvement cost to land value, long-term interest rates, value of the previous period of capital stock, government subsidies and acreage under conservation tillage. The factors that affect soil conservation investment were found to be set-aside land, capital stock, price ratio, as well as cost-share expenditure under the Acreage Conservation Program (ACP). Technical assistance from government programs did not impact significantly the importance of market-based returns and resource quality when farmers considered investing in soil conservation practices.

Other methods, such as dynamic theoretical model, have been used to maximize the present value of the firm [McConnell, K.E. (1983)]. Resource Accounting Technique has been used to estimate the cost of soil erosion, using the change in productivity approach [e.g., Pimentel, D., Harvey, C., Resosudarmo, P., Sinclair, K., Kurz, M., McNair, M., Crist, S., Shpritz, L., Fitton, L., Saffouri R., and Blair R. (1995)]. Land market prices have been also used in a Hedonic Pricing Model to evaluate the cost of erosion [e.g., Miranowski, J.A. and Hammes B.D. (1984) and Palmquist, R.B. and Danielson, L.E. (1989)]. The Cost-Benefit analysis technique is another approach that has been used to measure the efficacy of soil erosion protection [e.g., Araya, B. and Asafu-Adjaye, J. (1999)]. Because these methods appear infrequently in the literature, utility and profit maximization seem to be the most common and useful approaches to analyzing farmers' conservation technology adoption behavior where most of the previous study used.

The conceptual and empirical model in this study is based on Norton, N.A.' (1994) and Dlamini, D.'s (2005) studies, using utility (and profit) maximization of land owners. Their utility functions with and without conservation practices will be compared. This study's utility comparisons use the random utility model. A brief description of the comparison is given in the methods section (Chapter IV). This type of analysis is simpler and purely econometric in nature when compared to the less frequently-used techniques. Finally, since many studies point out factors related to farm profit, such as income or off-farm income, and economic welfare as key factors in testing farmers' adoption of conservation practices, profit and utility maximization theory-based models seem more appropriate. More details about these models are explained in Chapter IV.

II.4 Importance of Land Ownership

Land ownership rights have been important for the development of US agriculture, because assured property rights promote the adoption of conservation and sustainable agriculture practices. As Timmons, J. (1948) explained, land titular aspects had been at the forefront of issues and policies concerning ownership rights and land management in the 19th and early 20th centuries. Timmons stressed that ownership rights translated directly into better land management measures, such as efficient land allocation and soil conservation. His hypothesis was that private land owners are more likely to conserve their land, compared to the public lands managed by the government agents and others, because land was a major investment that defined wealth for those private land owners.

The Preemption Act of 1841 and The Homestead Act[2] of 1862 gave settlers a chance to buy the land that they farmed [Timmons, J. (1948)]. The focus of these acts was to

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[2] The passage of the Homestead Act by Congress in 1862 was the culmination of more than 70 years of controversy over the disposition of public lands. The Act, which became law on January 1, 1863, allowed anyone to file for a quarter-section of free land (160 acres). "The land was the settlers' at the end of five years if they had built a house on it, dug a well, broken (plowed) 10 acres, fenced a specified amount, and actually lived there". Additionally, one could claim a quarter-section of land by "timber culture" (commonly called a "tree claim"). This required that one person planted and successfully cultivated 10 acres of timber (Pence, n.d.) http://www.directlinesoftware.com/homestead.htm

promote the cultivation of land by the owner operators (OOs) themselves. The Homestead Act was probably the first piece of legislation that treated OOs differently from absentee owners (AOs), by imposing additional taxes on the latter category (ibid). Allotting the land to settlers and imposing additional taxes on absentee owners suggested that the US federal government was interested in promoting private ownership of agricultural land and its cultivation by owners themselves.

Various other measures (e.g., The Bankhead-Jones Farm Tenant Act of 1937 and the Landlord and Tenant Relationship Act of 1972) were enacted to assist tenants to purchase and operate their own land. This was believed to lessen the shortcomings of a US tenancy system, where tenancy was perceived to be associated with poorer adoption of land conservation measures [Maddox, J.G. (1937)]. Hence land conservation and agricultural sustainability are likely to be affected by the presence of tenants (in case of absentee owners) or their absence (owner operators).

Land ownership in Iowa

There has been a steady increase in the amount of land managed by tenants for AOs in Iowa: in 1880, 24 percent of land was rented; this increased to 28 percent in 1890, to 35 percent in 1900 and 38 percent in 1910 [Hibbard, B.H (1911)]. It rose further since then to 52 percent of land owned by AOs, in Iowa during 1935 [Rasmussen, C. (1999)]. Duffy, M. and Smith, D. (2005) show that in 2002, 55 percent of Iowa farm land was managed by tenants; this percentage increased to 60 percent only 5 years later in 2007.

Most of the existing literature deals with the terms of farm contract and transaction costs factors that affect land owners' and tenants' relationships. The relationship between land ownership and adoption of conservation practices is not yet fully understood. Rasmussen, C. (1999) noted that the depression era of the 1930s negatively affected attitudes toward many of the conservation laws in Iowa. According to the report on the Twenty Five Year Conservation Plan of 1931, higher soil conservation costs and declining productivity led to higher uncertainty among tenants, precluding them from committing more money and resources for land conservation. Rasmussen's article notes short-term leases were the major reason for tenants not to adopt soil conservation measures in the rented land. The land owners welcomed conservation measures whenever government programs provided them with sufficient financial incentives (e.g., Soil Conservation and Domestic Allotment Act of 1935).

In spite of the state-level implementation of 'agricultural districts' to conserve soil during 1930s and 1940s [CD Iowa (2008)], soil conservation had progressed only in staggered phases in Iowa. The major reason for such slow development was the considerable contention between land owners and tenants about who should be responsible for implementing conservation practices and who should pay for the costs of conservation. Both sides demanded that the 'other party' take up the expenses of adopting conservation practices [Rasmussen, C. (1999)]. The debate of who should bear financial burden of adopting conservation practices continues to the present day [Rasmussen, C. (1999)].

II.5 Recent Environmental Policy, Agriculture and Conservation Programs

The FY 2001 Agriculture Appropriations Act established the Farmable Wetland Program (FWP) to provide specific incentives to protect 500,000 acres of small, non-floodplain wetland and adjacent upland in six states: Nebraska, Iowa, Minnesota, North Dakota, South

Dakota and Montana. In 2002, the Farm Security and Rural Investment Act extended the duration of enrollment in Conservation Reserve Program (CRP) to 2007. A list of other state-level conservation programs is available from the Iowa Department of Agriculture and Land Stewardship [IDALS (2008)]. All of these programs have focused on retiring land from production—a fact that could (problematically) lead land owners to believe that their land is conserved only when it is retired (from production) under conservation programs.

The contract term for CRP program is generally of long duration (10 to 15 years), which could result indirectly in promoting the participation of AO as opposed to OOs. Since almost half of the land in Iowa is owned by AOs, poor conservation may occur. Thus, it is necessary to address the next, yet still unanswered, question: 'Have these new conservation programs and payment structures been designed to align with the interests and orientation of owner operators and absentee owners with regard to conservation practices?' This study focuses on identifying practices commonly used by absentee owners and owner operators, and distinguishing the practices between the two. Differences in adoption behavior, if they exist, will be tested to measure their significance, and then conclude whether the orientation of both types of owners toward conservation practices and programs are the same.

Another issue concerns the dichotomy between production and adoption of conservation practices, and the possibility both production and conservation occur simultaneously in agricultural lands. While CRP programs retire land from production, there are various conservation practices that can be adopted without removing the land totally from production—these practices are diverse in scope, benefits, costs and the ease with which they can be employed in agricultural lands. Thus, understanding the adoption behavior of conservation practices by OOs and AOs might lead to adjustments in current conservation policies to meet individual needs, and to achieve the goal of adopting needed conservation practices, both of which would ultimately sustain valuable agricultural land.

Conservation programs

Conservation practices are generally adopted on lands that are under cultivation. Conservation in agriculture occurs predominantly in the form of retiring lands to grasses or native vegetation. This practice started as early as 1930s, when the focus of US agricultural policy was focused on improving soil conservation as instituted under the Soil Conservation and Domestic Allotment Act of 1936. It was later supported by the Agricultural Adjustment Act of 1938, which targeted avoiding soil fertility loss, and maintaining and rebuilding land resources.

The Agricultural Act of 1956 created the Soil Bank, taking 29 million acres out of production, and maintaining land solely for conservation purposes. The Soil Bank was designed explicitly to reduce both soil erosion and surplus production, limiting commodity prices from falling. The Soil Bank Conservation Program, however, generally failed in its objectives to conserve, probably due to its dual objectives [Bowers, D.E., Rasmussen, W.G. and Baker, D.L. (1984)]. However, the ethic of implementing conservation programs to conserve fertile soil from being lost or jeopardized had been well understood. Despite the Soil Bank’s failure, the push to conserve land continued five years later with The Emergency Feed Grain Act of 1961, which intended to take more land out of corn and sorghum production, and to use it as set-aside conservation areas [Cain, Z. and Lovejoy, S. (2004)]. It is important to note that whenever US laws and acts have sought to conserve soil, they have done so through incentives to take crop land out of production; conservation efforts in fields that are under continued production have received only nominal support. This tendency has resulted in an ongoing dichotomy between production and conservation (discussed in Chapter I). Unfortunately, this perception of viewing production and conservation as mutually exclusive undervalues the complementary relationship that exists between them.

Today, the Conservation Reserve Program (CRP) created by the Food Security Act of 1985 continues to remain the major concentrated form of land conservation in the US. The goal of CRP was to idle 35 to 40 million acres of highly-erodible land by 1990 to reduce soil erosion, to protect (long-run) land productivity and to improve farm sustainability [Lasseter, T.C. (2007)].

The Food, Agriculture, Conservation and Trade Act of 1990 and the Federal Agriculture Improvement and Reform (FAIR) Act of 1996 extended the CRP Program's duration to 2000, with a ceiling of 36.4 million acres. The special provisions of the 1985 Food Security Act, referred to as the 'swamp buster' and 'sod buster' provisions, aimed to protect all heavily eroded lands by not converting them back into production or if they were brought into production they were farmed using an approved conservation plan. Landowners who adopt certain conservation practices, according to this provision will be eligible for certain government programs such as price-support loan program, farm storage loans, federal crop insurance, disaster payments and new loans made by Farmers Home [O'Brien, D. (n.d)].

The land owners of these sensitive areas were supported to adopt a basic conservation system that reduced erosion to a tolerable (T) level [USDA 2. (n.d)][3].

A main feature of the special provisions of the 1985 Food Security Act is the compensation offered to farmers who retire land under these CRP, WRP and CREP[4] programs [Lasseter, T.C. (2007)]. Currently, 1.97 million acres (over 10 percent of farm land) are registered under various types of conservation programs in Iowa. The average payment (which served as incentive for conservation) of $110.60 per acre (2008 dollars) in Iowa is well above the national average of $50.63 per acre [USDA 1-FSA (2008)]. The signups during recent years encompass 60 percent of Iowa farms [USDA-NASS (2008)][5]. Such a high level of popularity suggests that the CRP program may serve as the prime or sole form of conservation. The higher proliferation of CRP has one potential downside. The farmers (absentee owners and owner operators) may end their participation with the CRP ‘programs’ without adopting the conservation ‘practices’.

II.6 Land Ownership and Conservation Practices and Programs

Traditionally, the focus of adopting agricultural technology was primarily to increase productivity. With the growing concern about the environment and quality of natural resources, the focus of sustainable agricultural practices have shifted from emphasizing simple profits to including long-term utility gained by conserving resources. Many studies

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[3] Soil loss tolerance T-level is defined as the maximum amount of soil loss in tons per acre per year that can be tolerated and still maintain a high level of crop productivity.

[4] CRP: Conservation Reserve Program; WRP: Wetland Reserve Program; CREP: Conservation Reserve Enhancement Program.

[5] Total farms in Iowa = 88,600 farms in 2006 [USDA-NASS (2008)].

have identified a set of factors that impact farmers' decisions to adopt conservation practices or retire land under CRP programs. While many of them analyzed the impacts of agro-ecological, socio-economic and institutional impacts, only a few of them studied how the land ownership pattern (operator- versus absentee-ownership) affects the adoption of conservation practices.

The primary reason to adopt a new technology was determined by the potential to increase profits (increase yields or reduce costs), the level of adoption depended on different factors. These factors ranged from financial constraints, labor requirements and land quality to risk-bearing ability of the farmers associated with uncertain outcomes of new technology and tenure arrangement [Feder, G.R., Just, J. and Zilberman, D. (1985)].

Economic and land ownership type characteristics

The economic incentives and costs of adopting conservation practices by owner operators and absentee owners are possibly different. This possibly explains why the newer conservation schemes and programs have yielded mixed results [Lichtenberg, E. (2007)]. A few empirical studies found that tenants who managed land for AOs spent less money toward conservation expenditures than do owner operators [Featherstone, A.M. and Goodwin, B.K. (1993) and Norris, P.E. and Batie, S.S (1987)]; however, a few other studies found that tenants were more likely to adopt certain conservation practices, such as conservation tillage [Lee, L.K. and Stewart, W.H. (1983)]. Harbaugh, W.H. (1992) provides an extensive historical overview of research on tenancy and soil conservation practices. Various studies (international and domestic) during the pre-World War II era suggested that tenants did not adopt many conservation practices, causing deterioration of land owned by absentee owners and farmed by tenants. These studies identified as reasons for poorer adoption the shorter time frame of leases, higher land rents, failure of landlords to cooperate on leasing arrangements, lack of incentives for tenants, or (even worse) the tenants did not consider conservation practices as worthy of adoption [Harbaugh, W.H. (1992)]. This review did note that certain conservation practices (e.g., reduced tillage) were adopted by tenants because of their cost-effectiveness. Another interesting finding is that owner operators did not adopt sufficient conservation measures due to lack of sufficient economic incentives. Harbaugh concluded that both the owner operators and absentee owners required incentives to adopt land conservation practices. It is not yet established, however, whether such incentives have to be similar or different for owner operators and absentee owners.

Other studies found no differences in conservation expenses among lands owned by absentee owners and owner operators with regard to adoption of conservation practices (conservation tillage in particular) [Norris, P.E. and Batie, S.S. (1987) and Rahm, M.R. and Huffman, W.E. (1984)]. Lichtenberg, E. (2007) argued that these contradicting findings owe to contrasting actions of land owners, depending on the type of rental arrangement—if the tenant is risk-neutral, then optimal level of conservation was achieved only with share rental contracts, but not with cash rental contracts. If the tenants were risk-averse (investing conservatively), the solution of optimal conservation was found never to be attainable.[6] This

[6] The risk-averse behavior of tenants resulted in either investment or under-investment in conservation. If land owners gives strong incentives to tenants—for example, fixed rent contracts—then tenants might invest in conservation, since they bear the entire production risk [Stiglitz, J. (1974)]; otherwise, tenants will not invest or under-invest in conservation. By nature, tenants will not bear additional costs without having time to be compensated by the benefits adopting conservation practices.

finding suggests that the decision to adopt conservation should be viewed in relation to land owner behavior, and the possible risks faced by the tenants involved [Lewis, T.R. and Sappington, D.E.M. (1989)].

Land rented through crop share was found to be better conserved by the tenant if the full benefits accrued to the tenants within the contract period [Allen, D. and Lueck, D. (1992) and Soule, M.J., Tegene, A. and Wiebe K.D. (2000)]. Since tenants' concerns (length of contract, riskiness and temporal sequence of costs and benefits) need to be addressed by their landlords (AOs), the role and characteristics of absentee owners in land management and cultivation becomes an important area of study.

The behavior of part owners, those who rent part of the land and cultivate the other, toward adopting conservation practices in the rented land is yet uninvestigated. This issue is beyond the scope of this study. Land owners who themselves do not operate the surveyed land in this study are considered absentee owners. However, since the ratio of part owners to full owners is increasing in Iowa, investigating and understanding their conservation adoption behavior toward rented land becomes crucial to enhance conservation efforts in Iowa.

The Iowa case

This concern of relating conservation adoption to land owner behavior or type would be very important in the case of Iowa, since rented land –cash, crop share and other type of lease (60 percent) – is relatively bigger than land managed by owner operators (40 percent) [Duffy, M. and Smith, D. (2007)]. Iowa consists of 30.75 million acres of farm land, out of 35.76 million acres of total land. Out of the farm land, 26.32 million acres (85 per cent) were classified as crop land in 2007 [USDA-ERS (2008)]. The total number of farms increased from 90,600 farms in 2002 to 92,800 farms in 2007 [USDA-ERS (2008)]. This increase resulted in an appreciable decrease in average farm sizes in Iowa—from 351 acres in 2002 to 332 acres in 2007.

Of those farms, 55 percent (2002) and 57.6 percent (2007) operated under full owners; 33.4 percent (2002) and 31.2 percent (2007) were managed by part owners; and 11.6 percent (2002) and 11.2 percent (2007) were managed by tenants [USDA-ERS (2008)]. The number of farms controlled by tenants fell between 2002 and 2007 from 10,501 farms to 10,427 farms [USDA-ERS (2008)].

Growth in the amount of acreage under trust and a higher proportion of land under joint ownership characterize an important phenomenon in Iowa. These types of ownership might impact the type of cropping pattern and methods of cultivation that include or exclude conservation practices. For example, the incentive schemes that are both available and sufficient for an owner operator to adopt conservation practices may not be available or appealing enough for absentee owners. A part owner who owns and rents land at the same time adds another concern. The key concern would be whether these part owners use different crop management and conservation practices in both rented and owned lands.

First Hypothesis

Based on the literature and Iowa land ownership types, this study tests whether the types of ownership—Owner Operator (OO) or Absentee Owners (AO)—impacts adoption of conservation practices in general, and adoption of certain types of conservation practices in particular. The following hypotheses are thus proposed:

H0: There is no difference between absentee owners and owner operators in the adoption of conservation practices and in the types of conservation practices that they adopt.

H1: There is a difference between absentee owners and owner operators in the adoption of conservation practices and in the types of conservation practices that they adopt.

Second Hypothesis

H0: Land owners who own land for income reasons are more likely than other land owners to adopt conservation practices.

H1: Land owners who own land for income or investment reasons are less likely than other land owners to adopt conservation practices.

Demographic characteristics

Onianwa, O., Wheelock, G. and Hendrix, S. (1999) reported that education, gender, type of crops grown, farm tenancy and size of the farm were important factors in determining the adoption of conservation practices in lands designated for conservation under CRP programs. Other studies also identified other relevant variables: age, race, tenure, variables measuring risk attitudes, cost-sharing, erosion potential, institutional factors, experience, off-farm income, perception of soil erosion problem and capital [Norris, P.E. and Batie, S.S. (1987), Novak, P. and Korsching, P. (1979), Ervin, C.A. and Ervin, D.E. (1982), Lynne, G.D., Shonkwiler, J.S. and Rola, L.R. (1988), Pampel, F. and van Es, J.C. (1977) and Blasé, M. (1960)]. Interestingly, landlords' age and level of education played a mixed role. Some studies concluded that young and better-educated farmers were more likely to adopt more soil conservation practices [Hoover, H. and Wiitala, M. (1980)]. Similarly, Onianwa, O., Wheelock, G. and Hendrix, S. (1999) found that younger land owners are more receptive to a broad range of conservation practices. They attributed this finding to the higher education level, better understanding of soil erosion and low level of risk aversion in younger land owners.

However, another study [Nowak, P.J. and Korshing, P.F. (1981)] suggests that older farmers usually tend to adopt structural practices (e.g., terraces) and cultural practices (e.g., grass waterways). Hence, the impact of age on decisions to adopt conservation technology may be mixed [Cary, J., Webb, T. and Barr, N. (2002), Curtis, A. and Byron, I. (2002) and Latta, J. (2002)].

The Iowa case

Since age varies between absentee owners and owner operators in Iowa, the difference between absentee owners and owner operators may be mixed, as well. An increasingly high percentage of people over 65 years old own Iowa farm land. Duffy, M. and Smith, D. (2007) classified owners into three age categories: early-stage (up to 34 years of age), mid-stage (35 to 64 years) and late-stage (65 years and over). In the two latter categories (mid- and late-stage), owners owned 89 percent and 97 percent of farm land in Iowa during 1982 and 2002, respectively. The land held by late-stage owners over 65 years of age increased from 29 percent in 1982 to 48 percent in 2002, and to 55 percent in 2007 [Duffy, M. and Smith, D. (2005), (2007)]. The authors predicted that the aging structure of land ownership would cause significant transfers of land in the subsequent 15 to 25 years. This prediction raises the salient issue of whether the new and beginning farmers who receive land through such transfers would adopt land conservation. Although such an analysis would be beyond the scope of this study, Duffy and Smith's data can be used in testing some hypotheses regarding Iowa's young farmers in 2006.

Despite different results in the literature regarding the impact of age on the adoption of conservation practices, this study's hypotheses are based on the premise that adoption occurs when an owner has sufficient resources. Since older farmers are likely to have more resources than younger farmers, two additional hypotheses follow:

Third Hypothesis

H0: The adoption or use of conservation practices increases with age.

H1: The adoption or use of conservation practices neither increases nor decrease with age.

Fourth Hypothesis

H0: In comparison to older land owners, younger ones are less likely to use expensive conservation practices like terraces

H1: There is no difference among land owners due to age in adopting expensive or inexpensive conservation practices

Differences in the education level were also found to have an impact on adoption of conservation practices [Marsh, S., Pannell, D. and Lindner, R. (2000)]. Some studies found a positive association between education and having information about government programs regarding conservation practices [Ervin, C.A. and Ervin, D.E. (1982) and Taylor, D.L. and Miller, W.L. (1978)]. This association explains why many studies have hypothesized that education has a positive impact on the adoption of technology, assuming that a higher educational level leads to higher ability among farmers to obtain, analyze and use available information about these conservation technologies.

The Iowa case

The average education level of farm land owners in Iowa has increased since 2002. The percent of farm land owned by owners with a bachelor's degree or some college experience increased from 44 percent in 2002 to 46 percent in 2007. The percentage of farm land owned by owners who had not finished high school was the same -7 percent in 2002 and 2007 while the percent of farm land owned by owners with a graduate degree slightly increased from 7 percent in 2002 to 8 percent in 2007 [Duffy, M. and Smith, D. (2005), (2007)]. These changes in educational level could affect the adoption of conservation practices among land owners, because greater education could increase individuals' knowledge and awareness of environmental problems, and their ability to assimilate information from multiple sources, including modern sources like the Internet.

Fifth Hypothesis

H0: The higher an Iowa farmer's level of education, the more likely s/he will have adopted conservation practices.

H1: Education is unassociated with Iowa farmers' adaptation of conservation practices.

Ervin, C.A. and Ervin, D.E. (1982) also investigated the effect of farmer characteristics as well as economic, institutional and physical factors of farmers' land to analyze the decision-making process regarding the use of soil conservation practices. Their hypothesis stated that farmers' willingness to adopt conservation measures should be closely related to their perception of the soil erosion problem and the impact on farm income and land value. They also hypothesized that government cost share programs positively influence farmers' decisions to adopt. Their empirical model led them to conclude that education, erosion potential (which affects farmers' perceptions), risk aversion, type of farm (e.g., cash grain farm versus other farms), type of contract (crop share versus cash rental) and the percent of the farmer's crop land that received cost-share payment were significantly linked to farmers' adoption decisions. Their study was one of the very few studies that analyzed specific conservation practices in detail: they studied terraces, grassed waterways, contouring, minimum tillage and crop rotations with hay or pasture. Their analysis concluded that all the factors (listed above) affect the decision to adopt a particular conservation practice—but that the extent of influence varied for different conservation practices. Hence, it is important to distinguish among conservation practices.

The Iowa case

In Iowa, there are different types of conservation practices: terraces, contour buffer strips, cross wind trap strips, field borders, filter strips, grassed waterways, riparian forest buffers, windbreaks and shelterbelts. The extent of requirements for these conservation practices vary, depending on topography and climate. The common forms of conservation practices in Iowa include installation of terraces, conservation tillage practices—such as no till, ridge till, and reduced till practices—seeded downstream banks and grassed waterways [CTIC (2008)].Table 2.1 below displays the acres occupied and cost per acre of each practice in Iowa. Among these practices, terraces are most expensive, with benefits sustained over long periods of time. The seeded downstream banks and grassed waterways are relatively inexpensive, with mostly short-term environmental benefits [Feng, H., Kling, C., Gassman, P., Jha, M. and Parcel, J. (2006)].

Table 2.1 Adoption and cost of conservation practices in Iowa

Conservation practice	Usage estimates (million Acres)	Cost ($/acre)
Terraces	2.00	382.79
Water grassed way	2.23	47.85
Contour farming	5.15	6.00
Contour strip-cropping	0.24	14.79
No-Till	5.22	19.98
Mulch-Till	8.29	10.00
CRP	1.89	101.47

Source: From Feng, H., Kling, C. Gassman, P. Jha, M. and Parcel J. (2006).

The last line in the table lists the usage of CRP, one of Iowa's 25 Conservation Programs (CP). The CRP compensates land owners for taking their most erodible land out of production. Highly erodible cropland or other environmentally sensitive acreage under CRP can be converted to vegetative cover, such as native grasses, wildlife plantings, trees, filter strips or riparian buffers. Other types of conservation programs (CP) help and compensate farmers for conserving their land. For example, the Conservation Security Program or Conservation Stewardship Program (CSP) rewards land owners for their past conservation efforts, and helps with developing conservation plans targeted at specific natural resources. Conservation Technical Assistance (CTA) helps land users with planning and protecting natural resources on their land. Most of these CPs offer financial and technical assistance to land owner or land users. Thus, land owners who learn about these programs will likely adopt conservation practices, given this study's key premise that cost is the key factor in adoption decisions. Absentee owners, who are not farming themselves, will be generally less informed about these programs and practices, suggesting the following hypotheses:

Sixth Hypothesis

H0: Absentee owners are more likely than owner operators to adopt expensive conservation practices.

H1: Absentee owners and owner operators are equally likely to adopt expensive conservation practices.

Seventh Hypothesis

H0: Absentee owners and owner operators are equally likely to adopt conservation tillage.

H1: Absentee owners are less likely than owner operators to adopt conservation tillage.

Eighth Hypothesis

H0: Knowledge about cost share programs increases the likelihood of land owners' adoption of conservation practices

H1: Knowledge about cost share programs is unassociated with land owners' adoption of conservation practices..

This study extends the work of Ervin, C.A. and Ervin, D.E. (1982) by accounting for differences among owner operators and absentee owners with regard to their adoption and use of different conservation practices. These hypotheses will be tested using logit models (see Chapter III), and the results will be discussed and analyzed in Chapters V and IV.

To conclude, previous studies show how adoption of conservation technologies depend on multiple factors related to farms and land owners. Most studies utilized a combination of the profit and/or utility maximization conceptual models. This study uses the same factors found in the literature, and extends the knowledge of adoption behavior by differentiating between how owner operators and absentee owners adopt conservation technology.

II.7 Summary

This chapter reviewed relevant literature on conservation technology adoption decisions, and relationships with land ownership and tenancy. Different conservation practices (land terracing and creating seeded downstream banks, contour buffer strips, field borders, filter strips, grassed waterways and so on) were identified to have different scope and impact on land conservation. The costs and benefits of these conservation practices provide varying financial incentives for land owners and tenants. Potential non-adoption of conservation practices by absentee owners or tenants have now become increasingly possible, since more than half of the agricultural land in Iowa is now owned by absentee landlords. Existing studies provide limited and contradicting evidence with respect to whether owner operators differ from absentee owners in their adoption of conservation measures. Multiple factors were found to contribute toward these contradictions regarding the influence on adoption of farmers' type of contract (cash rent versus crop share), age, education, perception regarding their amount of soil erosion, place of residence (proximity to urban/rural areas), risk attitudes, farm and off-farm income, farm size and cost of specific conservation practices, as well as the capital available for expensive conservation practices (e.g., terracing). Few studies have analyzed specific conservation practices in detail. Most studies have not differentiated between owner operators and absentee owners with respect to specific conservation practices. This study is an attempt to fill these gaps by answering eight specific hypotheses, using data from a 2006 Iowa survey.

CHAPTER III. RANDOM UTILITY MODEL AND ADOPTION OF CONSERVATION PRACTICES

III.1 Introduction

In this chapter, a random utility model RUM (based on utility and profit maximization) is presented as a theoretical framework. Section III.2 discusses the theoretical underpinnings of Random Utility Models (RUM). Section III.3 develops a RUM-based model for farmers' adoption behavior, and explains how the proposed hypotheses can be tested using the model. Section III.4 briefly describes the computational aspects of these models. Appendix D supplements Section III.4 with a detailed explanation of utility and profit maximization as they form the basis of the RUM. Section III.5 displays the specification of this study's two logit models, (1) a model similar to those used in the literature, and (2) extended model to account for the factors that contribute significantly to Iowan OOs' and AOs' decisions to conserve.

III.2 Utility Maximization and Technology Adoption

Variables such as age, education, individual knowledge of conservation practices can have a combined effect on conservation technology adoption decisions by land owners. Their combined effect can be determined by using Random Utility Models (RUM), based on a utility maximization behavior of land owners.

Random Utility Models predict the dichotomous or discrete choice behavior of a consumer from a mutually exclusive finite set of preferences [Daly, A. (2001)]. In this study, land owners are considered consumers of agricultural inputs and conservation practices. Specifically, the random utility function measures the probability of discrete choices made by land owners from the Choice Set C of conservation practices, such as terracing, filter strips, CRP, and so on. The model is random for many reasons. Land owner decisions to adopt conservation technologies are not known with certainty to the analyst: full information on the variables that motivate adoption behavior is rarely available (as is the case here), nor is the correct measurement of motivations and individual preferences—all factors represented to specify correctly a model of land owners' preferences—known. Moreover, if complete information about the distribution of preferences in the population is available, the individual preferences of the randomly sampled land owners are still uncertain. As a result, the Random Utility Model always includes an error term (ε) to account for such possibilities of uncertainty [Daly, A. (2001)].

Utility Maximization

Following Dlamini, D. (2005), utility usually depends only on goods and services consumed (g). Since the focus of this study is on the adoption of conservation practices, the impact of those practices on land owners' utility in the form of changes in net farm profits (π) and resource quality (**Ř**), the utility function of a land owner can be defined as

$$U\,(\mathbf{g},\, \mathbf{\check{R}},\, Л(\mathbf{x^*},\, \mathbf{C^*})) \qquad (3.1)$$

where **g** is a vector (set) of goods and services consumed. Л(**x***, **C***) refers to the maximum farm profits achievable using input vector (set) **x***, conservation practices vector **C*** and resource quality (such as water quality, soil carbon, soil organic matter, soil erosion and so on) are denoted by the vector **Ř**. The optimal amounts are denoted by an asterisk "*".

Since **x*** and **C*** can be expressed in terms of output price (corn, soybeans prices), **p** and input prices (fertilizer, seeds and so on) **w,** the maximum (or indirect) profit function can be rewritten as

$$Л(\mathbf{p}, \mathbf{w}; \check{\mathbf{R}}) \tag{3.2}$$

where **p** and **w** are output and input price vectors, respectively. This result (3.2) can be derived from a standard profit maximization problem. For a detailed derivation of the indirect profit function Л(**p**, **w**; **Ř**), see Appendix D. The maximized farm profits for land owners are either from farm returns, if they are owner operators, or from rental returns, if they are absentee owners. The choice of variables **x** and **C** are optimally chosen from the profit maximization problem. The choice of variables **g** can be chosen from the utility maximization problem.

The maximization of land owner's utility, U, by choosing the optimal amount of consumption goods and services (**g***), results in the indirect utility function

$$V(\mathbf{v}, \mathbf{p}, \mathbf{w}; \mathbf{C^*}) \text{ or } V(\mathbf{d}; \mathbf{C^*}) \tag{3.3}$$

where **d** represents the set of vectors (**v**, **p**, **w**); the vector **v** refers to the cost of goods (**g**) consumed. For a detailed derivation of the indirect utility function, V, see Appendix D. Thus, the utility function U (**g**, **Ř**, Л (p, w); **C***) can be expressed in its optimal form as V (**v**, **p**, **w**; **C***). **C*** refers to a set (vector) of conservation practice decisions made by the land owner. A land owner would adopt a conservation practice C_k if the utility (v) is higher with the conservation practice than without it—that is, when

$$V_1 \geq V_0 \tag{3.4}$$

where the utility, with the adoption of k^{th} conservation practice is

$V_1 = V(\mathbf{d}; C_k = 1)$ (3.5)

and the utility in the non-adoption case is

$V_0 = V(\mathbf{d}; C_k = 0)$. (3.6)

Comparison of utilities

Following Wooldridge, J. (2009) and Haab, T.C. and McConnell, K.E. (2003), the decision to adopt the k^{th} conservation practice (C_k) depends on the comparison of the two utilities, V_1 and V_0. Hence, if a farmer has already adopted a conservation practice, C_k, the utility, V_1, would have been higher than V_0. Furthermore, since (1) utility V (.) is an abstract concept and not directly measurable, (2) the empirically estimated function for V(.) may contain errors even after approximation, and (3) only a certain proportion of land owners adopt C_k, it is possible to estimate the probability (Pr) of V_1 being higher than V_0. Note that there is a direct correspondence between the proportion of land owners adopting C_k and the probability that V_1 is greater than V_0 on the aggregate level.

Probability of the k_{th} conservation practice being adopted can be given as

$\Pr[C_k = 1] = \Pr[V_1 \geq V_0]$. (3.7)

To evaluate further, a functional form is needed for V. Thus, a latent index function Q can serve as the functional approximation. The land owner would adopt a conservation practice, C_k; if the estimated value for Q is above a certain value L (L is usually normalized to be zero). The function Q is estimated using the factors that literature found to significantly impact the land owner decision to adopt including the land owner characteristics vector, **q** (age, education and so on), and the error, ε, yielding:

$V_1 = Q(\mathbf{q}, \varepsilon_1; C_k=1) = \mathbf{q}\,\boldsymbol{\beta}_1 + \varepsilon_1$ (3.8 a)

$V_0 = Q(\mathbf{q}, \varepsilon_0; C_k=0) = \mathbf{q}\,\boldsymbol{\beta_0} + \varepsilon_0$ (3.8 b)

where β_0 and β_1 refer to the coefficients estimated for land owners who adopt versus those who do not adopt, and where ε_0 and ε_1 are the errors in the estimation for land owners who adopt versus those who do not adopt conservation practices, respectively.

III.3 Probability Models and Estimation

Researchers [e.g., Hanemann, W.M. (1984)] widely use Random Utility Models when examining discrete choices for technology adoption. A RUM can be estimated based on an indirect utility function. The comparison of utilities V_1 and V_0 enables prediction of the probability of adopting conservation practice, k (see Appendix E).

$$\Pr(C_k = 1) = \Pr(V_1 \geq V_0) = \Pr(\mathbf{q}\,\beta_1 + \varepsilon_1 \geq \mathbf{q}\,\beta_0 + \varepsilon_0) = \Pr[\varepsilon_1 - \varepsilon_0 \geq \mathbf{q}\,(\beta_0 - \beta_1)] =$$
$$\Pr[\varepsilon_1 - \varepsilon_0 \geq -\,\mathbf{q}\,(\beta_1 - \beta_0)] \qquad (3.9)$$

$$\Pr(C_k = 1) = \Pr[\mathbf{e} \geq -\,\mathbf{q}\,\mathbf{b}] = \Pr[\mathbf{e} \leq \mathbf{q}\,\mathbf{b}] = F(\mathbf{q}\,\mathbf{b}) \qquad (3.10)$$

where $\mathbf{e} = \varepsilon_1 - \varepsilon_0$ and $\mathbf{b} = \beta_1 - \beta_0$.

In equation 3.10, the difference in error terms, ε, is assumed to be independently, identically and symmetrically distributed (independent and identically distributed, iid) among land owners; and F(**q b**) represents the cumulative distribution function of that distribution. The symmetric CDF, F, is usually assumed to be a logistic (logit) or cumulative normal (probit) distribution. The differences between logit and probit models are slight [Haab, T.C. (2003)], but the logit model result is easier to interpret [Abebaw, D. and Belay, K. (2001)].

Logit Model

When F (q b) is assumed to be a logistic function denoted by F_L (q b), then the errors, ε, are assumed to be distributed among land owners according to a logistic function, with mean zero, and variance ($\pi^2/\sqrt{3}$). A logistic function is assumed, since it allows for easier interpretation of regression coefficients associated with dummy variables as log odds ratios. Previous studies (noted in Chapter II) that employed regression analysis to analyze adoption decision of conservation practices also assumed a logistic distribution for, ε, such as [Dlamini, D. (2005)]. Hence, to be consistent with the literature, the same distribution is assumed in this study. Assuming normal distribution for, ε, is also common, but imposes a stricter scope on normal distribution, which may not always be satisfied.

As a logistic distribution, F becomes

$$F(\mathbf{q}\,\mathbf{b}) = F_L(\mathbf{q}\,\mathbf{b}) = \exp(\mathbf{q}\,\mathbf{b}) / (1 + \exp(\mathbf{q}\,\mathbf{b}). \qquad (3.11)$$

The probability of V_1 being higher than V_0 can be estimated as the area under the cumulative distribution curve F_L ($\mathbf{q}\,\mathbf{b}^*$), where $\mathbf{b}^*$ is the vector of estimated coefficients.

Log odds ratio estimation and economic interpretation

The estimated coefficients using logistic regression are interpreted as the increment in the “log odds of adoption” for a one unit increase in an independent variable, where “odds” refer to the probability of an event occurring, divided by the probability that the event does not occur. The event of interest here is adoption of conservation practices.

The coefficient estimated for a particular independent variable reveals whether that variable increases or decreases the log odds of adopting the conservation practice under question. Log odds ratio can take any value—unlike odd ratio, which can take values between 0 and 1. The log odds ratio is the logarithm of the odds ratio. If the computed log odds ratio is positive for a dummy variable Z, then an increase in the value of Z increases the log odds of adopting the conservation practice under question. Log odds ratio also gives a direction of association. Consider the case where Z means type of land ownership (“1” if Owner Operator, or OO, and “0” if Absentee Owner, or AO). Let the probability to adopt a conservation practice K by OO be P_1 and by AO be P_2. Then, the log odds ratio to adopt the conservation practices K is:

$$\exp\{\frac{p_1/(1-p_1)}{p_2/(1-p_2)} = \frac{p_1/q_1}{p_2/q_2} = \frac{p_1 q_2}{p_2 q_1}\} \quad (3.12)$$

where $q_1 = 1-p_1$, $q_2 = 1-p_2$.

If the coefficient for Z is negative ‘m’, then an increase in owner operators by one leads to a decrease in the log odds to adopt the conservation practice K by ‘m’. If the coefficient for Z is positive, then an increase in OO by one increases the log odds to adopt the conservation practices K by ‘m’.

In the case of ordinary data (data considers more than two values with rank, like ‘age’ and ‘acreage’) there will be a base group to compare with. The resulting interpretation would be, for example, “increase the age by one year for age group of land owner between 34 and 65. The log odd to adopt conservation practices (for example ,expensive conservation practices) as opposed to not adopting practices increases by ‘m’ compare to the people who are less than 35 years old, keeping other factors constant. The same applies to the second age group: the higher the odd ratio, the higher the log odd ratio. Since odd ratio is the probability of success to failure—in our case, the probability of adoption to no adoption—then the higher the number, the higher the likelihood to adopt. So, the higher the log odd is, if it is positive, then the more likely adoption is to occur, if the age increases by one unit or one year.

III.4 Hypothesis Testing

First, a basic model for F (**q b**), as justified by the existing literature, will be identified for various conservation practices. The chosen land owner characteristics (**q**) include age, education, and so on. Since the existing literature has not dealt with the differences between absentee owners and owner operators (Z), this study will include an additional variable (Z) to differentiate between these two types of land owners. The effect of land ownership (variable Z) on adoption of conservation practices (K) will be studied after controlling for land owner characteristics q(.). That is, **q** and Z are used simultaneously as explanatory variables. The other hypotheses from Chapter II will be tested, similarly, by adding them as explanatory variables in the regression models. Differences among conservation practices (expensive practices, such as terraces, and inexpensive practices, such as grassed waterways) will be studied by changing the dependent variables in these regressions. Implications will be derived based on the findings.

III.5 Model Specification

The central objective of this study is to investigate if there is a difference in adoption behavior of conservation practices between OO and AO and the factors that affect the adoption decision of both owner types (OO, AO) in eight Iowa counties. This study may be relevant for future technology adoption-oriented government programs, since the main interest for policy makers is knowing which factors enhance the likelihood of future adoption of technological conservation practices.

To specify the relationship between adoption of technological conservation practices and owners' social, demographical and behavioral characteristics, logistic regression models are estimated. The data will show that the adoption of one technology does not necessarily prevent the adoption of other technologies. Reasons to adopt one technology are analyzed independently from decisions to adopt others, as explained in Chapter IV.

Empirical Models

Following the theoretical model, two econometric models for the adoption of conservation technology can be specified: the 'Base Line Model' and the 'Extended Model'.

The base line model is based on socio-economic and behavioral factors (**q**), including age (q_1), gender (q_2), education (q_3), debt on land (q_4), reason for holding the land (q_5) and size of owned land (q_6). The baseline model is specified in equation (3.14) below.

$$C_i = \Omega_0 + \Omega_1 q_1 + \Omega_2 q_2 + \Omega_3 q_3 + \Omega_4 q_4 + \Omega_5 q_5 + \Omega_6 q_6 + \varepsilon_1 \qquad (3.14)$$

The extended model includes additional variables pertaining to land ownership, such as who owns the land (AO or OO; Z), place of residence (q_8), type of land title such as sole owner, joint owners etc. (q_9), knowledge about government cost-share programs (q_{10}) and future plans whether to give or sell land (F). it is given in equation (3.15).

$$C_i = \delta_0 + \delta_1 q_1 + \delta_2 q_2 + \delta_3 q_3 + \delta_4 q_4 + \delta_5 q_5 + \delta_6 q_6 + \delta_7 Z + \delta_8 q_8 + \delta_9 q_9 + \delta_{10} q_{10} + \delta_{11} F + \varepsilon_2 \qquad (3.15)$$

Vectors δ and Ω are estimated coefficients equivalent to $\boldsymbol{\beta}$ in equation (3.9). Note that variables q_1, q_6, q_8 and q_9 are ordinal variables, and have sub–categories, as shown in Table 4.9.

Five sets of base line and extended models will be estimated. In the first model, the dependent variable is defined by whether owners use or adopt at least one or more of the following conservation practices: CRP, terraces, drainage tile, grass waterway, seeded downstream banks or a no-tillage system. Two other sets of models represent specific conservation practices based on the cost (expensive and non expensive practices), since the literature refers to the effects of cost on decisions to adopt conservation practices. The fourth model evaluates the adoption of conservation tillage. The last model estimates enrollment in conservation programs such as CRP, WRP and so on, all of which are important tools in alleviating problems resulting from soil erosion. Finally, data and primary statics are discussed in next chapter. The results for the five logit models are presented in Chapter V.

CHAPTER IV. SURVEY INSTRUMENT AND DATA

IV.1 Introduction

This chapter describes data and data transformations created from the survey for this analysis. Section 2 presents an overview of the survey instrument; section 3 describes salient features of the data. An overview of the surveyed area background is presented in Section 4. Section 5 discusses how these data were coded and measured for further empirical analysis. The sixth and final section gives primary descriptive statistics of the data, using the measure of association gamma.

IV.2 Survey Instrument and Sample: Overview

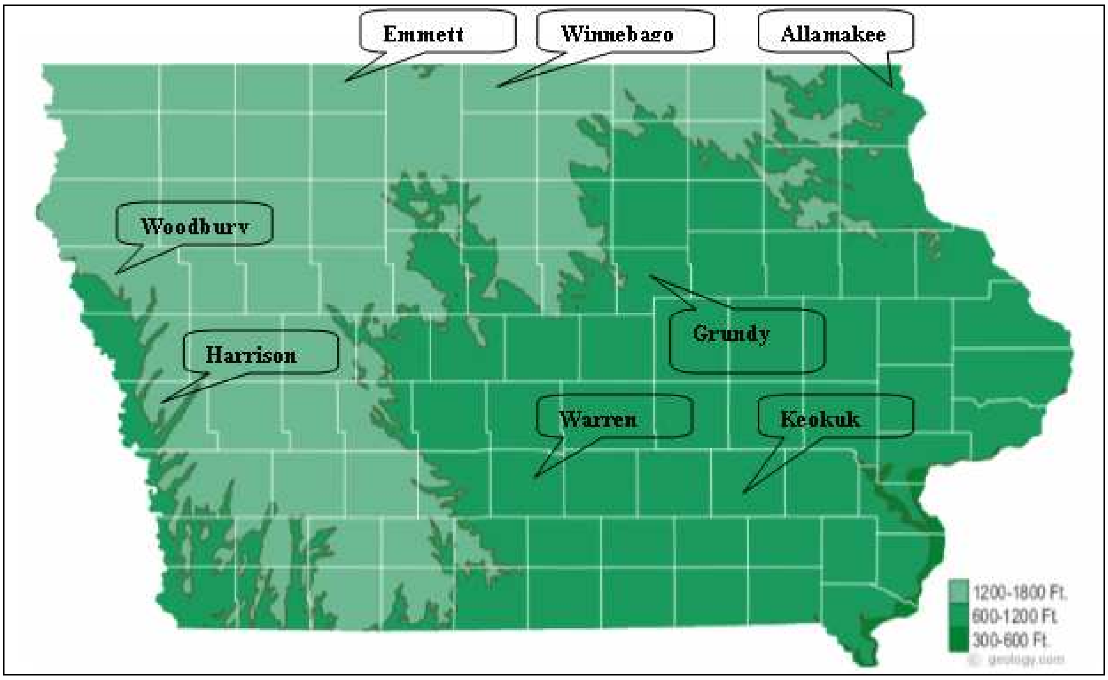
A survey entitled '*Agriculture Land Ownership and Conservation Practices in Iowa'* was conducted by mail in January 2006 [Iowa State University Extension (2006) APPENDIX A]. The survey questionnaire was prepared by Professor Michael Duffy and was processed in the Department of Economics, Iowa State University.

IV.2.a Sample selection

The sample for this study was selected by placing Iowa's 99 counties into a hierarchical sampling scheme. The steps for creating this study's sample were as follows: First, county assessors' websites were searched, where it was determined that 71 out of the 99 counties had owner information available online. Of these counties, eight had complete records (addresses), and were thus selected for this study.

The eight selected counties are Allamakee, Emmet, Grundy, Harrison, Keokuk, Warren, Woodbury and Winnebago. They are geographically distributed in six of Iowa's nine crop-reporting districts.[7] They are also distributed across Iowa, and differ by altitude.

Figure 4.1 The selected counties for the survey[8]



Each county is divided into a number of townships, and each township is further divided into sections. The selected counties varied in number of townships, sections and parcels. One section was randomly selected in each township in each of the eight counties. All the land parcels in these selected sections were included. Overall, the survey covered 112 out of 133 townships in the selected eight counties.

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[7] Emmet County is in the Northwest district; Winnebago County is in the North Central district; Allamakee is in the Northeast district; Harrison and Woodbury counties are in the West Central district; Grundy County is in the Central district; Keokuk County is in the Southeast district; Warren County is in the South Central district.

[8] Source: géologie web site : http://geology.com/state-map/iowa.shtml.

There are three reasons for not including all 133 townships in the survey: (1) some of the sections contained cities, (2) some of the sections had a preponderance of government-owned land and (3) some of the parcels in the chosen sections did not have sufficient information to contact land owners.

The survey covered 87,505 acres in the selected counties, which accounts for approximately three percent of these counties' farm land. More specifically, the survey covered farm land ranging between two and five percent of the total land in each county. Table 4.1 shows the total acreage of each county, and the percentage of each county's total farm land covered by this survey. The number of parcels varied between three and eight per section. The parcel size varied between 3 and 1,800 acres. The survey was sent out to a total of 698 parcels; 311 of them were returned, resulting in a 45 percent response rate (Table 4.2).

Table 4.1 Total acreage surveyed in each county

County	Total number of townships in the county	Total number of surveyed townships	Total county acreage	Total acreage surveyed in each county	Percent of the total county surveyed
Allamakee	18	14	327,700	10,414	3
Emmet	12	10	235,100	6,115	3
Grundy	14	10	323,500	6,372	2
Harrison	20	17	427,500	18,781	4
Keokuk	16	12	334,900	12,193	4
Warren	17	16	299,600	12,148	4
Winnebago	12	11	239,900	8,646	4
Woodbury	23	22	441,400	12,836	3
Total	**132**	**112**	**2,629,600**	**87,505**	**3**

In the questionnaire, respondents were asked to specify their parcel's county location to facilitate analyzing the data at the county level. Sixteen percent of respondents specified a different county—a county not included in the analysis—or failed to provide a response.

Table 4.2 Response rate, by county

County	Number of surveys sent	Number of surveys returned	Response rate (percent)	Total respondents (percent)
Allamakee	67	25	37	8
Emmet	51	21	41	7
Grundy	72	26	36	8
Harrison	132	41	31	13
Keokuk	76	29	38	9
Winnebago	65	31	48	10
Woodbury	117	46	39	15
Warren	118	41	35	13
Other counties		16		5
Not identified		35		11
Total	**698**	**311**	**45**	**99**

These eight counties are fairly representative of the state of Iowa[9]. The median age in these eight counties ranged between 36 and 43 years old, with an average age of 40 years old. This is very close to the state average of 38 years. The percentage of people 65years of age or older ranged between 11 and 19 and averaged 16 percent. This compares to the state average

[9] All the data is from the Iowa State University/Economics Department/ Regional Economics and Communities Analysis program http://www.recap.iastate.edu/atlas/table-index.html

of 14 percent. From an economic perspective, the per capita personal income varied among these counties from $27,000 to $33,000. The average per capita personal income in these eight counties was $30,000, which is lower than the state average of $33,000. Among these counties, only Grundy County has the same state level of per capita income.

These counties have education levels similar to the state. The total percentage of people with a high school degree or higher among the population 25 years and older varied in these counties between 12 to 21 percent. The average percentage of people with a high school degree or higher among the 25 years and older population in these counties was 19 percent, which is similar to the state level 21 percent.

Finally, the farms in this study ranged from 266 to 447 acres with an average farm size (352 acres) for the selected counties. This was higher than the state average of 331 acres.

The selected counties are similar to the rest of the state in most ways. They do tend to have slightly higher farm size and lower per capita income. But, in general, they can be considered representative of the state as a whole. A complete description and discussion of the selected counties can be found in Appendix C.

IV.2.b Survey instrument

The survey questionnaire contained three parts (see Appendix A). The first part dealt with economic and behavioral characteristics of land owners. The questionnaire inquired into the size of agricultural land owned, land location, and the method of acquiring the land. In addition, the questionnaire investigated the type of ownership (such as sole proprietor, joint, trustee ownership, partnership, life estate, unsettled estate, corporation LLC, LLP and limited partnership) (see Appendix B).

The second part of the survey focused on the use of conservation practices, such as tillage, installing terraces, drainage tiles, grassed water ways and seeded downstream banks, the presence of one or more conservation programs and land owners' knowledge of cost-share conservation programs. The second part examined the effect of land ownership/tenancy type on the use of conservation practices, such as the type of practice, the type of information that farmers have about conservation practices and whether being an absentee owner or an owner-operator (type of tenancy) affects the use of conservation practices. This section was crucial, since it collected information on the various types of conservation practices used in the survey area.

The third part of the survey focused on the demographic details of land owners, which can potentially affect farming and land conservation decisions—such as age, gender, education and location of residence. The details collected in the first and third sections enable to control for behavior and economic and personal characteristics of the farmers, while studying their adoption behavior of conservation practices.

IV.3 Background Information about the Survey Area

All eight counties experienced a decrease in total farm land and number of farms during 1982–2007. This decrease contributed to an increase in farm size in almost all counties under study.

Corn and soybeans were the major traditional crops in all these counties. The other crops, such as oat, alfalfa, sorghum and wheat, were grown in a much smaller area compared to the corn and soybeans acreage.

Population decreased steadily in all counties between 1982 and 2007, except in Warren and Woodbury counties. The outward migration might have affected the farms, since the average farm operator age increased during that time—possibly due to younger family members taking non-farm career.[10] The decrease in population could have directly impacted farm size, age of land owners and the mix of older and younger farmers in the survey area.

Topographically, the eight counties surveyed were situated in important geographical locations of Iowa. The counties were located in six of the Major Land Resource Regions (MLRA) in Iowa, and have steep, hilly, rolling plains beside flat areas, which can potentially experience soil erosion due to climate conditions like heavy rain (NRCS, see Appendix C).[11]

Conservation programs in the survey area

All of the eight selected counties have land areas enrolled in the Conservation Reserve Program (CRP), Conservation Technical Assistance (CTA), CTA-Grazing Land Conservation and Environment Quality Program, but the area under each of these programs varied among these counties. For example, CRP land ranged between 1 percent (Allamakee) and 15 percent (Keokuk) of total farm land area.

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[10] All statistical figures here are from U.S. Department of Agriculture (n.d.), National Agriculture Statistical Service, DATA, Last accessed November 26, 2007.

[11] All topography comes from the USDA. (USDA A, USDA G, USDA H).

The common conservation practices used are contour farming, filter strip, grassed waterways, strip cropping contour, surface drainage, field ditch, terrace, and water and sediment control basin. Table 4.3 shows some of the common conservation practices used in Iowa in 1997[12] (NRI-NRCS).

Inexpensive conservation practices

Although 85 to 99 percent of farm land was under cultivation in these eight counties, the conservation practices adopted appeared in only a fraction of this land. Contour farming was found to be more prevalent than any other practice—probably due to its low cost ($6/acre) (see Table 2.1). Contour farming was adopted in about one-third of farm land in six out of the eight counties (Table 4.3). Another common on–field conservation practice was grassed water ways, which were found in 27 percent of the farm land under cultivation. Grassed water ways are also relatively inexpensive, at $48/acre (see Table 2.1). Other practices, such as strip cropping, filter strips and sediment control basins are found only in select counties of the survey area. These practices may not have been widely adopted due to a general lack of substantial benefits, or even the characteristics/unawareness of the land owners (For more information about these counties, see Appendix C).

Expensive conservation practices

Another important conservation practice widely found in survey area (during 1997) was terracing. Terracing is expensive at $383/acre or more (see Table 2.1). The farm land in Woodbury and Harrison counties, located in the hilly western areas, are prone to soil erosion;

[12] NRCS publishes state summary NRI data only after 1997. For a county analysis like this, the detailed information is available only for the year 1997.

hence, terracing might be necessary to reduce erosion in those two counties. Table 4.3 shows indeed that these counties have 21 and 15 percent, respectively, of their farm land with terraces—which is significantly higher than the other counties. Emmet and Winnebago counties, which are also located at higher elevations, lack data on terraced agriculture, making comparisons incomplete. Since the exact topography of the fields is not known, it is not known whether terracing was necessary in other surveyed counties. The only other expensive conservation practice considered in the survey was the installation of drainage tiles.

Conservation drainage is used for several reasons: to maximize the benefits from retaining the groundwater reservoir for crops in dry seasons; to provide sufficient aeration for deep crop roots to minimize the problem of water pollution due to sedimentation and fertilizers, to reduce the negative impact on soil of the amount and the velocity of water movement in the edge areas and to reduce the loss of nutrients. Ultimately, conservation drainage can help improve water quality in rivers and lakes by expanding the use of conservation drainage [Minnesota Agriculture Department, 2008]. Drainage tiling is considered as an investment, due to its high cost of installation. The cost of commercially installed drainage tile can range from $250 to $500 per acre, and it varies based on the tile spacing and design [Fore, Z. (n.d.)]. However, most land owners are willing to install these conservation tiles, first, to improve the yield in poorly drained area; second, to improve field conditions to define the right time for tillage, planting and harvesting. A recent survey conducted by the USDA for drained land showed that 30 percent of the land in the upper

Midwest (Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin) was drained by using drainage tiles in 1985. [Lowell, B. and G. Sands (2002)].

Table 4.3 Common conservation practices area in the eight surveyed counties in Iowa in 1997 as a proportion of the total farm land

Counties	Inexpensive practices		Expensive practices	Conservation tillage		Conservation program
	Contour farming	Grassed waterways or outlets	Terrace	No tillage	Reduced tillage	CRP
Allamakee	32	27	6	11.35	7.87	0
Emmet		2		47.21	31.24	0
Grundy	4	10	3	61.74	20.59	0.29
Harrison	39		15	43.46	11.66	2.57
Keokuk	6	9	2	25.39	12.22	15.34
Warren	9		6	24.88	9.51	8.18
Winnebago				49.19	23.24	6.27
Woodbury	38	2	21	48.89	21.37	8.94

Source: (NRI-NRCS) 1997 Natural Resources Inventory data 1997.

IV.4 Description of Survey Data

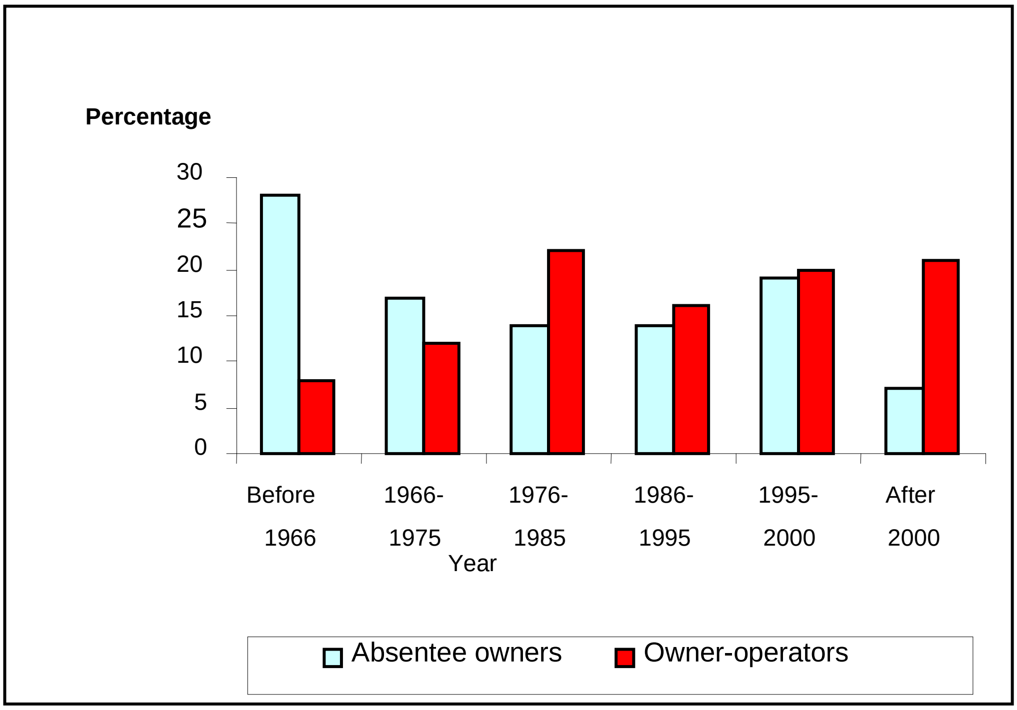
The questionnaire surveyed 87,505 acres of land (Table 4.1). After eliminating the incomplete observations, data pertaining to 85,853 acres (98.1 percent) were used in the empirical estimations. Almost two-thirds of this land was held by an AO (64 percent, or 54,692 acres), and the remaining one-third was cultivated by an OO (36 percent, or 31,161acres). The total agricultural acreage of a county’s land under AOs varied widely, from 49 percent in some counties to as much as 90 percent in others. Table 4.4 charts the distribution of land between AOs and OOs among the surveyed landowners by county.

Table 4.4 Land owned by absentee owners and owner operators, by county

County	Proportion of land (percent)	
	Land under AO	**Land under OO**
Allamakee	49	51
Emmett	56	44
Grundy	85	15
Harrison	69	31
Keokuk	67	33
Winnebago	90	10
Woodbury	60	40
Warren	49	51

About 60 percent of agricultural land owned by absentee owners was bought before 1985 (see Figure 4.2). The high proportion of absentee owners is probably due to the older age of land owners. Hence, age is likely to be a major factor in this study analysis, explaining the differences between owner operators and absentee owners. As mentioned in Chapter II, attitudes toward conservation could differ among younger land owners (who are likely to be owner operators) from older land owners (who are likely to be absentee owners); this is one of the hypotheses of interest in this study. According to the data, owner operators owned their farm for a shorter time relative to absentee owners, who are, based on information in Table 4.6, elderly, with a higher percentage being females, having less education, being non-farm residents, and who might have bought or inherited their land recently. Table 4.9 summarizes the demographic and behavioral differences between owner operators and absentee owners (see Section IV.6.c).

Figure 4.2 Time of land acquisition among land owners



Survey data was analyzed as if it were obtained from a simple random sample of land owners in the eight counties, although a hierarchical sampling scheme was actually used. To maintain confidentiality of the respondents and to encourage their response, the returned survey forms did not contain any information that could identify either the respondent or the section or township. Consequently, adjustments for the hierarchical sampling scheme could not be made. The exclusion of such adjustments should not unduly distort the significance of test results, since sampling from every township in a county produces less variable results than a simple random sample of land owners in the county. Therefore, any increase in variability resulting from selecting just one section from each township is negligible.

IV.5 Data Definition, Measurement and Descriptive Statistics

To conduct the empirical model discussed in Chapter III, the required data were chosen based on the literature and the scope of this study.

IV.5.a Explanatory variables (expected impacts)

These data are organized under three separate groups for simplicity. Each group of data is included for the following reasons:

IV.5.a.i Demographic factors

Previous studies [Rahm, M.R. and Huffman, W.E. (1984), Norris, P.E. and Batie, S.S. (1987)] have considered the demographic details of farmers: age, farm/residence proximity, education and gender. These demographic factors are used as proxy for possible differences in attitudes among farmers regarding technology adoption.

Age (q_1)

The impact of age on decisions to adopt conservation practices has not been uniform. Different studies have reported different results, based on location and type of farming activity. However, evidence from studies such as Onianwa, O. et al. (1999) has suggested that younger land owners are more receptive to a broad range of conservation practices. Other studies [Nowak, P.J. and Korshing, P.F. (1981)] have differentiated the age impact, based on types of conservation practices. Some studies have found that older farmers are more likely to adopt conservation tillage techniques [Hoover, H. and Witala, M. (1980), Lasley, P. and Nolan, M. (1981)], grassed waterways and strip-cropping [Nowak, P.J. and Korshing, P.F. (1981)]. Hence, the influence of age when land owners adopt conservation practices is mixed [also see Cary, et al. (2002), Curtis and Byron (2002), Latta, J. (2002)].

Measurement: Duffy, M. and Smith, D. (2007) classified land owners into three categories: 'early stage' (q_1) (less than 34 years), 'mid stage' (q_{1a}) (34–65 years) and 'late stage' (q_{1b}) (more than 65 years). The survey used here is very similar to Duffy and Smith's data, and therefore follows the same method of measurement.

Age is an ordinal-level variable with values of 1 (<35 years old), 2 (35-64 years old), and 3 (65+ years old). These values were used when calculating the tau-b measures of association discussed in this chapter. However, within the logit regression models in Chapter V this variable will be represented by a set of 2 dummy variables: q1a (1 if 35-64 years old, 0 otherwise) and q1b (1 if 65+ years old, 0 otherwise). This leaves "younger than 35 years old" as the baseline category for the age variable.

Gender (q_2)

Very few studies have examined the role of women regarding adoption of conservation practices. So, their role has generally remained unclear. Since female owners comprised 28 percent of the respondents in this survey, identifying the role of gender in conservation practice adoption here is necessary. It is important to note that even though a female might own a piece of land, it still could often be managed by or rented out to male tenants—a fact which shows the difficulty of ascertaining the role of gender.

Measurement: the variable is relatively easy to code. Female land owners were coded as 1, and male land owners were coded as 0.

Education (q_3)

Land owner education level is considered as a proxy to their ability to collect and process information about new conservation technologies effectively. Theoretically, the education level reflects the quality and extent of human capital. It would be expected that more education would correlate with a more positive impact on adopting new (cost saving, profit enhancing) conservation technology. However, there is slight counter-evidence to this claim, which can be attributed to the combined impacts of education and experience in farming [Marsh, et al. (2000)].

Measurement: The responses to the question 'what is your education level?' were coded into 3 categories: 'high school and below,' q_3 'post high school –two years degree' q_{3a} and 'bachelor's degree and higher' q_{3b}. The extremes—less and highly educated land owners—in education level were differentiated from the most common-post high school degree. Similar to 'Age' factor, Education is an ordinal-level variable with values of 1 (high school and below), 2 (post high school-two year), and 3 (bachelor's degree and higher). These values were used when calculating the tau-b measures of association discussed in this chapter. However, within the logit regression models in Chapter V this variable will be represented by a set of 2 dummy variables: q_{3a}=1 (post high school degree, 0 otherwise) and q_{3b} (1 if bachelor degree and higher, 0 otherwise). High school and below in this case would be base category for the education variable.

IV.5.a.ii Economic Factors

Land held free of debt (q_4)

Owners with a high level of debt on their land would be more concerned about the costs of conservation practices. If they adopt any, they might adopt only inexpensive conservation practices, since the financial burden would be lower. Higher amounts of debt have been found to negatively impact farming [Clearfield, F. and Osgood, B.T. (1986)]. Hence, we could expect a negative impact, due to higher levels of land owner debt. So, the expectation about landowner behavior due to debt is mixed, depending on both the level of debt and the cost associated with adopting conservation technology.

Measurement: The variable was coded to differentiate between being free of debt (q_4=1) and being in some kind of debt (q_4=0), due to borrowing money either by using mortgage or a contract to purchase their land.

Income or investment reason to own the land (q_5)

Vanclay (2004, p. 214) has stated that priorities, understanding problems inherent to conservation and value systems (economic versus non-economic) vary among land owners. The current study is one of the first that aims to identify the economic and non-economic reasons for owning and conserving land in Iowa: the reason for owning land can potentially impact decisions to adopt conservation technology [Pannell, D.J. et al. (2006)]. Pannell further found that even land owners who do not emphasize monetary returns from their land may not adopt conservation practices if those practices were to cause an economic loss—hence, the economics (cost-effectiveness) of conservation practices becomes more fundamental. This reasoning also shows that farm land owners whose primary objective is to earn money from agriculture might do well to adopt conservation practices if the adoption of conservation practices increases farm productivity and profitability.

Measurement: the measurement of this variable closely followed the study of Duffy and Smith, (2007). Reasons for owning land have been coded as follow: 'income or investment reason to own the land' (q_5=1), and land owners who own land for other reasons, such as family values and sentimental attachment to land as 'family sentimental' (q_5=0).

Owned agricultural acres: Acreage (q_6)

Farm size and the use of conservation practices in some of the studies showed positive impact on the adoption of conservation practices [Nowak, P.J. and Korsching, P.F. (1981), Abd-Ella, et al. (1981), Carlson, J.E., et al. (1981), Coughenour, C.M. and Kothari, K.B. (1962), Ervin, C.A. and Ervin, D.E. (1982) and Pampel, F. and van Es, J.C. (1977)]. Bigger farms grossed higher incomes, enabling the implementation of conservation practices. The economies of scale have also been cited as a reason for the bigger farms to adopt conservation practices [Abadi Ghadim, et al. (2005)]. However, there has been ambiguity in the effect of an increase in farm size on the likelihood of adoption practices. The ambiguity comes from: (1) unlike large farms, where the cost is low due to the economies of size and technology advancement, small farms will be limited in adopting new technologies, due to information costs and large transaction costs which is relatively expensive compared to big farm that can afford it due to its bigger return; and (2) small farms may be limited by the expensive practices, since their turnover is not high; if technology is adopted (but results in failure), losses would be small when compared to large farms [Just, R., et al. (1980)]. Also, bigger farms may not have time to adopt a conservation measure if it takes more labor or time in the field.

Measurement: owned agricultural acres ***(***Acreage) is classified into four categories in accordance with the same classification that the 2007 USDA-ERS census used: (1) farms with fewer than 100 owned agricultural acres (q_6), (2) owned agricultural acres between 101 and 500 acres (q_{6a}); (3) owned agricultural acres between 501 and 1,000 acres (q_{6b}); (4) owned agricultural acres with more than 1,000 acres (q_{6c}). Survey data showed that 19 percent of the respondents' owned 100 acres or less, 59 percent between 101 and 500 acres, 16 percent between 501 and 1,000 acres, and only 6 percent owned over 1,000 acres. Most of the land owners' acres ranged between 100 and 1,000 acres. As previously mentioned with the 'Age' and 'Education', variables, the acreage variable is an ordinal-level variable with a value of 1 (acreage fewer than 100), 2(acreage 101-500), 3 (acreage 501-1000) and 4 (acreage more than 1000 acres). These values were used when calculating the tau-b measure of association. However, within the logit regression models in Chapter V, this variable will be represented by a set of three dummy variables: q_{6a}=1(acreage owned between 101 and 500, 0 otherwise), q_{6b}=1(acreage owned between 500 and 1000, 0 otherwise), q_{6c}=1(acreage with variable. more than 1,000, 0 otherwise). Acreage less than 100, q_6 would be base category for acreage

IV.5.a.iii Land ownership factors

Type of ownership (owner operators or absentee owners) Z

A few studies concluded that owner operators used more conservation practices than absentee owners [Abd-Ella, M.M, et al. (1981), Carlson, J.C., et al. (1981)]. But this pattern is not universal. As mentioned in the literature review, some practices, such as conservation tillage, were adopted more often by tenants than owners. Hence, the results differentiate between who owns and who operates the land can be mixed, with regard to adoption of conservation practices—especially since there is not much reference in the literature to absentee owners. The expected impacts of the type of ownership on the adoption of conservation practices and programs, as well as other factors, are given in Table 4.5.

Measurement: to identify the difference between owner-operators and absentee owners, data were divided into two major categories, based on the following survey question: ‘Do you farm this property yourself?’ The respondents who answered ‘yes’ (34 percent) were defined as owner operators (Z=1); those who answered ‘no’ (66 percent) were considered to be absentee owners (Z=0). Five percent of survey responses were not included in this study, since they did not answer the question.

Farm/residence proximity (q_8)

Literature shows that physical proximity to other adopters, and the distance of the property from an information source, have a positive impact on adoption of conservation practices [Hagerstrand, T. (1967), Ruttan, V.W. (1996) and D’Emden, F.H., et al. (2006)].

Measurement: In this study, proximity is measured by the closeness of the location of land owners’ residency to the farm land. The assumption is that proximity affects adoption attitudes: if land owners reside close to farm land, then they are more likely to be aware of the condition of the land, which will likely spur them into action to conserve, if need be. This factor coded as follow: landowners live in: farm or rural area (q_8), town (q_{8b}), and in a city (q_{8c}).

Farm/residence proximity is ordinal-level variable. To use tau-b measure of association in this chapter, the following order will be considered: Landowners ‘live in a farm or rural area’ (1), ‘in nearby town’ (2), ‘live in a city’ (3). In Chapter V this variable, however, will be represented by 2 dummy variables as follow: q_{8a} =1(landowners live in a nearby town, 0 otherwise), q_{8b} =1(land owners live in a city, 0 otherwise), which leaves land owners who live on a farm or a rural area as the base group for the farm/residence proximity variable.

Structure of ownership (q_9)

The extent of family participation in farming and land management decisions depends on the method of owning the land such as spousal partnership, collective ownership within family, and so on. Some studies have shown a statistically significant impact of these methods of owning the land on adoption of conservation practices. If there is a common future plan and aspiration among family members, the use of conservation practices were more likely to be adopted [Abd-Ella, M.M., et al. (1981), Carlson, J.E. and Dillman, D.A. (1983)]. Especially, land managed by married couples was found to be conserved better [Abd-Ella, M.M. et al. (1981)]. Hence, joint management can promote adoption of conservation technology adoption.

Measurement: Survey data found 31 percent of respondents as sole owner (q_9); 38 percent are joint owners (husband and wife) (q_{9a}), and 31 percent hold the land under different titles (Tenancy in Common, Partnership (Legal), Life Estate, Unsettled Estate, Trust, Corporation, LLC, LLP, Limited Partnership**)** (q_{9b}),. These later categories were not frequently reported, so the data regarding these categories are grouped together under 'other', including holding land in a trust. This variable is also an ordinal-level variable with a value of 1 (1) for Sole owner, (2) for spousal joint ownership, and (3) ownership under trust and others. These values were used when calculating the tau-b measure of association. However, in the logit model, this variable will be represented by 2 dummy variables in chapter V:

q_{9a}=1 (spousal joint ownership, 0 otherwise), q_{9b}=1(ownership under trust and others, 0 otherwise) which leave sole owner q_9 as base group for the structure of ownership variable.

Knowledge about cost-share programs (q_{10})

Adoption of new technology is considered by many researchers to be a learning process, with two distinct aspects [Abadi Ghadim, A.K and Pannell, D.J. (1999)]. The first step in this process is to collect and evaluate new information, provided the owner with a better understanding of the new technology [Marra, M., Pannel, D.J. and Abadi Ghadim, A. (2003)]. The second step is fostering the ability and skills of land owners to use technology on their land, based on their own situation [Tsur, Y., Stemberg, M. and Hochman, E. (1990) Abadi Ghadim, A.K. and Pannell, D.J. (1999)]. This step needs more knowledge about how to apply these new technologies efficiently.

Land owners will reduce the uncertainty about the outcome of the new technology when they accumulate enough knowledge, increase the probability to adopt and improve the quality of their decision [Pannell, D.J., et.al. (2006)]. So, information is important, and is expected to have a positive impact on decisions to adopt new technologies. Land owner knowledge of government cost share programs proved to have a positive association with education [Ervin, C.A. and Ervin, D.E. (1982), Taylor, D.L. and Miller, W.L. (1978)]. More broadly, however, there is little research on the direct impact of knowledge about these programs on adoption of conservation technology; thus, owners' adoption practices in this case are unknown. In this study, land owners who know about cost-share programs are coded (q_{10}=1), and those who do not are coded (q_{10}=0).

Future plan: Plan to bequeath, will or give the land to family (F)

Future plans and intentions for using land seem to have a crucial impact on adoption of conservation practices. Older land owners who intend to bequeath their land to family members, and who do not highly emphasize the monetary aspect (costs and returns) of conservation practices, were found to be more likely to adopt conservation practices [Gasson, R. and Errington, A. (1993)]. The main reason for this attitude could be that such land owners value the non-economic value of conservation more than its costs. In addition, land owners who plan to sell their land might not be interested in holding the land for economic or personal reasons—hence, their attitudes toward adopting conservation practices also change. Also, landowners whose intention is not to retain land under farming are less likely to adopt conservation technologies.

Measurement: Existing literature suggests that owners whose intention to keep land for their family members after them are more likely to adopt conservation practices. Survey data on future plans was grouped into two categories: ‘plans to bequeath, will or give the land to family or other, (F=1), and owners who intend to ‘sell the land’ (F=0).

The expected effects based on the literature of these explanatory variables are listed in Table 4.5.

Table 4.5 Expected signs based on previous studies for the estimated regression coefficients for the explanatory variables

Variable	Expected sign
Demographic factors	
Age (q_1)	-/+
Gender (q_2)	-/+
Education (q_3)	+
Economic factors	
Land held free of debt(q_4)	+
Income or investment reasons to own the land	-/+
Acreage (q_6)	-/+
Land ownership factors	
Type of ownership(OO 'Z=1') vs. AO 'Z=0')	-/+
Farm/residence proximity	-/+
Structure of ownership	-/+
Knowledge about cost share program (q_{10})	+
Plans to bequeath, will or give the land to	+

IV.5.b Description and measurement of the dependent variables

This study used five dependent variables to analyze thoroughly the adoption behavior of conservation practices and programs.

IV.5.b.i Adopting conservation practices or program: Adopt at least one or more CP

To measure the willingness of land owners to adopt conservation practices, the variable 'Adopting conservation practices or program' has been created, indicating whether land owners have adopted or used at least one or more conservation practices, or possessed land under a conservation program. This variable aggregates all responses, including adoption of terraces, drainage tiles, grassed waterways, seeded downstream banks, conservation tillage and conservation programs. It is coded as, "1", if land owners have conducted at least one or more practices and, "0", if not.

IV.5.b.ii Adopting expensive conservation practices

The cost and benefits derived from conservation practices are diverse. Since economic variability (costs and benefits) was found to play a key role in adoption decisions, differentiating these conservation practices by costs could yield additional insight. The two high-cost conservation practices in Iowa are conservation drainage and terraces. Conservation drainage serves as a method to remove excess water from the tile, and reduce the nitrate load and other pollutants carried to adjacent water bodies [Minnesota Department of Agriculture, Conservation Practices][13]. Terraces serve to stop or slow soil erosion and rapid surface run off in hilly cultivated areas. The installation of these two practices costs between $350–400 per acre and their benefits are derived over the long-term, extending into decades. Hence, they can be classified under 'expensive—long-term' practices. Thus, this study aggregates responses for adopting terraces and drainage tiles into a code of "1" if such technologies are adopted, "0" if not.

IV.5.b.iii Adopting inexpensive conservation practices

Land owners would obviously treat expensive conservation practices differently from that of others such as grassed waterways and seeded downstream banks. The latter set is grouped as 'inexpensive—short-term' conservation practices, which usually range in cost from $50–100 per acre, with benefits lasting over a few years.

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[13] More information about conservation drainage found on the Minnesota website.

http://www.mda.state.mn.us/protecting/conservation/practices/consdrainage.htm

IV.5.b.iv Adopting conservation tillage

Although a type of conservation practice, conservation tillage differs from others in that it is usually less expensive than others, and enables some cost-saving for land owners. Other conservation practices, whether expensive or inexpensive, incur additional costs. Hence, the adoption of conservation tillage is considered separately from other practices**.**

IV.5.b.v Have land enrolled in a conservation program

Although having land enrolled in conservation program is not solely dependent on a land owner's willingness to set aside part of his or her land, environmental circumstances, such as the level of soil erosion, are important determinants. However, with the high market incentives—that is, high level of commodity prices—land owners may keep their land under production, even though it is highly eroded. Thus, participation in conservation programs reflects land owner awareness not only of environmental problems, but also the impact of monetary incentives to remove the land from production.

IV.6 Descriptive Statistics

The Kendall's tau-b test is used to measure and explore the relationship among explanatory variables. It measures the strength of association of cross-tabulated data, and is often, but not limited to 2-by-2 tables. Few variables in the data set used in this study are not binary—most fit neatly into binary terms. Kendall's Tau-b was used as a measure of association that can work with all data, and is not limited to 2x2 tables.

Tau-b is computed "*as the excess of concordant over discordant pairs (C-D), divided by a term representing the geometric mean between the number of pairs not tied on* $X(X_0)$ *and the number not tied on* $Y (Y_{0+})$*; tau-b =* $(C-D) / SQRT[((C + D + Y_0)(C + D + X_0))]$". Where C is the number of concordant pairs; D is the number of discordant pairs, Tx denoted the number of pairs tied on X Ty denoted the number of pairs tied on Y, so,[C+D+Yo]=[n(n-1)/2-Ty] and [C+D+X0]= [n(n-1)/2-Tx] where is n is number of observation.[14] [Agresti.Alan and Finlay.B (1986) p:220-230]

IV.6.a Measure of association of the independent variables by type of Ownership (AO or OO)

The Tau-b values range from -1 (100% negative association) to +1 (100% positive association). A value of zero indicates the absence of association. The level of association is measured as follows: less than 0.2 = a weak relationship, 0.21 to 0.49 = a moderate relationship, > 0.5 and above = a strong relationship [Acock, A.C. (2008) p.122]. Table 4.6 displays the tau-b test to measure the significance of demographic and behavioral differences between AOs and OOs.

The relationship between AOs or OOs with age is moderate to strong, and it is statistically significant[15] (tau-b=-0.45). A negative sign indicates the inverse association between land ownership type and age. In other words, AOs tend to be older than OOs. The same association applies for gender. Female AOs outnumber female OOs (tau-b=-0.31). The association is moderate between gender and being an OO or AO. Regarding location, absentee owners tend to live in places far from their farm, in towns or cities, compared to OOs (tau-b=-0.37). The association is moderate, but statistically significant at the 5 percent

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[14] For more information see the book of Statistical Methods for the Social Sciences

[15] Note: $Z = est / ASE$ where est=tau-b, and ASE is asymptotic standard error of the estimate. If the estimated Z is greater than the statistic Z at 5 percent significant level (1.96) then the association is statistically significant at 5 percent significant level.
Estimation in bold are significant at 2 tailed test at 5 percent significant level.

level. Type of ownership-the relationship between being AO or OO and acquiring information regarding cost share programs is moderate (tau-b= 0.22), and statistically significant. Owner operators (OOs) tend to know more about these programs than do AOs.

A significant level of association exists between OOs and AOs regarding their debt level. The negative tau-b (-0.29) indicates that AOs tend to own their land free of debt more than OOs. Although the association is not significant and is weak, both OOs and AOs plan to give or bequeath their land to a family member.

In conclusion, OOs and AOs are statistically different in their age, gender, place of residency, method of owning the land, their knowledge level about cost-share programs, and the level of debt. Expanding this method to verify the association level among these variable, e.g. the association between age and place or residency and so on is interesting to understand the land owners' characteristics and it is discussed in the next section.

Table 4.6 Percentage of land owner characteristic between absentee owners and owner operators—with tau-b test results

	Absentee owners (AO)	Owner operators (OO)	Differences	Tau-b
Demographic factors				
Age : <35 =1	2	5	-3	-0.45(0.056)***
35-64=2	27	75	-48	
>64=3	71	20	51	
Gender: Male =0	62	91	-29	-0.31(0.05)***
Female=1	38	9	29	
Education : High school and less=1	45	42	3	-0.09(0.06)
Post high school=2	34	22	12	
Bachelor degree and higher=3	22	37	-15	
Economic factors				
Land held free of debt: Fully paid =1	86	60	26	-0.29(0.07)***
Use contract or mortgage =2	14	40	-26	
Income or investment reason to own the land=1	59	66	-7	-0.07(0.06)
Family sentimental=2	41	34	7	
Acreage<100 acres=1	17	23	-6	-0.01(0.06)
101-500 acres=2	63	50	-13	
501- 1000 acres=3	13	23	-10	
>1000acres=4	7	5	2	
Land ownership factors				
Farm/residence proximity: Farm or rural area =1	52	90	-38	-0.37(0.04)***
Town=2	33	10	23	
City =3	15	0	15	
Structure of ownership: Sole ownership =1	29	34	-5	-0.13(0.06)***
Spousal joint ownership =2	34	46	-12	
Ownership under land trust, other =3	37	20	17	
Know about the cost share program	60	81	-21	0.22(0.06)***
Plan or bequeath the land to family or other=1	74	81	-7	0.08(0.06)

Note: ASE (asymptotic standard error of the estimate) is reported in the parenthesis along with the Tau-b estimate.

IV.6.b Measure of association among the independent variables

The level of association among independent variables ranged from weak to moderate (Table 4.7). Age is associated negatively with education. The level of association is moderate, meaning that young land owners show a high level of education (tau-b = -0.31), while older land owners show low levels of education.

This has an implication on the place of residency. Land owners who have attained high levels of education tend to live in towns or cities. The association, though, is fairly weak, where tau-b is 0.18, but it is statistically significant at the 5 percent level. Elderly land owners tend to live in the city; while the association is not strong between place of residence and age, it is statistically significant (tau-b = 0.21).

The other significant association shown in Table 4.7 is between age and the level of debt that land owners have incurred to purchase land. More elderly land owners own the land mostly free of debt – paid fully for purchasing the land (tau-b = 0.40) compared to young land owners who used mortgage or contract to finance their purchase.

Sole land owners own agricultural acres of greater size (tau-b =- 0.2) than joint owners, such as husbands and wives or any other methods of owning the land. Owners with a higher number of owned acres tend also to know more than other owners about cost share programs, the association is positive and statistically significant (tau-b = 0.34) between large owned agricultural acres and knowledge about such programs.

Size of owned agricultural land also varies among land owners based on their reasons for holding land. Land owners who use their land to generate income mostly have small-sized farms (tau-b = -0.17). This association is weak, but statistically significant. Although the association is weak but significant, older land owners tend to have larger owned agricultural land than young land owners (tau-b=0.12) may be through either accumulation of land or wealth over time.

In conclusion, the data shows levels of association among the independent variables ranks between weak and moderate. This suggests that there is no serious problem with multicolinearity in the data. However, while multicolinearity does not cause bias, its existence can cause the estimated coefficient to be less significant even with high model goodness of fit. Thus, when the variables' importance demands they be included, econometricians usually trade-off between significance and the importance of including these variables i.e. if the variable is highly associated with another, then there is a level of multicolinearity but since the variable is essential and it is an important factor then the econometrician will keep the variable resulting in lower significance than would be the case of taking the variable out of the model.

The relationships among the dependent variables will help to explain the difference in the decision processes regarding adopting conservation practices among land owners, in general, and between owner operators and absentee owners, in particular. Dummy variables will be created for the ordinal variables for the following reasons: in order to capture specific impact of each category of these variables. For example, age was classified into three categories to capture the impact of early vs. mid. vs. old age owners, if the age used as continuous variable then we would just be able to compare the impact of the increase or decrease in age. Second, encoding the independent variables as dummy variables in logistic regression model facilitates the interpretation and calculation of odds ratios and increases the significance of the estimated coefficient [Garavaglia, Susan and A. Sharma (n.d.)].

Table 4.7 Measure of association among the independent variables: tau-b(upper right) and Z (lower left) statistics

Z \ tau-b	Age	Gender	Education	Land free of debt	Income or Investment reason to own the land	Acreage	Farm/ residence proximity	Structure of ownership	Knowledge of cost share programs	Plans to bequeath, will or give the land to family or other
Age	1	**0.22**	**-0.31**	**0. 40**	0.11	**0.12**	**0.21**	-0.01	0.05	-0.05
Gender	3.73	1	0.07	-0.21	0.02	-0.014	0.18	-0.07	-0.14	-0.04
Education	-5.38	1.18	1	0.07	-0.02	-0.08	**0.18**	0.1	-0.08	-0.01
Land free of debt	7.23	-0.41	1.07	1	-0.09	-0. 06	**-0.12**	0.09	-0.02	-0.01
Income or Investment reason to own the land	1.75	0.28	-0.25	-1.61	1	-0.17	0.03	-0.01	-0.16	-0.05
Acreage	1.99	-0.22	-1.3	-0.97	-3.56	1	-0.07	**-0.2**	**0.34**	0.1
Farm/residence proximity	3.61	2.74	3.09	2.18	1.54	-1.28	1	0.01	-0.12	-0.07
Extended of ownership	-0.08	-1.04	1.82	1.64	-0.13	3.4	0.16	1	0.06	0.08
Knowledge of cost share program	0.73	-2.04	-1.25	-0.37	-2.5	6.42	-0.81	0.98	1	0.04
Plans to bequeath, will or give the land to family or other	0.82	0.53	0.14	-0.15	-0.85	1.72	1	1.25	0.59	1

Note: $Z = est / ASE$ where est=tau-b, and ASE is asymptotic standard error of the estimate. If the estimated Z is greater than the statistic Z at 5 percent significant level (1.96) then the association is statistically significant at 5 percent significant level.

Estimation in bold are significant at 2 tailed test at 5 percent significant level.

IV.6.c Measure of association among the dependent variables

Unlike the independent variables, the associations among dependent variables are not statistically significant, except between “Adopting expensive CP” and “Adopting inexpensive CP” and “Having land enrolled in conservation” (Table 4.8). The tau-b measure of association is 0.35, and is significant at the 5 percent level between “Adopting expensive CP” and “Adopting inexpensive CP”. Thus, farmers who tend to adopt expensive are likely to adopt inexpensive conservation practices. The association between “have land enrolled in conservation programs” and “adopting inexpensive conservation practices” is moderate and statistically significant at the 5 percent level (tau-b=0.29). This means that adopting these conservation practices would not hinder have land enrolled in conservation programs when there is a need for being enrolled in these conservation program.

The strong association between “Adopting conservation practices or program”—adopt at least one CP—dependent variable and “Adopting expensive CP”, “Adopting Inexpensive CP” and “Having land enrolled in conservation program” is due to the nature of the “Adopting conservation practices or program—adopt at least one CP” variable as an aggregated measure. As mentioned earlier, this variable was created to measure the overall willingness of land owners to adopt conservation practices. Thus, it is expected that this “Adopt conservation practices or program—adopt at least one or more CP” variable would associated strongly with the other dependent variables.

Table 4.8 Kendall's tau-b test results as measures of association among the dependent variables

Z \ tau-b	Adopt Cp or program: Adopt at least one CP	Adopt expensive CP	Adopt inexpensive CP	Adopt conservation tillage	Having land enrolled in conservation program
Adopt Cp or program: Adopt at least one CP	1.00	**0.52**	**0.50**	0.07	**0.39**
Adopt expensive CP	10.45	1.00	**0.35**	0.06	0.08
Adopt inexpensive CP	11.15	5.78	1.00	0.002	**0.29**
Adopt Conservation tillage	1.19	0.86	0.03	1.00	-0.02
Having Land Enrolled in Conservation programs	9.8	1.26	4.8	0.31	1.00

CP: Conservation Practices; Bolded numbers are statistically significant

Finally, Table 4.9 lists all of the dependent and independent variables, with their corresponding measurements, that have been used in the regression model to define owners' behavior regarding adoption of conservation technology. Table 4.9 also displays the coding method and letter for each variable, and specifies the basic group compared in the case of non-binary variables.

Table 4.9 Definition of variables used in modeling the decision for adopting conservation technology model(s)

Variable/parameter	Definition
Dependent variables: C_1	Adopting conservation practices or program :Adopting at least one or more conservation practices (Yes = 1, No = 0)
C_2	Adopting expensive conservation practices (Yes = 1, No = 0)
C_3	Adopting inexpensive conservation practices (Yes = 1, No = 0)
C_4	Adopting conservation tillage (Yes = 1, No = 0)
C_5	Having land enrolled in conservation programs (Yes = 1, No = 0)
Demographic factors q_1	Age (early stage <34 = 1, 0 otherwise) BASE GROUP
q_{1a}	Age (mid-stage 35–64 = 1, 0 otherwise)
q_{1b}	Age (late stage >65 = 1, 0 otherwise)
q_2	Gender (female =1, male=0)
q_3	Education (High school degree or less = 1,0 otherwise) BASE GROUP
q_{3a}	Education (Post high school training and less = 1, 0 otherwise)
q_{3b}	Education (Graduate degree and higher = 1, 0 otherwise)
Economic factors q_4	Land held free of debt (free of debt =1, 0 otherwise)
q_5	Income or investment reason to own the land = 1, 0 otherwise
q_6	Owned agricultural acres (<= 100 acres = 1, 0 otherwise) BASE GROUP
q_{6a}	Owned agricultural acres(between 101–500 = 1, 0 otherwise)
q_{6b}	Owned agricultural acres (501–1,000 = 1, 0 otherwise)
q_{6c}	Owned agricultural acres (>1,000 = 1, 0 otherwise)
Land ownership factors Z	Owner operator = 1, Absentee owners = 0
q_8	Farm/residency proximity (Live on farm or in rural area = 1, 0 otherwise (BASE GROUP)
q_{8a}	Farm/residency proximity (Live in town = 1, 0 otherwise)
q_{8b}	Farm/residency proximity (Live in city = 1, 0 otherwise)
q_9	Extended of ownership (Sole ownership = 1, 0 otherwise BASE GROUP)
q_{9a}	Structure of ownership (Joint ownership =1, 0 otherwise)
q_{9b}	Structure of ownership (Others, including trust = 1, 0 otherwise)
q_{10}	Knowledge of cost-share program = 1, 0 otherwise
F	Plans to bequeath, will or give the land to family or other = 1, 0 otherwise

IV.6.d Data description for the rest of the survey questionnaire

The following discussion analysis some of the other data gathered in the questionnaire but not used in the descriptive statistics tests nor the modeling. These summaries are provided for further information regarding the differences between AO and OO.

The most common rental method used by absentee owners is the cash rent (62 percent). The crop share method accounted for 20 percent (Table 4.10). This difference might imply that absentee owners do not want to be involved in farm activities. This observation is further supported by noting that most absentee owners do not use professional farm managers, and leave management decisions entirely to the tenant.

By definition owner operators are more involved in their farm activities, and farm revenue is commonly their main source of income. However, 23 percent of them use professional farm managers to help with their decisions. An important difference between type of ownership and level of direct responsibility for farm activities emerges: absentee owners by and large leave decision making to tenants regarding different farm management practices, such as tillage systems, weed management, crop residue and crop selection (Table 4.10).

Not surprisingly, 53 percent of owner operators visit their farm daily, while 28 percent of them visit their farm infrequently: about once per week. About one-quarter of absentee owners visit their farm (23 percent) daily; similarly, one-quarter (24 percent) of them visit their farm once or twice per week.

Absentee ownership did not prevent such owners from using some type of conservation practice or enrolling in conservation programs. Sixty-seven percent of them declared that they had one form of conservation practice or another, and 38 percent had land enrolled in some

conservation program. Similarly, 80 percent of owner operators adopted some type of conservation practice, and 39 percent had land enrolled in a conservation program.
Both OOs and AOs engaged in conservation practices and some type of land improvement. Installation of terraces and drainage tiles were adopted both by owner operators and absentee owners.

Both OOs and AOs are aware of the disadvantage of full tillage on the soil and, ultimately, on crop productivity. The common tillage system used in the surveyed areas is reduced tillage; the no-till option was used mostly by absentee owners; however, a smaller percent of absentee owners (4 percent) than owner operator (9 percent) used full tillage.

In an attempt to better understand the impact of ownership on conservation, respondents were asked “If you rent additional land, are the same tillage practices followed?”. For OO who rent additional land, 87 percent said they did use the same tillage practices regardless of whether or not it was owned or rented land. The AO’s who answered the question indicated 64 percent of the land used the same tillage system.

Finally, owner operators and absentee owners tended to be slightly different in their marital status, in that the majority of owner operators (83 percent) are currently married, whereas 66 percent of absentee owners are married. For both types of owners, a small percentage of each indicated being divorced or widowed. The study also indicates that OOs are younger than AOs, and 22 percent of AOs are widowed.

Table 4.10 Percent of Absentee Owners and Owner Operators by Responses

	Absentee Owners (AO)	Owner Operators (OO)
***Method of receiving information regarding land management**		
Newspaper, radio, TV	30	43
Magazines, periodicals	30	54
USDA/Natural Resource and Conservation Service	29	51
USDA/Farm Service Agency	43	61
State of Iowa	8	11
County Extension	27	39
Farm manager	11	5
Neighbors	14	26
Tenant	46	5
Internet	6	19
Other	9	9
Preferred way to receive information regarding the property		
Direct mailing	50	45
Fact sheets	2	2
Radio/TV	3	2
Newspapers	5	2
Videos	0	0
Dealers/salespeople	1	2
Library	1	0
Internet	0	5
Other	5	5
Do not answer	25	38
Method of renting the land		
Cash	62	N/A
Crop share	20	N/A
Land is custom farmed for me	2	N/A
Other	9	N/A
No answer	6	N/A
Professional farm manager		
Use	4	2
Do not use	90	23
No answer	5	71
Who Makes the decision regarding tillage system		
Owner	15	83

Table 4.10. (Continued)

	Absentee Owners (AO)	Owner Operators (OO)
Tenant	54	3
Joint	18	3
Farm manager	3	1
More than one party	7	3
No answer	4	6
Who Make the decision regarding weed management program		
Owner	11	83
Tenant	57	3
Joint	16	3
Farm manager	3	1
More than one party	9	2
No answer	4	8
Who Make the decision regarding crop residue management		
Owner	11	79
Tenant	58	3
Joint	16	3
Farm manager	3	1
More than one party	9	2
No answer	3	12
Who Make the decision regarding crop rotation		
Owner	10	79
Tenant	59	3
Joint	16	3
Farm manager	3	1
More than one party	10	4
No answer	3	10
Who Make the decision regarding crop selection		
Owner	9	81
Tenant	62	3
Joint	14	3
Farm manager	3	1
More than one party	10	1
No answer	3	11
Number of visits to the farm		
Never	6	3
Once or twice	24	3

Table 4.10. (Continued)

	Absentee Owners (AO)	Owner Operators (OO)
Once a month	15	7
Once a week	25	28
Daily	23	53
No answer	6	6
Are there any conservation practices used (CP)		
Use any CP	67	80
Do not use any CP	13	9
No answer/Unclear answer	19	11
Land in Government Conservation Program		
Have land under conservation program	38	39
Do not have land under conservation program	48	58
No answer/Unclear answer	13	3
***Improvements to the land**		
Installed or mended fences	46	48
Installed terraces	36	25
Installed drainage tile	43	46
Removed unused buildings	50	48
Removed fences	46	64
Removed living or dead trees	55	68
Installed grass waterways	43	46
Seeded downstream banks or other sensitive areas	28	35
Other	9	14
Tillage System used		
No-till	24	16
Modified no-till	13	7
Reduced tillage	34	37
Full tillage	4	9
No answer/multiple answers	26	30
Tillage System in the rented land (as a % of people who respond to this question)		
Use the same tillage system as owned land	64	87
Use different tillage system from owned land	36	13
No answer/Unclear answer/ Did not rent additional land	62	38
Have you ever considered installing a conservation practices but did not because of the expenses?		
Yes	20	28

Table 4.10 (Continued)

	Absentee Owners (AO)	Owner Operators (OO)
No	69	61
No answer/Unclear answer	10	11
***Future Plans for the property**		
Will it to family	67	71
Will it to other	4	4
Give it to family	19	21
Give it to other	2	1
Sell it to family	22	28
Sell it to other	17	16
Put it in trust	33	30
Do something else	5	2
Marital Status		
Married	66	83
Separated	0	0
Divorced	2	7
Widowed	22	2
Single/Never been married	5	5
No answer/Unclear answer	6	3

***Note: These answers do not sum to 100 percent since the option exists to choose more than one answer , so some of the respondents chose more than one, in this case this observation counted more than once.**

CHAPTER V. EMPIRICAL RESULTS AND ANALYSIS

V.1 Introduction

Analyses of factors that determine land owners' decisions to adopt conservation practices in Iowa were conducted using econometrics estimation and analysis. This chapter presents five econometric models of conservation adoption decisions, and discusses the estimated results. The estimations are for 10 equations, based on logit models. Section V.2 presents the empirical logit model results. Section V.3 summarizes the results of the logit regression. Specifically, Sections V.3.a–V.3.e use the 5 empirical models discussed in Chapter IV.

V.2 Empirical Logit Model Results and Analysis of Adoption of Technology

Logistic regressions were estimated For the combined effect of all variables (**q**), land ownership (Z) and differences in adoption of conservation practices (C_k), (See Chapter III).

The hypothesis testing was conducted on the logit model results obtained from the five models (Adopting conservation practices or program- Adopting at least one or more CP , Adopting expensive conservation practices, Adopting inexpensive conservation practices, Adopting conservation tillage and Having land enrolled under conservation programs), which produced 10 equations (5 for baseline and 5 extended model). This structure is necessary for testing the statistical significance of the parameter estimates and the overall significance of the model. To compare between two equations for each model i.e. for example "Adopting expensive CP" using baseline and extended equations, Akaike's Test AIC (An Information Criterion) was used. AIC is not a hypothesis test, but a tool for model selection. It estimates the appropriate fit of estimated models, and is commonly used to distinguish between different models—the smaller the AIC test, the better the model fit. The coefficient and AIC were estimated using STATA software.

STATA estimation results list log odds ratios with p-values. The statistical significance of such results lies in deriving an estimated measure of the true representation of the population in the sample. The value of p-level represents a decreasing index of the reliability of a result: the higher the p-value, the less the possibility that the observed relation between variables in the sample is a reliable indicator of the same relation among the land owner population. For example if the p-value is 0.05, then there is a five percent probability that the relationship between the variables found in the sample due to sampling errors.

To test the null hypothesis, the Likelihood Ratio Test was used to measure the model's ability to explain land owners' adoption behavior. Given (in the null hypothesis) that all slope coefficients are zero, in the base line model $\Omega_i = 0, i = 1,....k$, and extended model $\delta_i = 0, i = 1,....k$, the LR statistics are distributed as χ^2 with 10 (10 independent variables used in the "baseline model") and 17(17 independent variables used in the extended model when the ownership factors are included) degrees of freedom, respectively. To test the statistical significance difference between the base line and extended model, the difference in χ^2 for each model was tested with 7 degrees of freedom of the 0.05 significance level. Importantly, this tool will help to evaluate the land owners' characteristics, particularly whether being an owner operator or absentee owner plays a role in the decision of adopting conservation practices.

In the logit model, there are different types of Pesudo R2, Likelihood Ratio chi2 (LR chi2) and P-value. Unlike the R2 in the ordinary least square (OLS) regression model, where R2 consists of single indicators that tell us about the proportion of variance accounted for by the model. Likelihood Ratio chi square is the F ratio test to a whole OLS model. In the logit model, there is no single indicator in logistic regression that tells us everything about the model. So, different researchers use different Pesudo R2. Since I need to compare two models, and Pesudo R2 is limited in its scope to the task at hand, LR chi square and AIC are used to compare between the two logit models.

In all tables in this chapter, the first column gives the name of explanatory variables included in the model estimation. The second column presents the log odds ratios computed for variables in the base line model as mentioned in the previous studies. The third column presents the log odds ratios where land ownership variables are included in the study. These tables also include: AIC, difference in χ^2 between the LR Test of the base line and extended model and number of observations.

V.3 Empirical Results

This section presents the data that suggest land owner characteristics do influence decisions to adopt conservation practices.

V.3.a Model 1: Adopting conservation practices or program: Adopting at least one or more CP

The empirical estimates of regression coefficients that denote the log odd ratio to adopt or use one or more conservation practices are presented in Table 5.1. The results show how land owners view the whole set of conservation practices when benefits and costs are not differentiated; i.e. all types of conservation practices are considered irrespective of whether or not they are expensive or inexpensive.

The extended model differs from the baseline model by including the owner characteristics. AIC suggests that the extended model is a better fit for explaining land owners' behavior toward adoption of conservation practices. The difference in χ^2 between the two models is significant at the 5 percent level so only the extended model will be discussed.

Model, including landowner characteristics: The third column in Table 5.1 shows the log odds ratios associated with land ownership factors. Log odds ratios estimated for economic and demographic factors remain relatively unchanged when landowner factors are added to the logit model. 'Land held free of debt' and 'income or investment reason to own the land' seem to have more influence when the land ownership variables are included in the regression. The odds that conservation practices are adopted on medium-sized farm remain high related to other acreage. It is significant at the 1 percent level. Small-and large-, sized owned agricultural land also have marginally greater odds of adopting conservation practices than micro owned agricultural farm.

The conservation practices in general (i.e., the adoption of at least one or more CP) were likely to be found in lands that owners hold free of debt (log odds ratio of 0.92 positive; significant at 5 percent level, means the log odds for adopting conservation practices for a landowner how have no debt on his land purchase is 0.92 higher than the landowner who has some kind of debt).

The demographic variables, such as age and education show a positive effect on the probability to adopt conservation practices. However, graduate education degree does show a marginal positive effect on the probability to adopt conservation practices. This result is supported by the existing literature [Marsh, S., D. Pannell, and R. Lindner (2000)], human capital accumulation—which helps farmers to assimilate information that leads to a positive influence on conservation adoption.

Table 5.1 Impact of land ownership on adopting conservation practices and program: adopting at least one or more CP (C_1)

Explanatory Variables	Baseline model	Model, including owner characteristics
Demographic factors		
Age (BC: < 35 years old)		
35–64 years (q_{1a})	0.97 (0.93)	0.85 (0.99)
=/>65 years (q_{1b})	1.48 (1.02)*	1.22 (1.11)
Female Gender (BC: male) (q_2)	0.18 (0.40)	0.25 (0.47)
Education (BC: High school or less) (q_3)		
Post-high school (two years) (q_{3a})	0.00007 (0.42)	0.34 (0.46)
Graduate and higher degree (q_{3b})	-0.09 (0.45)	0.26 (0.5)*
Economic factors		
Method of purchasing the land: Land held free of debt (q_4)	0.57 (0.47)	0.92 (0.52)**
Income or investment reasons to own land (q_5)	-0.70 (0.38)**	-0.95 (0.41)***
Size of owned agricultural land (BC: < 100 ac) (q_6)		
Small: 101–500 ac (q_{6a})	0.86 (0.42)***	0.72 (0.46)*
Medium: 501–1,000 ac (q_{6b})	2.56 (0.82)***	2.52 (0.91)***
Large: >1,000 ac (q_{6c})	1.40 (0.86)*	1.47 (0.97)*
Land owner characteristics factors		
Land owned and operated by owner-operator (Z)		-1.098 (0.544) **
Farm/residence proximity (BC: on-farm) (q_8)		
In a nearby town (q_{8a})		-0.69(0.48)
In a city (q_{8b})		-0.46 (0.68)
Structure of ownership (BC: sole ownership)		
Spousal joint ownership (q_{9a})		-0.43 (0.50)
Ownership under land trusts and others (q_{9b})		-1.32 (0.53)***
Knowledge about cost-share program(s) (q_{10})		1.30 (0.44)***
Plans to bequeath, will or give the land to family (F)		0.29 (0.43)
Constant	-0.33 (1.04)	-0.85 (1.47)
Number of observations, N	**234**	**234**
LR Test (overall significance of regression)	21.54	38.13
Chi2 difference from base line model		16.59**
Akaike AIC	0.99	0.98

Note: standard error reported in parentheses
*, **, *** refer to significance at 10, 5, and 1 percent levels, respectively. BC = Base Category

The land ownership characteristics variables were found to have a significant impact on the adoption of conservation practices. The log odds ratio for type of landownership variable (Z) was estimated to be -1.098, and is significant at the 5 percent level. That means, when the land status changes from absentee owner (explanatory variable, Z = 0) to owner operator (Z = 1), the log odds of “Adopting conservation practices or program – Adopting one or more CP” decreases. Contrary to the common perception that owner operators conserve better than the absentee owners, this survey result suggests that once the demographics, economic, and other owner-characteristic factors are taken into account, the odds of conservation adoption by owner operators is less when conservation practices are considered in general irrespective of the type of conservation practices. This is not as counter-intuitive as it may seem: owner operators incur comparably higher variable costs of farm production since they are directly operating their land holdings. Those costs may deter them from using conservation practices, because conservation measures increase the costs of their operation (farming). Hence, it is also consistent with the log odds ratio (-0.95) estimated for the variable q_5 ‘income or investment reasons to own the land’ (i.e., instances of adoption of conservation practices decrease when income is the prime reason for holding the land). Table 4.6 showed that 41 percent of absentee owners own the land for sentimental and other reason than income or investment, versus 34 percent of owner operators who own the land for the same reason.

Three possible explanations can answer why absentee owners (AOs) use more conservation practices than owner operator (OOs) in their fields. Explanation (1): since they are not directly involved in agricultural production, they do not incur cultivation expenses—hence, AOs might be willing to use some conservation practices in their lands to maintain its value in the long run. Explanation (2) absentee land owners who are not willing to sell their land may in fact be planning to will or bequeath the land to some family member—this intention increases the emotional attachments to their land holdings, and furthermore, absentee land owners may be more inclined to use conservation practices in their fields to improve the quality of land to sustain its value. The second reason seems possible, because a log odds ratio of 0.29 was estimated for the variable 'plans for bequeath, will or give the land to family or other'. In spite of its lack of significance, a positive value suggests that if a land owner intends to will or bequeath land, then he or she is more likely to adopt conservation practices—a possibility that is consistent with Explanation (2). Finally, Explanation (3): since the average age of absentee owners is higher than that of owner operators, which it is possible that absentee owners could be retired owner operators. Since they are older, they might be wealthier since 86 percent of them hold the land free of debt, and they are more capable of adopting conservation practices prior to retiring.

Another important variable is land owners' knowledge about cost-share programs for conservation practices. When their knowledge increases, they seem to adopt more conservation practices. This indicates landowners are more likely to use conservation practices when they know there is money available to help defray the cost of implementing the conservation practices. The estimated log odds ratio is 1.30, and is significant at the 5 percent level.

Table 5.1 results apply to the adoption of conservation practices in general. The question of whether or not these results extent to different types of conservation practices is explored below.

V.3.b Model 2: Adopting expensive conservation practices

The regression results of variables' impact on "Adopting expensive conservation practices" are presented in Table 5.2. The baseline model includes socio-economic and demographic factors; the extended model adds land ownership factors to the baseline model—similar to Table 5.1.

AIC suggest that the second model is better fit, and the difference in χ^2 is significant, suggesting that the model will explain the adoption behavior better when characteristics of land owners are included. Hence, only the extended model will be discussed here. Results for the baseline and extended models are presented in Table 5.2.

Model, including landowner characteristics: When land owner characteristics are included in the extended model, the results are similar to that of the previous discussion—absentee land owners are more likely to adopt expensive conservation practices. The log odds ratio computed for land ownership variable is -0.81, negative and significant at the 1 percent level; hence, absentee owners have a higher chance to adopt expensive conservation practices that provide benefits over longer time period. One major conclusion that can be drawn is that absentee owners are most likely to adopt expensive conservation practices (terraces, drainage tiles), since they want to keep land within their families. The computed log odds ratio for the variable ‘will or bequeath’ is positive at 0.49 (although not significant), and is consistent with the previous conclusion that chances of adopting expensive conservation practices increase when the plan of the land owner is to bequeath or give it to someone in the family.

The extended model also has one important demographic variable—age—which is significant. The log odds ratios computed for the middle (35–65 years) and late (above 65 years) age groups are 2.52 and 3.03, respectively, meaning that older land owners are likely to adopt more expensive conservation practices than the base group of young owners (less than 35 years).

The log odds ratio for post-graduates is -0.98 (negative), and is significant at the 5 percent level—suggesting that the higher the farmers’ education, the less likely they are to adopt expensive conservation practices. It is not clear why this would be the result because as shown in Table 5.1 the use of conservation practices in general increases with education. Why education would negatively impact the decision to adopt more expensive conservation practices could be the subject for future research.

The extended model's economic variables (income or investment reasons for owning land and the amount of land owned) are statistically significant at the 10, 1 percent levels respectively. Knowledge of cost-share programs are significant, and increased the log odds of adoption (similar to Table 5.1 result).

Table 5.2 Impact of land ownership on adopting expensive conservation practices (C_2)

Explanatory Variables	Baseline model	Model, including owner characteristics
Demographic factors		
Age (BC: < 35 years old)		
35–64 years (q_{1a})	2.29 (1.21)**	2.52 (1.27)***
=/> 65 years (q_{1b})	2.91 (1.24)***	3.03 (1.31)***
Female Gender (BC: male) (q_2)	-0.30 (0.34)	-0.43 (0.39)
Education (BC: High school or less) (q_3)		
Post-high school (two years) (q_{3a})	-0.27 (0.36)	-0.25 (0.38)
Graduate and higher degree (q_{3b})	-1.03 (0.38)***	-0.98 (0.42)***
Economic factors		
Method of purchasing the land: Land held free of debt (q_4)	-0.07 (0.39)	0.12 (0.42)
Income or investment reasons to own land (q_5)	0.57 (0.31)**	0.52 (0.32)*
Size of owned agricultural land (BC: Micro: < 100 ac) (q_6)		
Small: 101–500 ac (q_{6a})	0.70 (0.39)**	0.51 (0.43)
Medium: 501–1,000 ac (q_{6b})	1.64 (0.55)***	1.16 (0.60)***
Large: >1,000 ac (q_{6c})	1.72 (0.77)**	1.26 (0.83)*
Land owner characteristics factors		
Land owned and operated by owner-operator (Z)		-0.81 (0.43)***
Farm/residence proximity (BC: on-farm) (q_8)		
In a nearby town (q_{8a})		-0.61 (0.39)*
In a city (q_{8b})		-0.41 (0.56)
Structure of ownership (BC: sole ownership)		
Spousal joint ownership (q_{9a})		-0.57 (0.42)*
Ownership under land trusts and others (q_{9b})		-0.23 (0.43)
Knowledge about cost-share programs (q_{10})		1.09 (0.35)***
Plans to bequeath, will or give the land to family (F)		0.49 (0.37)
Constant	-2.74 (1.28)**	-3.12 (1.55)**
Number of observations, N	**234**	**234**
LR Test (overall significance of regression)	44.06	58.69
Chi2 difference from base line model		14.63**
Akaike AIC	1.25	1.24

Note: standard error reported in parentheses
*, **, *** refer to significance at 10, 5, and 1 percent levels, respectively
BC = Base Category

V.3.c Model 3: Adopting inexpensive conservation practices

Table 5.3 presents the results of the regression model, using the dependent variable of adopting inexpensive conservation practices (such as grassed waterways, seeded downstream banks). It is regressed on the same explanatory variables used in the previous two models in this Chapter. The difference in χ^2 between the baseline and the extended model was significant at the 1 percent level. Importantly, this result proves that variables related to land ownership should be included in the study of conservation adoption behavior in Iowa. Hence, similar to the previous model, only the extended model will be discussed.

Model, including landowner characteristics: The log odds ratio for land owner differences (AO vs. OO) was found to be very close to 0 (-0.03), and not significant. The lack of significance suggests that there are no differences between OO and AO in the level of adoption of inexpensive conservation practices (e.g., seeded downstream banks and grassed waterways).

Land owners were less likely to adopt inexpensive cultivation practices if the primary reason for holding land was to earn income (the log odds ratio was negative at -0.59). The nature of inexpensive conservation practices makes them affordable for many land owners, but their short-term nature makes them a recurring (variable) cost in farming. Hence, this ratio implicitly suggests that land owners are more likely to adopt conservation practices whose effects last over long periods of time. One consistent variable across all the three tables (5.1, 5.2 and 5.3) is the effect of knowledge of government cost-share programs. Whenever land owners are aware of such programs, they are more likely to adopt conservation practices—an effect of incentives that the government seeks to provide. Another interesting feature is that land owners are less likely to adopt conservation practices if they live far away from the farm (e.g., in a city). This result was another recurring theme in Tables 5.1–5.2, but it turned out to be statistically significant only in the case of inexpensive practices. The proximity to farm can play a significant role in the adoption of conservation practices—be it inexpensive.

Table 5.3 Impact of land ownership on Adopting inexpensive conservation practices (C_3)

Explanatory Variables		**Baseline model**	**Model, including owner characteristics**
Demographic factors			
Age	(BC: < 35 years old)		
	35–64 years (q_{1a})	1.15 (0.92)	1.09 (0.93)
	=/>65 years (q_{1b})	1.53 (0.96)*	1.69 (0.99)**
Female Gender	(BC: male) (q_2)	-0.07 (0.31)	0.08 (0.35)
Education	(BC: High school or less) (q_3)		
	Post-high school (two years) (q_{3a})	0.137 (0.33)	0.37 (0.35)
	Graduate and higher degree (q_{3b})	-0.17 (0.36)	0.19 (0.39)
Economic factors			
Method of purchasing the land: Land held free of debt	(q_4)	0.42 (0.36)	0.50 (0.39)
Income or investment reasons to own land (q_5)		-0.42 (0.29)*	-0.59 (0.31)**
Size of owned agricultural land	(BC: Micro: < 100 ac) (q_6)		
	Small: 101–500 ac (q_{6a})	0.42 (0.37)	0.20 (0.41)
	Medium: 501–1,000 ac (q_{6b})	1.39 (0.50)***	0.91 (0.55)*
	Large: >1,000 ac (q_{6c})	0.18 (0.63)	-0.27 (0.70)
Land ownership factors			
Land owned and operated by owner-operator (Z)			-0.03 (0.40)
Farm/ residence proximity (BC: on-farm) (q_8)			
	In a nearby town (q_{8a})		-0.47 (0.35)*
	In a city (q_{8b})		-1.52 (0.58)***
Structure of ownership	(BC: sole owners(q_9)		
	Spousal joint ownership (q_{9a})		-0.22 (0.38)
	Ownership under land trusts and others (q_{9b})		-0.26 (0.39)
Knowledge about cost-share program (q_{10})			0.92 (0.33)***
Plans to bequeath, will or give the land to family (F)			0.06 (0.34)
Constant		-1.38 (0.99)*	-2.04 (1.23)**
Number of observations, N		**234**	**234**
LR Test (overall significance of regression)		15.62	34.29
Chi2 difference from base line model			18.67***
Akaike AIC		1.40	1.38

Note: standard error reported in parentheses
*, **, *** refer to significance at 10, 5, and 1 percent levels, respectively
BC = Base Category

V.3.d Model 4: Adopting conservation tillage

Model, including landowner characteristics: While including land ownership patterns helped to derive better results for expensive and inexpensive conservation practices, the patterns did not improve the regression estimates in the case of conservation tillage. Very few parameters changed between the baseline and extended model. Variables such as education and level of debt were significant at the 10 percent level. Age, reasons to cultivate land, future plans to bequeath, type of ownership (sole vs. joint vs. spousal) and, finally, knowledge about conservation programs did not seem to have any significant impact on the adoption of conservation tillage practices. The overall model is not significant, and neither is the difference in χ^2 between the baseline and extended models for adopting conservation tillage (Table 5.4).

According to the 2006 CTIC Report, 60 percent of cropland in Iowa is under conservation tillage. Because awareness of conservation tillage is widespread, even an increase in the knowledge of cost-share programs may not improve the chances of converting land from conventional tillage to conservation tillage practices. Another reason could be that there are no special incentives in the cost-share programs for adopting conservation tillage. These reasons also show that knowledge of government support in the form of cost-share programs is beneficial only when the programs provide monetary incentives, as opposed to spreading awareness and knowledge. In the near future, it will be interesting to see how the adoption of conservation tillage changes when new monetary incentives for conservation tillage practices are created under the emerging regime of carbon sequestration in agricultural soils.

Table 5.4 Impact of land ownership on Adopting conservation tillage (C_4)

Explanatory Variables	Baseline model	Model including owner characteristics
Demographic factors		
Age (BC: < 35 years old)		
35–64 years (q_{1a})	-0.41 (0.94)	-0.40 (0.96)
=/>65 years (q_{1b})	-0.24 (1.00)	-0.20 (1.03)
Female Gender (BC: male) (q_2)	-0.46 (0.31)	-0.50 (0.35)
Education (BC: High school or less) (q_3)		
Post-high school (two years) (q_{3a})	0.10 (0.34)	0.20 (0.35)
Graduate and higher degree (q_{3b})	0.21 (0.37)	0.55 (0.40)*
Economic factors		
Method of purchasing the land: Land held free of debt (q_4)	0.13 (0.38)	0.22 (0.39)*
Income or investment reasons to own land (q_5)	0.15 (0.29)*	0.13 (0.30)
Size of owned agricultural land (BC: Micro: < 100 ac) (q_6)		
Small: 101–500 ac (q_{6a})	0.46 (0.37)	0.41 (0.39)
Medium: 501–1,000 ac (q_{6b})	1.67 (0.55)*	1.50 (0.59)
Large: >1,000 ac (q_{6c})	0.41 (0.64)	0.259 (0.70)
Land ownership factors		
Land owned and operated by owner-operator (Z)		-0.57 (0.40)
Farm/ residence proximity (BC: on-farm) (q_8)		
In a nearby town (q_{8a})		-0.64 (0.35)
In a city (q_{8b})		-1.10 (0.53)
Structure of ownership (BC: sole owner(q_9)		
Spousal joint ownership (q_{9a})		-0.17 (0.38)
Ownership under land trusts and others (q_{9b})		-0.24 (0.39)
Knowledge about cost-share program (q_{10})		0.30 (0.33)
Plans to bequeath, will or give the land to family (F)		0.192(0.34)
Constant	0.20 (1.00)	0.19 (1.25)
Number of observations, N	**234**	**234**
LR Test (overall significance of regression)	14.88	22.37
Chi2 difference from base line model		7.49
Akaike AIC	1.36	1.39

Note: standard error reported in parentheses
*, **, *** refer to significance at 10, 5, and 1 percent levels, respectively
BC = Base Category

V.3.e Model 5: Have a land enrolled in conservation programs

Table 5.5 presents the results of the regression model where the dependent variable is defined as having land enrolled in government conservation programs (such as CRP, WRP and so on). This factor was regressed using the same explanatory variables as in Tables 5.1–5.4. The difference in χ^2 between the baseline and extended models was significant at the 10 percent level. Similar y only the extended model will be discussed here.

Model, including landowner characteristics: In addition to education and size of owned agricultural lands (Acreage), the land owner characteristics, such as spousal joint ownership and knowledge of government cost-share programs, had a positive impact on retiring the land under conservation programs. Overall, the chances are higher for married (log odds ratio of 0.67) than unmarried owners and for those who have knowledge of conservation programs (log odds ratio of 0.67) than those who do not, who are more likely to seek to retire their land under conservation programs like CRP or have land enrolled in other conservation programs. The land ownership pattern (Z), absentee owners versus owner operators, was not found to significantly affect the retirement of land under government conservation programs. It would seem, then, that only ecological or environmental sensitivity mattered, but not differences between OO and AO characteristics.

Table 5.5 Impact of land ownership on have a land enrolled in conservation program C_5)

Explanatory Variables	Baseline model	Model including owner characteristics
Demographic factors		
Age (BC: < 35 years old)		
35–64 years (q_{1a})	-0.01 (1.00)	-0.07 (1.03)
=/>65 years (q_{1b})	0.10 (1.04)	-0.004 (1.08)
Female Gender (BC: male) (q_2)	0.04 (0.34)	0.28 (0.37)
Education (BC: High school or less) (q_3)		
Post-high school (two years) (q_{3a})	0.67 (0.35)***	0.76 (0.37)***
Graduate and higher degree (q_{3b})	0.60 (0.38)*	0.67 (0.41)**
Economic factors		
Method of purchasing the land: Land held free of debt (q_4)	-0.34 (0.38)	-0.40 (0.40)
Income or investment reasons to own land (q_5)	-0.31 (0.31)	-0.38 (0.32)
Size of owned agricultural land (BC: Micro: < 100 ac) (q_6)		
Small: 101–500 ac (q_{6a})	1.15 (0.44)***	0.95 (0.46)**
Medium: 501–1,000 ac (q_{6b})	1.91 (0.53)***	1.80 (0.58)***
Large: >1,000 ac (q_{6c})	0.47 (0.69)	0.25 (0.76)
Land ownership factors		
Land owned and operated by owner-operator (Z)		-0.12 (0.39)
Farm/residence proximity (BC: on-farm) (q_8)		
In a nearby town (q_{8a})		0.203 (0.37)
In a city (q_{8b})		-0.18 (0.61)
Structure of ownership (BC: sole owner ($q_{9)}$		
Spousal joint ownership (q_{9a})		0.67 (0.40)**
Ownership under land trusts and others (q_{9b})		0.22 (0.40)
Knowledge about cost-share program (q_{10})		0.67 (0.35)**
Plans to bequeath, will or give the land to family (F)		0.37(0.35)*
Constant	-1.42 (1.08)*	-1.35 (1.34)
Number of observations, N	**234**	**234**
LR Test (overall significance of regression)	19.52	27.92
Chi2 difference from base line model		12.40*
Akaike AIC	1.38	1.41

Note: standard error reported in parentheses
*, **, *** refer to significance at 10, 5, and 1 percent levels, respectively
BC = Base Category

Overall, the analysis reveals that many of the factors associated with adoption behavior of conservation technology found in the literature are applicable in Iowa. Amount of owned agricultural land seems to be a key factor in all models. Educations, reason for owning land, age and level of land owner debt, have different impacts on the decision to adopt conservation practices. Adding land owner type and related characteristics not mentioned in the previous literature improved the level of model fit. Thus, these factors are important to consider in any subsequent study that aims to understand conservation adoption behavior and decisions.

Finally, results from the extended model support common themes—not only demographic and socio-economic concerns, which have been identified by the literature, but also the specific land ownership characteristics discussed earlier (e.g., status as AO or OO; sole ownership vs. joint ownership; proximity to farm, and so on)—all of which impact adoption decisions of conservation practices and answer the study's hypotheses (Chapter II). The hypotheses, policy implications, limitations and suggestions for future research will be discussed in the next chapter.

CHAPTER VI. SUMMARY, POLICY IMPLICATIONS AND CONCLUSION

VI.1 Summary

The natural resources that make up the environmental base of agriculture and other economic activities are under threat of degradation. Many studies nationally and globally have highlighted the contribution of agricultural practices to environmental problems. Interventions by government and environmental organization in response to these issues have been widely provided. Specifically, many conservation programs were developed to help land owners overcome these problems, plan to avoid future problems and sustain the major important natural resources for agricultural.

In this study, the success of stopping and limiting these problems varied among land owners in Iowa. In the end, the development of resource conservation programs and practices requires better knowledge of the factors that hinder the use of conservation practices. The high percentage of farm land under absentee ownership in Iowa makes the State a special case. It raises concern whether absentee owners use conservation practices. This concern is the main focus of this study.

The main objective of this study was to examine the difference in owner operator and absentee owners' decisions to adopt environmentally-focused conservation practices as a means to prevent land and water degradation, and sustain agriculture productivity.

The main hypotheses tested whether being owner operators or absentee owners (taking into account socio-economic, behavioral and demographic characteristic of land owners) affect adoption of conservation practices, and whether adoption of conservation practices was differentiated due to cost (i.e., expensive and inexpensive conservation practices) or the importance of particular practices (conservation tillage and conservation programs).

Five models were estimated to help draw conclusions about the impact of being owner operators or absentee owners on adoption conservation practices, accounting for the characteristics mentioned. The first model tested the willingness to adopt conservation practices as measured by adopting at least one or more conservation practices and/or programs. It used both binary choice response variable ('adopt' versus 'do not adopt') and explanatory variables—which are the same across the five models: demographics (age, education and gender) economic (land held free of debt, income or investment reason to own the land and amount of land owned), land owner factors (type of ownership (OOs.vs. AOs), farm/residence proximity, structure of ownership—sole, spousal joint ownership, trust and other, knowledge about cost share programs and plans for bequeath, will or giving the land to family or other).

The other four models used the same explanatory variables with different dependent variables; "Adopting expensive conservation practices" (terraces, drainage tile), "Adopting inexpensive conservation practices" (grassed waterway, seeded downstream bank), "Adopting conservation tillage" (mulch, reduced and no till) and "Have land enrolled in conservation programs".

Past studies have highlighted the methodological approach used in modeling adoption behavior in the agriculture sector. Those results have indicated that adoption of conservation technology is influenced by an array of factors including demographic, economic, institutional and non-institutional factors. Importantly, these past studies were helpful in identifying the specific combinations of factors to test the case of Iowa owners' adoption behavior regarding conservation practices. The literature regarding Iowa land owners and adoption of conservation programs and practices also allowed for the development of a new assessment model.

A theoretical framework of adoption behavior of conservation technology by land owners was thus developed for hypotheses testing. The model investigated the decisions land owners face to maximize both profit and utility by controlling their environmental problem(s). This model was tested in different cases, such as cost-sensitive cases (expensive and inexpensive conservation practices), or highly environmentally-important cases like conservation tillage and conservation programs. The models included demographic, economic, and landownership factors (highlighted by the literature) and additional variables, such as land owners' characteristics (e.g., being an owner operator or absentee owner). An empirical logit model was used to assess the response variables, since they are binary.

VI.2 Major Conclusions, Based on Hypotheses

Several hypotheses were identified in Chapter II, Section 5. The following conclusions can now be drawn:

First Hypothesis

H0: There is no difference between absentee owners and owner operators in the adoption of conservation practices and in types of conservation practices that they adopt.

This hypothesis is rejected, based on the results in Table 5.1, since absentee owners seem to adopt more than owner operator. Table 5.2, suggest that AO are more likely to adopt expensive practices.

Second Hypothesis

H0: Land owners who own land for income reasons are more likely than other land owners to adopt conservation practices.

This hypothesis would be rejected. Table 5.1 shows a negative log odds ratio for income reason for owning land and whether or not there is at least one conservation practice adopted. This result is statistically significant at the 1 percent level. It is interesting to note that the results are inconclusive for the type of conservation practice as shown in Tables 5.2 and 5.3. Table 5.5 shows a negative and insignificant effect of owning the land for income purposes on whether or not the land is enrolled in a government conservation program.

Third Hypothesis

H0: The adoption or use of conservation practices increases with age.

This hypothesis is rejected because the results show age is insignificant in the model whether or not the landowner adopts a conservation practice (Table 5.1). There does appear to be an age effect when estimating the use of expensive and inexpensive conservation practices (Tables 5.2 and 5.3). The use of conservation practices when separated by expense does show an age effect but this age effect is not present when simply evaluating whether or not a conservation practice is used. Age does not have an effect on land enrolled in a government conservation program (Table 5.5)

Fourth Hypothesis

H0: In comparison to older land owners, younger ones are less likely to use expensive conservation practices like terraces

This hypothesis is accepted. Table 5.2 shows the odds log ratio for both the upper age categories are positive and significant. This means age has a significant impact on the decision to use expensive conservation practices. Also, the age log odds ratio is positive and higher (3.03) for land owners who are 65 and above years old than the land owners who are in their mid age (2.52), thus, the older the land owners, the higher the probability to adopt expensive CP. In addition, the AO are significantly more likely to adopt expensive conservation practices and the AOs have a much higher portion over the age of 65 relative to the OOs. (Table 4.6)

H0: The higher an Iowa farmer's level of education, the more likely s/he will have adopted conservation practices.

The results have mixed effects. This hypothesis is accepted at only the 10 percent level when considering adoption of any conservation practice or conservation tillage for those with at least a college degree. Otherwise education is insignificant. (Tables 5.1 and 5.4) But, education is significant for any post high school level of education at the five or one percent level for whether or not the land is enrolled in a government conservation program (Table 5.5)

Sixth Hypothesis

H0: Absentee owners are more likely than owner operators to adopt expensive conservation practices.

Tables 5.2 shows that adoption of expensive conservation practices (terraces and drainage tiles) differ between owner operators and absentee owners. The latter group seems to adopt the expensive measures, despite the costs involved, since they might believe that the long-term impact of such expensive practices ensure the value of their land.

Seventh Hypothesis

H0: Absentee owners and owner operators are equally likely to adopt conservation tillage.

This hypothesis is accepted based on the results in Table 5.4, since the differences between AO and OO in adopting conservation tillage is not statistically significant.

Eighth Hypothesis

H0: Knowledge about cost share programs increases the likelihood of land owners' adoption of conservation practices.

This hypothesis is accepted in all models. Land owners who know about cost-share programs are more likely to adopt conservation practices. It seems that cost is a major factor deterring land owners from adoption of conservation practices. This is further supported by the answer to the question "Have you ever considered implementing a conservation practices but did not because of the cost". Almost one-third (32 percent) of the respondents indicated they had been in such a position. It is likely an important conclusion for policy makers, if we want conservation practices adopted, then we will have to find ways to help pay for them.

Overall, the major findings of this study can be summarized as follows:

1) Absentee owners and owner operators are equally willing in adopting conservation tillage or enroll in conservation programs. However, in general when conservation practices are not differentiate based on cost or environmental importance, absentee owners (AOs) are more likely to adopt them. This result needs further investigation to understand reasons for becoming absentee owners (e.g., retiring due to age, taking off-farm jobs due to different levels of education, owning the land as an investment, or owning as a hobby).

2) "Sentimental reasons for holding land" is a strong motivation to conserve.
3) Absentee owners are more likely to adopt expensive conservation practices, such as terraces or drainage tiles. But, AO and OO are equally likely to adopt inexpensive or short-term conservation practice.
4) The probability of adopting conservation tillage by owner operator and absentee owner is the same. This result may be due to the low or diminished cost of, and widespread knowledge about, conservation tillage. Thus, being an owner operator or an absentee owner is not a key factor in determining whether to adopt these practices. The same result is also true regarding enrollment in conservation programs, such as CRP. Instead of land owner characteristics or status as OO or AO being deciding factors, the type of environmental problem encountered on the land is a key in swaying decisions to enroll.
5) Other key determinants of adopting conservation practices in Iowa are: education, age, farm/residence proximity, knowledge about cost-share programs, level of debt and the amount of agricultural land owned. Age and education are negatively correlated between AO and OO; the result of the impact of education might be a consequence of this negative association. The impact of age and education were different, based on the type of conservation practices implemented. Age was highly significant in the case of expensive conservation practices, but slightly significant in the case of inexpensive conservation practices, which suggests older land owners have higher probability of adopting these conservation practices. Age did not have any impact in the cases of conservation programs or conservation tillage, due to the result that the key factors for enrolling in CRP or other programs, and adopting conservation tillage are influenced by

the nature of governmental policies, not to mention the wide spread knowledge about the importance of conservation tillage.

6) Education was highly significant when considering enrollment in a conservation program. But, education was only slightly significant when considering adopting a conservation practice in general.

7) The place of residence did affect the adoption of inexpensive conservation practices. Living in the farm does affect the type of simpler (Inexpensive) practices adopted, and conservation tillage. But the same cannot be said for other conservation practices (e.g., terraces installation, which is expensive). However, living in the farm increases the probability of adopting certain conservation practices.

8) Knowledge of cost-share programs seems to have a positive impact on increasing the probability of adopting conservation practices in Iowa. Thus, it is important to provide land owners with this information to encourage them to take further steps toward adopting conservation practices. Education level has a key role in helping to assimilate and process this information also.

9) The literature focused on the importance of farms' proximity to an information center, such as an extension office. Findings from this literature confirm that the closer a farm is to an information center, the higher the probability to conserve the land when there is a need to. This finding highlights the importance of providing information to land owners. Data from the survey for this study explored the type of information sources that land owners are most likely to depend on, or prefer to use, to get their managerial information. Choices ranged between media such as, "TV, Radio, Magazines, Newspapers",

government agencies such as, “USDA/Natural Resources and Conservation Services, USDA/ Farm Service agency, County Extension”, and individual sources like “Farm managers, Neighbors, Tenants”, and finally the internet. A high percent of absentee land owners (46 percent) depend on tenants to get their managerial information for their property. However, Absentee land owners also get their information from government agencies like USDA/FAS (43 percent) and USDA/NRCS (29 percent). This data is supported by the previous result that most of both AOs and OOs know about the cost-share programs that the government—usually the USDA/NRCS and FSA—offer them. The second-most used source of information is through media: Radio, TV, Newspapers (31 percent) and Magazines (30 percent). The internet was the least used information source among AOs (6 percent), and also the least preferred source of information. The most preferred method for AOs to receive managerial information was direct mailing (50 percent). A small percent of them for example (5 percent) preferred newspaper, 3 percent preferred media-TV, Radio- and 2 percent preferred factsheet method.

10) Owner operators have a similar pattern. The most common information source used is USDA/NRCS (61 percent), Magazines (54 percent), USDA/FSA (51 percent) and Newspapers (43 percent). County extension (39 percent) and Neighbors (26 percent) are also important sources of information. This data proves that close proximity to information centers is important in providing land owners with required information. Similarly with AOs, the internet is also not a common source of information for OOs when managing their land; however, a higher percent of OOs (16 percent) than AOs used the internet. This difference may be due to the fact that OOs are younger, and have higher

education than AOs, as Chapter 5 discusses. Similar to the AOs the most preferred method to OOs to receive their managerial information is direct mailing. Unlike AOs, 5 percent of OOs said their choice to receive their managerial information is internet.

11) These data are needed for policy makers when they design conservation policies in Iowa. This study suggests that land owner knowledge about cost-share programs has positive impact on adoption of conservation practices. Since both types of owners use government agencies and media, like TV and magazines, and prefer direct mailing, it is thus necessary to target these people with new technologies, or, any important information regarding conservation practices/programs would be more effective though such channels. As a relatively new technology, the internet is widely recognized as an important exchange for, and distinguished source of, information. It is crucial that further investigations inquire into the reasons land owners do not commonly use the internet. This may be due to age and lower education levels, but it could be also due to technical problems, such as the availability of cable and high speed internet. Internet service would be useful to landowners because of its ability to aid them in managing their properties easily and effectively.

12) The amount of owned agricultural acres seems to have positive impact on adopting conservation practices. Compared to owners of small amount of owned agricultural acres, land owners who have medium owned agricultural acres are more likely to adopt conservation practices. This difference could be due to the fact that operators of small owned agricultural acres are lower risk takers, especially in the case of expensive conservation practices. The log odd ratio was not significant in the case of small owned

agricultural acres for expensive practices. On the other hand, large amounts of owned agricultural acres are also likely to adopt expensive practices, with a positive log odd ratio, significant at the 10 percent significance level. Medium size of owned agricultural acres does not have much impact when the conservation practice in question is inexpensive and easy to adopt. But it has high impact in cases of adopting conservation tillage and programs. Small number of owned agricultural acres shows positive significant impact (5 percent level) in the case of enrolling in conservation programs, but not in the case of conservation tillage. This result might be due to the small scale of a family-oriented farm producing one crop or limited amounts of livestock. Setting aside the land might give land owners of this type more return than the small-scale production when the land is under threat environmentally.

13) Structure of ownership factor also has a mixed effect on decisions to adopt conservation practices. In general, the results show that sole owners are the more likely 'adopters'. However, lands owned jointly (by husband and wife) are more likely to be under conservation programs than those under sole owners. In clear contrast, sole owners are more likely to adopt expensive conservation practices than joint owners. This result raises the concern about the difficulties of decision making when there is more than one owner involved.

14) Even though future plans that land owners have for their agricultural land is statistically insignificant except in the case of having a land enrolled in a conservation program, land owners who intend to give or bequeath the land to family members are more likely to adopt conservation practices.

VI.3 Policy Implications

The results of the empirical models are important for technology development and identification of policy strategies that would promote natural resource conservation in Iowa. This study is important in that it highlights the differences in adoption behavior between owner operators and absentee owners. The results from the empirical models suggest that absentee owner status does not hinder adoption of conservation practices. However, adoption of a given technology should be quite responsive to a number of incentive programs. Other implications that may arise from the study results include:

1) The positive impact of knowing about the cost-share program in adoption behavior may call for government help to distribute information more widely about the available programs, and encourage land owners to use technology like the Internet to obtain the needed information about these programs.
2) Since conservation programs that retire land from agriculture cannot be applied to all farm lands, targeting assistance for adopting on-farm conservation resources, such as terraces, may achieve more satisfactory results in maintaining production, while improving land resources.
3) Older land owners with low levels of education may require support to utilize information about the new technology and farm management available to improve their capacity for resource management.
4) Targeted policies affecting the use and management of land should be designed to facilitate appropriate decision making for joint land owners.

5) Provision of the policy for land under trust may be desirable to protect that land and attain the optimal level of resource conservation in a wide range of Iowa farms, since the percentage of land under trust in Iowa is increasing.
6) Targeting young land owners to encourage them to farm and adopt conservation practices is a desirable policy to transfer the land within the coming few decades smoothly, since the average age of Iowa farmers is high, and land will soon be transferring to the next generation.

VI.4 Limitations of this Analysis and Suggested Further Research

The analysis in this study did not include questions on non-farm income, which likely impacts significantly adoption decisions; such income affects wealth and spending level.

The main limitation to understanding adoption behavior differences between absentee owners and owner operators is due to the current problem with defining recent adoption of conservation practices based on the time of adoption by the surveyed landowners. Clearer understanding of this issue is needed. Such a temporal aspect of adoption might be more meaningful given the dynamics of conservation practice adoption in Iowa. Thus, it is not clear whether the land was already being conserved when it was purchased; the motivations of the land owners is not explicitly understood, since it is not clear whether current land owners comprised the population that adopted the given conservation practices and the time of adoption.

Another limitation—which is imperative to account for in further research—is to define absentee owners, reasons for being absentee owners, AOs' off-farm income sources and type of degree they have. This information will clearly explain the behavior of adoption inherent from being an absentee owner, and the role of high degree education on adoption behavior. For example, it would be interesting to investigate the impact of type of education degree on adoption behavior and the probability to be absentee owners.

In this study, absentee ownership was defined according to those who did not currently farm their land, those who rented out land to tenants, those who have put land into trust, and those who are part owners. Such a broad definition made it impossible to identify the motivations toward adoption of conservation practices that might differ among these absentee land owners.

The increasing percentage of part owners justifies the need for further investigation into whether there is any difference in land management between rented and owned land. This research would help identify appropriate policies to target these part owners regarding land conservation. Significantly, defining “absentee owners” is crucial, when designing future surveys, to target them appropriately. In this study, for example, the definition of absentee owners is, “land owners who do not operator their land”. Narrowing this definition, and separating this broad category into subgroups of absentee landowners based on the reason of being absentee owners, will help to understand the structure of land owners in Iowa and, subsequently, understand their motivations toward land conservation.

The survey could be improved if more details were collected regarding land owners’ need for adoption, type of the environmental problem they have, the scale of the problem, number of conservation practices or programs adopted and the time of adoption by the person who is surveyed, amount of off-farm income and type of education level achieved after high school.

Previous studies stress the effect of off-farm income on the likelihood of adopting conservation practices. The inference of this factor could not have been drawn or studied in the case of Iowa, due to the lack of information.

In conclusion, this study highlighted the importance to differentiate between absentee owners and owner operator's motivation to conserve. The different characteristic each group has is clearly contributed to differentiate attitude toward conservation. With the increasing percent of old owners, further research investigating absentee owners, characteristics and reasons for being absentee owners is highly recommended in Iowa . Improving the questionnaire to target this specific issue with regard to conservation adoption in Iowa is necessary.

Finally, this study has shown that the adoption of conservation practices depends on many factors. Ownership is just one of those factors. Based on the findings presented here we cannot say an increase in rented land will lead to a decrease in conservation. The study finding of little or no difference between absentee owners and owner operators in the adoption conservation practices is important. Policy makers should use this information as they develop policies that will achieve the most conservation efficiently.

APPENDIX A. THE SURVEY INSTRUMENT

Agriculture Landownership and Conservation Practices in Iowa

Landownership:

1-How many agricultural acres do you own? ______________________

2- Is all your property located in this township?
- ◘ Yes Go to question 4
- ◘ No

3- Of the other acres you own out of this township, how many are

- ◘ In the county_____________________________
    - ◘ In Iowa _____________________________
    - ◘ Outside Iowa _____________________________

(Note: if you own more than one parcel in this township please answer the following questions for the largest parcel.)

4- What year did you acquire this property? ________________

5- How did you acquire this property?
- ◘ purchase?
- ◘ receive as a gift from a person who was living at the time of the transfer?
- ◘ inherit?
- ◘ obtain in some other way?

6- How do you own this land?
- ◘ Sole owner
- ◘ Joint Tenancy (husband & wife)
- ◘ Tenancy in Common
- ◘ Partnership (Legal)
- ◘ Life Estate
- ◘ Unsettled Estate
- ◘ Trust
- ◘ Corporation
- ◘ LLC
- ◘ LLP
- ◘ Limited Partnership

7- How many owners are there for this property? __________
If you are the only owner skip to Question 9.

8- What is your relation to the majority of the other owners?
- Family
- Non-family
- Other, Please specify ____________________________

9- Which of the following best describes your financial position in this property?
- Fully paid for
- Being purchased with a contract (not a mortgage)
- Being purchased with a mortgage
- Owned under another financial arrangement

10- What is your primary reason for owning this property?
- Income
- Long term investment
- Portfolio diversification
- Family, sentimental
- Other, please specify ____

11- How do you receive information regarding management options for this property?
(Please check all that apply)
- Newspaper, radio, TV
- Magazines, periodicals
- USDA/ Natural Resource and Conservation Service
- USDA/ Farm Service Agency
- State of Iowa
- County Extension
- Farm manager
- Neighbors
- Tenant
- Internet
- Other. Please specify______________________________

12- What is the best way for you to receive information regarding this property?
- Direct mailings
- Fact sheets
- Radio/TV
- Newspapers
- Videos
- Dealers/salespeople
- Library
- Internet

◘ Others. Please specify___________________________

13- Do you farm this property yourself? (If yes skip to question 16)

◘Yes

◘ No

14- How do you rent this land?

◘ Cash

◘ Crop share

◘ Land is custom farmed for me

◘ Other

15- Do you use a professional farm manager?

◘ Yes

◘ No

16- Who makes the decisions regarding the;

	I do	Tenant	Joint	Farm Manager
Tillage system?	___	___	___	___
Weed management program?	___	___	___	___
Crop residue management?	___	___	___	___
Crop rotation?	___	___	___	___
Crop selection?	___	___	___	___

17- How often do you actually go to the site to check on this land during a typical farming season?

◘ never,

◘ once or twice,

◘ once a month,

◘ once a week, or

◘ daily

Conservation practices:

18-are there any conservation practices used?

◘ Yes, please specify.______________________________

◘ No

19-Is this land in any government conservation program such as CRP, WRP, or others?

◘ Yes. Please specify_______________________________

◘ No

20- Have you made any improvements to the land while you have owned it?
Please check all that apply:

◘ Installed or mended fences

- ◘ Installed terraces
- ◘ Installed drainage tile
- ◘ Removed unused buildings
- ◘ Removed fences
- ◘ Removed living or dead trees
- ◘ Installed grass waterways
- ◘ Seeded down stream banks or other sensitive areas
- ◘ Other, please specify ______________________________

21- Which bests describes the type of tillage system used?
- ◘ No – till
- ◘ Modified no-till
- ◘ Reduced tillage
- ◘ Full tillage

22- If you rent additional land, are the same tillage practices followed?
- ◘ Yes
- ◘ No

23- Do you know about cost-share programs available for implementing conservation practices on this property?
- ◘ Yes
- ◘ No

24- Have you ever considered installing a conservation practices but did not because of the expenses?
- ◘ Yes If yes what? ______________________________________
- ◘ No

Future Plans:

25- Do you think any of this land will be used for something other than agriculture within the next five years?
- ◘ Yes If yes, what? ______________________________________
- ◘ No

26- Even though we know that these plans may change in the future, we would like to know how you **currently** expect to transfer this property.

	Do you expect to…	YES/ MAYBE	NO
a.	will any of it to a family member?		
b.	will any of it to others?		

c.	give any of it to a family member?		
d.	give any of it to others?		
e.	sell any of it to a family member?		
f.	sell any of it to others?		
g.	put any of it in a trust? (including living or testamentary trusts)		
h.	do something else? What else do you plan to do? ___________________________________		

Demographics:

27- What is your gender?
- ◘ Male
- ◘ Female

28- What is your current age? _______

29- Are you currently
- ◘ married or living as married,
- ◘ separated,
- ◘ divorced,
- ◘ widowed
- ◘ single and never been married?

30- Do you have children?
- ◘ Yes How many live at home? _________ How many live away from home? __________
- ◘ No

31- Do you currently live
- ◘ On a farm,
- ◘ In a rural area but not on a farm,
- ◘ In a town of less than 2500,
- ◘ In a town from 2500 up to 10,000,
- ◘ In a town of 10,000 up to 50,000,
- ◘ Or in a city of 50,000 or more?

32- What is the highest level of education you have completed? Please include any college, vocational, or technical training.
- ◘ 11th grade or less
- ◘ High School (includes GED)
- ◘ Some post-high school but no 4-yr degree
- ◘ B.S., B.A., etc.
- ◘ Graduate degree completed (Masters, PhD, MD, etc.)

33- Do you have any comments or suggestion regarding soil conservation?

____

Thank You! Please return this survey in the self-addressed envelope provided.

APPENDIX B. DEFINITION OF DIFFERENT TYPES OF OWNERSHIP

1-Joint Tenancy: “A way for two or more people to share ownership of real estate or other property. When two or more people own property as joint tenants and one owner dies, the other owners automatically own the deceased owner's share. For example, if a parent and child own a house as joint tenants and the parent dies, the child automatically becomes full owner. Because of this right of survivorship, no will is required to transfer the property; it goes directly to the surviving joint tenants without the delay and costs of probate”: *NoLo, Home, Glossary: (http://www.nolo.com/definition.cfm/term/32420395-C624-4456-8D5C31CB8A630F67)*

2-Tenancy in Common: “A way two or more people can own property together. Each can leave his or her interest upon death to beneficiaries of his choosing instead of to the other owners, as is required with joint tenancy. In some states, two people are presumed to own property as tenants in common unless they've agreed otherwise in writing”. *NoLo Home, Glossary: http://www.nolo.com/definition.cfm/term/32420395-C624-4456-8D5C31CB8A630F67.*

3- Partnership: “When used without a qualifier such as "limited" or "limited liability," usually refers to a legal structure called a general partnership. This is a business owned by two or more people (called partners or general partners) who are personally liable for all business debts” *Nolo, Home, Glossary: http://www.nolo.com/definition.cfm/term/B231626C-786C-441D-8DF771BC879ED909.*

4-Life Estate: “Life Estate is the right to occupy, possess or otherwise use a property during one's life time. The right in the property exists so as the right holder is alive. After his or her death it reverts to the title holder or the survivor mentioned in the deed of bestowing life estate.” *Legal-Explanation.com, legal resources in plain English: http://www.legal-explanations.com/definitions/life-estate.htm.*

5-Trust: “A legal arrangement in which an individual (the trustor) gives fiduciary control of property to a person or institution (the trustee) for the benefit of beneficiaries.” *Investor World.com; the biggest, best investing glossary on the web: http://www.investorwords.com/5084/trust.html.*

6-Corporation: “The most common form of business organization, and one which is chartered by a state and given many legal rights as an entity separate from its owners. This form of business is characterized by the limited liability of its owners, the issuance of shares of easily transferable stock, and existence as a going concern. The process of becoming a corporation, call incorporation, gives the company separate legal standing from its owners and protects those owners from being personally liable in the event that the company is sued (a condition known as limited liability). Incorporation also provides companies with a more flexible way to manage their ownership structure. In addition, there are different tax implications for corporations, although these can be both advantageous and disadvantageous. In these respects, corporations differ from sole proprietorships and limited partnerships. *Investor World.com; the biggest, best investing glossary on the web: http://www.investorwords.com/1140/corporation.html.*

7-LLC (Limited Liability): “Type of investment in which a partner or investor cannot lose more than the amount invested. Thus, the investor or partner is not personally responsible for the debts and obligations of the company in the event that these are not fulfilled.” *Investor World.com; the biggest, best investing glossary on the web: http://www.investorwords.com/2816/limited_liability.html.*

8-LLP(Limited Liability Partnership): “A type of partnership recognized in a majority of states that protects a partner from personal liability for negligent acts committed by other partners or by employees not under his or her direct control. Many states restrict this type partnership to professionals, such as lawyers, accountants, architects and healthcare providers.” *Nolo, Home, Glossary*: *http://www.nolo.com/definition.cfm/term/3BC8FAC9-DAE7-4250-AD82550E6C594201*.

9-Limited Partnership: “A business structure that allows one or more partners (called limited partners) to enjoy limited personal liability for partnership debts while another partner or partners (called general partners) have unlimited personal liability. The key difference between a general and limited partner concerns management decision making--general partners run the business, and limited partners, who are usually passive investors, are not allowed to make day-to-day business decisions. If they do, they risk being treated as general partners with unlimited personal liability.” *Nolo, Home, Glossary: http://www.nolo.com/definition.cfm/term/47C1F613-9F91-4E5F-A875C749D658183C.*

APPENDIX C. CHARACTERISTICS OF THE EIGHT COUNTIES SELECTED FOR THIS STUDY

Allamakee County

Overview. Allamakee County is located in the far northeast corner of Iowa. The county has 18 townships and six cities.[16] Allamakee County has an area of 422,200 acres. Total farmland acreage was 374,800 in 1982, and decreased to 325,500 acres in 2006.

Crops. Crops grown in Allamakee Country include corn, alfalfa, soybeans, oats and hay. The harvested area of corn for grain decreased from 85,800 acres in 1982 to 62,100 acres in 2006. The harvested area of alfalfa hay also decreased, from 55,000 acres in 1982 to 40,000 acres in 2006. The other hay harvest area decreased from 8,559 acres in 1982 to 2,000 acres in 2006. Oats had small harvested acreage among crops, with harvested areas decreasing from 18,700 acres in 1982 to 8,600 acres in 2006. The other major crop grown in Allamakee Country is soybeans, and the harvested area increased from 4,000 acres in 1982 to 31,000 acres in 2006.

Farm size and farm number. Farm size and farm number has decreased during the last two decades, to 307 acres and 1,060 farms in 2006. The total number of farm operators has also steadily decreased, from 1,716 in 1959 to 1,083 farm operators in 2002. The average age of farm operators has increased, from 47.4 years in 1959 to 55.3 years in 2002. The number of young farm operators aged 34 years or younger has decreased, from 326 in 1959 to 60 in 2002. Farm operators aged 65 or older have increased, from 184 in 1959 to 286 in 2002.

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[16] The 18 townships are Center, Fairview, Franklin, French Creek, Hanover, Iowa, La Fayette, Lancing, Linton, Post, Taylor, Union City, Union Prairie, Waterloo, Makee, Pain Creek, Jefferson and Ludlow. The six towns are New Albin, Lansing, Waukon, Waterville, Harpers Ferry and Postville.

Population. The population in Allamakee Country has been steadily decreasing since 1970. The county had 14,968 inhabitants in 1970, and decreased to 14,551 inhabitants in 2002.

Topography and environmental issues.[17] Generally, the topography in Allamakee County is characterized by rolling hills to hilly or steep areas. Allamakee County has two types of land. The first is upland, which features narrow ridge tops, bordered by steep-sided slopes that have numerous outcrops of limestone and sandstone. The west-central part of the county is characterized by gentle rolling areas, with many scattered sinkholes. Sinkholes collect the runoff water that carries different materials, such as agricultural chemicals, that flow into underground water. Sinkholes usually form after heavy precipitation, and are considered to be the main reason for underground water pollution [USDA A. (1997)].

Allamakee County has soil erosion and water quality problems due to water drainage into the streams. It also has a serious problem in the Yellow River area, where excessive stream bank erosion occurs, due to intensive row crops in the watershed area and to-stream straightening. Additionally, the Yellow River is listed as impaired, due to a high content of bacteria, such as *E. coli*, which exceeds the standard by 25 times [Jeffrey R. Vonk (2005)].

Five conservation programs[18] have been used in Allamakee Country as of 2007. The first is the CRP, with 3,869 acres enrolled. The second program is Conservation Technical Assistance, with 5,715 acres enrolled. Third is the CTA-Grazing Land Conservation Program,

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[17] Unless stated, all topography information is from the USDA's 1997 Allamakee County Soil Survey.

[18] The data about the current conservation programs in all counties are from the NRCS website: http://ias.sc.egov.usda.gov/prsreport2007/report.aspx?report_id=102.

with 60 acres enrolled. The fourth program is EQIP, with an enrollment of 3,891 acres; the fifth program is the Wildlife Habitat Incentive Program, with 159 acres enrolled.

Emmet County

Overview. Emmet County is located in the north-central part of Iowa. Emmet County has 12 townships[19], and an area of 257,000 acres. Farmland area was made up of 241,600 acres in 1982, and decreased to 233,500 acres in 2006.

Crops. The crops grown in Emmet County include corn, soybeans, oats, and alfalfa hay. In 1982, the harvested area of corn was 118,000 acres, which increased to 121,900 acres in 2006. The alfalfa hay harvest area was 3,500 acres in 1982, and decreased to 2,300 acres in 2006. The other hay crop harvest area decreased from 1,100 acres in 1982 to 500 acres in 2006. Oats had a large harvest area in 1982; however, the oat area has decreased steadily from 2,400 acres in 1982 to 100 acres in 2006. The soybean harvest area remained almost constant from 1982 to 2006, with 95,700 acres in 1982, and decreasing slightly to 94,300 acres in 2006.

Farm size and farm number. In 1982, the average farm size was 336 acres, and the number of farms was 720. Noticeably, farm size increased steadily, while the number of farms has decreased since 1982. The average farm size was 458 acres, with 510 total farms in 2006.

The total number of farm operators has decreased since 1959. In 1959, there were 1,083 farm operators, whose numbers decreased steadily to 510 by 2002. The average age of farm operators has increased from 46.2 years in 1959 to 52.7 years in 2002. The number of young

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[19] The 12 townships in Emmet County are Armstrong Grove, Ellsworth, Emmet, Estherville, High Lake, Iowa Lake, Jack Creek, Lincoln, Swan Lake, Twelve Mile Lake, Denmark and Center. The 6 towns are Estherville, Armstrong, Ringsted, Wallingford, Gruver and Dolliver.

farm operators 34 or younger decreased from 239 in 1959 to 48 in 2002. The number of farm operators 65 or older has fluctuated slightly, having totaled 102 in 1959 and increasing to 109 in 2002.

Population. Since 1970, the population in Emmet County has progressively decreased—similar to other counties in Iowa. The total population in Emmet County was 14,009 in 1970. This number decreased to 10,805 in 2003.

Topography and environmental issues. Emmet County is characterized by undulating or rolling prairie areas. The county has areas consisting of steep hills, such as in the west fork of the Des Moines River. These steep hills are a result of glacial ice. Other areas of the county are known as the Wisconsin Drift Plain. The elevation in this county ranges between 1,225 and 1,480 feet above sea level [Jones (1997)].

Generally, the groundwater in Emmet County is good; however, a few wells in the county have shown high levels of nitrates [Jones (1997)].

In 2007, Emmet County farmers were enrolled in five conservation programs. The first program is CRP, with 8,289 acres. Second is the Conservation Technical Assistance Program, with enrollment acres of 3,129. Third is the CTA-Grazing Land Conservation Program, with 79 acres. The fourth is EQIP, with 1,266 acres enrolled. Finally, 117 acres are enrolled in the WRP.

Grundy County

Overview. Grundy County is located in the northeastern part of the state and on the divide between the Iowa and Cedar Rivers. Grundy County has 14 townships and 7 cities.[20] Total area and the farm land trends for Grundy County will not be reported, due to data discrepancies. However, the change in harvested areas will be reported in the “Crops” section to indicate the trend of the harvested area crops grown in Grundy County.

Crops. The main crops in Grundy County are corn, soybeans, hay, oats and a few acres of sorghum for silage. The harvested area of corn remained almost constant from 1982 to 2006. The harvested corn area was 158,900 acres in 1982, but decreased slightly to 152,800 acres in 2006. Alfalfa hay harvest areas have decreased steadily since 1982, from 7,900 acres, to 2,600 acres in 2006. The harvested area of the other hay crops increased from 1,300 acres in 1982 to 1,500 acres in 2006. The oat harvest areas also decreased from 1982 to 2006, from 6,000 acres to 370. The other major crop in Grundy County is soybean, and the harvest areas have increased steadily since 1982, from 104,600 to 136,000 acres in 2006. Wheat was grown in Grundy County only in 1997, and the harvested area was 170 acres.

Farm size and farm number. The average farm size has increased from 273 acres in 1982 to 454 acres in 2006. The total number of farms decreased from 1,150 farms in 1982 to 710 farms in 2006.

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[20] The townships are Beaver, Clay, Colfax, Fairfield, Felix, German, Grant, Melrose, Pleasant Valley, Shiloh, Palermo, Washington, Colfax and Melrose. The towns are Grundy Center, Reinbeck, Conrad, Dike, Wellsburg, Holland and Stout.

The number of farm operators has decreased also since 1959, when there were 1,680 operators, to 2002, when only 724 operators remained. The average age of the farm operators increased from 45.8 years in 1959 to 53.6 years in 2002. Specifically, the number of young farm operators aged 34 and younger has decreased dramatically, from 310 in 1959 to 43 in 2002. Similar to the other counties, the number of farm operators whose age is 65 or more has increased, from 107 in 1959 to 146 in 2002.

Population. The population of Grundy County decreased from 14,119 inhabitants in 1970 to 12,341 inhabitants in 2003.

Topography and environmental issues. Grundy County has seven types of land classifications based on soil type. First, there is the upland area, which consists of land that is nearly level to gently, moderate, or strongly sloping land, with different degrees of drainage [USDA G. (1997)].

In 2007, Grundy County had land in four conservation programs. The first is CRP, with 4,179 acres. The second program is Conservation Technical Assistance, with enrollment acres of 6,621. The third conservation program is CTA-Grazing Land Conservation, and enrollment is 22 acres. The fourth program being used is EQIP, and Grundy Country has 4,752 acres enrolled.

Harrison County

Overview. Harrison County is located on the west-central side of Iowa. Harrison County has 20 townships and 10 cities.[21] The total area in Harrison Country is 445,300 acres. The total farmland area was 426,300 acres in 1982, which decreased slightly to 425,500 acres in 2006.

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[21] The townships are Allen, Calhoun, Cass, Cincinnati, Clay, Douglas, Boyer, Harrison, Jefferson, La Grange, Lincoln, Little Seix, Magnolia, Morgan, Taylor, Union, Washington, St John, Jackson and Raglan. The ten towns

Crops. Harrison County grows corn, soybean, oats, and alfalfa. The harvested area of corn has remained almost constant from 1982, when it was 165,100 acres, to 2006, when it was 163,700 acres. The alfalfa harvest areas have decreased by almost half, from 13,000 acres in 1982 to 6,100 acres in 2006. The harvest area of the other hay crops decreased from 2,000 acres in 1982 to 900 acres in 2006. Oats have witnessed a substantial decrease in harvest area, from 7,900 acres in 1982 to 300 acres in 2006. Sorghum was grown in Harrison Country for only three years—1982, 1983, 1984—and the harvest area did not exceed 600 acres. The other major crop, after corn, in Harrison Country is soybean. The harvested area of soybean increased from 121,500 acres in 1982 to 136,800 acres in 2006. Wheat is also grown in Harrison Country, with a significant decrease in harvest areas: from 5,300 acres in 1982 to 400 acres in 2006.

Farm size and farm number. Harrison County, like the other counties in Iowa, experienced both an increase in farm size and a decrease in the number of farms between 1982 and 2006. The farm size was 352 acres with 1,210 total farms in 1982. By 2006, farm size had increased to 519 acres, and the total number of farms decreased to 820.

The total number of farm operators in Harrison County decreased from 1,862 in 1959 to 828 in 2002. The average age of the farm operator increased from 48.3 years in 1959 to 54.1 years in 2002. At the same time, Harrison County, like the other counties, experienced a decline in young farm operators aged 34 and younger, from 315 in 1959 to 58 in 2002. Surprisingly, the number of farm operators aged 65 and over decreased from 224 in 1959 to 188 in 2002.

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are Dunlap, Modale, Persia, Logan, Little Sioux, Mondamin, Pisgah, River Sioux, Magnolia, Missouri Valley and Woodbine.

Population. The population in Harrison County has decreased from 16,240 inhabitants in 1970 to 15,579 inhabitants in 2002.

Topography and environmental issues. Harrison County has three topographic areas: rolling upland, steep bluffs along the Missouri River bottom land and the broad level bottom land along the Missouri and Boyer rivers. The county is drained by the Missouri River and its tributaries. The need for artificial drainage exists in the bottom land, which lacks natural drainage systems, and the soil in these areas is fine-textured [USDA H. (1997)].

Land in Harrison County was enrolled in six conservation programs as of 2007. The first conservation program was CRP, with 16,531 acres enrolled. The second program was Conservation Technical Assistance, and Harrison County had 11,278 acres enrolled. The third program was CTA-Grazing Land Conservation, and enrollment acreage was 627. The fourth conservation program was EQIP, and enrollment acreage was 8,584. The fifth conservation program was EQIP-Ground and Surface Water Conservation, with 2,115 acres. The final conservation program was the Wildlife Habitat Incentive Program, and the enrollment acreage was 176.

Keokuk County

Overview. Keokuk County is located in the southeastern part of Iowa. Keokuk County has 16 townships and 7 cities.[22] Keokuk County has an area of 371,300 acres. The total farmland was estimated at 357,500 acres in 1982, and decreased to 341,500 acres in 2006.

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[22] Keokuk Country has 16 townships: Adams, Benton, Clear Creek, East Lancaster, English River, Jackson, Keokuk Lafayette, Liberty, Plank, Richland, Sigourney, Steady Run, Van Buren, Warren and Washington. Keokuk County has seven towns: Sigourney, Keota, Hedrick, What Cheer, Richland, Delta and Keswick.

Crops. Keokuk Country primarily grew corn and soybean. The harvested areas of corn was estimated to be at 27,300 acres in 1982, but decreased to 102,400 acres by 2006. The other major crop, soybean, has increased from 67,200 harvested acres in 1982 to 91,400 harvested acres in 2006. Alfalfa acres decreased from 19,300 in 1982 to 16,000 in 2006. The harvest areas of other hay crops decreased from 7,500 acres in 1982 to 3,900 acres in 2005. There was no other hay crop in 2006. Oat harvest areas varied substantially, from 7,600 acres in 1982 to 710 acres in 2006. Keokuk Country is the second county among the selected counties in this survey that grew wheat. The harvest areas of wheat experienced large variations during 1982 to 2006, with 1,900 acres in 1982 and only 500 acres in 2006. The peak in wheat harvest areas was in 1990, when there were estimated to be 3,000 acres.

Farm size and farm number. The farm size in Keokuk County has increased from 295 acres in 1982 to 319 acres in 2006. Like the other counties, the number of farms has decreased from 1,210 in 1982 to 1,070 farms in 2006.

The number of farm operators decreased from 1,762 in 1959 to 1,024 in 2002. The average farm operator's age increased from 47.2 years in 1959 to 55.2 years in 2002. However, just like the previous counties, farm operators aged 34 years and younger have decreased in number from 332 in 1959 to 55 in 2002. In the same period of time, the number of operators whose age is 65 years or more has increased from 187 to 297.

Population. Population in Keokuk Country was estimated to be 13,943 inhabitants in 1970. Since then, the population decreased steadily to 11,401 in 2002.

Topography and environmental issues. Keokuk County has three kinds of areas. Upland is 910 feet above sea level; lowland has an elevation of 625 feet above sea level; the land located between the adjoining upland and the lowland ranges from about 100 to 120 feet above sea level along the Skunk River. The difference in elevation between the lowlands and the adjoining uplands ranges from 80 to 100 feet along the South English River and its tributaries in the northern part of the county. Keokuk County has moderately sloping and strongly sloping areas adjacent to the lowland [USDA K. (1997)].

Keokuk County had land enrolled in four conservation programs as of 2007. The first conservation program was CRP, with 52,912. The second program was Conservation Technical Assistance, with 8,906 acres enrolled. The third program was CTA-Grazing Land Conservation, and the enrollment acres were 550. The fourth conservation program was EQIP, with 4,674 acres enrolled. Finally, the fifth conservation program was the WRP, with 29 acres enrolled.

Warren County

Overview. With 366,000 acres, Warren County is located in the southern part of Iowa. The total farmland was estimated at 335,300 acres in 1982, but decreased to 297,000 acres in 2006. Warren County has 17 townships and seven cities.[23]

Crops. Warren County grows corn, alfalfa hay, soybeans, sorghum, and wheat. The first major crop in Warren County is corn. The harvested area of corn was 87,000 acres in 1982 and decreased to 67,100 acres in 2006. The harvested area of alfalfa was 28,300 acres in 1982, and the area decreased to 24,300 acres in 2006. The harvested area of the other hay crops decreased from 6,300 acres in 1982 to 2,900 acres in 2006.

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[23] Warren County has 16 townships: Allen, Belmont, East Lincoln, Greenfield, Jackson, Jefferson, Liberty, Linn, Otter, Palmyra, Richland, Squaw, Virginia, West Lincoln, Whit Breast, Union and White Oak. Warren County has seven cities: Indianola, Norwalk, Carlisle, Milo, Hartford, New Virginia and Martensdale.

The other crop is oats, for which harvested area has dropped dramatically from 7,900 acres in 1982 to 320 acres in 2006. Soybean is a major crop grown in Warren County. The harvested area was 60,600 acres in 1982 and increased to 63,600 acres in 2006. The last two minor crops were sorghum and wheat. Sorghum was grown in Warren County from 1957 to 1984. The harvested area was 2,680 acres and dropped to 100 acres by 1982 and 200 acres by 1984, which was the last year Warren County grew sorghum. Wheat started to be grown in Warren County in 1972 with a harvested area of 460 acres, which peaked at 2,200 acres in 1985. Dramatically, the harvested area decreased to 100 acres in 1997, which was the last year wheat was grown in Warren County.

Farm size and farm number. Comparatively, farm size and total farm numbers have changed since 1982, like other counties in the survey. Farm size was 238 acres in 1982, and increased slightly to 232 acres by 2006. The total number of farms decreased from 4,410 in 1982 to 1,280 by 2006. The total number of farm operators decreased from 1,847 in 1959 to 1,338 in 2002, during which time the average age of farm operators increased from 49.7 years to 56.8 years. Farm operators aged 34 or younger decreased from 278 in 1959 to 47 in 2002. Farm operators 65 years or over increased from 327 in 1959 to 428 in 2002.

Population. Unlike the other counties in this survey, the population in Warren County has been steadily increasing, from 27,432 inhabitants in 1970 to 41,456 inhabitants in 2002.

Topography and environmental issues. The majority of Warren County land is in the upper landscape, and along the neighboring river. Fully 80 percent of land is considered hilly or has high slopes. The major environmental problems the county faces include soil erosion and water quality (due to sediment), which compounds livestock issues.

Warren County had land enrolled in five conservation programs as of 2007. The first conservation program was CRP, with 28,813 acres. The second program was Conservation Technical Assistance, with enrollment acres of 5,366. The third conservation program was CTA-Grazing Land Conservation, with 229 acres enrolled. The fourth conservation program was EQIP, with enrollment acres of 2,678. The fifth program was the Wildlife Habitat Incentive Program, with only four acres enrolled.

Winnebago County

Overview. Winnebago County is located in northern Iowa. Winnebago County has 12 townships and 7 towns.[24] Winnebago County has an area of 256,700 acres. The total farmland area was 244,000 acres in 1982, but decreased to 238,000 acres in 2006.

Crops. Winnebago County grows corn, soybean, alfalfa, oats, and all hay crops. The harvested areas of corn have increased since 1982, from 119,100 acres, to 124,600 acres in 2006. Alfalfa harvest areas decreased since 1982, from 4,100 acres, to 1,700 acres in 2006. The harvested areas of the other hay crops also decreased, from 700 acres in 1982 to 300 acres in 2006. The harvested areas of oats have dramatically decreased, from 4,400 acres in 1982 to 470 acres in 2006. Soybean harvest areas stayed almost constant over time: there were 96,900 acres in 1982, which decreased slightly to 96,600 acres in 2006. Finally, wheat was grown in Winnebago County for four years (1984, 1985, 1986, and 1992). The harvested areas constituted 350 acres in 1984 and decreased to 100 acres in 1992.

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[24] Winnebago has 12 townships: Buffalo, Center, Eden, Forest, Grant, King, Lincoln, Linden, Logan, Mount Valley, Newton, and Norway. Its seven towns are Forest City, Lake Mills, Buffalo Center, Thompson, Leland, Rake and Scarville.

Farm size and farm number. Farm size in Winnebago County increased from 248 acres in 1982 to 384 in 2006; the total number of farms decreased from 860 in 1982 to 620 in 2006.

The number of farm operators has dramatically decreased since 1959, when it was estimated at 1,454, whereas only 631 farm operators remained in 2002. The average age of farm operators has increased slightly, from 46.8 years to 50.5 years. The number of farm operators aged 65 or older decreased from 134 in 1959 to 122 in 2002—like Harrison County. The number of farm operators aged 34 or younger decreased from 281 in 1959 to 106 in 2002.

Population. The population in Winnebago County has steadily decreased since 1970, when an estimated 12,990 inhabitants lived in the county, to 11,429 inhabitants in 2002.

Topography and environmental issues. Winnebago has two types of land: flat and hilly. The eastern part of Winnebago County has more highly erodible land than the western part of the county.

Winnebago County had land enrolled in four conservation programs as of 2007. The first conservation program was CRP, and enrollment totaled 13,601 acres. The second program was Conservation Technical Assistance, with enrollment acres of 15,964. The third program was EQIP, with enrollment acres of 2,986. Finally, 858 acres were enrolled in the WRP.

Woodbury County

Overview. Woodbury County is located in west-central Iowa. Woodbury County has 24 townships and 8 cities.[25] The county has an area of 557,400 acres. Total farmland was estimated at 511,600 acre in 1982, but decreased to 439,500 acres in 2006.

Crops. Woodbury County grows corn, soybean, oats, alfalfa, all hay crops, and (like some counties) wheat. The harvested areas of corn have fluctuated since 1982, when there were 239,200 acres, but have decreased to 198,700 acres in 2006. Alfalfa acreage decreased from 17,200 in 1982 to 7,600 in 2006. The harvested areas of the other hay crops decreased from 5,000 acres in 1982 to 3,100 acres in 2006. Oat harvested areas have dramatically decreased, from 22,000 acres in 1982 to 710 in 2006. Sorghum was grown for only two years; the total harvested area was 800 acres in 1982, and decreased to 400 acres in 1984. Wheat was grown from 1982 to 1997, and the harvested areas decreased from 900 acres in 1982 to 380 by 1997.

Farm size and farm number. Average farm size has increased from 320 acres in 1982 to 389 acres in 2006. Consequently, farm numbers have decreased from 1,600 farms in 1982 to 1,130 in 2006.

The number of farm operators also decreased, from 2,387 in 1959 to 1,148 in 2002. Additionally, the average age of farm operators increased from 47.6 years in 1959 to 54.1 years in 2002. However, the number of farm operators aged 34 or younger decreased from 435 in 1959

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[25] Woodbury has 12 townships: Arlington, Banner, Concord, Floyd, Grange, Grant, Kedron, Lake Port, Liberty, Liston, Little Sioux, Miller, Morgan, Moville, Oto, Rock, Rutland, Sloan, Union, West Fork, Willow, Wolf Creek, Woodbury and Sioux City. The county also has eight towns: Sioux City, Sergeant Bluff, Moville, Sloan, Correctionville, Lawton and Anthon.

to 80 in 2002. Conversely, the number of farm operators aged 65 years or older increased slightly, from 245 in 1959 to 259 in 2002.

Population. The population in Woodbury County increased slightly between 1970 and 2002, from 103,052 inhabitants to 103,220.

Topography and environmental issues. Woodbury County has two types of land: flat area, represented by the Missouri River Flood Plain, and which is used for growing row crops, corn, and soybeans, and hilly land, represented by the Loess Hills, which is used for grazing. Woodbury Country has prairies (natural ecosystems) which are jeopardized because of improper management of grazing in the area. Additionally, the county experiences invasion of some native plant species, such as Eastern Red Cedar trees and Leafy Spurge, which is not edible for cows, because of its bitter taste and adverse health effects. Finally, Woodbury County has soil problems, especially in the hilly area.

Woodbury County had land in seven conservation programs as of 2007. The first conservation program was CRP, where the enrollment acreage was 27,708. The second program is the Conservation Technical Assistance Program, where the enrollment acreage was 15,964. The third program was CTA-Grazing Land Conservation, and the enrollment acreage was 614. Fourth was EQIP, with 326 acres enrolled. The fifth program was the Flood Prevention Operation, where 4,009 acres were enrolled. The sixth program was the WRP, with 80 acres enrolled. The final program was the Wildlife Habitat Incentive Program, with 220 acres enrolled.

APPENDIX D: RANDOM UTILITY MODEL

A landowner, like any consumer, would consume a basket of goods and services that maximizes his (or her) utility subject to a budget constraint. Let the land owner utility 'depends on goods and services consumed' be represented by the vector ge = {g1, g2, … gn}, and his utility be derived from the function U(g). He has to maximize his utility subject to his budget constraint $\sum$ ve ge $\leq$ M, where ve is the price of good ge. M is the total income earned by the land owner. Then, the land owner has to choose optimal quantities of goods and services (denoted by g*),given the budget constraint.

There are two major sources of income (M) for a landowner: farm profits (Π) and non-farm income (Λ). Hence, the utility maximization of the farmer can be stated as

Max	U(g)	(4.1a)
with respect to vector	g	
subject to the budget constraint	$\sum$ ve ge $\leq \Pi + \Lambda$	(4.1b)

If the landowner is an absentee owner, the farm returns (Π) is entirely composed of land rents, since he is not directly involved in farming; if he is an owner operator, then the income is derived from farm cultivation, which entails a profit maximization problem, described below. The land owner maximizes his farm profits subject to production function constraints; assume that the farmer produces a vector (set) of outputs (e.g., corn, soybeans, wheat, and so on), denoted by y from an input vector x. Then, his profit maximization problem can be written as

Max	$\Pi = \sum$ pm ym – $\sum$ wn xn – FC	(4.2a)
with respect to inputs	x = {x1, x2,…,xn}	
subject to production functions,	ym = f(x), m = 1,2,…M	(4.2b)

where,

pm = price of output m (corn, soybeans, etc), m = 1,2,…M

ym = yield of output m

wn = cost of variable input n (chemicals, seeds, machinery, etc), n = 1,2,…N

xn = quantity of variable input n

FC = fixed costs of land, labor, buildings, machinery and others

Note that in the above problem (4.2), the land owner considers the net returns (owner operator) derived from regular farm inputs alone (in case of an absentee land owner, it is simply rental returns). If the land owners adopt a set of conservation practices (C), it will affect their farm profitability (Π), since adoption of conservation practices entails certain costs, denoted by g(C). Adoption of conservation practices also changes the output production functions, since they increase the physical conditions and the synergy between the inputs x. For a land owner who adopts conservation practices, the profit maximization problem would be:

Max	$\Pi = \sum pm\ ym - \sum wn\ xn - FC - g(C)$	(4.3a)
with respect to input vector	x	
and conservation practice vector	C	
subject to production functions,	$ym = f(x; C)$, m = 1,2,…M	(4.3b)

Problem 4.3 is different from 4.2 in two ways. First, there is an extra set of choice variables C, the conservation practices, that can be chosen by the land owner; if the farmer chooses certain conservation practices, then he has to incur some fixed and variable costs associated with them (represented by g(C), where g is a function with g(0) = 0). Second, the

production functions in 4.3b change to reflect the benefits to farm productivity and enhanced resource quality (such as water quality, soil carbon, soil organic matter, soil erosion, and so on), denoted by the vector $\check{R} = \{\check{R}h, h = 1,2,\ldots H\}$, with conservation practices. In addition, land owners can also get utility from the improved resource quality ($\check{R}$). If land owners choose not to install any conservation practice ($C = 0$), then Problem 4.3 simplifies into 4.2 described above.

The profit maximization problem (4.3) can be maximized by choosing optimal levels of farm inputs and conservation practices. The optimal level for farm inputs is denoted by $x^*(p,w; C^*)$, meaning that it depends on the input price vector (w), output price vector (p) and the chosen levels of conservation practices (C^*); the optimal level of conservation practice denoted by $C^*(w,p; \check{R})$ would depend on input price vector (w), output price vector (p) and land owners' desired quality of land, soil and water resources ($\check{R}$). The decision to choose x^* and C^* can be either sequential or simultaneous. (Given that a land owner might have some preferred level of resource quality ($\check{R}$), he will choose a certain C^*—given the choice of C^*, he will choose a certain level of inputs x^*). In either case, the resultant farm income could be represented by this indirect profit function

$\Pi^* = Л(x^*, C^*; \check{R}) = Л(p, w; \check{R})$, since x^* and C^* are functions of p and w.

To quantify the impacts of conservation practices and to reflect the fact that farmers derive additional utility from the quality of natural resources, problem 4.1 can be rewritten as

Max	$U(g, \check{R}; C^*)$	(4.4a)
with respect to vector	g	
subject to the budget constraint	$\sum ve\ ge \leq Л + \Lambda$	(4.4b)

The above problem is different from 4.1 in two respects. First, the utility of land owner depends not only on the goods and services consumed (g), but also on the quality of natural resources in farming (Ř); second, the budget constraint 4.4b has the net farm returns function (Π) replaced with the indirect profit function (Л) to ensure that farm profits remain at optimized levels for all levels of inputs and outputs. Upon maximization of utility by choosing optimal values of g, Ř (implicitly, from C* and x*)—the indirect utility function—can be written as V(v, p, w; C*) or V(d; C*), where d represents the set of vectors (v, p, w). Note that indirect utility function V gives the optimal values of consumption for goods and services for all levels of income (Л + Λ).

If the land owner adopts kth conservation practice, then the maximal utility attained by the landowner can be expressed as V1 = V(d; Ck* = 1), where the number 1 refers to the adoption of kth conservation practice. Hence, the maximum utility for the land owner who did not adopt the kth conservation practice would be V0 = V(d; Ck* =0).

APPENDIX E. PROBABILITY MODEL

The probability measure Pr [Ck = 1] = Pr [V1 ≥ V0] can be written as

$$\Pr (Ck = 1) = \Pr [Q(q, \varepsilon; Ck=1) \geq Q(q, \varepsilon; Ck=0)]. \quad (4.5b)$$

Assuming a linear function for Q and additive error, this becomes

$$\Pr (Ck = 1) = \Pr [q\, \beta 1 + \varepsilon\, 1 \geq q\, \beta 0 + \varepsilon\, 0], \text{ where} \quad (4.5c)$$

β1 = functional parameters estimated when the conservation practice Ck = 1 (adoption)

β0 = functional parameters estimated when the conservation practice Ck = 0 (non-adoption)

ε 1 = error in the linear functional approximation q β1, when Ck = 1

ε 0 = error in the linear functional approximation q β0, when Ck = 0

Rearranging (4.5c)

$$\Pr (Ck = 1) = \Pr [\varepsilon\, 1 - \varepsilon\, 0 \geq q\, (\beta 0 - \beta 1)\,] = \Pr [e \geq q\, b]$$

where

e = difference in error, ε1 – ε 0

q = landowner characteristics such as age, education

b = difference in estimated parameters, β0 – β1

If e is assumed to be independently and identically distributed according to a symmetric distribution, we have

$$\Pr (C_k = 1) = \Pr [e \geq \mathbf{q\, b}] = \Pr [e \leq \mathbf{q\, b}] = F(\mathbf{q\, b}) \quad (4.9)$$

where $e = \varepsilon_1 - \varepsilon_0$ and $\mathbf{b} = \boldsymbol{\beta_0 - \beta_1}$.

where F(**q b**) is a cumulative distribution function of e.

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