# IMPORTANCE OF CONTRACT ATTRIBUTES ON CONSERVATION RESERVE PROGRAM ENROLLMENT DECISIONS IN THE PRAIRIE POTHOLE REGION

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**Title**

Importance of Contract Attributes on Conservation Reserve Program Enrollment Decisions in the Prairie Pothole Region

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

**MASTER OF SCIENCE**

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# ABSTRACT

U.S. farmers' interest in CRP has waned. Enrollment for 2015 was targeted at 26 million acres but as of the end of February, actual enrollment had declined to 24.6 million acres (USDA, 2015). Available studies point to recent fluctuations in commodity prices as a predominant factor in this enrollment gap. Other potentially influencing factors remain understudied, including farmer preferences for contract design. A choice experiment survey was conducted in the Prairie Pothole region to assess these preferences. An exploded logit model was used to evaluate the preference heterogeneity among program attributes. Results indicate that an increase in the maximum payment, length of contract, and the government's share of establishment cost increase the utility of farmers, whereas, fixing terms at the beginning of the contract and imposing more land use restrictions on enrolled land have a negative impact on farmers' utilities.

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# CHAPTER 1. INTRODUCTION TO THE STUDY

## 1.1. Introduction

Land retirement programs have a long history in the United States. They were initiated in the 1930s in response to decreasing commodity prices. By removing land from production, these programs met the objectives of supporting commodity prices by reducing agricultural supply and stimulating agricultural conservation. The Conservation Reserve Program (CRP) is an example of such a program. It too had an initial focus on commodity price support although, over time, objectives have shifted to conservation.

"CRP is designed to establish long-term conservation covers and local ecosystem improvements on American farmland. The program pays producers a rental payment for establishing long-term plant cover to improve water quality, control soil erosion, and improve wildlife habitat. CRP enrollment is voluntary, the contract duration is from 10 to 15 years, and most contracts are awarded through competition" (Ferris and Siikamäki, 2009, P.2).

Administered by the U.S. Department of Agriculture (USDA), the CRP has a current enrollment of 24.3 million acres on 365,000 farms. Enrollment has been affected by fluctuations in commodity markets. For example, in 2007-2008, mounting commodity prices increased the opportunity cost of placing land in long-term land retirement programs and henceforth affected landowners' enrollment decisions. In fact, CRP acreage decreased 17.1 million acres between FY2007 and FY2014 (Stubbs, 2014). Currently, the policy stipulates an enrollment cap of 24 million by FY2018[1]. A federal budget savings of $3.3 billion dollars over the next ten years is anticipated as a result of the reduced enrollment cap. However, this comes at a cost to include loss of benefits associated with improved wildlife habitat, prevented erosion, and reduced carbon

[1] CRP acreage enrollment cap decreases to no more than 27.5 million acres in FY2014; 26 million acres in FY2015; 25 million acres in FY2016; and 24 million acres in FY2017 and FY2018 (Stubbs, 2014).

sequestered in soils after land is re-introduced to production. Maximum benefits are provided by those lands which remain under a land retirement program for the longest period (Farm Service Agency, 2014).

Anticipating this crisis, authors have contributed to the literature by suggesting modifications for the CRP. For example, Secchi and Babcock (2007) used the Environmental Policy Integrated Climate (EPIC) model to estimate the environmental impact of rising corn and soybean prices on the return of CRP to production status in Iowa. They concluded that under higher commodity prices, either a substantial increase in budget would be required to maintain the current level of environmental benefits or a targeted approach for maximizing the cost/benefit ratio from land retirement programs would be necessary. Baker and Galik (2009) also studied the impact of higher crop prices and increasing land returns on CRP acreage. They concluded that several modifications in the program would be required to increase income flow from CRP lands to maintain enrollment, such as allowing the sale of carbon-offset credits.

Roberts and Lubowski (2007) noted that land on which farming is more profitable has a higher probability of contract cancellation and of land conversion back to production after contract expiration. To overcome the problem of resulting acreage reductions, they suggested that a onetime signing bonus should be provided to new enrollees because opportunity costs are higher for newly enrolled land than for re-enrolled land. This first-time premium could be more effective if it varied according to the likelihood that land will remain out of production after the contract expires. Finally, Roberts and Lubowski highlighted the fact that CRP land with trees and/or wildlife practices were about half as likely to return to crop production as lands covered with grasses and/or legumes. Based on this finding they concluded that, in order to achieve

environmental goals cost-effectively, greater focus should be conferred on tree-planting and wildlife benefits.

Wu (2000) identified another major issue affecting the effectiveness of CRP, its tendency to bring non-cropland into crop production, known as slippage. High commodity prices associated with reduced production on CRP land, and substitution effects[2] are the two major reasons for slippage.

Several other studies, discussed in more detail in Chapter 2, investigated the characteristics, motivations, beliefs, and attitudes of CRP contract holders. However, none of the CRP-specific literature has considered the impact of these factors on landowner utility or on their likelihood of (re) enrolling. In fact, because choices with tradeoffs were not explicitly investigated, previous research may overstate the importance of various factors to the landowners and, in general, does not allow estimation of the relative importance of their priorities. One exception is Lambert et al. (2006a; 2006b) who predicted the likelihood of participating in a land retirement program using actual behaviors rather than stated or intended behavior.

Against this background, the focus of the current study was to investigate farmers' responses to alternative designs of CRP program contracts by identifying the effects of contract attributes on farmer preferences. This study follows up on findings from the literature that, in order to keep this program competitive, viable, and working towards its intended goals, CRP payments must keep pace with rising farmland rental rates. This is accomplished by investigating the extent to which farmers are willing to trade off payments for less restrictive program requirements.

[2] When some cropland is taken out of production, farmers may substitute other land for crop production because of scale economies and fixed input costs

The study was conducted in the Prairie Pothole Region (PPR; Figure 1.1) of the United States including parts of Montana, North Dakota, South Dakota, Minnesota and Iowa. The PPR is the most important waterfowl production area in North America, covering approximately 185,000 square miles of wetlands.

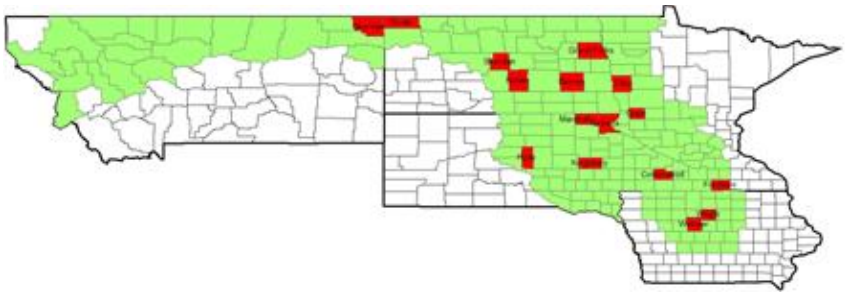

Figure 1.1. Prairie Pothole Region of United States

Source: USDA, http://www.rma.usda.gov/data/pothole/2008/all_states.pdf

## 1.2. Problem Statement

Efficacy of conservation programs depends on preserving the environmentally sensitive land and participation of the producers/owners of such land. Return per acre is the most significant factor for any producer and many input decisions are based on the output potential of scarce resources although other factors also play a role. Policy makers would benefit from an enhanced understanding of how farmers make land use decisions about their scarce land, which factors affect their willingness to accept CRP contracts, and how they would react to future program changes.

In this study, a quantitative model was applied to understand and identify the important attributes to the farmers' decision to enroll or not to enroll in the CRP. In particular, we identify how contract specifications influencing the decision of farmers' willingness to participate,

identify the heterogeneity of preferred level of attributes within defined subsets and draw conclusions based on the suggestions and feedback received

The empirical analysis is based on the discrete choice experiments (DCE) completed by 76 farmers from family farms during 2014. The DCE allows us to understand the effects of different contract attributes. It also allows evaluation of tradeoffs that farmers are willing to make between rental payment and other terms of the contract. Statistical regression analysis was constructed to identify heterogeneity of the economic and socio-economic factors by using an exploded logit model, which is described more in more detail in chapter 3. This analysis will assist both policy makers and producers involved by evaluating the important factors that could change current characteristics, policies, and effectiveness of the CRP.

## 1.3. Research Objectives

The research objectives of this study are as follow:

i. Examine preferred levels of attributes for the CRP
ii. Identify how these different attributes affect the decision of farmers to enroll in CRP
iii. Identify socio-economic characteristics and attitudes that impact farmers' preferences, and
iv. Estimate willingness to tradeoff (WTT) between rental payments and other contract attributes.

## 1.4. Operational Definitions of Terms and Acronyms

*Conservation Reserve Program (CRP):* A voluntary long-term cropland diversion program administered by the Farm Service Agency (FSA). In this program, USDA establishes contracts with farmers to set aside their highly erodible or environmentally sensitive croplands,

for conservation use, in exchange for financial and technical assistance. Long-term program goals are to improve water quality, prevent soil erosion, and reduce loss of wildlife habitat.

*Farm Bill*: A comprehensive omnibus multi-year bill, authorizing legislation pertaining to agriculture and food programs under the purview of the USDA.

*Natural Resources Conservation Services:* The Natural Resources Conservation Service (NRCS), formerly known as the Soil Conservation Service (SCS), is an agency of the United States Department of Agriculture (USDA) that provides technical assistance to farmers and private landowners.

*Environmental Benefits Index:* The Environmental Benefits Index (EBI) is an index used by FSA to evaluate and rank farmers' land on the basis of expected environmental benefits to soil resources, water quality, wildlife habitat, and other resource concerns for enrollment in the CRP during a general signup.

*Local Maximum:* A local maximum value is the highest value of a function within a small interval hence there could be more than one local maximum within the entire domain.

*Global Maximum:* A global maximum is the highest value of the function within the entire domain and there can only be a single global maximum within that domain.

## 1.5. Summary

The Conservation Reserve Program is one of more than twenty voluntary conservation programs in the United States. Changes in agricultural commodity markets necessarily affect land retirement programs, and make their management challenging. The PPR is a rich habitat of many species. About half of the prairie potholes and surrounding grasslands have been converted for production, raising alarm among the conservation community. The purpose of this study was to analyze and assess the most significant parameters affecting farmers' decisions on CRP

enrollment by developing and analyzing hypothetical choice sets. Contemporary research on this subject does not allow for assessment of the tradeoffs between program attributes.

The CRP is a federal program employed locally. There have been very limited provisions to analyze the effectiveness of the program locally. For policy makers, the results will also help in providing more information about PPR farm operators so as to improve the balance, efficiency and effectiveness of the CRP. Furthermore, understanding what is important to farmers will help to target educational effects.

# CHAPTER 2. LITERATURE REVIEW

## 2.1. Introduction

Since the inception of CRP in 1985, evolution in guidelines and advancement in technology, along with fluctuating market conditions, have endured as factors affecting producer's enrollment decisions. This review covers literature focusing on producer decision-making in the areas of land use and conservation.

Academic, scholarly, historical and industry literature were reviewed. Additionally, government publications relating to conservation programs and farm bills were studied. The initial focus was on the evolution of land-retirement programs. Second, consideration focused on the influence of commodity prices on CRP enrollment. Finally, the literature regarding factors affecting conservation decisions is discussed.

## 2.2. The Conservation Reserve Program: Brief Review

The Conservation Reserve Program was initiated with the passage of the Food Security Act of 1985 and was reauthorized in all subsequent farm bills (Wu and Weber, 2012). It is a voluntary, long-term cropland diversion program under management of the USDA. In this program, farmers voluntarily set aside their environmentally sensitive cropland with appropriate cropping history in exchange for monetary and other benefits (e.g., technical assistance) for 10 to 15 years.

Although CRP was not established until the mid-1980s, government involvement in cropland diversion has a much longer history. As noted in Chapter 1, the first program was initiated in the early 1930s with the purpose of controlling over-production. Later, objectives were expanded towards reducing soil erosion and increasing availability of water for agriculture. In 1956, a Soil Bank Program was instituted that paid farmers to retire their farm land from

production for 3 to 10 years with the main purpose of supply reduction of the six basic crops:- wheat, corn, cotton, tobacco, rice, and peanuts (erodible land was not targeted) (Helms, 1985). In 1983, the government launched the Payment in Kind (PIK) program to idle cropland. This was only for a short period and the focus was again to manage supply.

The aforementioned early efforts set the roots for what is today the CRP. In the 1985 farm bill, many changes were made to the guidelines of its predecessor programs. The length of the contract was increased from 3 years to periods of 10 or 15 years. The purpose was also modified and prevention of soil erosion became its primary goal. Secondary objectives were to manage over-production of commodities, support farm incomes, preserve long-term capacity to produce food and fiber, reduce sedimentation, improve water quality, and create fish and wild life habitat.

Overtime, the program has evolved in every farm bill. The Food and Agricultural Conservation and Trade Act (1990) broadened eligibility of CRP to include more environmentally-sensitive land and expanded existing primary goals of reducing soil erosion and improving soil quality to include improving wildlife habitat and water quality (Jacobs, Thurman and Marra, 2011). In 1991, the bidding procedure was changed. The Environmental Benefits Index (EBI)[3] was employed to rank bids, and a maximum rental rate was determined based on comparable cropland (Soil and Water Conservation Foundation and Environmental Defense Fund, 2008). The Federal Agriculture Improvement and Reform Act of 1996 added wildlife habitat to the EBI and provided other options for farmers to participate (Kirwan, Lubowski and Roberts, 2005). It allowed early termination of contracts with the exception of filter-strips,

[3] The EBI ranks CRP offers by weighing program costs for enrolling land in CRP against six environmental objectives (wildlife habitat, water quality, erosion control, enduring benefits, air quality, and state or national conservation priority areas) (Cattaneo et al, 2002).

waterways, strips adjacent to riparian areas, and highly-sensitive or highly-erodible land (O'Brien, 2003). In 1997, the USDA established the Conservation Reserve Enhancement Program (CREP), a partnership among producers and state and federal governments. In this program, the USDA funds part of the program and states provide the remaining funds. The program was designed to encourage farm conservation practices that meet specific state and national conservation and environmental objectives (Farm Service Agency, Undated). Under the 2002 Farm Bill, the cropping history requirement for land eligibility for CRP enrollment was increased and changes were made related to contract extension and re-enrollment. A requirement was added that there is an equitable balance between program objectives. The eligibility requirement was once again changed in the 2008 Farm Bill. Changes in this legislation included (i) a reduced total enrollment cap from 39.2 million acres in 2009 to 32 million in 2010-2012, (ii) the addition of a local preference criteria, (iii) authorization for the USDA secretary to waive the 25% of county cap, (iv) allowance that currently enrolled land be automatically considered for re-enrollment, and (v) a requirement that the USDA post rental rates. The Agriculture Act of 2014 reduced the maximum allowable CRP enrollment from 32 million to 24 million over the five-year life of the bill. It allows contract holders, with certain land classes, to terminate contracts in fiscal year 2015 if the land has already been enrolled for at least five years.

### 2.3. CRP Implementation

CRP is administered by the Farm Service Agency (FSA) under USDA, with technical support from the Natural Resources Conservation Service (NRCS) and other USDA-controlled agencies (Stubbs, 2014). There are two ways to enroll: general sign-up and continuous sign-up. Combined enrollment is restricted to no more than 25 million acres at any given time in FY2015. General sign-up is competitive, and is only open on specific dates, during which landowners can

submit bids defining the rental rate amount at which they would accept a contract. Bids are then ranked based on EBI. As of March 2015, 75% of total CRP lands, comprising 18.2 million acres, were enrolled under general sign-up contracts. This includes 239,209 contracts on 164,790 farms. Environmentally-sensitive land devoted to certain conservation practices may be enrolled in CRP at any time under continuous sign-up. Unlike the general sign-up process, offers are automatically accepted, provided the land and producer meet certain eligibility requirements. Acceptance is not subject to competitive bidding. As of February 2015, 6.1 million acres—25% of total CRP lands—were enrolled under continuous sign-up. This 25% acreage also includes acreage enrolled under two sub-programs, 1.2 million acres enrolled in the Conservation Reserve Enhancement Program (CREP) and 354,473 acres in the Farmable Wetland Program.

To be eligible for CRP enrollment, a producer must have owned or operated the land for at least 12 months prior to the close of the CRP sign-up period, unless: "(i) the new owner acquired the land due to the previous owner's death, (ii) the ownership change occurred due to foreclosure where the owner exercised a timely right or redemption in accordance with state law, or (iii) the circumstances of the acquisition present adequate assurance to FSA that the new owner did not acquire the land for the purpose of placing it in CRP" (FSA Fact Sheet, 2014, p, 2)

**2.4. Eligible Land**

USDA may consider the following land types for enrollment:

- "Highly erodible cropland that: (i) if untreated could substantially reduce the land's future agricultural production capability or (ii) cannot be farmed in accordance with a conservation plan; and has a cropping history or was considered to be planted for four of the six years preceding February 7, 2014 (except for land previously enrolled in CRP); or is marginal pasture land devoted to appropriate vegetation for water quality purposes";

- "Grasslands that: (i) contain forbs or shrubland on which grazing is the predominant use; (ii) are located in an area historically dominated by grasslands; and (iii) could provide habitat for ecologically significant animal and plant populations if restored or retained in its current condition."
- "Cropland that is otherwise ineligible, if it is determined that: (i) if permitted to remain in agricultural production, it would contribute to the degradation of soil, water, or air quality; (ii) the land is a newly created, permanent grass sod waterway, or a contour grass sod strip; (iii) the land will be devoted to newly established living snow fences, permanent wildlife habitat, windbreaks, shelterbelts, or filter strips or riparian buffers devoted to trees or shrubs; (iv) the land poses an off-farm environmental threat; or (v) enrollment of the land would facilitate a net savings in groundwater or surface water resources; or certain land enrolled as a riparian buffer or for similar water quality purposes" (Stubbs, 2014, p.3).

## 2.5. Commodity Prices and the Conservation Reserve Program

Fluctuating agricultural commodity prices have always been a challenge for management of long-term land retirement programs. For example, in 2007, CRP acreage reached its peak of almost 37 million but surging commodity prices during the 2007–2008 marketing year were in large part responsible for a 2.1 million acre decrease in CRP acreage in a short span of 12 months. In the PPR region alone, more than 1 million acres were removed that year.

Some of the major factors likely responsible for the decline include (i) changes in program priorities, (ii) advancement of farming technologies, and (iii) changes in producer's preference due to availability of various alternative subsidy-based programs. However, there is general agreement that the most important one was the unprecedented increase in commodity

prices and subsequent increase in income from farming (Stubbs, 2014 and Rashford, Walker and Bastian, 2010).

Roger (2011) mentioned when high commodity prices persist in the long run, a two-fold issue is created. First is the increase in commodity prices themselves. Farmers are assumed to be profit-maximizing. The gap between CRP rental payments net of associated costs and prospective profits earned from farming is sufficient incentive to return land under expiring contracts to production. A second problem emerges when the government updates the rules and guidelines of CRP as a result of shifts in price. Subsequently, acreage under expiring CRP contracts is not renewed or extended. This also results in farmers bringing their environmentally-sensitive land into production.

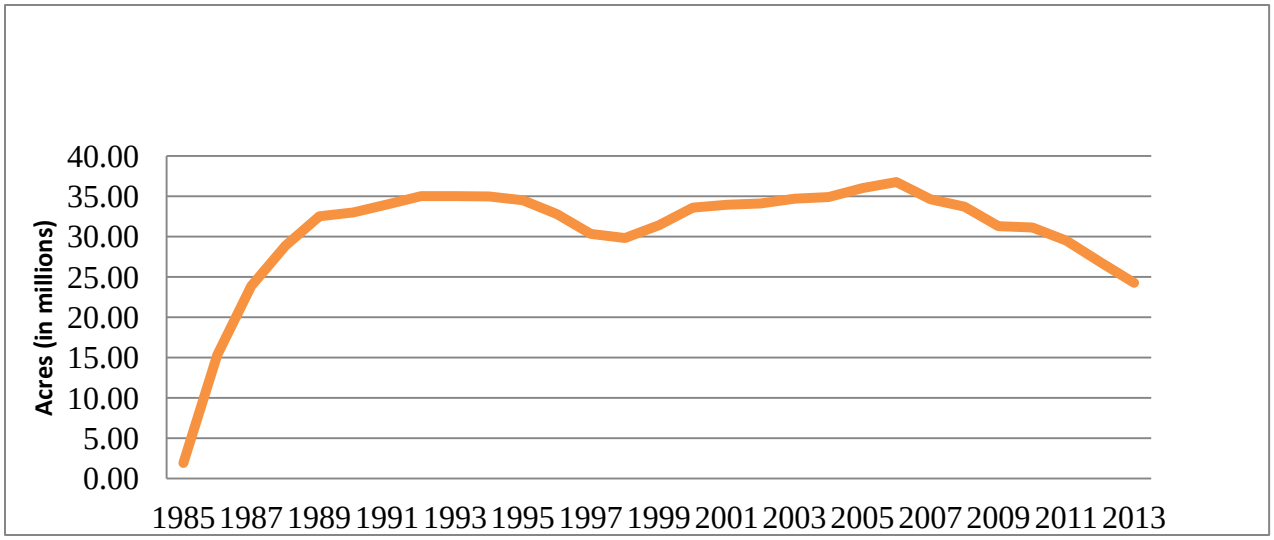


Figure 2.1. Yearly CRP enrollment from 1986 to 2014

Source: Data collected from USDA[4]

Cooper and Osborn (1998) investigated the impact of changes in rental rates on existing CRP contract holders and on re-enrollment decisions, considering CRP rental rates as an

[4] http://www.usda.gov/wps/portal/usda/usdahome?navid=DATA_STATISTICS

opportunity cost. In their study, CRP contract holders were asked about their willingness to extend their current contract under two hypothetical scenarios. In the first case, they were given an option to get 'X' percent of their current payment for an extension of their current contract for another 10 years but were not allowed to hay or graze the land. In a second case, the payment was changed to 'Y' percent with an option of haying and grazing allowed only after mid-July. They found that CRP rental rate had a positive and strong effect on farmers' willingness to extend their contracts. There was a large and significant difference in preference for the haying and/or grazing option between farmers with livestock and those without livestock. Livestock farmers were willing to accept lower rental rates if haying and/or grazing was permitted, whereas those without livestock required higher rental payments if grazing was permitted. Other independent variables such as farm income, market value of adjacent land and erosion rate on CRP land prior to its enrollment reduced the likelihood of contract re-enrollment.

Secchi and Babcock (2007) modeled the effects of rising corn and soybean prices on the return of CRP to production in Iowa. They constructed CRP supply curves by estimating whether land enrolled in CRP would earn more by remaining in the program or by returning to production under various corn prices, assuming soybean prices remained at $4 per bushel. These supply curves for CRP were constructed with the corn prices ranging from $2 to $5 per bushel. Sechi and Babcock estimated that an increase in corn prices to $3 would result in conversion of a million acres of Iowa's CRP land into production, while an increase to $5 per bushel would result in about a 70,000 acres shift of Iowa's CRP acres into production. They concluded that there is a need for higher CRP program payments in order to reverse the effect of high commodity prices.

Gill-Austern (2011) employed a series of models to evaluate the impact of corn prices, corn yield, state GNP, and corn acreage on CRP enrollments within the Corn Belt region (Indiana, Illinois, Iowa, Missouri, Nebraska, Ohio and Kansas) from 1986 to 2010. Increasing corn prices generally preceded reduced CRP enrollment, and, depending on the model, these estimated decreases ranged from 135,000 to 250,000 acres (estimated to be between 13 and 22% of enrolled acres) over a three-year, lagged impact window. Corn yields did not contribute to model efficacy, and results for state GNP were mixed, although they favored an inverse relationship with CRP enrollments. The author points out short-term spikes in prices are not likely to impact CRP enrollment levels, whereas the data reveal that after the three-year period, impacts of consistently high commodity prices are statistically discernible.

Hellerstein and Malcolm (2011) undertook the most comprehensive examination of the effects of changing prices and other factors on CRP enrollment. They looked at the cost of maintaining 32 million CRP acres as targeted in the 2008 Farm Bill. They used a likely-to-bid model (LTB) for predicting the effects on acreage if the program was started from scratch and all enrollment signups were done at one time and an opt-out model for analyzing which contracts would withdraw from their current contract under varying commodity prices, ethanol policy, and CRP rental payments. They found that it would require doubling the rental rates in order to enroll enough acreage to provide the same environmental benefits that were generated by existing CRP contracts at the time. They predicted that, if government spending did not increase or remained constant; landowners would start looking for some more lucrative alternatives for their profitable (but environmentally sensitive) land, resulting in reduced benefits provided from enrolled acres.

McLaughlin et al. (2002) examined the consequences of bringing CRP land into production due to increased bioenergy crop production. They found that 13.3 million acres

would be removed from CRP if prices of switch grass reached $47.50. Baker and Galik (2009) mentioned a couple of ways to prevent the land coming out from CRP for crop production. First, they suggested providing additional compensation in those years where commodity prices are extremely high resulting in higher profits from farming, and second, allowing the sale of carbon credits.

## 2.6. Producers and CRP Decision

Other studies have analyzed the impact of participant characteristics, motivations, beliefs, and attitudes on CRP enrollment. Hatley et al. (1989) examined socioeconomic characteristics of CRP holders in 11 counties of the Texas High Plains. Participants were randomly selected and were interviewed on the basis of age, education, occupation, tenure, operation size, and operation type. They found older farmers (64 years and above) were more interested in participating in CRP than younger farmers (44 years or less). Age, full ownership, and part-time farming were positively correlated with CRP participation but operations with 140 acres or less (small farmers) hardly participated. Mortensen et al. (1990) applied a similar approach in North Dakota and they found a positive correlation between age, farming as a primary occupation, and decisions regarding participation in a CRP contract.

Soule et al. (2000) studied data on 941 U.S. corn producers to analyze the effect of land tenure on the adoption of conservation practices. The variables used in their study were conservation practice type, farm size, operator characteristics, land erodibility, annual precipitation, average temperature and regional location. They found that tenure had a positive effect on conservation practice adoption and owners were interested to adopt practices that provide benefits only over the longer term (grassed waterways, strip-cropping, and contour farming).

Lambert et al. (2006a) examined numerous conservation programs that included the CRP, Water Reserve Program (WRP), Environmental Quality Incentives Program (EQIP), and Conservation Security Program (CSP). The EQIP is a conservation program in which participants receive financial and technical assistance to implement conservation practices, some of which are also allowed under CRP (e.g. riparian buffers), and others that are not (e.g. waste storage, water tanks). The CSP program is designed to provide financial incentives for maintaining and improving participants' existing conservation systems. Lambert et al. (2007a) found positive relationships between percentage of land enrolled under conservation programs and farming experience, government payments to value of production, use of land under these programs and female operators. However, presence of grain crops and highly valued crops were inversely related and no association was found between percentage of land enrolled under a retirement program and high value crops, household size, a farm birthright, location proxemics to a water source or environmentally sensitive land, or the presence of a highly erodible land index.

In a follow-up paper, Lambert et al. (2007b) examined the effect of farm structure, farm household characteristics, and operator attributes on CRP enrollment. Farm structure characteristics included total cropland acres, percentage of acres owned to acres operated, percentage of revenue from crop production, and government and CRP payments per acre. The farm household characteristics were percentage of off-farm income to total household income and percentage of less than 18 years of age living in the household. Human capital characteristics included number of years in farming experience and education. Results showed that CRP payments and farm size were positively related with the amount of land enrolled under CRP.

## 2.7. Slippage

A major issue affecting the effectiveness of the efficiency of conservation programs in meeting program objectives is the tendency to replace acres enrolled in a conservation reserve program with non-cropland in crop production. This is referred to as slippage. Wu (2000) identified two reasons for slippage. First is a price effect, when some cropland may be brought into production because of increased commodity prices associated with less supply of such commodities in market. Another reason for slippage is substitution effects. When some cropland is taken out of production, farmers may substitute non-farming or marginal land for crop production because of scale economies and fixed input effects.

One potential limitation of Wu's analysis is that it does not anticipate the effect of increased supply on price of similar commodities to feed back into land-use decisions. That is, if land will be brought into production, this would increase supply and reduce commodity prices, further lowering expected revenue from all affected crops. This situation would discourage some farmers from planting these crops. If this happens, the national and state estimates of production and revenue impacts may be over- or understated, depending on interregional shifts in cultivation. This is slippage in reverse. For many years, research contradicted the claim of supply-control phenomena of land retirement programs. The contradiction was attributed to the price effect; farmers are motivated to bring marginal and/or uncultivated land into production that ultimately increases supply (Sullivan et al., 2004). A number of authors have claimed that ignoring slippage effects would result in an overestimation of acreage control benefits by 20 to over 50 percent, depending greatly upon type of crop, land quality, and location. However, others have found that the actual slippage effects may be lower than claimed (Hoag et al., 1993; Roberts and Bucholtz, 2005). If reverse slippage follows a similar pattern, CRP land coming into

production in one area may cause non-CRP land to drop out of production in other areas. Sullivan et al. (2004) suggested that to estimate the approximate correct size of slippage due to changes in commodity prices, an analysis should be made on effect on overall agricultural economy if CRP expired completely.

## 2.8. Producers Attributes, Perceptions and Intentions

Literature was considered which examined the determinants and effect of land use decisions after termination of CRP contracts. Land owners have an option between bringing back their land to non-conservation use or enrolling into any available voluntary programs (including re-enrolling into CRP). Johnson et al. (1997) conducted a survey in the Texas High Plains Region to identify and assess certain characteristics and attributes of participants and their land enrolled into a CRP contract. The survey was emailed to 740 contract holders. The response rate was 60 percent. Respondents were asked about characteristics of land (type of soil, availability of water), grazing potential, land use options if the contract will not be extended, reason for enrollment, and socio-demographic characteristics.

Results of this survey showed participant's interest in bringing back their CRP land into regular farming practices completely (44%) or partially (23%), subsequently impacting 69% of CRP acres amongst participants' acreage. They also found that participants who had livestock in their operation and availability of water and fencing for their livestock were more interested in continuing their CRP contract with the purpose of grazing. Having land that was put in CRP because of economic factors or with loamy soil types, and education were positively correlated with the reenrollment decision. Participants who enrolled with productive ground wanted to bring back it to production.

Allen and Vanderever (2003) and Allen and Witter (2008) represent the most comprehensive approach to date. They employed a national survey of CRP participants. The focus of the 2003 study was to determine the social and environmental benefits of the program on the land, individual, and society. For their study, a mail survey was sent to 2,200 randomly selected CRP contract holders which were identified proportional to the incidence of regional contracts. The largest category of respondents was retirees (52%). There were 1,419 responses resulting 64.5% response rate.

Allen and Vanderever (2003) found that maximum participants cited control of soil erosion at first planting of CRP covers (nearly 85%) as a benefit. Drought was acknowledged as a failure of initial planting for some respondents (9%). Many respondents (over 73%) noticed an increase in wildlife population on the land and/or at adjacent land enrolled under CRP. An opportunity to observe wildlife was the most often environment benefit mentioned by respondents (over 59%). More than 80% of respondent believed that the CRP had contributed to greater numbers of wildlife and a very small percentage of respondents (less than 10%) did not perceive wildlife habitat as a priority. Improved water quality (39%), opportunities to personally hunt (38%), and scenic improvements to the farm or landscape (37%) also received mention by more than one third of respondents. Control of drifting snow (30%), improved air quality (29%), greater permanence to surface water (24%), potential increase in future income (17%), and an increase in opportunity to lease land for hunting (12%) were also mentioned.

Although roughly 25% of contractees reported no negative effects from the CRP, others reported CRP as a source of weeds (mentioned by 29% of respondents), a fire hazard (19%), or as a source of unwanted requests for hunting (18%). Appearance (unkempt; 13%), the attraction of unwanted wildlife (9%), and negative effects on the local economy (8%) were mentioned

along with reduction in production lands (4%). Management of CRP by the contractees differed by region. For example, those respondents from Mountain states clearly preferred grazing over alternatives (63%), compared with those in the Corn Belt whose interest in grazing was low (10%). Most respondents were, at that time, satisfied with the range of management alternatives available, although a significant number would have preferred more intensive management with an increased level of payment.

Allen and Witter (2008) examined the potential recreational use of CRP acres and possible opportunities of generating revenue from these recreational uses. Four thousand surveys were sent to randomly-selected CRP contractees and 74% (2,953) of participants responded.

Respondents (57%) mentioned that some portions of their CRP acreages were used for many recreational activities. Of those mentioning use of CRP for recreation; hunting (89%) wildlife viewing (44%); hiking (23%); and fishing (7%) were the most popular activities. Of those who mentioned about recreational activities materializing on their land, over half (55%) mentioned that users included those of outside families and friends. A significant number of farmers (39%) mentioned that these users are from outside their local community plus users (22%) from outside the state as well. The money spent by these outsiders on some other activities might provide economic benefits to other local residents as well.

Usage of CRP land varied among the landowners in the Midwest (61%), Plains states (51%), East (58%), and West (53%). Among those who allow recreation activities, landowners from the East were most likely (19%) and least likely from the Midwest (4%) to charge for recreation activities on their CRP land. Also, very few landowners from West and Plains states receive income from recreational activities as well. Overall they estimated that U.S. landowners were receiving $21.3 million from these recreational activities and if potential earnings of those who

do not charge any fee on their land were added than the expected market value of earning from recreational activities on CRP land would be at least $72.3 million.

## 2.9. Summary

Fluctuating agriculture commodity markets have long been a hindrance for long term land retirement programs and makes their management challenging. For example, in 2007, CRP acreage reached peak of just under 37 million but exponential surge food prices during 2007–2008 triggered demands to reduce land retirements. Consequently, CRP acreage was reduced by 2.1 million acres in a short span of 12 months of FY2008. In the PPR region alone, over one million acres were removed in that year. This stumble in CRP acreage continued and in the next seven years, CRP enrollment was reduced by 12.5 million acres from 36.8 to 24.3 million acres in FY 2014 (USDA).

This chapter discussed findings from the literature regarding CRP. Four studies examining the impact of commodity prices on CRP enrollment and six other studies were incorporated which report on analyzes of the effect of participant characteristics, motivations, beliefs, and attitudes on CRP enrollment.

Few other studies were included which highlighted that ignoring slippage effects, would result in an overestimation of acreage control benefits by 20 to over 50 percent, depending greatly upon type of crop, land quality, and location. However, other two studies determined this claim was an over estimation. Sullivan et al., (2004) suggested that in order to estimate the approximate size of CRP land returning to production due to change in commodity prices, an assessment should be based on the U.S. Regional Agricultural Sector Model (USMP); now the Regional Environment and Agriculture Programming Model (REAP).

In the last section of the chapter, other studies were discussed which examined the determinants and effect of land use decisions after their termination on conservation contract. These studies were majorly conducted with the help of surveys and they found that other than commodity prices, post-CRP use intentions will vary with characteristics of land, socio-economic factors, and participants' attitudes.

In crux, many studies were included to understand how producers make decisions about CRP and attributes about efficiency of the program. However, in the capricious world where nothing is fixed and predictable for long, there is still a need to evaluate the different factors that are important from the producer's side. This will provide an informed basis to educate decision makers on all aspects of available options for conservation programs which are likely to influence their enrollment decisions. Further in the study, chapter 3 will describe methods used in the study, chapter 4 will present results, and chapter 5 will focus on the policy recommendations.

# CHAPTER 3. RESEARCH METHODS

## 3.1. Introduction

Various survey, experimental, and statistical methods have been applied to the problem of economic valuation of non-market goods. Contingent valuation surveys using binary or multinomial discrete choice experiments (DCEs) have been deployed by researchers through in-person interviews, as well as via mail, phone, and online survey instruments (Christensen et al., 2011; Ruto and Garrod, 2009). Data gathered by DCE survey methods are well-suited for econometric analysis using limited dependent variable techniques, such as heteroskedastic logistic modeling, logit scaling approach, multinomial logistic regression, mixed logit modeling, and random parameters logistic regression, which can be used to predict the probability of a particular decision from a set of possible decisions based on the attributes of the outcomes and/or the attributes of the decision maker(s) (Ruto and Garrod, 2009). Within the discipline of environmental economics, many studies have been conducted to investigate how producers and consumers evaluate environmental benefits of different policy initiatives (Adamowicz et al., 1998; Boxall et al., 1996; Hanley et al., 1998; Garrod and Willis, 1999). In recent years, DCEs have been applied to evaluate farmers' decisions about or preferences for land retirement programs or agro-environmental schemes (AES) (Ruto and Garrod, 2009; Christensen et al., 2011; Espinosa-Goded et al., 2010; Vanslembrouck et al., 2002; Schulz et al., 2014)

Espinosa-Goded et al. (2010) used a random parameters logit model to evaluate the factors affecting farmers' willingness to participate in AES, for the introduction of nitrogen fixing crops in dry land areas, in Spain. Farmers were asked to complete DCEs by choosing one of the three options—either one of the two hypothetical AES enrollment contracts with varied attributes, or not to enroll in the AES at all. Design attributes for the hypothetical contracts

included grazing permission, minimum enrolled area requirement, compulsory technical assistance and monitoring, and a fixed rental payment. Results showed eliminating the minimum enrollment area requirement and direct provision of technical assistance and monitoring increased respondents' willingness to sign a contract.

Christensen et al. (2011) collected data using DCE techniques, and used a random parameters logit model to estimate Danish farmers' willingness to accept agro-environmental subsidy schemes to implement pesticide-free buffer zones. Farmers preferred contracts with a flexible zone width, short contract period, greater flexibility in use of fertilizers, and the option to quit the contract year to year. Ruto and Garrod (2009) used a mixed logit model and latent class model approach to analyze farmers' willingness to participate in AES in 10 European countries—not including Denmark. They investigated farmer preferences for monetary compensation, contract length, flexibility of whole farm or partial farm being entered into the scheme, flexibility in undertaking some conservation practices, and time spent on paperwork/administration. Ducos et al. (2009) assessed the impact of compliance costs on farmers' participation in AESs using a Tobit model. They found that the most significant barrier to entry for small farmer AES participation was fixed transaction costs, and suggested that modifying the payment structure by concurrently providing a higher lump sum payment upfront, and smaller annual rental payments, might decrease the government expenditure and simultaneously increase farm participation rates. Vanslembrouck et al. (2002) used the latent class model to investigate Belgian farmers' preferences for increasing land-scape value. They identified a group of farmers who were simply not interested in participating in a voluntary agreement (even though they could set the price themselves). Another group of farmers was generally inclined to participate, and their willingness to participate increased if they were

informed about the environmental benefits involved. In spite of the valuable contribution of these papers, the latent class model has not been used much in evaluating farmers' preferences in the classification of local agro-environmental policies in the U.S.A. The present study uses orthogonally-designed hypothetical DCE to investigate farmers' preferences for alternative CRP contract provisions that could feasibly enter the design of real CRP contracts at some future date. In the following section, DCE methods are presented in detail, and then statistical methods for DCE analysis are explained

## 3.2. Background

A DCE consists of several orthogonally-designed choice sets, each of which presents two or more hypothetical decision alternatives. For each choice set, participants may be asked to select their most preferred alternative, or to rank the alternatives. Every decision alternative is defined by a group of attributes, which take on values that vary among the hypothetical alternatives (Street et al, 2005, Schulz et al., 2014). DCEs are a common tool for assessing people's preferences and/or decisions in hypothetical situations. Use of DCEs is based on random utility theory. Rather than examining the entire scenario as a package, the choice experiment allows the researcher to determine how specific attributes of the alternatives affect respondents' choices (Garrod and Willis, 1999). Systematic, orthogonal experimental design of the attribute levels in the choice sets is essential to the survey methodology. Otherwise, the researcher may find that the effects of the attributes (and marginal rates of substitution among them) are confounded by collinearity and therefore not statistically discernible (Mengoni, 2011,).

Statistical analyses of DCEs with limited dependent variable models can be used to evaluate the overall importance of different attributes to program participants, as well as how the levels of these attributes affect participation rates levels. Per Lancsar and Savage (2004), DCEs

can be used to evaluate the importance of the attributes to the decision maker's choice to participate, and/or the marginal rate of substitution at which the respondent is prepared to accept tradeoffs amongst these attributes. If appropriately designed, applied, analyzed, and interpreted, DCE methods offer a viable alternative or complement to other methods of valuation and preference elicitation, such as revealed preference methods and experimental auctions (Lancer and Louviere, 2008).

During the 1970s and 1980s, conjoint analysis (CA) was considered for predicting and analyzing consumers' decision-making and choice behavior. DCE sometimes gets confused with conjoint analysis (CA). The latter is based on conjoint measures, which are purely mathematical, and concerned with the behavior of number systems, rather than with human behavior or preferences. Unlike CA, random utility theory seeks to explain human decision making by modeling choices as a function of unobserved preferences (or utility). Other differences between CA and DCE methods include: (i) the treatment of error components and (ii) the feasibility of the alternatives included in the choice sets. Treatment of error components is an afterthought in CA, whereas it is the starting point in DCEs, which rely on random utility theory. Feasibility of at least one alternative in each choice set is required for valid DCE, whereas traditional CA choice sets sometimes offer respondents an entire set of infeasible (or unrealistic) alternatives (Louviere et al, 2010).

The use of ranking and rating techniques suffers from theoretical and practical obstacles (Bennett and Blamey, 2001). These concerns include (i) the difficulty involved in making interpersonal comparisons of ranking or rating data, (ii) the difficulty for respondents to rank large numbers of alternatives, and (iii) the fact that rating tasks in particular involve a departure from contexts actually faced by decision makers. The greatest advantage of DCE is that by using

this method a low cognitive complexity arises —i.e. it is relatively simple (Louviere et al., 2000). Hence, DCEs are consistent with economic theories (Hamlet et al., 2001) and can simulate types of decisions that are familiar from respondents' life experiences (Ryan, 1996).

DCE is based on random utility theory, originated by Thurstone (1927), but theoretical foundations of choice experiments were laid out by Lancaster (1966). This has been introduced in economics by Marschak (1960), formalized by Manski (1977) and further maneuvered by McFadden (1974). Recent work in DCE theories and methods relies heavily on work by McFadden, who extended Thurstone's original theory of paired comparisons (pairs of choice alternatives) to multiple comparisons, and, since its inception, it has been considerably developed and is now an important statistical method in various academic disciplines.

In the current study, stated preference in the form of discrete choice experiments (DCEs) was used to identify and evaluate the relative importance of several contract attributes in farmers' decision to participate in the CRP.

Figure 3.1 represents the key stages of developing DCE. Every stage is important and, at each, researchers are required to select among different available approaches. Research objectives are the object of choice for which preference will be quantified. But, the most important aspect of DCE design is the identification of attribute levels that could illustrate a hypothetical situation efficiently. Attributes and levels are the individual features that comprise the research object, among which the survey will elicit tradeoffs. Attributes can be quantitative or qualitative.

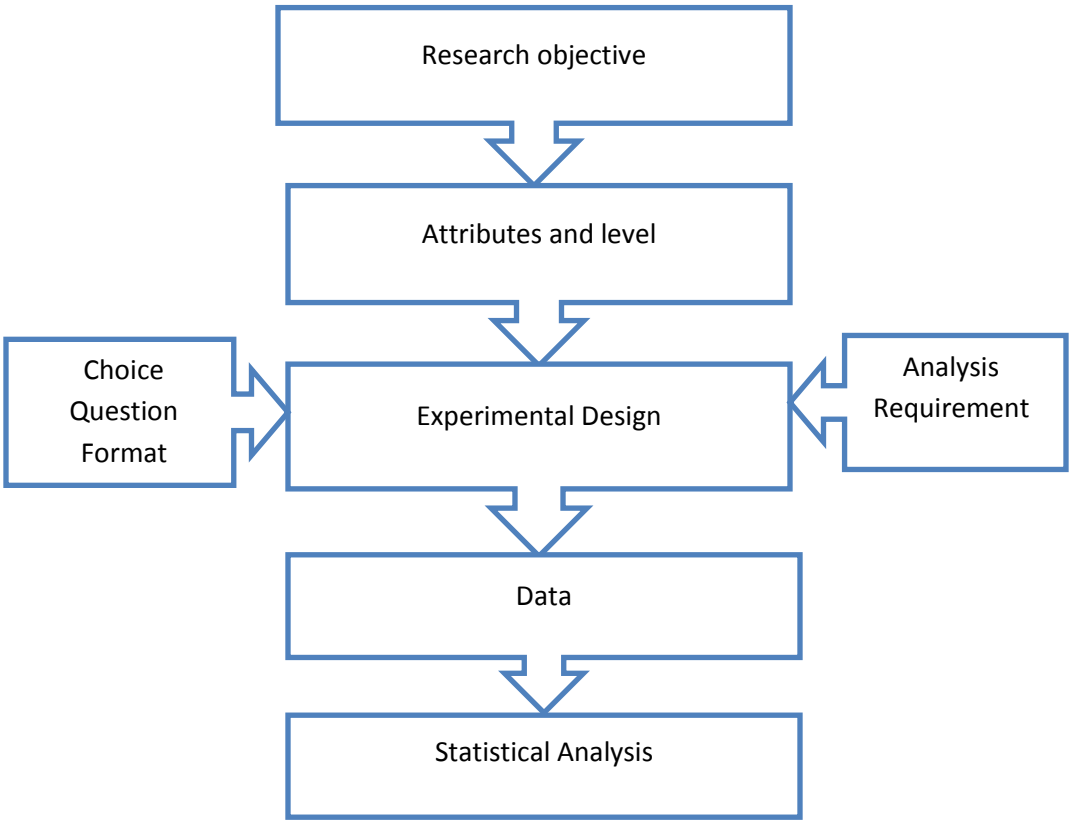


Figure 3.1. Key stages for developing and analyzing a discrete-choice experiment

Source: Johnson et al, 2013

The choice question format describes how a series of sets of alternatives from among all possible profiles of attribute-level combinations will be presented to the respondent. Analytical requirements encompass information about the intended choice-model specifications. The attributes and levels, choice question format, and analysis requirements all form the basis for the experimental design, which is a process of generating specific combinations of attributes and levels that are to be evaluated by survey respondents.

Data for choice questions are then analyzed to predict choice and produce estimated preference weights, or choice-model parameters, that are consistent with the observed pattern of choice by respondents (Statistical Analysis). The resulting estimates are then used to evaluate important factors related to the research objective.

### 3.3. The Discrete Choice Design and Implementation

The present study was formulated to evaluate farmers' preferences for five hypothetical CRP contract attributes:

i. Maximum payment (% of FSA-determined local county rental rates)
ii. Terms of contract payment (fixed at start or re-adjusted every 5 years)
iii. Length of the contract (10 or 15 years)
iv. Establishment sharing (50% or 100% government cost share)
v. Land use restrictions (Idle or graze/hay every other year)

Table 3.1 is an example of a choice set. Table 3.2 provides more detail on the different levels for each attribute. In this study, the choices of attributes and levels were identified based on a combination of evidence from literature, CRP program policies and benefits, farm bill provisions, and information from focus group discussions with county FSA directors.

Table 3.1. An example of a choice set from the discrete choice experiment

| Option A | Option B | Option C |
|---|---|---|
| Maxbid<br>100 %<br><br>Terms<br>Readjusted at five years<br><br>Length of contract<br>15 years<br><br>Establishment cost<br>100 %<br><br>Land use restriction<br>Graze/hay permitted | Maxbid<br>120 %<br><br>Terms<br>Readjusted at five years<br><br>Length of contract<br>10 years<br><br>Establishment cost<br>50 %<br><br>Land use restriction<br>Idle only | No contract<br><br>Do not enroll in CRP |

SAS software was used to generate 23 choice sets, representing a reduced orthogonal experiment design with a D-efficiency of 89%. Prior to conducting the survey, pre-tests of questionnaire and sample surveys were conducted with samples of farmers. On the basis of the given feedback, three different introductory videos were recorded along with the adjustments of the questionnaire's wording to make sure that respondents fully understood the questions and the purpose of the study.

Respondents were offered choice sets of 3 alternatives (option A, option B, and no contract as option C). Respondents were asked to rank these alternatives according to their preferences. Inclusion of the 'opt out' alternative (no contract) avoids a forced choice by allowing respondents to select neither alternative in the choice set and serves to make the results obtained consistent with demand theory ( Ruto and Garrod, 2009).

Table 3.2. CRP attributes and levels used in choice experiments

| **Study Attribute** | **Description** | **Attribute levels** |
|---|---|---|
| Max Bid (Contract Rental Rate) | Percent of FSA county rental rate | 80%, 100%, 120% |
| Terms of Contract Payment | The flexibility of the rental payment amount. | Fixed in the beginning, Re-adjustment every 5 years |
| Length of the contract | Duration of CRP contract | 10, 15 years |
| Establishment cost in the beginning | The government share of cost to initiate the conservation practices | 50%, 100% |
| Land use restrictions | Permitted uses of land | Idle, graze/hay every other year |

## 3.4. Model Estimation

In economic theory, discrete choice modeling is compliant with Lancaster's consumer theory (Lancaster, 1966) and random utility theory (Luce, 1959; McFadden, 1974). Lancaster

consumer theory is based on the underlying assumption that what consumers are seeking to acquire is not goods themselves but the characteristics they contain, and these characteristics/attributes give rise to utility.

Random utility theory decomposes utility into two parts: (i) a systematic component explained by the independent variables (or attributes), and (ii) a random component not explained by the attributes. This theory also assumes the utility maximization principle, i.e. if a respondent chooses one alternative over another, then the utility from the chosen alternative is greater than that of the unselected alternative.

In this study, respondents were asked to rank the alternatives in each choice set, according to their preference order. To evaluate the individual's choice in relation to different attributes and characteristics of a contract, an exploded logit model with no ties in ranking was used. In the economics literature, this is also known as rank-ordered logit model. This model is a generalization of the binomial logistic regression model, and was proposed by Beggs, Cardell, and Hausman (1981) and further extended by Hausman and Ruud (1987) with the name of rank-ordered logit model in the economics literature. The model was independently formulated by Punj and Staelin (1978) and Chapman and Staelin (1982) in the field of marketing with the name exploded-logit model.

In the exploded-logit model, $Y_{ij}$—the rank given by a respondent to alternative $j$ in choice set $i$—is the independent variable. Given $J$ alternatives per choice set, $Y_{ij}$ can take on any integer value between 1 and $J$, with 1 being the rank of the most-preferred alternative, and $J$ the rank of the least-preferred. The indirect utility function ($V_{ij}$) is a mapping function of the utility of option $j$ in choice set $i$ in as many dimensions as the choice sets have attributes. $V_{ij}$ is comprised of (i) a systematic component that is a function of the attributes of each alternative in the choice set and,

potentially, characteristic of the *respondent* completing choice set *i* (denoted $\mu_{ij}$) and (ii) an unexplained error component (denoted $\varepsilon_{ij}$). The error terms are assumed to be independently and identically distributed. Thus, the indirect utility of option *j* in choice set *i* is given by:

$$V_{ij} = \mu_{ij} + \varepsilon_{ij}, \quad (1)$$

where $\mu_{ij}$ is the systematic component relating utility to the attributes of the contract, decision maker, or both, and $\varepsilon_{ij}$ is the unexplained for option *j* in choice set *i*, which follows a Gumbel (aka double-exponential) distribution (Train, 2009). The systematic component of the indirect utility function can be expanded in various ways. The general model is as follows:

$$V_{ij} = \beta_j x_i + \Upsilon z_j + \theta w_{ij} + \varepsilon_{ij}, \quad (2)$$

where x, z, and w are column vectors of measured variables, and β, ϒ, and θ are row vectors of coefficients to be estimated. The $x_i$ vector contains variables that describe respondents but do not vary over options, and one of the $\beta_j$ vectors must be set as 0 to achieve identification (the choice of the references item is arbitrary). The $z_j$ vector contains variables that vary across options but are the same for respondents. The $w_{ij}$ vector contains variables that describe a relation between i and j, i.e., interaction between characteristics of contracts and respondents' variables (Allison and Christakis, 1994).

In Equation 2, if ϒ and θ become 0 then the model is similar to the multinomial model, i.e. $\mu_{ij} = \beta_j x_i$ , and if only θ is 0, a conditional logit model results. However, an exploded logit model was used because the rank order of J values may be regarded as an explosion into J-1 independent observations, such that $U_{i1} > U_{i2} > \ldots > U_{ij}$ give rise to $(U_{i1} > U_{ij}, j=2,\ldots, J)$ , $(Ui2 > Uij, j=3, \ldots, J)$,$\ldots.( U_{i(j-1)} > U_{ij} )$ (Salomon, 2003). Hence, the data have been collected and

considered as a series in which respondents were asked to rank 1,2 and 3, for the all the choices according to their highest to lowest preference, respectively.

This explosion is only possible because of the independence of irrelevant alternatives (IIA) assumption (also known as Luce's choice axiom). In the IIA assumption, it is believed that the $\varepsilon_{ij}$ terms are independent of each other, although it depends on the part of external value distribution of ε terms (Allison and Christakis, 1994; Luce, 1959). In other words, introduction or elimination of a particular item or choice does not change the relative preference of the respondents. This assumption is very important, and there might be difficulty in either computation if this assumption is not made. However, this assumption is equally important in the multinomial logit model, where the respondent has to choose one item instead of ranking choices, but violation of this assumption is easily identifiable with ranked data because more information is available on relative preferences in terms of ranks.

The exploded logit model is not reversible, in the sense that inverting the rank does not merely change the sign of coefficients (as it would in a dichotomous logit model or in a cumulative logit model) but fundamentally changes the model and its associated likelihood (Allison and Christakis, 1994).

The random utility model implies the following likelihood $L_i$ for a single respondent

$$L_i = \prod_{j=1}^{J} \left[ \frac{\exp\{\mu_{ij}\}}{\sum_{k=1}^{j} \delta_{ijk} \exp\{\mu_{ik}\}} \right] \tag{3}$$

where $\delta_{ijk}$ =1 if $Y_{ik} \geq Y_{ij}$, and 0 otherwise. The probability that a respondent will assign the highest rank to option *j* from among the *J* alternatives is

$$P(j) = \frac{e^{\mu_j}}{\sum_{k=1}^{J} e^{\mu_k}}. \tag{4}$$

After the first rank has been assigned, then the probability of assigning the next rank to alternative *m* item from the remaining alternatives is:

$$P(m) = \frac{e^{\mu m}}{\sum_{k=1}^{J} e^{\mu k - e^{\mu j}}}. \quad (5)$$

That is, the top-ranked alternative(s) is (are) assumed to be irrelevant to a respondent's preference order for the remaining items, and this assumption is enforced by removing previously selected items. This continues through each step, so in the case of final choice, say, items r and s, the probability of choosing r is:

$$P(\mathrm{r}) = \frac{e^{\mu r}}{e^{\mu r - e^{\mu s}}}. \quad (6)$$

**3.5. Estimation of Exploded Logit Model**

Estimation of an exploded logit model is based on a maximum likelihood procedure that can easily be accomplished with most partial likelihood estimation procedures for proportional hazard models. For a sample of $n$ independent respondents, equation (3) implies a log likelihood of

$$\log L = \sum_{i=1}^{n} \sum_{j=1}^{J_i} \mu_{ij} - \sum_{i=1}^{n} \sum_{j=1}^{J_i} \log \left[ \sum_{k=1}^{J_i} \delta_{ijk} \exp(\mu_{ik}) \right] \quad (7)$$

In this likelihood function, $J_i$ is allowed to vary across respondents. Also, we can substitute equation (2) in place of $\mu_{ij}$. Equation (7) is then maximized by iteratively changing the vectors of coefficients ($\beta_j$, $\Upsilon$, and $\theta$) and if a maximum is found it would be global maximum rather than a local maximum. (Allison and Christakis, 1994).

## 3.6. Validity Issues

It is always possible for researchers to execute the consistency test to validate the subject's response. As DCE tasks are cognitively challenging, where reliability of responses, along with theoretical principle, helps to identify whether the results from the survey are valid and accurate. Rational preferences must satisfy several axioms. Among these are completeness, transitivity, monotonicity, and continuity, which are commonly tested assumptions (Mengoni 2013). Per Lancsar and Louviere (2006), the most essential of these axioms for the preference-based view of rationality are transitivity and completeness.

Nicholson and Snyder (2011) stated that this basic set of postulates, or axioms, helps in analyzing 'rational behavior'. Completeness simply means that, given any pair of conceivable alternatives—either two baskets of consumption goods or two contracts with varied attributes—the respondent can determine (1) which of the two is more desirable or (2) whether both are equally desirable. That is, an individual whose preferences are complete is capable of stating a preference order for any set of two or more alternatives. The transitivity assumption requires that an individual's choices be internally consistent—i.e. for any options x, y, and z if x is preferable to y and y is preferable to z, then x must also be preferable to z.

These axioms are very important for an analysis of rational behavior while applying DCEs. However, if respondents fail to follow these axioms, then it leads to a problem of what to do with such responses. Lancsar and Louviere (2006) argued that responses from these respondents might be valid, so removing responses would be inappropriate. Lancsar and Louviere (2006) argue that even if the marginal rate of substitution cannot be estimated, these preferences are still relevant for analyzing and interpreting effects on policy making.

# CHAPTER 4. RESULTS AND INTERPRETATION

## 4.1. Choice Experiment Data Collection

In this study, a convenience sample of 76 Prairie Pothole Region (PPR) farmers was interviewed in person during the spring, summer and fall of 2014. The PPR is a 197- county area in five[5] states that contains approximately 3.8 million acres of CRP, representing 24% of the total CRP acres in the U.S. (as of 06/20/2014; USDA). The survey targeted both participants and non-participants in CRP selected by FSA directors in specific counties to represent a variety of producers, production systems and land types. So the data was collected from a convenience sample including a cross-section of farmers and ranchers within each county. Participants included those enrolled in CRP as well as those not enrolled.

The choices of program attributes and levels were identified based on a combination of evidence from the literature, CRP program policies, farm bills and information from a focus group discussion with FSA and other USDA officials. SAS software was used to generate 23 combinations for a three option choice set design, representing a reduced orthogonal experiment design with a D-efficiency of 89%. In each choice set, respondents were asked to rank alternatives as per their preference from 'best' to 'worst'. Table 3.1 is an example of a choice set and Table 3.2 provides more detail on the different levels for each attribute. Apart from the choice experiment, participants were asked a variety of questions regarding characteristics of their farm, reasons for entry into a CRP contract, livestock and grazing potential, socio-demographic characteristics, and what they like and dislike, and what kind of changes they would like to see in current CRP guidelines. The purpose was to identify important factors contributing to CRP-enrollment and re-enrollment decisions.

[5] PPR states IW, MT,MN,ND,SD

Table 4.1. Summary statistics of survey respondents (N= 76)

| Variable | Mean (Standard Deviation) | Description |
|---|---|---|
| Age | 54 .22 (11) | Age of farmer |
| Total Farmland | 3,666 (3,631) | Total of farmland includes grass land, acres covered under water, and all other marginal land (owned+ rented) |
| Tillable Land | 2,122. (1,986) | Tillable land out of all farmland (owned+ rented)[6] |
| Completely Dependent on farm* | 0.51 | 1= 100% of family income comes from farm |
| Native Grasses | 0.59 | 1 = Farm includes native pasture or/and Idle grasses |
| Livestock* | 0.47 | 1= Farm Includes cow/calf herd |
| CRP | 0.67 | 1= Currently enrolled into CRP |
| CRP Acres | 129 (230) | Number of acres currently enrolled in CRP |

Notes: One farmer had a swine operation and another raised chickens. These were coded as 0 because they were raised in captivity.

Mean of dummy variables represents the percentage of farms or farmers with this characteristic.

## 4.2. Descriptive Statistics

Table 4.2 presents the descriptive statistics of our sample which included 76 farm operators. The average respondent was 54.2 years old—younger than the average age of US farmers which is 58.3 years (USDA, 2012 Census of Agriculture). Total farm distribution was skewed right, with a mean farm size of 3,666 acres and median of 2,500 acres. Average total arable land was 2,122 acres. Fifty-eight percent of participants have native grasses on their land and 47% raise cows on their farms. Wheat, corn and soybeans are the three most common crops

[6] Total cropland includes all the land that farmers operate.

in participants' rotations while alfalfa and grass hay are also common for operators with livestock.

Sixty-seven percent of farmers were enrolled in at least one CRP contract and 48% said they intended to re-enroll their contracts. Seventy-seven percent of farmers are participating in one or more conservation programs apart from CRP. Eighty-five percent of participants have water bodies larger than two acres on their land. Forty-nine percent of participants' households reported having some off-farm income that could be an important factor for those valuing the income stability associated with long-term land retirement programs.

Table 3.2. Concern showed by respondents about CRP

| **Details** | **Percentage of farmers expressing this concern** |
|---|---|
| Payment limit under CRP | 7% |
| Different counties have different guidelines for maintaining CRP | 5% |
| Rigid and complex eligibility criteria to include new criteria for land previously enrolled into CRP | 31% |
| Administrative process or officials involved | 41% |
| Terms of the contract need to be changed | 69% |
| Too many rules involved in implementation. | 35% |
| Benefits go to absentee landowners and farmers with large acreages | 3% |
| 1= Restricts availability of land to young farmers / limits scope of expansion | 29% |

Table 4.2 reports participants' responses to an open-ended attitudinal statement. The percentage noted is that which indicated the concern about CRP. For example, payment limit represents the cap of maximum rent allowed, which is to be received by an individual every year Seven percent of respondents noted this concern. Different guidelines represent farmers'

concerns about the different guidelines under the same program, especially within counties or in adjacent counties. Some respondents showed their concern about land which came out from the CRP being no longer eligible to be re-enrolled.

Problems with the administration office or the administrative process such as filling paperwork for enrolling into the CPR program were noted as a concern by 41% of respondents. Terms of the contract were another major challenge raised by the respondents. They include the current program's characteristics such as rental payment, penalties for early termination of contract, restrictions on farming, length of the contract, and midterm management contract. Rules implementation includes the respondents' concerns about requirements to replace new grasses with old grasses, restrictions on cutting noxious weeds, and other rules related to planting new grasses.

### 4.3. Estimation Results

Each of the 76 farm operators ranked 23 choice sets; each consisting of three alternatives: two CRP contract options, and an opt-out or "no contract" option. Sixteen percent of the participants gave the highest rank to the opt-out option in every choice set indicating they are opposed to the CRP as defined in the attributes defined current program or it does not suit their farming operation. The regression results for the exploded logit model are shown in Appendix A. It includes alternative-specific constants for option 1 and option 2, which in have nearly identical negative coefficients that are statistically different from the opt-out alternative at the 1% significance level, but indistinguishable from each other even at the 90% significance level. This indicates that these two options are statistically different from the opt-out option. The negative signs of the alternative-specific constants indicate that, barring sufficient compensatory contract attributes; the survey participants will not enroll in the program. Interaction terms with

demographic variables were included in the analysis. The McFadden pseudo $R^2$ ($\rho^2$) measures the goodness-of-fit and based on the model output $\rho^2$ is 0.203 representing an extremely good model fit. As per Louviere et al. (2000), $\rho^2$ could not be expected as high as $R_s^2$ which is commonly obtained in many stated choice OLS applications. The primary reason is that the logistics regression model estimates maximum likelihood coefficients; so $\rho^2$ cannot be calculated to minimize variance as in OLS models, instead it shows a proportion reduction in error variance. Although $\rho^2$ is measured on the similar scale as $R^2$, ranging from 0 to 1, it is calculated differently (Equation 8).

$$\rho^2 = 1 - \frac{\ln \hat{L}(M_{without\ intercepts})}{\ln \hat{L}(M_{with\ intercepts})} \tag{8}$$

The log value of any likelihood value between 0 and 1 is lesser than or equal to zero. Also the log value of low likelihood value will have a larger magnitude than values of the log of better likelihood models; hence a smaller value of log likelihoods is a better fit and explains better goodness-of- fit of a logistic regression.

The list of variables used in the analysis is presented in the Appendix B. The signs of the exploded logit coefficients are generally expected. The coefficient on 'Maxbid' is positive and strongly significant which represents that the higher the maximum bid rate (payment) is allowed, the more likely a farmer is to choose a CRP contract. The positive effect of higher rental rates decreases with increasing age of farmers, as illustrated by statistically discernible negative coefficient (-0.0003455) of the 'age*maxbid'. Conversely, those farmers with concerns about the terms of the current contract and rules implementation are more responsive to an increase in the maxbid as shown by the positive coefficients for the related interaction terms 'terms of contract*maxbid' (0.00800) and 'rules implementation*maxbid' (0.00939). Increases in maxbid

have less of an effect on the likelihood of enrolling in CRP for farmers with concerns about the application process (-0.0127).

The independent variable ‘Terms’ in the model represents the attribute defining if rental payments are fixed at the beginning of contracts or re-adjusted after every five years on the basis of market conditions. The flip side of market based adjustments was explained to respondents; specifically that if there is a bear market for cash rent and commodity prices then rental payment could also decrease. This variable is considered in three categories in the model: (a) terms of the contract fixed at start (Terms = 2); (b) terms of the contract readjust every five years (Terms = 1); and (c) do not participate in the program (Terms = 0). Results show that the fixed rental rate at the beginning of the CRP contract has a tendency to reduce the probability of selecting a CRP alternative, which causes statistically diminishing effect (-0.96497) on the likelihood ratio of enrolling in CRP. Cross term ‘age*terms’ has a positive significant effect (0.01322) which indicates that as a landowner gets older they prefer to have the more restricted option of fixed payment for the life of the contract. Other cross terms such as ‘livestock*terms’, ‘different guidelines*terms’, ‘Eligibility*terms’, ‘application process* terms’, ‘rules implementation*terms’, and ‘terms of the contract*terms’ are statically insignificant. Contract term length diminishes the likelihood of participating in CRP alternatives (-0.11689) but positive effect (0.04259) interaction term between length and concern related to different eligibility criteria (eligibility*length) increases the incentive for landowners and therefore the likelihood (0.04259) they will choose the CRP alternative. However, the cross term between concerns with rules implementation and length of the contact ‘rules implementation *length’ reduces the likelihood of selecting CRP alternatives (-0. 07196). Interactions between ‘length’ and other

variables - age, livestock, different guidelines, eligibility, application process, and terms of the contract – do not have significant effect on the likelihood ratio of enrolling in a CRP contract.

Land use is another variable with three categories in the model: (a) No usage of the land and it remains idle (land use = 2); (b) land can be used for grazing/haying every other year (land use = 1); and (c) do not participate in the program (Land use = 0).The negatively significant (-2.08740) variable 'land-use' represents that requiring the land to be idle has negative effect on the likelihood of enrolling in CRP. Likewise, cross terms between land_use and livestock (livestock*land_use), and land_use and concerns regarding rules implementation (rules implementation *land_use) also have negative effects on the enrollment alternative. The reason could be that livestock farmers want to use their land more often to get feed for their livestock. Conversely, as the positive affect of 'age*land_use' (0.033793) shows that farmers prefer to have more restrictions on usage of land with an increasing age. We expected a higher level of establishment cost paid by the contract to increase likelihood of enrollment. All other cross variables with establishment cost such as age, livestock, different guidelines, eligibility, application process, rules implementation, terms of the current contract are insignificant.

### 4.4. Probability of Enrollment Decisions and Willingness-to-Tradeoff (WTT) Decision

Although signs and coefficients of different attributes and interaction terms indicate the effects of changes on the likelihood ratio of enrolling into a contract due to the changes in respective attributes, no direct inference could be concluded to strengthen any relationship among attributes of participation. A convenient and efficient way of making coefficients understandable is by computing marginal effects on utilities and marginal willingness to tradeoff (WTT) of policy attributes. This helps in better understanding the effect of change in a farmer's preference due to a change in policy attributes in order to maintain the similar likelihood ratio.

For dummy variables, the discrete change in the probability of choosing CRP alternative (ceteris paribus) is evaluated by changing the dummy's value from zero to one. Also, these WTT estimates represent the percentage monetary equivalent of increasing the attribute values by one unit. For example, a marginal WTT of 18.23 for the land use attribute represents (refer to Table 4.3) that a landowner needs to be compensated by an increase of 18.23% in payment for a contract to have an equal utility when the contract moves from one allowing grazing/haying to one that requires land be idle. In other words, offering the farmers an extra 18.23% payment would restore the initial utility attained by enrolling into CRP contract before imposing this restriction.

In this analysis, the impacts of various socio-economic factors on the probabilities of enrollment decisions are also evaluated. To investigate the possible source of variability in preference orders, mean value of age and mode (most commonly chosen) variables of utility parameters are used as a base contract, which is presented in table 4.3. Then, with the help of equation 9, the impact of these base contracts' estimates on the probability of participation was quantified.

$$P_{enroll} = \frac{\exp(V_{enroll})}{1 + \exp(V_{enroll})} \tag{9}$$

According to the results shown in Table 4.3, as a base case, suppose a 54.2 year old farmer, who does not have livestock and expressed issues related to the CRP program such as with different guidelines in different counties, eligibility criteria, application process, and terms of the contract, is offered a CRP contract with following contract specifications:

1) 10-year long contract

2) 100% Maxbid

3) Flexible terms of the contact

4) 50% of establishment cost

5) Grazing and haying allowed every other year.

Then, his probability of accepting the contract is 0.8523. Table 4.3 also presents (i) variables of the base case, (ii) the impact of change in utility due to change in respective variable (iii) the impacts of change on probabilities due to the changes in various socio-economic factors, and (iv) estimates of the variables' marginal effects on the likelihood of the 'CRP' alternative.

Table 4.3. Discrete change in probability, marginal effect in utilities, and tradeoffs

| **Variable** | **Mean** | **Marginal Effect on utilities** | **Willingness to tradeoffs (WTT) w.r.t to Maxbid** | **Probability of Participation** | **Change in Probability** |
|---|---|---|---|---|---|
| AGE | 54.2 | 0.0312*** | -0.9096 | 0.8561 | 0.0039 |
| Livestock | 0 | -0.7948*** | 21.2840 | 0.7248 | -.1274 |
| DG | 1 | -0.6111* | 21.2527 | 0.7608 | -0.0915 |
| Elig | 1 | -0.2594** | 7.4889 | 0.8172 | -0.351 |
| AP | 1 | 0.8439* | 18.3118 | 0.9302 | 0.0779 |
| RI | 0 | -0.1847 | 4.1906 | 0.8278 | -0.0245 |
| TC | 1 | -0.7127* | 5.7937 | 0.7396 | -0.1127 |
| MaxBid | 100 | 0.3468*** | -- | 0.8565 | 0.0042 |
| Terms | 1 | 0.0973 | 2.8070 | 0.8390 | -0.0133 |
| Length | 10 | 0.0196 | -0.5680 | 0.8548 | 0.0025 |
| Estb | 50 | 0.0088*** | -0.2544 | 0.8534 | 0.0011 |
| Land_Use | 1 | -0.6323** | 18.2350 | 0.7547 | -0.0976 |

In the above table; *, **, *** represents significance levels at the 10%, 5%, and 1% levels, respectively calculated by using Krinsky Robb method. To measure the significance level of change in utilities and its statistical impact on probability and willingness to tradeoff the Krinsky and Robb parametric bootstrapping method was used. "The Krinsky Robb approach is parametric bootstrap procedure and involves simulating multiple draws from the distribution of

structural parameters. One of the biggest assumptions of applying Krinsky and Robb's method is that it usually assumes normality of the parameter estimates, as well as the normality of their ratio" (Carson and Czajkowsk, 2013, p.10)

In general sign-up, CRP contracts are accepted depending on a bid submitted. Once approved, landowners receive payments based on the submitted bids. Tradeoffs are considered and calculated with respect to maxbix (rental payments). However, change in maxbid has a positive impact on the probability of enrollment. Ceteris paribus, an increase in the maxbid by 1% would increase the likelihood of enrollment by .39%. When the contract changes for the more flexible readjustment after 5 years to fixed at start for life of the contract (terms) there is a negative impact on probability. Fixing payment at the beginning of the contract would reduce the likelihood of participation by 13.3%ceteris paribus.

Table 4.3 shows that, on average, producers are willing to trade off flexibility in terms of the contract with an increase in maxbid of 2.81% in order to maintain the initial utility. The probability of respondents' participation decision into CRP program would increase by .25% for each year increase in contract length. Ceteris Paribus, farmers are willing to take a 5.7% reduction in maxbid for an additional year on the contract (retaining utility). Results also show that an increase in the government share of the establishment cost by 1% would only increase the probability of participation decision by .0011. However, the WTT of this variable states to maintain equal level of utility; for an additional 1% establishment cost, farmers are willing to accept a payment (bid rate) cut of nearly .25%.

Interestingly, the elasticity of the probability with respect to land use restriction is found to be relatively high (-0.0976). An increase in the restriction on land usage would reduce the probability of farmers' participation in the CRP by 0.0976. This result is consistent with

literature examining the importance of land usage to farmers (Cooper and Osborn, 1998; Langpap 2006). The idle cropland and restrictions on farming on land enrolled in CRP may be an indicator of the environmental sensitivity of that region but, on average, this restriction increases the opportunity costs of participation in CRP. As explained previously, the WTT estimate of 18.23 for 'land use' means that farmers are willing to accept more restrictions on usage of enrolled land with an increase in max bid by 18.23%. This result seems reasonable because more restriction on usage of land would increase the opportunity costs by making their farm lands idle.

In terms of socio-economic factors, older farmers are expected to participate more in the CRP. This is reflected in the WTT estimate for variable 'Age'. First, according to the results shown in Appendix A, an increase in the variable age by one year would increase the probability of enrollment into CRP program to 0.8561. An additional payment cut by .91% of maxbid is required to restore the utilities. However, farmers with livestock operations face a highly inelastic effect on the probability of enrollment. These findings suggest that if the farmers with livestock operations are being offered the base contract, the chances of enrolling decision would be 12.74% less than for those who don't operate livestock, ceteris paribus. To compensate livestock farmers, an additional 21.28% of max bid is required as shown by WTT estimate.

This analysis also examines the impacts of various concerns raised by farmers related to existing characteristics of the contracts. Based on the results, any difference in guidelines, especially between adjacent counties, inconsistent eligibility criteria, rules implemented for midterm management, and characteristics of the current program have a negative effect on the probability of enrollment. The respective changes in probabilities of these factors are -0.0915, -0.351, -0.0245 and -0.1127. As shown by WTT estimates, an additional 21.25% and 7.5 %

payment are required to compensate farmers who had an issue with the different guidelines or inconsistent eligibility criteria, respectively, to maintain constant utility.

Concerns about midterm management rules reduce the probability of participation in CRP. Offering an increase of 4.2% in maxbid would compensate farmers for their concern about midterm management rules; i.e., it would return their utility back to that expected for farmers without this concern. Concerns about changes in existing terms have a negative impact on likelihood of enrolling in CRP. An increase of 5.7% in maxbid will compensate for these concerns.

Farmers' concern related to the application process for enrolling into CRP and dealing with the FSA officials were represented by AP (application process) estimates. An improvement in issues related to the application process would increase the participation decision by 7.8%. Results also shows that farmers are ready to accept payment cut by 18.31% to either avoid hassle involved with 'AP' or have some improvements regarding application process.

# CHAPTER 5. SUMMARY, CONCLUSION AND FUTURE REFRENCES

Land retirement programs have a long history in the United States. Started in the 1930s, with the downturn of commodity prices, the objectives of these programs have evolved with passing years. By 1985, the primary focus of these programs shifted more towards emphasizing conservation. Although, the CRP has evolved after almost 30 years of existence, it still maintains support among conservation and agricultural communities.

From farmers' perspectives, CRP is more beneficial than other land retirement programs because it is voluntary, doesn't require permanent easements or transfer of property rights, provides fixed income and other financial support, and has the potential of controlling commodity prices by reducing supplies (Ferris and Siikamäki, 2009). However, highly fluctuating commodity prices have negatively affected participants' decisions to enroll into this and other land retirement programs. In fact, CRP acreage was reduced by 17.1 million acres between FY2007 and FY2014 (Stubbs, 2014). Reduction in acres reduces budgetary pressures, but it also has inevitable environmental consequences because land coming out from CRP is generally more environmentally-sensitive land

Some of the major factors which might be responsible for this reduction are changes in program priorities, advancement of farming technologies, and changes in producer's preferences due to availability of various alternative subsidy-based programs. However, evidence strongly suggests that the most important factor has been the unprecedented increase in commodity prices and subsequent increase in income from farming.

This study discussed findings from the literature regarding the impact on CRP enrollment of changes in commodity prices. Hellerstein and Malcolm (2011), Gill-Austern (2011), and Secchi and Babcock (2007) studied the impact of rising commodity prices on the CRP

enrollment decision. These studies identified a negative correlation between commodity prices and CRP enrollment. They also mentioned that if commodity prices remain high, landowners would start taking land out from CRP contracts and start bringing their land back into production. These studies focused only on the economic impact between high commodity prices and CRP enrollment. There is no evidence in these studies about how current characteristics of the CRP program affect landowners' enrollment decision.

This report also considered literature profiling producers enrolled in CRP. Lambert and Sullivan (2006) and subsequent papers offered the only research reviewed with the specific objective of identifying factors contributing to CRP participation. Lambert and Sullivan found the presence of a land retirement program to be directly related with land ownership and the presence of highly erodible land and negatively related with production of high value crops. They found the percentage of land enrolled in a land retirement program to be negatively related to the presence of a grain crop and positively related to farm ownership, participation in other government programs, and the female gender.

On basis of similar consideration, this study was conducted to provide insight into the attributes which influence farmers' preference for participating into CRP by developing and analyzing hypothetical choice sets. The other purpose of this study was to identify the extent to which farmers are willing to tradeoff rental rates for more favorable scheme requirements. The focus is on the PPR region which helped to provide insight for a region where potential impact and efficacy of conservation programs on environment is highly important.

A stated preference discrete choice experiment was completed during in person interviews with 76 farmers during the spring, summer and fall of 2014. While conducting interviews, respondents were asked to rank the choices as per their preference order. These

choices were evaluated using an exploded logit model. Forty-one percent of farmers expressed their concerns regarding the application process or with its management, and sixty-nine percent with contract terms. Twenty-nine percent reported the belief that land retirement schemes are an easy source of income and that lots of absentee owners and farmers with large acreages put significant land under such schemes; subsequently restraining the ability of young farmers to acquire their own land or expand.

A number of factors that were assumed to be important for affecting farmers' preferences were included in the model. The choice experiment revealed that payment, length of the contract, and land use restrictions are the most influential factors associated with the likelihood of farmer's enrollment; consistent with the literature.

As per the base case (Table 4.3), on average, age of the farmers, rental payment, terms of the contract, length of the contract, and establishment cost paid by the government have a positive effect on the likelihood a farmer will enroll in CRP and more restrictions on the usage of enrolled land have a negative effect. Farmers with livestock operations are less likely to enroll under the base case. A majority of farmers have concerns about one or more characteristics of the program, such as different guidelines for maintenance of CRP-enrolled land in different counties, inconsistent eligibility criteria, rules for mid-term management, and current terms of the contract. These concerns have a negative effect on farmer's likelihood of enrolling in CRP. A concern about the application process has a positive effect on the farmers' likelihood of enrolling into CRP program.

This study also found that farmers are willing to trade-off program attributes for higher rental payments. We acknowledge that tradeoffs of preferences and specific requirements are indeed case specific. As a consequence, the robustness of these tradeoffs needs to be more

explicitly examined. Nevertheless, the detailed focus on individual preference for the desired contract requirements through the use of choice experiments provides a new way to consider the kind of changes desired in the current rules and restrictions of this program.

The results most directly relevant to policy include: 1) haying and grazing allowances as an important factor for the farmers, particularly those with cow/calf operations; 2) if the rental payment can be assessed and adjusted periodically based on prevailing market conditions (we considered after every five 5 years in this study), farmers would be more encouraged to stay in the contract for a longer period; 3) rental rate is one of the most significant factors for influencing a farmer's decision to participate in the program. A well-targeted increase in rental rates may help meet program objectives; and 4) farmers have issues related to the policy and management of the program which might influence their willingness to participate. These fundamental barriers if reconciled could increase farmers' interest in the program.

This study also has some limitations to be addressed in future work. First, the findings should be generalized only with caution due in part to limitations associated with stated preferences methodology. In stated-preference studies, respondents may overstate required benefits (hypothetical bias). In the present study, we worked to reduce hypothetical bias by explaining each policy attribute and difference in the categories in person and including in the description references to current CRP policies that farmers are familiar with and by asking respondents to rank the choices instead of selecting the best suitable option. A second limitation is that the population was a convenience sample. Farmers were selected by FSA directors in specific counties to represent a variety of producers, production systems and land types. This convenience sample may be more interested in CRP then the average farmer. Using a random sample would increase confidence in reliability of the results. Third, on the basis of Ruto and

Garrod (2009), this study also predicted (like others) that by allowing higher payments, the government can enforce longer and more restrictive contracts but this does not mean lesser rent or financial incentive is required by some farmers to enroll into shorter and less restrictive contracts. Different farmers have different attribute preferences; different trade-off preferences and opportunity costs could also differ on the basis of region, size of the farm and other factors. Further research is required to identify the correlation between tradeoffs and the opportunity cost of participation.

With those limitations in mind, findings of this study provide valuable information for future policies. Regardless of these findings, in a voluntary context, it is important for the success of the land retirement programs that they be profitable enough to motivate farmers to participate. Looking at the land use restrictions (or other requirements) in this study, the benefits have not been measured in terms of participation rate but rather in looking at how easing those restrictions would impact program participation.

Based on findings from this study, some suggestions can be drawn for policy options that may increase farmers' willingness to participate. The research suggests it is important to remove farmers' basic concerns and issues related to CRP. One of the best possible ways is to focus on providing education to farmers about the program and its effectiveness. Also, farmers generally evaluate participation decisions on the basis of monetary incentives or on the basis of profitability. But, an increase in the rental payment can put an extra burden on the agency budgets. Allowing haying and grazing (or some environmental friendly alternative use) on CRP lands could reduce the opportunity cost of the farmers and make participation in the CRP a more competitive option.

In this study focus was on how farmers preferred the characteristics of a program but analyzing or finding its impact on the environment or the cost-effectiveness of doing so through land retirement programs is another challenge for future studies.

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# APPENDIX A. RESULTS OF EXPLODED LOGIT ESTIMATION

| Criterion | Without Covariates | With Covariates |
|---|---|---|
| **-2 LOG L** | 5430.417 | 4326.23 |
| **AIC** | 5430.417 | 4410.23 |
| **SBC** | 5430.417 | 4679.945 |

| Testing Global Null Hypothesis: BETA=0 | | | |
|---|---|---|---|
| **Test** | **Chi-Square** | **DF** | **Pr > ChiSq** |
| **Likelihood Ratio** | 1104.187 | 42 | <.0001 |
| **Score** | 974.693 | 42 | <.0001 |
| **Wald** | 770.2361 | 42 | <.0001 |

| Analysis of Maximum Likelihood Estimates | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Paramete Estimate** | **Standard Error** | **Chi-Square** | **Pr > ChiSq** | **Hazard Ratio** |
| opt1 | -1.75308 | 0.34445 | 25.903 | <.0001 | 0.173 |
| opt2 | -1.67025 | 0.3454 | 23.384 | <.0001 | 0.188 |
| Maxbid | 0.05217 | 0.01022 | 26.062 | <.0001 | 1.054 |
| Age*Maxbid | -0.0003455 | 0.000154 | 5.0198 | 0.0251 | 1 |
| Livestock*Maxbid | 0.00315 | 0.00327 | 0.9282 | 0.3353 | 1.003 |
| Different guidelines*Maxbid | 0.00579 | 0.00553 | 1.0983 | 0.2946 | 1.006 |
| Eligibility*Maxbid | -0.0001936 | 0.00326 | 0.0035 | 0.9527 | 1 |
| application process*Maxbid | -0.01266 | 0.00327 | 15.029 | 0.0001 | 0.987 |
| Rules Implementation*Maxbid | 0.00939 | 0.00333 | 7.932 | 0.0049 | 1.009 |
| Terms of contract*Maxbid | 0.008 | 0.00368 | 4.721 | 0.0298 | 1.008 |
| Terms | -0.96497 | 0.36001 | 7.1845 | 0.0074 | 0.381 |
| Age*Terms | 0.01322 | 0.00545 | 5.8909 | 0.0152 | 1.013 |
| Livestock*Terms | 0.04541 | 0.11615 | 0.1528 | 0.6958 | 1.046 |
| Different guidelines*Terms | 0.08721 | 0.19017 | 0.2103 | 0.6465 | 1.091 |
| Eligibility*Terms | 0.00584 | 0.11644 | 0.0025 | 0.96 | 1.006 |

| Parameter | Paramete Estimate | Standard Error | Chi-Square | Pr > ChiSq | Hazard Ratio |
|---|---|---|---|---|---|
| application process*Terms | -0.00693 | 0.11669 | 0.0035 | 0.9526 | 0.993 |
| Rules Implementation*Terms | 0.07653 | 0.11614 | 0.4342 | 0.51 | 1.08 |
| Terms of contract*Terms | 0.00726 | 0.13144 | 0.0031 | 0.9559 | 1.007 |
| Length | -0.11689 | 0.07038 | 2.7583 | 0.0968 | 0.89 |
| Age*Length | 0.00151 | 0.00106 | 2.0293 | 0.1543 | 1.002 |
| Livestock*Length | -0.00991 | 0.02262 | 0.1919 | 0.6613 | 0.99 |
| Different guidelines*Length | 0.01236 | 0.03704 | 0.1113 | 0.7387 | 1.012 |
| Eligibility*Length | 0.04259 | 0.02268 | 3.5279 | 0.0603 | 1.044 |
| application process*Length | 0.02007 | 0.02262 | 0.7878 | 0.3748 | 1.02 |
| Rules Implementation*Length | -0.07196 | 0.02308 | 9.7204 | 0.0018 | 0.931 |
| Terms of contract*Length | -0.00961 | 0.02581 | 0.1387 | 0.7096 | 0.99 |
| Establishment | 0.00297 | 0.00812 | 0.1334 | 0.7149 | 1.003 |
| Age*Establishment | 0.0000433 | 0.000123 | 0.1234 | 0.7254 | 1 |
| Livestock*Establishment | 0.00194 | 0.00266 | 0.5299 | 0.4667 | 1.002 |
| Different guidelines*Establishment | -0.00174 | 0.00441 | 0.1565 | 0.6924 | 0.998 |
| Eligibility*Establishment | 0.0008253 | 0.00267 | 0.0957 | 0.7571 | 1.001 |
| application process*Establishment | 0.00217 | 0.00267 | 0.6622 | 0.4158 | 1.002 |
| Rules Implementation*Establishment | 0.00104 | 0.0027 | 0.1466 | 0.7018 | 1.001 |
| Terms of contract*Establishment | -0.0008874 | 0.00303 | 0.0858 | 0.7695 | 0.999 |
| Land_use | -2.0874 | 0.42929 | 23.643 | <.0001 | 0.124 |
| Age*Land_use | 0.03331 | 0.00654 | 25.921 | <.0001 | 1.034 |
| Livestock*Land_use | -1.09213 | 0.1404 | 60.51 | <.0001 | 0.336 |
| Different guidelines*Land_use | -0.0527 | 0.2402 | 0.0481 | 0.8263 | 0.949 |
| Eligibility*Land_use | -0.21588 | 0.14021 | 2.3709 | 0.1236 | 0.806 |
| application process*Land_use | 0.01497 | 0.13981 | 0.0115 | 0.9147 | 1.015 |
| Rules Implementation*Land_use | -0.5203 | 0.14202 | 13.422 | 0.0002 | 0.594 |
| Terms of contract*Land_use | 0.12324 | 0.15859 | 0.6039 | 0.4371 | 1.131 |

# APPENDIX B. DETAIL OF THE VARIABLES USED IN THIS STUDY

| Parameter | Terms | Details | Variables |
|---|---|---|---|
| opt1 | | Contract option A | |
| opt2 | | Contract option B | |
| Maxbid | | Payment/ Rent (tied to local county's rental rate) | 80%, 100%, and 120% of the FSA county rental rate |
| amaxbid | Age*maxbid | Interaction term between age and maxbid | |
| lmaxbid | Livestock*maxbid | Interaction term between livestock and maxbid | 1 = Includes cow/calf herd |
| dgmaxbid | Different guidelines*maxbid | Interaction term between different guidelines and maxbid | 1= Different counties have different guidelines for maintaining CRP |
| Emaxbid | Eligibility*maxbid | Interaction term between eligibility and maxbid | 1= Rigid and complex eligibility criteria to include new criteria for land previously enrolled into CRP |
| apmaxbid | Application Process*Maxbid | Interaction term between application process and maxbid | 1= Administrative process or officials involved |
| rimaxbid | Rules Implementation*Maxbid | Interaction term between rules implementation and maxbid | 1= Terms of the contract need to be changed |
| tcmaxbid | Terms of contract*maxbid | Interaction term between terms of contarct and maxbid | 1= Too many rules involved in implementation. |
| Terms | | Terms of the contract | 1 = Re-adjustment every 5 years<br>2= Fixed at start |
| aterms | Age*terms | Interaction term between age and Terms | |
| lterms | Livestock*terms | Interaction term between livestock and Terms | 1 = Includes cow/calf herd |

| Parameter | Terms | Details | Variables |
|---|---|---|---|
| dgterms | Different guidelines*terms | Interaction term between different guidelines and Terms | 1= Different counties have different guidelines for maintaining CRP |
| Eterms | Eligibility*terms | Interaction term between eligibility and Terms | 1= Rigid and complex eligibility criteria to include new criteria for land previously enrolled into CRP |
| apterms | Application Process*terms | Interaction term between application process and Terms | 1= Administrative process or officials involved |
| riterms | Rules Implementation*terms | Interaction term between rules implementation and Terms | 1= Terms of the contract needs to be changed |
| Tcterms | Terms of contract*terms | Interaction term between terms of contract and Terms | 1= Too many rules involved in implementation. |
| Length | | Duration of the contract | 10 Years and 15 years |
| alength | Age*length | Interaction term between age and Length | |
| llength | Livestock*length | Interaction term between livestock and Length | 1 = Farmers Includes cow/calf herd |
| dglength | Different guidelines*length | Interaction term between different guidelines and Length | 1= Different counties have different guidelines for maintaining CRP |
| Elength | Eligibility*length | Interaction term between eligibility and Length | 1= Rigid and complex eligibility criteria to include new criteria for land previously enrolled into CRP |
| aplength | Application Process*length | Interaction term between application process and Length | 1= Administrative process or officials involved |

| Parameter | Terms | Details | Variables |
|---|---|---|---|
| rilength | Rules Implementation*length | Interaction term between rules implementation and Length | 1= Terms of the contract needs to be changed |
| tclength | Terms of contract*length | Interaction term between terms of contract and Length | 1= Too many rules involved in implementation. |
| Establishment | | Establishment Cost share of government | 50%, and 100% government share of establishment cost |
| aestablishment | Age*establishment | Interaction term between age and Establishment | |
| lestablishment | Livestock*establishment | Interaction term between livestock and Establishment | 1 = Farmers Includes cow/calf herd |
| dgestablishment | Different guidelines*establishment | Interaction term between different guidelines and Establishment | 1= Different counties have different guidelines for maintaining CRP |
| Eestablishment | Eligibility*establishment | Interaction term between eligibility and Establishment | 1= Rigid and complex eligibility criteria to include new criteria for land previously enrolled into CRP |
| apestablishment | Application Process*establishment | Interaction term between application process and Establishment | 1= Administrative process or officials involved |
| riestablishment | Rules Implementation*establishment | Interaction term between rules implementation and Establishment | 1= Terms of the contract needs to be changed |
| tcestablishment | Terms of contract*establishment | Interaction term between terms of contract and Establishment | 1= Too many rules involved in implementation. |
| Land_use | | Allowed usage of land enrolled into CRP for Haying and/or grazing | 1= Allowed every alternate year, 2= Not allowed at all and enrolled land will remain Idle |
| aland_use | Age*land_use | Interaction term between age and Land_use | |

| Parameter | Terms | Details | Variables |
|---|---|---|---|
| lland_use | Livestock*land_use | Interaction term between livestock and Land_use | 1 = Farmers Includes cow/calf herd |
| dgland_use | Different guidelines*land_use | Interaction term between different guidelines and Land_use | 1= Different counties have different guidelines for maintaining CRP |
| Eland_use | Eligibility*land_use | Interaction term between eligibility and Land_use | 1= Rigid and complex eligibility criteria to include new criteria for land previously enrolled into CRP |
| apland_use | Application Process*land_use | Interaction term between application process and Land_use | 1= Administrative process or officials involved |
| riland_use | Rules Implementation*land_use | Interaction term between rules implementation and Land_use | 1= Terms of the contract needs to be changed |
| tcland_use | Terms of contract*land_use | Interaction term between terms of contract and Land_use | 1= Too many rules involved in implementation. |