THE CONSERVATION RESERVE PROGRAM CHOICE

A Thesis

by

JUSTIN REYNALDO BENAVIDEZ

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Chair of Committee,	David P. Anderson
Committee Members,	James W. Richardson
	David J. Leatham
Head of Department,	C. Parr Rosson III

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ABSTRACT

The Conservation Reserve Program was first established by the Food Security Act of 1985, with the primary purpose of preventing damage to highly erodible soils, made worse by intensified farming practices. Since its inception, the CRP has grown to become the largest federal, private-land retirement program in the United States with an approximately $2 billion annual budget. The Agricultural Act of 2014 mandates a reduction in the enrollment cap from 32 million acres to 24 million acres by 2018. The reduction coupled with the higher than average commodity prices makes the decision of whether or not to reenroll in to the CRP a difficult one for producers with expiring land. Expiring lands will equal almost 2 million acres in the year 2015, and approximately 7.1 million acres over the life of the farm bill.

This research will develop a computer based decision aid that incorporates all major aspects of the decision when considering enrollment in the CRP, to be used by landowners and producers. These considerations include eligibility, the Environmental Benefits Index (EBI), the producers bid level, and evaluation of practice options within the CRP and options outside the CRP. The goals of this research are to produce a computer web based decision aid, as described above, with specific emphasis on a few key outputs. These include a probability of acceptance measure, the Net Present Value of all options available to the landowner/manager, and a measure of what that landowner's/manager's optimal bid is.

The methodology of this study relies on the use of simulation using the excel add-in Simetar. Users of the program are allowed to enter details about the land being considered for CRP enrollment that the decision aid then uses to test scenarios for the land. Five hundred randomized point estimates are generated and compiled as a cumulative distribution function comparison chart, stoplight chart, and several other customized output representations for the user's consideration.

This thesis details a test of an Agriculture and Food Policy Center representative farm. The results, given the input data taken from the farm, suggest that the least risky option for this farm with the highest net returns is to enroll the land in CRP. It is important to note that this is simply a test of one farm and not a recommendation for all producers. Also, the results could be changed given different assumptions about the producer's goals.

The study concludes that including risk in the decision making process regarding CRP enrollment is a critical factor when determining the most financially rewarding result. Including riskiness in the decision making process warrants the use of a decision tool, like the one presented in this thesis.

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INTRODUCTION

The Conservation Reserve Program was established by the Food Security Act of 1985, with the primary purpose of preventing damage to highly erodible soils, made worse by intensified farming practices. Since its inception, the CRP has grown to become the largest federal, private-land retirement program in the United States (Stubbs, 2014) with an approximately $2 billion annual budget.

At the end of 2014, approximately 24.2 million acres were enrolled in the CRP (FSA Monthly Summary, Dec 2014), with 77 percent of these acres being General Sign-up land, enrolled through a competitive bid process, and the other 23 percent being enrolled under Continuous Sign-up, targeting the specific needs of states and special goals of the federal government.

Since its inception, the CRP has grown to target much more than simply erodible soil. The CRP Annual Summary and Enrollment Statistics for FY 2012 estimates that runoff of nitrogen and phosphorus were decreased by 95 percent and 86 percent, respectively, compared to runoff levels had the CRP not been implemented. CRP reduces water pollution, and reduces hypoxic zones, particularly in the Gulf of Mexico.

The annual CRP report also estimates that there are approximately 2 million additional ducks/year added to the flock due to improved nesting provided by the CRP in the Prairie Pothole Region. In addition, the endangered sage grouse and lesser prairie chicken have both seen an increase in numbers since the establishment of the CRP. Also, bobwhite quail density in upland buffers, a CRP management cover crops are 70-72 percent greater than on cropped land, and estimates show that a 4 percent increase in CRP land in a region can increase ring-neck pheasant numbers by as much as 22 percent.

CRP land reduces greenhouse gas emission levels. Estimates indicate that CRP land has removed 49 million tons of CO_2 from the atmosphere. The reduction comes through the reduction of fuel use and nutrient runoff from fertilizer application, as well as CRP land itself serving as a carbon sink. The aggregate benefits of CRP equate to an estimated decrease of 9.6 million cars on the road (Conservation Reserve Program Annual Summary and Enrollment Statistics, 2012).

On top of all of these environmental benefits, the CRP has reduced "surplus" crops and boosted crop prices, provided stable income to landowners and producers, and bolstered regional economies through hunting and recreation. But CRP enrollment has also prevented more land from being planted when crop prices were record high.

The Agricultural Act of 2014 mandates a reduction in the enrollment cap from 32 million acres to 24 million acres by 2018. The cap reduction coupled with the higher than average commodity prices makes the decision of whether or not to reenroll land into the CRP a very difficult decision for producers with expiring land. Expiring lands will equal almost 2 million acres in the year 2015 alone, and approximately 7.1 million acres over the life of the farm bill (Conservation Reserve Program Statistics).

This research develops a computer based decision aid that incorporates all major aspects of the decision when considering enrollment in the CRP, to be used by landowners and producers. These considerations include eligibility, the Environmental Benefits Index (EBI), the producers bid level, and evaluation of practice options within the CRP and options outside the CRP.

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CHAPTER II

REVIEW OF LITERATURE

History of the CRP

The history of land retirement programs in the United States dates to the 1930's, but they did not begin with the goal of preserving sensitive land. The 1930's were an era of financial hardship for most American's, and in particular, for those who lived in rural areas. Not only was the Great Depression at its peak, but the Dust Bowl was in full swing in the plains. According to "History and Outlook for Farm Bill Conservation Programs," by Cain and Lovejoy 2005, in the 1930's approximately one in four Americans lived on farms, and an even greater percentage had incomes tied directly, or indirectly to farming. Yields were poor, and rural incomes showed it, dropping 52 percent from 1929 to 1933 (Cain and Lovejoy 2004). Poverty, along with other major concerns regarding agriculture led President Roosevelt's Secretary of Agriculture, Henry A. Wallace, to produce the first "Farm Bill", called "The Agricultural Adjustment Act (AAA)".

The administration sought a way to support farmer incomes without using direct payments, as money being handed directly to individuals would have been politically impossible, and this led to the first real wave of land retirement. The AAA created a parity price for farmers. It guaranteed that, as long as you participated in voluntary production reduction programs, including acreage set-asides, the price you received would not fall below a set level based on parity to the 1910-1914 period. This program was not to last, as it was funded by a tax levied on processing of the commodities; a tax that was eventually passed on to consumers. "In 1936 this tax was declared unconstitutional on the grounds that Congress had passed a tax that was beneficial to one segment of the nation – the farmer – while causing detriment to everyone else." (Cain and Lovejoy 2004)

Congress' ruling led to the first real push towards large-scale conservation programs. Before the finalization of the Supreme Court case, Wallace developed the Soil Conservation Act (SCA) of 1935. This method of getting cash to producers wasn't challenged, and became the most significant method of support and surplus reduction in the 1936 Farm Bill. Unfortunately, Wallace's SCA did not work as expected, and the cause was partly of his own doing. A huge supporter of science in agriculture, Wallace also supplied government funding for science and technology to advance the farming industry. This funding, which enhanced yields, led to significant slippage. Slippage can be described as a smaller reduction in production than expected from removing a certain amount of acres from production. In fact, due to the new tech and focused production on reduced acres, surpluses increased significantly following the 1936 Farm Bill. Technology driven production gains exceeded the production of acres idled.

A few other adjustments were made to conservation initiatives prior to 1950, but due to the war-time economy and the need for more food production, focus shifted away from acreage controls for the majority of the 1940's. Focus returned to conservation in 1956 with the passing of the Agricultural Act of 1956, which created the Soil Bank. The purpose of the Soil Bank was to, "[D]eal with the stifling effects of erosion that threatened the welfare of every American and disrupted markets and commerce on the whole" (Can and Lovejoy 2004). The Soil Bank was made up of two programs, the Acreage Reserve Program and, in its first real iteration, the Conservation Reserve Program. "The conservation reserve program called for a three-year contract wherein the government would pay for land improvements that increased soil, water, forestry, and wildlife quality if the farmer would agree not to harvest or graze contracted land" (Cain and Lovejoy 2004). The Soil Bank resulted in some unintended consequences that would affect future land retirement programs. The act devastated rural economies focused on agricultural processing and farming. Vast amounts of land were removed from production in concentrated areas, effectively killing the processing industries that depended on through-put from the agricultural industry. This led to the 25 percent limit on acreage enrollment in a single county, which will be discussed later in the paper.

The 1980's were the first time that conservation concerns began for the sole sake of conservation itself, without the explicit inclusion of price or supply control. The Food Security Act of 1985 was the first to have a conservation title, and it included the creation of the Conservation Reserve Program as its own program, and the creation of Conservation Compliance. The first Conservation Reserve Program signup aimed at enrolling 40-45 million acres of highly erodible land, and was managed strictly on the goals of preventing erosion. This act included a provision allowing no more than 25 percent of acres in a county to be enrolled, to protect rural economies. Conservation compliance put regulations on land conversion and other practices in order for farmers to participate in farm programs.

The Conservation Reserve Program has undergone changes to its structure since 1985, but the overall idea has remained largely the same. In the Food, Agriculture, Conservation, and Trade Act of 1990, CRP saw a refocusing to include benefits to water, and created the first version of the Environmental Benefits Index (EBI). According to, "Conservation Reserve Program: Annual Summary and Enrollment Statistics FY 2012," the EBI was later amended in the Federal Agriculture Improvement and Reform Act of 1996 to include emphasis on wildlife benefits equal to those gained by water and reduced soil erosion. The 1996 farm bill also led to the creation of the first continuous CRP sign ups. Continuous sign ups target specific state environmental issues and focus on aligning successes at the state level with the overall federal program. The Farm Security and Rural Investment Act of 2002 saw the creation of the, 4-of-6 previous year cropping rule, included provisions for non-emergency harvesting of CRP land, and expanded the Farmable Wetlands Program, enacted the year before, to all 48 contiguous states. Finally, in the Food, Conservation, and Energy Act of 2008, the acreage cap was decreased to 32 million acres.

The Agricultural Act of 2014 saw few significant changes to the CRP, mostly related to severe droughts occurring in Texas and California, and severe flooding in the Midwest. The first notable change was that emergency haying/grazing on CRP was now allowed with reduced or no penalty. In, "Conservation Reserve Program (CRP): Status and Issues," Megan Stubbs of the Economic Research Service says that use of CRP land forage due to drought or flood, seasonal use of vegetative buffer practices, and grazing for a beginning farmer/rancher will be allowed with no penalty. However, managed harvesting, commercial use, grazing for invasive species, routine grazing, and wind turbine establishment on land in the CRP will all be penalized 25 percent of their annual payment/acre. Many of these provisions came from the 2014 elimination of the Grassland Reserve Program. The 2014 farm bill included a provision allowing early non-penalty termination of CRP contracts if the land has been enrolled for over five years, and is not considered “environmentally sensitive”. Lastly, in a continuing trend, the 2014 Farm Bill decreased the acreage cap of the CRP from 32 million to 24 million acres by 2018.

Operation of the CRP

The description of the CRP on the USDA Farm Service Agency website is, “In exchange for a yearly rental payment, farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality.” In reality, the program is much more focused and intensive than this simple description leads one to believe, and has multiple initiatives working to specifically address the health of the environment, while balancing the needs of producers.

The CRP is administered by the Farm Service Administration (FSA) with support from other governmental agencies, primarily the Natural Resource Conservation Service (NRCS), and is funded by the Commodity Credit Corporation (CCC). It is the largest federal/private land retirement program, and widely considered to be one of the most successful.

The first consideration when looking at the CRP is determining what land is eligible. The first condition actually applies to the producer themselves. In order for a producer to be deemed ‘eligible’ for CRP they, “…must be an owner, operator, or tenant of the land for at least 12 months prior to the close of the CRP sign-up period, and show control of the land for the duration of the contract” (Stubbs 2014). There are special considerations that can get around this rule, but in general, it applies to all producers. The basic idea is to prevent people from buying land specifically for CRP enrollment.

Considerations for land eligibility are more extensive. In general, the land must be:

- Highly erodible
- Marginal pasture land
- Grasslands in areas that could provide habitat for ecologically significant plant and animal populations if maintained/returned to grassland
- Land to be enrolled in a riparian buffer

Each of these eligibility criteria have specific caveats that apply to them, ensuring that the land is used to its highest environmental potential, but in general, land must meet one of the above criteria in order to be eligible for enrollment. It is important to note that land is enrolled in one type of CRP ‘practice’ which is implemented via a plan created in conjunction with the farmer and FSA. The top five CRP practices are listed in Table 2.1. The established practice is voluntary, unless the specific ‘initiative’ a producer is enrolling in requires the establishment of a specific type of cover.

Table 2.1 Top Five Conservation Practices Installed on CRP Acres (Current as of July 2014)

Practice Code	Practice Description	Acres Enrolled	Leading States
CP2	Establishment of permanent native grasses	6,753,649	Texas, Colorado, Kansas
CP10	Already established vegetative cover (grasses and legumes)	4,289,400	Texas, Colorado, Montana
CP1	Establishment of permanent introduced grasses and legumes	3,370,780	Missouri, Montana, Washington
CP4D	Permanent wildlife habitat	2,126,750	Colorado, North Dakota, Kansas
CP25	Rare and declining habitat	1,708,108	Kansas, Nebraska, Minnesota

(STUBBS, 2014)

There are two ways to 'opt in' to the CRP. The first is through the general sign-up. The general sign-up is the largest portion of the CRP, and accounts for 19.7 million acres, or 77 percent of all land enrolled in CRP (Stubbs 2014). It operates on a competitive bid process, whereby farmers submit a bid to the FSA and, based on their bid and environmental factors, the FSA either accepts or rejects their enrollment. General enrollment occurs during set time periods, and the next period begins on December 1, 2015, and ends February 26, 2016.

The second way to enroll land in the CRP is to work through the continuous sign-up. Continuous sign-ups are non-competitive and target the most environmentally sensitive land under specific needs of the state. These sign-ups include special signing and enrollment incentives to encourage participation. Continuous sign-ups account for 23 percent of CRP enrollment, or approximately 5.75 million acres. The largest two 'initiatives' under this sign-up are the Conservation Reserve Enhancement Program (CREP), and the Farmable Wetlands Program (FWP). These two initiatives account for 1.6 million acres of CRP enrollment.

Table 2.2 is a detailed description of how payments work for each sign-up and initiative.

Table 2.2 CRP Payment Description Under Each Signup.

Payment Type	Description	Limit	Sign-up Type
Rental Payment	Annual payment to participants. Based on soil productivity for each county and the average dryland case rental rate.	$50,000 annually for any person or legal entity	general and continuous sign-up
Cost-share Payment	Payment for a percentage of installing or establishing an eligible practice.	No more than 50% of the actual or average cost of establishing the practice.	general and continuous sign-up
Maintenance Incentive Payment	Reimburses participants for the average annual cost of certain practice maintenance.	$5 per acre per year	certain continuous sign-up practices
One-time Sign-up Incentive Payment (SIP)	One-time incentive payment made to participants that enroll certain practices.	$10 per acre per year enrolled (not to exceed 10 years)	certain continuous sign-up practices.
One-time Practice Incentive Payment (PIP)	One-time incentive payment for eligible installation costs for certain practices	40% of the eligible cost of practice installation	certain continuous sign-up practices.
Other Financial Incentive	Additional incentives, as part of annual rental payments, for windbreaks, grass waterways, filter strips, and riparian buffers	Up to 20% of the annual rental payment	certain continuous sign-up practices.

(STUBBS, 2014)

CRP payments to participants are based on a few factors that are discussed in detail later in this review, however, it is important to note that the payments cannot exceed the Maximum Acceptable Rental Rate (MARR), which is based on a calculation of the county average rental rate, taken from the National Agricultural Statistics Service, and takes in to consideration the soil productivity.

CRP is not in a sense ‘binding’ for the duration of the contract, as there are provisions for removing your land from the program. These provisions allow for the removal of land with some financial penalties. First, upon removal of land from the program, it is necessary to repay all financial incentives and one time payments in full, with interest, and second, 25 percent of the rental payments received must be returned to the government.

Taxes on CRP payments are a timely issue. In October 2014, *Morehouse v. Commissioner of the Internal Revenue* was decided by the United States Court of Appeals, Eighth Circuit. In 1994, Morehouse inherited a large amount of land in South Dakota, and in 1997, after renting out a portion of the land to producers, and maintaining a portion in existing CRP contracts, chose to enroll another portion in the CRP. In an excerpt from the Decision on the case the circuit judge states:

> Morehouse received CRP payments of $37,872 in both 2006 and 2007. The Morehouses timely filed tax return forms for both years and identified their occupations as "self-employed." On Schedules E of their tax returns, the Morehouses listed the CRP payments for both years as "rents received," and thus the CRP payments were not taxed as self-employment income. On October 14, 2010, the Internal Revenue Service Commissioner (Commissioner) mailed to the Morehouses a notice of deficiency for 2006 and 2007. The notice stated the CRP payments should have been reported as income on a Schedule F, Profit or Loss From Farming, and were thus unreported self-employment income, which should have been taxed.

The Morehouses petitioned the Tax Court, which upheld the Commissioner's claim, and the Morehouses in turn appealed the decision of the Tax Court. Eventually, the United States Court of Appeals, Eighth Circuit overturned the ruling based on the fact that, "…2006 and 2007 CRP payments were "considered paid [by the government] for the use [and occupancy] of [Morehouse's] property" and thus constituted rentals from real estate fully within the meaning of § 1402(a)(1)." (*Morehouse v. Commissioner*, 2014) This means there are two methods of taxation for CRP revenue. If you are an active producer, revenue is subject to the 15.3 percent self-employment tax, however if you are a 'non-farmer' with land enrolled in the CRP, the money is not subject to the tax.

CRP Acreage

CRP is impacted by a myriad of forces, and can be significantly changed following upturns or downturns in prices, large environmental changes, or government program adjustments. Figure 2.1 shows the annual enrollment by acres from the CRPs inception to 2013. Note that in 2013 CRP acreage was the lowest it has been since pre-1990.

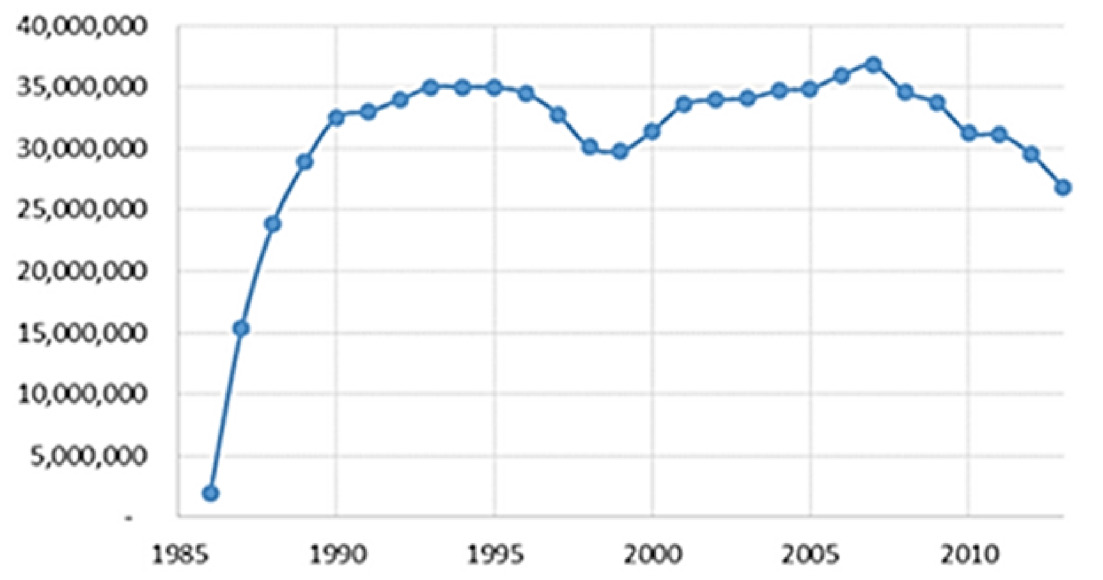


Figure 2.1 Acres Enrolled in the CRP in the US 1985-2013
(Conservation Reserve Program Statistics, 2015)

The most recent downturn in CRP enrollment follows a significant increase in commodity prices that began in late 2006. The upturn in commodity prices can be attributed to the aggressive increases in the Renewable Fuel Standard's (RFS) volume requirements from 9 billion gallons in 2008 to 36 billion gallons by 2022 (H.R. 6, 2007), the sudden onset of drought in the Midwest and Texas during the 2010s, and higher production costs. Higher production costs and drought cut corn supplies while the RFS rapidly boosted demand for corn for ethanol production. Higher crop prices, especially corn, meant there was less incentive for farmers to keep their land out of production if CRP rental rates remained the same. Even though, as we will later postulate, biofuel commodities are not the most commonly replaced by CRP acreage, an increase in price would lead producers to attempt biofuel commodity production on more marginal, i.e. CRP qualified land.

It should be noted that from 2008 to 2014 rental rates have, in fact, increased. According to data taken from the "Conservation Reserve Program Statistics" page of the FSA website, in 2008 the national average rental rate for cropland was $85.50/acre, while in 2014 that rate had increased to $141/acre. In a less significant, yet similar, trend the national average rental rate for pastureland went from $10.50/acre in 2008 to $12.00/acre in 2014. While this is an increase, it is unknown if it was simply not enough to retain producers whose land might be highly productive, or if other factors kept them from the CRP.

CRP land is concentrated in a few large areas. The heaviest concentrations are generally located east of the Rocky Mountain range and west of the Mississippi river, however lesser concentrations of CRP are found in all 48 of the lower states except for Arizona. Figure 2.2 contains the CRP enrollment as of 2014, based on the concentration of acres in a county.

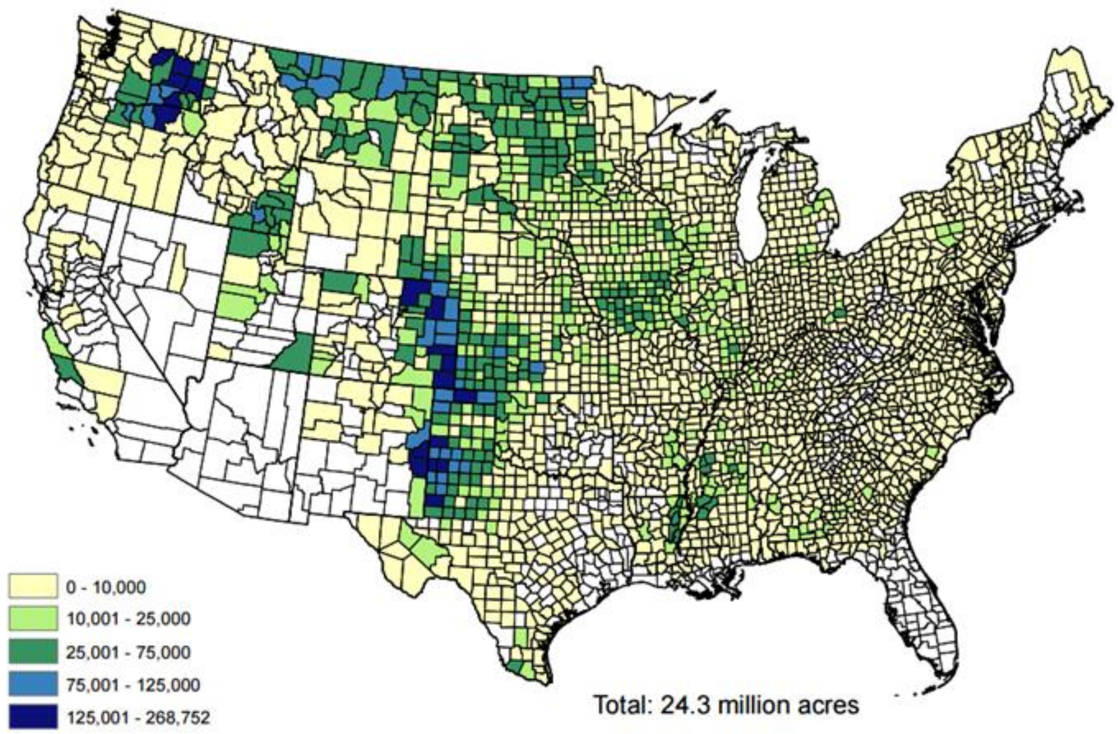


Figure 2.2 Map of CRP Enrollment in Acreage per County - December 2014
(Conservation Reserve Program Statistics, 2015)

The highest concentration of acreage enrolled in the CRP occurs in the lower great plains encompassing areas in Texas, Oklahoma, Kansas, and Colorado, the Prairie Pothole Region, encompassing portions of Montana, North Dakota, South Dakota, and Minnesota, and portions of Iowa, Illinois, and Missouri.

Economics of the CRP

There are many economic factors to take into consideration when studying the CRP. In, "The Influence of Rising Commodity Prices on the CRP," Hellerstein and Malcolm (2011) used a 'Likely to Bid' model to study the impact of rising commodity prices on CRP acreage and bid pricing. They simulated, at the national level, three scenarios under which commodity crop prices stayed at their established baseline (prices in 2005), a medium level of prices (prices in 2007), and one in which the prices remained at significantly high 2008 prices. They also tested two levels of Soil Rental Rate, the maximum level of allowable bids. The metrics they used to frame the study were differences in offered acres, average EBI scores (not including the cost factor of EBI), lost agricultural production through CRP enrollment, rental payments on an aggregate and per acre level, and regional distribution of acres. Their results indicated that higher crop prices were significant determinants of CRP bid prices. "[C]ommodity price changes influence not only the amount but the quality of lands offered: their agricultural productivity, environmental benefits, and geographic location" (Hellerstein & Malcolm, 2011).

Hellerstein and Malcolm's findings for their baseline scenario indicate that 51.1 million acres would be offered into CRP. In the medium price (2007 levels) they used two different Soil Rental Rates. These rates were the 2007 SRR, and a SRR increased by 60 percent. With the 2007 SRR and the increased prices, the offered acres dropped to 28.8 million. With the increased SRR, offered acres went back towards the baseline scenario, reaching 45 million acres. Their results when conducting the high level price scenario, with an SRR increased by 120 percent from the baseline were similar to the increased SRR findings of the 2007 price level study.

SRR increases could help to combat price increases in commodities, and Hellerstein and Malcolm's work corroborates that evidence. Hellerstein and Malcolm's model also gives an explanation as to why CRP acreage has decreased, despite increases in SRRs. Hellerstein and Malcolm did not have a, "…straightforward [method] to predict what rental rates would be under different commodity price regimes," so they simply chose the 60 percent and 120 percent across the board increases. "Actual CRP rental rates increased by… 20 percent between 2008 and 2010." (Hellerstein and Malcolm, 2011) This provides insight as to why their predictions did not materialize, as the increase in payments was substantially less than the increases assumed in the study.

Changes in crop prices not only impact quantity of land enrolled in CRP, but also its locale and EBI scores. Hellerstein and Malcolm estimate that if prices stayed at 2007 levels, the costs of the program would double. Hellerstein and Malcolm also postulate that while this empirical analysis has held mostly true, variances in their results could be a result of the popularity of the program itself. Essentially, the popularity of the CRP program might mean that token increases in rental rates may keep producers in the program, even if it doesn't explicitly meet their best financial interest. Overall, Hellerstein and Malcolm find that, "Higher crop prices, as observed in summer 2008… are likely to sway some landowners in favor of agricultural production over conservation," and that, "[C]ommodity price changes influence not only the amount but the quality of lands offered[.]"

Sullivan et al. (2002), forecast the use of land were it to leave CRP. They first determined what factors influence the land use choice. Three factors; the type of cover used when the land is in CRP, the profitability of the possible uses, and the aspirations of the owner, including age, wealth, and the tenure of CRP enrollment effected future land use. In an effort to simplify the study, aspirations of the owner were assumed away, and the type of CRP cover and the profitability of future uses were analyzed.

Sullivan et al. assumed that all CRP contracts were suddenly eliminated and used the Likely-to-Bid model developed by the Economic Research Service (ERS) to develop the probability that land will switch from CRP to another use. They based their data on 2001 prices and pre-2002 programs. They found that, when ending the CRP immediately, 51 percent of CRP land would return to cropland, with the highest concentrations of this occurring in areas the authors named, the Northern Plains Crescent, which encompasses parts of Montana, North and South Dakota, and Wisconsin, the Southern Plains Ellipse, which includes portions of eastern Colorado, western Kansas, western Oklahoma, and the Texas Panhandle, and the Southwestern Corn Belt, which includes northern Missouri, southern Iowa, and eastern Illinois. The national average of 51percent is lower than found in previous studies, but they assume this could be due to the lack of personal information, or to the inclusion of new assumptions on land rigidity as a good. Figure 2.3 contains an ERS estimate of what would happen to lands under the assumption that the CRP suddenly expired.

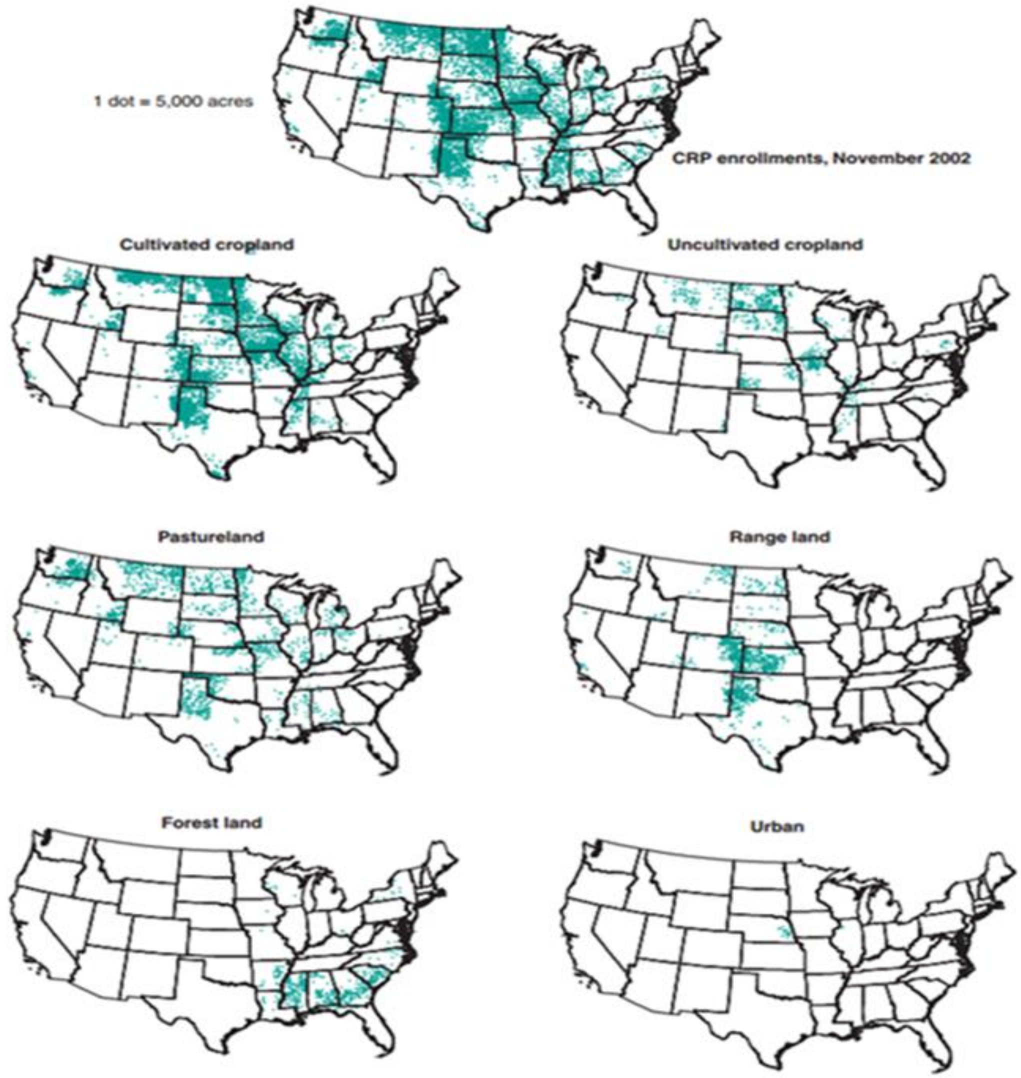


Figure 2.3 Disposition of Enrolled Acreage Under Hypothetical CRP Expiration Based on 2001 and 2002 Prices
(Sullivan, 2004)

Increasing population pressure, along with a demand for higher standards of living in the developing world, is driving a need for more food, and therefore more places to grow it. In, "Is America Running out of Farmland?" Gottlieb addresses this concern by studying historical trends in population growth and land use.

Gottlieb discusses the dire predictions of a 1981 study that claims there is need for approximately 77 million acres of additional farmland to keep up with population growth. The fallacy of this argument is that it suffers from the Malthusian problem. The study assumed a straight line in both population growth and food supply growth, although is technology may be actually increasing yields on the same amount of land. Even with the worst-case ‘straight-line’ scenario, the farmland ‘cap’ would not be reached until, at the earliest 2051, but with some estimates ranging all the way to the year 4000 (Gottlieb). The result is that the urban sprawl problem, and the loss of production land is not a ‘real’ problem.

Another issue that Gottlieb focuses on that is pertinent to the study of the CRP, is that market forces, along with technology will continue to provide adequate farmland. What this means is that, as the prices for commodities rise, as discussed previously, land will move away from uses like conservation towards production, as government subsidies are unable to keep up with the market price of commodities. Gottlieb points out that the problem of farmland loss cannot be looked at as an aggregate, because transportation costs become an issue. With farmland in New Jersey cited as rapidly decreasing, the cost of transporting food to that region will go up, as the distance from food increases. This may, Gottlieb theorizes, drive local parcels that are enrolled in uses, such as CRP, out of those programs and in to production, as their returns would be higher on the market, and still less expensive than transporting commodities over long distances.

In, “Agricultural Land Values and Rents Under the CRP,” Shoemaker theorized that CRP might increase land values over time. The formula used to evaluate this claim was simple:

Impact on Farm Income = CRP Pmt. – Cover Establishment – Loss from Decreased Production

Shoemaker (1989) found that, with the CRP functioning as an annuity, the value has been bid-up by farmers and landowners treating enrolled land the same way they would treat a bond. Shoemaker stated that, “The direct effect of the CRP on eligible land depends on the excess beyond the minimum incentive required to induce participation in the program,” and “…that excess will be capitalized in to the program.” The research has interesting implications regarding farmer bids. According to the Shoemaker, “[T]here is a certain asymmetry of information regarding land quality.” In essence, the land owner knows a substantially greater deal about their land and its value than the government. This asymmetry of information allows farmers to gain ‘economic rents’. CRP rent is also a certain return vs. an uncertain farming return. During the first four sign ups, Shoemaker documented the behavior of farmers ‘bidding up’ their prices. “During the initial sign-up the average rental rates were lower than the bid caps in all regions. By the fourth sign-up, average contract rates approached or equaled the bid caps for all regions.” (Shoemaker, 1989) Farmers who wait to bid in to a program could discover their bid caps. The bid caps are now published and widely known, however it does show that farmer bidding patters do not attempt to put less valuable land at a lower price, but always push the limit of the bid cap or Maximum Acceptable Rental Rate.

Jacobs, Thurman, and Marra (2011) discuss bidding practices in, "How Farmers Bid into the CRP: An Empirical Analysis of CRP Offers Data". They discuss the fact that proposed rental rates are given negative weight in the EBI, and that the rental rate is what farmers base their bid on, as well as the EBI being roughly equal to a landowners probability of acceptance. According to Jacobs et al. producers face two problems when bidding. They have uncertainty about government actions and uncertainty about competing bids on nearby acreage. The authors develop an equation that estimates the level at which a bid must be accepted:

$$r + b(N) > \pi$$

where r is the bid, b(N) are other benefits assumed to be increased in future farming, social benefits, and unquantifiable "open space" enjoyment, and π is the returns to farming. The data came from signup data in the 16th, 18th, and 20th sign ups in the Prairie Pothole Region.

The authors found that bids are clearly conditioned on the Maximum SRR. They also found that changes in bids are not perfectly correlated. A $1.00 increase in the Maximum SRR only increased average bids by $.05 to $.55. This varied slightly by locale, as, landowners in Iowa and, to a lesser degree, Minnesota perceive (correctly) that they are penalized in the EBI cost scoring for being high rent enrollments which leads them to bid well below their maximum rental rate in an attempt to increase their probability of acceptance. The opposite case holds for landowners in low rent areas (Jacobs et al., 2011). Also, the authors found that a landowner with a high EBI score will increase their bid by more than a landowner with a lower EBI score, if both gain one additional EBI point. This greater increase on high EBI scores is less likely to hurt the high EBI's chance of acceptance, whereas it will likely keep a lower EBI score out of the program.

Williams et al. (2009) examined producer level concerns when considering the decision of whether or not to enroll in CRP, by conducting an empirical analysis to show the significance of incorporating risk when making the CRP choice. Multiple cited articles by the authors recommend leaving land idle at least one year after taking it out of the CRP to significantly increase yields. To incorporate risk, the authors conducted a static analysis and a stochastic analysis of several different production methods on sorghum-fallow and wheat-fallow rotations on an experiment station in Tribune, Kansas. The static study resulted in a substantial increase in income under the reduced till or no till methods over CRP. The stochastic study incorporates a producer's general risk aversion, and found that, while conventional tilling has the highest returns to production, CRP has higher returns than any production methods. The authors determine that a risk averse/risk neutral producer will choose CRP due to their entire cumulative distribution function being positive under CRP, while under production, negative returns occurred. CRP was preferred to cropping for all producers when accounting for Absolute Risk Aversion Coefficient (ARAC) of greater than 0.04. Williams et al. work supported incorporating risk when considering the economic CRP decision is important, as a large amount of CRP land is ‘marginal’ and financial losses occur frequently.

Feng, Hennessy, and Du (2013) argue that crop insurance should be considered when calculating the cost portion of the EBI, as high concentrations of CRP occur in areas of marginal land, where crop insurance premiums are high. The potential savings by not having to continue subsidizing those premiums are significant, and if included in the EBI, areas with high premiums could have more competitive bids. This could effectively change the geography of the CRP.

On a study of 12 counties in Southwest North Dakota, Bangsund, Hodur Leistritz, and Nudell (2011) conducted an analysis of the economic implications to an entire region from the reduction of CRP acreage. The authors found that, a reduction in CRP acreage, was correlated with significantly lower permit hunting returns, and that regional hunting related expenditures (i.e. hotel rooms, restaurant income) decreased. The authors point out that as CRP acreage decreases, there is typically a documented accompanying decrease in wildlife numbers. They hypothesize that the number of hunters and their spending decreases with fewer CRP acres. There are implications of ‘game-theory’ complications in the study, as the authors point out that, even if a farmer keeps his land enrolled in CRP, overall regional habitat loss will decrease the amount of wildlife, and therefore it is likely that fee-hunting revenues for an individual producer will decrease.

Environmental Benefits Index

The Environmental Benefits Index (EBI) has become an integral part of the CRP since it's development in 1990. It was developed to compare the conservation benefits that different offered lands provide. Heimlich (2002) details the structure of the EBI. There are several components of the EBI in CRP. Table 2.3 contains the points given to each EBI consideration.

Table 2.3 EBI Categories and Their Values

	Cover	*Proximity to Water*	*Adjacent Protected Area*	*Wildlife Enhancement*	*Total*
Wildlife	0-50	0,5,10	0,5,10	0,5	10-100
	Location	*Groundwater*	*Surface*	*Wetlands Proximity*	
Water Quality	0-30	0-30	0-30	0-10	0-100
Enduring Benefits	0-50				0-50
	Wind Erosion	*Erodible Soils*	*Air Quality*		
Air Quality	0-25	0-5	0-5		0-35
Erosion	0-10				0-10
State or Nat. Conservation Priority Area	0-25				

(Heimlich, 2002)

Following the measurement of the EBI benefits, the government creates a national standard EBI. Typically, lands that meet this national standard are considered acceptable for enrollment, contingent on their bid, while parcels that do not meet this

EBI are not usually accepted. The most recent standard EBI equaled a score of 209. (Stubbs, 2014) Once the environmental EBI is calculated, the government factors in the cost, and an important thing to consider is the fact that while the acreage of the program is capped, the costs are not. The government sets a Maximum Acceptable Rental Rate (MARR), which is essentially truncates the distribution of CRP bidders. Those with acceptable EBIs and rental bids below the MARR are accepted. The easiest way to envision the EBI is a type of balance (Figure 2.4), with costs on one side and environmental considerations on the other. As your bid, accompanied by cost-sharing commitments from the government get 'heavier', your EBI must go up, and as your environmental benefits get 'heavier', you can place a higher bid.

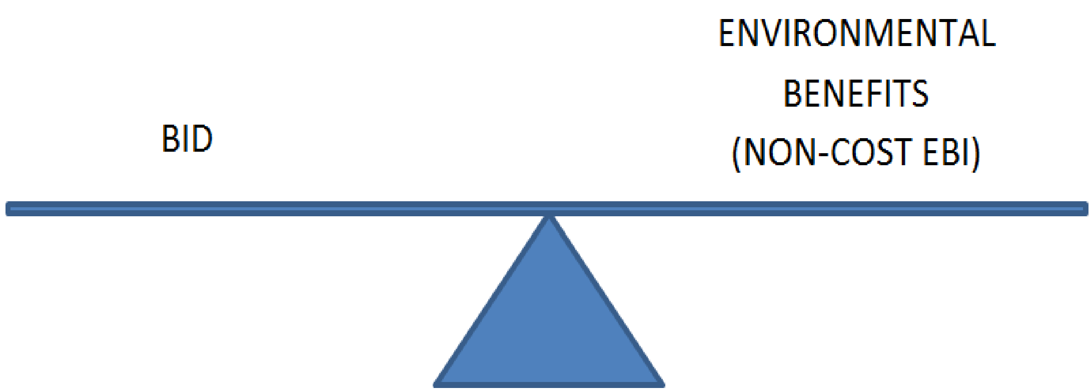


Figure 2.4 The Tradeoff Between CRP Bid and EBI

The EBI is constantly in flux, and changes based on the needs of the current conservation attitudes, and political pressure. "The EBI was not meant to be a rigid index, but to be adjusted and improved depending on the progress of sign-ups, perceived deficiencies, and/or changed priorities" (Ribaudo et al., 2001). The EBI is often lauded as a strong example of compromise in the political/conservation spectrum. “The EBI was not developed solely by scientists seeking to maximize the potential benefits from the CRP, but by a combination of program administrators, physical scientists, social scientists, and politicians trying to meet the demands of diverse consumer groups, the needs of farmers, and the realities of implementing a massive conservation program” (Ribaudo et al., 2001).

Figure 2.5 contains the average EBI score of land enrolled in the CRP as of the 43rd sign-up in 2012. As you can see, EBI scores tend to be concentrated in specific areas. These include the previously mentioned Southern Great Plains, the Northern Plains Crescent, the Southwestern Corn Belt, and the Deep South, although they all likely have differing environmental benefits.

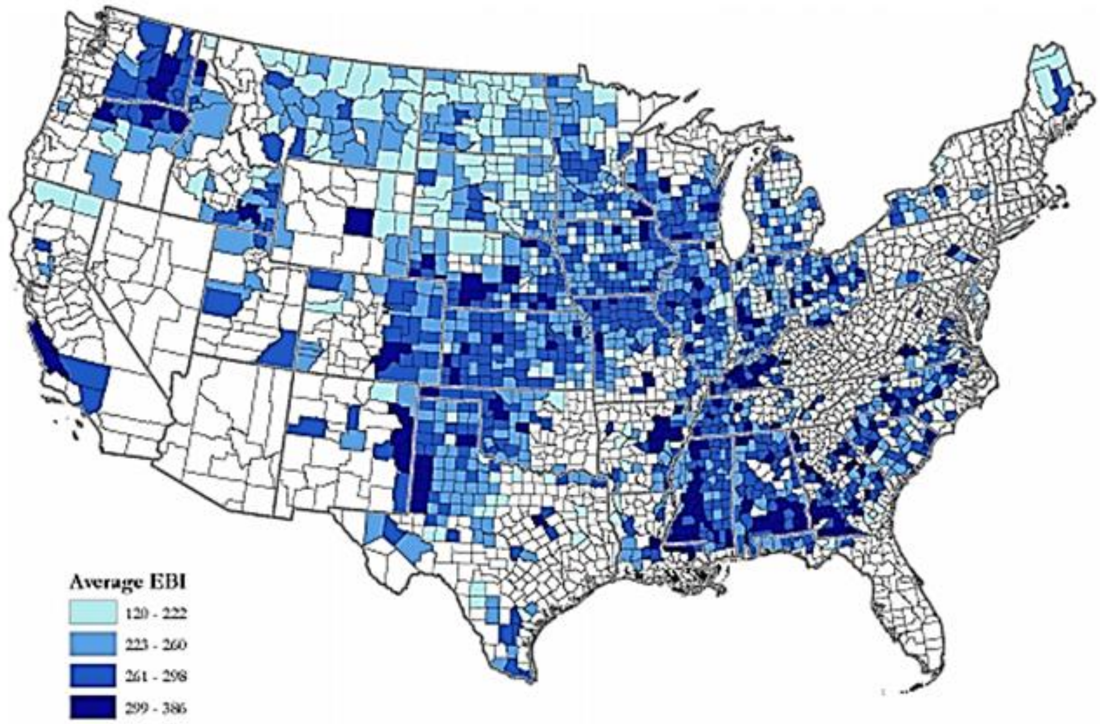


Figure 2.5 Average EBI Score as of Sign-up 43; 2012
(Conservation Reserve Program Statistics, 2015)

Soil Fertility Considerations of the CRP

Depending on its use, land can function as a major carbon 'sink.' Along with nitrogen, these elements are essential for the healthy development of crops, and contribute to growth in yields. Loss of these nutrients creates the necessity for fertilization and therefore increases costs of production. Therefore, it is important to study whether or not CRP or different types of production are healthier for the soil.

Reeder, Schuman, and Bowman (1998) discuss the loss of Carbon (C) and Nitrogen (N) in the Central Great Plains. They began by testing land on seventeen experiment stations with dryland cropping histories extending back from 40-60 years. They found that, compared to land that had been in its natural state for that period, C and N had decreased by 42 percent and 36 percent, respectively. They theorized that this was caused by exposure to erosion, reduced additions from organic matter, and enhanced soil organic matter (SOM) decomposition through depth mixing, temperature change, and aeration. One major question they hoped to address was the question of rate of decrease; do the levels of C and N decrease rapidly and stay low? Their estimates of achieving steady state ranged from 30-90 years.

In order to answer these questions, the authors selected two plots in Wisconsin (controlled for water erosion through selection of a level site), and applied treatments to each plot. One plot was a sandy loam soil, and the other was a clay loam soil. The treatments applied consisted of: native left in native, native land converted to cropping, cropped land left in cropping, and cropped land converted to native.

While fields left in their original states functioned as controls, with C and N remaining essentially unchanged, the results on the converted parcels were significantly different. There was a rapid decline in the levels of C and N on the native land converted to cropping, with the levels dropping in just 6 years, to the level of the cropped land that had been in production for 60+ years. This indicates that there is a rapid decrease in soil nutrients, and that they hit a steady state early after conversion. There was also a drastic change in soil nutrients on land that was converted from cropping to native state. After just 6 years in a managed CRP state, the land had reached levels of C and N greater than that of land that had never been put in production in the first place. There was a small disparity between the types of soil, with sandy loam doing better than clay loam, but the results were the same overall.

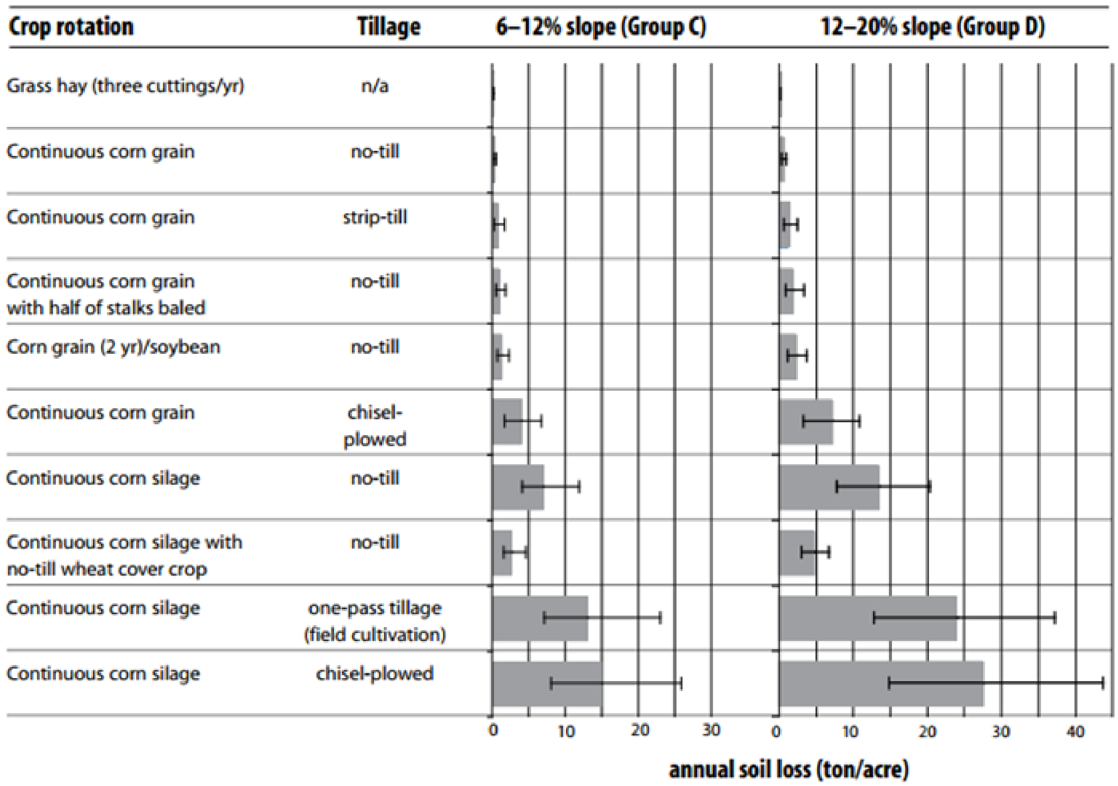
Burke, Lauenroth, and Coffin (1995) studied organic matter to determine if, "…abandoned fields recover total soil organic matter, active soil matter, and N availability after 53 years [of non-cropping, following decades of cropping]" (Burke et al., 1995). They theorized that tillage/cropping decreases SOM because these practices increase output of SOM and also decrease residual plant replenishment.

The authors used 12 sites in the Pawnee National Grasslands in northeast Colorado, that they termed 'abandoned' fields. These fields had been cropped until 1942 and left idle until the study period in 1995. At five of their sites there was nearby cropland they used as controls. Three sites were chosen from the Pawnee National Grasslands for immediate C and N testing, with their samples being refrigerated and sent to lab. The method of testing was soil core extraction with test depths of 0-5 in. and 5-10 in. below the surface.

"Microbial biomass C and N were significantly higher on both native and abandoned fields than on cultivated fields. However, there were no significant differences between native and abandoned treatments with respect to microbial biomass for either microsite or depth." (Burke et al., 1995) These findings support a large body of literature that says that cultivated land typically has 30-40 percent less C and N than native/abandoned land. Addressing this issue is important for land managers who are considering taking land out of production or enrolling in the Conservation Reserve Program.

A key issue to address is the attempt to retain as much of the benefits gained from the CRP program as possible after the rejection of a parcels bid, or the choice to remove that parcel from the program. A key benefit to try to maintain is the soil retained from prevented erosion. Panuska, Good, and Wolkowski address this issue in, "Converting CRP Land to Corn: Minimizing Soil Loss." They use a SNAP (Soil Nutrient Application Planner)-Plus nutrient management software to evaluate the sediment loss from different farming methods. This program incorporates NRCS's Revised Universal Soil Loss Equation (RUSLE2), and their data was taken from multiple fields with two differing slope ranges; 6-12 percent and 12-20 percent. Their results are found in Table 2.4, with the gray bars representing averages and the black lines representing actual observances.

Table 2.4 Soil Losses Under Various Crop Rotation and Tillage Practices



(Panuska, Good, Wolkowski, 2007)

The authors found that soil erodability and slope both significantly impact soil loss, and they compared the results to 'tolerable' soil loss, which is equal to the rate of soil formation. If the amount of soil loss is greater than the tolerable amount, there will be long term damage to the soil. Their suggestions following these comparisons are that, to prevent degradation, erodible, sloped land should be enrolled in CRP, and when planting corn, no-till or minimal-till is highly recommended, as is rotation, and the use of no-till cover crops for corn-silage are beneficial to the soil. It should be noted that corn is not the most common crop replaced by CRP in the Great Plains, which holds the highest enrollment of CRP, but in the Southwest Corn Belt it is very common, and these results are likely transferrable to land that is commonly used to grow wheat, cotton, or sorghum.

Hunting and Wildlife on the CRP

A key difference in this study's decision aid will be the inclusion of hunting benefits to landowners. Wildlife considerations account for a large portion of the EBI, and should also be considered when making choices on whether or not to retain land in the CRP or to convert back to cropland.

In, "Estimating the Response of Ring-Necked Pheasants (*Phasianus Colchicus*) to the CRP," Nielson et al. attempt to determine whether or not Ring-Necked Pheasants (Pheasants) will be impacted by a change in the amount of CRP acreage enrolled in a given area. They point out that, due to their adaptability to differing habitats, pheasants should benefit from most types of CRP cover, and that in past literature an increase in CRP acreage typically increased the number of pheasants.

The study uses the Breeding Bird Survey (BBS) and data from the Farm Service Agency (FSA) to estimate whether or not CRP acreage will have an impact on pheasant population. The BBS methodology is simple; a driver and a spotter drive through different locales and stop for 3 minutes at pre-designated locations to count the number of birds seen or heard. This study took in to account all 4615 bird counts conducted within a year, and used the sum of pheasants along a route as an index of abundance. The study developed a set of 'buffer' zones. These zones had radiuses of 400 meters, 700 meters, and 1000 meters, and the percentages of CRP and other land types in each buffer were used as predictor variables. These buffers were established based on the daily range of a pheasant's movement. The study was conducted in two regions in the northwestern United States.

The final results find a positive relationship between pheasant numbers and routes with increased CRP acreage. An increase in CRP acreage by 4 percent correlated to an approximate 22 percent increase in the pheasant count, and as these results were similar across such a large range, the authors deem the information to be widely applicable and reliable.

With wildlife being a potential source of income during and post-CRP, Geaumont, Vlaminck, Schauer, and Sedivec (2007) studied the number of pheasant on land that was recently removed from the CRP. The authors posit that managing post-CRP land for agriculture and environmental outputs can be beneficial environmentally and economically.

The authors selected two study sites that were 640 acres each that had, until recently, been CRP land. The plots were each split and given different treatments that included grazing by 33-45 cows, haying, idling, and cropping. The pheasant nests were found by 'dragging', or hooking a chain up between two vehicles and driving across a field every two weeks. When a bird 'flushed' they searched for the nest near that point and made a count.

The authors found that substantially more pheasant nested in the seasonal grazing plots and idled land, to the point that the cropping and haying results were inconsequential. The authors believe this proves the need for maintaining areas of permanent cover, if pheasant production is a desired outcome. They also theorized that no more than 50 percent ‘disappearance’ of grazing lands would be sufficient for pheasant nesting.

The ring-necked pheasant is not the only species that is impacted by the CRP. The Prairie Pothole Region (PPR), or as it is sometimes called, “The Duck Factory,” is a region in the northern United States in which five of the most common species of ducks nest. The PPR was, at one point, covered in glacial formations that, as they receded, left huge ‘potholes’ that later filled with water and became millions of ponds that now make a prime nesting area for duck recruitment.

Reynolds, Shaffer, Renner, Newton, and Batt (2001) describe the CRP programs long term effects on the duck population in the critical area of the PPR. Between 1992 and 1995, the authors evaluated the success of duck nesting in fields composed of various types of CRP cover. The genesis of this study was the hope that due to increased conservation land through the CRP, the number of ducks would be increasing from their dismal levels, which were at their lowest levels in 1992 since 1955, when the counting of waterfowl species began. The evaluation of nesting success is important, as increased nesting success is directly correlated with increased duck numbers. The objective of the study was to estimate the average Daily Survival Rates (DSR) in CRP cover and compare that with pre-CRP numbers, and to compare duck recruitment in CRP with a predictive model evaluating the situation if the land had never been converted to CRP.

The authors monitored 335 plots in the PPR, which were classified by cover type, and conducted annual surveys of those plots for breeding pairs. They then used regression-ratio analysis to estimate the number of breeding pairs. One hundred thirty-eight of these plots included over 16.2 hectares of CRP land, which was a pre-established measure for evaluation. These plots were the sites of nest counting.

Nest success and recruitment in CRP were 46 percent and 30 percent higher, respectively, than land without a presence of CRP. The authors noted that due to the presence of such a high quantity of CRP in the region, some of which were near control i.e. cropped fields, those controls may have been impacted. However, this does mean that the results, if anything, would increase. The authors found that CRP nest rates were as good as Wetland Reserve Program (WRP) nesting rates, and both were substantially better than predicted. The authors estimate this increase in nesting success and recruitment adds 2.7 million ducks per year to the population.

The authors theorize that CRP may increase the success and recruitment of ducks for several reasons. The first is that an increase in grass provides increased cover for nesting and reduces predator contact with nests, and that the increased availability of other prey animals such as other birds, voles, and mice, which increase with the presence of CRP acreage, may decrease the need for predation by foxes on duck nests.

Nesting ducks are sometimes found in groupings or ‘hot spots’ and that several of these were found in CRP land. This could mean that ducks do prefer the cover of CRP managed land to even natural state land. While this is good during the presence of a large amount of CRP, it does provide a potential explanation for the drastic drop in population after the initiation of the Soil Bank program. The authors hypothesize that, if ducks concentrate in CRP, and there is little CRP acreage, that there will be a over-nesting in CRP fields, which not only means adults may have to travel further for forage, leaving the nest unattended, but that predators have easier access to a large amount of nests at one time, making population decline intensify due to intensified nest failure. These explanations show that, if increased duck population is a goal of a landowner or a regional economy, enrollment in the CRP is a very viable option.

Once again addressing the possibility of wildlife management for post-CRP land, however this time with ducks, Geaumont, Sebesta, Sedivec, and Schauer (2007) tested multiple plots for duck populations. They theorized that, much like the case of the ring-necked pheasant, land exiting the CRP could be managed for agriculture and environmental outputs in such a way that would provide profit for the producer both environmentally and economically. The study was conducted in the PPR region.

The methods were the same as the authors' previous pheasant study. Two 640 acre sights were chosen, each having recently exited the CRP. The plots were split into different practices including grazing by 33-45 cows, haying, idling, and cropping. The duck nests were found by 'dragging' for birds, and searching for the nests when a bird had 'flushed'. The authors do note that, due to the increased mobility of ducks, these results may be slightly less reliable than those of the pheasant study.

The authors found notable nesting concentrations by mallards, gadwalls, pintails, and teal, four of the five major species that nest in the PPR. The authors found that, while pheasant had limited nesting in cropped and hayed land, ducks avoided these areas entirely. They found zero nesting sites for any species in these plots. The authors found that their nesting rates were higher than any found in any other literature. The authors theorize that this was likely due to the presence of cattle, which discouraged the presence of any of the small predators that typically prey on ducks and duck nests. This, once again, supports the hypothesis that management in a CRP cover can realize rents from both agriculture outputs and hunting/environmental outputs.

In an attempt to prove that hunting on CRP land is a viable economic option, Williams and Mjelde (1994) authored a study entitled, “Conducting a Financial Analysis of Quail Huting within the CRP”, which establishes several practices and compares them to land idled in the CRP.

Under the study, the authors established three scenarios under which hunting could be compared to no hunting. Scenario One included amenities to guests such as accommodations and meals, along with pen raised birds. Scenario Two provides amenities to guests, but develops a wild population on CRP land. Scenario Three is a typical hunting lease on CRP land with an established wild population. Under their study they took budget items from the Texas regional average obtained from Texas AgriLife Extension Service, Texas Parks and Wildlife, the National Rifle Association, local appraisal districts, and the Texas Department of Agriculture. The authors assumed that half of the establishment costs of the enterprise were shared under government funding, that there was no debt prior to the beginning of the enterprise, and that there was no borrowing.

The study results, simplified to fit this study of CRP are presented in table 2.5.

TABLE 2.5 Returns to Quail Hunting within the CRP

PRACTICE	NPV
CRP Alone	241,534
Scenario 1; Amenities and Pen Birds	297,138
Scenario 2; Amenities and Wild Birds	219,257
Scenario 3; Hunting Lease on CRP Land	255,766

(Williams, Mjelde, 1994)

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As you can see from the results, the best scenario, in terms of Net Present Value (NPV) is Scenario 1, netting over $40,000 more over the 10 year life of the analysis than the next-best scenario, Scenario 3. The authors note that economies of scale could change these results, and that assumed management practices within each scenario could be adjusted. While this study is slightly dated, (1994) it does prove the need for evaluating hunting options in conjunction with operating CRP land.

Finally, in, “Wildlife Considerations in the Management of CRP Lands,” an appendix to a report published by the Texas Parks and Wildlife Department, the authors point out that, if habitat improvement is the goal, it should be noted that the same kind of CRP cover does not always work for all game species.

Under considerations for big game, the document specifically addresses the needs of mule deer, white tail deer, and pronghorn antelope, the major large species that are found on CRP land. The report states that these species will benefit from planned grazing and burning, as this helps with cover establishment and health. This cover provides ideal fawning conditions and escape cover from coyotes, the biggest threat to fawn populations. However, while the establishment of low brush is good for both deer species, it does not provide benefits for pronghorn, which are ideally suited to massive open range. The report does note that if CRP is established near cropping practices, the establishment of legumes or forbs will decrease the damage done to those cropped areas by these big game animals.

When planning for game birds, the considerations are as widely varied as the birds themselves. The specific birds identified by the report as inhabiting CRP are quail, pheasant, prairie chicken, and turkey. In planning for any of these birds, a planned burning or grazing will increase forb production which will increase insect production providing two types of food for these birds. It is also considered beneficial to hay, as long as it is after July 15, the end of the primary nesting season for most upland birds, and strategic places, like fencerows, are left alone.

When specifically targeting pheasant, it is advised to plant smaller tracts, specifically fencerows in brush, as this can provide ideal habitat for the birds. The report mentions a common practice of the Texas Panhandle called cornering, which simple means leaving the corners of the circle irrigation pivots idle. These corners provide ideal habitat for pheasant, and are frequented by hunters.

When planning for quail, there are two species to consider. Both operate in small tracts of CRP, but need separate cover types. Woody canopy cover and brush establishment along fencerows will lead to more Northern Bobwhites, while less woody cover will lead to Scaled Quail.

When planning for turkey or prairie chickens on CRP land, the situation becomes more complex. The report says that these birds must have increased tracts of land available in CRP, as they have a much larger range than the previously mentioned birds, and are more mobile on a daily basis. They must also have a more diverse habitat than quail or pheasant as their roosting habitats, escape cover, nesting, and feeding cover are not all the same.

When planning for waterfowl, such as ducks, geese, and cranes, it is recommended that a 3:1 ratio of CRP upland buffers to playa basins is maintained. The Texas Panhandle, a region of the Southern Great Plains, is a major wintering area for ducks, geese, and Sandhill Cranes, as well as the Bald Eagle, and the retention of prescribed buffers with planned haying and grazing, along with legume inter-seeding is highly recommended.

This review of literature proves a few major points. The choice of whether or not a producer should leave their land in the CRP can have major financial decisions. There are a few major considerations to take when looking at that choice.

The first is to make sure the producer understands the function of the CRP and whether or not they, and their land, are eligible. This is a simple matter of informing the producer of their options and making sure they understand where their official documentation can be found and returned to, as well as who they can contact about the program.

The second, more complex, area of this decision is incorporating producers EBIs and their bids. It is important to understand the balancing act of these two factors and how they are the key factors influencing a parcels probability of acceptance in the CRP.

The final important piece of the puzzle is ensuring the producer understands the options available. If they choose to stay, or enter, the CRP which practice will be the best choice for them financially and in terms of the health of their land? This must incorporate not only their budgets, but the variability of the fertility of their land. If they choose to exit the CRP, or their bid is not accepted, the producer needs to understand their options. These include, but are not limited to, commodity production, livestock production, continued conservation practices with no management, and continued conservation with wildlife in mind, either for hunting or not.

This study, and resulting thesis, develops a decision aid that accounts for all of these important components of the enrollment choice. By developing a model that accounts for eligibility, bidding, the EBI, and discounted net incomes from different options, a decision aid can help a producer make an informed decision that will impact their financial future, as well as the future of their land.

CHAPTER III

METHODOLOGY

Risk

Accurate economic modeling requires incorporating an element of risk. Risk is the part of a business model that cannot be controlled by the decision maker, also called the error term. Risk is particularly relevant to agriculture, which faces biological risk, price risk, weather risk, and risk associated with government policies. Ignoring risk in economic modeling can yield a point estimate, also called a deterministic estimate, however this method could under or overstate the risk of a particular investment.

Including stochastic values in an economic model incorporates an element of risk (Richardson, 2014). A stochastic model assumes two things that are essential to its operation. The first is that future risk is the same as historic risk, and the second is that while a variable may be unknown, its probability distribution is known. Stochastic models, and particularly Monte Carlo sampling, which is used in the Conservation Reserve Program Choice model, simulate risky variables a large number of times. This constructs a probability distribution of Key Output Variables (KOV) (Richardson, 2014) which can be used by a decision maker in evaluating the returns of a future investment. Richardson and Mapp (1976) use Net Present Value (NPV) as their key output variable, and indicate that this is an acceptable measure when evaluating investment decisions in small businesses, i.e. agriculture production.

As discussed previously, Monte Carlo simulation constructs probability distributions. There are two types of probability distributions, parametric and non-parametric (Richardson, 2014). A parametric distribution has known parameters, while a non-parametric distribution does not. The non-parametric distribution is used in cases when there are too few observations to find the required parameters for a parametric distribution. These parameters include mean and standard deviation, for a normal distribution, and minimum and maximum values for a uniform distribution (Richardson, 2014). When these values are not known, an empirical distribution can be constructed using the sorted values of the available data and the probabilities of each of those values.

Richardson and Mapp (1976) lay out the steps for developing a simulation model connected to an investment decision. "The first step in developing a stochastic model for investment analysis is identification of critical variables…" (Richardson & Mapp, 1976). The next step is to develop probability distributions for those key variables thought to be stochastic. Next, links must be formed between stochastic variables, and fixed, or known variables that will influence the eventual outcome of the investment. Finally, these variables must be connected to accounting relationships associated with the proposed investment, and linked to the Key Output Variables (KOVs) (Richardson & Mapp 1976).

While simulation yields a more accurate prediction of an investments return by including risk, it is ultimately up to the decision maker, not the model, to act on that investment. When facing this choice, a decision maker's attitude towards risk becomes important. Nicholson and Snyder (2012) describe decision makers as one of three risk types; risk-loving, risk-neutral, or risk-averse, under the assumption that all three types are attempting to maximize utility.

Methods of Ranking Risky Alternatives

After the construction of a simulation model that includes risk, the decision maker must choose their option. Several simulation outputs constructed by Simetar, the software used in this research, can assist producers in these decisions.

The first method of evaluating multiple options is the cumulative distribution function (CDF). A CDF displays all possible outcomes for each option within the simulation, with the X axis representing an individual KOV's value associated with the Y axis' probability, which ranges from 0-1. This method's major limitation is that the CDFs for each option often cross (Richardson, 2014). Under ideal circumstances, the decision maker would take the investment option whose CDF falls the furthest to the right, however, things become more complicated when the CDFs of two options cross, and it is often the case that more than two cross at different points.

Incorporating a decision maker's utility function in ranking scenarios can impose a tighter restriction on risk aversion. This can be done using stochastic dominance with respect to a function (SDRF). A decision maker's utility is bounded by a lower risk aversion coefficient and an upper risk aversion coefficient (LRAC and URAC respectively) (Richardson, 2014). Each alternative is calculated at both the LRAC and URAC, and if the same choice is preferred at both levels, then the preferred alternative is the 'efficient set'.

In 2004, Hardaker et al. developed a second method of ranking alternatives incorporating risk called stochastic efficiency with respect to a function (SERF). Like SDRF, SERF ranks risky alternatives over a specified range of risk preferences, in terms of certainty equivalences. Hardaker et al. According to Richardson (2014), SERF has the advantage of comparing multiple scenarios while SDRF can only compare pairwise combinations. SERF has two possible outcomes. When the certainty equivalent of an option is greater than the certainty equivalent of another option, that option with the greater certainty equivalent is preferred. The second option is that, when two options have an equal certainty equivalent, the decision maker will be indifferent between the two.

A final useful method of ranking risky alternatives is a stoplight chart ranking. This visual method of ranking evaluates probabilities of realizing favorable outcomes and displays them on a stacked bar chart. Outcomes that are deemed favorable are colored green, outcomes that are deemed unfavorable are colored red, and outcomes falling between the two thresholds, or cautionary results, are colored yellow. An advantage of the stoplight ranking method is that it allows the decision maker to set their own threshold of 'favorable' and 'unfavorable', by selecting a lower cut-off value and an upper cut-off value. The idea of ranking scenarios based on probabilities was described by Richardson and Mapp (1976), and the stoplight method of presentation was presented by Richardson (2014).

Environmental Benefits Index Estimate

One of the goals of this study was to develop a fields 'likelihood of acceptance' in to CRP. Upon conducting an exhaustive literature review, it was determined that this is not technically possible. Accepting and Rejecting Signup 45 Offers (2013) states that, "Offers with an EBI score of 209 or greater were determined basically acceptable." This is a national standard set after all submitted bids were compared. If a particular parcel's EBI was higher than 209, it was accepted, and if that particular parcel's EBI was lower than 209, it was not. While this does set a previous standard, it also makes it impossible to develop a probability of acceptance, as the probability is conditional upon all other bids received. This information cannot be known until after the General Signup period has expired in February 2016.

While this procedure means that we cannot develop a probability of acceptance, it did allow for the construction of a slightly different tool. The Agricultural Act of 2014 only limits the amount of acres in the CRP, not the amount of money spent. This means that as long as a parcel's EBI is above the national threshold, it will be accepted, subject to the acreage constraint even if there are a high number of acceptable applications that year. As a basis of comparison, the EBI Estimator (to be discussed further in this section) value can be compared to the last three general signup EBI thresholds. Signup 45, 43, and 41 had EBIs thresholds of 209, 209, and 221, respectively. A bar chart on the 'Home Page' of the decision aid compares a parcel's estimated EBI to the past general signup thresholds.

A particular field's non-cost EBI is made known to them prior to bid selection. As described above, this EBI is developed through scientific analysis conducted by the Natural Resource Conservation Service (NRCS). The NRCS conducts scores a parcel's soil erosion impacts, wildlife practice establishment impacts, water quality impacts, air quality impacts, and enduring benefit impacts (FSA Handbook; Agricultural Resource Conservation Program, 2008). A decision maker must take their EBI in to account when making an accurate bid to increase their probability of acceptance, and maximize their profits from CRP participation. The EBI estimator was designed in order for a producer to have a method of constructing their approximate EBI. Information for this tool was taken from the Conservation Reserve Program Sign-Up 45 Environmental Benefits Index (EBI) Fact Sheet (FSA, 2013). Each point allocation for a specific practice or qualification is included in Appendix A.

Section A of the EBI Estimator is the Wildlife Score. The Wildlife Score is composed of three parts, the wildlife habitat cover benefits score, the wildlife enhancement score, and the wildlife priority zone score. The wildlife habitat cover benefits score allows a producer to enter a number of acres in to a wildlife practice, which generates a weighted average of their cover establishment plan. Point value assignments for each cover practice can be found in Table A.1 in Appendix A.

The wildlife enhancement section allows a producer to qualify for 20 points, 5 points, or 0 points. To qualify for 20 points the producer must convert at least 51 percent of a primarily monoculture stand to a mixture of native species that provides wildlife benefits, or establish a pollinator habitat. To qualify for 5 points, the producer must choose a practice that makes their field an annual or permanent food plot that remains in the same location for the duration of the contract. To qualify for 0 points, the producer will not have chosen any of the above options. A table of these choices and their specifics can be found in Table A.2 in Appendix A. These points are not weighted, but added directly to the weighted average of wildlife habitat cover benefits. The EBI Estimator allows a producer to select one of the above options, indicating their participation, or lack thereof, in a wildlife enhancement practice.

Wildlife priority zone points are based on the lands qualification as a Wildlife Priority Zone. According to the FSA EBI Fact Sheet, “FSA consulted with farm, commodity, wildlife and environmental groups to develop high-priority wildlife areas that would benefit from being enrolled in CRP. For land located within this defined geographic area, points are awarded for planting cover mixes to benefit wildlife species.” If a particular field qualifies as a wildlife priority zone, the 30 points are added to the EBI. This is only the case if the weighted average of the wildlife habitat cover benefits score is greater than 40 points. The county FSA office in conjunction with the area NRCS office has information on areas designated as wildlife priority areas. The EBI Estimator allows a producer to indicate whether or not their parcel qualifies as a wildlife priority zone or not, and allocates either 0 or 30 points based on their choice.

Section B. of the EBI Estimator tool is the Water Quality Benefits section. This score is comprised of a composite score of the parcel’s location, groundwater quality score, and surface water quality score. Each of these factors requires contact with local USDA service centers in order to determine a parcel's eligibility and score. The first component, location, is worth either 0 or 30 points. At least 51 percent of the acreage offered must be in an approved water quality zone to receive 30 points, otherwise the point allocation is 0 (FSA EBI Fact Sheet, 2013). The EBI Estimator allows a producer to indicate whether or not their parcel qualifies as a water priority zone or not, and allocates either 0 or 30 points based on their choice.

The second component of the water quality benefits section is groundwater quality, which is worth 0 to 25 points. Point scores are based on the weighted average leach index for soils and the population that utilizes that groundwater for drinking (FSA EBI Fact Sheet, 2013). The EBI Estimator allows a producer to assume average groundwater quality, or enter their FSA assigned score. The final component of the water quality benefits score is the surface water quality score which is worth 0 to 45 points, and is determined by potential water erosion in the watershed the field is located in. The EBI Estimator allows a producer to assume average surface water quality, or enter their FSA assigned score.

Section C. of the EBI Estimator is the erosion factor score. This is based on an Erosion Index of wind and water erosion. The erosion factor is worth up to 100 points. The score is based the weighted average of the higher value of either the wind or water erosion index. These values can be found in Table A.3 in appendix A. Information on a parcel's erosion can be found using the Web Soil Survey (http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx), or by contacting local FSA offices. The EBI Estimator allows a producer to either assume the minimum qualifying erodibility or choose the FSA assigned score.

Section D. of the EBI Estimator is the Enduring Benefits factor. This is an evaluation of certain wildlife cover practices that will have benefits beyond the CRP contract. These values are determined by taking the weighted average of participation in certain cover practices, which can be found in Table A.4 in Appendix A. The EBI Estimator allows a producer to choose any combination of practices they are enrolled in, and allocates the weighted average points for these practices.

The final component of the environmental portion of the Environmental Benefits Index (EEBI) is the Air Quality benefits score, which is worth 3 to 45 points and is composed of a wind erosion impacts score, a wind erosion soils list score, and a carbon sequestration score. The wind erosion impacts score is determined by FSA and the point value is 0 to 25. The FSA determines wind erosion impacts by taking in to account climatic factors such as wind speed, wind direction and duration, and soil erodibility. The EBI Estimator allows a producer to assume the average wind erosion impact, or to choose the FSA assigned wind erosion impact value.

The second component of the air quality benefits is the wind erosion soils list points. This section is worth 0 or 5 points, based on if a field's soil is on the 'list' or not. Soils that qualify are susceptible to wind and contribute to nonattainment of air quality standards. If at least 51 percent of the offered acres are made up of these soils, the offer is given 5 points (FSA EBI Fact Sheet, 2013). The EBI Estimator allows a producer to indicate whether or not their parcel qualifies for these points, and if so, adds them to the score.

The third portion of the air quality benefits score is the Air Quality Zone score. If at least 51 percent of enrolled land qualifies as an air quality zone, the offer is given an additional 5 points. If a field's calculated wind erosion index is greater than or equal to three, it qualifies as an air quality zone. The EBI Estimator allows a producer to choose whether their land qualifies as an air quality zone or not, and allocates either 0 or 5 points based on their choice.

The final portion of the air quality benefits score is carbon sequestration. This is worth 3 to 10 points, and is based on a practice's accrued benefits from sequestering greenhouse gases. The point value is a weighted average of these benefits from practices found in Table A.5 in Appendix A. The EBI Estimator allows a producer to select all practices that their land will be enrolled in, and allocates points based on the formula described above.

A separate portion of the EBI is the cost factor. According to the FSA EBI Fact Sheet from the 45th sign up (2013), the cost factor optimizes the environmental benefits per dollar of CRP payments. These points are allocated in two categories. The first is called Cost. This point value is not determined until after all offers are entered, and is subject to the per acre rental rate nationwide. Offers with lower per acre rental rates will receive more of these points, and therefore have a higher chance of being accepted in to the program.

A second, more transparent, portion of this cost factor is the points allocated for an offer being less than the maximum payment rate. This portion is worth 0 to 25 points. The maximum payment rate for an offer is set by FSA, and is tailored to each field. Offers are allocated these points based on their offer's value as a percentage of the maximum rental rate. Table A.6 in Appendix A. shows the point value associated with each percentage less than the maximum offer. The EBI estimator uses a stochastic prediction of county payment rate, based on historic county averages, to determine the percentage below the maximum a bid is. The stochastic maximum payment rate was developed using data from FSAs CRP enrollment and rental payments by county records. As one county's rental rate is not conditional upon another county's, each county's stochastic rate was estimated as an individual empirical value. The actual producer bid is taken from the home page, where the producer can change their bid to whatever level they choose.

After sections A-F are completed, the points from each section are aggregated to compose the overall EBI. This EBI can then be compared to the general sign-up 45, 43, and 41 thresholds, and the counties previous average EBI, if that data is available.

Enrollment Decision

The purpose of this study is to develop a decision aid that will assist producers in choosing the best use of their land. Five practices were selected for evaluation. These include CRP, cropping (six different options common to Texas were included), cow-calf production, hunting, and a hunting/CRP combination use. A difference in this aid compared to previous research is that it allows a producer to begin the analysis from a position of previous CRP enrollment, or not enrolled. This means that a producer that is already enrolled or that is not enrolled has the same five options, and penalties and conversion costs are included in the analysis. According to Sullivan et al. (2004), producers will likely choose the land-use option that has the highest net returns. However, they do point out that non-quantifiable aspects of the decision, such as time commitment to producing on previous CRP land, attitude of producers, and age can have an impact on the final decision.

As stated previously, agricultural production deals with inherent risk related to biological variability, weather, policy, and prices. In order to accurately model a producer's choices, risk was incorporated through stochastic variables for yields and prices, as well as other select components that varied by practice. Production costs are taken from sample AgriLife Extension budgets per each enterprise, however they are fully adjustable based on the producer's specific situation. This model can be tailored to any individual producer with enough production information to fill out the Home Page of the model. A test is conducted on a farm in Dallam County, Texas, that does not have any previously enrolled CRP land, and stochastic estimates for each of the five listed practices are used to determine the best decision for a producer. The key output variables (KOVs) that are examined and compared are the net present value (NPV) and the present value of ending net worth (PVENW) for each of the five listed options. Each of the listed comparison methods are taken in to consideration, and evaluated for each of the five options.

CRP Enrollment

The first option evaluated is the decision to enroll, or re-enroll land in CRP. Before considering returns to investment, a producer must ensure that they are eligible to participate in the program. For land to be eligible, it must meet the ‘previously cropped’ provision, which means it must have been cropped in four of the six years preceding enrollment in CRP. A producer must have owned or operated the land for, at minimum, twelve months prior to the CRP sign-up. Exceptions include land acquired due to previous owner’s death, change in ownership due to foreclosure, or land purchased by the new owner without the sole intent of enrolling in CRP (FSA, 2014). These provisions are in place in an attempt to keep any entity from purchasing large tracts of land for the sole purpose of treating CRP payments as an investment (Stubbs, 2014). The land cannot be currently enrolled in a CRP contract, which means it can be expiring, or not have been enrolled in the first place.

The decision aid uses the producer’s bid to construct the stream of net returns composed of CRP payments. Schuchard (2011) uses a multivariate empirical distribution to determine the stream of revenues for CRP, however that study was conducted at the county level, making it impossible to evaluate at an individual level. As this study is aimed at an individual producer, and not a county level, it is appropriate to use a producer's chosen bid as the factor when weighing the CRP option. These returns are held constant over the life of the contract, and therefore held constant in the aid.

If land is not currently enrolled in CRP, the costs to convert it are calculated by the decision aid. Conversion budgets for Texas were sought, but not found, so a budget developed by Iowa State Extension was adjusted to fit the typical Texas case. The budget was annualized, as some costs only occur every few years, and taken to a per acre basis. Table 3.1 shows the adjusted budget used under the assumption that the producer has previously had the land enrolled in CRP, i.e., there are no conversion costs.

Table 3.1 Conversion of Original Enterprise to CRP

CONVERSION TO CRP FROM OTHER USE			
Initial establishment costs (leave blank if CRP is already established)		**$/acre**	
Machinery fuel, lube, repairs		$	-
Fertilizer and lime			
Seed		$	-
Herbicide		$	-
Total establishment costs		$	-
Cost - Share Payment		$	-
Net Cost of Establishing CRP		$	-

The typical cost-share of establishing CRP is 50 percent. This means that whatever the sum of the cost from converting land to CRP equals, the government will assume half. Cost-share is taken in to account by the CRP conversion budget, and is based upon an individual producers costs.

A departure from previous literature in this study is the inclusion of hunting returns on land enrolled in CRP. The decision aid allows producers to choose a daily lease fee per person and to estimate a minimum, middle, and maximum number of hunters that will participate in hunting on the CRP land. The daily lease fee is multiplied by a GRKS distribution of the minimum, middle, and maximum estimated number of hunters, and this figure is divided by the number of acres, and added on to the CRP bid per acre to determine total returns from CRP enrollment.

The only decrease in CRP payments comes from penalties accrued from activity that is described under the Agricultural Act of 2014. These penalties come from early exit, which is not an issue to someone enrolling in CRP, or grazing. The decision aid calculates penalties based upon the users input. If prescribed rotational grazing (limited to two years) is to be undertaken on CRP land, the producer has the option to indicate that on the home page. The decision aid's penalty calculator, shown in Table 3.2, shows a stream of penalties over the first five years of the CRP contract. The case shown is of land that was not previously enrolled, that is to be enrolled, and will have rotational grazing conducted every two years, beginning in 2015. The penalty is calculated on a per acre basis, and is equal to 25 percent of the per acre payment.

Table 3.2 Penalty Calculator

Penalty Calculator					
Individual Payments for General CRP		**AMT/$**			
Rental Payment		$ -			
Cost- Share Payment		$ -			
Haying/Grazing Penalties					
% Reduction in rental rate for year grazing occurred		25%			
Penalty if grazed		$ -			
Sum of grazing penalties		$ -			
Contract Termination Penalties					
Interest Rate		4%			
Repayment in full of all rental payments plus interest		$ -			
Additional exit fee for all rental payments		$ -			
Cost share repayments plus interest		$ -			
Sum of penalty for early termination		$ -			
	Current Year	2015			
Penalties by Year Worksheet	End Date				
	2015	2016	2017	2018	2019
Enrolled?	1	1	1	1	1
Penalty for Grazing	$ -	$ -	$ -	$ -	$ -
Early Termination	$ -	$ -	$ -	$ -	$ -
Sum of Penalties	$ -	0	0	0	0
Already Enrolled, Exit	$ -	$ -	$ -	$ -	$ -

Cropping

The second option evaluated by the aid is for a producer to either continue cropping land, or if they are enrolled in the CRP, exit and return land to cropping. Six options were given to the producer through the aid. These options include production of corn, cotton, hay, sorghum, and wheat. For each option the producer is able to choose irrigated or dryland production, although the majority of the literature indicates that CRP land is primarily interchanged with dryland production and not irrigated. If the user chooses the “Hay” option, the only choice they have is irrigated. This is due to the fact that National Agricultural Statistic Service (NASS) data is only available for irrigated hay in the state of Texas. The entire process described in this section is based on the user's input regarding their cropping history and future cropping choice.

Historical yields are used when building a stochastic estimate of future yields. The decision aid allows a producer to either enter their own historical yields, or use historical yields taken from the National Agricultural Statistics Service (NASS) Quick Stats 2.0 tool. Where available, the NASS data is county specific, and where county-specific data was not available, the Texas state average was used. If NASS had no record at the state or county level, the producer must enter an estimated average yield, even if cropping was not undertaken, in order for the model to function correctly. Any time the producer enters a yield, the model uses that yield over NASS data. Food and Agricultural Policy Research Institute (FAPRI) baseline prices are used as the predicted price information. The historic price and future price predictions were taken from the U.S. Baseline Briefing (Westhoff et. al, 2015). The producer has the option of entering a local price basis on the home page, if there is one present. This allows the model to construct a more accurate prediction based on the user's geographic basis.

The historic price and yield data were used to develop a deterministic estimate of price and yield. A multivariate empirical distribution was then used to develop a stochastic price estimate based the user's crop decision. Depending on the user's input, a price basis is incorporated in to the stochastic estimate of prices. These localized prices are then multiplied by the stochastic yields to generate market receipts per acre. An insurance worksheet uses input from the home page to calculate an insured yield by multiplying the user determined APH yield by their chosen insurance coverage percentage. This worksheet also accounts for the cost of a premium per acre, which is also taken from user input. The guaranteed price is taken from the Agricultural Act of 2014's Title I commodity prices. If the worksheet calculates a yield loss, it will calculate an insurance indemnity by multiplying the lost yield of the chosen crop by the price guaranteed by the Agricultural Act of 2014.

The insurance worksheet has a separate case for cotton, as it is no longer considered a covered commodity in Title I of the Agricultural Act of 2014. The Stacked Income Protection Plan (STAX) payments are generated using historic county yield taken from NASS. The expected county income is calculated by multiplying the expected county yield and FAPRI projected price. Payments from STAX are triggered if the actual county income, calculated by multiplying the actual yield by actual price, is below 90 percent of the expected county income. If an indemnity is due from the cotton STAX program, or the standard insurance worksheet, it is added to the market receipts per acre to calculate total returns per acre.

After receipts per acre are calculated, expenses for each enterprise are included. Texas A&M AgriLife Extension develops enterprise budgets for each of these crops on an annual basis. These budgets were adapted for use in the decision aid to include insurance payments, and stochastic yields. Each of the original budgets can be seen in Appendix B., tables B1-B12. Lines were moved, added, and eliminated where necessary for model functionality. As the decision of whether or not to enroll in CRP is a marginal one, fixed costs are not included in the test case, although a budget is available in the aid if a producer would like to include fixed costs, for instance, in the case of a whole-farm analysis. FSA maps show that the majority of CRP land in Texas is concentrated in the Panhandle and Southern Plains, therefore the budgets that were chosen for use were taken from Extension districts one and two where available, and adapted from other districts where necessary.

These adapted budgets, selected based on the users crop choice, are incorporated in to an income statement, statement of cash flow, and balance sheet in order to calculate the KOV net present value. Each cost is inflated by the forecasted prices paid index prediction, taken from the FAPRI baseline outlook. If the user indicates that there is a land rental cost, it is inflated by the consumer price index. The final output is a simulated NPV, which is divided by five (the number of years forecasted by the model).

This research includes conversion costs when changing enterprises which has not been included in past research. Warminksi et al. (2009) presents sample budgets based on the necessary activities when converting CRP land to cropland. If the user indicates that their land is enrolled in CRP, the decision aid uses a budget adapted from Warminksi et al. (2009) to include conversion costs in the financial statements. The adapted budget is shown in Table 3.3.

Table 3.3 Cropland Establishment Budget

CROPLAND ESTABLISHMENT					
Months Prior to Planting	**Practice**	**Unit**	**Price**	**Quantity**	**Amount**
14	controlled burn	acre	$5.50	1	$5.50
11	herbicide and application	acre	$16.50	1	$16.50
10	disk	acre	$12.10	1	$12.10
9	chisel	acre	$16.75	1	$16.75
8	sweep	acre	$12.60	1	$12.60
2	sweep	acre	$12.60	1	$12.60
1	soil test sample	acre	$0.50	1	$0.50
Month of Planting	herbicide and application	acre	$33.45	1	$33.45
Month of Planting	fertilizer (P) 10-34-0	lb	$0.79	40	$31.60
Month of Planting	fertilizer (N) 32-0-0	lb	$0.64	60	$38.40
Month of Planting	fertilizer application	acre	$12.00	1	$12.00
		Total direct expenses			$192.00
Fixed Costs		**Units**	**$/Unit**	**Quantity**	**Total**
Machinery Depriciation					
Tractors/Self-Propelled		Acre	$3.03	1	$3.03
Implements		Acre	$4.95	1	$4.95
Equipment Investment					
Tractors/Self-Propelled		Dollars	6.00%	$34.22	$2.05
Implements		Dollars	6.00%	$40.83	$2.45
Total Fixed Costs					$12.48
Total Costs					*$204.48*

The conversion costs budget is based on the establishment of cropland on land that was enrolled in a CRP practice not including trees. According to the June 2015 Conservation Reserve Program Monthly Summary, this accounts for 2,108,416 acres, or 99.9 percent of the approximately 2,109,881 acres enrolled in the state of Texas. If a producer indicates that their land was not previously enrolled in CRP, the decision aid bypasses the establishment budget, and does not include those costs in the final output.

Two other budgets are taken in to consideration for calculating the cost of converting land to cropping. The first is the penalty calculator described in the previous section. If the user indicates that the land is enrolled in CRP but will be exiting prior the end of the contract life, the penalty calculator in Table 3.2 uses the producer input from the home page indicating the rental payment amount to determine the cost of terminating the CRP contract prior to the expiration of the contract. If the user indicates that the land was not previously enrolled, the penalty calculator is bypassed, and that figure is not included in the final output.

The second budget is a well cost budget adapted from Warminksi et al. (2009). And it is included for completeness. If the user indicates that a well is not present, they have the option to choose a depth, and pump type. These choices are then used to budget the cost of a well, shown in Table 3.4. If the user indicates that there is already a well, or that the land does not require the use of a well, this budget is bypassed by the decision aid, and the information is not included in the final output.

Table 3.4 Well and Associated Pump Budget

WELL COST & ASSOCIATION PUMP COST				
WELL		*WINDMILL COST*		
Depth (ft)	Cost	Cost	GPM	System Cost
150	$ 3,500.00	$ 13,685.00	4	$ 17,185.00
250	$ 5,600.00	$ 14,865.00	4	$ 20,465.00
350	$ 7,700.00	$ 16,045.00	3	$ 23,745.00
450	$ 9,800.00	$ 20,775.00	4	$ 30,575.00
550	$ 11,900.00	$ 21,995.00	4	$ 33,895.00
WELL		*SOLAR PUMP COST*		
Depth (ft)	Cost	Cost	GPM	System Cost
150	$ 3,500.00	$ 4,650.00	4	$ 8,150.00
250	$ 5,600.00	$ 6,700.00	4	$ 12,300.00
350	$ 7,700.00	$ 7,925.00	3	$ 15,625.00
450	$ 9,800.00	$ 7,600.00	2	$ 17,400.00
550	$ 11,900.00	$ 8,050.00	1	$ 19,950.00
Total Well Establishment Cost based on Producer Input				
				$ -
Cost/Acre				$ -
WELL COST & ASSOCIATION PUMP COST				
Sprinkler Captial Cost				90,000
Cost/Acre				0

Cow-Calf

The decision aid’s third enterprise option is cow-calf production. The user has the option to input the number of head owned that will graze, the number of head to be purchased, and the fencing option.

Stochastic prices were used to generate a probability distribution of profits for the cow-calf enterprise. Historic data was taken from NASS on steers and heifers at 500 lbs. in dollars per hundredweight, and utility cow price in dollars per hundredweight.

Again, the standard for future price predictions is FAPRI (Richardson, 2014). Projected mean prices were taken from the FAPRI baseline outlook from March 2015. A multivariate empirical distribution was used to calculate the stochastic value of steer price and utility cow price, in order to ensure that any correlation between the two was not ignored. Heifer and bull prices were taken as a function of steer price. As the NASS data is a composite of steer and heifer prices, heifer price was set equal to steer price. Bull price was estimated to be 50 percent of steer price. Receipts per head are converted to a per acre figure in order to compare the cow-calf option with the other enterprises.

A variable weaning rate was used. A GRKS distribution of three possible weaning rates was developed. This value is a function of a minimum, middle and maximum value, set at 70 percent successful weaning, 80 percent successful weaning, and 90 percent successful weaning, respectively. These three rates can be adjusted by the producer in the cow-calf enterprise budget. The successful weaning rate corresponds directly to the amount of calves available for sale, and therefore profit.

A Texas A&M AgriLife Extension budget was used to incorporate expenses in to the model. The model was adjusted to include cow purchase, and to incorporate the stochastic weaning rate, and user established number of head. The budget was also converted to a per acre figure in order to compare the cow-calf option with the other enterprises. The original extension budget is shown in Table 3.5.

Table 3.5 Cow-Calf Budget (Comment in red indicates that this table is only an example and should be updated with individual producer's information prior to use.)

Projections for Planning Purposes Only -- Not to be Used without Updating
2015 Estimated Costs and Returns per Animal Unit
Cow-Calf Budget - 200 Cows
Panhandle Extension District - 1

Animal Units (AU)	200					
Breeding Females	200					
REVENUE	Head	Quantity Per Head	Units	$/Unit	Total	Enterprise Total
Steer	0.425	5.25	CWT	$279.00	$622.52	$124,503.75
Heifer	0.230	4.75	CWT	$275.00	$300.44	$60,087.50
Cull Cow	0.120	10.00	CWT	$120.00	$144.00	$28,800.00
Cull Bull	0.010	18.00	CWT	$135.00	$24.30	$4,860.00
Total Revenue					$1,091.26	$218,251.25
VARIABLE COSTS		Quantity	Units	$/Unit	Total	Enterprise Total
Production Costs						
Miscellaneous						
Miscellaneous - Cow		1	AU	$5.00	$5.00	$1,000.00
Marketing Expense		1.00	AU	$25.34	$25.34	$5,067.00
Feed						
Hay Pound		280	Pound	$0.05	$14.00	$2,800.00
Salt and Mineral		50	Pound	$0.45	$22.50	$4,500.00
Supplement		350	Pound	$0.17	$59.50	$11,900.00
Vet. Medicine						
Vet Medicine - Cow		1	AU	$15.00	$15.00	$3,000.00
Fuel		1.0	AU	$5.51	$5.51	$1,101.60
Lube (As a % of fuel)		10.0%	Percent	$5.51	$0.55	$110.16
Repairs		1	AU	$13.03	$13.03	$2,606.23
Labor		3.58	Hours	$11.75	$42.01	$8,401.25
Interest on Credit Line				4.90%	$10.45	$2,089.13
Total Variable Costs					$212.88	$42,575.37
Planned Returns Above Variable Costs:					$878.38	$175,675.88
Average Offspring Breakeven Price to Cover Variable Costs				$13.41	CWT	
FIXED COSTS		Quantity	Units	$/Unit	Total	Enterprise Total
Depreciation - Equipment		1	AU	$12.46	$12.46	$2,491.47
Depreciation - Livestock		1	AU	$17.71	$17.71	$3,542.40
Equipment Investment		$713.13	dollars	5.40%	$38.51	$7,701.75
Pasture Cost		25	Acres	$6.50	$162.50	$32,500.00
Total Fixed Costs					$231.18	$46,235.62
Total Costs					$444.05	$88,810.98
Planned Returns to Management, Risk, and Profit:					$647.20	$129,440.27
Average Offspring Breakeven Price to Cover Total Costs				$82.97	CWT	

(Cornforth, 2015)

The cow-calf budget also incorporates the costs from converting land from CRP to a cow-calf enterprise. Warminksi et al. (2009) presents sample budgets based on the necessary activities when converting CRP land to a cow-calf enterprise. If the user indicates that their land is enrolled in CRP, the decision aid uses a budget adapted from

Warminksi et al. (2009) to include conversion costs in the financial statements. The adapted budget is shown in Table 3.6.

Table 3.6 Cow-Calf Conversion Budget

COW-CALF ESTABLISHMENT						
1-Strand, 1 Mile Electric						
			Price per unit	Quantity	Total	
	Rebar posts		$0.80	264	$211.20	
	Wire (avg./acre)		$174.24	1	$174.24	
	Insulators		$0.21	264	$55.44	
	Solar panel		$199.00	1	$199.00	
	Charger		$129.00	1	$129.00	
	Total				$768.88	
2-Strand, 1-Mile Electric						
			Price per unit	Quantity	Total	
	Rebar posts		$0.80	264	$211.20	
	Wire (1 mile)		$174.24	2	$348.48	
	Insulators		$0.21	528	$110.88	
	Solar panel		$190.00	1	$190.00	
	Charger		$129.00	1	$129.00	
	Total				$989.56	
5-Strand, 1-Mile Barbed Wire						
			Price per unit	Quantity	Total	
	5-strand barbed wire		$8,500.00	1	$8,500.00	
	Total				$8,500.00	
Date	Item	Unit	Price	Quantity	Amount	
April	controlled burn	acre	$5.50	1	$5.50	
May	soil test	acre	$0.50	1	$0.50	
June	fertilizer (N) 32-0-0	lb	$0.64	40	$25.60	
June	fertilizer application	acre	$12.00	1	$12.00	
Total direct Expenses of Conversion					$43.60	
				Index for Fence Choice		Per Acre Amt
				Five Strand Barbed Wire	$8,543.60	$18.99
				Land already fenced	$43.60	$0.10
				One Strand Electric	$812.48	$1.81
				Two Strand Electric	$1,033.16	$2.30

The calculations are based on the user's chosen fencing option. They can choose between 1-strand electric, 2-strand electric, and 5-strand barbed wire. If the user indicates that the land is already fenced, the decision aid bypasses the budget and does not include this figure in the final output.

Two other budgets are taken in to consideration for calculating the cost of converting land to a cow-calf operation. The first is the penalty calculator described in the CRP enrollment section. If the user indicates that the land is enrolled in CRP but will be exiting prior the end of the contract life, the penalty calculator in Table 3.2 uses the producer input from the home page indicating the rental payment amount to determine the cost of terminating the CRP contract prior to the expiration of the contract. If the user indicates that the land was not previously enrolled, the penalty calculator is bypassed, and that figure is not included in the final output.

The second budget is a well cost budget adapted from Warminski et al. (2009). If the user indicates that a well is not present, they have the option to choose a depth, and pump type. These choices are then used to budget the cost of a well, shown in Table 3.4. If the user indicates that there is already a well, or that the land does not require the use of a well, this budget is bypassed by the decision aid, and the information is not included in the final output.

CHAPTER IV

RESULTS

Test Assumptions

The Agricultural and Food Policy Center at Texas A&M University develops representative a series of representative farms with producers from around the country. The land owned outright by a representative farm in Dallam County, Texas was chosen to test the decision aid, as Dallam County is in a region with a high concentration of CRP land according to USDA CRP maps. The amount of land owned outright by the Dallam county farm totals 450 acres.

The CRP decision aid simultaneously tests the twelve potential scenarios for feasibility. Comparisons of net returns are made using a SERF, SDRF, and stoplight chart, a CDF, and a simple output comparison. The output comparison compares means, standard deviations, minimums, and maximums from all twelve enterprises. Since CRP enrollment is the subject of this study, the comparison chart highlights any amount in the mean or maximum row that is greater than the CRP mean or maximum, respectively. It is assumed that for all tests considering owned land, the land debt is paid in full. Since the Dallam farm does not currently have CRP enrollment listed, the test will assume that the producer is newly enrolling in CRP. Since there is no indication of CRP enrollment in the summary, an EBI was estimated for the producer.

The EBI estimator allows the user to enter his/her data to estimate their EBI to provide insight into the odds of selection for CRP. In section one of the wildlife score, wildlife habitat cover benefits, the producer enrolls all 450 acres in, “Existing stand or planting mixed stand (minimum of five species) of at least three native grasses and at least one shrub, forb, or legume species best suited for wildlife in the area, totaling fifty points. Wildlife enhancement, section 2, assumes, “Conversion of at least 51 percent of a primarily monoculture stand to a mixture of native species that provides wildlife benefits,” and is worth 20 points. In section three of the wildlife score, the test assumes, “At least 51 percent of land qualifies as a Wildlife Priority Zone,” worth 30 points.

Part B. of the EBI is the Water Quality Score. Section one assumes, “At least 51% of land qualifies as an approved water quality zone,” and is worth 30 points towards the EBI. Section two, groundwater quality, assumes an FSA assigned score of 12, which is worth 12 points. Section three, surface water quality, assumes an FSA assigned score of 2, which is worth two points.

The Erosion Factor is Part C and assumes average erodibility which is worth 50 points towards the overall EBI. Part D., Enduring Benefits, assumes that, based on the chosen CRP practice, there are no enduring benefits and therefore scores zero points towards the overall EBI.

Part E. of the EBI estimator, Air Quality Benefits, has four sections. Section one, wind erosion impacts, assumes an average wind erosion impact, worth twelve and a half points. Section two, the wind erosion soils list, assumes that, “Less than fifty-one percent of land is comprised of predominantly volcanic or organic soils,” which is worth zero points. Section three, air quality zone, assumes that, “Less than fifty-one percent of land is in an air quality zone," which is worth zero points, and section four, carbon sequestration assumes both, "Permanent wildlife habitat (corridors), non-easement and Permanent wildlife habitat, non-easement," and, "Permanent introduced grasses and legumes, and Establishment of permanent native grasses," which combined are worth three and a half points.

The final portion of the EBI takes into account the producer's per acre dollar bid to enroll in CRP. The producer's bid is weighed against a maximum payment rate that is established by NRCS and FSA. The EBI/Bid comparison table, shown below in Table 4.1 compares potential bids against the EBI scores that bid level is worth, and whether or not the bid would be eligible under the CRP general signup forty-five EBI score of 209. The test of the model assumes a bid price of $47.50; the maximum bid that would be accepted based on the producer's other environmental factors in the EBI estimator.

Each part of the EBI can be changed by the decision aid user based on information from NRCS. Erosion measures are different for different areas of the state or country. The decision aid is customized in this way for users in generating their own estimate of CRP acceptance.

Table 4.1 EBI/Bid Comparison Table

BID		EBI	ELIGIBLE
$	10.00	219.00	
$	12.50	219.00	
$	15.00	219.00	
$	17.50	219.00	
$	20.00	219.00	
$	22.50	219.00	
$	25.00	219.00	
$	27.50	219.00	
$	30.00	219.00	
$	32.50	219.00	
$	35.00	219.00	
$	37.50	219.00	
$	40.00	219.00	
$	42.50	219.00	
$	45.00	219.00	
$	47.50	215.00	
$	50.00	208.00	NOT ELIGIBLE
$	52.50	198.00	NOT ELIGIBLE
$	55.00	194.00	NOT ELIGIBLE
$	57.50	194.00	NOT ELIGIBLE
$	60.00	194.00	NOT ELIGIBLE

The Dallam county farm has irrigated wheat information on record, and the EBI calculator uses data from that portion of representative farm history as historic input for yields when forecasting production. There are no cattle listed for the Dallam county representative farm. To test the model on the cow-calf enterprise it was assumed that twenty-five bred heifers were purchased, with stochastic calving rates and sale weights of offspring. The Hunting returns were calculated using estimates assumed by the "producer". A daily lease fee of $50, a 40 day hunting season, two simultaneous hunters, and a minimum, middle, and maximum "days hunted" of zero percent, ten percent, and twenty-five percent of the possible hunting days, respectively, were assumed. The calculator also assumes that an irrigated well was already on the farm and operational, and that the land was already fenced.

Output

Each of the twelve crops was simulated over the period of 2015-2019, and the cumulative net present value (NPV) and an annual estimate of that figure (PYNPV) were calculated. The following are a series of outputs generated by the model designed to aid the producer in the final enrollment decision. All figures are calculated on a per acre basis, and are an average of the NPV over five years (PYNPV).

Figure 4.1 is a CDF comparison of the twelve enterprise options available under this decision aid, with the previously stated data entered.

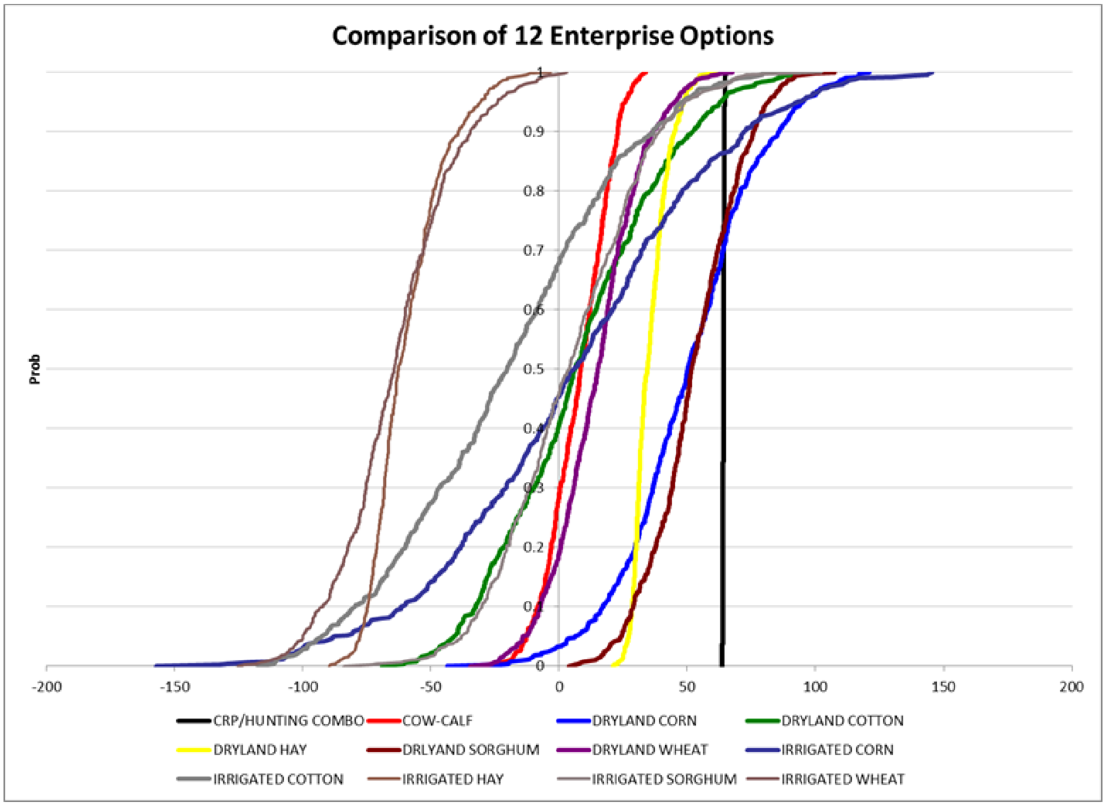

Figure 4.1 CDF Comparison of 12 Enterprise Options Considered in the CRP Decision Aid.

The CRP/Hunting Combo option does not have the highest maximum value; however it does have the highest mean per acre returns. The shape of the CDFs also indicates that there is significantly less variability under the CRP/Hunting Combo option than the other eleven enterprises. The decreased variability is due to the fact that CRP payments are constant, and the only variation the model calculates comes from hunting revenues which are added to the CRP payment. The options to produce irrigated crops tend to do the worst overall (irrigated hay and wheat), while dryland crops have the widest variability on annual returns per acre.

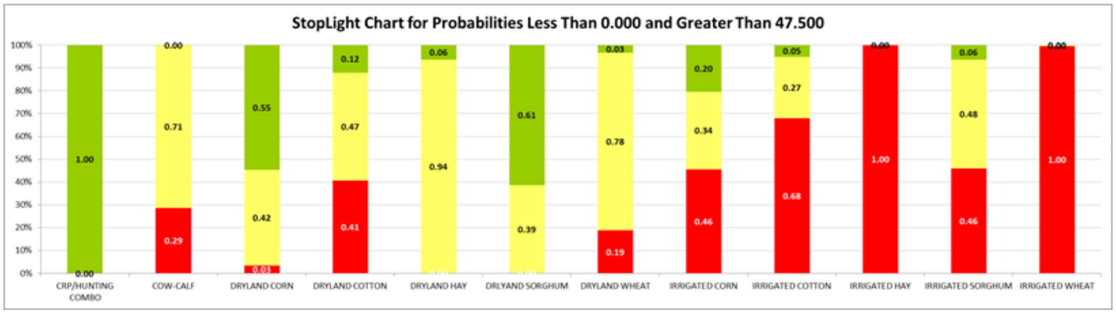

Figure 4.2 Stoplight Comparison of 12 Enterprise Options Considered in the CRP Decision Aid.

The stoplight chart (Figure 4.2) contains each option's probability of a "good" or "bad" outcome. Since this study is based on deciding whether or not to enroll in CRP, the upper boundary, which is the "good" case is equal to the producer's bid, in this case $47.50. The lower bound, which is analogous to a bad outcome, is $0.00. There are three options that have zero probability of negative returns. These include the CRP option, the dryland hay option, and the dryland sorghum option. The same information can also be seen in Figure 4.1, as all three of these options' CDFs fall entire on the right side of the y-axis, designating a 100% chance of positive returns. There are two options that have entirely "bad" outcomes; irrigated hay and irrigated wheat each have 100% probability of achieving negative returns.

There are nine scenarios with possible returns greater than $47.50, including the CRP/Hunting combo, dryland corn, dryland cotton, dryland sorghum, irrigated corn, irrigated cotton, and irrigated sorghum. Dryland corn and dryland sorghum have a greater than 50% chance of netting over $47.50, making them the most promising options to replace CRP under this test's assumptions. The CDFs in Figure 4.1 shows that approximately 30% of the time dryland corn and dryland sorghum perform better than CRP.

Table 4.2 Stochastic Dominance with Respect to a Function Analysis of 12 Enterprise Options Considered in CRP Decision Aid.

	Efficient Set Based on SDRF at			Efficient Set Based on SDRF at	
	Lower RAC	0		Upper RAC	0.002197
	Name	Level of Preference		Name	Level of Preference
1	CRP/HUNTING COMBO	Most Preferred	1	CRP/HUNTING COMBO	Most Preferred
2	DRLYAND SORGHUM	2nd Most Preferred	2	DRLYAND SORGHUM	2nd Most Preferred
3	DRYLAND CORN	3rd Most Preferred	3	DRYLAND CORN	3rd Most Preferred
4	DRYLAND HAY	4th Most Preferred	4	DRYLAND HAY	4th Most Preferred
5	DRYLAND WHEAT	5th Most Preferred	5	DRYLAND WHEAT	5th Most Preferred
6	DRYLAND COTTON	6th Most Preferred	6	COW-CALF	6th Most Preferred
7	COW-CALF	7th Most Preferred	7	DRYLAND COTTON	7th Most Preferred
8	IRRIGATED CORN	8th Most Preferred	8	IRRIGATED SORGHUM	8th Most Preferred
9	IRRIGATED SORGHUM	9th Most Preferred	9	IRRIGATED CORN	9th Most Preferred
10	IRRIGATED COTTON	10th Most Preferred	10	IRRIGATED COTTON	10th Most Preferred
11	IRRIGATED HAY	11th Most Preferred	11	IRRIGATED HAY	11th Most Preferred
12	IRRIGATED WHEAT	12th Most Preferred	12	IRRIGATED WHEAT	12th Most Preferred

The SDRF analysis shows pairwise comparisons of the enterprise options under different risk aversion coefficients (RAC). The lower RAC for this test was set at zero, while the upper RAC was calculated using the ending net worth of the scenarios. The CRP/Hunting combo is the most preferred choice under both RACs, with irrigated wheat being the least preferred option under both RACs.

The analysis under both RACs produce similar results, with CRP/Hunting and dryland enterprises as the most preferred options, and the irrigated enterprise options the least preferred, with the cow-calf enterprise falling in the middle. Options six through nine differ between RACs. These enterprises include cow-calf, dryland cotton, irrigated sorghum, and irrigated corn. When looking at the CDFs in Figure 4.1, those four options are in the central group, and cross over each other around .5. This shows that under differing attitudes towards risk, these options will vary in their preference.

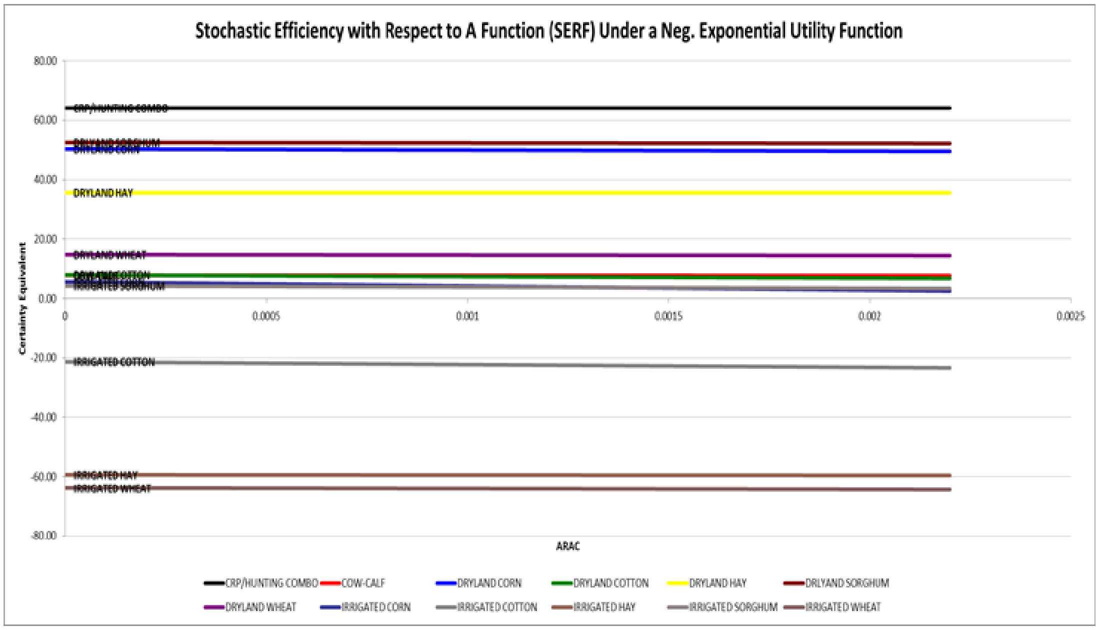

Figure 4.3 Stochastic Efficiency with Respect to a Function Analysis of 12 Enterprise Options Considered in the CRP Decision Aid

While the SDRF analysis compares discrete pairwise options, SERF compares continuous options, assuming the same shape utility function for each enterprise, in this case a negative exponential utility function. Once again, Figure 4.3 shows that CRP is the best option under this test. The findings of SERF confirm that there are no significant changes in rankings across the enterprises when analyzed in a continuous setting as opposed to the SDRFs discrete setting.

Table 4.3 was developed specifically for the decision aid. It is a comparison chart of each enterprise’s means, standard deviation, minimum, and maximum values. The chart in the aid is all on the same set of rows, however Table 4.3 was split in two to increase it's clarity for this paper.

Table 4.3 Comparison of Enterprise Values Considered in the CRP Decision Aid.

Comparison of Enterprise Values

Variable	CRP/HUNTING COMBO	COW-CALF	DRYLAND CORN	DRYLAND COTTON	DRYLAND HAY	DRLYAND SORGHUM
Mean	$ 64.16	$ 7.78	$ 50.41	$ 7.85	$ 35.66	$ 52.60
StDev	0.274276349	11.974148	26.75036871	32.04109343	6.741278346	17.76130046
Min	$ 63.43	$ (27.02)	$ (43.73)	$ (69.02)	$ 21.10	$ 3.93
Max	$ 65.14	$ 33.91	$ 120.96	$ 97.39	$ 61.72	$ 107.41

Variable	DRYLAND WHEAT	IRRIGATED	IRRIGATED COTT	IRRIGATED HAY	IRRIGATED SOR	IRRIGATED WHEAT
Mean	$ 14.84	$ 5.57	$ (21.31)	$ (59.33)	$ 4.22	$ (63.83)
StDev	17.30044787	52.632694	42.72712533	14.33954895	27.94492929	22.52281356
Min	$ (34.52)	$ (157.16)	$ (117.30)	$ (89.67)	$ (83.99)	$ (125.28)
Max	$ 67.45	$ 145.37	$ 94.07	$ (3.17)	$ 102.35	$ 3.08

The purpose of the comparison table is to help producers establish a minimum bid threshold. The highlighted value under the CRP/Hunting combo option is the mean net returns from CRP/Hunting. Any option taken in lieu of CRP/Hunting combo should have a value at least that high, or higher. This would return a highlighted cell in the mean row for the other enterprises. Under the decision aid testing conditions, this did not occur.

Another potential method of evaluating the bid price could be to look at the maximum values for each enterprise. Table 4.3 is designed to take that "maximum-maximum" approach into account. The maximum returns achieved by the CRP/Hunting combo are $65.14. For a producer to choose another enterprise based on this option the maximum net returns would have to exceed that dollar amount. A value higher than the CRP/hunting option occurs seven times. The maximum return achieved by dryland corn, dryland cotton, dryland sorghum, dryland wheat, irrigated corn, irrigated cotton, and irrigated sorghum exceed the returns from CRP/Hunting combo, although dryland wheat only exceed the returns by approximately $2.00 per acre.

The decision aid generates estimated returns to production options specified by the user. the results are displayed to take into account risk in yields, prices, and net returns. Alternative rental rates can be specified to examine various CRP bids and the effect of those bids on the EBI.

CHAPTER V

CONCLUSIONS

The Agricultural Act of 2014 mandates an 8 million acre reduction for CRP over the life of the bill. This fact combined with the rapidly approaching general signup period make evaluating land-use options important to producers. Incorporating risk in to a decision about future land use can enhance a farmer’s ability to make sound financial decisions. The primary goal of this research was to develop a computer decision aid model that would provide producers with a method to evaluate five land use options based on their chosen inputs.

The land use options evaluated by the decision aid model were enrollment (or re-enrollment) in CRP combined with hunting returns, ten different cropping options, a cow-calf enterprise. Using a farm in Dallam County, Texas, an Environmental Benefits Index score was estimated, and several scenarios were simulated under different assumptions about the producer’s management choices. The choices were each ranked using four methods; a cumulative distribution function, the stoplight ranking method stochastic dominance with respect to a function, and stochastic efficiency with respect to a function. Each of these are available to a producer using the aid.

CRP/Hunting was the most preferred alternative based on all ranking options, unless the decision is based on maximum potential returns, which is not typically a sound decision making method. This is a reasonable conclusion as enrollment in CRP at any given bid has no variability and can be viewed as a sure investment opportunity with a known stream of returns. The other enterprises were variable in their ranking depending on the method used.

It is important to remember that this was only a test based on one test farm, and not an actual recommendation in general. With that in mind, under all but the most optimistic outlooks, CRP/Hunting is the recommended choice based on this test. It has the lowest level of variability, which is attractive to decision makers with a high risk aversion coefficient, as well as the highest mean. Depending on a producer's attitude towards risk and their ability to remain solvent given a poor outcome, dryland corn, and particularly dryland sorghum could compete with CRP/Hunting. Based on this test example dryland sorghum has no likelihood of negative net returns, which may be unrealistic, and realizes a potentially much higher net return than CRP/Hunting. Dryland corn has the drawback of potential negative returns making it a less attractive, but still possible choice over CRP/Hunting.

This test has several limiting factors. The Texas A&M AgriLife Extension budgets used to evaluate expenses for each option are generalized for a region, and will vary by landowner, and across different regions of the state. Individualization of each budget for each unique situation will yield more accurate estimates. The correct decision may be dependent on other factors that cannot be economically analyzed. This model only produces a recommendation, not a final rule on the decision. Attitudes towards production could influence the decision of whether or not to enroll in a set-aside program like CRP. Research also indicates that age may play a role in the enrollment decision.

Several improvements could be made to this model. The first is to incorporate a decreased productivity rate in the first year or two of the cropping options if the land is broken out of CRP. The literature shows that this is typical, and this could impact the net returns to cropping options. The wheat enterprise should also include a cattle stocker operation. This was not programmed into the model, however the cow-calf and wheat system typically work as a system together, and that could potentially make the wheat and cow-calf options more attractive. In the future, the analysis should be extended to ten years, as that is the typical life of a CRP contract, and it would yield more realistic results. The EBI calculator can also be improved upon, particularly in the calculation of air quality improvements, water quality, and the erosion factor section. The data and calculation for these sections are not readily available, or necessarily easy for a farmer to enter, but their improvement will help make the aid more efficient. A potential next step for this analysis is to incorporate the CRP decision into a whole-farm analysis, searching for an optimal level of CRP land to incorporate into a farming system.

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APPENDIX A

	Point Score
CP1 – Permanent introduced grasses and legumes	
Existing stand of one to three species or planting new stand of two to three species of an introduced grass species	10
Existing stand or planting mixture (minimum of four species) of at least 3 introduced grasses and at least one forb or legume species best suited for wildlife in the area.	40
CP2 – Establishment of new permanent native grasses and legumes	
Existing stand (minimum of one to three species) or planting mixed stand (minimum of three species) of at least two native grass species and at least one forb or legume species beneficial to wildlife.	20
Existing stand or planting mixed stand (minimum of five species) of at least 3 native grasses and at least one shrub, forb, or legume species best suited for wildlife in the area.	50
CP3 – Tree planting (general) 2/	
Southern pines (softwoods) – Solid stand of pines/softwoods (existing, according to state developed standards, or planted at more than 550 trees per acre).	10
Northern conifers (softwoods) – Solid stand of conifers/softwoods (existing, according to state developed standards, or planted at more than 850 trees per acre).	10
Western pines (softwoods) – Solid stand of pines/softwoods (existing, according to state developed standards, or planted at more than 650 trees per acre).	10
Southern pines (softwoods) – Pines/softwoods existing or planted at a rate of 500 to 550 per acre depending upon the site index (state-developed standards) with 10 to 20 percent openings managed to a CP4D wildlife cover.	50
Northern conifers (softwoods) – Conifers/softwoods existing or planted at a rate of 750 to 850 trees per acre depending upon the site index (state-developed standards) with 10 to 20 percent openings managed to a CP4D wildlife cover.	50
Western pines (softwoods) – Pines/softwoods existing or planted at a rate of 550 to 650 per acre depending upon the site index (state-developed standards) with 10 to 20 percent openings managed to a CP4D wildlife cover.	50
CP3A – Hardwood tree planting	
Existing or planting solid stand of nonmast producing hardwood species.	10
Existing or planting solid stand of a single hard mast producing species.	20
Existing or planting mixed stand of two hardwood species best suited for wildlife in the area.	30
Existing or planting mixed stand (three or more species) of hardwood species best suited for wildlife in the area.	50
Existing or planting stand of Longleaf pine or Atlantic white cedar - Planted at rates appropriate for the site index.	50
CP4B - Permanent wildlife habitat (corridors), noneasement.	
Existing stand or planting mixed stand (minimum of four species) of either grasses, trees, shrubs, forbs, or legumes planted in mixes, blocks, or strips best suited for various wildlife species in the area. A wildlife conservation plan must be developed with the participant.	40
Existing stand or planting mixed stand (minimum of five species) of either predominantly native species including grasses, forbs, legumes, shrubs, or trees planted in mixes, blocks, or strips best suited to providing wildlife habitat. Only native grasses are authorized. Introduced grasses are not authorized for and cannot be included in cover mixes for 50-point N1a scores for CP4B. A wildlife conservation plan must be developed with the participant.	50
CP4D - Permanent wildlife habitat, noneasement	
Existing stand or planting mixed stand (minimum of four species) of either grasses, trees, shrubs, forbs, or legumes planted in mixes, blocks, or strips best suited for various wildlife species in the area. A wildlife conservation plan must be developed with the participant.	40
Existing stand or planting mixed stand (minimum of five species) of either predominantly native species including grasses, forbs, legumes, shrubs, or trees planted in mixes, blocks, or strips best suited to providing wildlife habitat. Only native grasses are authorized. Introduced grasses are not authorized for and cannot be included in cover mixes for 50-point N1a scores for CP4D. A wildlife conservation plan must be developed with the participant.	50
CP12 –Wildlife food plot 3/	
Wildlife food plots are small non-cost-shared plantings in a larger area. Wildlife food plots will never be the predominant cover.	NA
CP25 –Rare and declining habitat restoration 4/	
Existing stand or seeding or planting will be best suited for wildlife in the area. Plant species selections will be based upon Ecological Site Description data.	50
CP42 – Pollinator Habitat	
Existing stand or planting of a diverse mix of multiple species suited for pollinators.	50

Table A.1 Cover Practices (CP) for the N1a Criteria

(Conservation Reserve Program Sign-Up 45 Environmental Benefits Index (EBI) Fact Sheet, 2013)

<table>
<tr><th>Practice</th><th>Point Score</th></tr>
<tr><td>Conversion of at least 51 percent of a primarily monoculture stand to a mixture of native species that provides wildlife benefits.</td><td>20</td></tr>
<tr><td>Establishment of pollinator habitat (CP42) that remains in the location of the CRP-1. The habitat size, shape, and composition must meet the following requirements:

Size
<table>
<tr><th>CRP Acreage Offered</th><th>Habitat Size Requirement</th></tr>
<tr><td>Less than 10 acres</td><td>At least one acre of pollinator habitat. Habitat areas must be at least 0.5 acre.</td></tr>
<tr><td>10 acres or greater</td><td>At least 10 percent of the acreage offered in pollinator habitat. Habitat areas must be at least 0.5 acre.</td></tr>
</table></td><td>20</td></tr>
<tr><td>Annual or permanent food plot (CP12) that remains in the same location for the contract length, or rotated food plot (CP12) for which the location on the contract is moved during the contract length consistent with the NRCS Field Office Technical Guide up to 10 percent of a field, not to exceed 5 acres per field.</td><td>5</td></tr>
</table>

Table A.2 Practices for the N1b Criteria

(Conservation Reserve Program Sign-Up 45 Environmental Benefits Index (EBI) Fact Sheet, 2013)

EI	Points	EI	Points	EI	Points
4	1	10	22	16	79
5	2	11	29	17	92
6	4	12	37	18	97
7	7	13	46	19	98
8	11	14	56	20	99
9	16	15	67	21+	100

1/ EI of less than 4 = 0 points

Table A.3 Erodibility Index Points

(Conservation Reserve Program Sign-Up 45 Environmental Benefits Index (EBI) Fact Sheet, 2013)

Practice	Point Score
New hardwood tree, longleaf pine, and/or Atlantic white cedar plantings (CP3A) and CP25 (Rare and declining habitat restoration) if the plant community is existing or will be established to primarily trees.	50
Existing or enhanced stand of hardwood tree, longleaf pine, and/or Atlantic white cedar plantings (CP3A).	40
New pine/softwood tree (CP3).	30
Rare and declining habitat restoration (CP25) where the plant community is existing or will be established to a primarily grass and/or shrub complex, or CP42.	25
Existing pine/softwood tree - original contract signed as CP3.	20
CP1, CP2, CP4B, CP4D.	0

Table A.4 Practices for the N4 Criteria

(Conservation Reserve Program Sign-Up 45 Environmental Benefits Index (EBI) Fact Sheet, 2013)

Practice	Point Score
CP3 (Tree planting - general), CP3A (Hardwood tree planting), and CP25 (Rare and declining habitat restoration) planted to trees.	10
CP25 (Rare and declining habitat restoration) planted to grass/shrub complexes, and CP42 (Pollinator Habitat).	5
CP4B (Permanent wildlife habitat (corridors), noneasement) and CP4D (Permanent wildlife habitat, noneasement).	4
CP1 (Permanent introduced grasses and legumes) and CP2 (Establishment of permanent native grasses).	3
CP12 (Wildlife food plot).	0

Table A.5 Air Quality

(Conservation Reserve Program Sign-Up 45 Environmental Benefits Index (EBI) Fact Sheet, 2013)

Percent Below Maximum Payment Rate	N6b Points
1	2
2	4
3	6
4	8
5	10
6	12
7	14
8	16
9	18
10	20
11	21
12	22
13	23
14	24
>=15	25

Table A.6 Offer Less than Maximum Payment Rate
(Conservation Reserve Program Sign-Up 45 Environmental Benefits Index (EBI) Fact Sheet, 2013)

APPENDIX B

Projections for Planning Purposes Only -- Not to be Used without Updating
2015 Estimated Costs and Returns per Acre
Bt Corn for Grain, Furrow Irrigated (NG) - 122 Acres
Panhandle Extension District - 1

	Crop Acres	122				
REVENUE		Quantity	Units	$/Unit	Total	Enterprise Total
Corn		200.00	Bushel	$4.37	$874.00	$106,628.00
Total Revenue					$874.00	$106,628.00
VARIABLE COSTS		Quantity	Units	$/Unit	Total	Enterprise Total
Production Costs						
Custom						
	Fertilizer Application - ANH3	1	Acre	$11.75	$11.75	$1,433.50
	Crop Consultant	1	Acre	$8.63	$8.63	$1,052.86
	Harvest and Haul - Corn	200	Bushel	$0.44	$88.00	$10,736.00
Fertilizer						
	Fertilizer (P) - Liquid	60	Pound	$0.85	$51.00	$6,222.00
	Fertilizer (N) - ANH3	152	Pound	$0.40	$60.80	$7,417.60
	Fertilizer (N) - Liquid	50	Pound	$0.55	$27.50	$3,355.00
Herbicide						
	Herbicide - Corn Preplant	1	Acre	$17.70	$17.70	$2,159.40
	Herbicide - Corn Postplant	1	Acre	$16.00	$16.00	$1,952.00
Insecticide						
	Miticide	1	Acre	$22.00	$22.00	$2,684.00
Seed						
	Seed - Bt Corn for Grain	0.38	Bag	$287.50	$109.25	$13,328.50
Miscellaneous						
	Crop Insurance Corn Irrigated	1	Acre	$25.63	$25.63	$3,127.10
Irrigation						
	Energy Cost	26.00	AcreInch	$4.30	$111.80	$13,639.60
	Irrigation Labor	3.65	Hour	$11.75	$42.92	$5,236.58
Machinery Labor						
	Tractors/Self-Propelled	1.19	Hour	$11.75	$13.98	$1,705.87
Diesel Fuel						
	Tractors/Self-Propelled	3.45	Gallon	$3.30	$11.39	$1,388.97
Gasoline						
	Pickup/General Use Equipment	1	Acre	$9.19	$9.19	$1,121.25
Repairs & Maintenance						
	Pickup/General Use Equipment	1	Acre	$3.76	$3.76	$459.00
	Irrigation Equipment	1	Acre	$103.03	$103.03	$12,569.66
	Tractors/Self-Propelled	1	Acre	$5.31	$5.31	$648.36
	Implements	1	Acre	$13.11	$13.11	$1,599.01
Interest on Credit Line				4.90%	$11.97	$1,460.24
Total Variable Costs					$764.73	$93,296.49
Planned Returns Above Variable Costs:					$109.27	$13,331.51
Breakeven Price to Cover Variable Costs				$3.82	Bushel	
FIXED COSTS		Quantity	Units	$/Unit	Total	Enterprise Total
Machinery Depreciation						
	Pickup/General Use Equipment	1	Acre	$3.95	$3.95	$481.95
	Irrigation Equipment	1	Acre	$14.42	$14.42	$1,759.40
	Tractors/Self-Propelled	1	Acre	$5.49	$5.49	$669.97
	Implements	1	Acre	$16.07	$16.07	$1,960.68
Equipment Investment						
	Pickup/General Use Equipment	$47.03	Dollars	5.40%	$2.54	$309.83
	Irrigation Equipment	$379.51	Dollars	5.40%	$20.49	$2,500.20
	Tractors/Self-Propelled	$62.00	Dollars	5.40%	$3.35	$408.46
	Implements	$125.00	Dollars	5.40%	$6.75	$823.48
Cash Rent - Corn		1	Acre	$133.00	$133.00	$16,226.00
Total Fixed Costs					$206.07	$25,139.97
Total Specified Costs					$970.79	$118,436.46
Returns Above Specified Costs					($96.79)	($11,808.46)
Breakeven Price to Cover Total Costs				$4.85	Bushel	

Table B1. Irrigated Corn Budget

(Cornforth, 2015)

Projections for Planning Purposes Only -- Not to be Used without Updating

2015 Estimated Costs and Returns per Acre

Dryland Corn - 100 Acres

Southwest Extension District - 10

	Crop Acres	100				
REVENUE		Quantity	Units	$/Unit	Total	Enterprise Total
Corn		55.00	Bushel	$4.20	$231.00	$23,100.00
Total Revenue					$231.00	$23,100.00
VARIABLE COSTS		Quantity	Units	$/Unit	Total	Enterprise Total
Production Costs						
Custom						
	Haul Corn	55	Bushels	$0.16	$8.80	$880.00
Fertilizer						
	UAN(32% N)	1.375	CWT	$16.00	$22.00	$2,200.00
	Fertilizer 18-46-0	87	Pound	$0.28	$24.36	$2,436.00
Herbicide						
	Glyphosate	4.4	Pint	$2.03	$8.93	$893.20
Seed						
	Corn Seed BtRR	20	Thousand	$2.96	$59.20	$5,920.00
Miscellaneous						
	Miscellaneous Corn Overhead	1	Acre	$4.00	$4.00	$400.00
	Crop Insurance - Cotton Dry	1	Acre	$13.00	$13.00	$1,300.00
Machinery Labor						
	Tractors/Self-Propelled	1.11	Hour	$12.00	$13.32	$1,332.00
Diesel Fuel						
	Tractors/Self-Propelled	7.32	Gallon	$2.15	$15.74	$1,573.80
Gasoline						
	Pickup/General Use Equipment	1	Acre	$29.43	$29.43	$2,943.36
Repairs & Maintenance						
	Pickup/General Use Equipment	1	Acre	$6.72	$6.72	$672.00
	Tractors/Self-Propelled	1	Acre	$22.28	$22.28	$2,227.55
	Implements	1	Acre	$13.84	$13.84	$1,383.72
Interest on Credit Line				6.50%	$8.15	$814.91
Total Variable Costs					$249.77	$24,976.53
Planned Returns Above Variable Costs:					($18.77)	($1,876.53)
Breakeven Price to Cover Variable Costs				$4.54	Bushel	
FIXED COSTS		Quantity	Units	$/Unit	Total	Enterprise Total
Machinery Depreciation						
	Pickup/General Use Equipment	1	Acre	$25.20	$25.20	$2,520.00
	Tractors/Self-Propelled	1	Acre	$22.02	$22.02	$2,201.85
	Implements	1	Acre	$17.19	$17.19	$1,719.25
Equipment Investment						
	Pickup/General Use Equipment	$168.00	Dollars	6.50%	$10.92	$1,092.00
	Tractors/Self-Propelled	$250.15	Dollars	6.50%	$16.26	$1,625.96
	Implements	$141.44	Dollars	6.50%	$9.19	$919.37
Dryland Winter Garden Rent		1	Acre	$20.00	$20.00	$2,000.00
Total Fixed Costs					$120.78	$12,078.44
Total Specified Costs					$370.55	$37,054.97
Returns Above Specified Costs					($139.55)	($13,954.97)
Breakeven Price to Cover Total Costs				$6.74	Bushel	

Table B2. Dryland Corn Budget

(Cornforth, 2015)

Projections for Planning Purposes Only -- Not to be Used without Updating
2015 Estimated Costs and Returns per Acre
Cotton, Sprinkler Irrigated (Roundup Ready Flex) - 122 Acres
Panhandle Extension District - 1

Crop Acres	122				
REVENUE	Quantity	Units	$/Unit	Total	Enterprise Total
Cotton Lint	1,100.00	Pound	$0.58	$638.00	$77,836.00
Cottonseed	0.83	Ton	$160.00	$132.80	$16,201.60
Total Revenue				$770.80	$94,037.60
VARIABLE COSTS	Quantity	Units	$/Unit	Total	Enterprise Total
Production Costs					
Custom					
Fertilizer Application	1	Acre	$5.50	$5.50	$671.00
Strip and Module - Cotton	11	CWT	$9.00	$99.00	$12,078.00
Ginning - Cotton	40.48	CWT	$2.70	$109.30	$13,334.11
Fertilizer					
Fertilizer (P) - Dry	25	Pound	$0.60	$15.00	$1,830.00
Fertilizer (N) - Dry	100	Pound	$0.49	$49.00	$5,978.00
Herbicide					
Herbicide and Apply Preplant	1	Acre	$14.80	$14.80	$1,805.60
Herbicide and Apply Postemerge	1	Acre	$19.75	$19.75	$2,409.50
Insecticide					
Insecticide and Apply Cotton	1	Acre	$10.00	$10.00	$1,220.00
Boll Weevil Assessment Irrigated	1	Acre	$0.75	$0.75	$91.50
Seed					
Seed - Cotton	0.22	Bag	$360.00	$79.20	$9,662.40
Miscellaneous					
Crop Insurance Cotton - Irrigated	1	Acre	$36.96	$36.96	$4,509.12
Other Chemicals					
Harvest Aid Apply Cotton Irrigated	0.75	Acre	$26.50	$19.88	$2,424.75
Irrigation					
Energy Cost	12.00	AcreInch	$4.30	$51.60	$6,295.20
Irrigation Labor	0.77	Hour	$11.75	$9.02	$1,100.93
Machinery Labor					
Tractors/Self-Propelled	1.15	Hour	$11.75	$13.51	$1,648.53
Diesel Fuel					
Tractors/Self-Propelled	2.81	Gallon	$3.30	$9.27	$1,131.31
Gasoline					
Pickup/General Use Equipment	1	Acre	$10.42	$10.42	$1,270.75
Repairs & Maintenance					
Pickup/General Use Equipment	1	Acre	$4.26	$4.26	$520.20
Irrigation Equipment	1	Acre	$48.48	$48.48	$5,914.56
Tractors/Self-Propelled	1	Acre	$3.72	$3.72	$453.63
Implements	1	Acre	$5.42	$5.42	$661.60
Interest on Credit Line			4.90%	$10.35	$1,263.23
Total Variable Costs				$625.20	$76,273.90
Planned Returns Above Variable Costs:				$145.60	$17,763.70
Breakeven Price to Cover Variable Costs			$0.45	Pound	
FIXED COSTS	Quantity	Units	$/Unit	Total	Enterprise Total
Machinery Depreciation					
Pickup/General Use Equipment	1	Acre	$4.48	$4.48	$546.21
Irrigation Equipment	1	Acre	$22.50	$22.50	$2,745.60
Tractors/Self-Propelled	1	Acre	$3.51	$3.51	$428.31
Implements	1	Acre	$6.33	$6.33	$771.98
Equipment Investment					
Pickup/General Use Equipment	$53.30	Dollars	5.40%	$2.88	$351.14
Irrigation Equipment	$703.28	Dollars	5.40%	$37.98	$4,633.20
Tractors/Self-Propelled	$39.64	Dollars	5.40%	$2.14	$261.13
Implements	$50.12	Dollars	5.40%	$2.71	$330.21
Cash Rent - Cotton Irrigated	1	Acre	$80.75	$80.75	$9,851.50
Total Fixed Costs				$163.27	$19,919.28
Total Specified Costs				$788.47	$96,193.19
Returns Above Specified Costs				($17.67)	($2,155.59)
Breakeven Price to Cover Total Costs			$0.60	Pound	

Table B3. Irrigated Cotton Budget

(Cornforth, 2015)

Projections for Planning Purposes Only -- Not to be Used without Updating
2015 Estimated Costs and Returns per Acre
Cotton, Dryland (Roundup Ready Flex) - 160 Acres
Panhandle Extension District - 1

	Quantity	Units	$/Unit	Total	Enterprise Total
Crop Acres	160				
REVENUE	Quantity	Units	$/Unit	Total	Enterprise Total
Cotton Lint	400.00	Pound	$0.58	$232.00	$37,120.00
Cottonseed	0.30	Ton	$160.00	$48.00	$7,680.00
Total Revenue				$280.00	$44,800.00
VARIABLE COSTS	Quantity	Units	$/Unit	Total	Enterprise Total
Production Costs					
Custom					
Fertilizer Application	1	Acre	$5.50	$5.50	$880.00
Strip and Module - Cotton	4	CWT	$9.00	$36.00	$5,760.00
Ginning - Cotton	18	CWT	$2.70	$48.60	$7,776.00
Fertilizer					
Fertilizer (P) - Dry	20	Pound	$0.60	$12.00	$1,920.00
Fertilizer (N) - Dry	30	Pound	$0.49	$14.70	$2,352.00
Herbicide					
Herbicide and Apply Preplant	1	Acre	$14.80	$14.80	$2,368.00
Herbicide and Apply Postemerge Dry	1	Acre	$14.60	$14.60	$2,336.00
Insecticide					
Insecticide and Apply Cotton	0.5	Acre	$10.00	$5.00	$800.00
Boll Weevil Assessment Dryland	1	Acre	$0.75	$0.75	$120.00
Seed					
Seed - Cotton Dryland	0.18	Bag	$360.00	$64.80	$10,368.00
Miscellaneous					
Crop Insurance Cotton - Dryland	1	Acre	$22.46	$22.46	$3,594.24
Other Chemicals					
Harvest Aid Apply Cotton Dryland	0.5	Acre	$26.50	$13.25	$2,120.00
Machinery Labor					
Tractors/Self-Propelled	1.2	Hour	$11.75	$14.10	$2,256.00
Diesel Fuel					
Tractors/Self-Propelled	2.97	Gallon	$3.30	$9.80	$1,568.16
Gasoline					
Pickup/General Use Equipment	1	Acre	$6.07	$6.07	$971.75
Repairs & Maintenance					
Pickup/General Use Equipment	1	Acre	$2.49	$2.49	$397.80
Tractors/Self-Propelled	1	Acre	$3.98	$3.98	$637.42
Implements	1	Acre	$11.54	$11.54	$1,846.47
Interest on Credit Line			4.90%	$5.69	$910.00
Total Variable Costs				$306.14	$48,981.83
Planned Returns Above Variable Costs:				($26.14)	($4,181.83)
Breakeven Price to Cover Variable Costs			$0.65	Pound	
FIXED COSTS	Quantity	Units	$/Unit	Total	Enterprise Total
Machinery Depreciation					
Pickup/General Use Equipment	1	Acre	$2.61	$2.61	$417.69
Tractors/Self-Propelled	1	Acre	$3.82	$3.82	$610.53
Implements	1	Acre	$14.41	$14.41	$2,305.78
Equipment Investment					
Pickup/General Use Equipment	$31.08	Dollars	5.40%	$1.68	$268.52
Tractors/Self-Propelled	$43.08	Dollars	5.40%	$2.33	$372.23
Implements	$112.99	Dollars	5.40%	$6.10	$976.27
Cash Rent - Cotton Dryland	1	Acre	$28.50	$28.50	$4,560.00
Total Fixed Costs				$59.44	$9,511.01
Total Specified Costs				$365.58	$58,492.84
Returns Above Specified Costs				($85.58)	($13,692.84)
Breakeven Price to Cover Total Costs			$0.79	Pound	

Table B4. Dryland Cotton Budget

(Cornforth, 2015)

Projections for Planning Purposes Only -- Not to be Used without Updating
2015 Estimated Costs and Returns per Acre
Irrigated Sorghum - 122 Acres
South Plains Extension District - 2

Crop Acres	122				
REVENUE	Quantity	Units	$/Unit	Total	Enterprise Total
Grain Sorghum	55.00	CWT	$7.20	$396.00	$48,312.00
Total Revenue				$396.00	$48,312.00
VARIABLE COSTS	Quantity	Units	$/Unit	Total	Enterprise Total
Production Costs					
Seed					
Seed - Sorghum	4.5	Pound	$2.40	$10.80	$1,317.60
Fertilizer					
Fertilizer (N) - Liquid	40	Pound	$0.58	$23.12	$2,820.64
Fertilizer (P) - Liquid	44	Pound	$0.74	$32.34	$3,945.48
Fertilizer (N) - NH3	70	Pound	$0.38	$26.46	$3,228.12
Custom					
Harvest and Haul - Sorghum	55	CWT	$0.60	$33.00	$4,026.00
Fertilizer Application - Liquid High	1	Acre	$4.75	$4.75	$579.50
Fertilizer Application - Liquid Low	1	Acre	$3.50	$3.50	$427.00
Fertilizer Application - NH3	1	Acre	$3.50	$3.50	$427.00
Miscellaneous					
Crop Insurance Sorghum - Irrigated	1	Acre	$29.00	$29.00	$3,538.00
Herbicide					
Herbicide and Apply Sorghum Irrigated	1	Acre	$21.12	$21.12	$2,576.64
Insecticide					
Insecticide and Apply Sorghum	1	Acre	$4.29	$4.29	$523.38
Irrigation					
Energy Cost	9.00	AcreInch	$9.00	$81.00	$9,882.00
Irrigation Labor	0.90	Hour	$12.00	$10.80	$1,317.60
Machinery Labor					
Tractors/Self-Propelled	1.3	Hour	$12.00	$15.60	$1,903.20
Diesel Fuel					
Tractors/Self-Propelled	3.2	Gallon	$3.00	$9.60	$1,171.20
Gasoline					
Pickup/General Use Equipment	2	Gallon	$2.25	$4.50	$549.00
Repairs & Maintenance					
Pickup/General Use Equipment	1	Acre	$0.50	$0.50	$61.00
Irrigation Equipment	1	Acre	$15.75	$15.75	$1,921.50
Tractors/Self-Propelled	1	Acre	$6.00	$6.00	$732.00
Implements	1	Acre	$3.00	$3.00	$366.00
Interest on Credit Line			6.00%	$6.65	$811.71
Total Variable Costs				$345.28	$42,124.57
Planned Returns Above Variable Costs:				$50.72	$6,187.43
Breakeven Price to Cover Variable Costs			$6.28	CWT	
FIXED COSTS	Quantity	Units	$/Unit	Total	Enterprise Total
Equipment Investment					
Pickup/General Use Equipment	$17.89	Dollars	7.00%	$1.25	$152.78
Irrigation Equipment	$785.72	Dollars	7.00%	$55.00	$6,710.01
Tractors/Self-Propelled	$171.40	Dollars	7.00%	$12.00	$1,463.76
Implements	$142.90	Dollars	7.00%	$10.00	$1,220.37
Wholr Farm Insurance	1	Acre	$2.00	$2.00	$244.00
Cash Rent - Sorghum Irrigated	1	Acre	$100.00	$100.00	$12,200.00
Total Fixed Costs				$180.25	$21,990.91
Total Specified Costs				$525.54	$64,115.47
Returns Above Specifiied Costs				($129.54)	($15,803.47)
Breakeven Price to Cover Total Costs			$9.56	CWT	

Table B5. Irrigated Sorghum Budget
(Cornforth, 2015)

Projections for Planning Purposes Only -- Not to be Used without Updating
2015 Estimated Costs and Returns per Acre
Dryland Sorghum - 160 Acres
South Plains Extension District - 2

Crop Acres	160				
REVENUE	Quantity	Units	$/Unit	Total	Enterprise Total
Grain Sorghum	18.00	CWT	$7.20	$129.60	$20,736.00
Total Revenue				$129.60	$20,736.00
VARIABLE COSTS	Quantity	Units	$/Unit	Total	Enterprise Total
Production Costs					
Seed					
Seed - Sorghum	2.25	Pound	$2.40	$5.40	$864.00
Fertilizer					
Fertilizer (N) - Liquid	30	Pound	$0.58	$17.34	$2,774.40
Custom					
Custom Harvest - Sorghum Dryland	1	Acre	$14.00	$14.00	$2,240.00
Custom Haul - Sorghum Dryland	18	CWT	$0.40	$7.20	$1,152.00
Fertilizer Application - Liquid High	1	Acre	$4.75	$4.75	$760.00
Miscellaneous					
Crop Insurance Sorghum - Dryland	1	Acre	$16.50	$16.50	$2,640.00
Herbicide					
Herbicide and Apply Sorghum Dryland	1	Acre	$10.50	$10.50	$1,680.00
Insecticide					
Insecticide and Apply Sorghum	1	Acre	$4.29	$4.29	$686.40
Machinery Labor					
Tractors/Self-Propelled	1	Hour	$12.00	$12.00	$1,920.00
Diesel Fuel					
Tractors/Self-Propelled	2.4	Gallon	$3.00	$7.20	$1,152.00
Gasoline					
Pickup/General Use Equipment	2	Gallon	$2.25	$4.50	$720.00
Repairs & Maintenance					
Pickup/General Use Equipment	1	Acre	$0.50	$0.50	$80.00
Tractors/Self-Propelled	1	Acre	$6.00	$6.00	$960.00
Implements	1	Acre	$3.00	$3.00	$480.00
Interest on Credit Line			6.00%	$2.33	$373.50
Total Variable Costs				$115.51	$18,482.30
Planned Returns Above Variable Costs:				$14.09	$2,253.70
Breakeven Price to Cover Variable Costs			$6.42	CWT	
FIXED COSTS	Quantity	Units	$/Unit	Total	Enterprise Total
Equipment Investment					
Pickup/General Use Equipment	$17.84	Dollars	7.00%	$1.25	$199.85
Tractors/Self-Propelled	$171.40	Dollars	7.00%	$12.00	$1,919.68
Implements	$142.90	Dollars	7.00%	$10.00	$1,600.48
Whole Farm Insurance	1	Acre	$2.00	$2.00	$320.00
Cash Rent - Sorghum	1	Acre	$30.00	$30.00	$4,800.00
Total Fixed Costs				$55.25	$8,840.01
Total Specified Costs				$170.76	$27,322.31
Returns Above Specifiied Costs				($41.16)	($6,586.31)
Breakeven Price to Cover Total Costs			$9.49	CWT	

Table B6. Dryland Sorghum Budget
(Cornforth, 2015)

Projections for Planning Purposes Only -- Not to be Used without Updating
2015 Estimated Costs and Returns per Acre
Irrigated Soybeans - 122 Acres
South Plains Extension District - 2

	Quantity	Units	$/Unit	Total	Enterprise Total
Crop Acres	122				
REVENUE	Quantity	Units	$/Unit	Total	Enterprise Total
Soybeans	40.00	Bushel	$9.00	$360.00	$43,920.00
Total Revenue				$360.00	$43,920.00
VARIABLE COSTS	Quantity	Units	$/Unit	Total	Enterprise Total
Production Costs					
Seed					
Seed - Soybeans	60	Pound	$0.65	$39.00	$4,758.00
Innoculant Soybeans	1	Acre	$7.00	$7.00	$854.00
Seed - Soybeans Tech Fee	60	Pound	$0.63	$37.50	$4,575.00
Fertilizer					
Fertilizer (P) - Liquid	45	Pound	$0.74	$33.08	$4,035.15
Custom					
Harvest and Haul - Soybeans	40	Bushel	$0.50	$20.00	$2,440.00
Miscellaneous					
Crop Insurance Soybeans	1	Acre	$23.00	$23.00	$2,806.00
Crop Insurance Hail Soybeans	2	Acre	$6.00	$12.00	$1,464.00
Herbicide					
Herbicide and Apply Soybeans	1	Acre	$18.00	$18.00	$2,196.00
Insecticide					
Insecticide and Apply Soybeans	1	Acre	$5.12	$5.12	$624.64
Irrigation					
Energy Cost	15.00	AcreInch	$9.00	$135.00	$16,470.00
Irrigation Labor	0.90	Hour	$12.00	$10.80	$1,317.60
Machinery Labor					
Tractors/Self-Propelled	1.5	Hour	$12.00	$18.00	$2,196.00
Diesel Fuel					
Tractors/Self-Propelled	3.8	Gallon	$3.00	$11.40	$1,390.80
Gasoline					
Pickup/General Use Equipment	2	Gallon	$2.25	$4.50	$549.00
Repairs & Maintenance					
Pickup/General Use Equipment	1	Acre	$0.50	$0.50	$61.00
Irrigation Equipment	1	Acre	$26.25	$26.25	$3,202.50
Tractors/Self-Propelled	1	Acre	$6.00	$6.00	$732.00
Implements	1	Acre	$3.00	$3.00	$366.00
Interest on Credit Line			6.00%	$6.98	$851.82
Total Variable Costs				$417.13	$50,889.51
Planned Returns Above Variable Costs:				($57.13)	($6,969.51)
Breakeven Price to Cover Variable Costs			$10.43	Bushel	
FIXED COSTS	Quantity	Units	$/Unit	Total	Enterprise Total
Equipment Investment					
Pickup/General Use Equipment	$17.89	Dollars	7.00%	$1.25	$152.78
Irrigation Equipment	$785.72	Dollars	7.00%	$55.00	$6,710.01
Tractors/Self-Propelled	$171.40	Dollars	7.00%	$12.00	$1,463.76
Implements	$142.90	Dollars	7.00%	$10.00	$1,220.37
Whole Farm Insurance	1	Acre	$2.00	$2.00	$244.00
Cash Rent - Soybeans	1	Acre	$100.00	$100.00	$12,200.00
Total Fixed Costs				$180.25	$21,990.91
Total Specified Costs				$597.38	$72,880.42
Returns Above Specifiied Costs				($237.38)	($28,960.42)
Breakeven Price to Cover Total Costs			$14.93	Bushel	

Table B7. Irrigated Soybeans Budget
(Cornforth, 2015)

Projections for Planning Purposes Only -- Not to be Used without Updating
2015 Estimated Costs and Returns per Acre
Soybeans - GMO Seed, Conventional Till-12 Row, Dryland, 30 bu. Yield Goal - 500 Acres
Upper Coastal Bend Extension District - 11

Crop Acres	500				
REVENUE	Quantity	Units	$/Unit	Total	Enterprise Total
Soybeans	30.00	Bushel	$9.50	$285.00	$142,500.00
Total Revenue				$285.00	$142,500.00
VARIABLE COSTS	Quantity	Units	$/Unit	Total	Enterprise Total
Production Costs					
Seed					
Roundup Ready Soybean Seed	1	Bag	$60.00	$60.00	$30,000.00
Inoculants	1	Bag	$6.00	$6.00	$3,000.00
Custom					
Scout Soybeans	1	Acre	$5.00	$5.00	$2,500.00
Custom Grain Haul	18	CWT	$0.30	$5.40	$2,700.00
Miscellaneous					
Crop Insurance -Soybeans	1	Acre	$18.00	$18.00	$9,000.00
G&A Overhead	1	Acre	$10.50	$10.50	$5,250.00
Herbicide					
Glyphosate (gal.)	0.5625	Quart	$5.13	$2.89	$1,442.81
2, 4D Amine	1	Pint	$1.75	$1.75	$875.00
Soybean PreEmerge Herbicide	1	Pint	$7.50	$7.50	$3,750.00
Roundup	0.5	Pint	$3.66	$1.83	$915.00
Insecticide					
Stinkbug Control Soybeans	1.5	Pound	$5.25	$7.88	$3,937.50
Machinery Labor					
Tractors/Self-Propelled	0.68	Hour	$19.50	$13.26	$6,630.00
Diesel Fuel					
Tractors/Self-Propelled	7.6	Gallon	$3.30	$25.08	$12,540.00
Repairs & Maintenance					
Tractors/Self-Propelled	1	Acre	$20.75	$20.75	$10,376.58
Implements	1	Acre	$12.63	$12.63	$6,316.59
Interest on Credit Line			5.00%	$4.26	$2,129.19
Total Variable Costs				$202.73	$101,362.67
Planned Returns Above Variable Costs:				$82.27	$41,137.33
Breakeven Price to Cover Variable Costs			$6.76	Bushel	
FIXED COSTS	Quantity	Units	$/Unit	Total	Enterprise Total
Machinery Depreciation					
Tractors/Self-Propelled	1	Acre	$23.77	$23.77	$11,882.67
Implements	1	Acre	$15.40	$15.40	$7,700.13
Equipment Investment					
Tractors/Self-Propelled	$270.17	Dollars	7.00%	$18.91	$9,455.81
Implements	$141.09	Dollars	7.00%	$9.88	$4,938.15
Management Fee, Owner/Operator Labor	1	Acre	$14.25	$14.25	$7,125.00
UCB - Land Charge	1	Acre	$85.00	$85.00	$42,500.00
Total Fixed Costs				$167.20	$83,601.76
Total Specified Costs				$369.93	$184,964.43
Returns Above Specified Costs				($84.93)	($42,464.43)
Breakeven Price to Cover Total Costs			$12.33	Bushel	

Table B8. Dryland Soybean Budget
(Cornforth, 2015)

Projections for Planning Purposes Only -- Not to be Used without Updating
2015 Estimated Costs and Returns per Acre
Irrigated Wheat - 122 Acres
South Plains Extension District - 2

	Quantity	Units	$/Unit	Total	Enterprise Total
Crop Acres	122				
REVENUE	Quantity	Units	$/Unit	Total	Enterprise Total
Wheat	60.00	Bushel	$5.50	$330.00	$40,260.00
Grazing - Wheat Irrigated	136.00	Pound	$0.50	$68.00	$8,296.00
Total Revenue				$398.00	$48,556.00
VARIABLE COSTS	Quantity	Units	$/Unit	Total	Enterprise Total
Production Costs					
Seed					
Seed - Wheat	1.5	Bushel	$25.00	$37.50	$4,575.00
Fertilizer					
Fertilizer (P) - Liquid	56	Pound	$0.74	$41.16	$5,021.52
Fertilizer (N) - Liquid	50	Pound	$0.58	$28.90	$3,525.80
Fertilizer (N) - NH3	90	Pound	$0.38	$34.02	$4,150.44
Custom					
Harvest and Haul - Wheat Irrigated	60	Bushel	$0.50	$30.00	$3,660.00
Fertilizer Application - NH3	1	Acre	$3.50	$3.50	$427.00
Fertilizer Application - Liquid Low	1	Acre	$3.50	$3.50	$427.00
Fertilizer Application - Liquid High	1	Acre	$4.75	$4.75	$579.50
Miscellaneous					
Crop Insurance Wheat Irrigated	1	Acre	$19.50	$19.50	$2,379.00
Insecticide					
Insecticide and Apply Wheat	1	Acre	$11.00	$11.00	$1,342.00
Irrigation					
Energy Cost	15.00	AcreInch	$9.00	$135.00	$16,470.00
Irrigation Labor	0.90	Hour	$12.00	$10.80	$1,317.60
Machinery Labor					
Tractors/Self-Propelled	1	Hour	$12.00	$12.00	$1,464.00
Diesel Fuel					
Tractors/Self-Propelled	2.4	Gallon	$3.00	$7.20	$878.40
Gasoline					
Pickup/General Use Equipment	2	Gallon	$2.25	$4.50	$549.00
Repairs & Maintenance					
Pickup/General Use Equipment	1	Acre	$0.50	$0.50	$61.00
Irrigation Equipment	1	Acre	$26.25	$26.25	$3,202.50
Tractors/Self-Propelled	1	Acre	$6.00	$6.00	$732.00
Implements	1	Acre	$3.00	$3.00	$366.00
Interest on Credit Line			6.00%	$13.19	$1,608.63
Total Variable Costs				$432.27	$52,736.39
Planned Returns Above Variable Costs:				($34.27)	($4,180.39)
Breakeven Price to Cover Variable Costs			$6.07	Bushel	
FIXED COSTS	Quantity	Units	$/Unit	Total	Enterprise Total
Equipment Investment					
Pickup/General Use Equipment	$17.89	Dollars	7.00%	$1.25	$152.78
Irrigation Equipment	$785.72	Dollars	7.00%	$55.00	$6,710.01
Tractors/Self-Propelled	$171.40	Dollars	7.00%	$12.00	$1,463.76
Implements	$142.90	Dollars	7.00%	$10.00	$1,220.37
Whole Farm Insurance	1	Acre	$2.00	$2.00	$244.00
Cash Rent - Wheat Irrigated	1	Acre	$100.00	$100.00	$12,200.00
Total Fixed Costs				$180.25	$21,990.91
Total Specified Costs				$612.52	$74,727.30
Returns Above Specifiied Costs				($214.52)	($26,171.30)
Breakeven Price to Cover Total Costs			$9.08	Bushel	

Table B9. Irrigated Wheat Budget

(Cornforth, 2015)

Projections for Planning Purposes Only -- Not to be Used without Updating
2015 Estimated Costs and Returns per Acre
Dryland Wheat - 160 Acres
South Plains Extension District - 2

Crop Acres	160				
REVENUE	**Quantity**	**Units**	**$/Unit**	**Total**	**Enterprise Total**
Wheat	18.00	Bushel	$5.50	$99.00	$15,840.00
Grazing - Wheat	68.00	Pound	$0.50	$34.00	$5,440.00
Total Revenue				$133.00	$21,280.00
VARIABLE COSTS	**Quantity**	**Units**	**$/Unit**	**Total**	**Enterprise Total**
Production Costs					
Seed					
Seed - Wheat	1	Bushel	$25.00	$25.00	$4,000.00
Fertilizer					
Fertilizer (N) - Liquid	30	Pound	$0.58	$17.34	$2,774.40
Custom					
Custom Harvest - Wheat	1	Acre	$14.00	$14.00	$2,240.00
Custom Haul - Wheat	18	Bushel	$0.14	$2.52	$403.20
Fertilizer Application - Liquid High	1	Acre	$4.75	$4.75	$760.00
Miscellaneous					
Crop Insurance Wheat Dryland	1	Acre	$19.00	$19.00	$3,040.00
Herbicide					
Herbicide and Apply Wheat Dryland	1	Acre	$16.75	$16.75	$2,680.00
Insecticide					
Insecticide and Apply Wheat Dryland	1	Acre	$5.50	$5.50	$880.00
Machinery Labor					
Tractors/Self-Propelled	0.9	Hour	$12.00	$10.80	$1,728.00
Diesel Fuel					
Tractors/Self-Propelled	2.2	Gallon	$3.00	$6.60	$1,056.00
Gasoline					
Pickup/General Use Equipment	2	Gallon	$2.25	$4.50	$720.00
Repairs & Maintenance					
Pickup/General Use Equipment	1	Acre	$0.50	$0.50	$80.00
Tractors/Self-Propelled	1	Acre	$6.00	$6.00	$960.00
Implements	1	Acre	$3.00	$3.00	$480.00
Interest on Credit Line			6.00%	$4.58	$732.88
Total Variable Costs				$140.84	$22,534.48
Planned Returns Above Variable Costs:				($7.84)	($1,254.48)
Breakeven Price to Cover Variable Costs			$5.94	Bushel	
FIXED COSTS	**Quantity**	**Units**	**$/Unit**	**Total**	**Enterprise Total**
Equipment Investment					
Pickup/General Use Equipment	$17.84	Dollars	7.00%	$1.25	$199.85
Tractors/Self-Propelled	$171.40	Dollars	7.00%	$12.00	$1,919.68
Implements	$142.90	Dollars	7.00%	$10.00	$1,600.48
Whole Farm Insurance	1	Acre	$2.00	$2.00	$320.00
Cash Rent - Wheat Dryland	1	Acre	$30.00	$30.00	$4,800.00
Total Fixed Costs				$55.25	$8,840.01
Total Specified Costs				$196.09	$31,374.49
Returns Above Specifiied Costs				($63.09)	($10,094.49)
Breakeven Price to Cover Total Costs			$9.01	Bushel	

Table B10. Dryland Wheat Budget
(Cornforth, 2015)

Projections for Planning Purposes Only -- Not to be Used without Updating
2015 Estimated Costs and Returns per Acre
Dryland Coastal Bermudagrass Pasture - 100 Acres
Southwest Extension District - 10

Crop Acres	100				
REVENUE	Quantity	Units	$/Unit	Total	Enterprise Total
AUM Grazing Lease	5.00	AUM	$18.75	$93.75	$9,375.00
Total Revenue				$93.75	$9,375.00
VARIABLE COSTS	Quantity	Units	$/Unit	Total	Enterprise Total
Production Costs					
Fertilizer					
Fertilizer 22-6-17	772	Pound	$0.22	$166.14	$16,614.40
Herbicide					
Prowl H2O	4	Pint	$5.06	$20.24	$2,024.00
Miscellaneous					
Miscellaneous Forage Overhead	1	Acre	$4.00	$4.00	$400.00
Machinery Labor					
Tractors/Self-Propelled	0.27	Hour	$12.00	$3.24	$324.00
Diesel Fuel					
Tractors/Self-Propelled	1.42	Gallon	$2.15	$3.05	$305.30
Gasoline					
Pickup/General Use Equipment	1	Acre	$18.40	$18.40	$1,840.00
Repairs & Maintenance					
Pickup/General Use Equipment	1	Acre	$4.20	$4.20	$420.00
Tractors/Self-Propelled	1	Acre	$1.72	$1.72	$172.44
Implements	1	Acre	$0.97	$0.97	$97.26
Interest on Credit Line			6.50%	$8.60	$860.42
Total Variable Costs				$230.58	$23,057.81
Planned Returns Above Variable Costs:				($136.83)	($13,682.81)
Breakeven Price to Cover Variable Costs			$46.12	AUM	
FIXED COSTS	Quantity	Units	$/Unit	Total	Enterprise Total
Machinery Depreciation					
Pickup/General Use Equipment	1	Acre	$25.74	$25.74	$2,574.00
Tractors/Self-Propelled	1	Acre	$2.57	$2.57	$257.24
Implements	1	Acre	$0.80	$0.80	$79.98
Equipment Investment					
Pickup/General Use Equipment	$171.60	Dollars	6.50%	$11.15	$1,115.40
Tractors/Self-Propelled	$29.20	Dollars	6.50%	$1.90	$189.78
Implements	$12.25	Dollars	6.50%	$0.80	$79.64
Dryland Winter Garden Rent	1	Acre	$20.00	$20.00	$2,000.00
Total Fixed Costs				$62.96	$6,296.04
Total Specified Costs				$293.54	$29,353.86
Returns Above Specified Costs				($199.79)	($19,978.86)
Breakeven Price to Cover Total Costs			$58.71	AUM	

Table B11. Dryland Bermudagrass Hay Budget
(Cornforth, 2015)

Projections for Planning Purposes Only -- Not to be Used without Updating
2015 Estimated Costs and Returns per Acre
Irrigated Bermudagrass Hay - 100 Acres
Southwest Extension District - 10

	Quantity	Units	$/Unit	Total	Enterprise Total
Crop Acres	100				
REVENUE	Quantity	Units	$/Unit	Total	Total
Bermuda Hay	12.00	Ton	$170.00	$2,040.00	$204,000.00
Total Revenue				$2,040.00	$204,000.00
VARIABLE COSTS	Quantity	Units	$/Unit	Total	Enterprise Total
Production Costs					
Fertilizer					
Fertilizer 22-6-17	1816	Pound	$0.22	$390.83	$39,082.58
Herbicide					
Prowl H2O	4	Pint	$5.06	$20.24	$2,024.00
Miscellaneous					
Miscellaneous Forage Overhead	1	Acre	$4.00	$4.00	$400.00
Irrigation					
Energy Cost	2990.00	kWh	$0.17	$508.30	$50,830.00
Irrigation Labor	0.18	Hour	$11.00	$2.02	$202.40
Machinery Labor					
Tractors/Self-Propelled	4.03	Hour	$12.00	$48.36	$4,836.00
Diesel Fuel					
Tractors/Self-Propelled	17.65	Gallon	$2.15	$37.95	$3,794.75
Gasoline					
Pickup/General Use Equipment	1	Acre	$58.86	$58.86	$5,886.00
Repairs & Maintenance					
Pickup/General Use Equipment	1	Acre	$13.44	$13.44	$1,344.00
Irrigation Equipment	1	Acre	$31.06	$31.06	$3,105.72
Tractors/Self-Propelled	1	Acre	$23.55	$23.55	$2,354.89
Implements	1	Acre	$8.09	$8.09	$808.94
Interest on Credit Line			6.50%	$27.33	$2,732.94
Total Variable Costs				$1,174.02	$117,402.22
Planned Returns Above Variable Costs:				$865.98	$86,597.78
Breakeven Price to Cover Variable Costs			$97.84	Ton	
FIXED COSTS	Quantity	Units	$/Unit	Total	Enterprise Total
Machinery Depreciation					
Pickup/General Use Equipment	1	Acre	$25.74	$25.74	$2,574.00
Irrigation Equipment	1	Acre	$48.53	$48.53	$4,853.31
Tractors/Self-Propelled	1	Acre	$23.62	$23.62	$2,361.93
Implements	1	Acre	$9.62	$9.62	$961.86
Equipment Investment					
Pickup/General Use Equipment	$171.60	Dollars	6.50%	$11.15	$1,115.40
Irrigation Equipment	$728.00	Dollars	6.50%	$47.32	$4,731.98
Tractors/Self-Propelled	$266.82	Dollars	6.50%	$17.34	$1,734.35
Implements	$126.79	Dollars	6.50%	$8.24	$824.13
Irrigated Winter Garden Rent	1	Acre	$50.00	$50.00	$5,000.00
Total Fixed Costs				$241.57	$24,156.96
Total Specified Costs				$1,415.59	$141,559.18
Returns Above Specified Costs				$624.41	$62,440.82
Breakeven Price to Cover Total Costs			$117.97	Ton	

Table B12. Irrigated Bermudagrass Budget
(Cornforth, 2015)