EXAMINING THE ECONOMIC IMPLICATIONS AND CONSIDERATIONS FOR CONTINUED INVOLVEMENT IN THE CONSERVATION RESERVE PROGRAM IN TEXAS

A Thesis

by

LAURA MAE SCHUCHARD

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

August 2011

Major Subject: Agricultural Economics

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Approved by:

Chair of Committee,	Joe L. Outlaw
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ABSTRACT

Examining the Economic Implications and Considerations for Continued Involvement in the Conservation Reserve Program in Texas. (August 2011)

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Chair of Advisory Committee: Dr. Joe L. Outlaw

The Conservation Reserve Program (CRP) has become increasingly important in Texas due to the high level of program participation, particularly in the high plains of Texas. There is also a seemingly large amount of CRP contracts that will expire, particularly in the next five years. As these contracts expire, it becomes very important for landowners to evaluate fully the options that are available for future land use. This research focused primarily on the ten counties in Texas having the most acres of CRP enrollment, which include Gaines, Deaf Smith, Lamb, Hale, Floyd, Dallam, Hockley, Terry, Castro, and Swisher Counties.

The primary objective was to provide landowners in these counties with a comprehensive list of options available after CRP contract expiration. The options were identified as re-enrollment in CRP, conversion back into crop production, lease land to a tenant as rangeland, or lease land to a tenant as cropland. Latin Hypercube simulation was used to generate a stochastic value for probable net returns per acre for the four options. The four options were then evaluated based on a variety of methods typically used to rank risky alternatives. The results indicate that CRP enrollment is the most

preferred option for landowners. Dryland crop production, while it can return very high net returns per acre, also has the highest amount of risk involved. However, it is important to note that the best ranking method and decision are dependent on the specific decision maker and situation.

The second objective of the research was to determine if there are measurable economic impacts to the agricultural services industry associated with CRP enrollment. OLS regression models were only run for five of the ten counties in the study area due to a lack of data reported by the Bureau of Economic Analysis. Of the five counties modeled, the Gaines, Dallam, and Hale County models indicated that CRP has played a significant role in the annual earnings of the agricultural services industry. The results suggest that there would be a benefit in conducting further research to examine the relationship between CRP enrollment and the agricultural services sector.

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CHAPTER I

INTRODUCTION

1.1. Problem Statement

The Conservation Reserve Program (CRP) was first established by the Food Security Act of 1985 with the primary emphasis of reducing damage to highly erodible soils and environmentally sensitive land while providing farmers with annual rental payments. Essentially farmers are paid “rent” in exchange for taking cropland out of production for 10-year contract periods. This program was modeled after the conservation part of the Soil Bank Program that lasted from 1956-1970. CRP is still in operation today and has been a very successful Federal agricultural program (Bankhead, Outlaw, and Ernstes 2010). According to reports by the United States Department of Agriculture – Farm Service Agency, there were 34,612,417 acres of land enrolled in CRP nationally during 2008. The state of Texas has about 22,085 CRP contracts accounting for 3,462,620 acres of cropland on 16,218 farms. Approximately $124,543,000 is paid each year in annual CRP rental payments to Texas landowners. This amounts to annual rental payments of about $36 per CRP acre enrolled.
Texas has more CRP acres than any other state (USDA, FSA 2010). Figure 1 is a map of current CRP enrollment in Texas.

This thesis follows the style of *American Journal of Agricultural Economics.*

Counties are shaded according to the amount of CRP acres enrolled. The majority of the CRP acres enrolled in Texas are found in the Panhandle, South Plains, and Rolling Plains Regions.

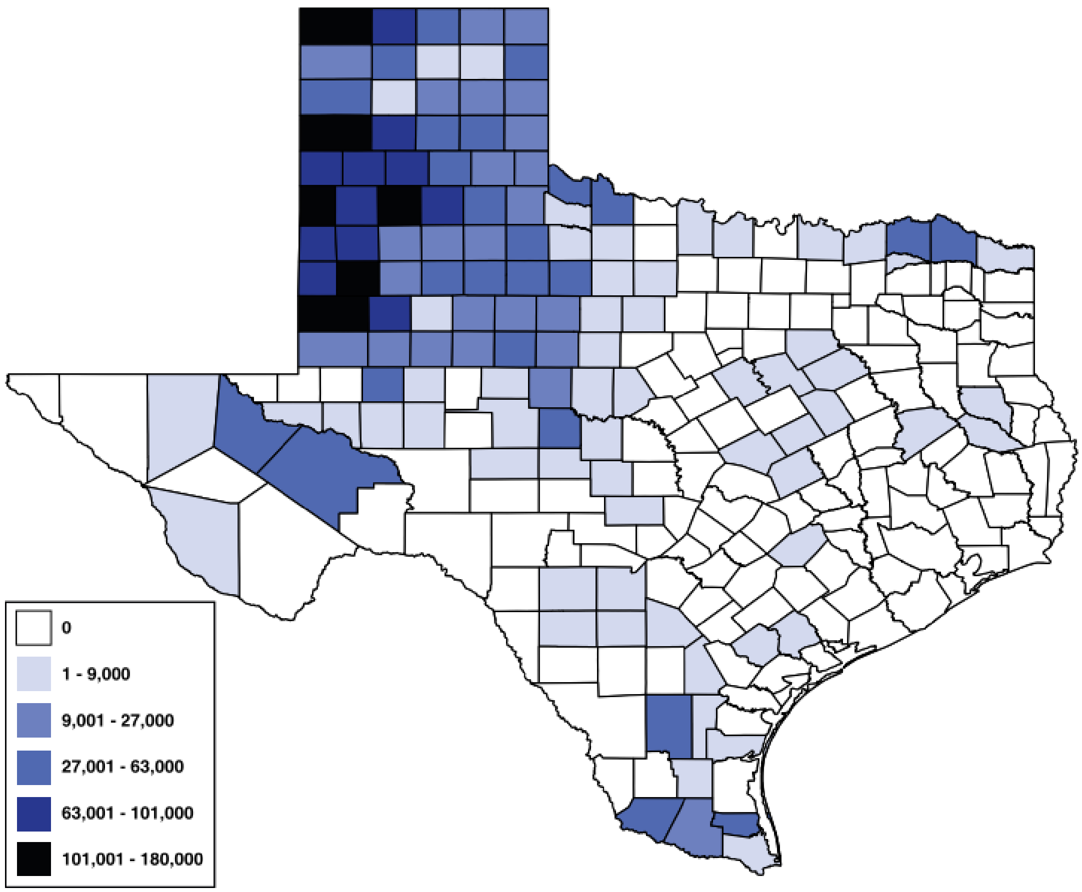

Figure 1. Acres of CRP enrollment in Texas, CRP sign-up periods 13-38 (Source: Bankhead, Outlaw, Ernstes 2010)

Although Texas currently has a great deal of land enrolled in CRP contracts, many of these contracts are also scheduled to expire. Between the years of 2010 and 2019 over 3 million acres of CRP will expire in Texas. The location and amount of acres expiring under current CRP contracts during the year 2012 is shown in Figure 2.

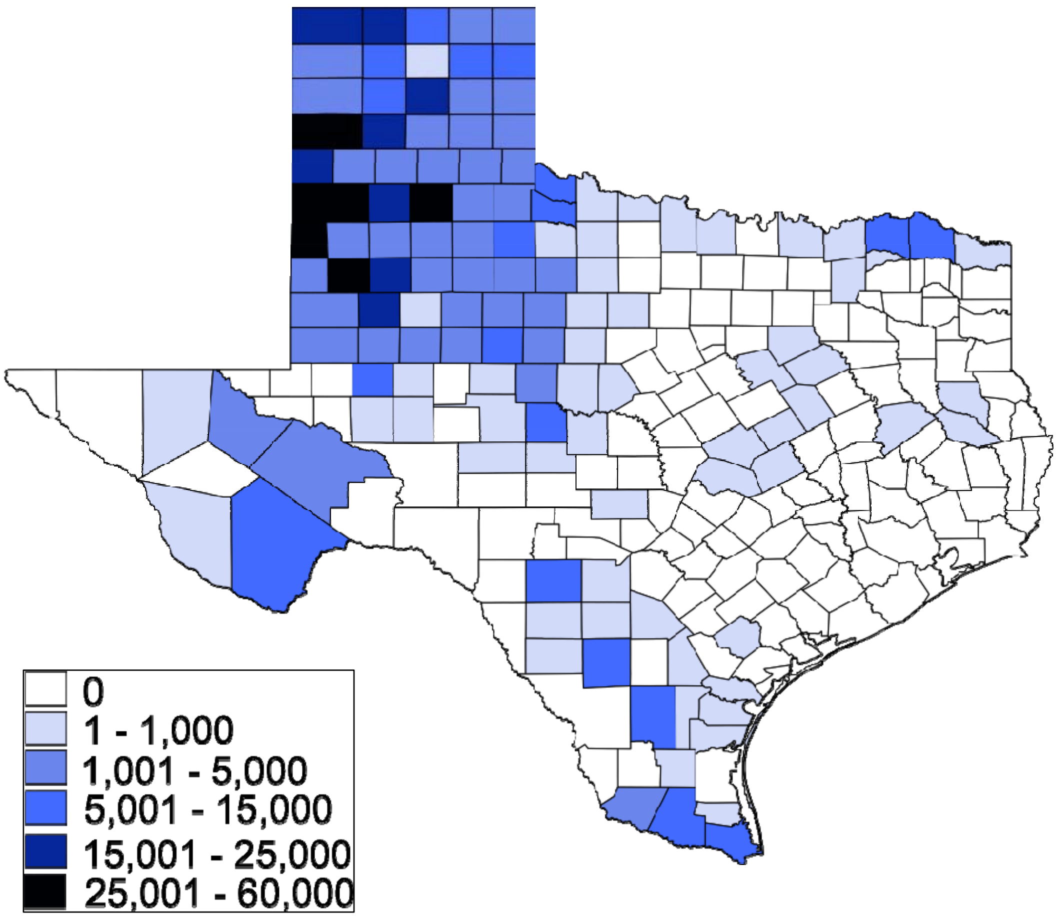

Figure 2. CRP acres expiring in 2012
(Source: Bankhead, Outlaw, Ernstes 2010)

As contracts expire, landowners must decide upon the best use of the land that is coming out. Some may decide to convert the land back into cropland or rangeland. Others may chose to attempt to re-enroll the land in CRP as many landowners did in August 2010 under CRP Sign-Up 39. The decisions that these individual landowners make could create significant increases or decreases in CRP enrollment. Significant changes in CRP enrollment may affect more than just the farmers. There has been some speculation that small communities located in CRP dense counties have been harmed due to the loss of income and revenues normally generated from farming the cropland. It would be beneficial for producers to understand all options that are available and the role that CRP plays in their local communities so that they can be informed decision-makers.

1.2. Objective

This research will primarily focus on the ten counties in Texas with the largest amount of acres enrolled in CRP. The counties that will be examined are as follows: Gaines, Deaf Smith, Lamb, Hale, Floyd, Dallam, Hockley, Terry, Castro, and Swisher. All ten counties are located in northwest Texas and have at least 100,000 acres of cropland enrolled in CRP (USDA, FSA 2011c). There are two main objectives associated with this research. First, it will present a comprehensive list of the options that landowners have as CRP contracts expire. This list will provide producers with realistic estimates that can be used in the decision-making process. The second objective of this research is to examine the economic implications that CRP has historically had on the agricultural services industry in the study area and determine if these impacts are measurable.

1.3. Outline of Study

This study is organized into six chapters. Chapter I provides an introduction to the research topic. Chapter II reviews the literature to determine what methods have been employed in examining this research topic. The literature review focuses on the legislative history of CRP, variables that affect the decision to enroll land in CRP, risk and simulation, the use of input-output models to evaluate economic impacts, and the use of various other methods to evaluate economic impacts. Chapter III focuses on the methodology used in the model followed by Chapter IV which presents the results of the study. The final chapter provides a summary of the research, further areas of research to be pursued, and concluding remarks.

CHAPTER II

REVIEW OF LITERATURE

2.1. CRP Legislative History

CRP was first established by the Food Security Act of 1985 with the primary emphasis of reducing damage to highly erodible soils and environmentally sensitive land while providing farmers with annual rental payments. Essentially farmers are paid "rent" in exchange for taking cropland out of production. This program was modeled after the conservation part of the Soil Bank Program that lasted from 1956-1970. In addition to the annual rental payments, producers are offered cost-share assistance (up to 50% of total expenses) for taking their land out of production and establishing long-term conserving covers. Landowners may enter into a CRP contract for a minimum of 10 years or a maximum of 15 years. When the program began in 1985, the goal was to remove 45 million acres from production in areas with environmentally sensitive land focusing primarily on highly erodible soils. This meant that about 100 million acres of the nation's cropland was eligible for CRP enrollment. Each individual county could not enroll more than 25% of its total cropland unless approved by the Secretary of Agriculture to avoid any possible adverse economic effects resulting from the program (Bankhead, Outlaw, and Ernstes 2010). During the first nine sign-ups about 34 million acres were enrolled in CRP across the nation. CRP is still in place today and is one of the most successful Federal agricultural programs. Although it has been in place for more than 30 years, there have been few significant changes to the program.

The Food, Conservation, Agriculture, and Trade Act of 1990 extended land eligibility beyond highly erodible soils to include state water quality priority areas, plots of land adopting high priority conservation practices, and Conservation Priority Areas (Great Lakes water shed, Chesapeake Bay, and Long Island Sound). This effectively increased the amount of cropland eligible for CRP enrollment from 100 million acres to 250 million acres. The 1990 Farm Bill also made changes to the way CRP contracts were ranked and annual rental rates were applied. The Environmental Benefits Index (EBI) was used as a way to rank CRP offers from producers based on water quality, air quality, and soil erodibility. Maximum soil specific rental rates were also set making it feasible for producers with highly productive land and highly erodible soils to enter into CRP contracts.

The Federal Agricultural Improvement and Reform Act of 1996 capped CRP enrollment at 36.4 million acres. Wildlife habitat was also added to the EBI. CRP continuous sign-up was created to allow environmentally desirable land devoted to specific conservation practices to be enrolled in CRP at any time. Eligible conservation practices included riparian buffers, wildlife habitat buffers, wetland buffers, filter strips, wetland restoration, grass waterways, shelterbelts, living snow fences, contour grass strips, salt tolerant vegetation, and shallow water areas for wildlife (USDA, FSA 2011b). Continuous sign-up contracts were not subject to competitive bidding. The USDA allowed some producers an early out option to modify or end their CRP contracts after 5 years of the program. During 1997 – 2002 many of the early CRP contracts began to expire and approximately 22 million acres were enrolled. The expiring contracts were not automatically renewed. There was increased competition because bids were ranked by the EBI.

The Farm Security and Rural Investment Act of 2002 made few minor changes to CRP. It increased the acreage cap to 39.2 million acres. Cropping history requirements were changed to four of the last six years. CRP enrollment began to shift geographically. The Northern Great Plains region gained slightly at the expense of the Heartland and the Southern Seaboard. Producers in the Plains offered land at a lower rental rate to increase the attractiveness of their offers.

The Food, Conservation, and Energy Act of 2008 capped the CRP at 32 million acres beginning on October 1, 2009. Eligibility requirements were modified to land cropped in four of six years prior to 2008 rather than 2002. Alfalfa, legumes, and multi-year grasses in a rotation practice with an annual commodity could be used to meet the cropping history requirement. A local preference criterion was also added in determining the acceptability of CRP offers. In previous bills, the Secretary used different criteria for different States and regions to determine acceptability. No more than 25% of a county’s cropland could be enrolled in CRP; however, exceptions were created to waive this limit in the case of continuous or CREP enrollment. A provision was also added for beginning or socially disadvantaged producers to help them make the transition from CRP land to production or other conservation programs; $25 million in funding was authorized for these transitions (Classen and Nickerson 2008).

About 75% of CRP contracts (28 million acres) are scheduled to expire between 2007 and 2010. During 2006 in an attempt to distribute the upcoming administrative burden, holders of expiring contracts were allowed to re-enroll or extend their contracts and 82% of contract holders chose to do this. Over the next five years 3.9 – 5.6 million acres are scheduled to expire each year (USDA, FSA 2010).

2.2. Decision Variables

As a result of contract expirations, over 22 million acres will expire in the United States over the next five years. Three million acres will expire in Texas alone. Producers will be faced with the decision of what to do next. Due to the reduced acreage cap, CRP bids are expected to be very competitive. They must determine if it is more profitable to attempt to re-enroll the land in a CRP contract, return land to production, rent land to a tenant, or maybe even use the land for livestock grazing. There are various factors that affect a producer's ultimate decision. Certain characteristics of farm operators also influence CRP land use. Many researchers have made predictions about what the future of CRP land holds (Sullivan et al. 2004, Sudduth, Ervin, and Elam 1993, Devino, Van Dyne, and Braschler 1988, Chang and Boisvert 2009, Dicks 1990).

In the USDA, ERS report "The Conservation Reserve Program Economic Implications for Rural America" the CRP was extensively examined as it related to economic impacts in rural counties. The report began by characterizing farm operators who participate in CRP. The majority of CRP participants were found to be either farm operators looking to retire or part-time farmers (farmers who identify their principal occupation to be something other than farming). Farm operators who participate in CRP can be further classified as whole-farm or partial-farm enrollees. Whole-farm enrollees are classified based on the percentage of total acres owned that are enrolled in the program. They are also less likely to be able to bring CRP land back into production when contracts end because they usually no longer actively participate in crop or livestock production. The Prairie Gateway Region (which includes parts of Texas) currently has the largest percentage of whole-farm CRP enrollees. One particular concern associated with whole-farm enrollees is that they will relocate to other areas to find better living conditions or employment opportunities. When they relocate they take with them the CRP rental payments flowing into the rural community. A person who receives CRP rental payments in a location other than the area where the CRP land is located is called an absentee landowner. The study ran simple regression models and found that no statistically significant relationship existed between the proportion of whole-farm enrollees and the amount of CRP payments leaving a county (Sullivan et al. 2004).

Another way to examine the CRP enrollment decision is to survey the parties that buy and sell CRP land while it is still under government contract. During the 1990's many parcels of land enrolled in the CRP were sold or on the market to be sold in the Southern High Plains of Texas. Sudduth, Ervin, and Elam conducted a study to determine the motivations of buyers and sellers. The study area consisted of eight counties in the southern Panhandle of Texas: Bailey, Cochran, Hale, Hockley, Lamb, Lubbock, Lynn, and Terry Counties. Upland cotton is the primary crop grown in this area. Each of the eight county ASCS (now FSA) offices was visited to obtain a list of previous buyers and sellers of CRP enrolled land. Buyers and sellers were contacted in a phone survey. The study found that 74% of buyers purchased CRP land to expand their present operations while 22% purchased the land as an investment opportunity. Most people who purchased land for investment opportunities had intentions of re-selling the land once CRP contracts expired. When buyers were asked if they would re-enroll CRP land when contracts expired, 40% stated they would not re-enroll and 48% said they would re-enroll at the same rental rate. When sellers were asked why they chose to sell CRP land, 25% of sellers attributed the sale to a liquidated inheritance, 24% were retiring from farming, and 19% wanted to reduce the size of their operation. The average return from CRP payments (minus all costs associated with owning the land at a zero percent appreciation in the end-value of land) is 11.5 percent per year. From this estimate, it was determined that CRP enrolled land purchased at the correct price would produce higher than expected returns for buyers. Sudduth, Ervin, and Elam (1993) stated that it may be possible that the CRP is facilitating changes in agriculture that would have taken longer to occur otherwise. For example, CRP may help producers who want to get out of farming leave the industry much sooner than under normal circumstances (Sudduth, Ervin, and Elam 1993).

The regulations for the CRP state that no more than 25% of a county's total cropland can be enrolled in CRP acreage (Food Security Act of 1985). In certain cases, the USDA may grant an exception allowing a county to enroll more than the 25% acreage cap. In the article, "Agribusiness and the CRP," Devino et al. discusses the possible negative consequences of CRP enrollment particularly as they relate to the agribusiness sector. The article, written in 1988, studied northern Missouri where a large portion of cropland was already enrolled in the program. Devino et al. predicted that agribusiness firms that supplied farm inputs or handled grain would be most directly affected by high numbers of CRP enrollment. More indirect effects would appear in communities as these agribusiness firms began to struggle thereby reducing local tax revenue. CRP enrollment began in 1986, so many of the predicted adverse effects may not have been fully realized at the time the article was written. Devino et al. estimated that gross profit of agribusinesses could be reduced by as much as $10 million in northern Missouri. However, he also noted that most of the direct losses to agribusinesses could be recovered in local economies if the money generated by CRP rental payments was spent on local goods and services (Devino, Van Dyne, and Braschler 1988).

Certain characteristics of landowners and eligible cropland may influence the likelihood of CRP participation and thus the decision to re-enroll expiring CRP acres. A study conducted at Cornell University examined participation in the CRP and/or off-farm labor. It was noted that the two variables (CRP participation and off-farm labor) were correlated most likely because both involve taking resources away from agricultural production. A discrete choice model was developed for off-farm labor and CRP participation. Probabilities were then estimated for each decision and these probabilities were included in a heteroskedastic farm household income function. The study found that as farm size and the age of the farmer increased the likelihood of CRP participation also increased. Counties that had land with a high EBI classification were more likely to have higher participation rates. Participation rates vary by production regions. The study concluded that CRP participation and off-farm labor increased farm household income and decreased the variability in household income. Chang and Boisvert expected to arrive at this result due to the fact that CRP participation and off-farm labor are typically less variable than farm income earned from producing a crop (Chang and Boisvert 2009).

The first CRP contracts began in 1986 meaning that those contracts first began to expire in 1995. A paper by Dicks titled, "Southern Great Plains CRP Lands: Future Use and Impacts" estimated the most likely future use of expired CRP land and examined the factors that influenced the land use decision. Dicks examined the Southern Great Plains (which includes part of the Texas Panhandle) in particular where the majority of CRP acres were originally enrolled in wheat base acres. He found that the factors most likely to influence the land use decision were relative profitability of alternative enterprises, supply and demand conditions, government policies, and socio-economic characteristics. Supply and demand conditions refer primarily to the available market prices when CRP contracts expire. Food and Agricultural Policy Institute (FAPRI) prices were used as a good predictor of future commodity prices to use as an estimate. If the price of wheat is relatively high, then more producers would be likely to put land back into wheat production. Conversely, if the projected net returns of livestock production are high, more producers may consider a livestock option. Government policies also affect a producer's decision because if added restrictions are placed on land use and enterprise practices it could potentially decrease the profitability of commercial agricultural production. Socio-economic characteristics imply that although relative profitability should guide land into its best use, it doesn't necessarily mean that it will occur. Land will be converted to its most profitable use only if the landowner has the resources, experience, and willingness to undertake the most profitable enterprise. The USDA's Agricultural Stabilization and Conservation Service (ASCS) created a dataset in the beginning years of CRP after each sign-up period that contained information about each farmer's intended use for CRP land after contracts expired. Dicks used this dataset to determine that about 48 percent of CRP croplands would return to crop production in the Southern Great Plains with wheat base acres being the largest base returning. He also found that about 37 percent of the CRP croplands would return to production under lease or rental agreements (Dicks 1990).

Iowa State Extension economists in the 2009 publication "Life after CRP – Decisions, Decisions!" suggested five key considerations in the decision-making process: age, personal goals, financial considerations, additional investment needs, and keeping or selling the land. The first key consideration is age. A farmer must decide if he is at an age where he wants to speed up or slow down. In other words, how close is the farmer to retirement? Considering personal goals requires the farmer to determine if he wants to expand his operation, remain involved in farming operations, or if he wishes to bring another person into the farming operation. Financial considerations deal with determining any and all immediate or long-term cash needs. Farmers should also determine if there is any debt against the land in consideration. If the land is going to be placed back into crop or livestock production, determining additional investment needs is another important consideration. The final key consideration is determining if the farmer would like to keep, sell, or possibly even lease his land to a tenant (Benson, Sternweis, and Edwards 2009).

In some cases, considering the costs associated with the various options can become the determining factor in a producer's decision to put CRP land back into crop or livestock production. Economic decisions as they relate to farming and grazing in the Texas Panhandle specifically were examined by a group of AgriLife Extension specialists. The publication stated that when converting CRP land back into production the factors to be taken into consideration include tillage options, chemical applications, and crop selection. CRP land in Texas is primarily converted to cotton, wheat, or sorghum production. Most of these crops are farmed dryland due to lack of water or irrigation equipment. Lower yields during the first year of production should also be expected due to limited nutrients and soil moisture (Warminski et al. 2009). Before a crop can be planted, there are several steps a grower must take to convert the land from CRP land to cropland. In the cropland conversion process, producers must clear old grass residue, kill off existing grasses, prepare the soil, and apply fertilizer prior to planting a crop. Costs range from $100 to $130 per acre for dryland wheat production, and $150 to $180 per acre for dryland sorghum production. There are a few extra steps involved if a farmer wishes to convert CRP land to rangeland. In addition to clearing old grass residue, tillage, and fertilization landowners would have to purchase fencing and install a water source for the livestock. Costs range from $160 to $170 per acre for converting CRP land to livestock grazing (Jones 2009).

2.3. Risk and Simulation

2.3.1. Risk

Risk is often taken into consideration in economic modeling. Risk is the part of the model that falls outside a decision maker's control. Examples of risk could include climate or weather events, crop failure, government policies, and generally anything else that can't be controlled. According to Hardaker et al. (2004a), the types of risk that are found in agriculture include production risk, price risk, institutional risk, political risk, sovereign risk, and relationship risk (Hardaker et al. 2004a). If decision makers could control all variables, decision making would be very simple because the decision maker would simply pick the alternative with the highest return. Unfortunately, in most cases decision makers are not able to control every input variable. A model that ignores risk generally gives one predetermined estimate also referred to as a deterministic estimate based on a given set of inputs.

According to Richardson (2008), stochastic models are deterministic models that include variables that are uncertain but that do have certain probability distributions. These models assume that historic risk is the same as future risk. Stochastic models are typically simulated a large number of times based on randomly selected risky input variables to generate possible outcomes for key output variables (KOVs). This process generates a probability distribution that can be used in making risky decisions. Simulation models differ from mathematical programming in several ways. The main difference is that mathematical programming solves for optimal values giving the normative solution. Normative economics focuses on the way things "should" be.

Simulation includes risk and yields positive economic answers. Positive economics deals with determining solutions that are likely but not necessarily optimal (Richardson 2008). A particular scenario could have the potential for extremely high economic returns, but it may also carry the risk of realizing extremely negative economic returns. A decision maker's attitude toward risk could be the deciding factor in the decision-making process. If a decision maker is risk averse he may be less willing to give up a certain "safe" level of income for an uncertain level of potential income. A risk loving individual would be more willing to take risk if the payoff is higher.

According to Nicholson and Snyder (2008), decision-makers can be classified in one of three categories based on their attitudes toward risk. A decision-maker can be risk preferring (loving), risk neutral, or risk averse (Nicholson and Snyder 2008). A decision maker's risk preference can be determined based on the first or second derivative of his utility function. For example, the first derivative of the utility function for a risk averse individual could be represented by the following:

$$U^{(1)}(w) > 0$$

where:

- (w) represents wealth of the individual

A positive first derivative indicates that an individual is risk averse because more money is preferred to less. If the second derivative is negative this also indicates risk aversion. A risk averse individual prefers a certain income to an uncertain income with the same level of expected value. The first derivative of the utility function for a risk preferring individual would be negative. For a risk neutral individual the first derivative of the utility function would be equal to zero. Risk neutral individuals are indifferent between a certain income and an uncertain income with the same level of expected value (Nicholson and Snyder 2008).

2.3.2. Probability Distribution Sampling

Probability distribution sampling describes the process used to randomly select the stochastic variables for each iteration. Monte Carlo simulation involves randomly selecting values from a probability distribution. Richardson states that a major problem that occurs with this type of sampling is under sampling of the tails of the distribution and over sampling the area about the mean. To avoid under sampling the tails of a distribution, a larger number of iterations must be used. The second probability distribution sampling method is Latin Hypercube. Detailed computer codes for Latin Hypercube sampling were first published by Inman, Davenport, and Zeigler (Iman,R L., Davenport, J.M. and Zeigler 1980). This sampling procedure segments the distribution and takes one sample from each segment so that all areas of a probability distribution are represented in the simulation. This type of sampling requires less iterations to account for the tails of a distribution (Richardson 2008).

2.3.3. Probability Distributions

Distributions may be classified as parametric or non-parametric distributions. In the case of a parametric distribution, if the required parameters are known for a distribution, then we can determine the entire shape of the distribution. Normal and uniform distributions are good examples of a parametric distribution. Parameters for a normal distribution include the mean and standard deviation. If the values of these two parameters are known, then the shape of the entire distribution is also known. The same can be said for a uniform distribution when the parameters (minimum and maximum) are known. A non-parametric distribution is used if there are not enough observations to find the required parameters. The empirical distribution is a good example of a non-parametric distribution. The empirical distribution allows the data to define the shape of the distribution. The parameters used to calculate this distribution are the sorted values (of data) and the probabilities for the sorted values (Richardson 2008).

A probability distribution may also be classified as univariate or multivariate. Univariate distributions, as the name implies, are simulated using only one variable. Multivariate distributions take advantage of the fact that variables are often correlated with one another. Having more than one variable in a distribution prevents historical correlation among variables from being ignored. If historical correlation is ignored it could overstate or understate risk. Mulitvariate empirical (MVE) distributions are commonly used in order to capture historical correlation in simulation.

2.3.4. Ranking Risky Alternatives

Once a simulation model has been created, the decision maker must determine which option is most preferred. There are a number of methods used to rank risky alternatives. One method that can be used to rank risky alternatives is ranking based on mean only. A decision maker selects as most preferred the option that returns the highest mean. This method is based on the principle that more is preferred to less. A disadvantage to this form of ranking is that it ignores the risk that is associated with each scenario based on stochastic simulation. This method assumes a decision maker is risk neutral which may not necessarily be the case (Richardson 2008).

Another method used for ranking risky alternatives is ranking based on absolute risk. Absolute risk can be measured by the standard deviation. The method selects as most preferred the option that has the lowest standard deviation (absolute risk). A disadvantage to this form of ranking is that it ignores the level of returns generated by each option. The option with the lowest standard deviation could also be the option with the lowest return (Richardson 2008).

The mean variance (MV) method compares the mean to the variance for each alternative in a graphical display. The mean is represented on the X axis, and the variance is represented on the Y axis. The mean and variance for each option is estimated based on a Latin Hypercube simulation. This method selects as most preferred the option with a higher mean and a lower variance. The preferred option is located in the southeast quadrant of the graph. One problem that arises with this method it that it may be difficult to determine which option is most preferred if a situation arises where neither option is located in the southeast quadrant of the other (Richardson and Outlaw 2008) .

Yet another method for analyzing a risky decision is to select as most preferred the alternative that yields the best outcome or the alternative that yields the most acceptable worst outcome. This ranking method is often referred to as best case and worst case. The disadvantage to using this ranking procedure is that it bases the decision on a single iteration of a Latin Hypercube model. The results of stochastic simulation are for the most part ignored because it ignores about 98% of the iterations (Richardson 2008).

Risky alternatives may also be ranked based on the relative risk associated with the specified alternative. The coefficient of variation (CV) can be used to measure relative risk. The CV is defined as the absolute value of the ratio of the standard deviation to the mean. A higher CV indicates that the alternative has a higher level of relative risk. A decision maker would select as most preferred the option that generates the lowest relative risk. This method is better than evaluation based on absolute risk because it considers the average risk of each alternative. A disadvantage to relative risk ranking is that it really only works well if all alternatives have similar means and are not close to zero. It also ignores skewness and possible extreme downside risk (Richardson 2008).

Evaluating the cumulative distribution function (CDF) for each alternative graphically displays the full range of possible outcomes for each option under consideration. A CDF graphs all possible outcomes from a simulation model with the Y axis representing the probability of occurrence (0-1). The X axis represents the key output variable. A decision maker would generally select as most preferred the option that yields the highest returns over all possible outcomes, represented by the CDF that lies the furthest to the right. Hadar and Russell (1969) determined that first degree stochastic dominance (FSD) could be established if a decision maker preferred one alternative to another for all outcomes (Hadar and Russell 1969). In other words, FSD could be established if none of the CDFs cross. The basic assumption of FSD is that all decision makers prefer more to less. Mathematically FSD can be established by:

$\sum F(x) \leq \sum G(x) \text{ for all } x$

where:

- $F(x)$ represents the CDF for alternative F
- $G(x)$ represents the CDF for alternative G

Unfortunately, in most situations FSD can't be established because CDFs often cross at least once (Richardson and Outlaw 2008).

The FSD and second degree stochastic dominance were expanded upon by Meyer (1977) who created stochastic dominance with respect to a function (SDRF), also known as generalized stochastic dominance. SDRF incorporates utility into the ranking (Meyer 1977). The advantage to SDRF is that it places a tighter restriction on risk aversion. A decision maker's utility is defined by a lower risk aversion coefficient (LRAC) and an upper risk aversion coefficient (URAC). SDRF ranks risky alternatives for all decision makers whose utility is defined between the LRAC and URAC (Hardaker et al. 2004b). If alternative F is preferred to alternative G it would be represented by the following mathematical equation:

$\int [G(z) - F(z)]\, U'(z)\, dz \geq 0$

The preferred alternative is calculated at both the LRAC and URAC. If the same alternative is preferred at both risk aversion coefficients then the preferred alternative is in the efficient set. A disadvantage to SDRF is that it must be rerun for all possible pairwise combinations (Richardson 2008).

Hardaker et al. suggest that a more transparent method for ranking risky alternatives is that of stochastic efficiency with respect to a function (SERF). SERF ranks risky alternatives in terms of certainty equivalences over a specified range of risk preferences. A major advantage to SERF is that multiple alternatives can be compared simultaneously unlike SDRF where only pairwise comparisons can be made (Hardaker et al. 2004b). According to Richardson (2008), there are several possible outcomes for a SERF comparison. Suppose that risky alternatives F and G are being compared at each RAC_i, the possible conclusions could be:

- F(z) preferred to G(z) at RAC_i when $CE_{Fi} > CE_{Gi}$
- F(z) is indifferent to G(z) at RAC_i when $CE_{Fi} = CE_{Gi}$
- G(z) is preferred to F(z) at RAC_i when $CE_{Gi} > CE_{Fi}$

SERF can be used to rank any alternative as long as the inverse utility function can be derived (Richardson 2008).

A final method that is useful for ranking risky alternatives is the stoplight ranking method. This method evaluates the probabilities of realizing a favorable or unfavorable outcome. The probabilities for defined “favorable” or “unfavorable” outcomes are determined for each alternative being considered. Favorable outcomes are labeled green, unfavorable outcomes are labeled red, and outcomes that fall between the two thresholds are labeled yellow. The three outcomes are presented in a color coordinated stacked bar chart. A normally risk averse decision maker should select as most preferred the option with the lowest red value. This method is very useful because a decision maker needs to know very little about economics and utility theory to make a decision (Richardson and

Outlaw 2008). Ranking based on probabilities was first introduced by Richardson and Mapp (1976) when it was used to rank annual net returns over the life of an investment (Richardson and Mapp 1976).

2.3.5. Examples of Simulation Models

There have been many simulation models that successfully incorporate risk into the decision-making process. However, one model in particular that is very similar to the model in this study is the Farm Level Income and Policy Simulation Model (FLIPSIM). FLIPSIM was developed at Texas A&M University by Richardson and Nixon and was first released in 1981. This model simulates annual economic activities of select representative farms over a multiple year planning horizon. This model is particularly useful because it can be used to simulate the effect that farm policy, farm programs, technology, and risk management strategies could have on representative farms. Historical data collected on yields, production, and prices are simulated using a multivariate distribution. These stochastic variables can be used to calculate key output variables such as net cash farm income, cash inflows, income taxes, ending cash reserves, and net present value (Richardson and Nixon 1986). This model could be used to examine the effect CRP has on representative farms.

2.4. Measuring Economic Impacts: Input-output Models

A key concern related to CRP has been the possible adverse economic effect of CRP on local communities. Many researchers have attempted to quantify the total economic impacts of the CRP on a county or community level basis. One particular method frequently used has been Input-output (I/O) modeling. Leontief has been given credit for developing this model. A basic Leontief I/O model measures the linkages among economic sectors in a region's economy. I/O models keep track of the flow of goods between sectors and to the final consumers. This modeling assumes fixed proportions of inputs for each unit of output. Substitution among inputs can't occur even if there is a change in price or technology. It also assumes constant returns to scale (Mundell 2002). Creating an I/O model from primary data is very complicated and time consuming. The US Forest Service has created a pre-packaged I/O model called Impact analysis for PLANning (IMPLAN). IMPLAN consists of a database that has information for 528 sectors and a matrix of coefficients for national, regional, or a county-by-county basis (Broomhall and Johnson 1990).

One of the first studies to use an economic I/O model to evaluate the CRP was conducted by Martin, Radtke, Eleveld, and Nofziger (1988) in Oregon. The computer program IMPLAN was used in the modeling process. The primary objective of the study was to determine the overall effects of decreased agricultural production, decreased agricultural marketing activities, and increased transfer payments attributable to the CRP in Gilliam, Morrow and Umatilla counties. These counties were selected based on several similar characteristics. Martin et al., believed that these counties were representative of counties that would be most affected by CRP because agriculture was a major economic base. The counties also offered relatively few agricultural alternatives to traditional grain and livestock production. Representative farm surveys were conducted in each of the three counties in order to estimate the local personal income effects. The surveys were used to develop a typical budget for average expenditures per tilled acre. It was noted that "leakage" may occur in expenditures. "Leakage" occurs when a producer spends a certain amount on an input, but only a portion of that expenditure is realized in the local economy. Local impact was estimated in IMPLAN using the total income coefficients for each expenditure category. Using total income coefficients the total income generated was estimated for each county as a baseline. The baseline figures were compared to the income that would be lost or gained from CRP enrollment. The study concluded that areas with relatively productive land are more likely to be adversely affected. Areas that provide their own agricultural inputs are also more likely to be negatively affected because funds for these inputs would no longer be spent in the local economy. The study noted that some CRP participants may chose to leave the community which would likely exacerbate the negative consequences (Martin et al. 1988).

Two years later, in 1990, another notable I/O model was used to study CRP. One state that had a large amount of the total CRP acres nationally at the start of the program was North Dakota. When the Soil Bank Program existed prior to the establishment of the CRP, there was some concern about the negative effects of the program in North Dakota, as well as nationally. Mortensen, Leistritz, Leitch, Coon, and Ekstrom (1990) conducted a study to determine the characteristics of CRP landowners and to predict any negative short-run consequences that the CRP would cause in North Dakota. There were two major parts to this study. First, a statewide questionnaire was mailed to CRP contract holders. The surveys focused on land attributes and landowner characteristics. The second part of the study was a regional I/O model that estimated the indirect effects of the CRP. North Dakota was divided up into five pools (or regions) for both parts of the study. Data was collected for decreased input expenditures, increased federal commodity payments, and increased CRP contract payments on a county-county basis. Baseline business activity was then compared to CRP business activity. The study concluded that short-run negative consequences of the CRP were minimal at the statewide and substate regional levels at the time the study was conducted. However, it was noted that the adverse economic impacts were not evenly distributed throughout the various business sectors or communities. The retail sector accounted for the most impact, particularly retail sectors that dealt with farm supplies or machinery. Counties with the highest percentage of CRP enrollment also experienced the most impact (Mortensen et al. 1990).

Yet another I/O model was created to analyze the impacts of the CRP. Broomhall and Johnson's model was unlike the previous two because it studied an area that would be converted almost exclusively to trees rather than a grass cover. This study also placed more emphasis on what occurred post-CRP in local economies. The study was conducted in 8 Georgia counties covering about 2,031,000 acres of land. These counties were chosen because they had high CRP enrollment, similar agricultural production, and CRP land was converted to trees. The CRP was separated into five stages, covering a 40-year time span, to be evaluated. In Stage One and in year one any profits and costs that resulted from agricultural production were removed from the economy and replaced with the cost of establishing trees and CRP rental payments. Stage Two occurs from years two through ten (when CRP contracts usually expire).

During Stage Two the cost of forest establishment is removed and replaced with the cost of maintaining the forest cover. Stage Three takes place in years 11 through 20 when farmers no longer receive annual rental payments. Broomhall and Johnson make the assumption that most producers will allow their trees to mature and harvest them as timber after year 20. Stage Four occurs in years 21 through 25. It adds to the model harvest costs and annual annuity income (proceeds from timber sale). Stage Five covers years 26 through 40 where producers only receive the annual annuity income. The results showed that there would be increasing net negative impacts on the regional economy for the first twenty years (Stage One-Stage Three). When the trees are harvested in Stage Four there is an increase in economic activity; however, it is noted that if more than 10% of CRP participants migrate to a new location, economic activity could be negative. Economic activity decreases again in Stage Five after the trees are harvested. The study concluded that regional economic impacts could be substantial and there could be a regional shift in income distribution as land moves from agricultural use to forest use. This study was applicable to the region that was studied due to the tendency of producers to plant trees as a conservation cover; however, the results of this study may not be extremely applicable to Texas where producers opt for a grass cover. It is more feasible to convert grass covers back into agricultural production than tree covers (Broomhall and Johnson 1990).

Siegel and Johnson (1991) also used an I/O model to evaluate the CRP, but they chose to use a break-even approach instead. This approach examines negative economic impacts as well as the positive economic impacts associated with the CRP and determines what amount of positive impacts are needed to exactly offset the negative impacts. For example, the positive impacts could be represented by money spent on increased recreational expenditures. Negative impacts could be represented by decreased spending in the farm input sector. In this paper, Siegel and Johnson estimated the amount of beneficial activity that was needed to exactly offset any reductions in economic activity that resulted from the CRP in Virginia. The paper also proposed four guidelines for analyzing a program that provides compensation. In the case of CRP, farmers are provided compensation through the annual rental rate paid for not farming their land. The following is a list of the four guidelines to be used in analysis: exclude any measurements of decreased producer employment because producers are compensated with rental payments, include estimates of reduced levels of employment for hired labor, include transfer payments and any additional expenditures that result from the program, and exclude planned reductions in target sector outputs. It is also noted that I/O models are more accurate when demand for inputs from backward-linked input-supply sectors are changed rather than changing demand outputs in the producing sector. Siegel and Johnson used Type-II multipliers to calculate the economic impacts in IMPLAN software. These impacts were calculated in terms of total gross output, total income, and employment. There were three parts to the model: a sub-section on the baseline analysis, a sub-section on the break-even analysis from a farmer's perspective, and a sub-section on the break-even analysis from a regional perspective. From a farmer's perspective, it was concluded that at least $65/acre must be earned to achieve the break-even point. This figure could include CRP rental payments in addition to rental payments made by recreationists. In order to break-even from a regional perspective $70-$80/acre must be earned with by combination of CRP annual rental payments, rental payments received from recreationists, and local expenditures by recreationists. Siegel and Johnson concluded that levels of this magnitude were possible in many parts of Virginia meaning the CRP could achieve a break-even level (Siegel and Johnson 1991).

Another study that used an I/O model to analyze the impacts of the CRP was conducted by Hyberg, Dicks, and Hebert (1991) in the article "Economic Impacts of the Conservation Reserve Program on Rural Economies." The main objective of the paper was to illustrate that some national programs that target environmentally sensitive areas can inadvertently harm local economies. According to Hyberg et al., the impacts that should be considered include the direct impacts of reducing crop production, the indirect impacts of decreased agricultural input and processing industries, and the induced impacts to goods and services industries. The study used IMPLAN models to examine the economic impacts of CRP on rural communities by comparing national impacts, the impacts of ten regions, and the impacts of three areas located in the Mountain region. The study used three separate stages of CRP shocks. Stage 1 occurs when agricultural production is reduced and acres are taken out of production; however, money is still being spent in the agricultural input sectors because farmers must establish approved cover crops on CRP land. During Stage 2 the agricultural land remains out of production in accordance with CRP contract requirements. Farmers continue to receive annual rental payments. During Stage 3, the CRP contracts and annual rental payments end. It is assumed that some land does not return to production. The study found that agriculturally dependent economies were most affected by the CRP. In particular, the Northern Plains, Southern Plains (includes Texas Panhandle), and Mountain States experienced the greatest impact. Rural communities located in these regions were affected to an even greater degree with some communities experiencing as much as 35 times the national figure. Overall, the sector that was most affected by the CRP was the agricultural production and inputs sector (Hyberg, Dicks, and Hebert 1991).

In "The Economic Impacts of the CRP/CREP Programs in the Long Branch Watershed" Mundell used IMPLAN to estimate the total economic impact that the CRP/CREP programs would have on two Missouri counties located within the Long Branch Watershed (Adair and Macon Counties). It is important to note that the Conservation Reserve Enhancement Program (CREP) differs slightly from the Conservation Reserve Program (CRP). CREP is offered only in high priority conservation areas (such as watersheds) that are designated by state or local governments. In Missouri CREP offers an additional payment of 150% of the annual rental payment as an incentive for signing a contract. This played some role in the model because 75% of this bonus is received when the contract is signed. The last 25% is received after producers plant a cover crop to come into compliance. Most Texas CRP is not enrolled under CREP and doesn't receive additional incentives. Six-year average yields and prices were used to determine the income that would have been received if a specified crop was grown. Income received from normal crop production was compared to the total payments that would have been received if a farmer had enrolled in the CRP/CREP (including the additional 150%). When these figures were assigned to household IMPLAN sectors they generated a net gain of 2.6 jobs and $50,000 in total personal income for Adair and Macon counties. Farmers' incomes were then placed in IMPLAN to discern the total impact of reduced agricultural production on the economy. This resulted in a loss of 25.7 jobs and $248,000 in total personal income. Overall, 23.1 jobs were lost and total personal income decreased by $198,000 in the Long Branch Watershed over the study period. However, these effects are minimal when compared to totals for the region. In this region total personal income was over $800 million and total employment was 24,666. The net loss estimated by the study only accounts for less than 1% of the region's total employment and personal income. The study omits any economic gains from an improved environment and income from leasing CRP/CREP acres to hunters for recreational purposes. It also ignores any increases in price that might have resulted from decreased agricultural production due to CREP/CRP (Mundell 2002).

The 2004 USDA,ERS report by Sullivan et al. that focused on the economic implications of CRP mentioned earlier used a social accounting matrix (SAM) multiplier in the development of their I/O model. The report called this type of model a SAM multiplier model. Using a SAM framework can capture all endogenous linkages between sectors at a particular snapshot in time. SAM combines an input-output table with government, household, capital, rest-of-the-U.S., and rest-of-the-world accounts. This model looked at what would happen if all CRP acres were allowed to expire. The model allowed for two different scenarios. There was a traditional scenario (commodity prices were fixed and minimal recreational impacts were assumed) and an augmented scenario (commodity price effects and sizeable recreational impacts assumed). Under the augmented scenario nationwide output and jobs were 19 and 17 percent lower than the traditional scenario. Although each scenario had slightly different results, in general it was found that changes in household incomes were due to the loss of CRP transfer income and an increase in factor income due to increased agricultural production. It also found that the nationwide impact of all CRP contracts expiring likely would only lead to small changes in the amount of jobs and income (Sullivan et al. 2004).

The same USDA, ERS report then looked at the regional impacts if all CRP acres were allowed to expire under the same traditional and augmented scenarios. The local importance of CRP was measured based on the amount of local income coming from CRP rental payments. Three specific regions were selected to examine: the Northern Plains Crescent, Southwestern Corn Belt, and the Southern Plains Ellipse (which includes the panhandle of Texas). All three of these regions were selected because they are more dependent on agriculture than the nation as a whole. The augmented scenario produced output responses that were 30 to 60 percent lower than the traditional scenario and the impact on jobs was also much more significant under the augmented scenario. More specifically, it was discovered that with respect to production and jobs the Southern Plains Ellipse and the Southwestern Corn Belt had sharper declines in the nonagricultural sector and more moderate increases the agricultural sector. Household and value-added incomes also decreased in the Southern Plains Ellipse and the Southwestern Corn Belt. Overall, it was noted that local impacts of CRP can be vastly different for various regions of the country. The net effect of all CRP acres being allowed to expire would be a small positive impact for the country as a whole, but may be positive or negative for various regions (Sullivan et al. 2004).

2.5. Other Methods Used to Measure Economic Impacts

Although community level economic impacts have been predominantly measured by traditional I/O models some researchers have employed other methods such as computable general equilibrium models, the ordinary least squares (OLS) method, counterfactual simulations, and bioeconomic models.

2.5.1. Computable General Equilibrium Model

Computable General Equilibrium (CGE) models are similar to a Leontief I/O model. Both models attempt to measure the overall economic impact of a shock by taking into account the interrelationships among sectors. However, CGE models allow for changes to occur in prices or inputs over the study period. I/O models would typically fix prices or labor inputs where a CGE model would allow for changes in these variables. Boyd, Konyar, and Uri (1992) constructed a CGE model in 1992 to measure the aggregate impacts of the CRP. Their model was disaggregated into 12 producing sectors, 13 consuming sectors, six household categories, and the federal government. The model was calibrated for 1984 as the base year and data was obtained from the Bureau of Economic Analysis, the US Department of Commerce, the US Department of Agriculture, the US Department of Energy, the Bureau of Labor Statistics, and the Internal Revenue Service. The model compared CRP at the 1990 level of 33.9 million acres enrolled to an increase of enrollment to 45 million acres. As expected, Boyd et al.

found that the direction of the changes was the same, but the magnitude of the changes was larger for the 45 million acre enrollment scenario. Overall, it was concluded there would be lower output in the producing sectors, decreased consumption of goods and services, decreased social welfare, and increased government expenditures. Although there were changes, these changes were determined to be relatively modest (Boyd, Konyar, and Uri 1992).

2.5.2. Counterfactual Simulation

Using counterfactual simulation is another method for examining the economic impacts of CRP. A great deal of research related to the CRP examines the issue from a producer or community perspective. However, Barbarika and Langley (1992) chose to evaluate the CRP in terms of government outlays. They used computer simulation models of corn, soybeans, wheat, and cotton markets to examine the budgetary and farm-sector impacts of the program over the period from 1986-2000. The research examined three issues: government outlays attributable to CRP, impacts of CRP on commodity and farm prices, and the alternative assumptions that would have been made without the CRP. Barbarika and Langely determined that the estimated savings to the Commodity Credit Corporation (CCC), the USDA agency that makes the government outlays, could vary considerably over time. Due to the counter-cyclical nature of farm programs at the time, the amount of government outlays to producers were directly related to the current commodity market prices. Commodity prices tend to vary each year. When land is enrolled in CRP, a producer does not receive loan payments or deficiency payments. Therefore, when CCC payments were high CRP savings were also high. Conversely, when CCC payments were low CRP savings were low (Barbarika and Langley 1992).

2.5.3. Bioeconomic Model

Others have also employed various kinds of bioeconomic models to evaluate CRP. The North Dakota State University Department of Agricultural and Applied Economics conducted a regionalized study of the CRP in six rural areas of North Dakota from 1996-2000. Sixteen counties were placed into six study areas that were divided based on similar geographic, agricultural, and natural resource characteristics. This study attempted to place a monetary value on the net economic effects of decreased agricultural activity and increased recreational activity in North Dakota. In particular it was interested in evaluating the trade-offs that were attributable to the CRP. There were two components of the model: agricultural impacts and recreational impacts. It was noted that many previous studies had attempted to measure the negative impacts of CRP, but few had attempted to measure the positive impacts. A bioeconomic model was used to measure agricultural effects (effects of changes in production of selected crops) and recreational effects (the change in wildlife population and the change in number of hunters). Agricultural biophysical impacts were measured by reduced revenues from crop sales, reduced government commodity program payments, additional CRP rental payments, and increased prices for crops. Recreational impacts were measured by increased recreation expenditures by hunters. Foregone agricultural revenues were compared to hunter expenditures associated with the CRP to determine the net economic effect. The total annual impact on agriculture for the six areas (the change in agricultural revenues on CRP and non-CRP acres) was estimated at $50.2 million ($37 per CRP-acre). Similarly, the average spending per acre of CRP on recreational activities was estimated at $9.45. The study concluded that local economic effects of CRP would be more favorable if land enrolled had relatively low agricultural productivity. It also found that while there were some negative economic consequences of CRP from reduced agricultural production and spending on farm inputs, some North Dakota communities were able to offset in varying degrees those impacts by capitalizing on recreational opportunities created. The ability of a county to offset the negative consequences was determined by the type of hunting available in the county as well as the relative value of the crops grown. This study did not include all market and non-market benefits and costs of CRP (Bangsund, Hodur, and Leistritz 2004).

2.5.4. Ordinary Least Squares Method

According to *Introductory Econometrics: a Modern Approach*, ordinary least squares (OLS) is defined as "a method for estimating the parameters of a multiple linear regression model. The OLS estimates are obtained by minimizing the sum of squared residuals." (Wooldridge 2008) This method was used by Henderson, Tweeten, and Woods in 1992. The study used CRP to illustrate how changes in farm policy affect community retail sales in a mulitcommunity cluster. CRP particularly affects retail spending because it can change farm incomes. In most farm dependent counties, most changes in total personal income are directly caused by changes in personal farm income. Henderson et al. predicted that larger communities would benefit more from CRP than small communities because they would be able to attract more customers as total personal income increased. The model incorporated spending patterns among 22 communities in three Oklahoma Panhandle counties. A cross-sectional time series regression was created using OLS. Two separate equations were created to model the relationship between retail sales and farm crop income (no CRP, normal crop production) and the relationship between retail sales and government payments to farmers (CRP rental payments). Several results were implied by the model. First, Henderson et al. found that increasing total crop income caused spending to shift from small communities to larger communities. Second, the model found that increasing government payments also shifted retail spending from small communities to larger communities. Third, it was predicted that increased government payments led to more spending in larger communities than increased crop income. It was concluded that CRP would decrease the amount of farm consumer spending in the smallest communities (Henderson, Tweeten, and Woods 1992).

Although most studies are conducted on a county level basis to determine the economic impacts of the CRP, a sub-county analysis was conducted by Hamilton and Levins (1998). This is an interesting approach because the CRP enrollment cap is set at 25% of total cropland on a county-wide basis. In the analysis, community indicators were estimated using county level data and using data by zip codes. OLS estimation was used to evaluate three indicators of community economic well-being: population, median household income, and the percent of people in poverty. These indicators were evaluated using three separate cross sectional models. When using county-level data, the CRP variable showed a low statistical significance. It could have been reasonably concluded that changes in community indicators had little to do with the CRP. However, a different story emerged when zip code data was used. The statistical significance was noticeably higher. The zip code level analysis also revealed that the effects of CRP were more noticeable in smaller communities that had fewer off-farm employment opportunities. Hamilton and Levins concluded that it would be best to evaluate CRP community impacts using a zip code level study in counties with an uneven pattern of CRP enrollment. They also suggested that a new limitation boundary should be set for CRP enrollment on a community level rather than a county level basis (Hamilton and Levins 1998).

The USDA, ERS study conducted by Sullivan et al. (2004) that was mentioned earlier did an extensive study on the impact that high levels of CRP enrollment have had on economic trends in rural counties. This report used a wide variety of methods to estimate these impacts. One part of the report used econometric models to model relationships between the CRP and economic trends in counties. The hypothesis was that high levels of CRP negatively affect employment opportunities and may also encourage residents to leave rural counties to find more favorable economic opportunities elsewhere. In order to study rural economic trends associated with CRP, the report defined two ways to measure the local importance of CRP. The first measure of importance was determined by the percentage of a county’s total cropland that is enrolled in CRP. In order to avoid the measure of cropland being influenced by the CRP, data from the 1982 Census of Agriculture was used as the denominator (CRP was implemented in 1985 Farm Bill). The first measure was used to determine CRP’s effect on beginning farmers. The second measure of importance was determined by the size of an area's CRP rental payments compared to relative local income. This measure was used to determine CRP's effect on population and employment trends. "High-CRP" counties were compared to "low-CRP" counties. Regressions were then used to determine if and when socioeconomic trends were influenced by CRP enrollment.

A major concern that has been raised is whether or not high CRP enrollment prevents a young beginning farmer from acquiring the necessary assets to create a viable business. The ERS study found that there was a statistically significant negative relationship between whole-farm CRP enrollment and the number of beginning farmers.

Next, the relationships between population trends, job loss, and CRP enrollment were examined. The econometric models found that CRP had no statistically significant impact on population trends between 1985 and 2000. It was concluded that CRP likely did not systematically reduce a county's population once other factors were taken into account. However, there was some evidence that CRP enrollment was related to job loss in the short run. Although it is important to note that the impacts were short-lived and over the long run local economies were able to adapt to any job loss. The most negative effects on job loss due to CRP were found in counties with agricultural service centers. Larger and more diversified economies tend to be less affected by CRP. When a county had fewer absentee land owners (CRP rental payments stayed within a county) it was more likely that CRP contributed to economic growth. Overall, there was little convincing evidence that CRP led to a decline in population or in long-term job loss. Overall, the econometric models found that economic impacts were more significant in the short run, but that they decreased in significance over time. The extent of those impacts depended heavily on individual community characteristics. High levels of enrollment did not appear to have permanent impacts, but some businesses or communities may have still been economically harmed particularly those in small agricultural service centers (Sullivan et al. 2004).

One of the businesses in particular that Sullivan et al. focused on in the ERS study was farm-related businesses. Although it was found that most businesses were not significantly harmed over time, farm-related businesses are significantly more affected by large amounts of cropland being taken out of production. Sullivan et al. examined the changes in farm-related establishments and jobs from 1975-1997. County-level information on the number of farm-related establishment with at least one employee from County Business Patterns was used in the study. Counties were divided into "high CRP" counties and "low CRP" counties for comparison. Farm-related enterprises were characterized as agricultural services, farm suppliers, and food processors. Enterprises related to livestock were excluded from the study because it was determined that the livestock industry was less likely to be affected by CRP. In general it was found that farm-related businesses made up a greater percentage of all businesses in High CRP counties. The annualized growth rate (percentage) was found for farm-related establishments, all nonfarm related establishments, and all nonfarm jobs. It was found that rural communities saw a consistent decline in the number of farm-related establishments since 1975. The decline was greatest from 1985-1992 after the start of the CRP. The greatest impact on employment was seen in High CRP counties.

However, it was also noted that the 1980's were difficult economically for agriculture due to a national economic recession. Overall it was determined that businesses did seem to recover over the next 25 years partially due to the consolidation trends in farm-related industries (Sullivan et al. 2004).

The literature review identifies several studies evaluating the various factors affecting a producer's decision to enroll land in CRP. Unlike previous studies, this study will use the factors affecting decision making to identify four options for ten counties in Texas. The study will also provide a stochastic estimate of net returns per acre for each option. The reviewed literature only provided deterministic evaluations of the CRP enrollment decision. Warminski et al. (2009) and Jones (2009) provided similar estimates for decision makers, but did not create stochastic estimates. Dicks (1990) examined the land use decision for the Southern Great Plains to determine the most likely use of land after CRP. Dicks used an ASCS (now FSA) dataset to determine future land use. This study will instead use historical data on prices and yields to evaluate the future land use decision. This model also focuses specifically on the ten counties in Texas with the highest CRP enrollment. The study by Sullivan et al. (2004) was conducted on a national level rather than on a county level. Sudduth, Ervin, and Elam (1993) studied counties in Texas specifically, but focused instead on the motivations of buyers and sellers of CRP land.

A variety of methods used to evaluate the economic impacts of CRP were also reviewed. Methods used in the literature to evaluate impacts of CRP included the use of: input-output models, computable general equilibrium models, counterfactual simulation, bioeconomic models, and ordinary least squares (OLS) regression. This study will use OLS regression. OLS regression has been used to study annual retail sales (Henderson, Tweeten, and Woods 1992) and employment in the agricultural services industry (Sullivan et al. 2004); however, unlike previous studies this study focuses on annual earnings of the agricultural services industry on a county level basis.

CHAPTER III

METHODOLOGY

This chapter develops the framework that will be used to determine the best alternatives available to landowners with land eligible for CRP enrollment and the model used to evaluate the effect of CRP on the agricultural services industry. First, the chapter begins by discussing the basis of selection for the study area. Each county of interest is then described in further detail. Second, the framework used to evaluate the CRP enrollment decision is discussed. This section fully describes how each alternative was derived and how stochastic estimates were incorporated into the model. Third, the model used to evaluate the economic impacts of CRP on the agricultural services industry is developed and the dependent and independent variables are discussed. Potential problems that are associated with this modeling technique are also explained.

3.1. Study Area

The geographic area of particular interest in this analysis is the state of Texas. Texas is a major CRP state. The USDA Farm Service Agency (USDA, FSA) has data available for CRP in Texas on the county level; therefore, it was determined that the study would be conducted on a county level rather than a community level. Devino et al. (1988), Henderson, Tweeten, and Woods (1992), Hyberg, Dicks, and Hebert (1991), Martin et al. (1988), Siegel and Johnson (1991), and Sullivan et al. (2004) among others have indicated that agriculturally dependent counties and communities are typically more adversely affected by CRP enrollment than counties with more diverse sources of income and economic activity. It was decided that the Panhandle and South Plains Texas AgriLife Extension Districts were most likely to contain agriculturally dependent economies. A map of the Texas AgriLife Extension Districts is provided in Figure 3.

Figure 3. Texas AgriLife Extension Districts
(Source: Texas AgriLife Extension 2010)

A publication produced by the Texas Agricultural and Natural Resources Summit on Environmental and Natural Resource Policy indicated that Texas' net realized farm income is historically highest in the High Plains of Texas (this includes the Panhandle and South Plains AgriLife Extension Districts). The publication further noted that 50% of Texas' net farm income for the years 1969-1994 was generated in the High

Plains of Texas (Schumann et al. 1996). Figure 4 provides a map of the High Plains region.

Figure 4. Regions of Texas
(Source: Schumann et al. 1996)

The next criterion used in selecting the study area was the number of acres enrolled in CRP. According to the USDA, FSA publication, *Summary of Active Contracts by Program Year*, the top ten counties with the highest amount of total CRP acreage enrolled in Texas as of February 2011were Gaines, Deaf Smith, Lamb, Hale, Floyd, Dallam, Hockley, and Terry, Castro, and Swisher counties. All of these counties indicated have at least 100,000 acres of land under active CRP contracts. These counties are shaded in Figure 5 below. It is important to note that all ten counties are located in the Panhandle and South Plains AgriLife Extension districts, which was also determined to be the region accounting for the majority of agricultural production.

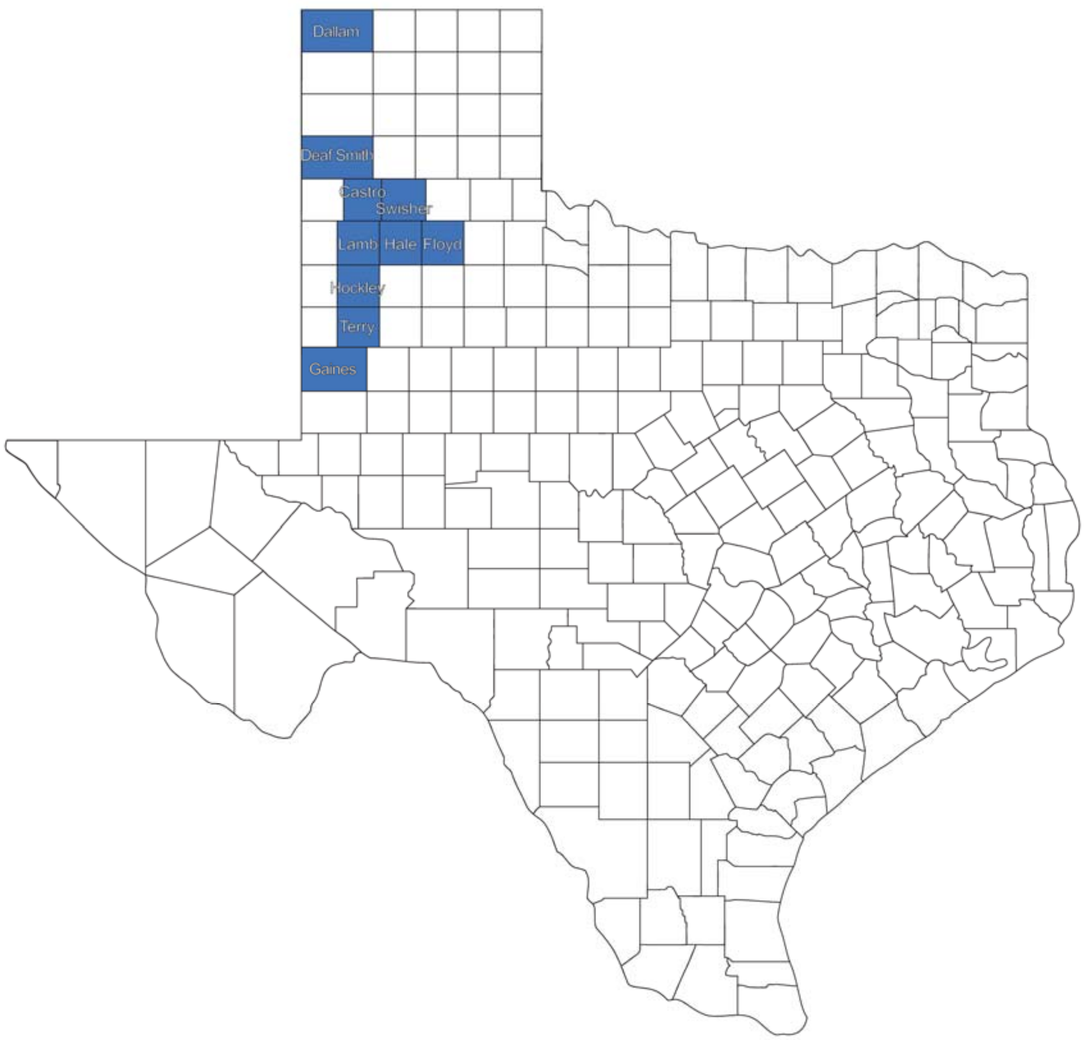

Figure 5. Study area

In order to further determine the importance of CRP to each of these counties, the percentage of total cropland acres enrolled in CRP was calculated. Sullivan et al. (2004) also calculated these percentages as a measure of CRP importance. In the ERS study, total cropland per county according to the 1982 Census on Agriculture was used rather than the most current census data in determining the amount of cropland in a county. Sullivan et al. chose to use 1982 as the denominator to avoid any bias potentially created from CRP being implemented in 1985 using the following equation:

$$= \frac{CRP}{Cropland82}$$

where:

- *CRP* is the total number of acres in a county enrolled in CRP
- *Cropland82* is the total cropland in a county according to the 1982 Census on Agriculture.

Table 1 provides the number of CRP acres enrolled for each county (as of February 2011) as well as a percentage of total 1982 cropland enrolled in CRP. Census data from 1982 was used as the denominator in calculating percentages in order to avoid any potential bias.

Table 1. Conservation Reserve Program Enrollment

County	2010 CRP Enrollment (acres)	Percentage of Cropland in CRP
Gaines	162,340.3	24%
Deaf Smith	158,056.2	22%
Lamb	124,016.0	24%
Hale	120,408.1	22%
Floyd	113,219.7	19%
Dallam	112,243.6	13%
Hockley	108,305.5	22%
Terry	106,172.8	22%
Castro	104,734.6	20%
Swisher	101,978.9	22%

Source: USDA,FSA (2010), USDA, NASS (2010)

3.1.1. County Profiles

A county profile was created for each county to provide a better understanding of the present conditions in each selected county. The county profiles include information about the crops grown in each county, the largest source of employment, population estimates, county tax rates, county size, and the population of cities within the county.

Gaines County

Gaines County is located in the Texas Panhandle. It is located in the South Plains AgriLife Extension District. The Texas Association of Counties conducted a County Information Project (CIP) to compile all data about Texas into one centralized database. The CIP collected information from the U.S. Census Bureau, the Bureau of Economic Analysis, the Environmental Protection Agency, and various other government agencies where it was then compiled into a comprehensive information table. The information presented in Table 2 below was created from information obtained from the CIP.

The county seat of Gaines County is Seminole. Seminole had 6,250 residents in 2009 according to the U.S. Census Bureau. Additionally, it was determined that the major source of employment for Gaines County was mining accounting for 16.16% of employment (Texas Association of Counties CIP 2010e). It is important to note that "the County Business Patterns does not include data for self-employed persons, employees of private households, railroad employees, agricultural production workers, and for most government employees" in its estimate of total employment per county meaning that this excludes agricultural production (Texas Association of Counties CIP 2010e).

Table 2. Gaines County Information

Gaines County	
Population (2009 estimate)	15,382
Population of Towns (2009 estimate)	
Seminole *	6,250
Seagraves	2,378
Denver city	3
Per Capita Income - 2008 (BEA)	$28,685
Total County Tax Rate	$0.35
County Size (Census Bureau and EPA)	
Land Area (square miles):	1,502
Water Area (square miles):	0
Total Area (square miles):	1,502
* Denotes county seat	

Source: Texas Association of Counties CIP (2010e)

The two major agricultural crops grown in Gaines County are cotton (upland) and peanuts (for nuts). The majority of irrigated acres are planted in cotton. The majority of non-irrigated acres are also planted in cotton (NASS - Texas Field Office 2011e). The NASS Texas Field Office has estimates for each county on Texas crop acreage, yield and production. The information for Gaines County is located in Table 3.

Table 3. Gaines County Texas Crop Acreage, Yield, and Production

Commodity	Practice	Year	Planted Acres	Harvested Acres	Yield	Production
Cotton Upland						
	Irrigated	2009	167,500	156,000	892 lbs/acre	290,000 bales
	Non Irrigated	2009	96,000	36,100	306 lbs/acre	23,000 bales
	Total	2009	263,500	192,100	782 lbs/acre	313,000 bales
Peanuts for Nuts						
	Total for Crop	2009	42,200	39,200	3,880 lbs/acre	152,000,000 lbs

Source: NASS - Texas Field Office (2011e)

Deaf Smith County

Deaf Smith County is one of two counties in the study area located in the Panhandle AgriLife Extension District. Information for Deaf Smith County was obtained from CIP and is presented in Table 4.

The county seat of Deaf Smith County is Hereford. According to the U.S. Census Bureau, the population of Hereford was 14,367 in 2009. Additionally, it was determined that the major source of employment for Deaf Smith County was manufacturing accounting for 23.23% of employment (Texas Association of Counties CIP 2010c). Knowing the major agricultural crops in the county is important for the study. The majority of irrigated acres are planted in wheat. The majority of non-irrigated acres are also planted in wheat (NASS - Texas Field Office 2011c). The NASS

Texas Field Office has county estimates for each county on Texas crop acreage, yield and production. The information for Deaf Smith County is located in Table 5.

Table 4. Deaf Smith County Information

Deaf Smith County	
Population (2009 estimate)	18,353
Population of Towns (2009 estimate)	
Hereford*	14,367
Per Capita Income - 2008 (BEA)	$26,830
Total County Tax Rate	$0.55
County Size (Census Bureau and EPA)	
Land Area (square miles):	1,497
Water Area (square miles):	1
Total Area (square miles):	1,498

* Denotes county seat

Source: Texas Association of Counties CIP (2010c)

Table 5. Deaf Smith County Texas Crop Acreage, Yield, and Production

Commodity	Practice	Year	Planted Acres	Harvested Acres	Yield	Production
Cotton Upland						
	Total for Crop	2009	9,100	5,500	794 lbs/acre	9,100 bales
Sorghum for Grain						
	Irrigated	2010	17,500	15,000	91.5 bu/acre	1,373,000 bu
	Non Irrigated	2010	30,000	21,600	46 bu/acre	994,000 bu
	Total for Crop	2010	47,500	36,600	64.7 bu/acre	2,367,000 bu
Wheat Winter All						
	Irrigated	2010	56,000	45,600	48.9 bu/acre	2,230,000 bu
	Non Irrigated	2010	158,000	106,500	24.5 bu/acre	2,604,000 bu
	Total for Crop	2010	214,000	152,100	31.8 bu/acre	4,834,000 bu

Source: NASS - Texas Field Office (2011c)

Lamb County

Lamb County is located in the South Plains AgriLife Extension District. Information for Lamb County was obtained from CIP and is presented in Table 6.

The county seat of Lamb County is Littlefield. According to the U.S. Census Bureau, the population of Littlefield was 13,162 in 2009. Additionally, it was determined that the major source of employment for Lamb County was health care and social assistance accounting for 17.05% of employment (Texas Association of Counties CIP 2010h).

Table 6. Lamb County Information

Lamb County	
Population (2009 estimate)	13,162
Population of Towns (2009 estimate)	
Amherst	693
Earth	967
Littlefield*	5,741
Olton	2,091
Springlake	125
Sudan	954
Per Capita Income - 2008 (BEA)	$28,271
Total County Tax Rate	$0.79
County Size (Census Bureau and EPA)	
Land Area (square miles):	1,016
Water Area (square miles):	2
Total Area (square miles):	1,018

* Denotes county seat

Source: Texas Association of Counties CIP (2010h)

There are five major agricultural crops produced in Lamb County. The majority of irrigated acres are planted in cotton. The majority of non-irrigated acres are also planted in cotton (NASS - Texas Field Office 2011h). The NASS Texas Field Office has county estimates for each county on Texas crop acreage, yield and production. The information for Lamb County is located in Table 7.

Table 7. Lamb County Texas Crop Acreage, Yield, and Production

Commodity	Practice	Year	Planted Acres	Harvested Acres	Yield	Production
Cotton Upland						
	Irrigated	2009	79,900	67,700	937 lbs/acre	132,200 bales
	Non Irrigated	2009	56,000	27,400	424 lbs/acre	24,200 bales
	Total for Crop	2009	135,000	95,100	789 lbs/acre	156,400 bales
Peanuts for Nuts						
	Total for Crop	2009	2,500	2,300	2,785 lbs/acre	6,400,000 lbs
Sorghum for Grain						
	Irrigated	2010	12,500	11,500	94.5 bu/acre	1,087,000 bu
	Non Irrigated	2010	6,500	6,100	31.8 bu/acre	194,000 bu
	Total for Crop	2010	19,000	17,600	72.8 bu/acre	1,281,000 bu
Sunflower Seed						
	Total for Crop	2010	5,400	5,300	1,640 lbs/acre	8,670,000 lbs
Wheat Winter All						
	Irrigated	2010	32,000	21,800	56.4 bu/acre	1,230,000 bu
	Non Irrigated	2010	28,000	19,800	25.4 bu/acre	503,000 bu
	Total for Crop	2010	60,000	41,600	41.7 bu/acre	1,733,000 bu

Source: NASS, Texas Field Office (2011h)

Hale County

Hale County is located in the South Plains AgriLife Extension District. Information for Hale County was obtained from CIP and is presented in Table 8.

The county seat of Hale County is Plainview. According to the U.S. Census Bureau, the population of Plainview was 21,389 in 2009. Additionally, it was determined that the major source of employment for Hale County was manufacturing accounting for 25.18% of employment (Texas Association of Counties CIP 2010f).

Table 8. Hale County Information

Hale County	
Population (2009 estimate)	35,408
Population of Towns (2009 estimate)	
Abernathy	2,070
Edmonson	122
Hale Center	2,158
Petersburg	1,232
Plainview*	21,389
Per Capita Income - 2008 (BEA)	$25,535
Total County Tax Rate	$0.49
County Size (Census Bureau and EPA)	
Land Area (square miles):	1,005
Water Area (square miles):	0
Total Area (square miles):	1,005

* Denotes county seat

Source: Texas Association of Counties CIP (2010f)

There are three major agricultural crops produced in Hale County. The majority of irrigated acres are planted in cotton. The majority of non-irrigated acres are planted in wheat (NASS - Texas Field Office 2011f). The NASS Texas Field Office has county estimates for each county on Texas crop acreage, yield and production. The information for Lamb County is located in Table 9.

Table 9. Hale County Texas Crop Acreage, Yield, and Production

Commodity	Practice	Year	Planted Acres	Harvested Acres	Yield	Production
Cotton Upland						
	Irrigated	2009	170,500	154,600	984 lbs/acre	317,000 bales
	Non Irrigated	2009	31,500	24,500	392 lbs/acre	20,000 bales
	Total for Crop	2009	202,000	179,100	903 lbs/acre	337,000 bales
Sorghum for Grain						
	Irrigated	2010	17,000	16,000	100.5 bu/acre	1,608,000 bu
	Non Irrigated	2010	8,200	8,000	59.5 bu/acre	476,000 bu
	Total for Crop	2010	25,200	24,000	86.8 bu/acre	2,084,000 bu
Wheat Winter All						
	Irrigated	2010	31,000	21,400	53.3 bu/acre	1,140,000 bu
	Non Irrigated	2010	32,000	23,500	33.5 bu/acre	787,000 bu
	Total for Crop	2010	63,000	44,900	42.9 bu/acre	1,927,000 bu

Source: NASS - Texas Field Office (2011f)

Floyd County

Floyd County is located in the South Plains AgriLife Extension District. Information for Floyd County was obtained from CIP and is presented in Table 10. The county seat of Floyd County is Floydada. According to the U.S. Census Bureau, the population of Floydada was 3,066 in 2009. Additionally, it was determined that the major source of employment for Floyd County was wholesale trade accounting for 14.71% of employment (Texas Association of Counties CIP 2010d).

Table 10. Floyd County Information

Floyd County	
Population (2009 estimate)	6,474
Population of Towns (2009 estimate)	
Floydada*	3,066
Lockney	1,672
Per Capita Income - 2008 (BEA)	$31,402
Total County Tax Rate	$0.67
County Size (Census Bureau and EPA)	
Land Area (square miles):	992
Water Area (square miles):	0
Total Area (square miles):	992
* Denotes county seat	

Source: Texas Association of Counties CIP (2010d)

There are three major agricultural crops produced in Floyd County. The majority of irrigated acres are planted in cotton. The majority of non-irrigated acres are planted in wheat (NASS - Texas Field Office 2011d). The NASS Texas Field Office has county estimates for each county on Texas crop acreage, yield and production. The information for Floyd County is located in Table 11.

Dallam County

Dallam County is one of two counties in the study area located in the Panhandle AgriLife Extension District. Information for Dallam County was obtained from CIP and is presented in Table 12.

Table 11. Floyd County Texas Crop Acreage, Yield, and Production

Commodity	Practice	Year	Planted Acres	Harvested Acres	Yield	Production
Cotton Upland						
	Irrigated	2009	104,000	99,300	1063 lbs/acre	220,000 bales
	Non Irrigated	2009	44,500	35,000	425 lbs/acre	31,000 bales
	Total for Crop	2009	148,500	134,300	897 lbs/acre	251,000 bales
Sorghum for Grain						
	Irrigated	2010	5,700	5,700	107 bu/acre	610,000 bu
	Non Irrigated	2010	9,400	9,300	66.5 bu/acre	618,000 bu
	Total for Crop	2010	15,100	15,000	81.9 bu/acre	1,228,000 bu
Wheat Winter All						
	Irrigated	2010	13,500	12,000	41.7 bu/acre	500,000 bu
	Non Irrigated	2010	81,000	70,800	29.4 bu/acre	2,078,000 bu
	Total for Crop	2010	94,500	82,800	31.1 bu/acre	2,578,000 bu

Source: NASS, Texas Field Office (2011d)

Table 12. Dallam County Information

Dallam County	
Population (2009 estimate)	6,293
Population of Towns (2009 estimate)	
Dalhart*	4,699
Texline	521
Per Capita Income - 2008 (BEA)	$34,793
Total County Tax Rate	$0.50
County Size (Census Bureau and EPA)	
Land Area (square miles):	1,505
Water Area (square miles):	1
Total Area (square miles):	1,506

* Denotes county seat

Source: Texas Association of Counties CIP (2010b)

The county seat of Dallam County is Dalhart. According to the U.S. Census Bureau, the population of Dalhart was 4,699 in 2009. Additionally, it was determined that there are two major sources of employment for Dallam County which include wholesale trade accounting for 20.72% of employment and accommodation and food services accounting for 21.88% of employment. Note that this estimate does not include self-employed, employees for private households, railroad employees, or agricultural production workers (Texas Association of Counties, CIP 2010b). There are three major agricultural crops produced in Dallam County. The most irrigated acres are planted in wheat. The majority of non-irrigated acres are also planted in wheat (NASS - Texas Field Office 2011b). The NASS Texas Field Office has county estimates for each county on Texas crop acreage, yield and production. The information for Dallam County is located in Table 13.

Table 13. Dallam County Texas Crop Acreage, Yield, and Production

Commodity	Practice	Year	Planted Acres	Harvested Acres	Yield	Production
Sorghum for Grain						
	Irrigated	2010	6,100	2,100	99 bu/acre	208,000 bu
	Non Irrigated	2010	4,800	4,200	57.6 bu/acre	242,000 bu
	Total for Crop	2010	10,900	6,300	71.4 bu/acre	450,000 bu
Sunflower Seed						
	Total for Crop	2010	1,700	1,620	1,688 lbs/acre	2,717,000 lbs
Wheat Winter All						
	Irrigated	2010	75,000	51,400	56.4 bu/acre	2,900,000 bu
	Non Irrigated	2010	39,000	35,500	23.7 bu/acre	840,000 bu
	Total for Crop	2010	114,000	86,900	43 bu/acre	3,740,000 bu

Source: NASS - Texas Field Office (2011b)

Hockley County

Hockley County is located in the South Plains AgriLife Extension District. Information for Hockley County was obtained from CIP and is presented in Table 14.

Table 14. Hockley County Information

Hockley County	
Population (2009 estimate)	22,272
Population of Towns (2009 estimate)	
Anton	1,125
Levelland*	12,465
Opdyke West	199
Ropesville	509
Smyer	482
Sundown	1,504
Per Capita Income - 2008 (BEA)	$33,406
Total County Tax Rate	$0.24
County Size (Census Bureau and EPA)	
Land Area (square miles):	908
Water Area (square miles):	0
Total Area (square miles):	908

* Denotes county seat

Source: Texas Association of Counties CIP (2010g)

The county seat of Hockley County is Levelland. According to the U.S. Census Bureau, the population of Levelland was 12,465 in 2009. Additionally, it was determined that there are two major sources of employment for Hockley County which include mining accounting for 17.32% of employment and retail trade accounting for 17.86% of employment (Texas Association of Counties CIP 2010g). There are three major agricultural crops produced in Hockley County. The most irrigated acres are planted in cotton. The majority of non-irrigated acres are also planted in cotton (NASS -

Texas Field Office 2011g). The NASS Texas Field Office has county estimates for each county on Texas crop acreage, yield and production. The information for Hockley County is located in Table 15.

Table 15. Hockley County Texas Crop Acreage, Yield, and Production

Commodity	Practice	Year	Planted Acres	Harvested Acres	Yield	Production
Cotton Upland						
	Irrigated	2009	129,000	121,000	833 lbs/acre	210,000 bales
	Non Irrigated	2009	128,000	83,000	335 lbs/acre	58,000 bales
	Total for Crop	2009	257,000	204,000	631 lbs/acre	268,000 bales
Sorghum for Grain						
	Total for Crop	2010	89,000	8,600	70.1 bu/acre	603,000 bu
Wheat Winter All						
	Total for Crop	2010	20,900	5,200	31.5 bu/acre	164,000 bu

Source: NASS - Texas Field Office (2011g)

Terry County

Terry County is located in the South Plains AgriLife Extension District. Information for Terry County was obtained from CIP and is presented in Table 16.

Table 16. Terry County Information

Terry County	
Population (2009 estimate)	12,142
Population of Towns (2009 estimate)	
Brownfield*	8,940
Meadow	617
Wellman	198
Per Capita Income - 2008 (BEA)	$29,915
Total County Tax Rate	$0.55
County Size (Census Bureau and EPA)	
Land Area (square miles):	890
Water Area (square miles):	1
Total Area (square miles):	891
* Denotes county seat	

Source: Texas Association of Counties CIP (2010j)

The county seat of Terry County is Brownfield. According to the U.S. Census Bureau, the population of Brownfield was 8,940 in 2009. Additionally, it was determined that the major source of employment for Terry County was retail trade accounting for 19.57% of employment (Texas Association of Counties CIP 2010j). There are four major agricultural crops produced in Terry County. The most irrigated acres are planted in cotton. The majority of non-irrigated acres are also planted in cotton (NASS - Texas Field Office 2011j). The NASS Texas Field Office has county estimates for each county on Texas crop acreage, yield and production. The information for Terry County is located in Table 17.

Table 17. Terry County Texas Crop Acreage, Yield, and Production

Commodity	Practice	Year	Planted Acres	Harvested Acres	Yield	Production
Cotton Upland						
	Irrigated	2009	112,000	104,000	817 lbs/acre	177,000 bales
	Non Irrigated	2009	148,000	42,800	237 lbs/acre	21,100 bales
	Total for Crop	2009	260,000	146,800	648 lbs/acre	198,000 bales
Peanuts for Nuts						
	Total for Crop	2009	17,100	16,100	3,505 lbs/acre	56,400,000 lbs
Sorghum for Grain						
	Total for Crop	2010	8,400	8,200	56.5 bu/acre	463,000 bu
Wheat Winter All						
	Irrigated	2010	68,000	19,800	35.9 bu/acre	710,000 bu
	Non Irrigated	2010	21,000	10,100	35.8 bu/acre	362,000 bu
	Total for Crop	2010	20,900	5,200	31.5 bu/acre	164,000 bu

Source: NASS - Texas Field Office (2011j)

Castro County

Castro County is located in the South Plains AgriLife Extension District. Information for Castro County was obtained from CIP and is presented in Table 18.

The county seat of Castro County is Dimmitt. According to the U.S. Census Bureau, the population of Dimmitt was 3,693 in 2009. Additionally, it was determined that there are two major sources of employment for Castro County which include wholesale trade accounting for 11.89% of employment and retail trade accounting for 18.80% of employment (Texas Association of Counties CIP 2010a).

Table 18. Castro County Information

Castro County	
Population (2009 estimate)	7,130
Population of Towns (2009 estimate)	
Dimmitt*	3,693
Hart	1,031
Nazareth	317
Per Capita Income - 2008 (BEA)	$37,678
Total County Tax Rate	$0.70
County Size (Census Bureau and EPA)	
Land Area (square miles):	898
Water Area (square miles):	1
Total Area (square miles):	899

* Denotes county seat

Source: Texas Association of Counties CIP (2010a)

There are three major agricultural crops produced in Castro County. The most irrigated acres are planted in wheat. The majority of non-irrigated acres are also planted in wheat (NASS - Texas Field Office 2011a). The NASS Texas Field Office has county estimates for each county on Texas crop acreage, yield and production. The information for Castro County is located in Table 19.

Table 19. Castro County Texas Crop Acreage, Yield, and Production

Commodity	Practice	Year	Planted Acres	Harvested Acres	Yield	Production
Cotton Upland						
	Irrigated	2009	19,600	16,700	1058 lbs/acre	36,800 bales
	Non Irrigated	2009	2,100	2,000	408 lbs/acre	1,700 bales
	Total for Crop	2009	21,700	18,700	988 lbs/acre	38,500 bales
Sorghum for Grain						
	Irrigated	2010	7,000	2,800	103.6 bu/acre	290,000 bu
	Non Irrigated	2010	4,500	3,800	27.6 bu/acre	105,000 bu
	Total for Crop	2010	11,500	6,600	59.8 bu/acre	395,000 bu
Wheat Winter All						
	Irrigated	2010	70,000	55,700	50.1 bu/acre	2,790,000 bu
	Non Irrigated	2010	86,000	59,000	23.6 bu/acre	1,394,000 bu
	Total for Crop	2010	156,000	114,700	36.5 bu/acre	4,184,000 bu

Source: NASS - Texas Field Office (2011a)

Swisher County

Swisher County is located in the South Plains AgriLife Extension District. Information for Swisher County was obtained from CIP and is presented in Table 20.

The county seat of Swisher County is Tulia. According to the U.S. Census Bureau, the population of Tulia was 4,435 in 2009. Additionally, it was determined that the major source of employment for Swisher County was retail trade accounting for 14.86% of employment (Texas Association of Counties CIP 2010i).

Table 20. Swisher County Information

Swisher County	
Population (2009 estimate)	7,424
Population of Towns (2009 estimate)	
Happy	554
Kress	746
Tulia*	4,435
Per Capita Income - 2008 (BEA)	$27,727
Total County Tax Rate	$0.81
County Size (Census Bureau and EPA)	
Land Area (square miles):	900
Water Area (square miles):	0
Total Area (square miles):	900

* Denotes county seat

Source: Texas Association of Counties CIP (2010i)

There are three major agricultural crops produced in Swisher County. The most irrigated acres are planted in cotton. The majority of non-irrigated acres are also planted in cotton (NASS - Texas Field Office 2011i). The NASS Texas Field Office has county estimates for each county on Texas crop acreage, yield and production. The information for Swisher County is located in Table 21.

Table 21. Swisher County Texas Crop Acreage, Yield, and Production

Commodity	Practice	Year	Planted Acres	Harvested Acres	Yield	Production
Cotton Upland						
	Irrigated	2009	50,300	25,400	839 lbs/acre	44,400 bales
	Non Irrigated	2009	18,700	10,500	325 lbs/acre	7,100 bales
	Total for Crop	2009	69,000	35,900	689 lbs/acre	51,500 bales
Sorghum for Grain						
	Irrigated	2010	11,300	10,000	94.5 bu/acre	945,000 bu
	Non Irrigated	2010	9,500	7,000	51.7 bu/acre	362,000 bu
	Total for Crop	2010	20,800	17,000	76.9 bu/acre	1,307,000 bu
Wheat Winter All						
	Total for Crop	2010	146,300	100,200	39 bu/acre	3,905,000 bu

Source: NASS, Texas Field Office (2011i)

3.2. The CRP Enrollment Decision

As CRP contracts have begun to expire and as new CRP sign-ups are offered, producers will be faced with the decision of what to do next. Producers should first take into account the feasibility of all available options. It was determined that there are four general options for landowners to evaluate. The four general options were identified as re-enrolling land in CRP, putting land back into crop production, leasing land to a tenant to farm, or leasing the land for livestock grazing. This portion of the model serves as a decision aid for landowners by providing the likely returns per acre for each option. According to research by Dicks (1990), producers are most likely to determine the land use decision by evaluating the relative profitability of alternative enterprises, supply and demand conditions, government policies, and socio-economic characteristics (Dicks 1990).

Stochastic estimates were generated to incorporate risk and variability into the model by assuming that future risk mimics historical risk. One reason that presenting a stochastic estimate rather than a deterministic estimate may be useful is due to the inherent uncertainty in agriculture. While it is possible to guess what a likely yield would be for dryland wheat, it is impossible to confidently predict a hail or dust storm that could destroy an entire crop. It is also difficult to confidently predict the market price of a commodity due to changes in world production, political events, and various other factors that affect market price. For each county in the study area, a model will be generated with stochastic estimates for each option to provide landowners with a tool to evaluate the financial consequences of their decision. Latin Hypercube simulation will be employed.

The key output variables (KOVs) will be the projected CRP government rental payments, the returns per acre above direct expenses expected for producing a given crop, and the amount of rental payments that could be received for leasing land to another party. The method used to determine each deterministic estimate will first be discussed. It will then be followed by a discussion on the methods used to generate a stochastic estimate of each option.

The majority of stochastic variables in this model are generated from a multivariate empirical (MVE) distribution. An empirical distribution is suitable for this study because it is a nonparametric distribution that allows the data itself to shape the distribution. According to Richardson (2008), empirical distributions can be univariate or multivariate. The difference between the two distributions is that a univariate distribution has only one variable while a multivariate distribution has multiple variables. Having more than one variable in a distribution prevents historical correlation among variables from being ignored. If historical correlation is ignored it could overstate or understate risk (Richardson 2008).

Verification and validation of the stochastic model will also be conducted once it is complete. Richardson states that verification is the process of being sure that all equations in the model correctly calculate what they are intended to calculate. Validation is the process of ascertaining that all simulated variables display the same important properties of their parent distributions. This involves testing the means, variances, and correlation of each simulated variable and comparing it to the historical data. The software program used for all modeling in this study was Simetar © 2008.

3.2.1. CRP Enrollment

The first option discussed is attempting to re-enroll the land in CRP. To be eligible as a producer for CRP enrollment, the producer must have owned or operated the land for at least 12 months prior to the end of the CRP enrollment period. Land must have been used for production of an agricultural commodity for four of the previous six years. The land must also have an average erosion index of 8 or higher. The CRP contract should be expiring or not currently enrolled in CRP. Land is also eligible for CRP enrollment if it is located in a state or national priority area (USDA, FSA 2011a). If the above criteria are met then CRP enrollment is possible.

A MVE distribution is used to determine a stochastic estimate of CRP enrollment. Historical CRP cash rental rates were used as a proxy for the returns per acre under CRP enrollment. The USDA, FSA maintains a database of average CRP rental rates for each county in a publication titled *Summary of Active Contracts by Program Year CRP- Monthly Contracts Report*. The deterministic component was calculated from the February 2011 FSA report (USDA, FSA 2011c). The average CRP rental rate per acre is determined by taking the total CRP payments to a county and dividing it by the total number of CRP acres from all sign-ups in a county. Upon graphing historical CRP rental payments, it was discovered that a significant dip in average rental rates occurred. It was determined that using only the latter part of historical data (1999-2010) for a MVE distribution would be appropriate due to the dip in rental values. An average CRP rental rate (1999-2010) was calculated for each county as the static deterministic component.

According to Richardson (2008), the stochastic component for a MVE distribution is the amount of dispersion about the deterministic component. This stochastic estimate uses percent deviations from trend for those counties with a significant trend present. The remaining counties were estimated using percent deviation from the mean. These deviations are sorted into a vector. A MVE distribution using historical data was employed in calculating the stochastic estimates for the years 2011-2015. These sorted MVE deviates comprise the stochastic component of the model. The multivariate component of the MVE distribution is the correlation matrix of the unsorted deviates of the ten counties (Richardson 2008). Figure 6 shows a line graph of historical CRP rental rates for the ten study counties.

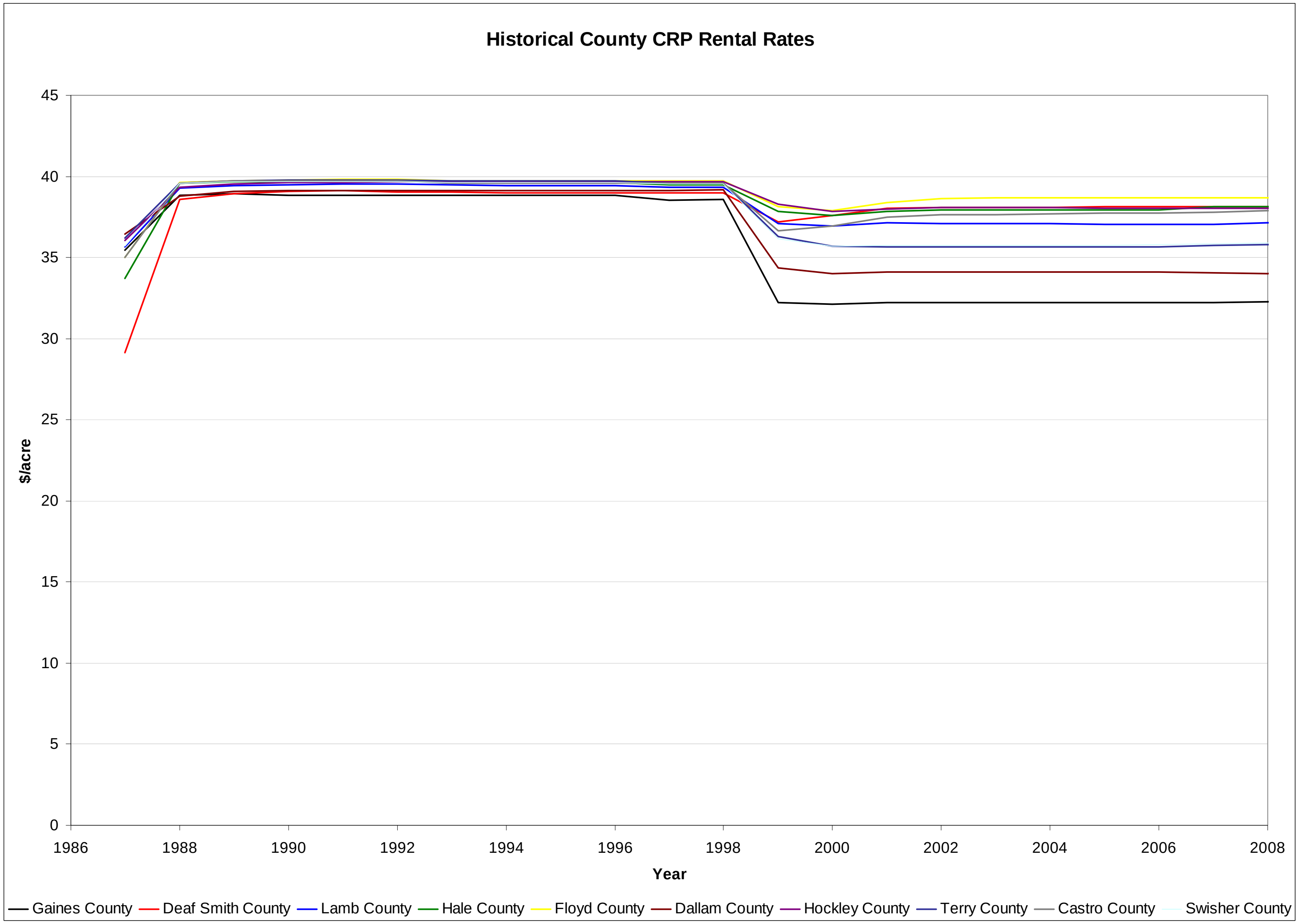

Figure 6. Line graph of historical county CRP rental rates

3.2.2. Farm It

The second option is to put the cropland back into crop production. To better assess this option, Texas AgriLife Extension Economists for District 1 (Panhandle) and District 2 (South Plains) were contacted and asked to identify the crop that was most likely to be planted if land was brought out of CRP and placed into crop production. The District 1 extension economist determined that producers would most likely produce dryland wheat on land coming out of CRP. The District 2 extension economist predicted that producers would most likely produce dryland cotton on land coming out of CRP contracts. According to work by another group of AgriLife Extension Economists, most of these crops are farmed dryland due to lack of water or irrigation equipment. Lower yields during the first year of production should also be expected due to limited nutrients and soil moisture (Warminski et al. 2009). The Texas AgriLife Extension Service develops crop enterprise budgets each year as guidelines for producers to use in developing their own crop enterprise budgets. The budgets are developed for individual crops for each of the 12 AgriLife Extension Districts.

The budgets include information on expected average market prices, expected yields, and input costs. These crop enterprise budgets were adapted for use in this model. Direct payments from the government were incorporated into the income section of the budget to account for added income due to government farm program payments. In the Panhandle AgriLife Extension District the budget that was selected for use was the *Estimated Costs and Returns per Acre Continuous Wheat, Dryland, Grazed 2011 Projected Costs and Returns per Acre*.

The original District 1 budget is shown in Figure 7. For the South Plains AgriLife Extension District the budget titled *Estimated Costs and Returns per Acre Cotton, Dryland – Herbicide-tolerant, Insect-resistant 2011 Projected Costs and Returns per Acre* was used. This budget is shown in Figure 8. Historical commodity production data was obtained from NASS to use in determining the average dryland crop yields per county that could be reasonably expected for a crop. It is also important to note that a planted acre yield is used rather than the harvested acre yield. The main difference between the two yield estimates is that the planted acre yield calculates the yield per acre based on the number of acres planted. Harvested acre yield calculates the yield per acre based only on what is harvested. This measure does not account for acres not harvested due to crop disaster. For example, consider a case where 20 acres are originally planted, but only 15 acres are harvested due to a hail storm that destroys 5 acres of the crop. Planted acre yield would calculate yield per acre based on the 20 acres originally planted where harvested acre yield would calculate yield per acre based on only the 15 acres that were harvested. A by year average of the NASS historical yields was generated.

Projections for Planning Purposes Only
Not to be Used without Updating after December 15, 2010

B-1241 (C1)

Table 21.A Estimated costs and returns per Acre
Continuous Wheat, Dryland, Grazed
2011 Projected Costs and Returns per Acre

ITEM	UNIT	PRICE	QUANTITY	AMOUNT	YOUR FARM
		dollars		dollars	
INCOME					
grazing - wheat	lbs	0.43	73.0000	31.39	________
wheat	bu.	6.48	20.0000	129.60	________

TOTAL INCOME				160.99	________
DIRECT EXPENSES					
SEED					
seed- wheat	bu.	14.40	1.0000	14.40	________
FERTILIZER					
fert(N) - ANH3	lb.	0.43	30.0000	12.90	________
CUSTOM					
fert appl - ANH3	acre	11.00	1.0000	11.00	________
cust harv-wheat	acre	20.00	1.0000	20.00	________
cust haul-wheat dry	bu.	0.23	20.0000	4.60	________
CROP INSURANCE					
wheat - dryland	acre	19.50	1.0000	19.50	________
OPERATOR LABOR					
Implements	hour	10.30	0.2764	2.84	________
Tractors	hour	10.30	0.4425	4.55	________
HAND LABOR					
Implements	hour	10.30	0.2121	2.18	________
DIESEL FUEL					
Tractors	gal	2.65	2.2211	5.88	________
GASOLINE					
Self-Propelled Eq.	gal	2.73	2.0100	5.48	________
REPAIR & MAINTENANCE					
Implements	Acre	3.80	1.0000	3.80	________
Tractors	Acre	4.46	1.0000	4.46	________
Self-Propelled Eq.	Acre	0.16	1.0000	0.16	________
INTEREST ON OP. CAP.	Acre	4.42	1.0000	4.42	________

TOTAL DIRECT EXPENSES				116.22	________
RETURNS ABOVE DIRECT EXPENSES				44.76	________
FIXED EXPENSES					
Implements	Acre	6.28	1.0000	6.28	________
Tractors	Acre	6.53	1.0000	6.53	________
Self-Propelled Eq.	Acre	0.25	1.0000	0.25	________

TOTAL FIXED EXPENSES				13.07	________

TOTAL SPECIFIED EXPENSES				129.30	________
RETURNS ABOVE TOTAL SPECIFIED EXPENSES				31.68	________
ALLOCATED COST ITEMS					
cash rent - wheatd	acre	25.00	1.0000	25.00	________
RESIDUAL RETURNS				6.68	________

Projections for Planning Purposes Only.

Figure 7. District 1 crop enterprise budget (Source: Texas AgriLife Extension 2011a)

Projections for Planning Purposes Only
Not to be Used without Updating after January 1, 2011

B-1241 (C2)

Table 5.A Estimated costs and returns per Acre
Cotton, Dryland - Herbicide-tolerant, Insect-resistant
2011 Projected Costs and Returns per Acre

ITEM	UNIT	PRICE	QUANTITY	AMOUNT	YOUR FARM
		dollars		dollars	
INCOME					
cotton lint	lb.	0.90	350.0000	315.00	________
cottonseed	ton	180.00	0.2450	44.10	________

TOTAL INCOME				359.10	________
DIRECT EXPENSES					
SEED					
seed - cotton dry	thou	0.90	39.0000	35.10	________
FERTILIZER					
fert. (P)	lb.	0.75	20.0000	15.00	________
fert. (N)	lb.	0.50	30.0000	15.00	________
CUSTOM					
preplant herb + appl	acre	12.00	1.0000	12.00	________
fert appl.	acre	4.50	1.0000	4.50	________
insec+appl - cotton	appl	12.00	0.5000	6.00	________
post emerg herb+appl	acre	16.00	1.0000	16.00	________
harvaid appl-cot dry	acre	20.00	0.5000	10.00	________
strip & module-cotto	lb.	0.08	350.0000	28.00	________
ginning - cotton	cwt.	3.00	12.5000	37.50	________
CROP INSURANCE					
cotton - dryland ins	acre	20.00	1.0000	20.00	________
BOLL WEEVIL ASSESS					
dryland	acre	1.00	1.0000	1.00	________
OPERATOR LABOR					
Implements	hour	10.00	0.8157	8.15	________
Tractors	hour	10.00	0.8440	8.44	________
HAND LABOR					
Implements	hour	10.00	0.1527	1.52	________
DIESEL FUEL					
Tractors	gal	3.00	3.9149	11.74	________
GASOLINE					
Self-Propelled Eq.	gal	3.00	2.0100	6.03	________
REPAIR & MAINTENANCE					
Implements	Acre	8.98	1.0000	8.98	________
Tractors	Acre	9.71	1.0000	9.71	________
Self-Propelled Eq.	Acre	0.50	1.0000	0.50	________
INTEREST ON OP. CAP.	Acre	7.27	1.0000	7.27	________

TOTAL DIRECT EXPENSES				262.47	________
RETURNS ABOVE DIRECT EXPENSES				96.62	________
FIXED EXPENSES					
Implements	Acre	14.82	1.0000	14.82	________
Tractors	Acre	14.77	1.0000	14.77	________
Self-Propelled Eq.	Acre	1.04	1.0000	1.04	________

TOTAL FIXED EXPENSES				30.64	________

TOTAL SPECIFIED EXPENSES				293.11	________
RETURNS ABOVE TOTAL SPECIFIED EXPENSES				65.98	________
ALLOCATED COST ITEMS					
cash rent - cottond	acre	25.00	1.0000	25.00	________
RESIDUAL RETURNS				40.98	________

Projections for Planning Purposes Only.

Figure 8. District 2 crop enterprise budget (Source: Texas AgriLife Extension 2011b)

Dicks (1990) suggests using Food and Agricultural Policy Institute (FAPRI) baseline prices as a predictor of future prices. The FAPRI prices were regionalized to account for the differences between Texas and U.S. prices received. Historical market prices for wheat and cotton were obtained from USDA, NASS databases (USDA, NASS 2010). Average prices received in Texas and in the United States were calculated based on the historical data. The average prices received in Texas were subtracted from the average prices received in the United States in order to account for the historical difference between Texas and U.S. prices. This difference was then added to FAPRI estimates in order to determine probable Texas prices in the future.

All of the above information was placed into the adapted AgriLife Extension budgets and used to generate a deterministic estimate of the total net returns per acre above direct expenses that a producer could expect if he chose to place land back into crop production. All direct costs reported in the budgets were in terms of 2011 dollars. It is important to note that the deterministic estimates that were generated do not include the cost of converting CRP land back into cropland. The cropland conversion process includes clearing old grass residue, tillage, soil preparation, and fertilization. Converting CRP land back into cropland is estimated to cost between $100-$150 per acre depending on the specific conversion process that is needed (Jones 2009).

The two specific budgets that were used were adapted from the AgriLife Extension Budgets. The two counties located in District 1 used the adapted AgriLife Extension Budget presented in Table 22. The remaining eight counties used the adapted AgriLife Extension Budget presented in Table 23.

The next step in the modeling process is creating the stochastic component based on the adapted AgriLife Extension Crop Enterprise Budgets and the deterministic estimates. The KOV of interest is the total net returns per acre above direct expenses because this value most closely represents what a producer could expect to earn per acre after input costs are accounted for. Two other important variables are needed to calculate this KOV. These include the receipts from production and the direct costs per acre. In calculating receipts, yield, market price, and government payments must be determined. Yield and market price are both stochastic variables. Empirical distributions were employed in calculating both expected yields and market prices.

Table 22. District 1 Dryland Wheat Budget

District 1, Continuous Wheat Dryland
RECEIPTS
grazing - wheat
wheat
GOVT. PAYMENTS
Direct Payment
TOTAL INCOME
DIRECT EXPENSES
SEED
Seed - wheat
FERTILIZER
fert (N) - ANH3
CUSTOM
fert appl - ANH3
cust harv - wheat
cust haul - wheat dry
CROP INSURANCE
wheat - dryland
OPERATOR LABOR
Implements
Tractors
HAND LABOR
Implements
DIESEL FUEL
Tractors
GASOLINE
Self-Propelled Eq.
REPAIR & MAINTENANCE
Implements
Tractors
Self-Propelled Eq.
INTEREST ON OP. CAP.
TOTAL DIRECT EXPENSES
RETURNS ABOVE DIRECT EXPENSES

Table 23. District 2 Dryland Cotton Budget

District 2, Dryland Cotton Budget
RECEIPTS
cotton lint
cottonseed
GOVT PAYMENTS
Direct Payments
TOTAL RECEIPTS
DIRECT EXPENSES
SEED
seed - cotton dry
FERTILIZER
fert. (P)
fert. (N)
CUSTOM
preplant herb + appl
fert appl.
insec+appl - cotton
post emerg herb+appl
harvaid appl-cot dry
strip & module-cotton
ginning - cotton
CROP INSURANCE
cotton - dryland ins
BOLL WEEVEIL ASSESS
dryland
OPERATOR LABOR
Implements
Tractors
HAND LABOR
Implements
DIESEL FUEL
Tractors
GASOLINE
Self-Propelled Eq.
REPAIR & MAINTENANCE
Implements
Tractors
Self-Propelled Eq.
INTEREST ON OP. CAP.
TOTAL DIRECT EXPENSES
RETURNS ABOVE DIRECT EXPENSES

The deterministic component of wheat yields was calculated based on the average yield estimates for Deaf Smith and Dallam counties. A MVE distribution was used to account for historical correlation between wheat yields and cotton yields in all ten counties. The stochastic component of the MVE distribution was in terms of percent deviations about the mean. A MVE distribution using historical data was employed in calculating the stochastic estimates for the years 2011-2015. These sorted MVE deviates comprise the stochastic component of the model. The multivariate component of the MVE distribution is the correlation matrix of the unsorted deviates for wheat yields and cotton yields in the ten study counties.

The wheat budgets also include receipts from grazing wheat. The receipts are reported in the budgets in terms of dollars per pound. The stochastic estimates of wheat production in bushels were converted into total pounds of production. It was then assumed that ten percent of total pounds of wheat production would receive receipts for grazing.

The deterministic component of cotton lint yields was also figured based on average expected yield estimates for Gaines, Lamb, Hale, Floyd, Hockley, Terry, Castro, and Swisher counties. Once again, the stochastic component for the MVE distribution in terms of percent deviations from the mean. A MVE distribution was used for determining stochastic estimates for the years 2011-2015. The multivariate component of the MVE distribution is made up of the correlation matrix of the unsorted deviates for the cotton planted acre yields and wheat planted acre yields for the ten counties. Cotton seed yield was calculated based on the stochastic lint yields. For every bale of cotton produced about 480 pounds of cotton lint and 800 pounds of cotton seed are generated (Anthony and Mayfield 1994). The stochastic estimates of bales per acre produced were multiplied by 800 to determine the amount of cotton seed per acre that would be generated to calculate total cotton seed production.

A MVE distribution was also used in determining a stochastic estimate of prices for wheat, cotton, and cotton seed. The deterministic component of prices in Texas was based on the regionalized FAPRI estimates of prices (FAPRI 2010). The stochastic component of the empirical distribution was in terms of percent deviations from trend. The stochastic values of price and yield were multiplied to determine stochastic receipts for wheat and cotton production.

Direct payments received from the government are calculated based on the product of the direct payment rate for a specific crop, the historical payment acres, and historical payment yields for the specific farm (USDA, ERS 2009). Only 83.3% of historical payment base acres are used in the calculation formula. The direct payment rates were set in the 2008 Farm Bill and are reported in Table 24.

Table 24. Direct Payment Rates

Direct Payment Rates

Commodity	**Unit**	**Direct Payment Rate**
Wheat	Bushel	$0.52
Corn	Bushel	$0.28
Grain Sorghum	Bushel	$0.35
Barley	Bushel	$0.24
Oats	Bushel	$0.024
Upland Cotton	Pound	$0.0667
Medium-Grain Rice	Hundredweight	$2.35
Long-Grain Rice	Hundredweight	$2.35
Soybeans	Bushel	$0.44
Other Oilseeds	Hundredweight	$0.80
Peanuts	Ton	$36.00

Source: USDA, ERS (2009)

The equation used to calculate the direct payments in these budgets was based on direct payment rates set by the 2008 Farm Bill and historical payment yields reported for each county. Historical payment acres were omitted from the calculations because the budgets are calculated on a per acre cost basis.

$$DP_{wheat} = (Payment\ Rate)_{wheat} * (Payment\ yield)_{wheat} * 0.833$$

where:

- DP_{wheat} represents the direct payment received for wheat
- $(Payment\ Rate)_{wheat}$ represents the direct payment rate that was set in the 2002 Farm Bill.
- $(Payment\ yield)_{wheat}$ represents the direct payment yield per acre for a specific county

Stochastic inflation rates were used to inflate the reported 2011 direct expenses into 2012-2015 dollars to calculate the direct expenses for both budgets. A MVE distribution was used to account for correlation among the different indexes used. Indexes for nitrogen fertilizer, fuel, services, wages, PPI, and operating interest rates were applied to direct cost items in the budgets. The deterministic component of the MVE distribution came from FAPRI 2010 baseline estimates of future inflation rates. The formula for inflating each of the direct expenses is demonstrated below:

$$Expense_{t+1} = Expense_t * (1 + Inflation\ Rate_{t+1})$$

where:

- $Expense_{t+1}$ represents the direct expense in year t+1
- $Expense_t$ represents the reported direct expense in nominal terms
- $(1 + Inflation\ Rate_{t+1})$ represents the percentage change in price

There were also a few variable expenses in both the dryland cotton and dryland wheat budgets. A variable expense is any expense that varies with the level of production. The expense for custom hauling of wheat was multiplied by the number of stochastic bushels produced for each year. In addition, there were two variable expenses in the cotton budgets. These expenses were for stripping and moduling cotton and ginning cotton. The cost of stripping and moduling cotton varies with the amount of cotton lint harvested. This cost was determined by multiplying the stochastic estimate of lint yield in pounds by the inflated per acre cost of stripping and moduling cotton in dollars per pound. The cost per acre of ginning cotton is reported in the budgets in terms of dollars per total hundredweights including lint, seed, and trash. It was necessary to determine the total weight of lint, seed, and trash to calculate this expense in the budget. It was determined by examining the AgriLife Extension budgets that an average of 410 pounds of trash is produced per acre of dryland cotton production. The total weight of production is multiplied by the inflated per acre cost of ginning cotton. The formula used for calculating the total weight of lint, seed, and trash harvested is demonstrated by the following equation.

$$\textit{Total Weight of Production (cwt)} = \frac{Lint\,yld(lbs) + Seedyld(lbs) + 410}{100}$$

All of the stochastic receipts and direct expenses were placed in the budgets to determine the KOV of total net returns per acre above direct expenses.

3.2.3. Lease Land

The last two options left to evaluate in the CRP enrollment decision are leasing the land as cropland or leasing the land as range land. Leasing the land involves receiving cash payments from a tenant who “rents” the land to grow crops or graze livestock. Texas AgriLife Extension Economists were contacted for the Panhandle District and South Plains District to determine a reasonable estimate of the appropriate rental rates for each county. The economists were asked to provide a range of estimates based on averages across all counties in the district. The economists generally talked to several landowners within the district and used their knowledge of the area in making the estimate. The ranges reported for each district are averages, and the actual rental rate for an individual landowner could potentially be higher or lower depending on specific land attributes.

A GRKS distribution was used due to the lack of available data to develop a stochastic estimate of cash rental payments for 2011-2015. A GRKS distribution is the most applicable distribution because it is designed to simulate subjective probability distributions based on minimal input data. The triangle distribution was also considered, but ultimately not used due to the fact that a triangle distribution will never simulate the minimum or maximum with a more than 1% probability. The GRKS allows for estimates slightly above and below the minimum or maximum to be generated (Richardson 2008). The parameters for the GRKS distribution were based on the minimum, modal, and maximum estimates given by each Texas AgriLife Extension Economist.

3.3. Modeling Economic Impacts

The second part of the model is concerned with modeling the economic impacts that CRP has had on each county in the study area. This model uses OLS regression to model the impacts that CRP has had on agriculturally dependent areas. More specifically the model examines the impact that CRP has had on the earnings of the agricultural services industry particularly in the short-run where it is expected to see the most significant impact. The model measures the effect of CRP on the agricultural supporting industry's health. Agricultural services industry is defined by the Bureau of Economic Analysis as the establishments that perform the services that are essential to the agricultural and forestry industry. These services may include things similar to soil preparation, crop services, labor, management services, and veterinary services among others (Bureau of Economic Analysis 2009a).

Devino et al. (1988), predicted that agribusiness firms which provided essential agricultural services would be most directly impacted by high levels of CRP enrollment. Others later confirmed his predictions including Martin et al. (1988), Mortensen et al. (1990), Siegel and Johnson (1991), and Hyberg et al. (1991). Additionally, Sullivan et al. (2004) found that the impacts resulting from the program where relatively modest, but were most apparent in the initial years after the program implementation. However, Sullivan et al. (2004) also discovered that local economies were usually able to adapt and the impacts typically leveled off after a transition period. Sullivan et al. used OLS regression to model the effect that CRP enrollment had on employment in the agricultural services industry. Henderson, Tweeten, and Woods (1992) conducted a similar study looking specifically at gross retail sales for a community.

Based on the reviewed literature, the model focuses on the earnings of the agricultural support services industry particularly in the years immediately following the inception of CRP, which occurred in 1985. A separate model will be run for each county in the study area. The OLS model uses time series data and is represented by the following equation:

$$Agserv_t = \beta_0 + \beta_1 CRP_t + \beta_2 finc_t + \beta_3 govt_t + \beta_4 (D*CRP_t) + \beta_5 pop_t + \beta_6 T_t$$

where:

- β_i are the standard OLS parameter estimates
- $Agserv_t$ is the variable reflecting the annual earnings of the agricultural services industry in year t

- CRP_t is the variable reflecting the percentage of total county cropland enrolled in CRP in year t
- $finc_t$ is the variable reflecting annual farm income for a county in year t
- $govt_t$ is a variable reflecting the total annual amount of government farm program payments for a county in year t
- *D* is a 0/1 dummy variable reflecting the years 1986-1990
- pop_t is the variable reflecting the total population in a county
- T_t is the variable reflecting trend

Each of the above variables is discussed in further detail in the following sections including a discussion of the data source.

3.3.1. Dependent Variable

The annual earnings of the agricultural services industry will serve as the dependent variable in this model. BEA estimates of agricultural services and support activities from 1975-2008 were selected to represent the dependent variable. The BEA has historically used two industry classification systems. The first system used was the Standard Industrial Classification (SIC). This system was created in the 1930's as a method for classifying economic data from various types of economic establishments for comparison and study. This system was periodically updated by the Office of Management and Budget. As the U.S. and world economies evolved, the SIC became outdated. The North American Industrial Classification System (NAICS) was adopted in 1997 to replace the SIC (NAICS Association 2009). The study period is from 1975-2008; therefore, the use of data from both classification systems is required. Data was collected from 1975-2000 from the "agricultural services, forestry, and fishing" SIC category. It was determined that the most similar category under NAICS for the years 2001-2008 was "agricultural and forestry support activities." The data for these categories was collected from personal income and detailed earnings by industry reports (CA05). All data collected from BEA is reported in nominal values, meaning that it has not been adjusted for inflation. All of the data was adjusted for inflation by using the Consumer Price Index (CPI) for All Urban Consumers to accurately reflect relative changes in agricultural earnings over time. The years 1982-1984 were used as the base years.

A major issue encountered was a lack of or holes in the data collected. The BEA does not disclose collected information to maintain confidentiality particularly when there are a limited number of establishments in a category. Of the ten counties located in the study area, five counties lack a significant portion of data making it difficult to model economic impacts. A significant portion of data is defined as missing three consecutive years of estimates. In the ERS report on CRP, Sullivan et al. (2004) also encountered the issue of missing data. This problem was dealt with by omitting the observations lacking sufficient data. Due to the fact that only one county of the ten had complete information, it was determined that an attempt must be made to estimate the withheld data in counties lacking three or less observations. Bryant suggested the use of "spatial interpolation" in solving the missing data problem. Spatial interpolation takes advantage of the fact that all counties in the study area are located in the same area and generally experience the same circumstances (Bryant 2011). This method assumes that the agricultural services earnings in a county are related to the agricultural services earnings in surrounding counties. This method uses standard OLS. Spatial Interpolation was used for 4 counties: Gaines, Lamb, Floyd, and Dallam.

Gaines = f(Lamb, Hale, Floyd)

Lamb = f(Gaines, Hale, Floyd, Dallam)

Floyd = f(Gaines, Lamb, Hale)

Dallam = f(Gaines, Lamb, Hale)

All of the above OLS equations had reasonably high R^2 and F-test values. The results of the above equations are listed in Table 25.

Table 25. Spatial Interpolation Results

	F-Test	R^2	$Rbar^2$	MAPE
Gaines County:	149.814	.949	.943	13.725
Lamb County:	86.486	.938	.927	9.634
Floyd County:	66.365	.900	.887	10.984
Dallam County:	33.488	.700	.699	26.293

3.3.2. Independent Variables

The independent variables were chosen based on the Henderson, Tweeten, and Woods (1992) study on gross retail sales in a community and the Sullivan et al. (2004) study on employment in the agricultural services industry.

CRP_t

This variable represents the percentage of total cropland enrolled in CRP. As discussed earlier, it was calculated based on the 1982 Census on Agriculture cropland estimates. Using data from 1982 is useful because it is before the start of CRP. All CRP data was collected from the USDA,FSA from 1986-2008. In the 2004 ERS study on employment in the agricultural services industry Sullivan et al. used the percentage of total cropland enrolled in CRP as a measure of importance for a county. Based on the use of the variable in the above mentioned study it was determined that using a percentage of cropland would be the best option for representing the importance of CRP to a county (Sullivan et al. 2004).

$finc_t$

This variable represents the total farm income for a county. The data for total farm income was collected from the BEA from 1975-2008 in the County Annual Series 05 (CA05). This data is reported in nominal terms. The CPI was used to deflate all data to account for inflation. It is expected that the beta coefficient on this variable will be negative. Paying for agricultural services is an input cost associated with farming. Therefore, as farmers pay more input costs, their overall farm income will decrease. This variable was included in Henderson, Tweeten, and Woods study on the effect that CRP has had on retail sales in a community (Henderson, Tweeten, and Woods 1992).

$govt_t$

This variable represents the total annual government payments given to farmers in a county. The data was collected from the BEA from 1975-2008 in the County Annual Series 45 (CA45). Federal government payments are defined by the BEA as, "payments made to farm operators under several federal government farm subsidy programs during a given calendar year. These payments include deficiency payments under price support programs for specific commodities, disaster payments, conservation payments, and direct payments to farmers under federal appropriations legislation." (Bureau of Economic Analysis 2009b). These payments would include all CRP rental payments that landowners receive annually. This variable was also chosen based on the Henderson, Tweeten, and Woods study on the effect that CRP has had on retail sales in a community (Henderson, Tweeten, and Woods 1992).

$(D*CRP_t)$

An interaction term was added to the model to account for increased economic impacts in the first few years after CRP was started. The variable *D* represents a dummy variable that is equal to 1 during the time period 1986-1990. It is equal to zero if it falls outside the period of interest. The total short-term effect of CRP on a county should be equal to the sums of the beta coefficients on the CRP_t and $(D*CRP_t)$ variables.

The basis for using a dummy variable to represent a time period was based on research conducted by Ringquist, Lee, and Ervin. In 1995 Ringquist, Lee, and Ervin conducted a study to measure the environmental impacts of agricultural policy. The dependent variable in the study was the amount of agricultural atmospheric particulate pollution (dust particles in the air). A dummy variable (1,0) was included as a variable to account for the time period when CRP was in effect. The idea was that if soil conservation policies had played a role in reducing air pollution, the dummy variables should have significant negative coefficients (Ringquist, Lee, and Ervin 1995). In this case, it is expected that if CRP enrollment has an adverse effect on agricultural services earnings in the short-term, the beta coefficient on $(D*CRP_t)$ should be negative and significant.

pop_t

This variable represents county population estimates for the years 1975-2008. All data was collected from the U.S. Census Bureau. Due to the fact that the Census occurs once each decade, the U.S. Census Bureau had to estimate the population for all years between Census years (U.S. Census Bureau 2011). These estimates were used as data for this model. A measure of population was included in both the Sullivan et al. study and the Henderson, Tweeten, and Woods studies (Sullivan et al. 2004; Henderson, Tweeten, and Woods 1992).

T_t

This variable represents trend in the data over time. The numbers 1-34 were used for each of the 34 data points. It was determined that trend would be an appropriate variable to include in modeling because scatter plots of the agricultural services earnings had an obvious upward slope.

The model will be validated by testing for the presence of serial correlation, multicollinearity, and heteroskedasticity. The results of these tests will be presented in detail in the Results section.

CHAPTER IV

RESULTS

4.1. The CRP Enrollment Decision

This section presents the results of the stochastic simulation model developed to predict returns per acre generated for each of the four options available to landowners. The four options were previously identified as re-enrollment in CRP, farming the land as a dryland crop, leasing land as rangeland, or leasing land as cropland. Prior to the comparison of the four options, all simulated variables were validated to ensure that the simulated data displayed the same properties as its parent distribution. The Hotelling's T-Squared Test was used to compare the vector of means from the simulated data to the vector of means from the parent distribution. This test failed to reject the null hypothesis indicating that the historical means were not significantly different from the simulated means. A correlation test was also performed for the MVE distributions. The correlation test checks if the simulated variables' correlation matrix is significantly different from the historical correlation matrix calculated from the original data at a 99% significance level. It was found that there was only one significant difference between two variables for all of the correlation matrices. The results for the validated KOVs will now be presented for each of the ten counties.

4.1.1. Gaines County

Each of the four options were simulated, and returns per acre for each of the options were generated from 2011-2015. It was assumed that Gaines county landowners would choose to produce dryland cotton if they placed the land back into agricultural crop production. The stochastic KOVs for 500 iterations were analyzed. Simulation summary statistics were calculated and are presented in Table 26.

Table 26. Gaines County Simulation Summary Statistics

	2011 CRP	2011 Farm it	2011 Lease as Range	2011 Lease as Crop
Mean	32.238	-74.409	10.000	25.002
StDev	.050	72.012	1.004	2.502
CV	.155	-96.778	10.038	10.008
Min	32.155	-179.744	6.567	17.519
Max	32.343	189.644	13.174	33.581
	2012 CRP	**2012 Farm it**	**2012 Lease as Range**	**2012 Lease as Crop**
Mean	32.238	-84.427	10.001	25.001
StDev	.050	72.434	0.999	2.500
CV	.155	-85.795	9.987	10.000
Min	32.155	-231.067	7.079	17.644
Max	38.343	144.406	13.010	33.225
	2013 CRP	**2013 Farm it**	**2013 Lease as Range**	**2013 Lease as Crop**
Mean	32.238	-87.581	10.000	24.999
StDev	.051	79.477	1.000	2.504
CV	.159	-90.747	9.998	10.018
Min	32.155	-282.515	7.013	16.303
Max	32.343	202.835	13.041	32.830
	2014 CRP	**2014 Farm it**	**2014 Lease as Range**	**2014 Lease as Crop**
Mean	32.237	-91.690	10.000	24.999
StDev	.051	85.156	0.997	2.497
CV	.157	-92.874	9.970	9.989
Min	32.155	-257.376	7.121	17.537
Max	32.343	226.363	12.922	32.472
	2015 CRP	**2015 Farm it**	**2015 Lease as Range**	**2015 Lease as Crop**
Mean	32.238	-94.256	10.000	25.000
StDev	.051	81.749	1.000	2.504
CV	.158	-86.730	9.997	10.015
Min	32.155	-255.326	6.780	17.192
Max	32.343	216.107	12.922	32.859

As previously discussed, there are several methods used for ranking risky alternatives (Richardson and Outlaw, 2008). The results for Gaines County landowners were ranked according to a variety of ranking methods. The ranking procedures that were initially evaluated include ranking by mean, standard deviation, worst case scenario, best case scenario, and relative risk. The most preferred option for each of these methods is presented in Table 27.

Table 27. Gaines County Ranking Matrix

	2011	2012	2013	2014	2015
Mean	CRP	CRP	CRP	CRP	CRP
Standard Deviation	CRP	CRP	CRP	CRP	CRP
Worst Case	CRP	CRP	CRP	CRP	CRP
Best Case	Farm it	Farm it	Farm it	Farm it	Farm it
Relative Risk	CRP	CRP	CRP	CRP	CRP

These rankings indicate that re-enrolling land in CRP is the most preferred option based on a mean only ranking because it returns the highest mean. Rankings based solely on mean assumes that the decision maker is risk neutral, which may not be the case. Ranking alternatives based on standard deviation selects the most preferred alternative as the one with the lowest standard deviation. According to the results, the most preferred option for Gaines County would be re-enrollment in CRP. Ranking according to the worst case scenario selects the alternative with the highest minimum value as the most preferred option. The simulation summary statistics indicate that re-enrolling land into CRP would result in the highest possible minimum return per acre. Ranking a risky decision based on the best case scenario is similar to the worst case scenario with the only difference being that the option with the highest maximum value is selected. The option that generates the highest possible maximum return is farming dryland cotton. It should be noted that ranking alternatives based on best (worst) case scenario ignores the downside (upside) risk associated with the distribution. It is also basing the entire decision on a single iteration out of 500. Ranking options based on relative risk selects as most preferred the option that has the lowest absolute coefficient of variation (CV). In this case, re-enrolling land in CRP returns the lowest relative risk.

Another option for ranking risky alternatives is based on mean variance. According to this ranking procedure, the most preferred alternative should be the option associated with the higher mean and lower variance. A mean variance chart was created for Gaines County for 2011. Using the mean variance ranking method would indicate that CRP enrollment is the most preferred option due to the fact that there is no other option found in the southeast quadrant of the chart. A major problem associated with this ranking procedure is that the option of farming the land has a mean too low (-74) and a variance too high (5186) to be plotted in the same chart. The farming option is by far the least preferred option according to mean variance. The three options with similar scales are plotted in Figure 9.

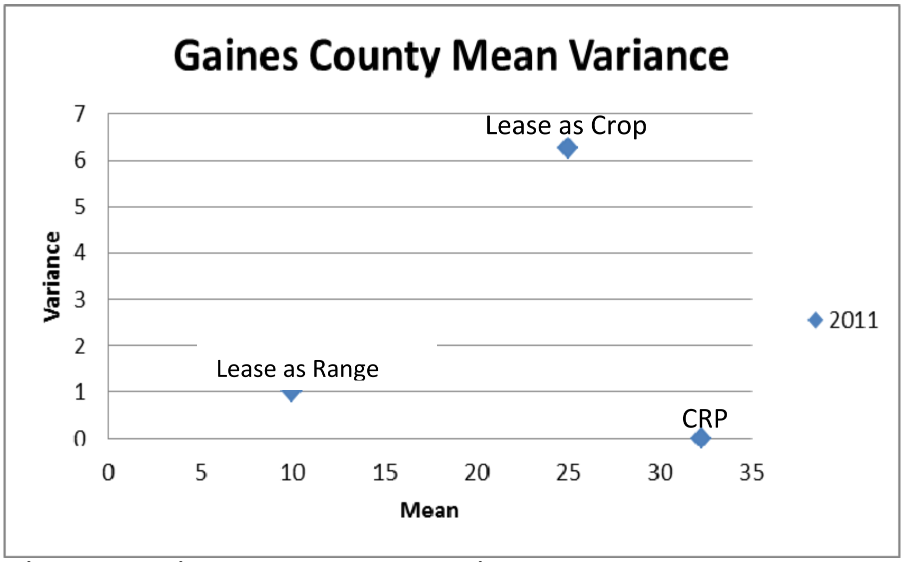

Figure 9. Gaines County mean variance

A cumulative distribution function (CDF) for each of the options is presented below. A CDF provides decision makers with a more complete picture of probable outcomes. All four options are presented in one CDF for overall comparison as well as individual CDFs for a more detailed look. These CDFs are presented in Figures 10 – 14. Based on the fact that the CDFs cross, first degree stochastic dominance can not be established. However, it can be noted based on the CDFs that choosing to farm the land has a much wider distribution of possible outcomes indicating more risk. The CDFs for each of five years are similar to the 2011 distribution. The CDFs presented below are for the year 2011. The CDFs for the remaining four years are located in Appendix A.

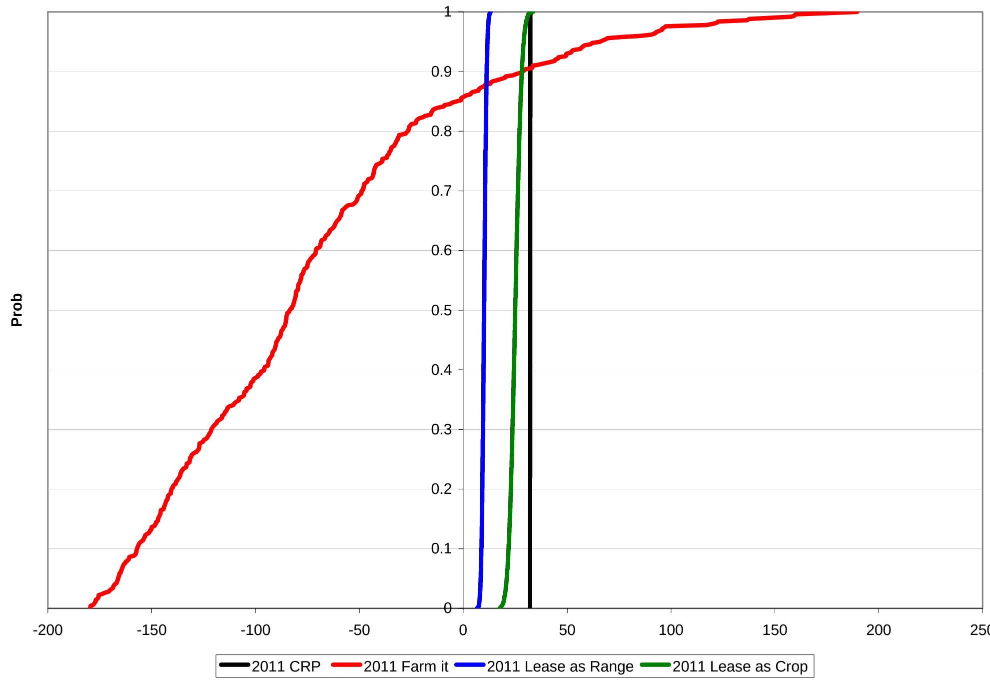

Figure 10. Gaines County 2011 returns per acre, cumulative distribution function

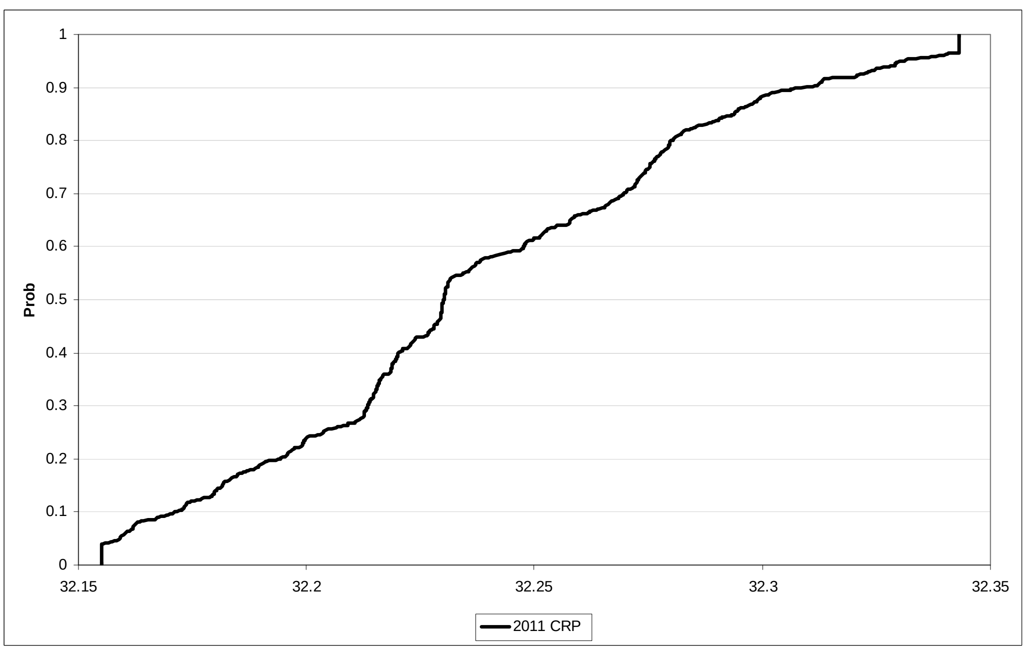

Figure 11. Gaines County 2011, conservation reserve program payments cumulative distribution function

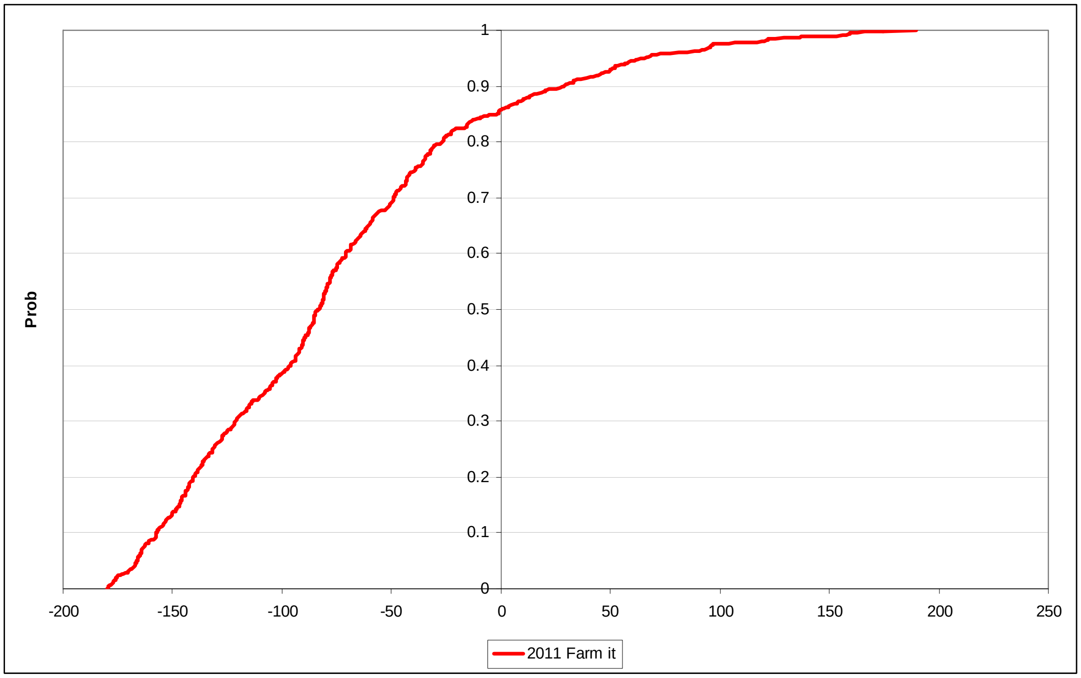

Figure 12. Gaines County 2011, dryland cotton production returns per acre cumulative distribution function

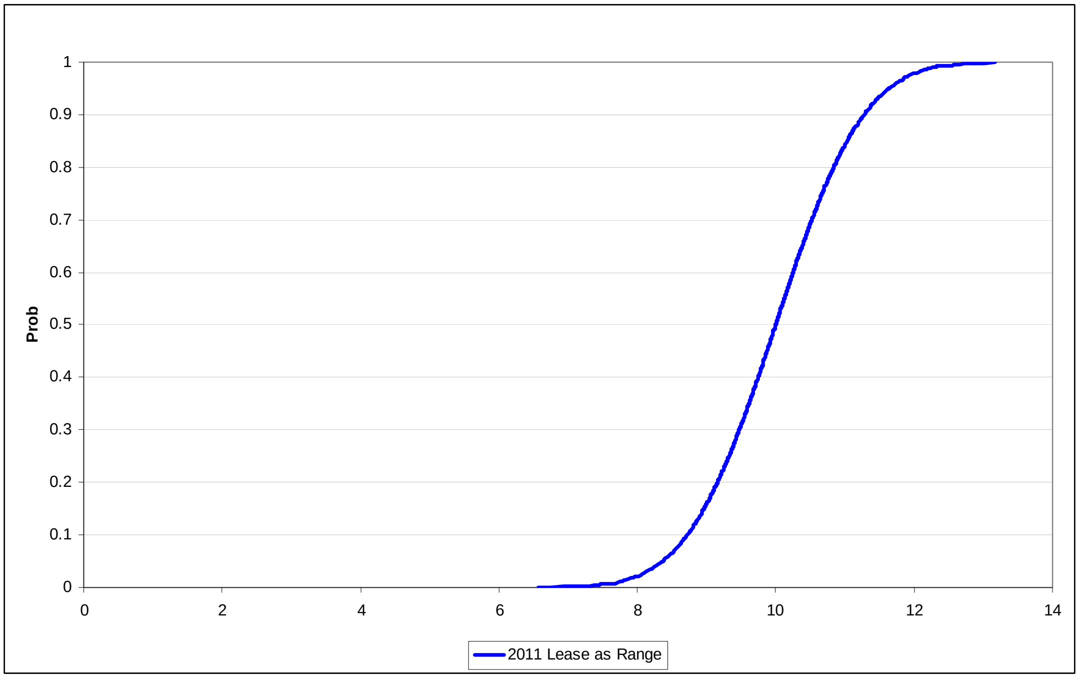

Figure 13. Gaines County 2011, lease as rangeland returns per acre cumulative distribution function

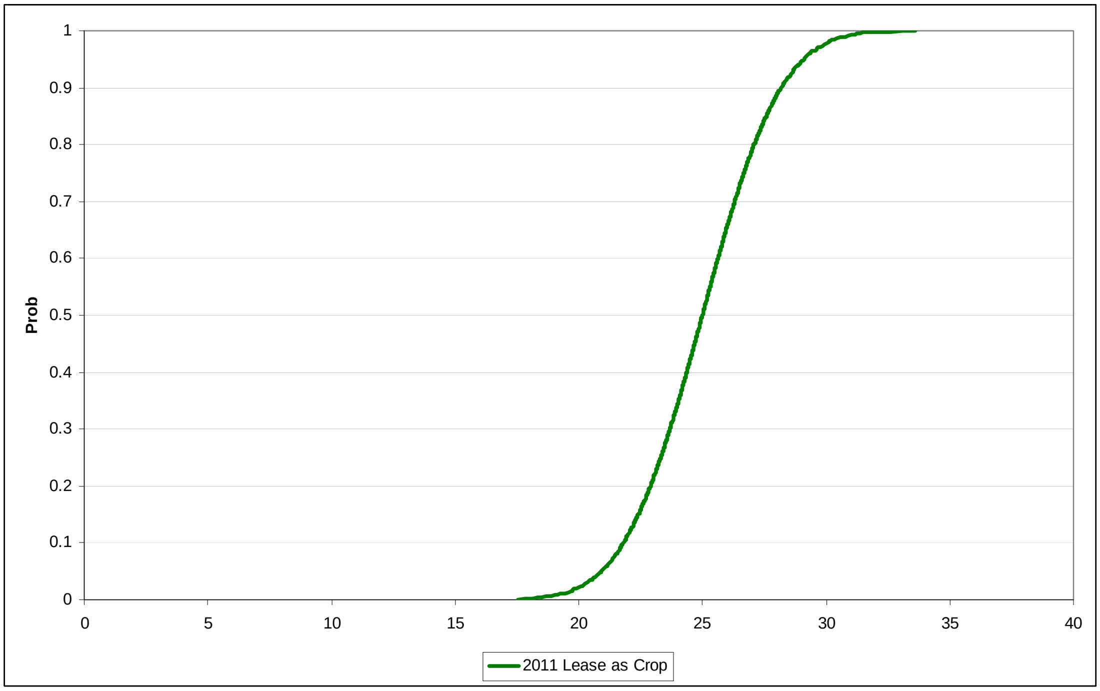

Figure 14. Gaines County 2011, lease as cropland cumulative distribution function

Figure 15 shows an analysis of Stochastic Dominance with Respect to a Function (SDRF) ranking method. Figure 16 presents the Stochastic Efficiency with Respect to a Function (SERF) under a Negative Exponential Utility Function. Both of these ranking methods are utility based ranking systems. Both SERF and SDRF indicate that re-enrollment in CRP is the most preferred option. The upper risk aversion coefficient (RAC) was calculated based on a wealth level equal to the county average market value per farm of land and buildings found in the 2007 Census of Agriculture conducted by the USDA, National Agricultural Statistics Service (USDA, NASS 2007). The lower RAC was set at zero to represent a risk neutral decision maker. Based on the selected RACs the decision maker would most prefer CRP enrollment at all risk aversion levels within the selected range.

	Efficient Set Based on SDRF at	
	Lower RAC	**0**
	Name	Level of Preference
1	2011 CRP	Most Preferred
2	2011 Lease as Crop	2nd Most Preferred
3	2011 Lease as Range	3rd Most Preferred
4	2011 Farm it	Least Preferred

	Efficient Set Based on SDRF at	
	Upper RAC	**3.66174E-06**
	Name	Level of Preference
1	2011 CRP	Most Preferred
2	2011 Lease as Crop	2nd Most Preferred
3	2011 Lease as Range	3rd Most Preferred
4	2011 Farm it	Least Preferred

Figure 15. Stochastic dominance with respect to a function ranking of four options for producers in Gaines County 2011

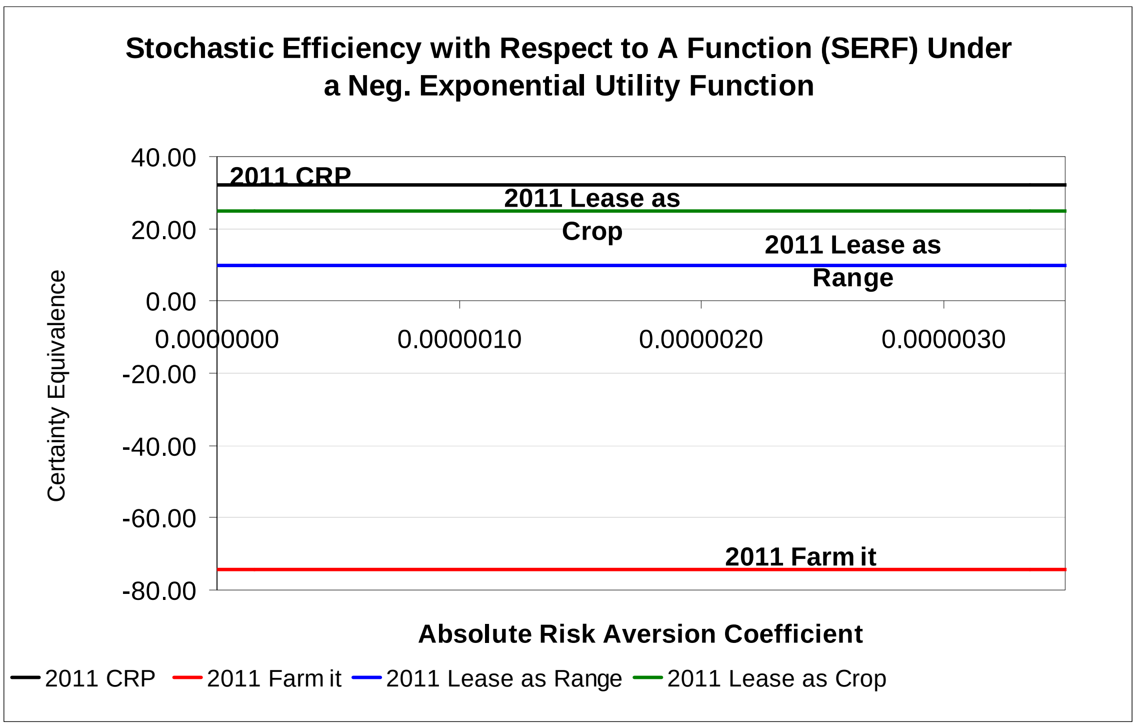

Figure 16. Stochastic efficiency with respect to a function ranking of four options for landowners in Gaines County 2011

Yet another method for ranking risky options is available. The stoplight method is possibly one of the easiest methods to understand for decision makers without a background in economics. The stoplight ranking procedure is based on the probabilities of achieving selected favorable and unfavorable outcomes. The stoplight chart for Gaines County 2011 is presented in Figure 17.

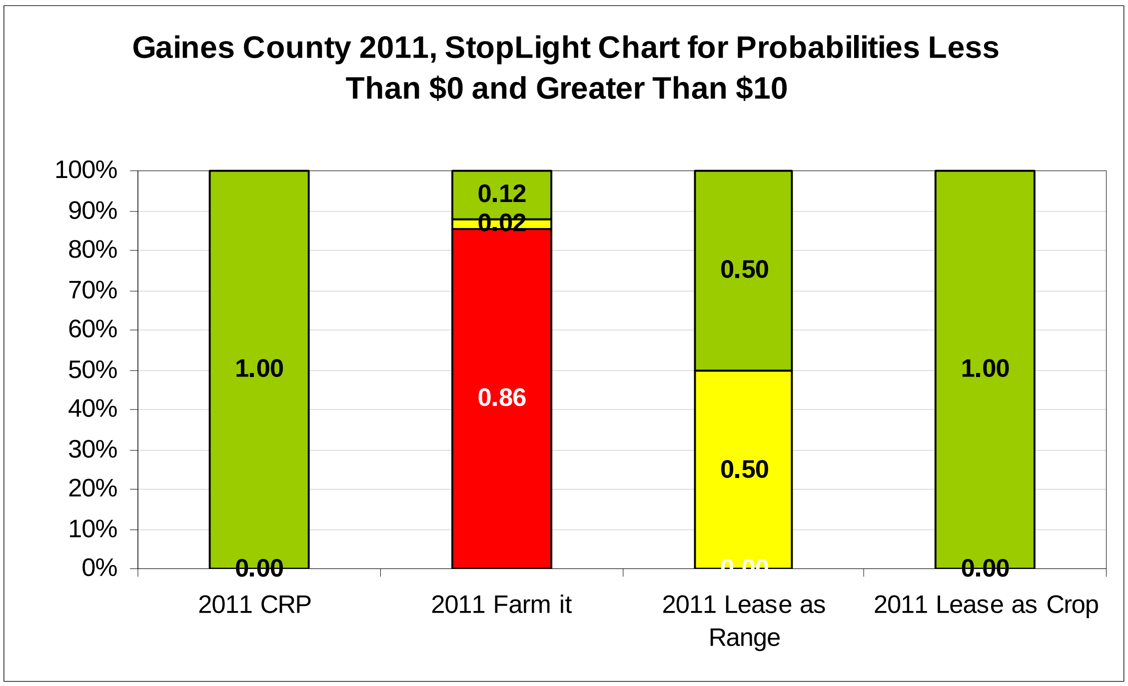

Figure 17. Stoplight chart summarizing the probabilities of returns per acre for landowners in Gaines County (2011)

The green values represent the probability of realizing a “good” outcome defined as achieving at least $10 per acre returns for each of the four options. The red values represent to probability of realizing a “bad” outcome defined as realizing negative returns per acre. Yellow values represent the values that lie between the favorable and unfavorable outcomes. According to the stoplight chart, re-enrollment in CRP and leasing the land as cropland to a tenant have the highest probabilities of achieving at least $10 per acre net returns. Choosing to farm the CRP land as dryland cotton is associated with an 86% probability of realizing negative returns per acre as well as the lowest probability of realizing at least $10 per acre returns above direct expenses.

4.1.2. Deaf Smith County

Each of the four options were simulated, and returns per acre for each of the options were generated from 2011-2015. Deaf Smith County is one of two counties in the study area located in the Panhandle AgriLife Extension District. District extension economists predicted that if any CRP land was placed back into crop production the crop would most likely be dryland wheat; therefore, the “farm it” option refers to dryland wheat production. The stochastic KOVs for 500 iterations were analyzed. Simulation summary statistics were calculated and are presented in Table 28.

Table 28. Deaf Smith County Simulation Summary Statistics

	2011 CRP	2011 Farm it	2011 Lease as Range	2011 Lease as Crop
Mean	37.976	-6.598	9.300	27.501
StDev	0.203	58.185	1.514	1.251
CV	0.534	-881.903	16.276	4.549
Min	37.485	-90.013	3.492	23.759
Max	38.212	167.350	13.468	31.790
	2012 CRP	**2012 Farm it**	**2012 Lease as Range**	**2012 Lease as Crop**
Mean	37.978	-10.162	9.301	27.501
StDev	0.197	56.893	1.505	1.250
CV	0.518	-559.861	16.183	4.546
Min	37.485	-108.082	4.389	23.822
Max	38.212	174.729	13.263	31.612

Table 28. Continued

	2013 CRP	2013 Farm it	2013 Lease as Range	2013 Lease as Crop
Mean	37.971	-12.099	9.301	27.499
StDev	0.207	61.641	1.507	1.252
CV	0.546	-509.478	16.203	4.553
Min	37.485	-105.454	4.273	23.151
Max	38.212	179.444	13.301	31.415
	2014 CRP	**2014 Farm it**	**2014 Lease as Range**	**2014 Lease as Crop**
Mean	37.984	-17.062	9.301	27.499
StDev	0.193	58.812	1.503	1.249
CV	0.508	-344.693	16.157	4.540
Min	37.485	-115.013	4.462	23.769
Max	38.212	151.946	13.153	31.236
	2015 CRP	**2015 Farm it**	**2015 Lease as Range**	**2015 Lease as Crop**
Mean	37.977	-19.380	9.300	27.500
StDev	0.207	61.731	1.508	1.252
CV	0.545	-318.523	16.213	4.552
Min	37.485	-124.052	3.865	23.596
Max	38.212	163.482	13.152	31.429

The above results for Deaf Smith county landowners were initially ranked by mean, standard deviation, worst case scenario, best case scenario, and relative risk. The most preferred option for each of these methods is presented in Table 29.

Table 29. Deaf Smith County Ranking Matrix

	2011	2012	2013	2014	2015
Mean	CRP	CRP	CRP	CRP	CRP
Standard Deviation	CRP	CRP	CRP	CRP	CRP
Worst Case	CRP	CRP	CRP	CRP	CRP
Best Case	Farm it	Farm it	Farm it	Farm it	Farm it
Relative Risk	CRP	CRP	CRP	CRP	CRP

These rankings indicate that re-enrolling land in CRP is the most preferred option based on a mean only ranking, which assumes a risk neutral decision maker, because it returns the highest mean for each of the five years studied. According to the results, a ranking based on the lowest standard deviation would select re-enrollment in CRP as the most preferred option for Deaf Smith County. The simulation summary statistics indicate that re-enrolling land into CRP would result in the highest possible minimum return per acre making it the most preferred option for rankings based on worst case scenario. The option that generates the highest possible maximum return is farming dryland wheat making it the most preferred option under a best-case scenario. Ranking options based on relative risk selects as most preferred the option that has the lowest absolute coefficient of variation (CV). In this case, re-enrolling land in CRP returns the lowest relative risk.

A mean variance chart was created for Deaf Smith County for 2011. Using the mean variance ranking method would indicate that CRP enrollment is the most preferred option due to the fact that there is no other option found in the southeast quadrant of the chart. Difficulties with graphing mean variance also occur in this county because the “farm it” option has a mean too low (-6.6) and a variance too high (3385) to be plotted in the same chart with the three other options. The “farm it” option is by far the least preferred option according to mean variance. The three remaining options with similar scales are plotted in Figure 18.

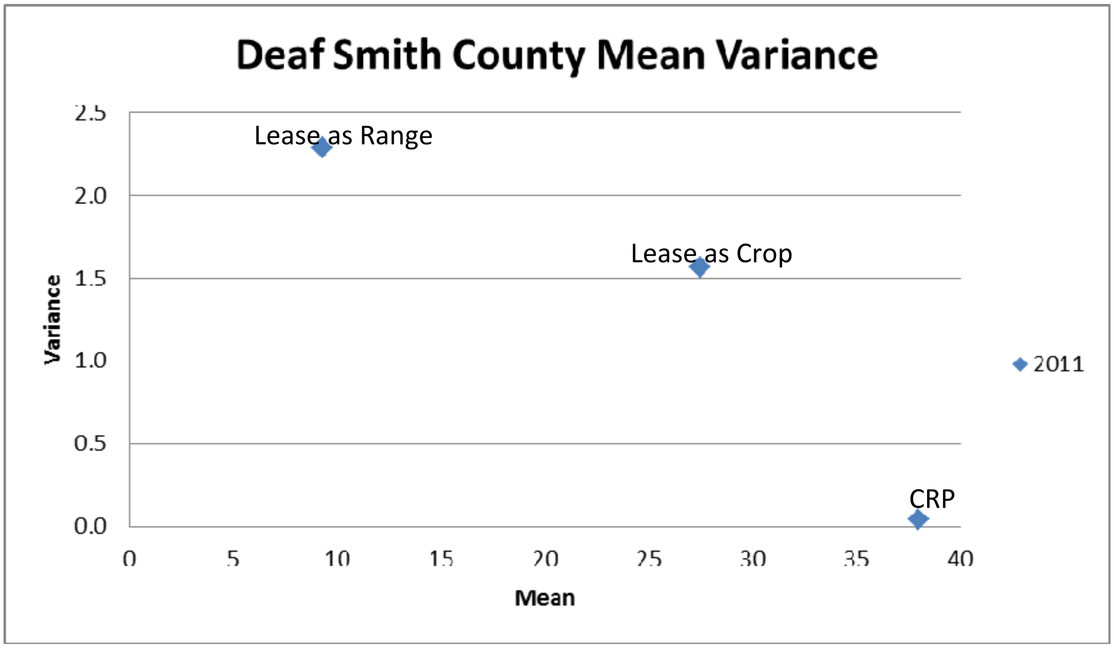

Figure 18. Deaf Smith County mean variance

A cumulative distribution function (CDF) for each of the options in Deaf Smith County is presented below. All four options are presented in one CDF for overall comparison as well as individual CDFs for a more detailed look. These CDFs are presented in Figures 19 – 23. Based on the fact that the CDFs cross, first degree stochastic dominance cannot be established. However, it can be noted based on the CDFs that choosing to farm the land has a much wider distribution of possible outcomes indicating more risk. The CDFs for each of five years are similar to the 2011 distribution. The CDFs presented below are for the year 2011. The CDFs for the remaining four years are located in Appendix A.

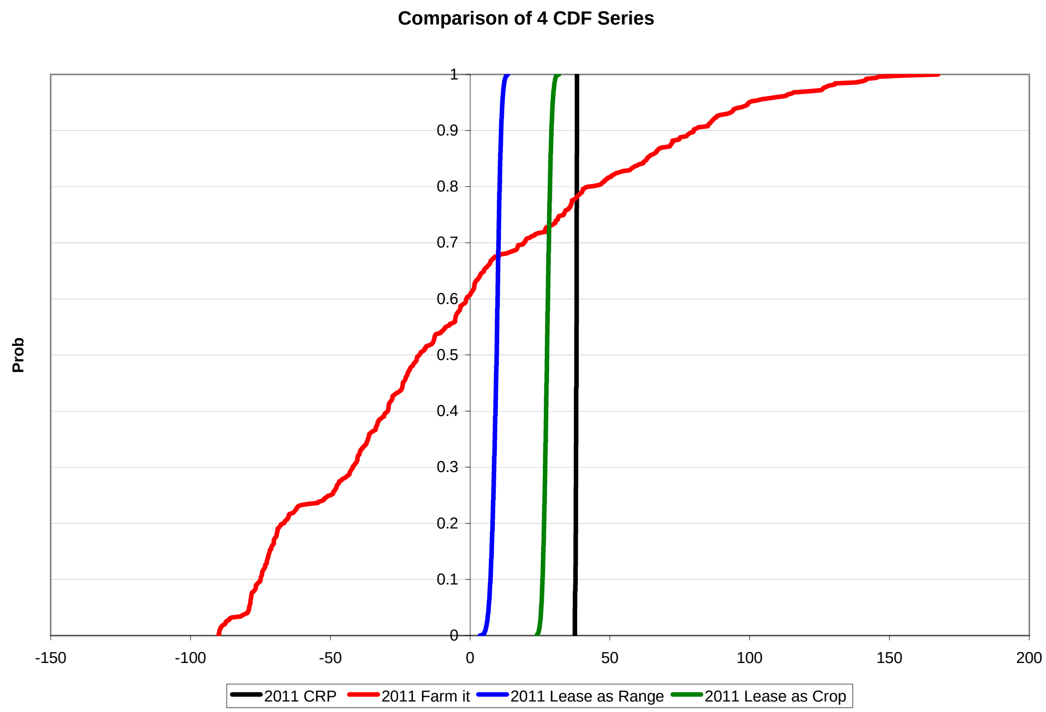

Figure 19. Deaf Smith County 2011 returns per acre, cumulative distribution function

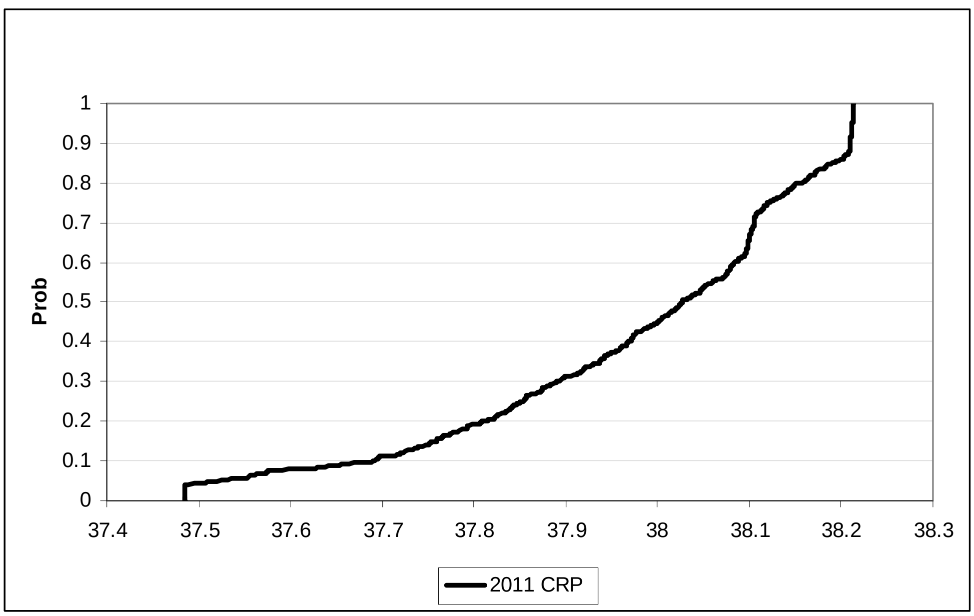

Figure 20. Deaf Smith County 2011, conservation reserve program payments cumulative distribution function

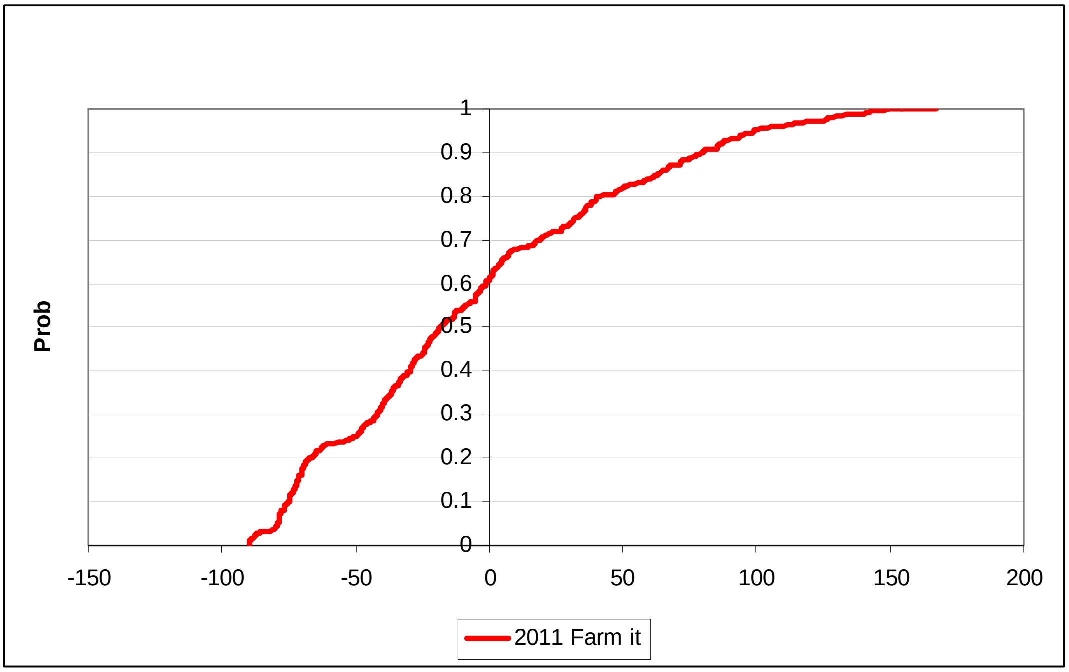

Figure 21. Deaf Smith County 2011, dryland wheat production returns per acre cumulative distribution function

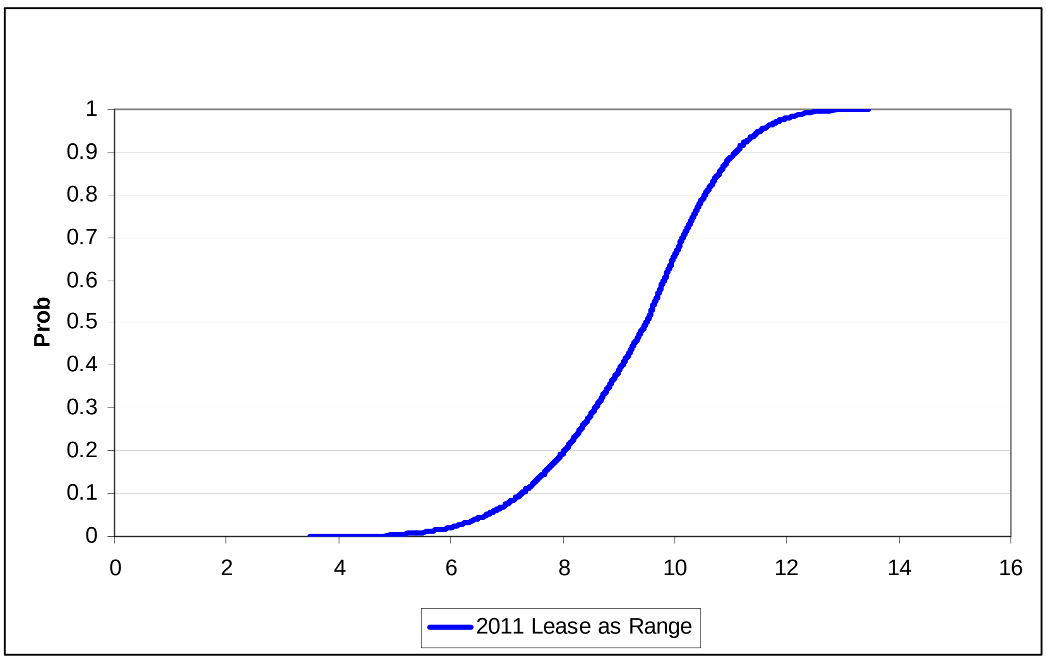

Figure 22. Deaf Smith County 2011, lease as rangeland returns per acre cumulative distribution function

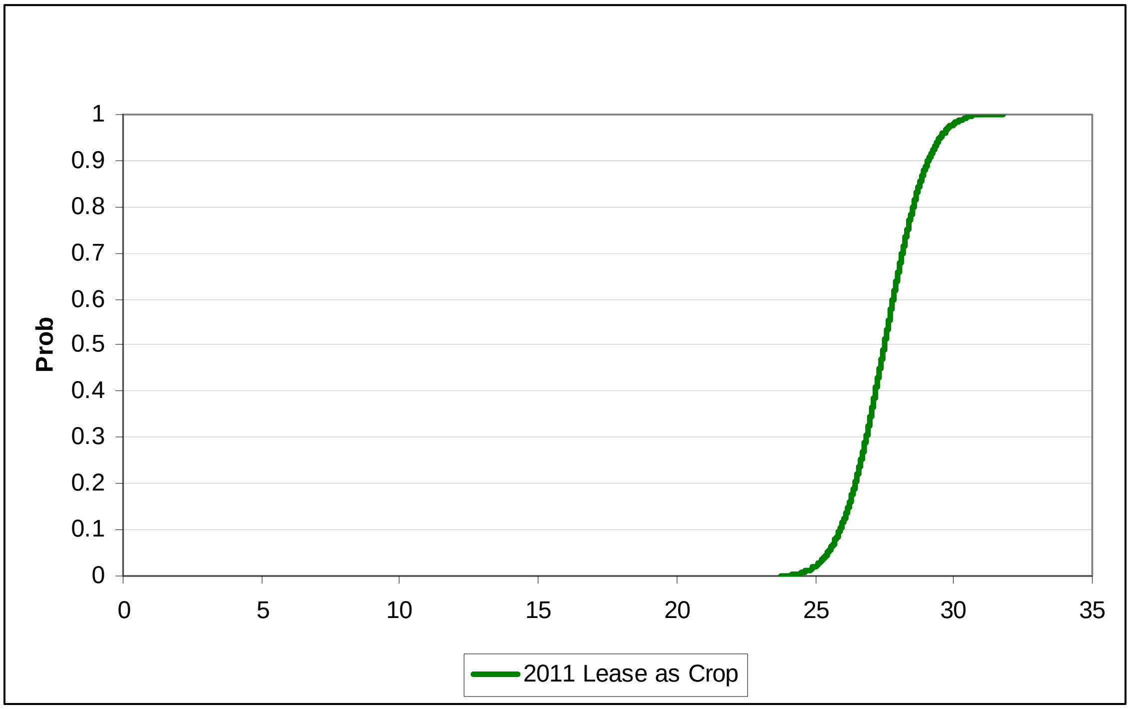

Figure 23. Deaf Smith County 2011, lease as cropland cumulative distribution function

Figure 24 shows an analysis of Stochastic Dominance with Respect to a Function (SDRF) ranking method. Figure 25 presents the Stochastic Efficiency with Respect to a Function (SERF) under a Negative Exponential Utility Function. Both SERF and SDRF indicate that re-enrollment in CRP is the most preferred option. The upper risk aversion coefficient (RAC) was calculated based on a wealth level equal to the county average market value per farm of land and buildings found in the 2007 Census of Agriculture conducted by the USDA, National Agricultural Statistics Service (USDA, NASS 2007). The lower RAC was set at zero to represent a risk neutral decision maker. Based on the selected RACs the decision maker would most prefer CRP enrollment at all risk aversion levels within the selected range.

Efficient Set Based on SDRF at

	Lower RAC	**0**
	Name	Level of Preference
1	2011 CRP	Most Preferred
2	2011 Lease as Crop	2nd Most Preferred
3	2011 Lease as Range	3rd Most Preferred
4	2011 Farm it	Least Preferred

Efficient Set Based on SDRF at

	Upper RAC	**2.94911E-06**
	Name	Level of Preference
1	2011 CRP	Most Preferred
2	2011 Lease as Crop	2nd Most Preferred
3	2011 Lease as Range	3rd Most Preferred
4	2011 Farm it	Least Preferred

Figure 24. Stochastic dominance with respect to a function ranking of four options for producers in Deaf Smith County 2011

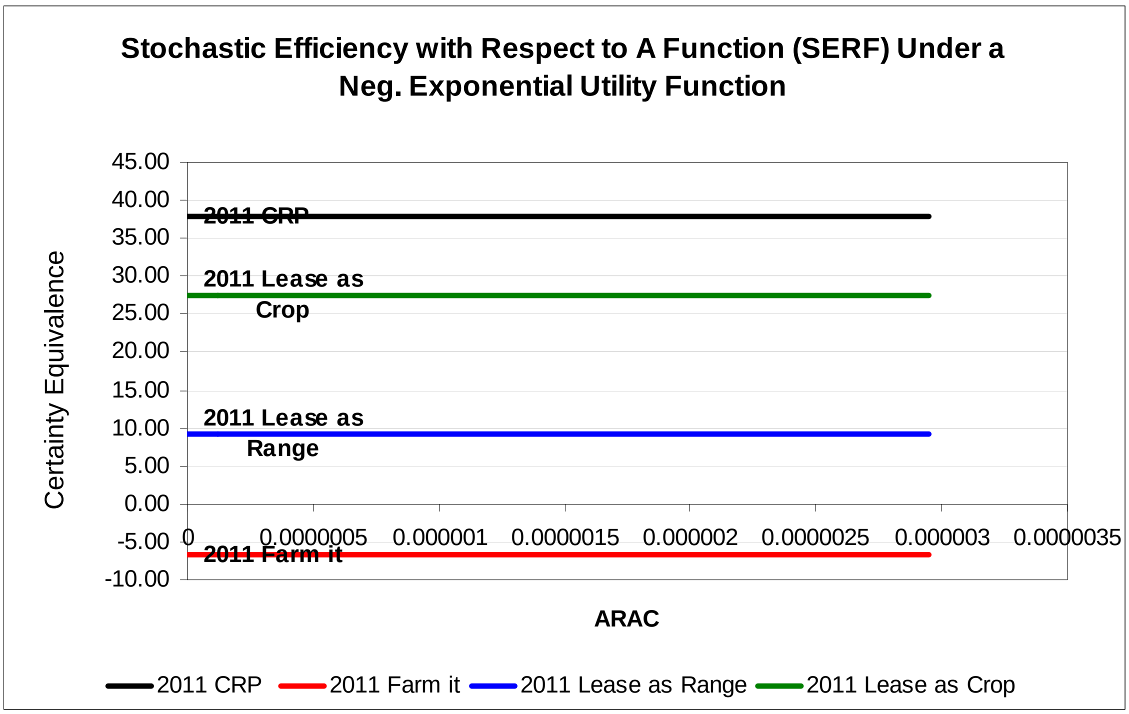

Figure 25. Stochastic efficiency with respect to a function ranking of four options for landowners in Deaf Smith County 2011

The stoplight ranking method was also used for evaluating a landowner's decision in Deaf Smith County. The stoplight ranking procedure is based on the probabilities of achieving selected favorable and unfavorable outcomes. The stoplight chart for Deaf Smith County 2011 is presented in Figure 26.

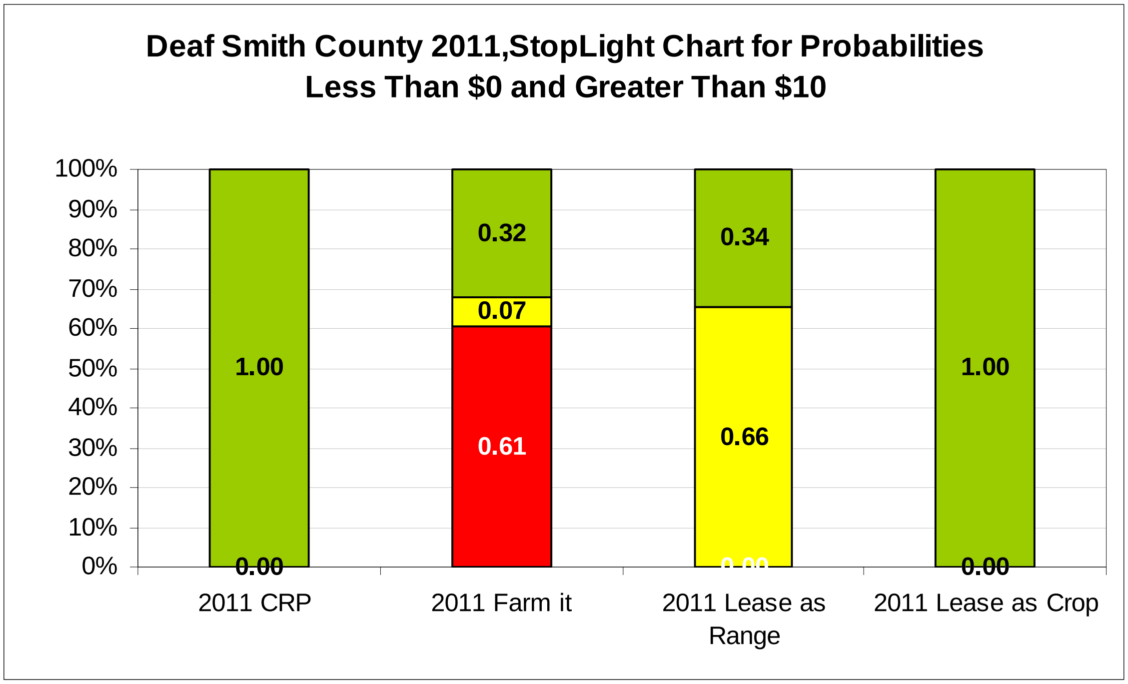

Figure 26. Stoplight chart summarizing the probabilities of returns per acre for landowners in Deaf Smith County (2011)

According to the stoplight chart, re-enrollment in CRP and leasing the land as cropland to a tenant have the highest probabilities of achieving at least $10 per acre net returns. Choosing to farm the CRP land as dryland wheat is associated with a 61% chance of realizing negative returns per acre as well as the lowest probability of realizing at least $10 per acre returns above direct expenses.

4.1.3. Lamb County

Each of the four options were simulated, and returns per acre for each of the options were generated from 2011-2015. South Plains AgriLife Extension economists predicted that if any CRP land was placed back into crop production the crop would most likely be dryland cotton; therefore, the "farm it" option refers to dryland cotton production. The stochastic KOVs for 500 iterations were analyzed. Simulation summary statistics were calculated and are presented in Table 30.

Table 30. Lamb County Simulation Summary Statistics

	2011 CRP	2011 Farm it	2011 Lease as Range	2011 Lease as Crop
Mean	37.085	-45.201	10.000	25.002
StDev	0.051	87.758	1.004	2.502
CV	0.137	-194.149	10.038	10.008
Min	36.957	-177.329	6.567	17.519
Max	37.135	263.179	13.174	33.581
	2012 CRP	**2012 Farm it**	**2012 Lease as Range**	**2012 Lease as Crop**
Mean	37.086	-55.614	10.001	25.001
StDev	0.048	88.692	0.999	2.500
CV	0.130	-159.479	9.987	10.000
Min	36.957	-212.151	7.079	17.644
Max	37.135	292.749	13.010	33.225
	2013 CRP	**2013 Farm it**	**2013 Lease as Range**	**2013 Lease as Crop**
Mean	37.086	-59.271	10.000	24.999
StDev	0.048	99.489	1.000	2.504
CV	0.131	-167.855	9.998	10.018
Min	36.957	-262.068	7.013	16.303
Max	37.135	273.374	13.041	32.830

Table 30. Continued

	2014 CRP	2014 Farm it	2014 Lease as Range	2014 Lease as Crop
Mean	37.085	-63.406	10.000	24.999
StDev	0.050	101.536	0.997	2.497
CV	0.136	-160.135	9.970	9.989
Min	36.957	-254.571	7.121	17.537
Max	37.135	282.646	12.922	32.472
	2015 CRP	**2015 Farm it**	**2015 Lease as Range**	**2015 Lease as Crop**
Mean	37.086	-64.108	10.000	25.000
StDev	0.049	101.639	1.000	2.504
CV	0.133	-158.542	9.997	10.015
Min	36.957	-249.554	6.780	17.192
Max	37.135	266.663	12.922	32.859

The results for Lamb county landowners were initially ranked by mean, standard deviation, worst case scenario, best case scenario, and relative risk. The most preferred option for each of these methods is presented in Table 31.

Table 31. Lamb County Ranking Matrix

	2011	2012	2013	2014	2015
Mean	CRP	CRP	CRP	CRP	CRP
Standard Deviation	CRP	CRP	CRP	CRP	CRP
Worst Case	CRP	CRP	CRP	CRP	CRP
Best Case	Farm it	Farm it	Farm it	Farm it	Farm it
Relative Risk	CRP	CRP	CRP	CRP	CRP

These rankings indicate that re-enrolling land in CRP is the most preferred option based on a mean only ranking, which assumes a risk neutral decision maker, because it returns the highest mean for each of the five years studied. According to the results, a ranking based on the lowest standard deviation would select re-enrollment in CRP as the

most preferred option for Lamb County. The simulation summary statistics indicate that re-enrolling land into CRP would result in the highest possible minimum return per acre making it the most preferred option for rankings based on worst case scenario. The option that generates the highest possible maximum return is farming dryland cotton making it the most preferred option under a best-case scenario. Ranking options based on relative risk selects as most preferred the option that has the lowest absolute coefficient of variation (CV). In this case, re-enrolling land in CRP returns the lowest relative risk.

A mean variance chart was created for Lamb County for 2011. Using the mean variance ranking method would indicate that CRP enrollment is the most preferred option due to the fact that there is no other option found in the southeast quadrant of the chart. Difficulties with graphing mean variance also occur in this county because the “farm it” option has a mean too low (-45) and a variance too high (7701) to be plotted in the same chart with the three other options. The “farm it” option is by far the least preferred option according to mean variance. The three remaining options with similar scales are plotted in Figure 27.

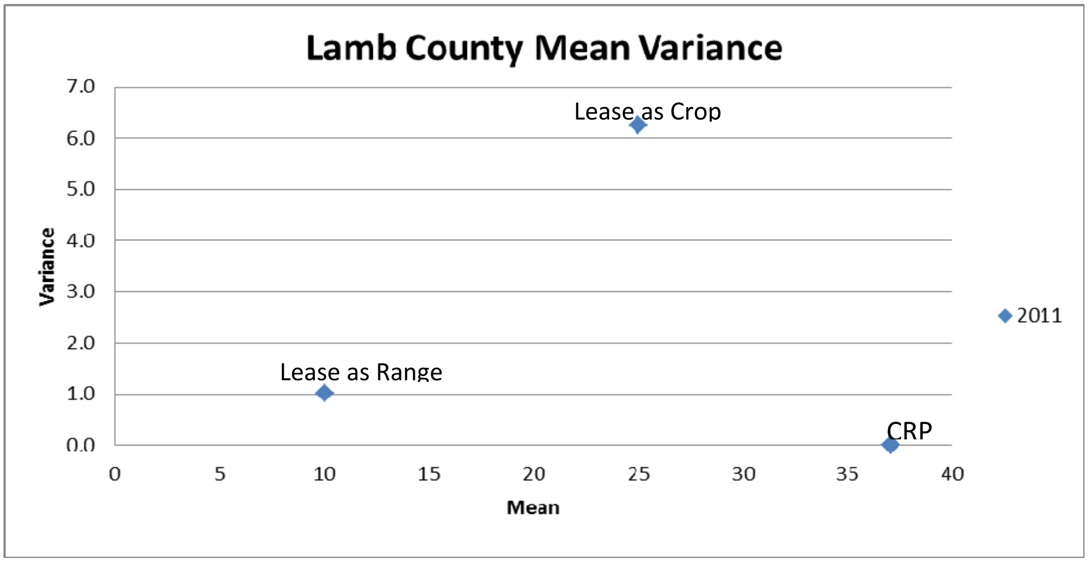

Figure 27. Lamb County mean variance

A cumulative distribution function (CDF) for each of the options in Lamb County is presented below. All four options are presented in one CDF for overall comparison as well as individual CDFs for a more detailed look. These CDFs are presented in Figures 28 – 32. Based on the fact that the CDFs cross, first degree stochastic dominance cannot be established. However, it can be noted based on the CDFs that choosing to farm the land has a much wider distribution of possible outcomes indicating more risk. The CDFs for each of five years are similar to the 2011 distribution. The CDFs presented below are for the year 2011. The CDFs for the remaining four years are located in Appendix A.

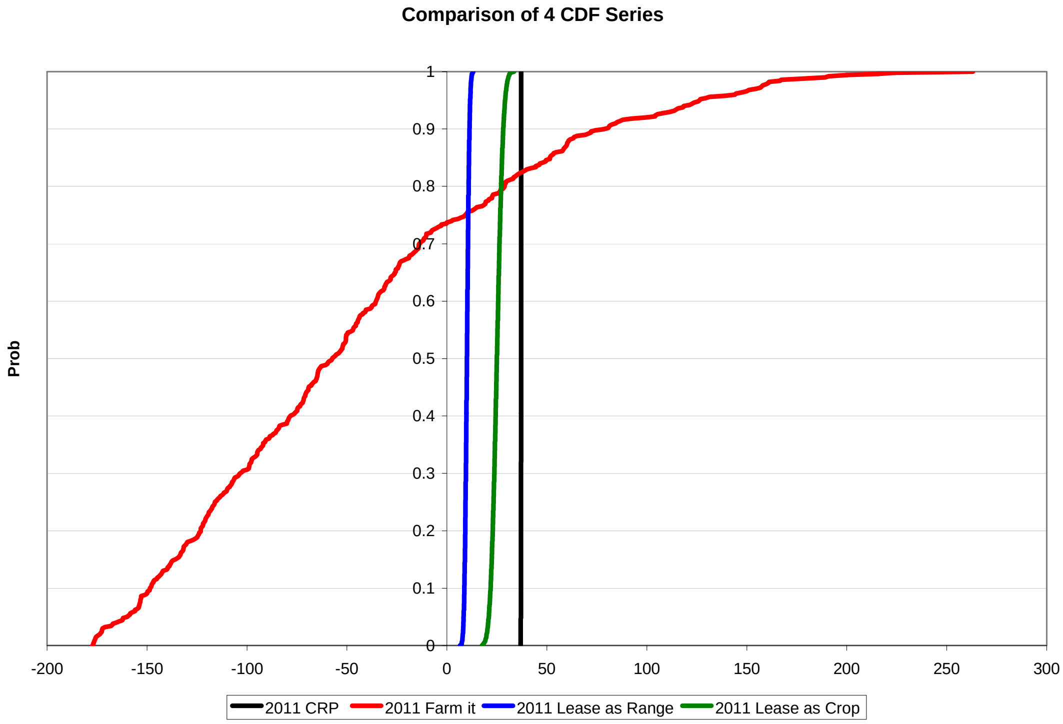

Figure 28. Lamb County 2011 returns per acre, cumulative distribution function

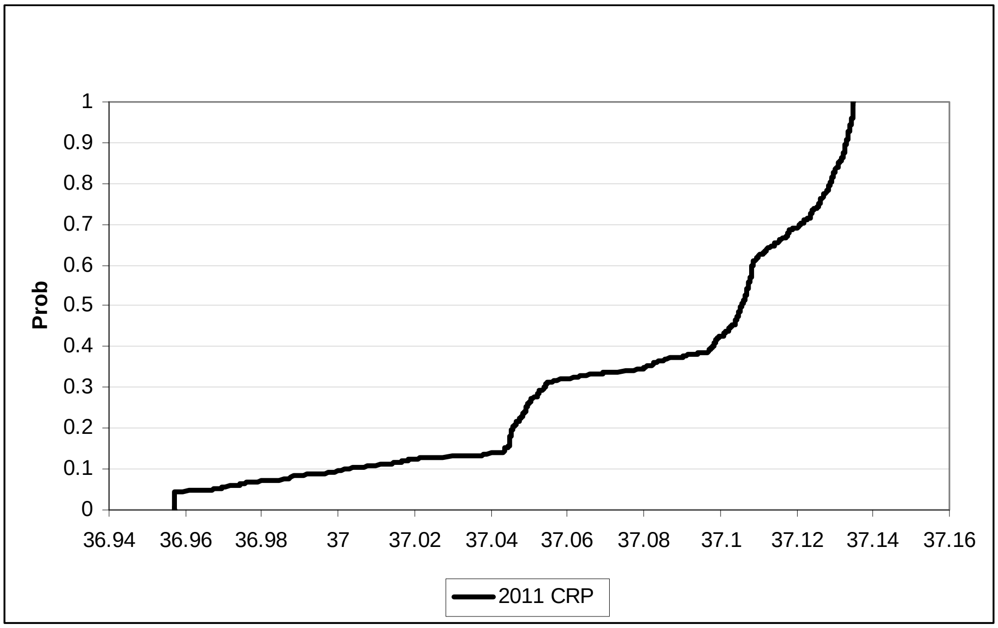

Figure 29. Lamb County 2011, conservation reserve program payments cumulative distribution function

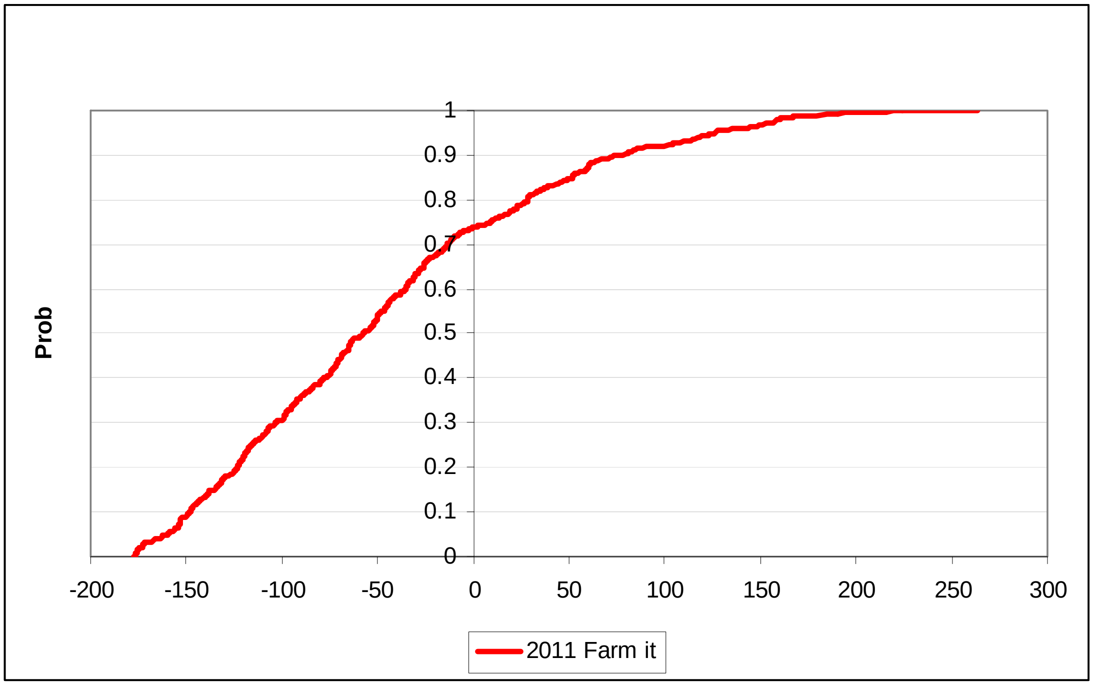

Figure 30. Lamb County 2011, dryland cotton production returns per acre cumulative distribution function

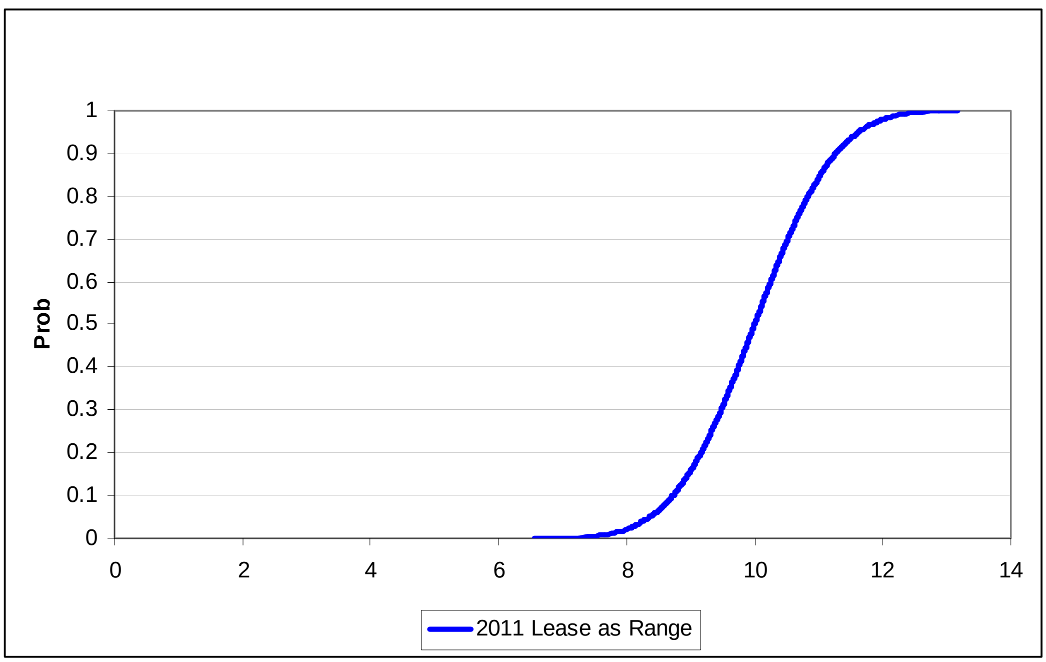

Figure 31. Lamb County 2011, lease as rangeland returns per acre cumulative distribution function

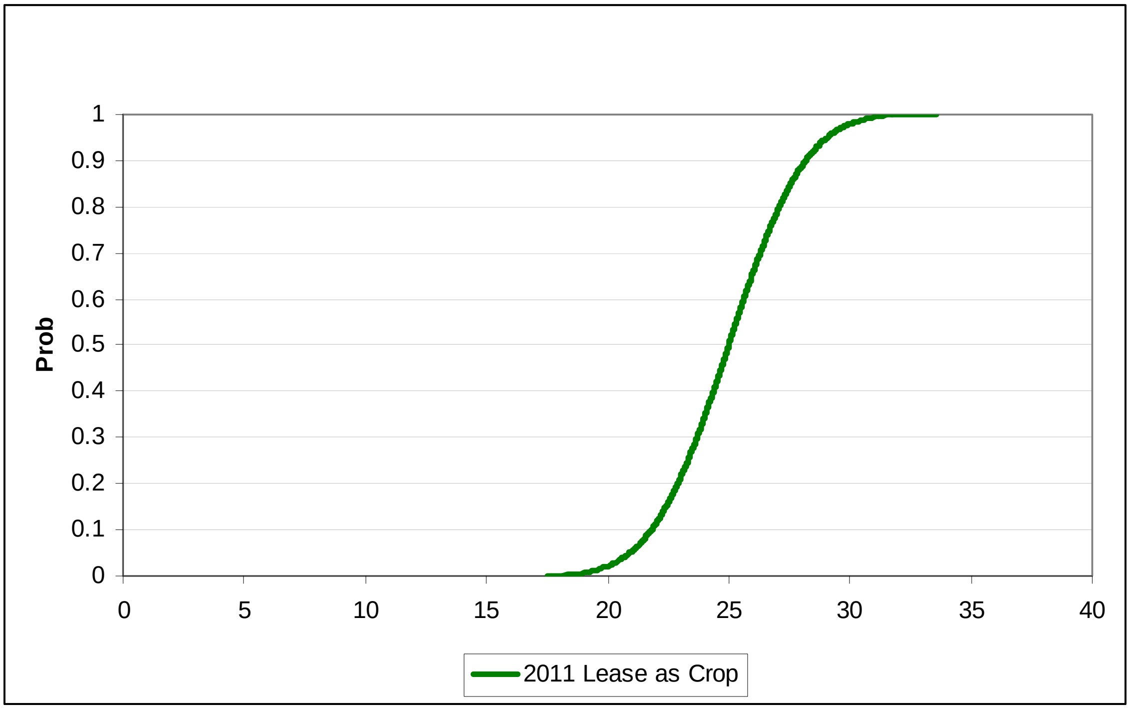

Figure 32. Lamb County 2011, lease as cropland cumulative distribution function

Figure 33 shows an analysis of Stochastic Dominance with Respect to a Function (SDRF) ranking method. Figure 34 presents the Stochastic Efficiency with Respect to a Function (SERF) under a Negative Exponential Utility Function. Both SERF and SDRF indicate that re-enrollment in CRP is the most preferred option. The upper risk aversion coefficient (RAC) was calculated based on a wealth level equal to the county average market value per farm of land and buildings found in the 2007 Census of Agriculture conducted by the USDA, National Agricultural Statistics Service (USDA, NASS 2007). The lower RAC was set at zero to represent a risk neutral decision maker. Based on the selected RACs the decision maker would most prefer CRP enrollment at all risk aversion levels within the selected range.

Efficient Set Based on SDRF at

	Lower RAC	**0**
	Name	Level of Preference
1	2011 CRP	Most Preferred
2	2011 Lease as Crop	2nd Most Preferred
3	2011 Lease as Range	3rd Most Preferred
4	2011 Farm it	Least Preferred

Efficient Set Based on SDRF at

	Upper RAC	**5.99626E-06**
	Name	Level of Preference
1	2011 CRP	Most Preferred
2	2011 Lease as Crop	2nd Most Preferred
3	2011 Lease as Range	3rd Most Preferred
4	2011 Farm it	Least Preferred

Figure 33. Stochastic dominance with respect to a function ranking of four options for producers in Lamb County 2011

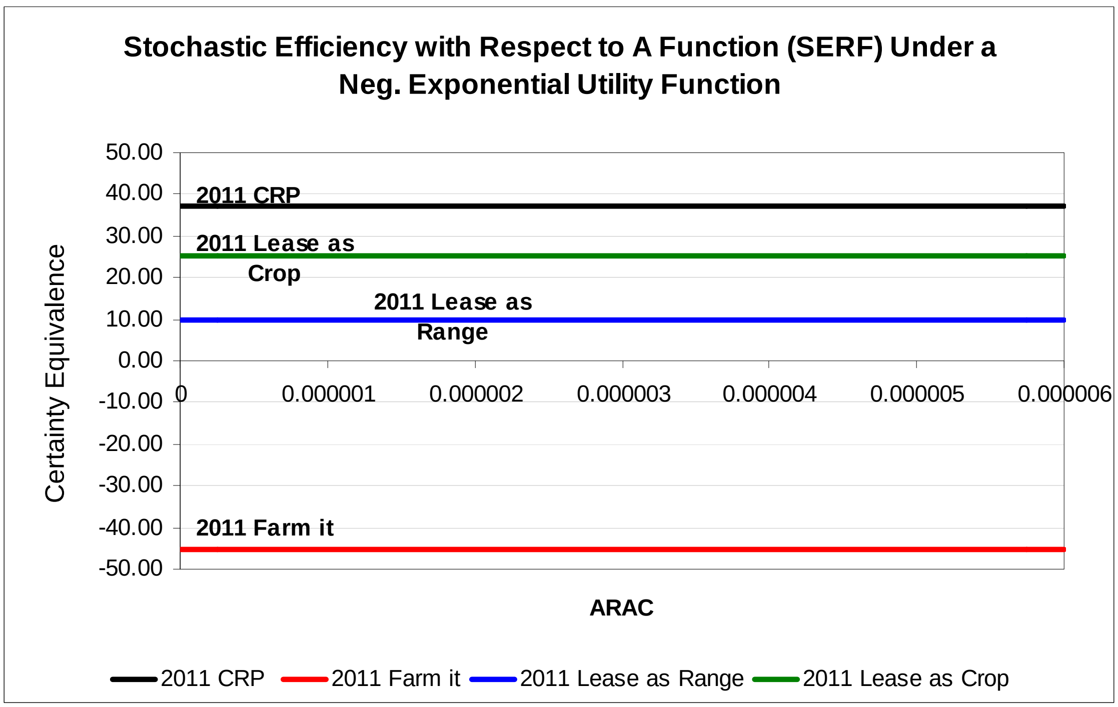

Figure 34. Stochastic efficiency with respect to a function ranking of four options for landowners in Lamb County 2011

The stoplight ranking method was also used for evaluating a landowner’s decision in Lamb County. The stoplight chart for Lamb County 2011 is presented in Figure 35.

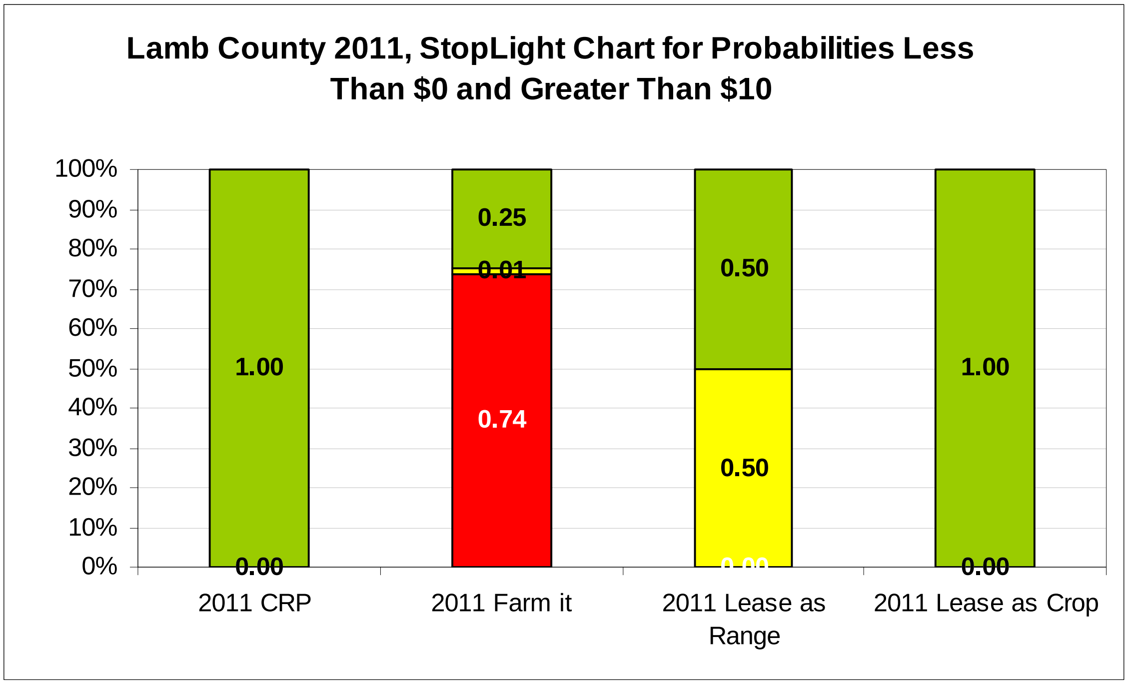

Figure 35. Stoplight chart summarizing the probabilities of returns per acre for landowners in Lamb County (2011)

According to the stoplight chart, re-enrollment in CRP and leasing the land as cropland to a tenant have the highest probabilities of achieving at least $10 per acre net returns. Choosing to farm the CRP land as dryland cotton is associated with a 74% chance of realizing negative returns per acre as well as the lowest probability of realizing at least $10 per acre returns above direct expenses.

4.1.4. Hale County

Each of the four options were simulated returns per acre for each of the options were generated from 2011-2015. . South Plains AgriLife Extension economists predicted that if any CRP land was placed back into crop production the crop would most likely be dryland cotton; therefore, the "farm it" option refers to dryland cotton production. Simulation summary statistics were calculated and are presented in Table 32.

Table 32. Hale County Simulation Summary Statistics

	2011 CRP	2011 Farm it	2011 Lease as Range	2011 Lease as Crop
Mean	37.984	-40.506	10.000	25.002
StDev	0.084	77.399	1.004	2.502
CV	0.220	-191.081	10.038	10.008
Min	37.789	-169.059	6.567	17.519
Max	38.111	244.329	13.174	33.581
	2012 CRP	**2012 Farm it**	**2012 Lease as Range**	**2012 Lease as Crop**
Mean	37.981	-49.120	10.001	25.001
StDev	0.089	82.315	0.999	2.500
CV	0.234	-167.578	9.987	10.000
Min	37.789	-215.498	7.079	17.644
Max	38.111	224.749	13.010	33.225
	2013 CRP	**2013 Farm it**	**2013 Lease as Range**	**2013 Lease as Crop**
Mean	37.984	-53.492	10.000	24.999
StDev	0.085	90.095	1.000	2.504
CV	0.223	-168.427	9.998	10.018
Min	37.789	-242.417	7.013	16.303
Max	38.111	261.288	13.041	32.830

Table 32. Continued

	2014 CRP	2014 Farm it	2014 Lease as Range	2014 Lease as Crop
Mean	37.982	-54.916	10.000	24.999
StDev	0.087	91.918	0.997	2.497
CV	0.229	-167.379	9.970	9.989
Min	37.789	-234.213	7.121	17.537
Max	38.111	257.169	12.922	32.472
	2015 CRP	**2015 Farm it**	**2015 Lease as Range**	**2015 Lease as Crop**
Mean	37.984	-59.111	10.000	25.000
StDev	0.084	89.661	1.000	2.504
CV	0.222	-151.682	9.997	10.015
Min	37.789	-255.838	6.780	17.192
Max	38.111	265.209	12.922	32.859

The results for Hale County landowners were initially ranked by mean, standard deviation, worst case scenario, best case scenario, and relative risk. The most preferred option for each of these methods is presented in Table 33.

Table 33. Hale County Ranking Matrix

	2011	2012	2013	2014	2015
Mean	CRP	CRP	CRP	CRP	CRP
Standard Deviation	CRP	CRP	CRP	CRP	CRP
Worst Case	CRP	CRP	CRP	CRP	CRP
Best Case	Farm it	Farm it	Farm it	Farm it	Farm it
Relative Risk	CRP	CRP	CRP	CRP	CRP

These rankings indicate that re-enrolling land in CRP is the most preferred option based on a mean only ranking, which assumes a risk neutral decision maker, because it returns the highest mean for each of the five years studied. According to the results, a ranking based on the lowest standard deviation would select re-enrollment in CRP as the most preferred option for Hale County. The simulation summary statistics indicate that re-enrolling land into CRP would result in the highest possible minimum return per acre making it the most preferred option for rankings based on worst case scenario. The option that generates the highest possible maximum return is farming dryland cotton making it the most preferred option under a best-case scenario. Ranking options based on relative risk selects as most preferred the option that has the lowest absolute coefficient of variation (CV). In this case, re-enrolling land in CRP returns the lowest relative risk.

A mean variance chart was created for Hale County for 2011. Using the mean variance ranking method would indicate that CRP enrollment is the most preferred option due to the fact that there is no other option found in the southeast quadrant of the chart. Difficulties with graphing mean variance also occur in this county because the “farm it” option has a mean too low (-40.51) and a variance too high (5991) to be plotted in the same chart with the three other options. The “farm it” option is by far the least preferred option according to mean variance. The three remaining options with similar scales are plotted in Figure 36.

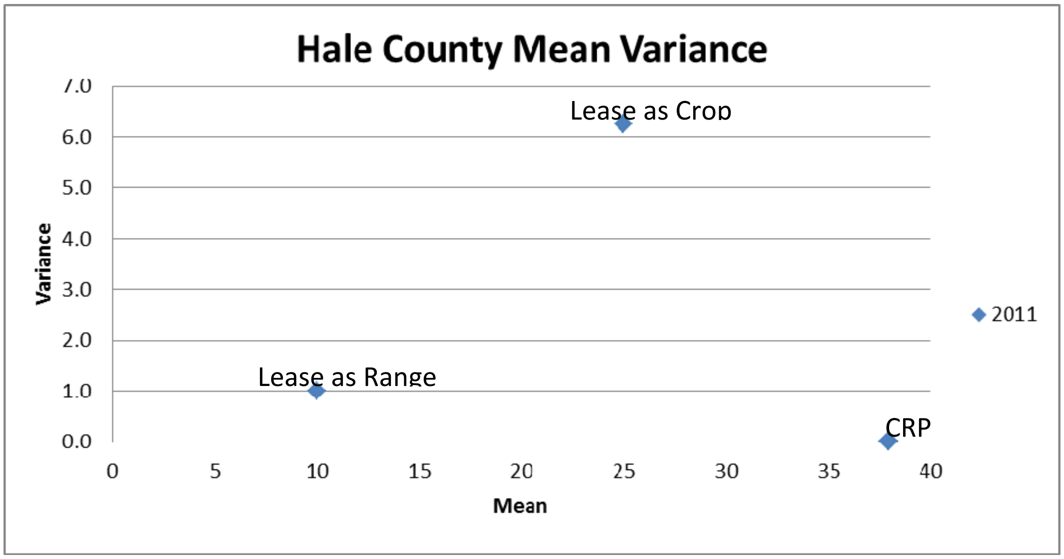

Figure 36. Hale County mean variance

A cumulative distribution function (CDF) for each of the options in Hale County is presented below. All four options are presented in one CDF for overall comparison as well as individual CDFs for a more detailed look. These CDFs are presented in Figures 37 – 41. Based on the fact that the CDFs cross, first degree stochastic dominance cannot be established. However, it can be noted based on the CDFs that choosing to farm the land has a much wider distribution of possible outcomes indicating more risk. The CDFs for each of five years are similar to the 2011 distribution. The CDFs presented below are for the year 2011. The CDFs for the remaining four years are located in Appendix A.

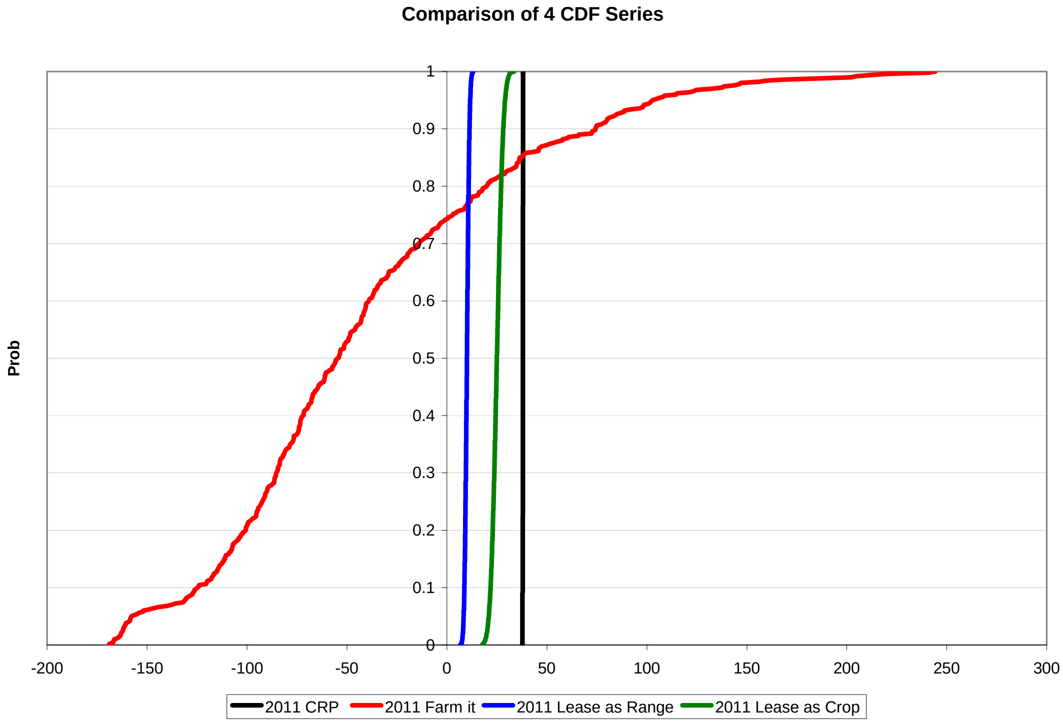

Figure 37. Hale County 2011 returns per acre, cumulative distribution function

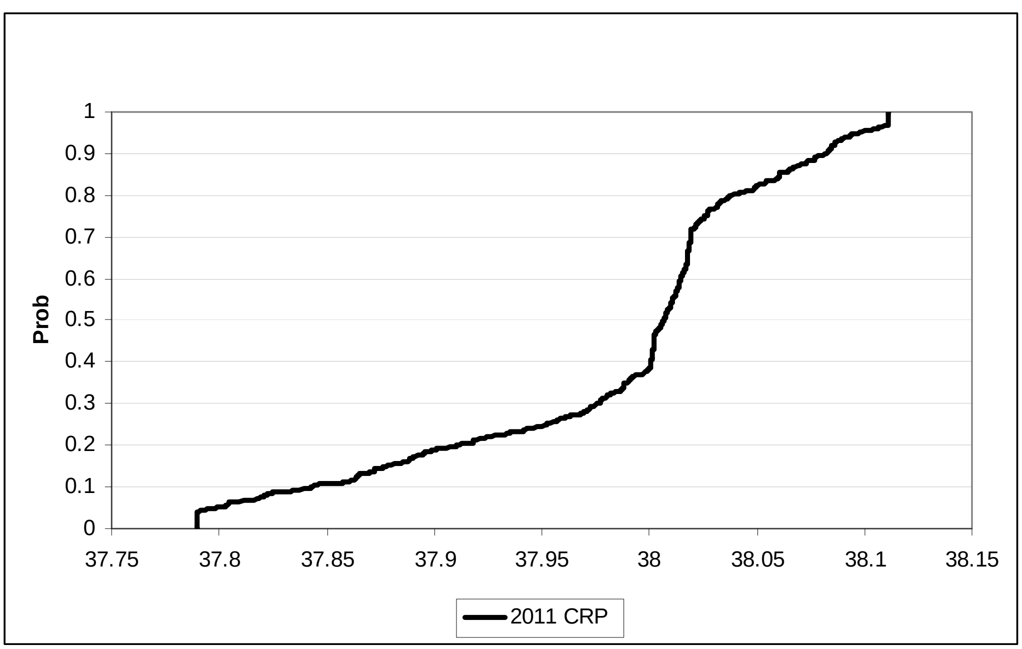

Figure 38. Hale County 2011, conservation reserve program payments cumulative distribution function

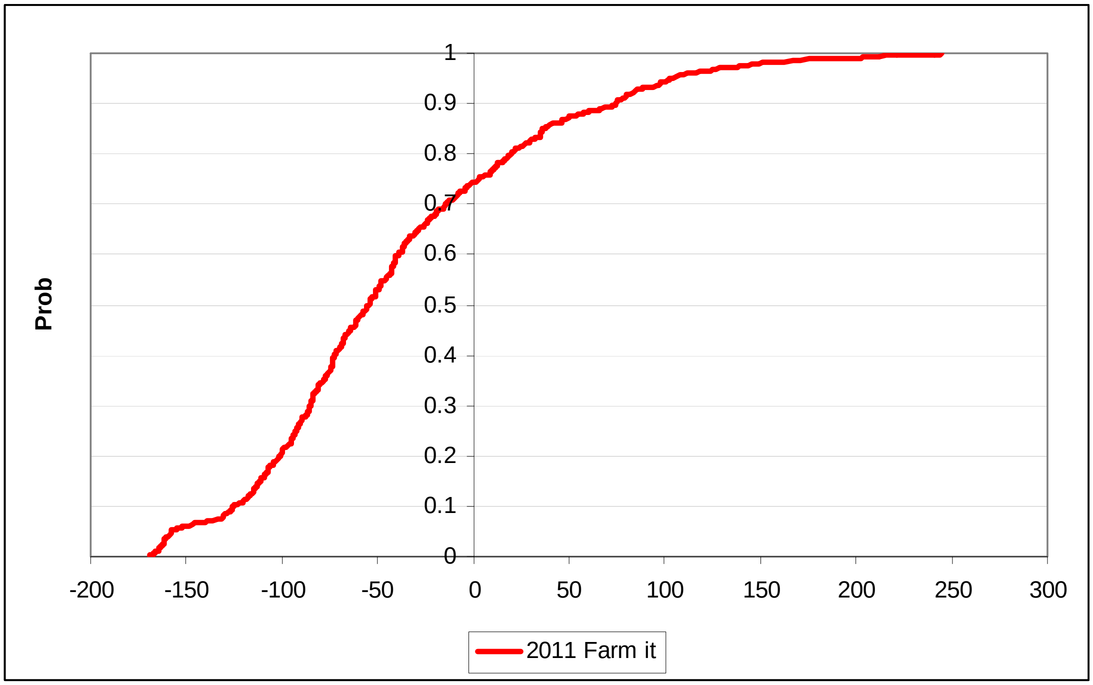

Figure 39. Hale County 2011, dryland cotton production returns per acre cumulative distribution function

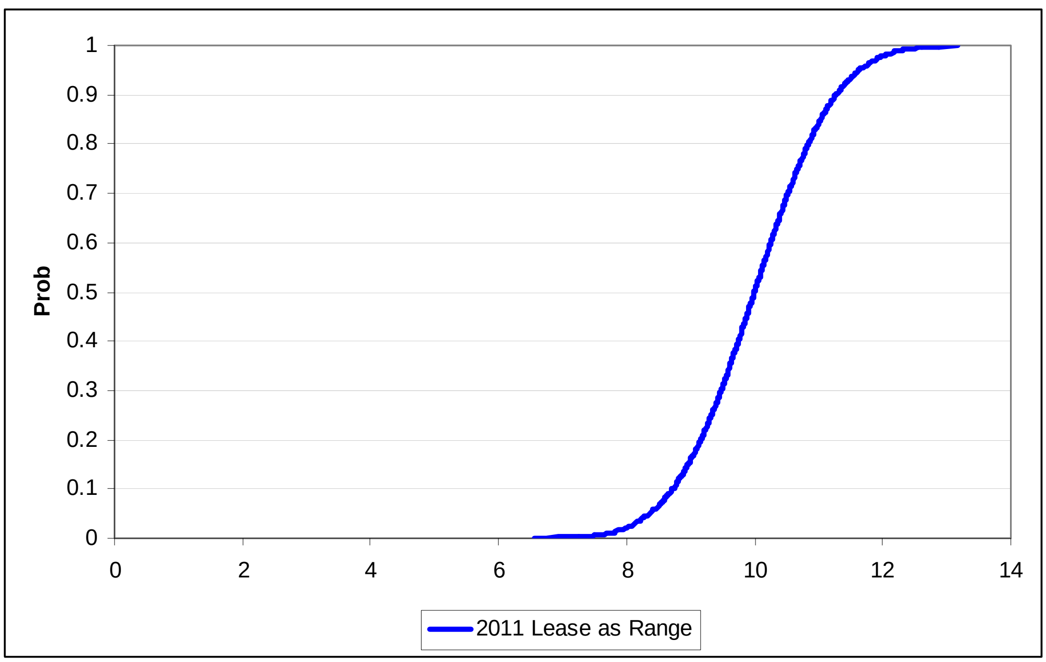

Figure 40. Hale County 2011, lease as rangeland returns per acre cumulative distribution function

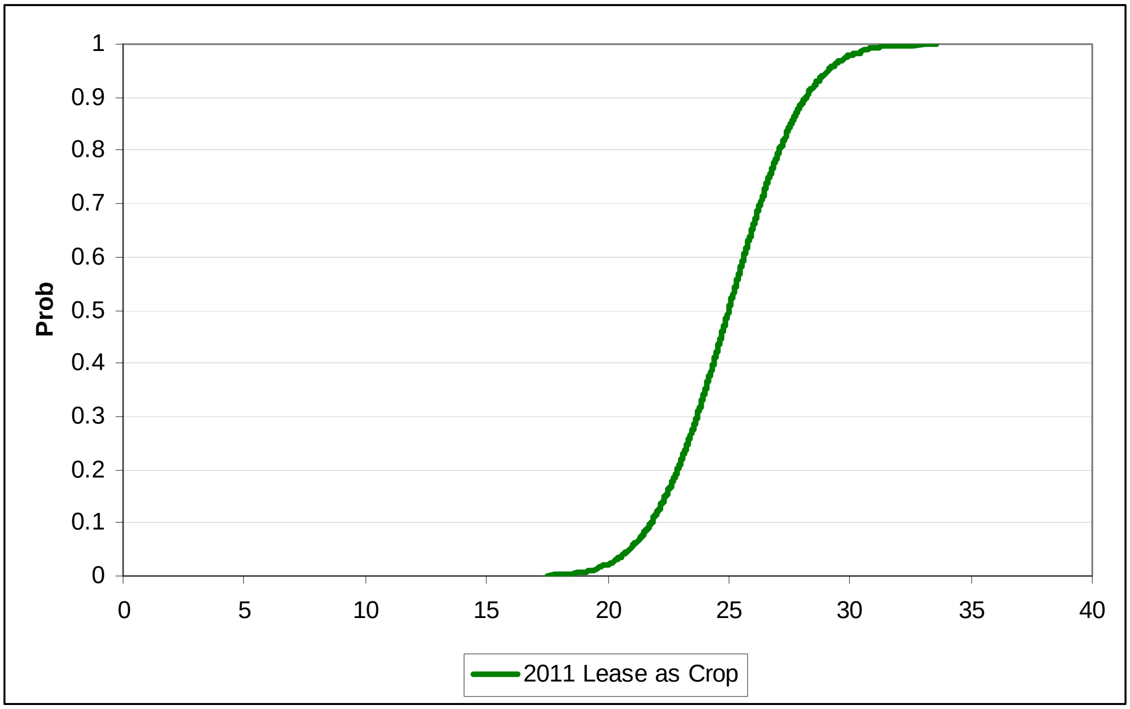

Figure 41. Hale County 2011, lease as cropland cumulative distribution function

Figure 42 shows an analysis of Stochastic Dominance with Respect to a Function (SDRF) ranking method. Figure 43 presents the Stochastic Efficiency with Respect to a Function (SERF) under a Negative Exponential Utility Function. Both SERF and SDRF indicate that re-enrollment in CRP is the most preferred option. The upper risk aversion coefficient (RAC) was calculated based on a wealth level equal to the county average market value per farm of land and buildings found in the 2007 Census of Agriculture conducted by the USDA, National Agricultural Statistics Service (USDA, NASS 2007). The lower RAC was set at zero to represent a risk neutral decision maker. Based on the selected RACs the decision maker would most prefer CRP enrollment at all risk aversion levels within the selected range.

Efficient Set Based on SDRF at

	Lower RAC	**0**
	Name	Level of Preference
1	2011 CRP	Most Preferred
2	2011 Lease as Crop	2nd Most Preferred
3	2011 Lease as Range	3rd Most Preferred
4	2011 Farm it	Least Preferred

Efficient Set Based on SDRF at

	Upper RAC	**5.61211E-06**
	Name	Level of Preference
1	2011 CRP	Most Preferred
2	2011 Lease as Crop	2nd Most Preferred
3	2011 Lease as Range	3rd Most Preferred
4	2011 Farm it	Least Preferred

Figure 42. Stochastic dominance with respect to a function ranking of four options for producers in Hale County 2011

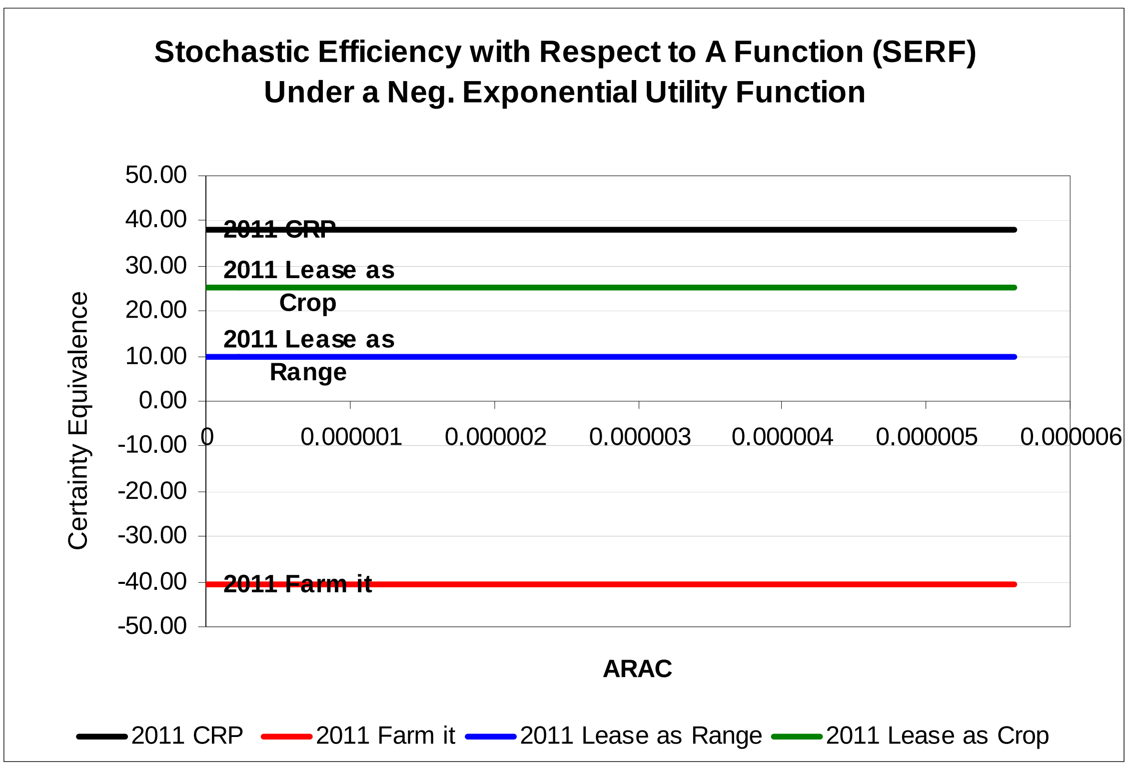

Figure 43. Stochastic efficiency with respect to a function ranking of four options for landowners in Hale County 2011

The stoplight ranking method was also used for evaluating a landowner's decision in Hale County. The stoplight chart for Hale County 2011 is presented in Figure 44.

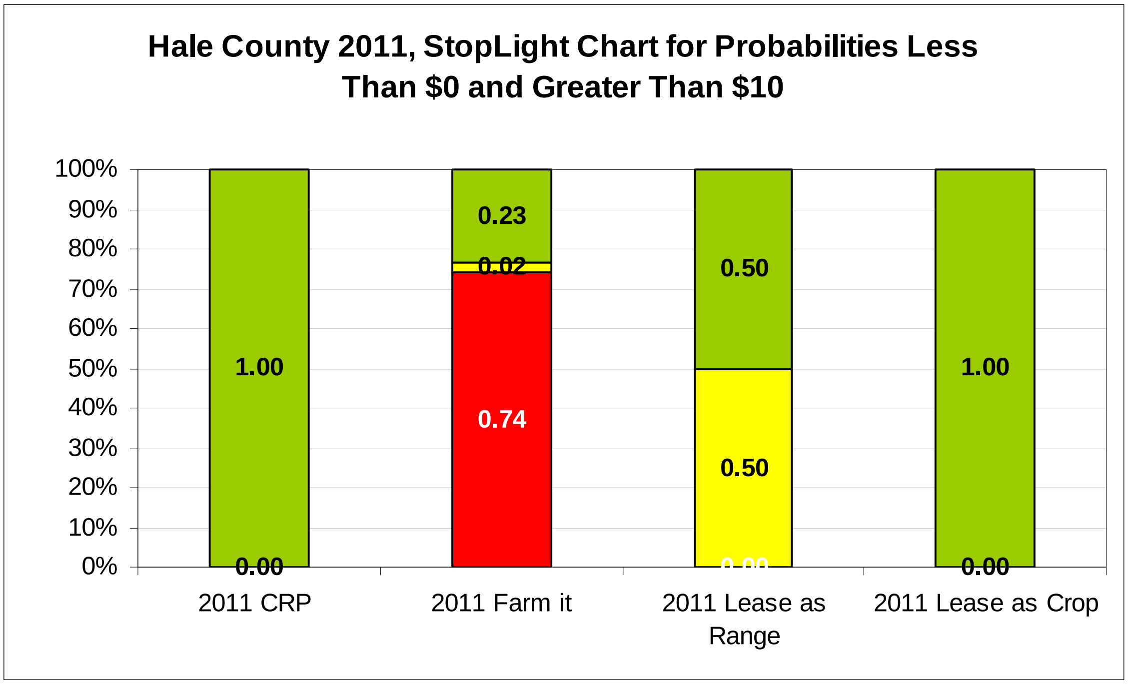

Figure 44. Stoplight chart summarizing the probabilities of returns per acre for landowners in Hale County (2011)

According to the stoplight chart, re-enrollment in CRP and leasing the land as cropland to a tenant have the highest probabilities of achieving at least $10 per acre net returns. Choosing to farm the CRP land as dryland cotton is associated with a 74% chance of realizing negative returns per acre as well as the lowest probability of realizing at least $10 per acre returns above direct expenses.

4.1.5. Floyd County

Each of the four options were simulated, and returns per acre for each of the options were generated from 2011-2015. South Plains AgriLife Extension economists predicted that if any CRP land was placed back into crop production the crop would most likely be dryland cotton; therefore, the "farm it" option refers to dryland cotton production. The stochastic KOVs for 500 iterations were analyzed. Simulation summary statistics were calculated and are presented in Table 34.

Table 34. Floyd County Simulation Summary Statistics

	2011 CRP	2011 Farm it	2011 Lease as Range	2011 Lease as Crop
Mean	38.557	12.451	10.000	25.002
StDev	0.167	104.043	1.004	2.502
CV	0.434	835.593	10.038	10.008
Min	38.142	-159.539	6.567	17.519
Max	38.805	391.369	13.174	33.581
	2012 CRP	**2012 Farm it**	**2012 Lease as Range**	**2012 Lease as Crop**
Mean	38.557	5.559	10.001	25.001
StDev	0.166	109.058	0.999	2.500
CV	0.430	1961.882	9.987	10.000
Min	38.142	-202.500	7.079	17.644
Max	38.805	405.399	13.010	33.225
	2013 CRP	**2013 Farm it**	**2013 Lease as Range**	**2013 Lease as Crop**
Mean	38.558	4.455	10.000	24.999
StDev	0.170	115.191	1.000	2.504
CV	0.440	2585.716	9.998	10.018
Min	38.142	-221.003	7.013	16.303
Max	38.805	369.682	13.041	32.830

Table 34. Continued

	2014 CRP	2014 Farm it	2014 Lease as Range	2014 Lease as Crop
Mean	38.558	5.920	10.000	24.999
StDev	0.170	121.778	0.997	2.497
CV	0.440	2057.163	9.970	9.989
Min	38.142	-218.875	7.121	17.537
Max	38.805	450.491	12.922	32.472
	2015 CRP	**2015 Farm it**	**2015 Lease as Range**	**2015 Lease as Crop**
Mean	38.559	8.475	10.000	25.000
StDev	0.166	123.648	1.000	2.504
CV	0.431	1458.956	9.997	10.015
Min	38.142	-239.597	6.780	17.192
Max	38.805	410.992	12.922	32.859

The results for Floyd County landowners were initially ranked by mean, standard deviation, worst case scenario, best case scenario, and relative risk. The most preferred option for each of these methods is presented in Table 35.

Table 35. Floyd County Ranking Matrix

	2011	2012	2013	2014	2015
Mean	CRP	CRP	CRP	CRP	CRP
Standard Deviation	CRP	CRP	CRP	CRP	CRP
Worst Case	CRP	CRP	CRP	CRP	CRP
Best Case	Farm it	Farm it	Farm it	Farm it	Farm it
Relative Risk	CRP	CRP	CRP	CRP	CRP

These rankings indicate that re-enrolling land in CRP is the most preferred option based on a mean only ranking, which assumes a risk neutral decision maker, because it returns the highest mean for each of the five years studied. According to the results, a ranking based on the lowest standard deviation would select re-enrollment in CRP as the

most preferred option for Floyd County. The simulation summary statistics indicate that re-enrolling land into CRP would result in the highest possible minimum return per acre making it the most preferred option for rankings based on worst case scenario. The option that generates the highest possible maximum return is farming dryland cotton making it the most preferred option under a best-case scenario. Ranking options based on relative risk selects as most preferred the option that has the lowest absolute coefficient of variation (CV). In this case, re-enrolling land in CRP returns the lowest relative risk.

A mean variance chart was created for Floyd County for 2011. Using the mean variance ranking method would indicate that CRP enrollment is the most preferred option due to the fact that there is no other option found in the southeast quadrant of the chart. Difficulties with graphing mean variance also occur in this county because the "farm it" option has a variance too high (10825) to be plotted in the same chart with the three other options. The "farm it" option is by far the least preferred option according to mean variance. The three remaining options with similar scales are plotted in Figure 45.

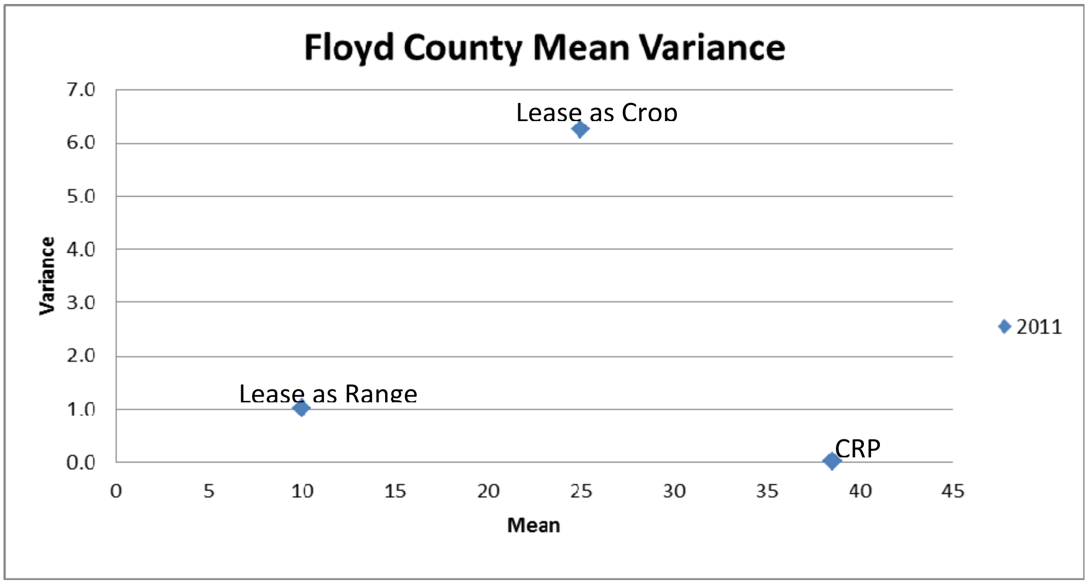

Figure 45. Floyd County mean variance

A cumulative distribution function (CDF) for each of the options in Floyd County is presented below. All four options are presented in one CDF for overall comparison as well as individual CDFs for a more detailed look. These CDFs are presented in Figures 46 – 50. Based on the fact that the CDFs cross, first degree stochastic dominance cannot be established. However, it can be noted based on the CDFs that choosing to farm the land has a much wider distribution of possible outcomes indicating more risk. The CDFs for each of five years are similar to the 2011 distribution. The CDFs presented below are for the year 2011. The CDFs for the remaining four years are located in Appendix A.

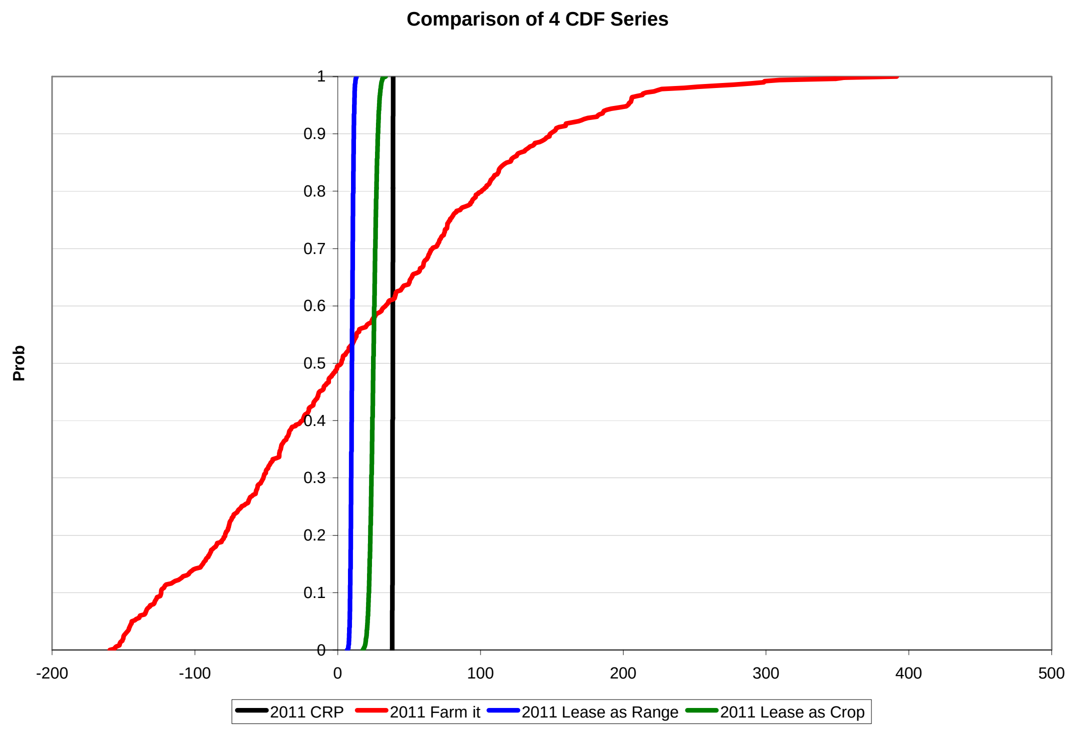

Figure 46. Floyd County 2011 returns per acre, cumulative distribution function

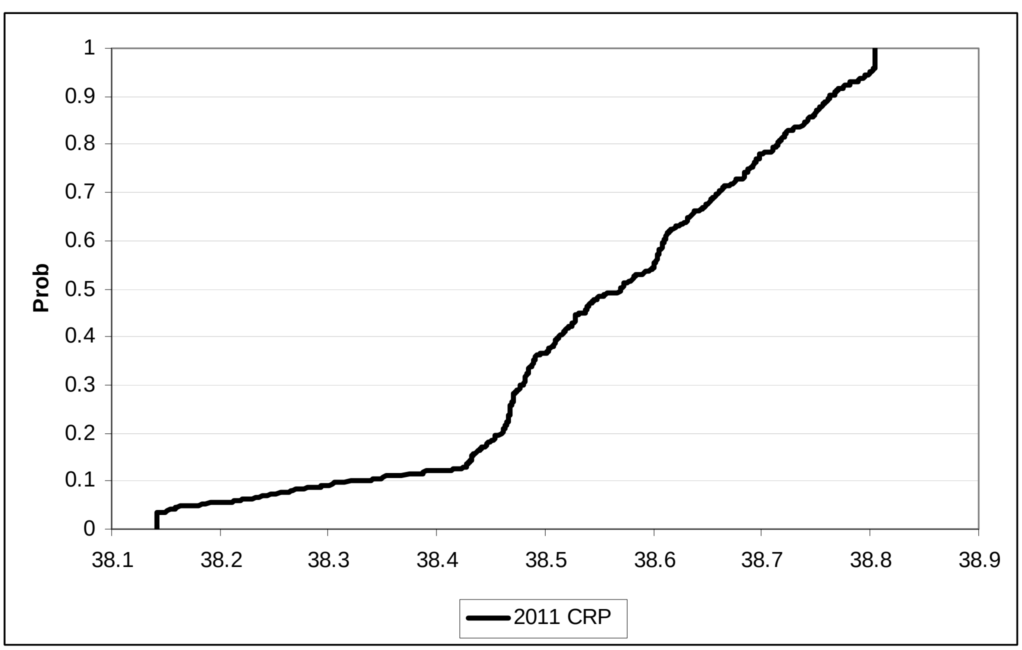

Figure 47. Floyd County 2011, conservation reserve program payments cumulative distribution function

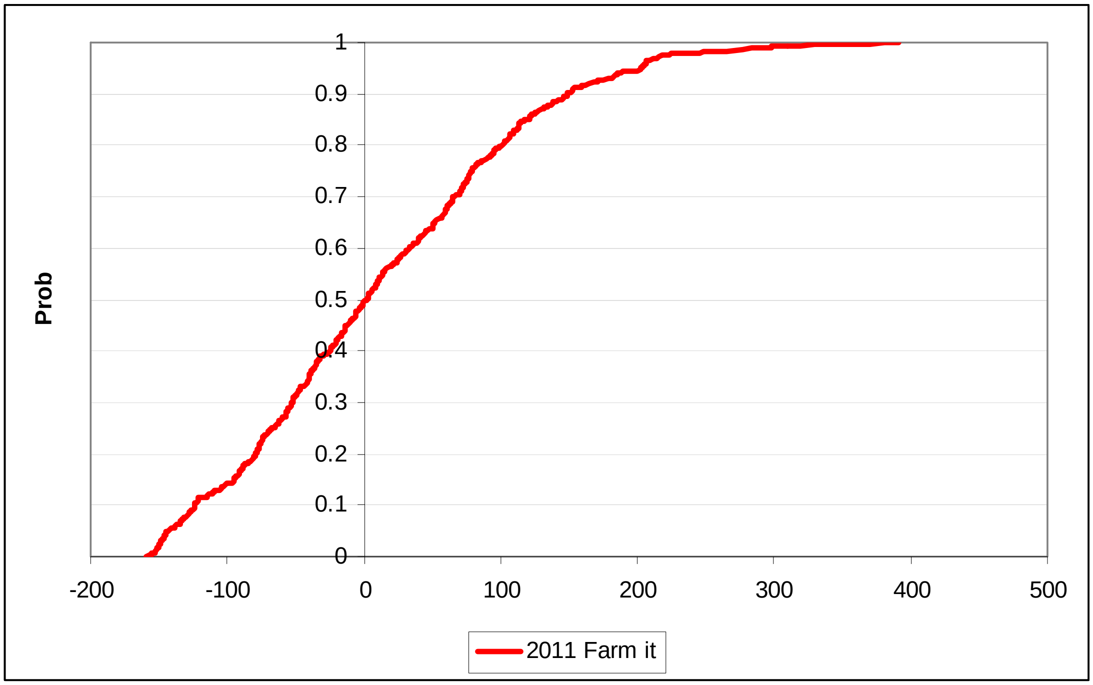

Figure 48. Floyd County 2011, dryland cotton production returns per acre cumulative distribution function

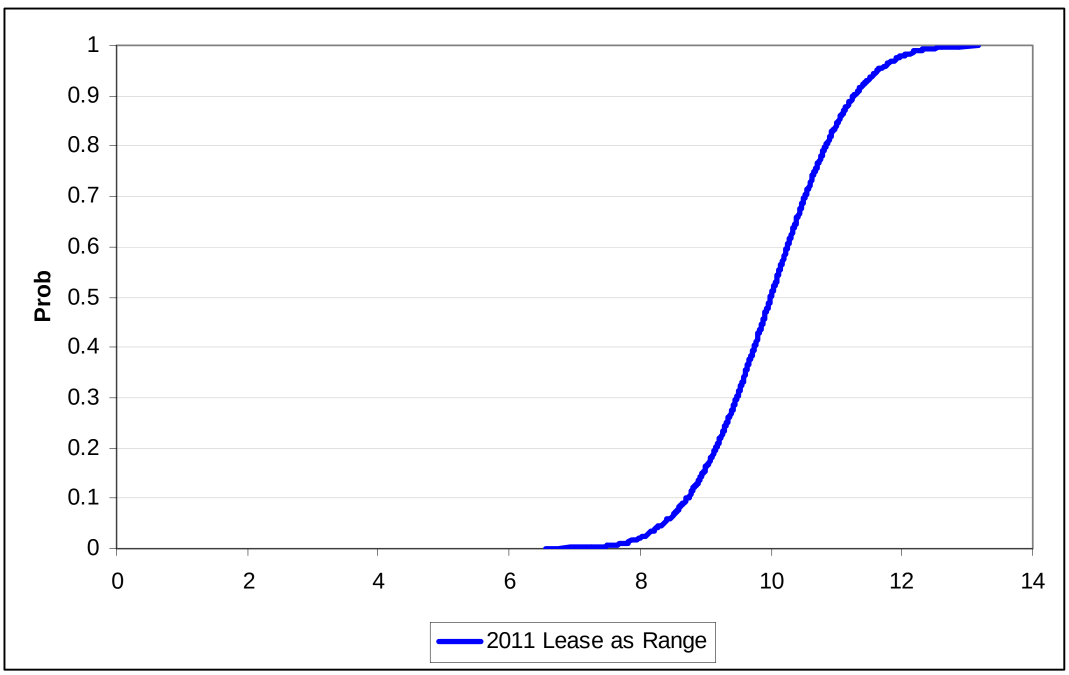

Figure 49. Floyd County 2011, lease as rangeland returns per acre cumulative distribution function

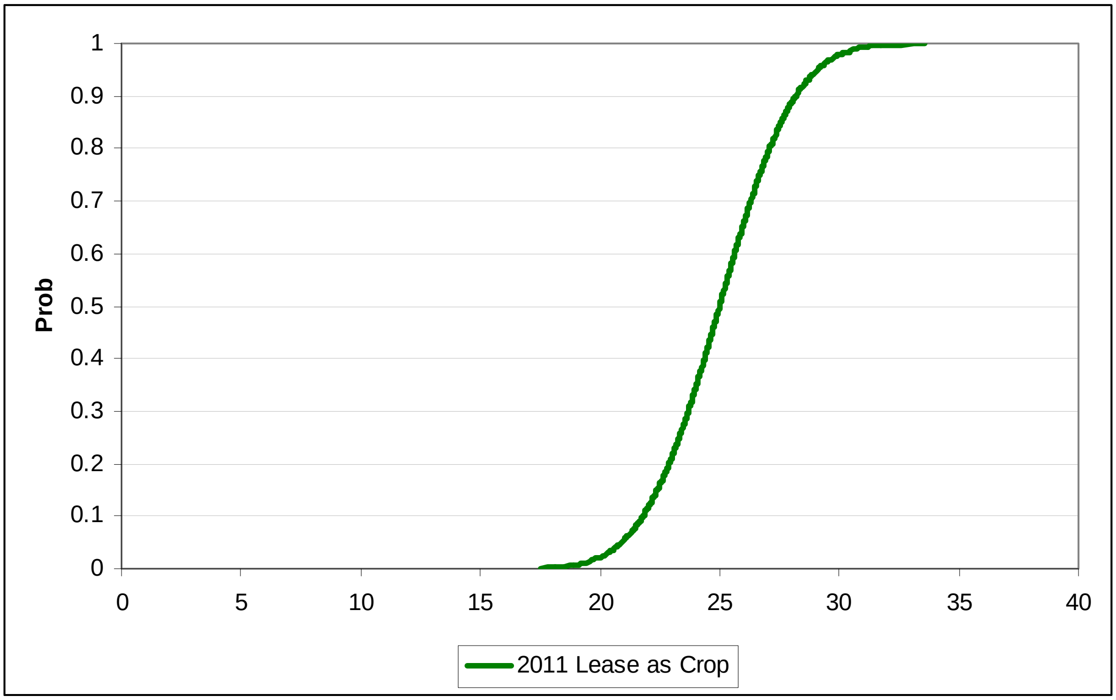

Figure 50. Floyd County 2011, lease as cropland cumulative distribution function

Figure 51 shows an analysis of Stochastic Dominance with Respect to a Function (SDRF) ranking method. Figure 52 presents the Stochastic Efficiency with Respect to a Function (SERF) under a Negative Exponential Utility Function. Both SERF and SDRF indicate that re-enrollment in CRP is the most preferred option. The upper risk aversion coefficient (RAC) was calculated based on a wealth level equal to the county average market value per farm of land and buildings found in the 2007 Census of Agriculture conducted by the USDA, National Agricultural Statistics Service (USDA, NASS 2007). The lower RAC was set at zero to represent a risk neutral decision maker. Based on the selected RACs the decision maker would most prefer CRP enrollment at all risk aversion levels within the selected range.

	Efficient Set Based on SDRF at	
	Lower RAC	**0**
	Name	Level of Preference
1	2011 CRP	Most Preferred
2	2011 Lease as Crop	2nd Most Preferred
3	2011 Farm it	3rd Most Preferred
4	2011 Lease as Range	Least Preferred

	Efficient Set Based on SDRF at	
	Upper RAC	**4.10357E-06**
	Name	Level of Preference
1	2011 CRP	Most Preferred
2	2011 Lease as Crop	2nd Most Preferred
3	2011 Farm it	3rd Most Preferred
4	2011 Lease as Range	Least Preferred

Figure 51. Stochastic dominance with respect to a function ranking of four options for producers in Floyd County 2011

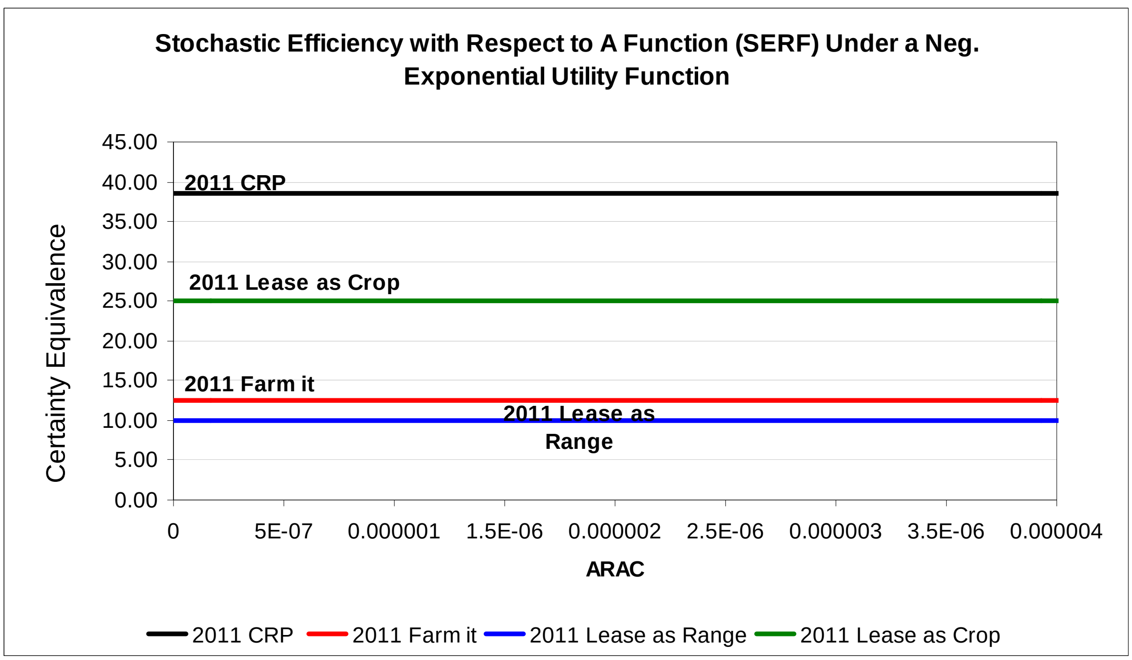

Figure 52. Stochastic efficiency with respect to a function ranking of four options for landowners in Floyd County 2011

The stoplight ranking method was also used for evaluating a landowner's decision in Floyd County. The stoplight chart for Floyd County 2011 is presented in Figure 53.

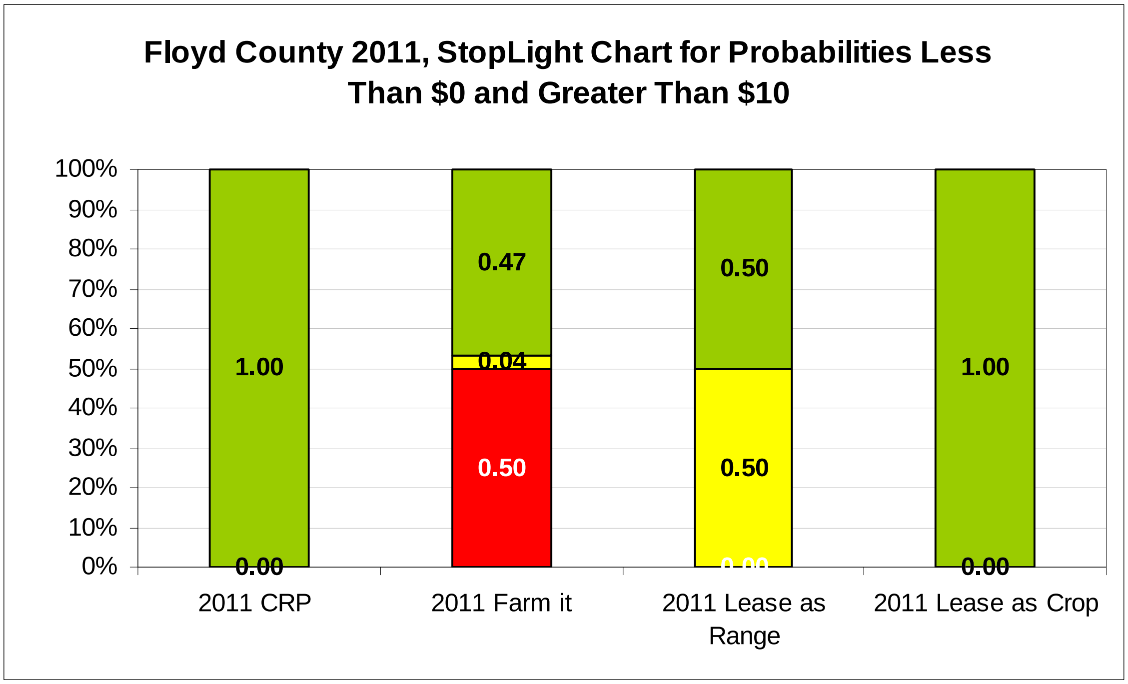

Figure 53. Stoplight chart summarizing the probabilities of returns per acre for landowners in Floyd County (2011)

According to the stoplight chart, re-enrollment in CRP and leasing the land as cropland to a tenant have the highest probabilities of achieving at least $10 per acre net returns. Choosing to farm the CRP land as dryland cotton is associated with a 50% chance of realizing negative net returns per acre as well as the lowest probability of realizing at least $10 per acre returns above direct expenses.

4.1.6. Dallam County

Each of the four options were simulated, and returns per acre for each of the options were generated from 2011-2015. Dallam County is one of two counties in the study area located in the Panhandle AgriLife Extension District. District extension economists predicted that if any CRP land was placed back into crop production the crop would most likely be dryland wheat; therefore, the "farm it" option refers to dryland wheat production. The stochastic KOVs for 500 iterations were analyzed. Simulation summary statistics were calculated and are presented in Table 36.

Table 36. Dallam County Simulation Summary Statistics

	2011 CRP	2011 Farm it	2011 Lease as Range	2011 Lease as Crop
Mean	34.188	-9.179	9.300	27.501
StDev	0.195	46.570	1.514	1.251
CV	0.570	-507.341	16.276	4.549
Min	33.996	-88.127	3.492	23.759
Max	34.581	124.786	13.468	31.790
	2012 CRP	**2012 Farm it**	**2012 Lease as Range**	**2012 Lease as Crop**
Mean	34.180	-13.381	9.301	27.501
StDev	0.185	46.782	1.505	1.250
CV	0.542	-349.617	16.183	4.546
Min	33.996	-102.399	4.389	23.822
Max	34.581	123.326	13.263	31.612
	2013 CRP	**2013 Farm it**	**2013 Lease as Range**	**2013 Lease as Crop**
Mean	34.180	-15.241	9.301	27.499
StDev	0.193	48.162	1.507	1.252
CV	0.563	-316.000	16.203	4.553
Min	33.996	-110.945	4.273	23.151
Max	34.581	125.424	13.301	31.415

Table 36. Continued

	2014 CRP	2014 Farm it	2014 Lease as Range	2014 Lease as Crop
Mean	34.177	-17.885	9.301	27.499
StDev	0.189	49.781	1.503	1.249
CV	0.552	-278.335	16.157	4.540
Min	33.996	-115.137	4.462	23.769
Max	34.581	127.048	13.153	31.236
	2015 CRP	**2015 Farm it**	**2015 Lease as Range**	**2015 Lease as Crop**
Mean	34.186	-21.466	9.300	27.500
StDev	0.193	49.116	1.508	1.252
CV	0.565	-228.813	16.213	4.552
Min	33.996	-132.896	3.865	23.596
Max	34.581	138.557	13.152	31.429

The results for Dallam County landowners were initially ranked by mean, standard deviation, worst case scenario, best case scenario, and relative risk. The most preferred option for each of these methods is presented in Table 37.

Table 37. Dallam County Ranking Matrix

	2011	2012	2013	2014	2015
Mean	CRP	CRP	CRP	CRP	CRP
Standard Deviation	CRP	CRP	CRP	CRP	CRP
Worst Case	CRP	CRP	CRP	CRP	CRP
Best Case	Farm it	Farm it	Farm it	Farm it	Farm it
Relative Risk	CRP	CRP	CRP	CRP	CRP

These rankings indicate that re-enrolling land in CRP is the most preferred option based on a mean only ranking, which assumes a risk neutral decision maker, because it returns the highest mean for each of the five years studied. According to the results, a ranking based on the lowest standard deviation would select re-enrollment in CRP as the

most preferred option for Dallam County. The simulation summary statistics indicate that re-enrolling land into CRP would result in the highest possible minimum return per acre making it the most preferred option for rankings based on worst case scenario. The option that generates the highest possible maximum return is farming dryland wheat making it the most preferred option under a best-case scenario. Ranking options based on relative risk selects as most preferred the option that has the lowest absolute coefficient of variation (CV). In this case, re-enrolling land in CRP returns the lowest relative risk.

A mean variance chart was created for Dallam County for 2011. Using the mean variance ranking method would indicate that CRP enrollment is the most preferred option due to the fact that there is no other option found in the southeast quadrant of the chart. Difficulties with graphing mean variance also occur in this county because the "farm it" option has a variance too high (2169) to be plotted in the same chart with the three other options. The "farm it" option is by far the least preferred option according to mean variance. The three remaining options with similar scales are plotted in Figure 54.

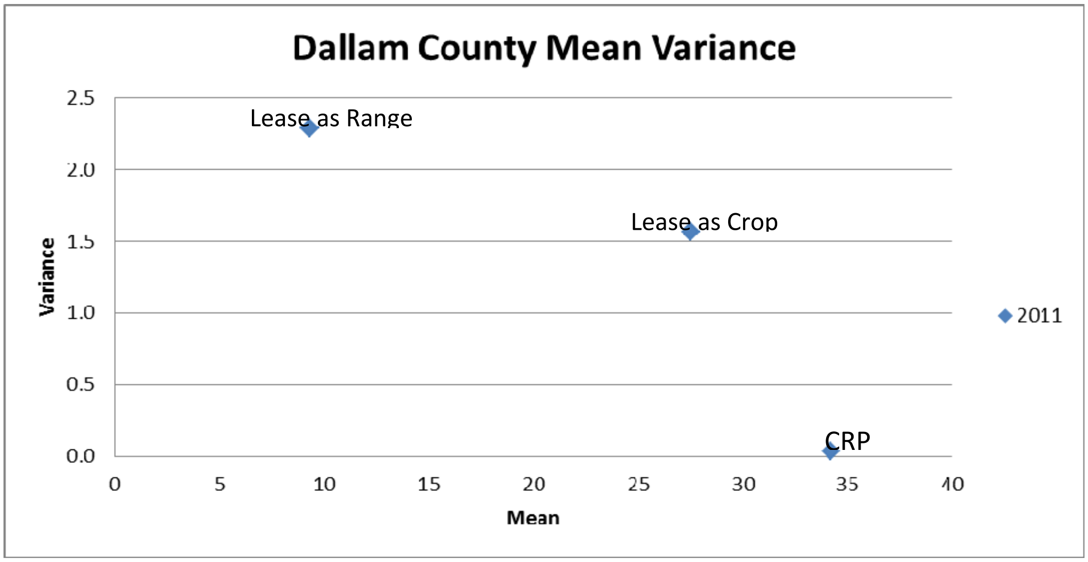

Figure 54. Dallam County mean variance

A cumulative distribution function (CDF) for each of the options in Dallam County is presented below. All four options are presented in one CDF for overall comparison as well as individual CDFs for a more detailed look. These CDFs are presented in Figures 55 – 59. Based on the fact that the CDFs cross, first degree stochastic dominance cannot be established. However, it can be noted based on the CDFs that choosing to farm the land has a much wider distribution of possible outcomes indicating more risk. The CDFs for each of five years are similar to the 2011 distribution. The CDFs presented below are for the year 2011. The CDFs for the remaining four years are located in Appendix A.

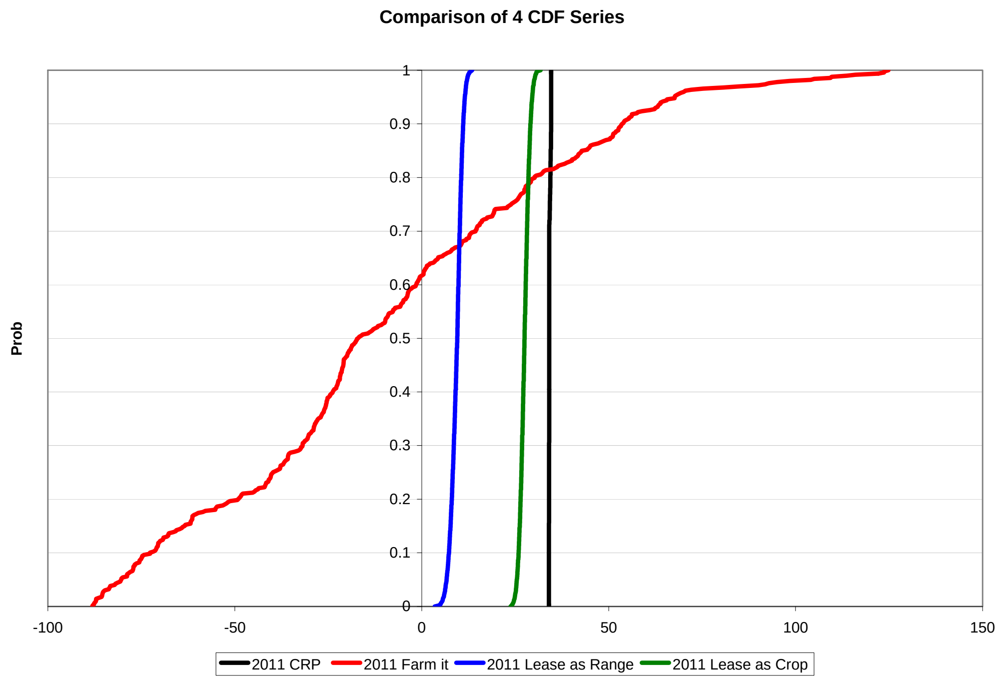

Figure 55. Dallam County 2011 returns per acre, cumulative distribution function

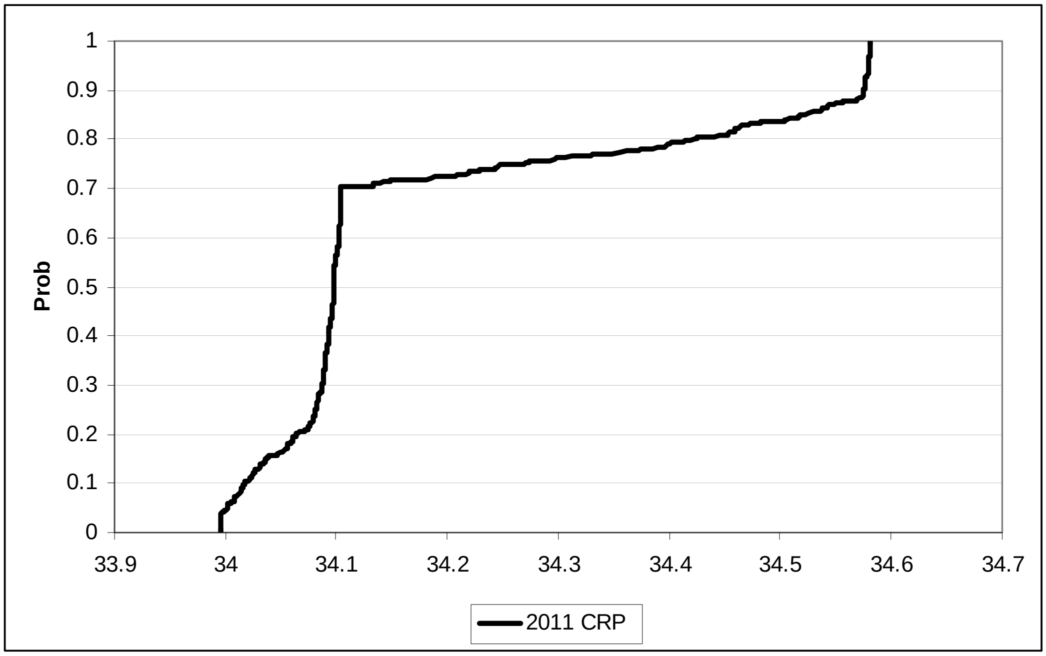

Figure 56. Dallam County 2011, conservation reserve program payments cumulative distribution function

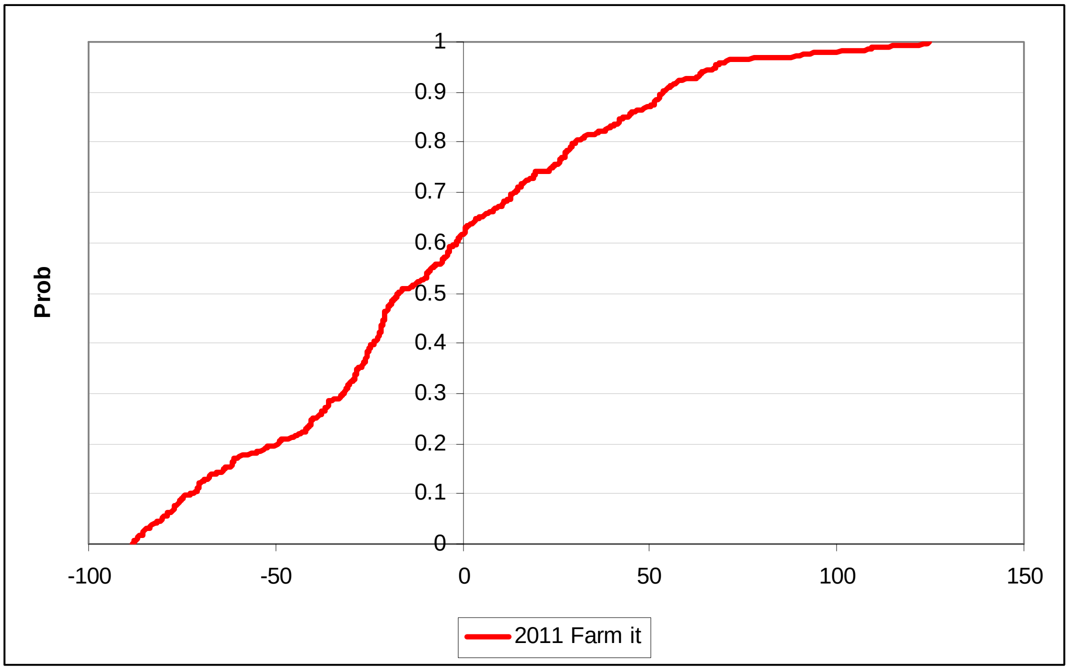

Figure 57. Dallam County 2011, dryland wheat production returns per acre cumulative distribution function

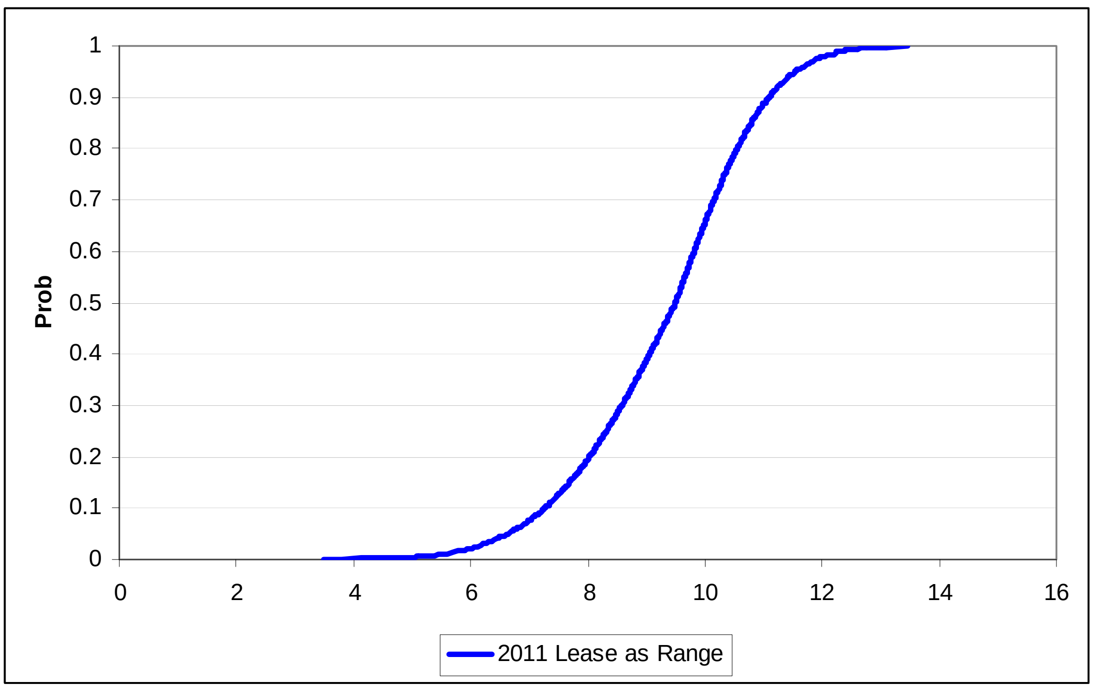

Figure 58. Dallam County 2011, lease as rangeland returns per acre cumulative distribution function

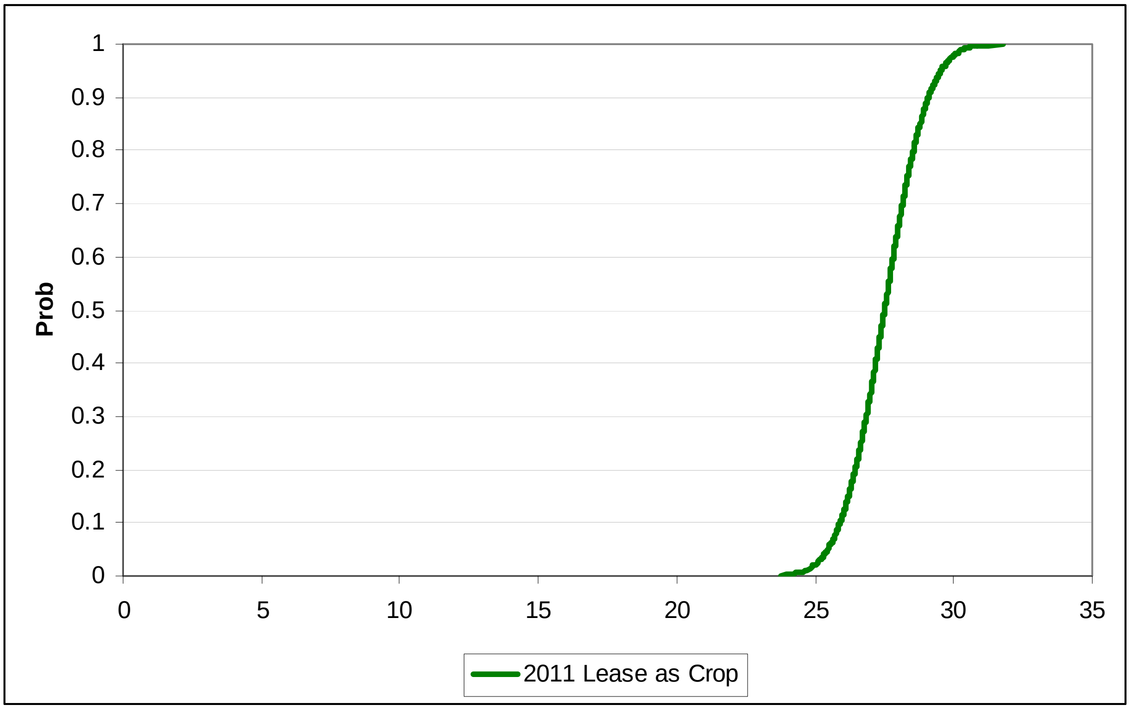

Figure 59. Dallam County 2011, lease as cropland cumulative distribution function

Figure 60 shows an analysis of Stochastic Dominance with Respect to a Function (SDRF) ranking method. Figure 61 presents the Stochastic Efficiency with Respect to a Function (SERF) under a Negative Exponential Utility Function. Both SERF and SDRF indicate that re-enrollment in CRP is the most preferred option. The upper risk aversion coefficient (RAC) was calculated based on a wealth level equal to the county average market value per farm of land and buildings found in the 2007 Census of Agriculture conducted by the USDA, National Agricultural Statistics Service (USDA, NASS 2007). The lower RAC was set at zero to represent a risk neutral decision maker. Based on the selected RACs the decision maker would most prefer CRP enrollment at all risk aversion levels within the selected range.

	Efficient Set Based on SDRF at	
	Lower RAC	**0**
	Name	Level of Preference
1	2011 CRP	Most Preferred
2	2011 Lease as Crop	2nd Most Preferred
3	2011 Lease as Range	3rd Most Preferred
4	2011 Farm it	Least Preferred

	Efficient Set Based on SDRF at	
	Upper RAC	**2.28336E-06**
	Name	Level of Preference
1	2011 CRP	Most Preferred
2	2011 Lease as Crop	2nd Most Preferred
3	2011 Lease as Range	3rd Most Preferred
4	2011 Farm it	Least Preferred

Figure 60. Stochastic dominance with respect to a function ranking of four options for producers in Dallam County 2011

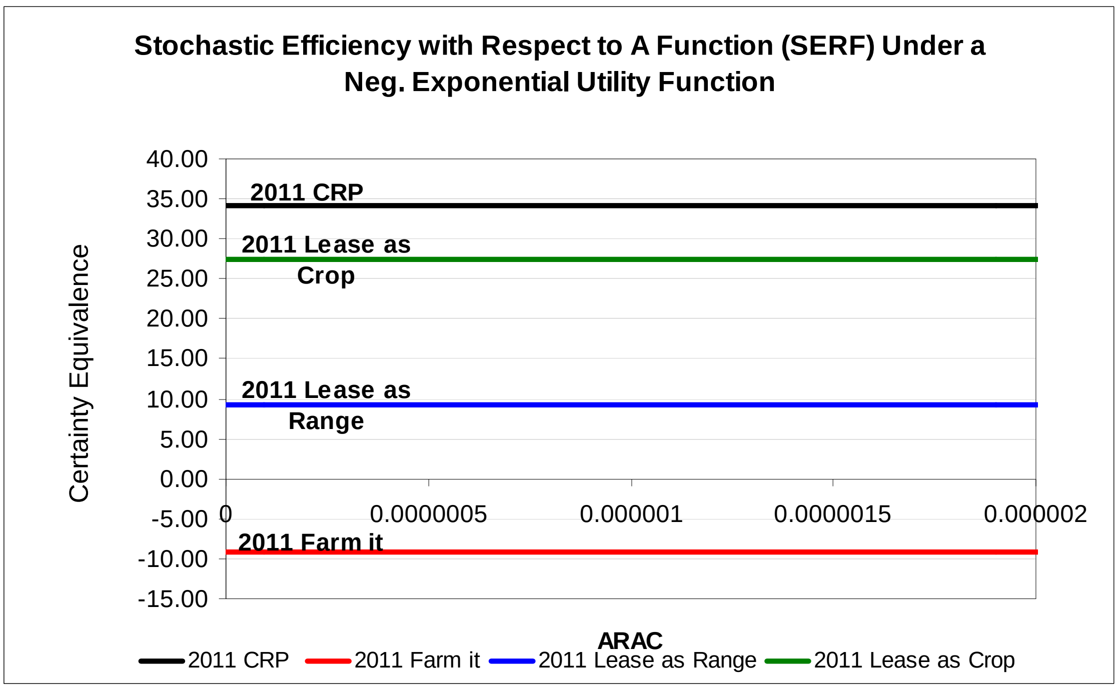

Figure 61. Stochastic efficiency with respect to a function ranking of four options for landowners in Dallam County 2011

The stoplight ranking method was also used for evaluating a landowner’s decision in Dallam County. The stoplight chart for Dallam County 2011 is presented in Figure 62.

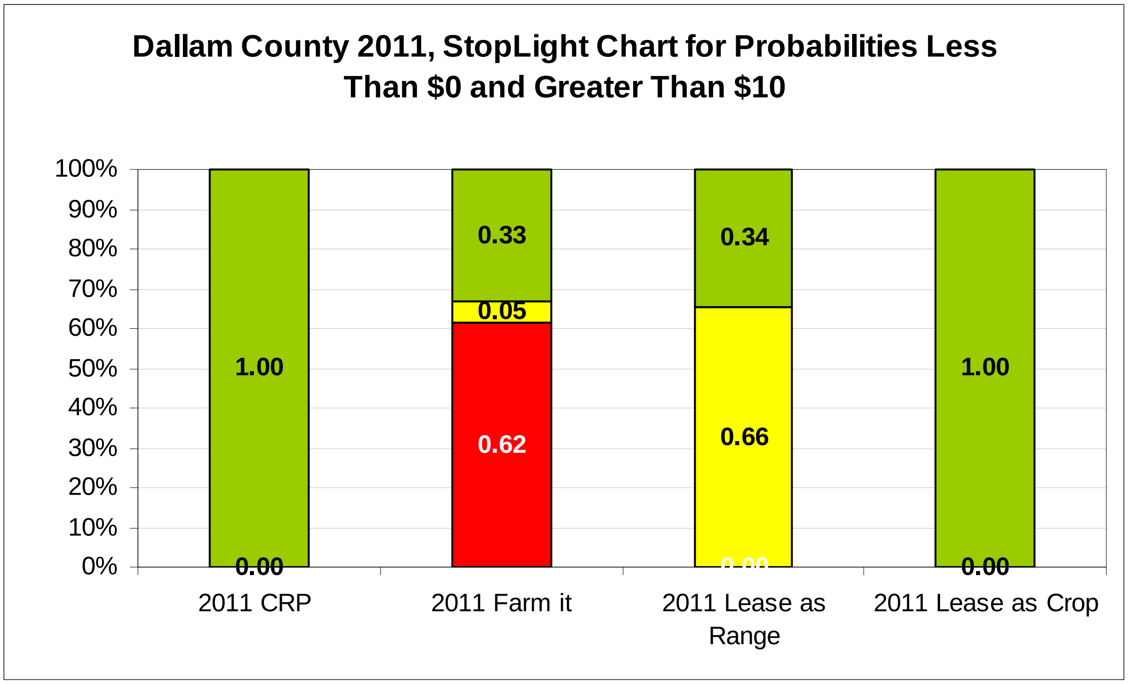

Figure 62. Stoplight chart summarizing the probabilities of returns per acre for landowners in Dallam County (2011)

According to the stoplight chart, re-enrollment in CRP and leasing the land as cropland to a tenant have the highest probabilities of achieving at least $10 per acre net returns. Choosing to farm the CRP land as dryland wheat is associated with a 62% chance of realizing negative net returns per acre as well as the lowest probability of realizing at least $10 per acre returns above direct expenses.

4.1.7. Hockley County

Each of the four options were simulated, and returns per acre for each of the options were generated from 2011-2015. South Plains AgriLife Extension economists predicted that if any CRP land was placed back into crop production the crop would most likely be dryland cotton; therefore, the "farm it" option refers to dryland cotton production. Simulation summary statistics were calculated and are presented in Table 38.

Table 38. Hockley County Simulation Summary Statistics

	2011 CRP	2011 Farm it	2011 Lease as Range	2011 Lease as Crop
Mean	38.045	-63.323	10.000	25.002
StDev	0.090	72.811	1.004	2.502
CV	0.236	-114.983	10.038	10.008
Min	37.863	-186.138	6.567	17.519
Max	38.273	202.755	13.174	33.581
	2012 CRP	**2012 Farm it**	**2012 Lease as Range**	**2012 Lease as Crop**
Mean	38.043	-72.778	10.001	25.001
StDev	0.088	77.140	0.999	2.500
CV	0.231	-105.994	9.987	10.000
Min	37.863	-237.799	7.079	17.644
Max	38.273	202.118	13.010	33.225
	2013 CRP	**2013 Farm it**	**2013 Lease as Range**	**2013 Lease as Crop**
Mean	38.045	-75.891	10.000	24.999
StDev	0.091	88.562	1.000	2.504
CV	0.239	-116.697	9.998	10.018
Min	37.863	-246.001	7.013	16.303
Max	38.273	252.376	13.041	32.830
	2014 CRP	**2014 Farm it**	**2014 Lease as Range**	**2014 Lease as Crop**
Mean	38.044	-80.579	10.000	24.999
StDev	0.087	84.369	0.997	2.497
CV	0.230	-104.704	9.970	9.989
Min	37.863	-256.820	7.121	17.537
Max	38.273	210.960	12.922	32.472

Table 38. Continued

	2015 CRP	2015 Farm it	2015 Lease as Range	2015 Lease as Crop
Mean	38.046	-83.812	10.000	25.000
StDev	0.089	86.701	1.000	2.504
CV	0.233	-103.448	9.997	10.015
Min	37.863	-276.343	6.780	17.192
Max	38.273	226.667	12.922	32.859

The results for Hockley County landowners were initially ranked by mean, standard deviation, worst case scenario, best case scenario, and relative risk. The most preferred option for each of these methods is presented in Table 39.

Table 39. Hockley County Ranking Matrix

	2011	2012	2013	2014	2015
Mean	CRP	CRP	CRP	CRP	CRP
Standard Deviation	CRP	CRP	CRP	CRP	CRP
Worst Case	CRP	CRP	CRP	CRP	CRP
Best Case	Farm it	Farm it	Farm it	Farm it	Farm it
Relative Risk	CRP	CRP	CRP	CRP	CRP

These rankings indicate that re-enrolling land in CRP is the most preferred option based on a mean only ranking, which assumes a risk neutral decision maker, because it returns the highest mean for each of the five years studied. According to the results, a ranking based on the lowest standard deviation would select re-enrollment in CRP as the most preferred option for Hockley County. The simulation summary statistics indicate that re-enrolling land into CRP would result in the highest possible minimum return per acre making it the most preferred option for rankings based on worst case scenario. The option that generates the highest possible maximum return is farming dryland cotton making it the most preferred option under a best-case scenario. Ranking options based on relative risk selects as most preferred the option that has the lowest absolute coefficient of variation (CV). In this case, re-enrolling land in CRP returns the lowest relative risk.

A mean variance chart was created for Hockley County for 2011. Using the mean variance ranking method would indicate that CRP enrollment is the most preferred option due to the fact that there is no other option found in the southeast quadrant of the chart. Difficulties with graphing mean variance also occur in this county because the "farm it" option has a variance too high (5301) to be plotted in the same chart with the three other options. The "farm it" option is by far the least preferred option according to mean variance. The three remaining options with similar scales are plotted in Figure 63.

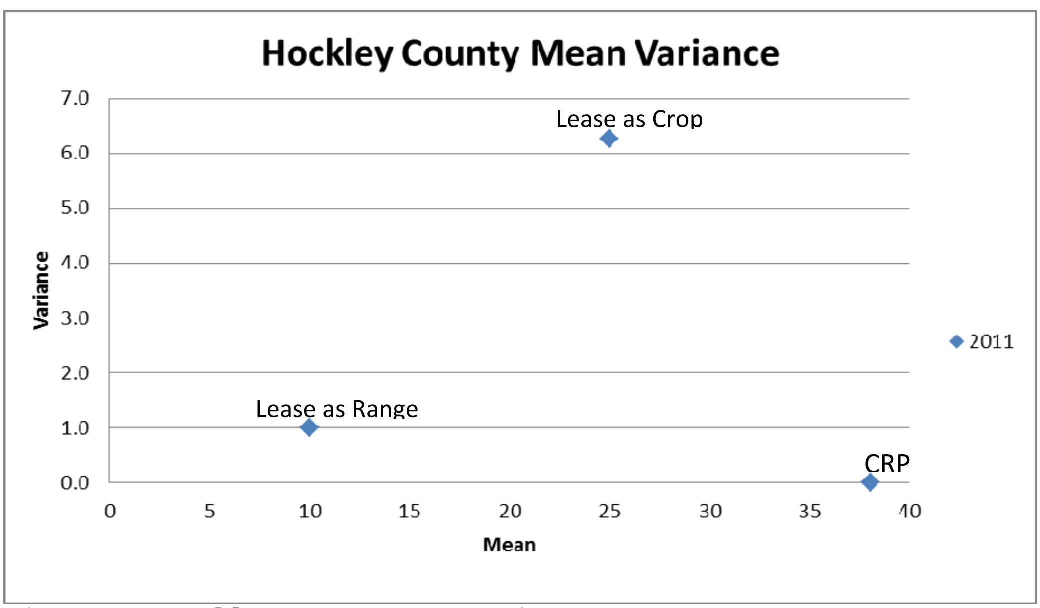

Figure 63. Hockley County mean variance

A cumulative distribution function (CDF) for each of the options in Hockley County is presented below. All four options are presented in one CDF for overall comparison as well as individual CDFs for a more detailed look. These CDFs are presented in Figures 64 – 68. Based on the fact that the CDFs cross, first degree stochastic dominance cannot be established. However, it can be noted based on the CDFs that choosing to farm the land has a much wider distribution of possible outcomes indicating more risk. The CDFs for each of five years are similar to the 2011 distribution. The CDFs presented below are for the year 2011. The CDFs for the remaining four years are located in Appendix A.

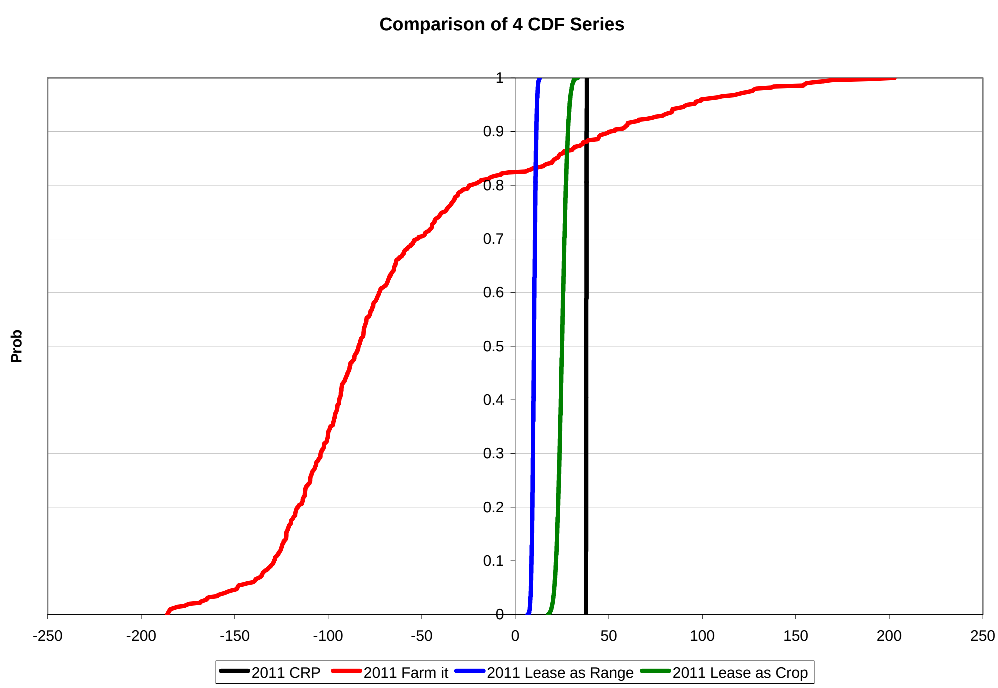

Figure 64. Hockley County 2011 returns per acre, cumulative distribution function

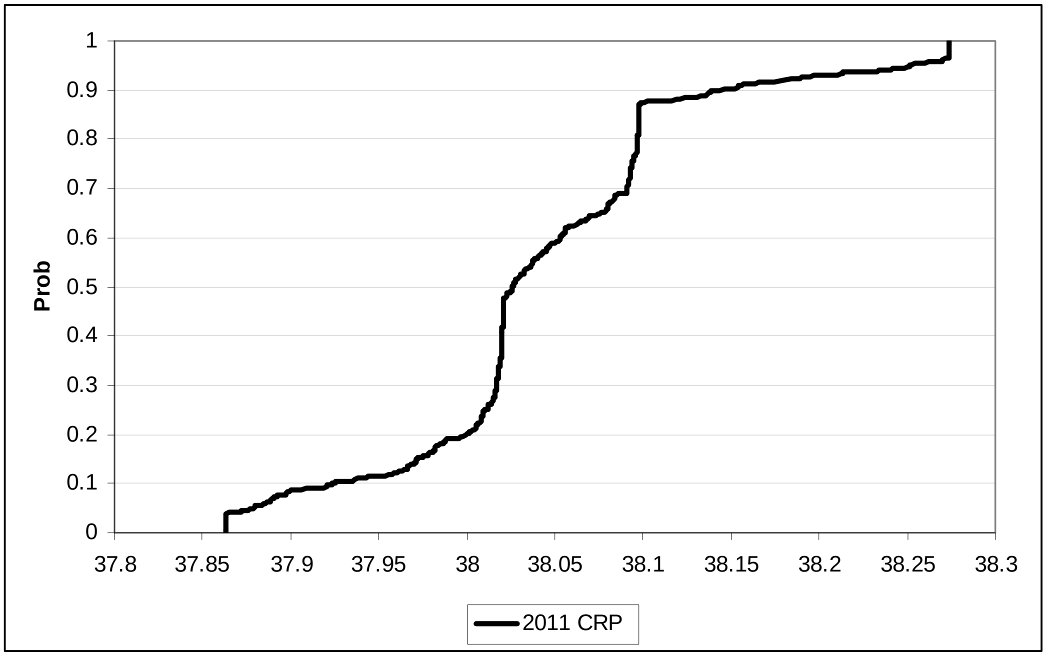

Figure 65. Hockley County 2011, conservation reserve program payments cumulative distribution function

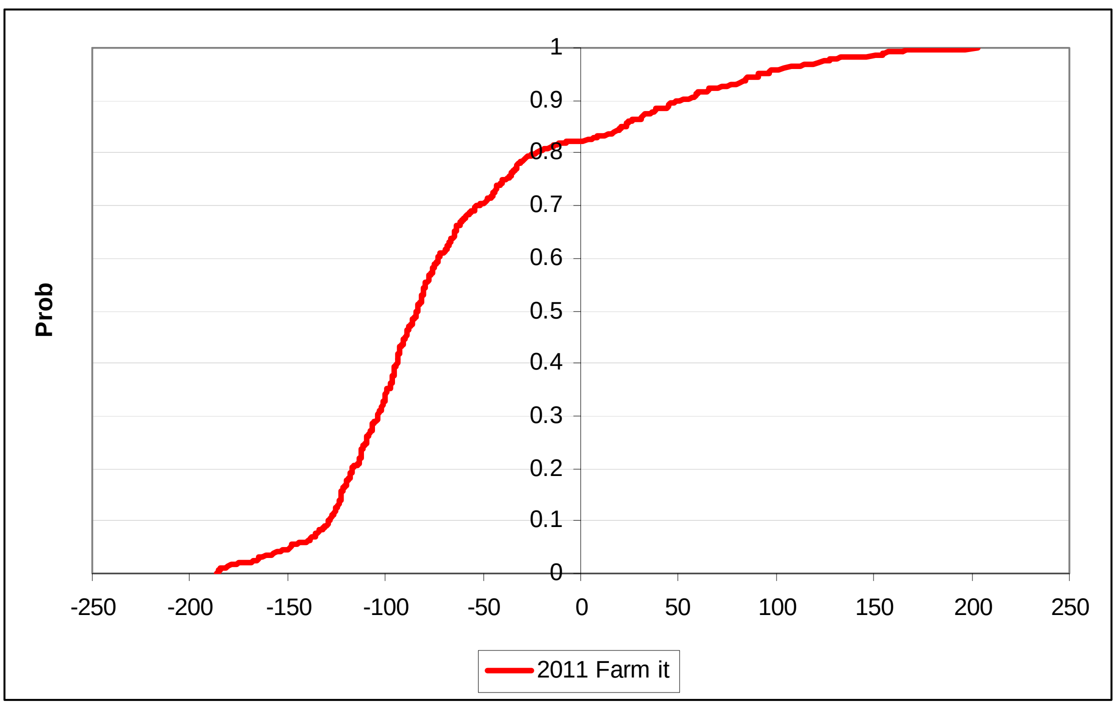

Figure 66. Hockley County 2011, dryland cotton production returns per acre cumulative distribution function

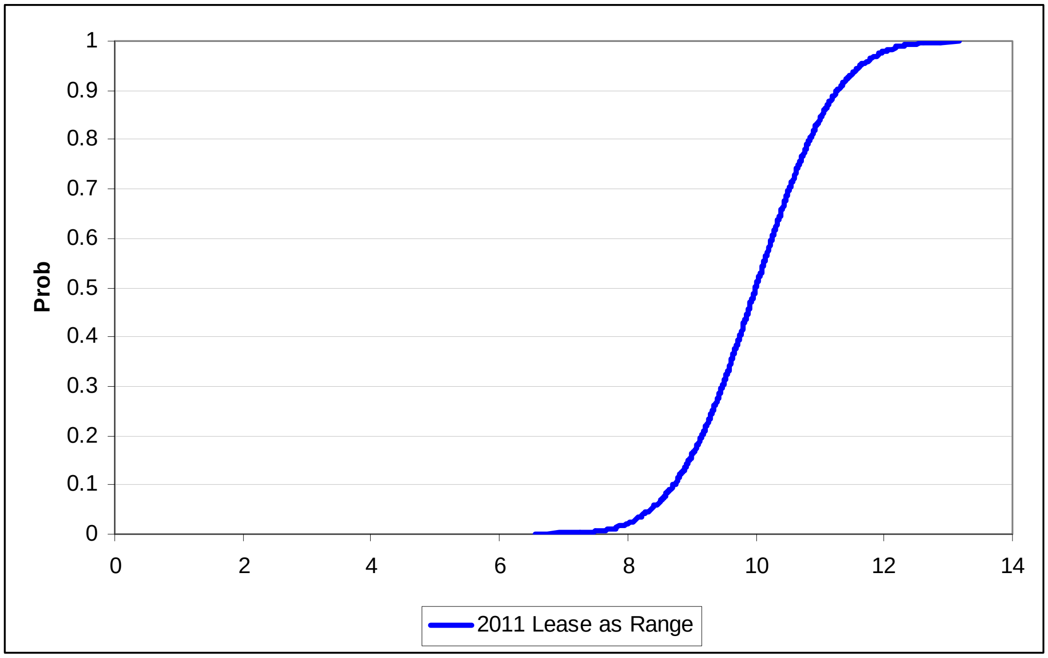

Figure 67. Hockley County 2011, lease as rangeland returns per acre cumulative distribution function

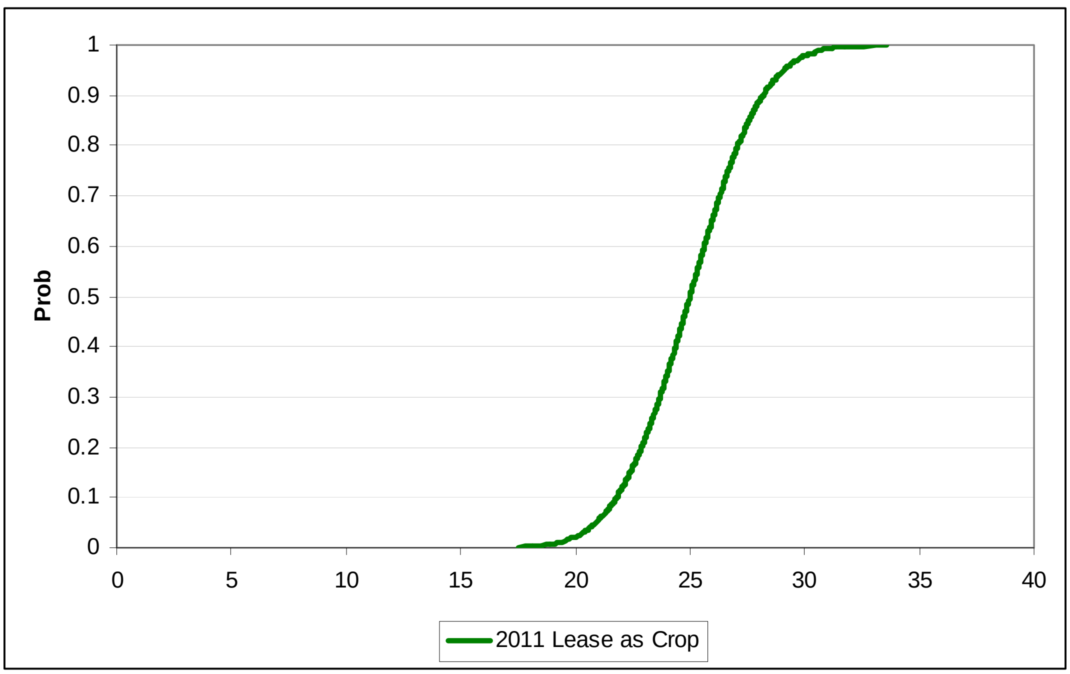

Figure 68. Hockley County 2011, lease as cropland cumulative distribution function

Figure 69 shows an analysis of Stochastic Dominance with Respect to a Function (SDRF) ranking method. Figure 70 presents the Stochastic Efficiency with Respect to a Function (SERF) under a Negative Exponential Utility Function. Both SERF and SDRF indicate that re-enrollment in CRP is the most preferred option. The upper risk aversion coefficient (RAC) was calculated based on a wealth level equal to the county average market value per farm of land and buildings found in the 2007 Census of Agriculture conducted by the USDA, National Agricultural Statistics Service (USDA, NASS 2007). The lower RAC was set at zero to represent a risk neutral decision maker. Based on the selected RACs the decision maker would most prefer CRP enrollment at all risk aversion levels within the selected range.

Efficient Set Based on SDRF at

	Lower RAC	**0**
	Name	Level of Preference
1	2011 CRP	Most Preferred
2	2011 Lease as Crop	2nd Most Preferred
3	2011 Lease as Range	3rd Most Preferred
4	2011 Farm it	Least Preferred

Efficient Set Based on SDRF at

	Upper RAC	**6.50632E-06**
	Name	Level of Preference
1	2011 CRP	Most Preferred
2	2011 Lease as Crop	2nd Most Preferred
3	2011 Lease as Range	3rd Most Preferred
4	2011 Farm it	Least Preferred

Figure 69. Stochastic dominance with respect to a function ranking of four options for producers in Hockley County 2011

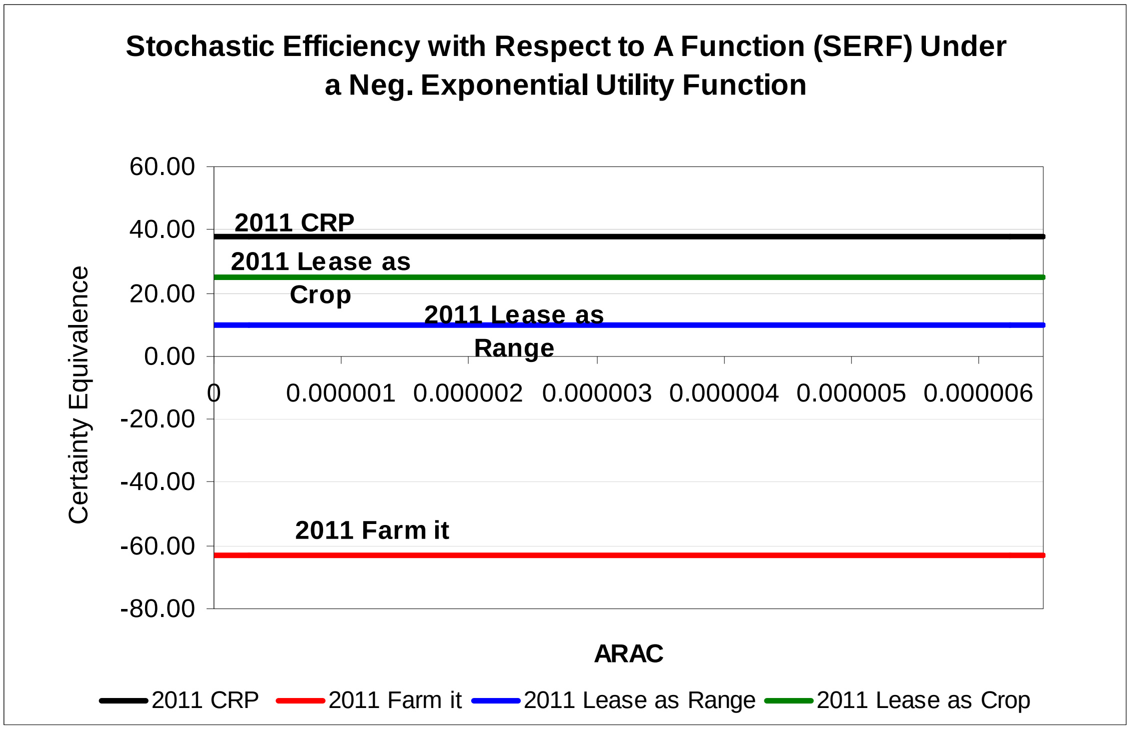

Figure 70. Stochastic efficiency with respect to a function ranking of four options for landowners in Hockley County 2011

The stoplight ranking method was also used for evaluating a landowner's decision in Hockley County. The stoplight chart for Hockley County 2011 is presented in Figure 71.

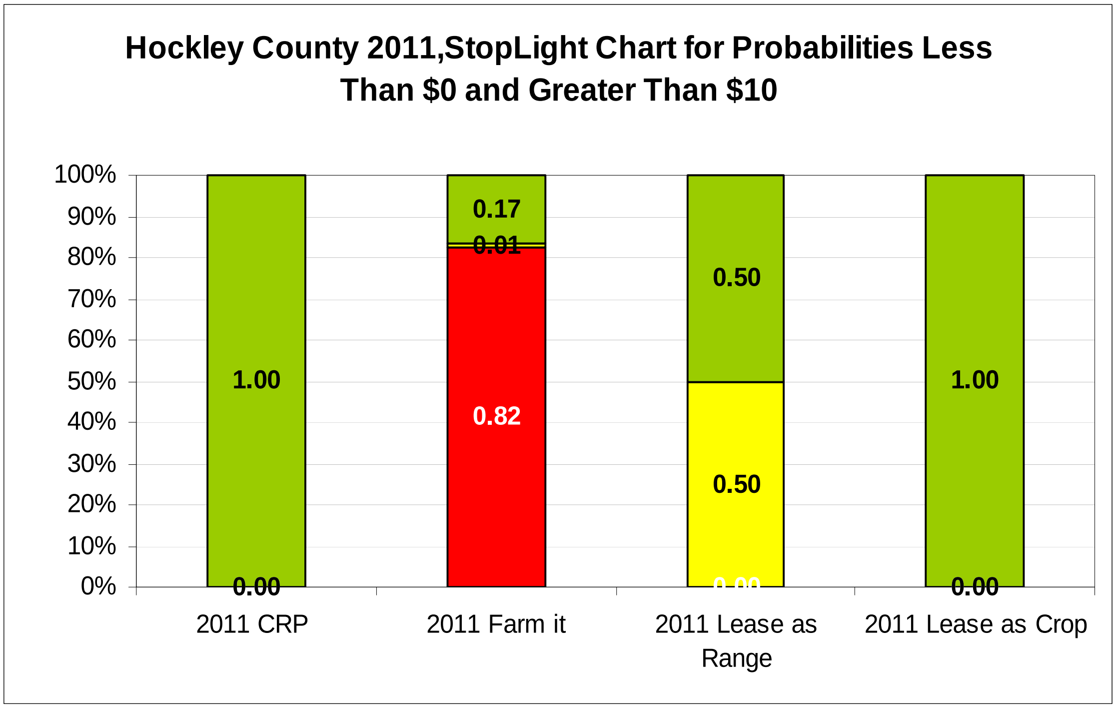

Figure 71. Stoplight chart summarizing the probabilities of returns per acre for landowners in Hockley County (2011)

According to the stoplight chart, re-enrollment in CRP and leasing the land as cropland to a tenant have the highest probabilities of achieving at least $10 per acre net returns. Choosing to farm the CRP land as dryland cotton is associated with an 82% chance of realizing negative net returns per acre as well as the lowest probability of realizing at least $10 per acre returns above direct expenses.

4.1.8. Terry County

Each of the four options were simulated, and returns per acre for each of the options were generated from 2011-2015. South Plains AgriLife Extension economists predicted that if any CRP land was placed back into crop production the crop would most likely be dryland cotton; therefore, the "farm it" option refers to dryland cotton production. Simulation summary statistics were calculated and are presented in Table 40.

Table 40. Terry County Simulation Summary Statistics

	2011 CRP	2011 Farm it	2011 Lease as Range	2011 Lease as Crop
Mean	35.747	-64.797	10.000	25.002
StDev	0.154	76.883	1.004	2.502
CV	0.430	-118.651	10.038	10.008
Min	35.648	-165.280	6.567	17.519
Max	36.275	227.743	13.174	33.581
	2012 CRP	**2012 Farm it**	**2012 Lease as Range**	**2012 Lease as Crop**
Mean	35.746	-73.368	10.001	25.001
StDev	0.156	80.523	0.999	2.500
CV	0.438	-109.752	9.987	10.000
Min	35.648	-213.418	7.079	17.644
Max	36.275	249.791	13.010	33.225
	2013 CRP	**2013 Farm it**	**2013 Lease as Range**	**2013 Lease as Crop**
Mean	35.749	-77.363	10.000	24.999
StDev	0.154	89.806	1.000	2.504
CV	0.430	-116.083	9.998	10.018
Min	35.648	-245.556	7.013	16.303
Max	36.275	276.812	13.041	32.830
	2014 CRP	**2014 Farm it**	**2014 Lease as Range**	**2014 Lease as Crop**
Mean	35.741	-81.195	10.000	24.999
StDev	0.147	88.928	0.997	2.497
CV	0.411	-109.524	9.970	9.989
Min	35.648	-238.581	7.121	17.537
Max	36.275	285.553	12.922	32.472

Table 40. Continued

	2015 CRP	2015 Farm it	2015 Lease as Range	2015 Lease as Crop
Mean	35.748	-83.848	10.000	25.000
StDev	0.155	91.929	1.000	2.504
CV	0.433	-109.638	9.997	10.015
Min	35.648	-252.493	6.780	17.192
Max	36.275	267.120	12.922	32.859

The results for Terry County landowners were initially ranked by mean, standard deviation, worst case scenario, best case scenario, and relative risk. The most preferred option for each of these methods is presented in Table 41.

Table 41. Terry County Ranking Matrix

	2011	2012	2013	2014	2015
Mean	CRP	CRP	CRP	CRP	CRP
Standard Deviation	CRP	CRP	CRP	CRP	CRP
Worst Case	CRP	CRP	CRP	CRP	CRP
Best Case	Farm it	Farm it	Farm it	Farm it	Farm it
Relative Risk	CRP	CRP	CRP	CRP	CRP

These rankings indicate that re-enrolling land in CRP is the most preferred option based on a mean only ranking, which assumes a risk neutral decision maker, because it returns the highest mean for each of the five years studied. According to the results, a ranking based on the lowest standard deviation would select re-enrollment in CRP as the most preferred option for Terry County. The simulation summary statistics indicate that re-enrolling land into CRP would result in the highest possible minimum return per acre making it the most preferred option for rankings based on worst case scenario. The option that generates the highest possible maximum return is farming dryland cotton making it the most preferred option under a best-case scenario. Ranking options based on relative risk selects as most preferred the option that has the lowest absolute coefficient of variation (CV). In this case, re-enrolling land in CRP returns the lowest relative risk.

A mean variance chart was created for Terry County for 2011. Using the mean variance ranking method would indicate that CRP enrollment is the most preferred option due to the fact that there is no other option found in the southeast quadrant of the chart. Difficulties with graphing mean variance also occur in this county because the “farm it” option has a variance too high (5911) to be plotted in the same chart with the three other options. The “farm it” option is by far the least preferred option according to mean variance. The three remaining options with similar scales are plotted in Figure 72.

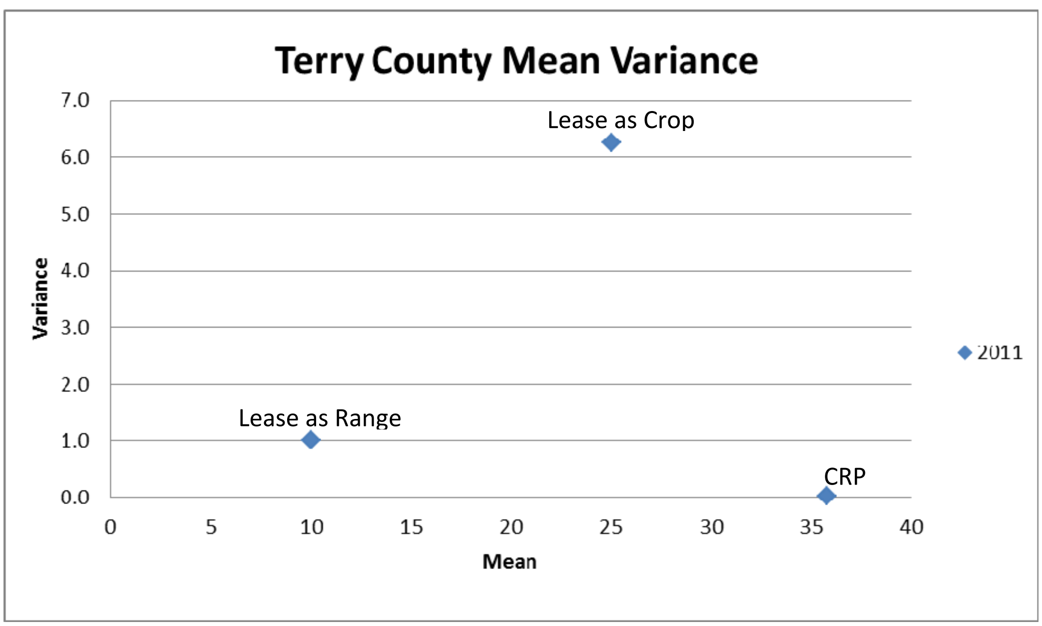

Figure 72. Terry County mean variance

A cumulative distribution function (CDF) for each of the options in Terry County is presented below. All four options are presented in one CDF for overall comparison as well as individual CDFs for a more detailed look. These CDFs are presented in Figures 73 – 77. Based on the fact that the CDFs cross, first degree stochastic dominance cannot be established. However, it can be noted based on the CDFs that choosing to farm the land has a much wider distribution of possible outcomes indicating more risk. The CDFs for each of five years are similar to the 2011 distribution. The CDFs presented below are for the year 2011. The CDFs for the remaining four years are located in Appendix A.

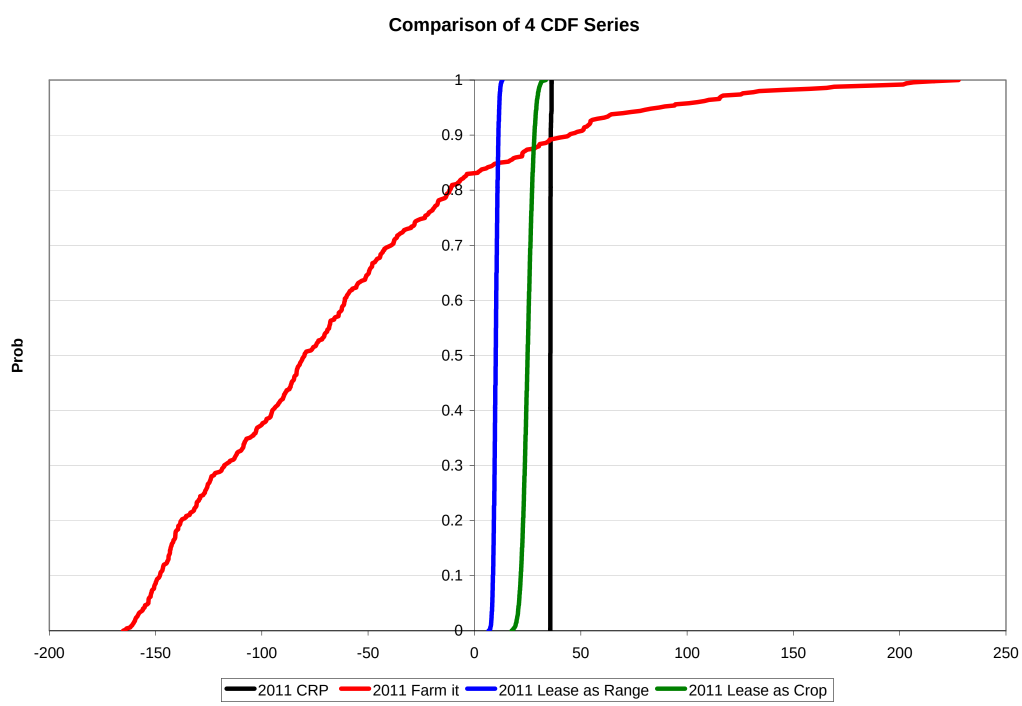

Figure 73. Terry County 2011 returns per acre, cumulative distribution function

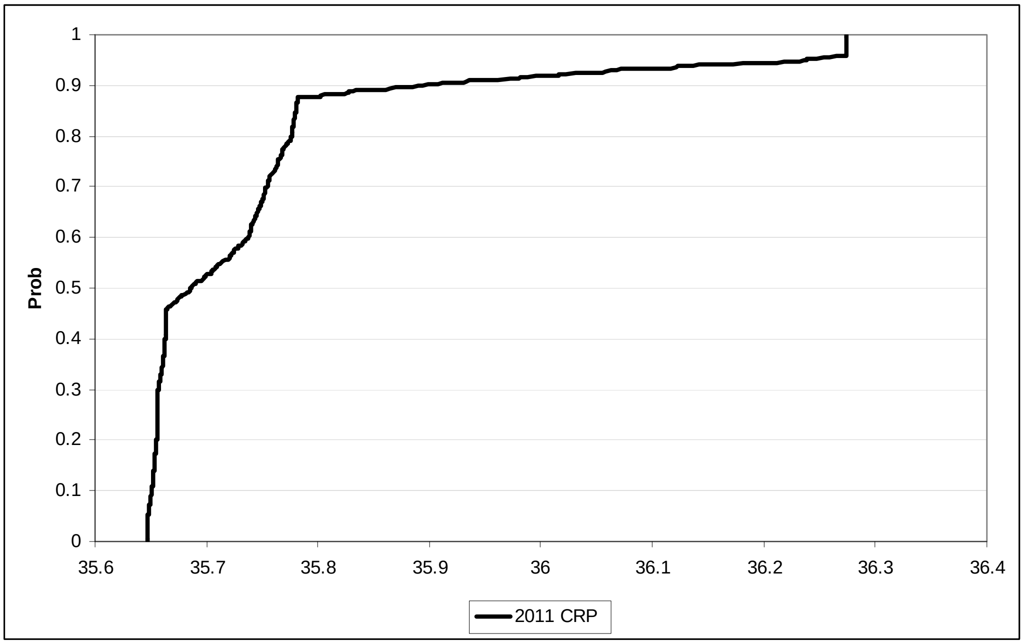

Figure 74. Terry County 2011, conservation reserve program payments cumulative distribution function

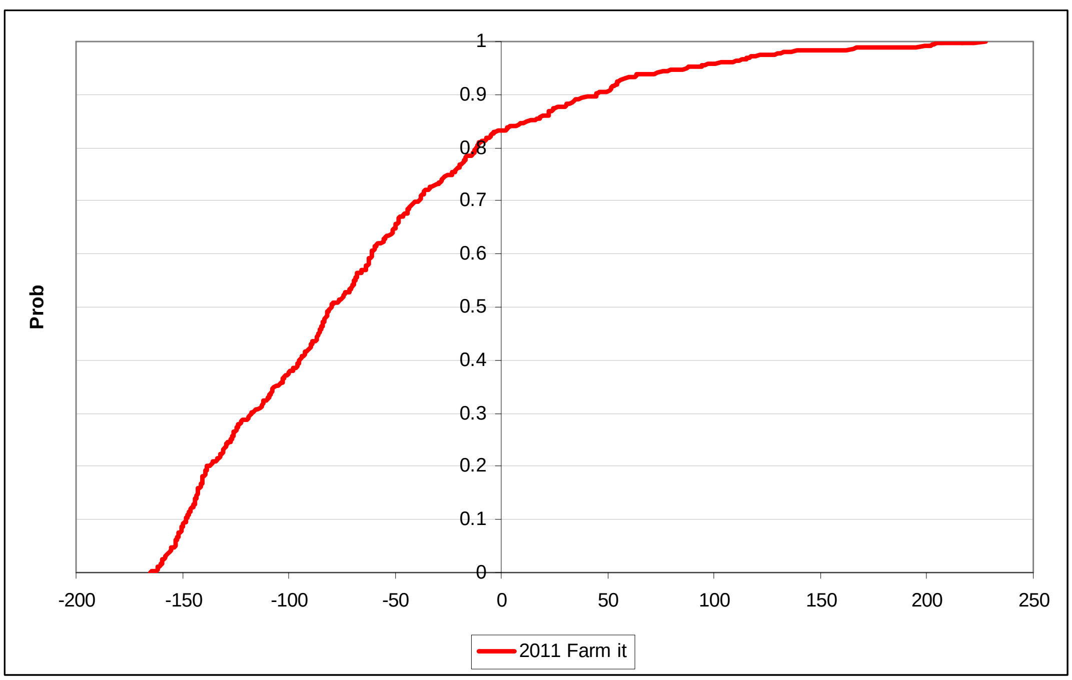

Figure 75. Terry County 2011, dryland cotton production returns per acre cumulative distribution function

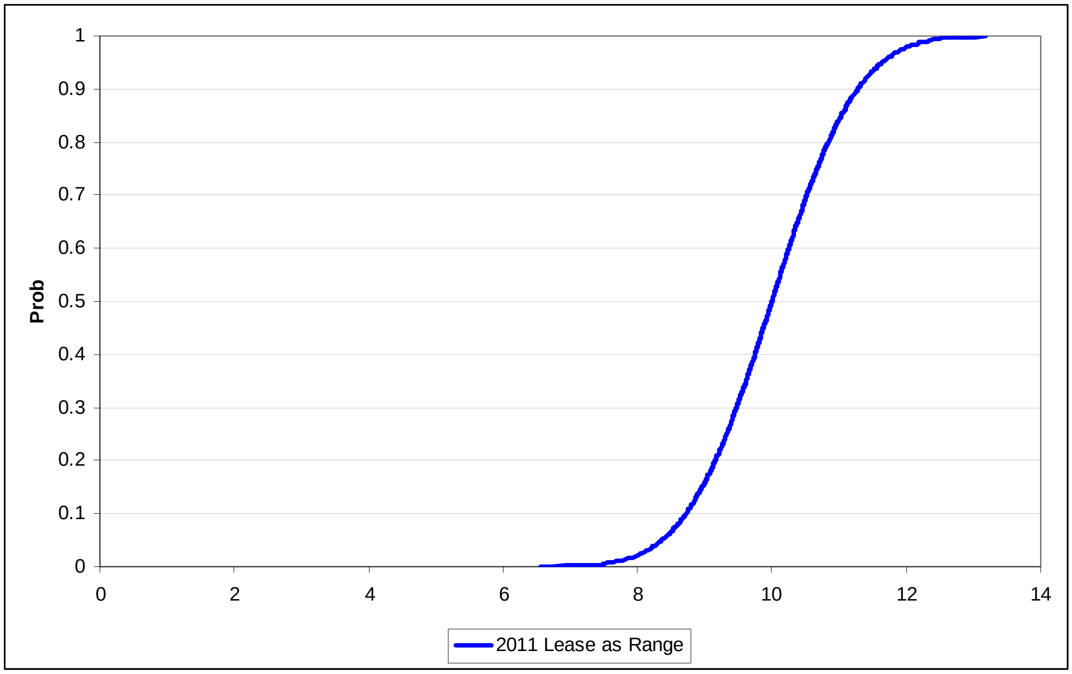

Figure 76. Terry County 2011, lease as rangeland returns per acre cumulative distribution function

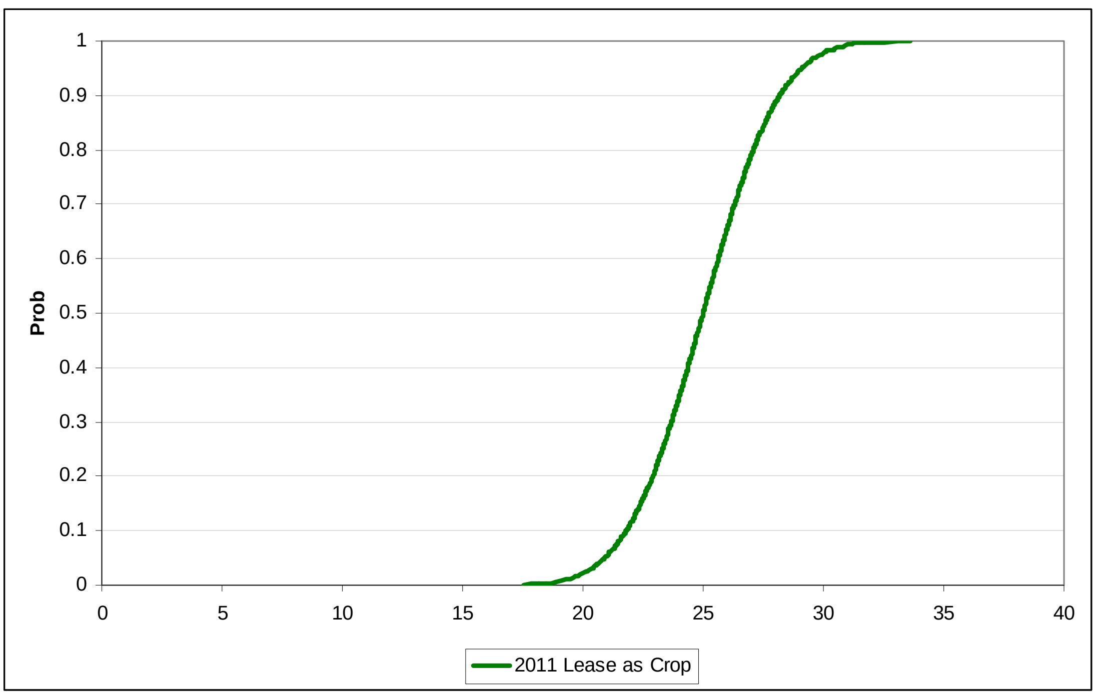

Figure 77. Terry County 2011, lease as cropland cumulative distribution function

Figure 78 shows an analysis of Stochastic Dominance with Respect to a Function (SDRF) ranking method. Figure 79 presents the Stochastic Efficiency with Respect to a Function (SERF) under a Negative Exponential Utility Function. Both SERF and SDRF indicate that re-enrollment in CRP is the most preferred option. The upper risk aversion coefficient (RAC) was calculated based on a wealth level equal to the county average market value per farm of land and buildings found in the 2007 Census of Agriculture conducted by the USDA, National Agricultural Statistics Service (USDA, NASS 2007). The lower RAC was set at zero to represent a risk neutral decision maker. Based on the selected RACs the decision maker would most prefer CRP enrollment at all risk aversion levels within the selected range.

	Efficient Set Based on SDRF at			Efficient Set Based on SDRF at	
	Lower RAC	**0**		Upper RAC	**5.67854E-06**
	Name	Level of Preference		Name	Level of Preference
1	2011 CRP	Most Preferred	1	2011 CRP	Most Preferred
2	2011 Lease as Crop	2nd Most Preferred	2	2011 Lease as Crop	2nd Most Preferred
3	2011 Lease as Range	3rd Most Preferred	3	2011 Lease as Range	3rd Most Preferred
4	2011 Farm it	Least Preferred	4	2011 Farm it	Least Preferred

Figure 78. Stochastic dominance with respect to a function ranking of four options for producers in Terry County 2011

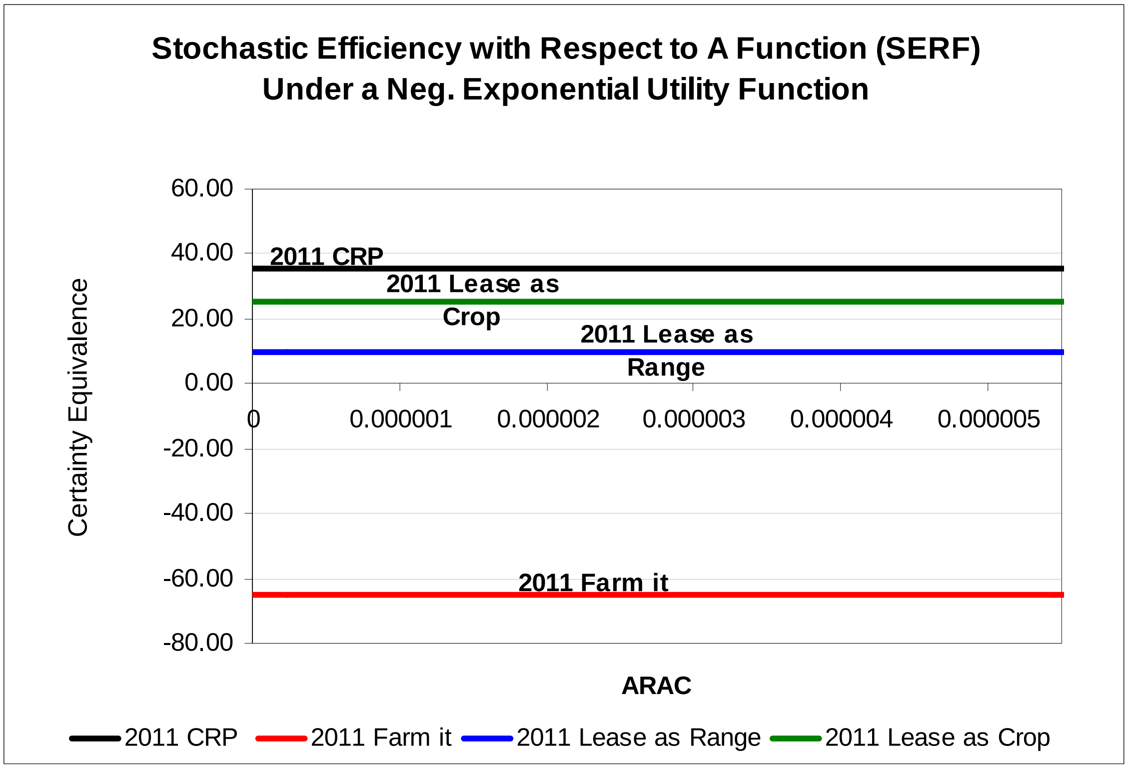

Figure 79. Stochastic efficiency with respect to a function ranking of four options for landowners in Terry County 2011

The stoplight ranking method was also used for evaluating a landowner's decision in Terry County. The stoplight chart for Terry County 2011 is presented in Figure 80.

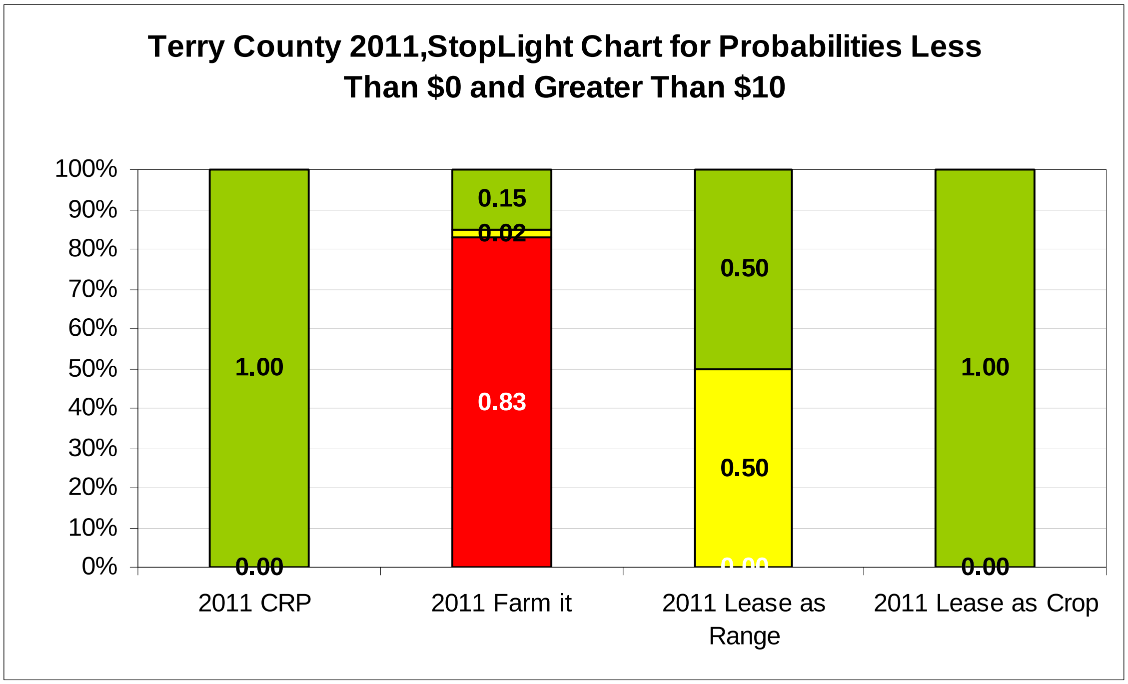

Figure 80. Stoplight chart summarizing the probabilities of returns per acre for landowners in Terry County (2011)

According to the stoplight chart, re-enrollment in CRP and leasing the land as cropland to a tenant have the highest probabilities of achieving at least $10 per acre net returns. Choosing to farm the CRP land as dryland cotton is associated with an 83% chance of realizing negative net returns per acre as well as the lowest probability of realizing at least $10 per acre returns above direct expenses.

4.1.9. Castro County

Each of the four options were simulated, and returns per acre for each of the options were generated from 2011-2015. South Plains AgriLife Extension economists predicted that if any CRP land was placed back into crop production the crop would most likely be dryland cotton; therefore, the "farm it" option refers to dryland cotton production. The stochastic KOVs for 500 iterations were analyzed. Simulation summary statistics were calculated and are presented in Table 42.

Table 42. Castro County Simulation Summary Statistics

	2011 CRP	2011 Farm it	2011 Lease as Range	2011 Lease as Crop
Mean	37.608	-67.020	10.000	25.002
StDev	0.193	89.166	1.004	2.502
CV	0.513	-133.043	10.038	10.008
Min	37.224	-180.105	6.567	17.519
Max	37.927	401.021	13.174	33.581
	2012 CRP	**2012 Farm it**	**2012 Lease as Range**	**2012 Lease as Crop**
Mean	37.607	-71.742	10.001	25.001
StDev	0.195	101.358	0.999	2.500
CV	0.520	-141.280	9.987	10.000
Min	37.224	-230.477	7.079	17.644
Max	37.927	387.087	13.010	33.225
	2013 CRP	**2013 Farm it**	**2013 Lease as Range**	**2013 Lease as Crop**
Mean	37.608	-76.734	10.000	24.999
StDev	0.197	107.662	1.000	2.504
CV	0.525	-140.305	9.998	10.018
Min	37.224	-241.860	7.013	16.303
Max	37.927	436.607	13.041	32.830
	2014 CRP	**2014 Farm it**	**2014 Lease as Range**	**2014 Lease as Crop**
Mean	37.610	-78.451	10.000	24.999
StDev	0.190	110.694	0.997	2.497
CV	0.505	-141.100	9.970	9.989
Min	37.224	-251.355	7.121	17.537
Max	37.927	347.752	12.922	32.472
	2015 CRP	**2015 Farm it**	**2015 Lease as Range**	**2015 Lease as Crop**
Mean	37.609	-87.154	10.000	25.000
StDev	0.195	101.571	1.000	2.504
CV	0.519	-116.542	9.997	10.015
Min	37.224	-279.607	6.780	17.192
Max	37.927	466.932	12.922	32.859

The results for Castro County landowners were initially ranked by mean, standard deviation, worst case scenario, best case scenario, and relative risk. The most preferred option for each of these methods is presented in Table 43.

Table 43. Castro County Ranking Matrix

	2011	2012	2013	2014	2015
Mean	CRP	CRP	CRP	CRP	CRP
Standard Deviation	CRP	CRP	CRP	CRP	CRP
Worst Case	CRP	CRP	CRP	CRP	CRP
Best Case	Farm it	Farm it	Farm it	Farm it	Farm it
Relative Risk	CRP	CRP	CRP	CRP	CRP

These rankings indicate that re-enrolling land in CRP is the most preferred option based on a mean only ranking, which assumes a risk neutral decision maker, because it returns the highest mean for each of the five years studied. According to the results, a ranking based on the lowest standard deviation would select re-enrollment in CRP as the most preferred option for Terry County. The simulation summary statistics indicate that re-enrolling land into CRP would result in the highest possible minimum return per acre making it the most preferred option for rankings based on worst case scenario. The option that generates the highest possible maximum return is farming dryland cotton making it the most preferred option under a best-case scenario. Ranking options based on relative risk selects as most preferred the option that has the lowest absolute coefficient of variation (CV). In this case, re-enrolling land in CRP returns the lowest relative risk.

A mean variance chart was created for Castro County for 2011. Using the mean variance ranking method would indicate that CRP enrollment is the most preferred option due to the fact that there is no other option found in the southeast quadrant of the chart. Difficulties with graphing mean variance also occur in this county because the "farm it" option has a variance too high (7951) to be plotted in the same chart with the three other options. The "farm it" option is by far the least preferred option according to mean variance. The three remaining options with similar scales are plotted in Figure 81.

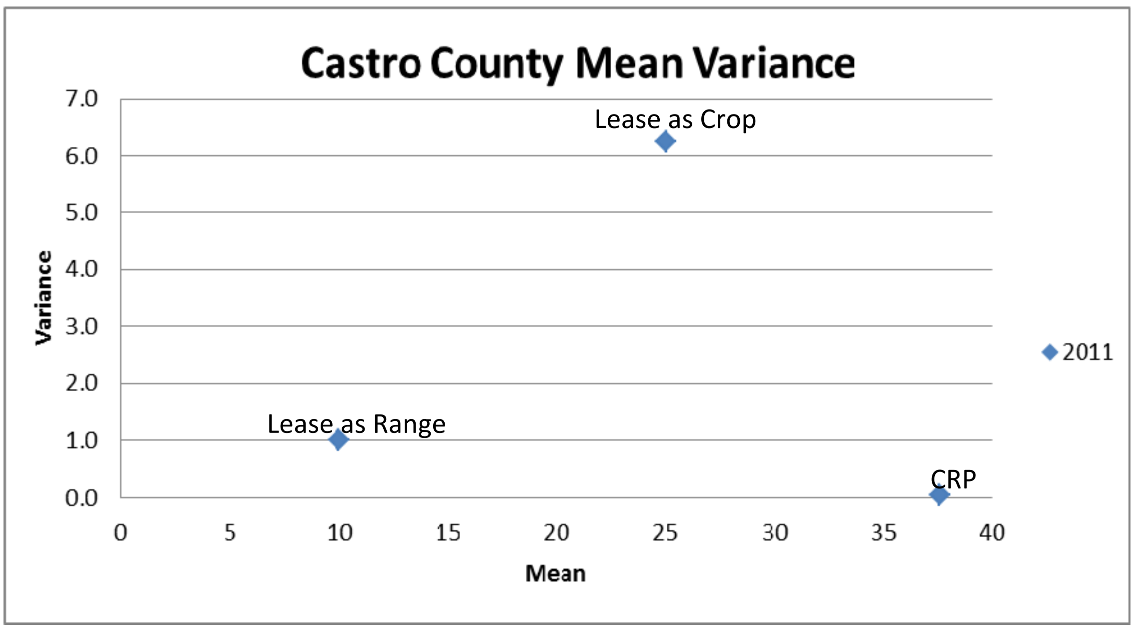

Figure 81. Castro County mean variance

A cumulative distribution function (CDF) for each of the options in Castro County is presented below. All four options are presented in one CDF for overall comparison as well as individual CDFs for a more detailed look. These CDFs are presented in Figures 82 – 86. Based on the fact that the CDFs cross, first degree stochastic dominance cannot be established. However, it can be noted based on the CDFs that choosing to farm the land has a much wider distribution of possible outcomes indicating more risk. The CDFs for each of five years are similar to the 2011 distribution. The CDFs presented below are for the year 2011. The CDFs for the remaining four years are located in Appendix A.

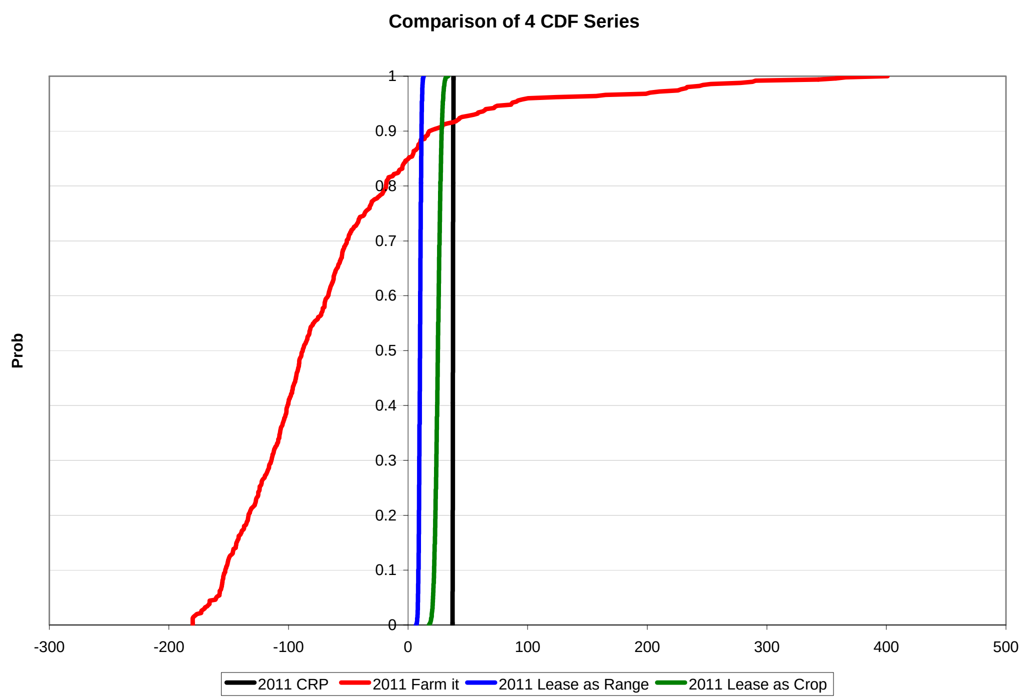

Figure 82. Castro County 2011 returns per acre, cumulative distribution function

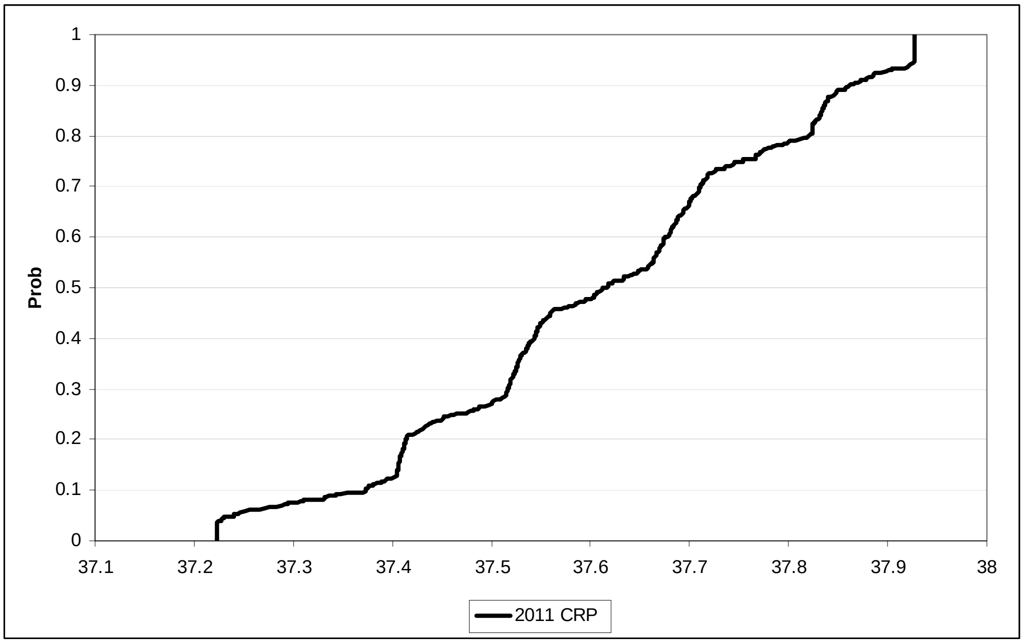

Figure 83. Castro County 2011, conservation reserve program payments cumulative distribution function

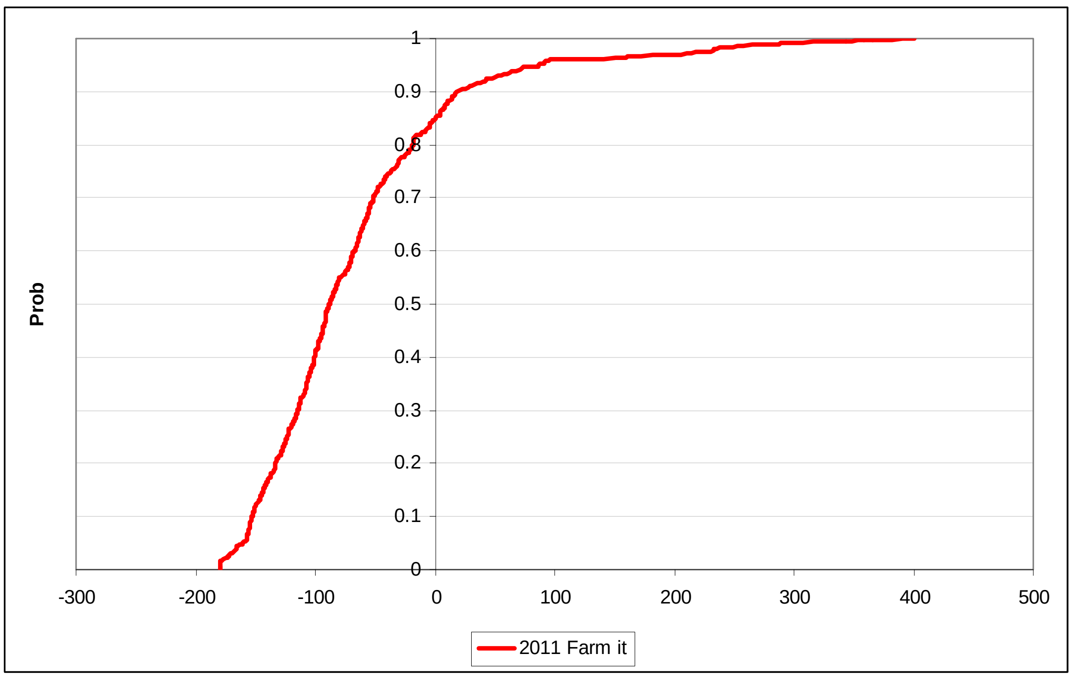

Figure 84. Castro County 2011, dryland cotton production returns per acre cumulative distribution function

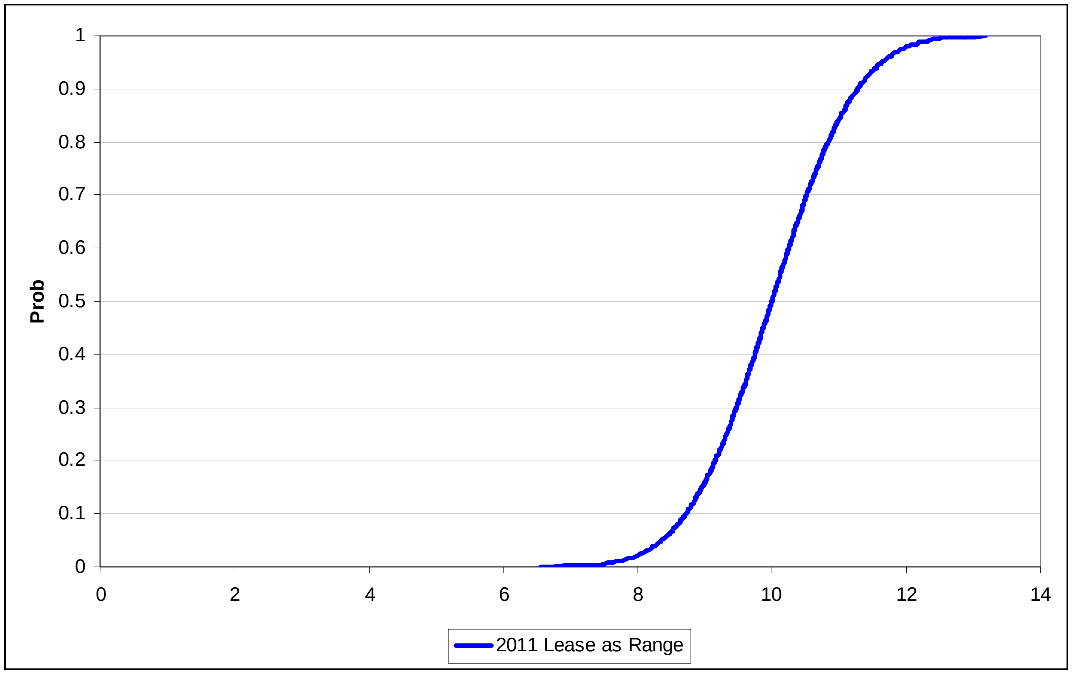

Figure 85. Castro County 2011, lease as rangeland returns per acre cumulative distribution function

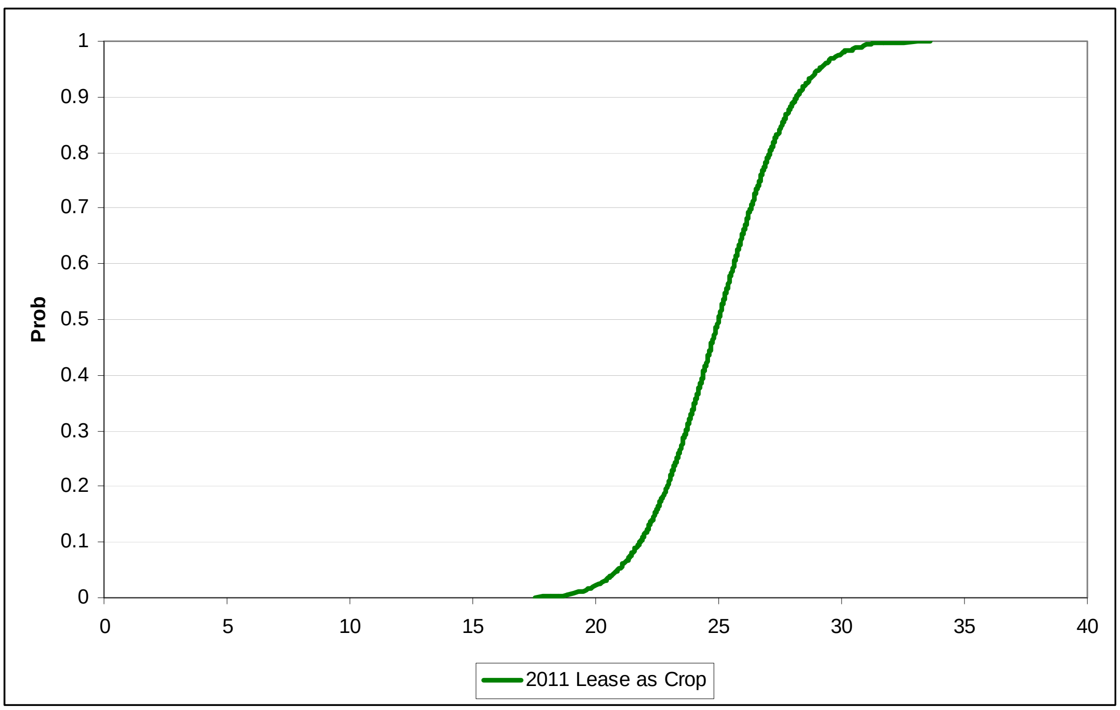

Figure 86. Castro County 2011, lease as cropland cumulative distribution function

Figure 87 shows an analysis of Stochastic Dominance with Respect to a Function (SDRF) ranking method. Figure 88 presents the Stochastic Efficiency with Respect to a Function (SERF) under a Negative Exponential Utility Function. Both SERF and SDRF indicate that re-enrollment in CRP is the most preferred option. The upper risk aversion coefficient (RAC) was calculated based on a wealth level equal to the county average market value per farm of land and buildings found in the 2007 Census of Agriculture conducted by the USDA, National Agricultural Statistics Service (USDA, NASS 2007). The lower RAC was set at zero to represent a risk neutral decision maker. Based on the selected RACs the decision maker would most prefer CRP enrollment at all risk aversion levels within the selected range.

Efficient Set Based on SDRF at

	Lower RAC	**0**
	Name	Level of Preference
1	2011 CRP	Most Preferred
2	2011 Lease as Crop	2nd Most Preferred
3	2011 Lease as Range	3rd Most Preferred
4	2011 Farm it	Least Preferred

Efficient Set Based on SDRF at

	Upper RAC	**3.30602E-06**
	Name	Level of Preference
1	2011 CRP	Most Preferred
2	2011 Lease as Crop	2nd Most Preferred
3	2011 Lease as Range	3rd Most Preferred
4	2011 Farm it	Least Preferred

Figure 87. Stochastic dominance with respect to a function ranking of four options for producers in Castro County 2011

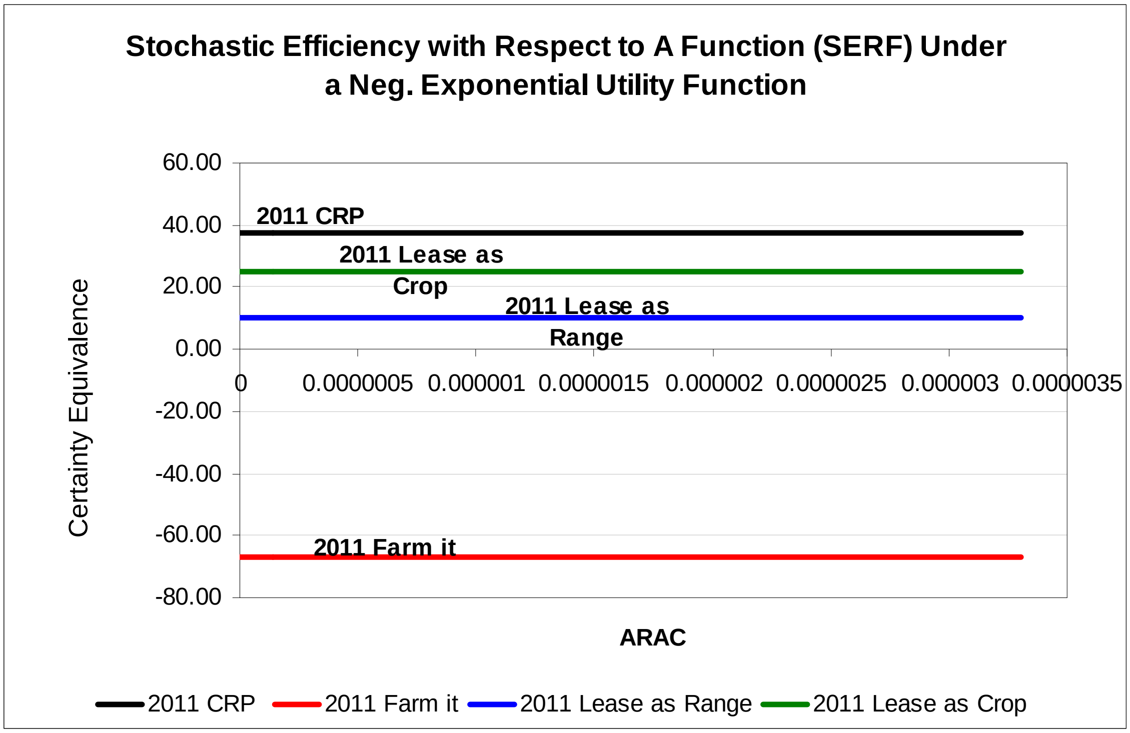

Figure 88. Stochastic efficiency with respect to a function ranking of four options for landowners in Castro County 2011

The stoplight ranking method was also used for evaluating a landowner's decision in Castro County. The stoplight chart for Castro County 2011 is presented in Figure 89.

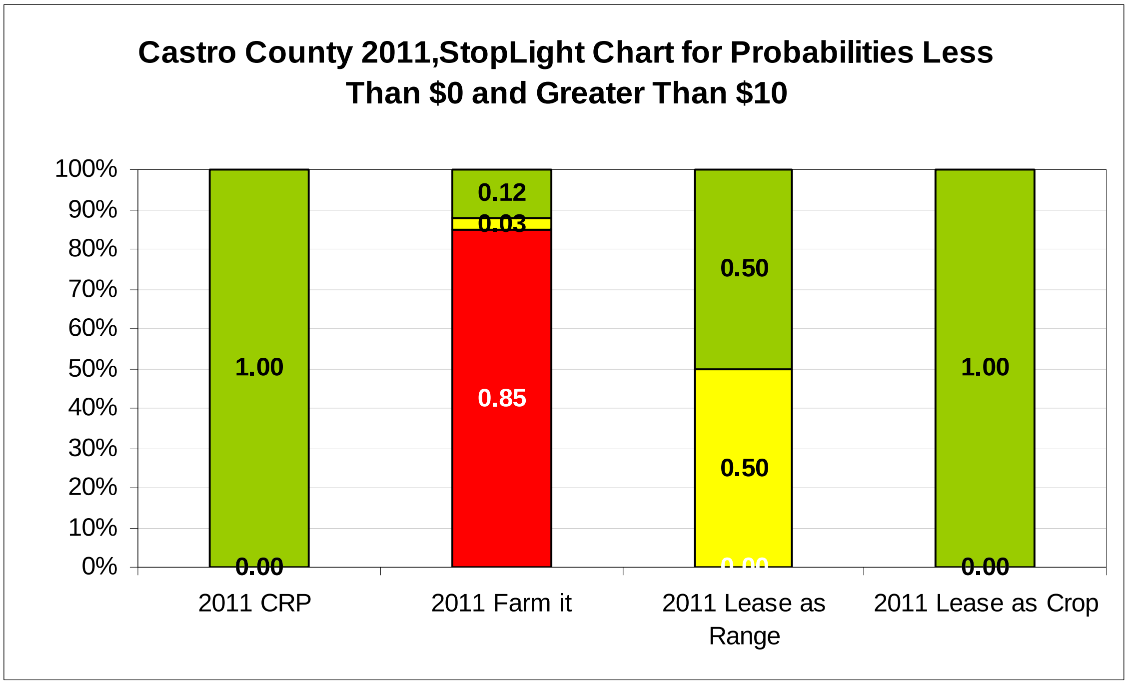

Figure 89. Stoplight chart summarizing the probabilities of returns per acre for landowners in Castro County (2011)

According to the stoplight chart, re-enrollment in CRP and leasing the land as cropland to a tenant have the highest probabilities of achieving at least $10 per acre net returns. Choosing to farm the CRP land as dryland cotton is associated with an 85% chance of realizing negative net returns per acre as well as the lowest probability of realizing at least $10 per acre returns above direct expenses.

4.1.10. Swisher County

Each of the four options were simulated, and returns per acre for each of the options were generated from 2011-2015. South Plains AgriLife Extension economists predicted that if any CRP land was placed back into crop production the crop would most likely be dryland cotton; therefore, the “farm it” option refers to dryland cotton production. The stochastic KOVs for 500 iterations were analyzed. Simulation summary statistics were calculated and are presented in Table 44.

Table 44. Swisher County Simulation Summary Statistics

	2011 CRP	2011 Farm it	2011 Lease as Range	2011 Lease as Crop
Mean	35.829	3.092	10.000	25.002
StDev	0.118	113.363	1.004	2.502
CV	0.330	3666.728	10.038	10.008
Min	35.710	-170.913	6.567	17.519
Max	36.139	386.142	13.174	33.581
	2012 CRP	**2012 Farm it**	**2012 Lease as Range**	**2012 Lease as Crop**
Mean	35.829	-4.701	10.001	25.001
StDev	0.118	116.863	0.999	2.500
CV	0.330	-2486.056	9.987	10.000
Min	35.710	-218.632	7.079	17.644
Max	36.139	372.676	13.010	33.225
	2013 CRP	**2013 Farm it**	**2013 Lease as Range**	**2013 Lease as Crop**
Mean	35.829	-3.452	10.000	24.999
StDev	0.118	121.427	1.000	2.504
CV	0.330	-3517.513	9.998	10.018
Min	35.710	-243.682	7.013	16.303
Max	36.139	393.363	13.041	32.830
	2014 CRP	**2014 Farm it**	**2014 Lease as Range**	**2014 Lease as Crop**
Mean	35.829	-1.777	10.000	24.999
StDev	0.118	131.279	0.997	2.497
CV	0.331	-7385.905	9.970	9.989
Min	35.710	-237.201	7.121	17.537
Max	36.139	428.350	12.922	32.472
	2015 CRP	**2015 Farm it**	**2015 Lease as Range**	**2015 Lease as Crop**
Mean	35.829	0.635	10.000	25.000
StDev	0.118	127.610	1.000	2.504
CV	0.331	20099.957	9.997	10.015
Min	35.710	-256.485	6.780	17.192
Max	36.139	427.455	12.922	32.859

The results for Swisher County landowners were initially ranked by mean, standard deviation, worst case scenario, best case scenario, and relative risk. The most preferred option for each of these methods is presented in Table 45.

Table 45. Swisher County Ranking Matrix

	2011	2012	2013	2014	2015
Mean	CRP	CRP	CRP	CRP	CRP
Standard Deviation	CRP	CRP	CRP	CRP	CRP
Worst Case	CRP	CRP	CRP	CRP	CRP
Best Case	Farm it	Farm it	Farm it	Farm it	Farm it
Relative Risk	CRP	CRP	CRP	CRP	CRP

These rankings indicate that re-enrolling land in CRP is the most preferred option based on a mean only ranking, which assumes a risk neutral decision maker, because it returns the highest mean for each of the five years studied. According to the results, a ranking based on the lowest standard deviation would select re-enrollment in CRP as the most preferred option for Terry County. The simulation summary statistics indicate that re-enrolling land into CRP would result in the highest possible minimum return per acre making it the most preferred option for rankings based on worst case scenario. The option that generates the highest possible maximum return is farming dryland cotton making it the most preferred option under a best-case scenario. Ranking options based on relative risk selects as most preferred the option that has the lowest absolute coefficient of variation (CV). In this case, re-enrolling land in CRP returns the lowest relative risk.

A mean variance chart was created for Swisher County for 2011. Using the mean variance ranking method would indicate that CRP enrollment is the most preferred option due to the fact that there is no other option found in the southeast quadrant of the chart. Difficulties with graphing mean variance also occur in this county because the “farm it” option has a variance too high (12851) to be plotted in the same chart with the three other options. The “farm it” option is by far the least preferred option according to mean variance. The three remaining options with similar scales are plotted in Figure 90.

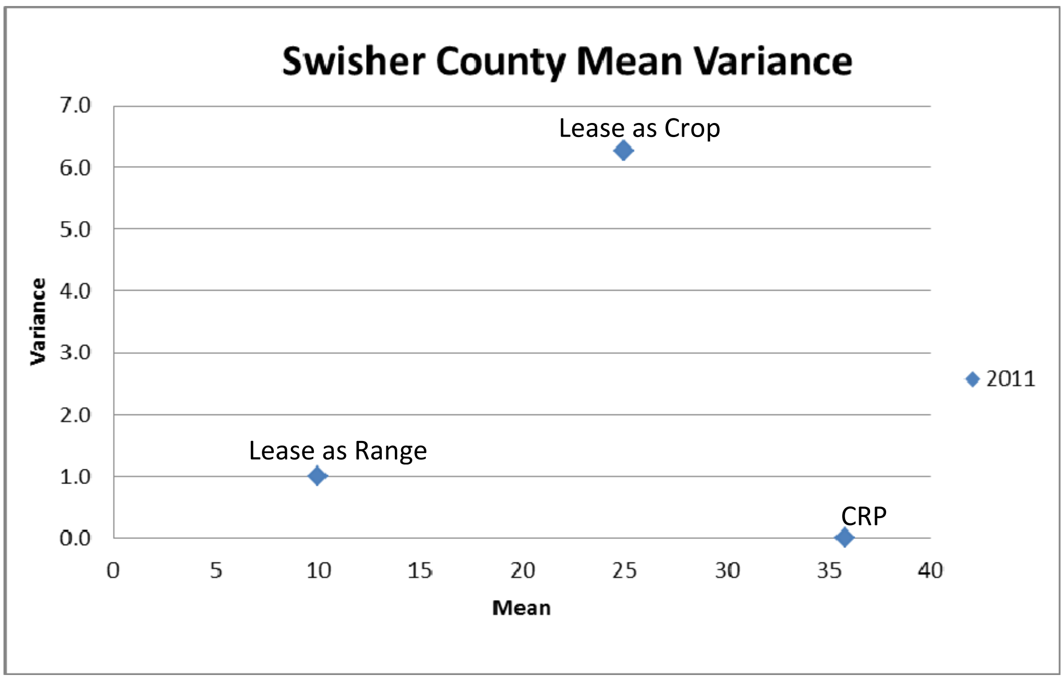

Figure 90. Swisher County mean variance

A cumulative distribution function (CDF) for each of the options in Swisher County is presented below. All four options are presented in one CDF for overall comparison as well as individual CDFs for a more detailed look. These CDFs are presented in Figures 91 – 95. Based on the fact that the CDFs cross, first degree stochastic dominance cannot be established. However, it can be noted based on the CDFs that choosing to farm the land has a much wider distribution of possible outcomes indicating more risk. The CDFs for each of five years are similar to the 2011 distribution. The CDFs presented below are for the year 2011. The CDFs for the remaining four years are located in Appendix A.

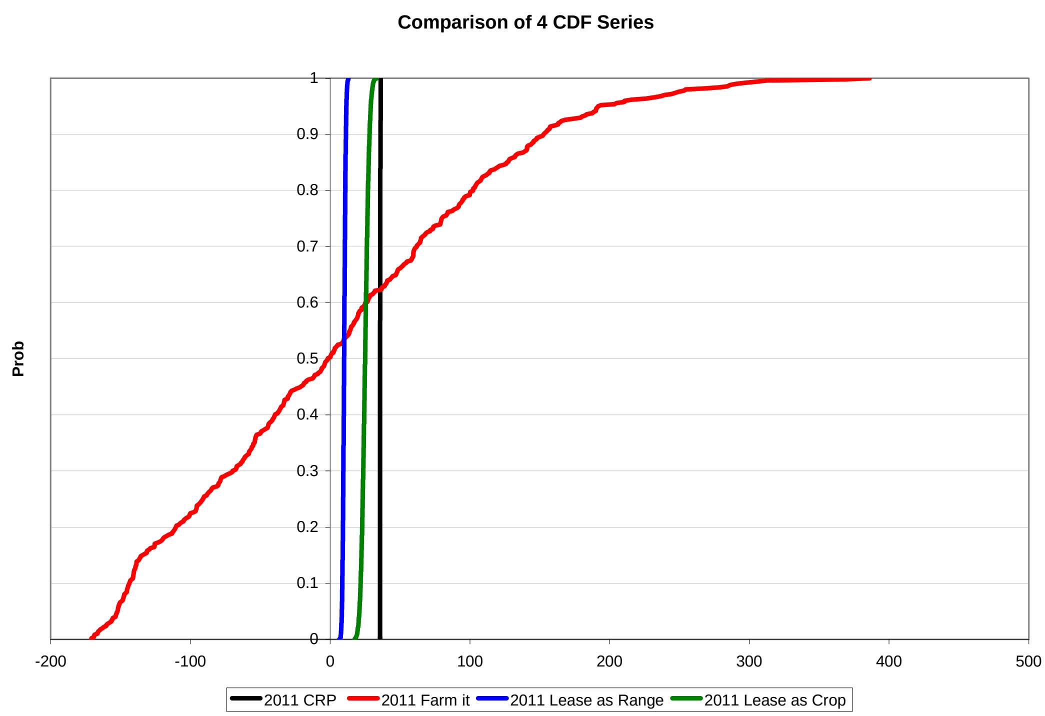

Figure 91. Swisher County 2011 returns per acre, cumulative distribution function

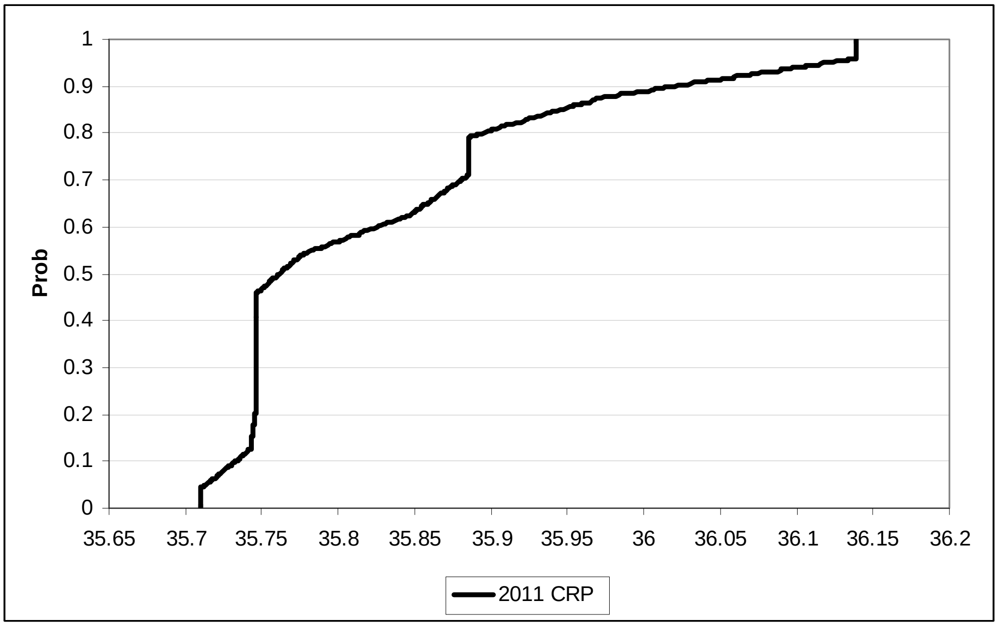

Figure 92. Swisher County 2011, conservation reserve program payments cumulative distribution function

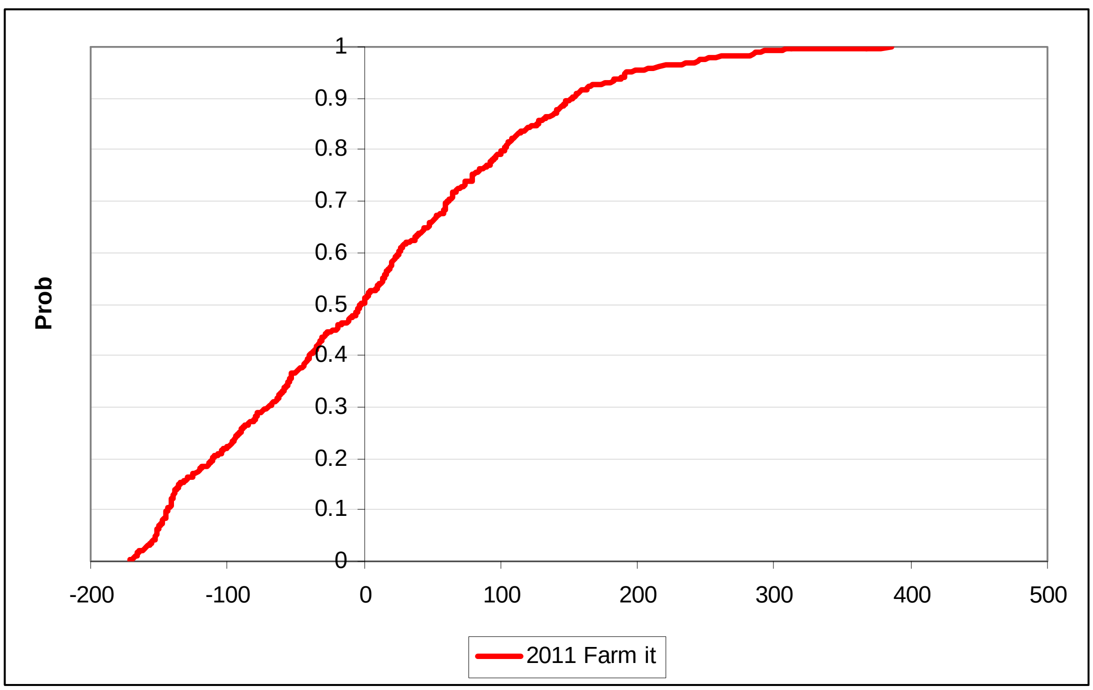

Figure 93. Swisher County 2011, dryland cotton production returns per acre cumulative distribution function

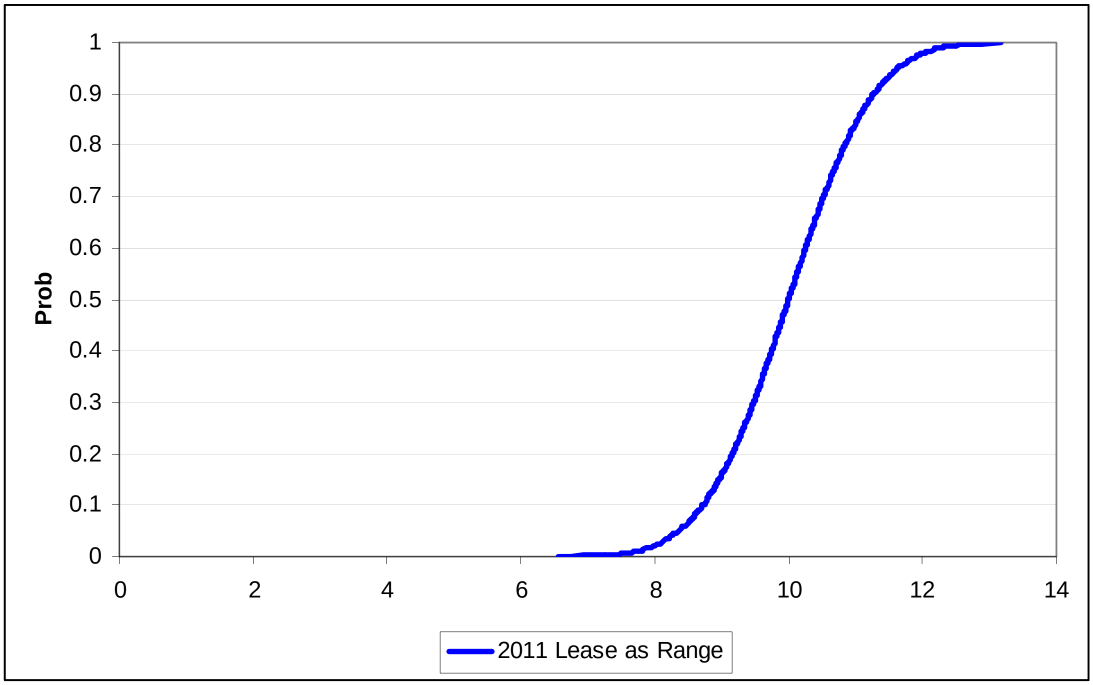

Figure 94. Swisher County 2011, lease as rangeland returns per acre cumulative distribution function

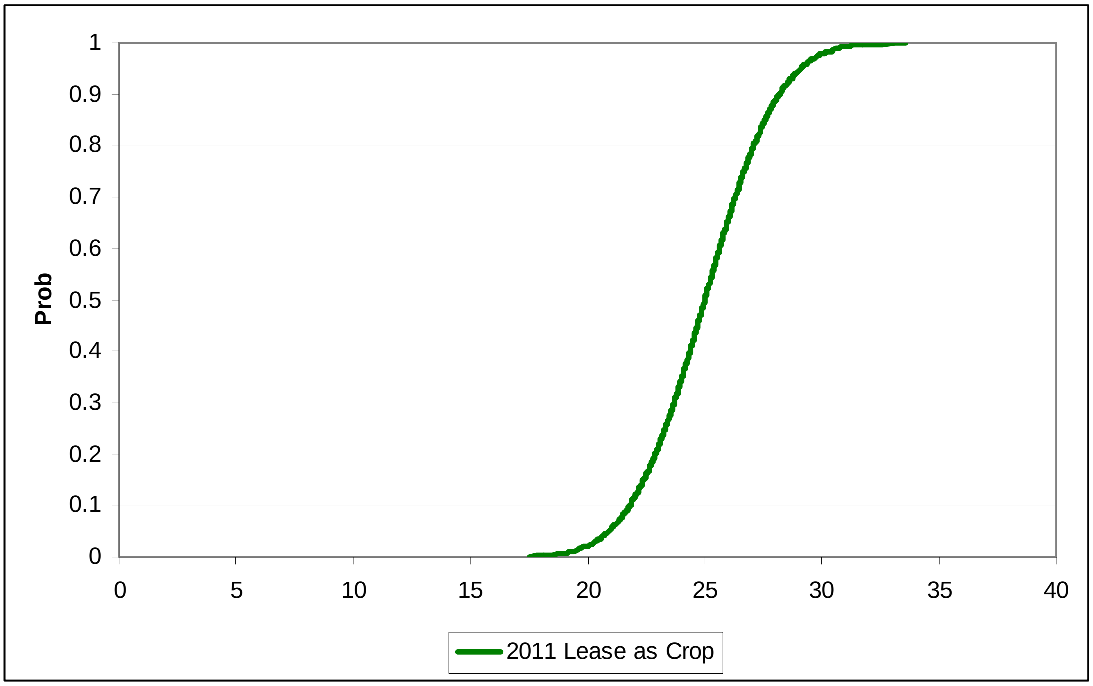

Figure 95. Swisher County 2011, lease as cropland cumulative distribution function

Figure 96 shows an analysis of Stochastic Dominance with Respect to a Function (SDRF) ranking method. Figure 97 presents the Stochastic Efficiency with Respect to a Function (SERF) under a Negative Exponential Utility Function. Both SERF and SDRF indicate that re-enrollment in CRP is the most preferred option. The upper risk aversion coefficient (RAC) was calculated based on a wealth level equal to the county average market value per farm of land and buildings found in the 2007 Census of Agriculture conducted by the USDA, National Agricultural Statistics Service (USDA, NASS 2007). The lower RAC was set at zero to represent a risk neutral decision maker. Based on the selected RACs the decision maker would most prefer CRP enrollment at all risk aversion levels within the selected range.

	Efficient Set Based on SDRF at			Efficient Set Based on SDRF at	
	Lower RAC	**0**		Upper RAC	**5.15859E-06**
	Name	Level of Preference		Name	Level of Preference
1	2011 CRP	Most Preferred	1	2011 CRP	Most Preferred
2	2011 Lease as Crop	2nd Most Preferred	2	2011 Lease as Crop	2nd Most Preferred
3	2011 Lease as Range	3rd Most Preferred	3	2011 Lease as Range	3rd Most Preferred
4	2011 Farm it	Least Preferred	4	2011 Farm it	Least Preferred

Figure 96. Stochastic dominance with respect to a function ranking of four options for producers in Swisher County 2011

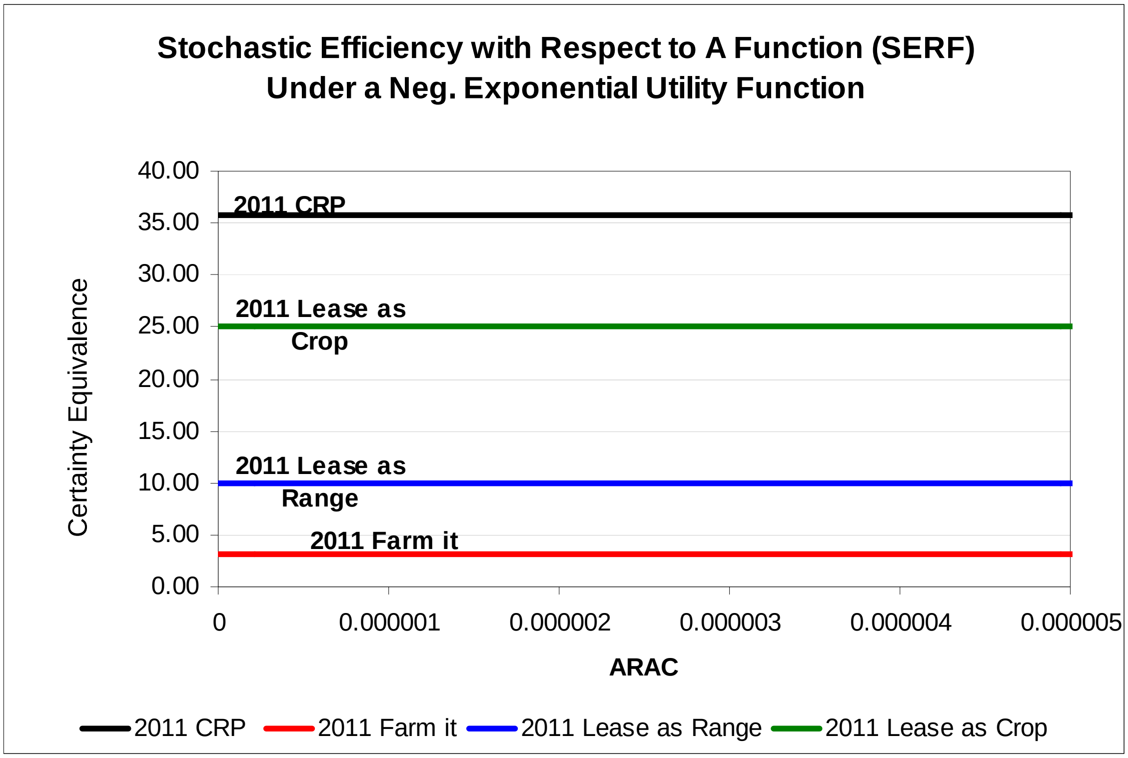

Figure 97. Stochastic efficiency with respect to a function ranking of four options for landowners in Swisher County 2011

The stoplight ranking method was also used for evaluating a landowner's decision in Swisher County. The stoplight chart for Swisher County 2011 is presented in Figure 98.

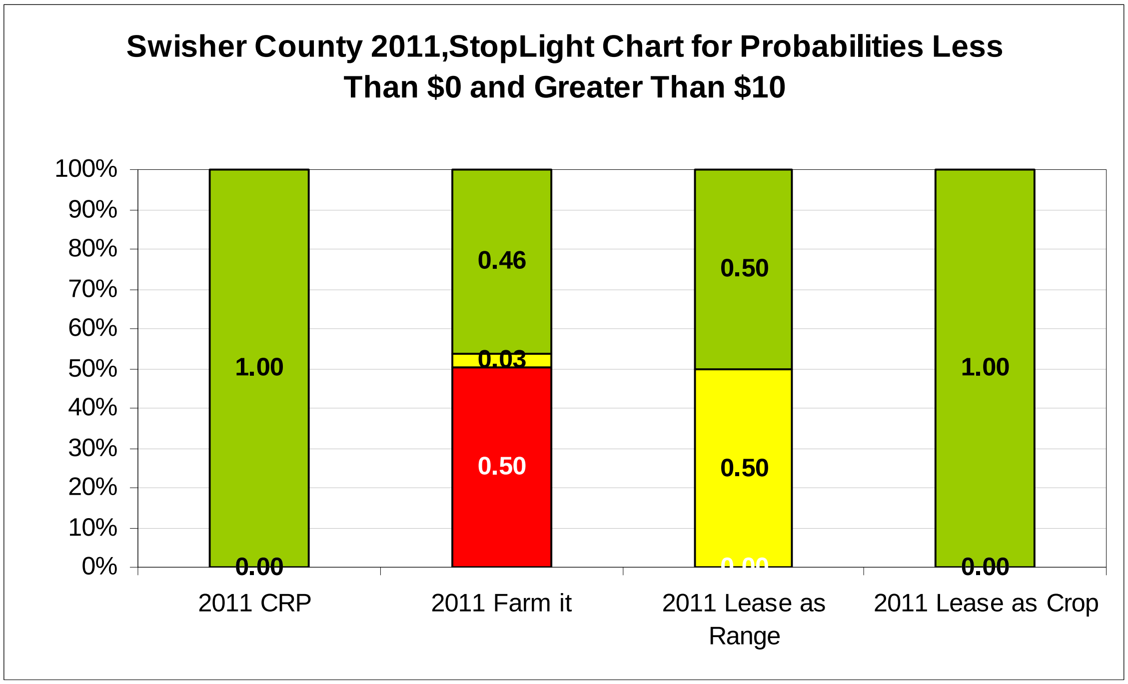

Figure 98. Stoplight chart summarizing the probabilities of returns per acre for landowners in Swisher County (2011)

According to the stoplight chart, re-enrollment in CRP and leasing the land as cropland to a tenant have the highest probabilities of achieving at least $10 per acre net returns. Choosing to farm the CRP land as dryland cotton is associated with a 50% chance of realizing negative net returns per acre as well as the lowest probability of realizing at least $10 per acre returns above direct expenses.

4.2. Modeling Economic Impacts

This section of the paper will discuss the results that were generated from the analysis of CRP economic impacts. This section will begin by examining goodness-of-fit and beta estimates of the original model. This will be followed by model validation where the models are tested for the presence of multicollinearity, serial correlation, and heteroskedasticity. Once adjustments are made, the final results will be reported and discussed in detail for each of the five county models created.

4.2.1. Original Model

Ordinary least squares (OLS) regression is a statistical method that is used to find the line that best fits through the data. There are several methods that can be used to determine how well the OLS estimate “fits” the data. These measures of fit are often referred to as “goodness of fit” measures. One measure commonly used is R-Squared (R^2). This method is often used in multiple regressions because it a measure of the proportion of total sample variation that can be explained by the given independent variables (Wooldridge 2008). R^2 typically falls between 0 and 1. As R^2 gets closer to one, it indicates that the independent variables are explaining more of the variation found in the model. An R^2 value of 1 indicates perfect fit. It would be logical to assume that as more independent variables are added, the R^2 value also increases as more variation is explained. A major drawback of using only R^2 is that it does not penalize for adding a large number of independent variables. Another goodness of fit measure that penalizes for the addition of independent variables is the adjusted R-Squared also known as $Rbar^2$. This goodness of fit measure uses degrees of freedom adjustment to estimate the error variance (Wooldridge 2008). A third goodness of fit measure that will be evaluated is the F-statistic. F-statistics are used to test several hypotheses simultaneously about the betas in a multiple regression (Wooldridge 2008). The goodness of fit measures for each of the five regressions are presented in Table 46. The goodness of fit measures are reported prior to adjustment for serial correlation and multicollinearity.

Table 46. OLS Regression Goodness-of-Fit Measures

	R^2	$Rbar^2$	F-Statistic
Gaines County:	.9437	.9312	75.4742
Lamb County:	.8301	.7923	21.9843
Dallam County:	.8393	.8036	23.5056
Hale County:	.7318	.6723	12.2811
Floyd County:	.8731	.8449	30.9553

According to these results, R^2 values range from .7318 - .9437. The initial model best fit Gaines County resulting in a R^2 of .9437 indicating that about 94% of variation could be explained by the selected independent variables which included percentage of cropland enrolled in CRP, farm income, government payments, population, and an interaction term used to indicate the 5 years after the start of the program. Hale County had the lowest R^2 value of .7318. Overall, it was concluded that all models explained a reasonable amount of variability.

The betas, t-tests, and p-values for each of the five counties are presented in Table 47. It is important to note that these are preliminary results, and will change once the model is adjusted for multicollinearity and serial correlation.

Table 47. Parameter Results for OLS Regression

	Intercept	CRP	Farm Income	Government Payments	D*CRP	Population	Trend
Gaines County:							
Beta	**28298321.84**	**-25155485.49**	-0.03	-0.03	**173344321.23**	**-2165.97**	**1076008.12**
T-Test	4.17	2.69	-1.81	-1.47	2.92	-4.08	8.81
P-Value	0.00	0.01	0.08	0.15	0.01	0.00	0.00
Lamb County:							
Beta	-14427872.34	-8133939.31	-0.01	0.02	7163667.83	939.16	**631878.45**
T-Test	-0.90	-0.61	-0.79	0.48	0.98	1.07	4.94
P-Value	0.37	0.55	0.44	0.64	0.34	0.29	0.00
Dallam County:							
Beta	-8793781.28	3938383.63	0.01	0.05	6533599.56	1396.29	**52866.95**
T-Test	-1.79	0.36	0.63	1.69	0.84	1.83	2.88
P-Value	0.09	0.72	0.53	0.10	0.41	0.08	0.01
Hale County:							
Beta	**-116561676.84**	**44570853.32**	-0.02	0.01	-14859112.24	**3451.12**	108052.35
T-Test	-3.93	2.01	-1.44	0.42	-1.20	4.28	0.63
P-Value	0.00	0.05	0.16	0.68	0.24	0.00	0.53
Floyd County:							
Beta	-2912952.08	-3902045.04	0.00	0.01	5838880.02	435.00	**260238.38**
T-Test	-0.37	-0.56	0.21	0.30	1.25	0.57	2.45
P-Value	0.72	0.58	0.83	0.76	0.22	0.57	0.02

4.2.2. Model Validation

Model validation must be conducted before the results are finalized. It was determined that tests must be conducted to check for the presence of multicollinearity, serial correlation, and heteroskedasticity.

Multicollinearity

Multicollinearity results when there is correlation among the independent variables in the multiple regression model. One method used to test for multicollinearity is to examine the correlation matrix. Variables may be positively or negatively correlated with values falling between -1 to +1. According to Pindyck and Rubinfield (1991) and Mirer (1995), absolute values of 0.50 or higher indicate strong correlation (Pindyck and Rubinfeld 1991; Mirer 1995). An examination of the correlation matrixes indicated that the trend value was highly correlated with the majority of independent variables.

Another method used to test for the significance of multicollinearity is the use of the Variance Inflation Factor (VIF). Richardson (2008) stated that a VIF of 10 or greater indicates the presence of multicollinearity (Richardson 2008). The VIF for each of the five regressions are presented in Table 48 below.

Table 48. Variance Inflation Factors

	CRP	Farm Income	Government Payments	D*CRP	Population	Trend
Gaines County:	**14.76**	3.22	2.96	1.88	2.56	**19.81**
Lamb County:	**17.25**	1.72	2.22	1.54	**15.71**	**11.93**
Dallam County:	**16.74**	4.71	1.82	2.79	2.75	9.55
Hale County:	**21.99**	2.35	2.47	1.79	3.31	**16.79**
Floyd County:	**16.58**	3.84	2.40	1.75	**31.21**	**55.82**

According to the VIF, Gaines and Hale County both had a VIF greater than 10 for the percentage of cropland enrolled in CRP and the trend variable. Lamb and Floyd County had VIFs greater than 10 for the percentage of cropland enrolled in CRP, population, and the trend variable. Dallam County only had one variable, the percentage of cropland enrolled in CRP, with a VIF greater than the threshold level. Based on the correlation matrixes and the VIF table, it was determined that the best way to avoid multicollinearity issues was to remove the trend variable from the regression. The new VIFs without the trend variable are reported in Table 49. The removal of the trend variable brought all VIFs below 10 for all but Lamb County, which still had A VIF greater than 10 for the CRP and population variables. The possibility of multicollinearity in Lamb county could cause the standard errors of the affected coefficients to be too large, which could lead to a false conclusion that there is not a significant linear relationship between the independent and dependent variables when in fact there could be.

Multicollinearity likely exists between the CRP, population, and trend variables because all three variables are steadily increasing or decreasing over time. The percentage of total cropland enrolled in CRP has a significant trend. Population in most of these rural counties has also experienced a steady decline and also has a significant trend. The new parameter results for the OLS regression without trend are in Table 50.

Table 49. Variance Inflation Factors after Trend Removal

	CRP	Farm Income	Government Payments	D*CRP	Population
Gaines County:	4.32	3.07	1.96	1.06	1.59
Lamb County:	**14.55**	1.51	1.70	1.11	**13.87**
Dallam County:	4.90	4.18	1.71	2.15	2.68
Hale County:	4.48	2.02	1.77	1.33	2.92
Floyd County:	8.06	3.60	2.37	1.11	6.94

Table 50. Parameter Results for OLS Regression after Trend Removal

	Intercept	CRP	Farm Income	Government Payments	D*CRP	Population
Gaines County:						
Beta	-5024194.87	**44193379.42**	-0.05	**0.08**	-17124675.14	719.07
T-Test	-0.46	4.51	-1.95	2.33	-1.99	0.89
P-Value	0.65	0.00	0.06	0.03	0.06	0.38
Lamb County:						
Beta	16185344.85	17828977.45	-0.04	**0.10**	-11979256.01	-539.39
T-Test	0.814	1.08	-1.96	2.42	-1.43	-0.48
P-Value	0.42	0.29	0.06	0.02	0.17	0.63
Dallam County:						
Beta	-10019087.78	**30562505.90**	0.00	**0.07**	-4205235.79	**1733.83**
T-Test	-1.82	4.58	-0.32	2.18	-0.55	2.05
P-Value	0.08	0.00	0.75	0.04	0.59	0.05
Hale County:						
Beta	**-122511974.31**	**57105734.54**	-0.02	0.03	-18832955.55	**3627.28**
T-Test	-4.40	5.76	-1.83	0.90	-1.78	4.84
P-Value	0.00	0.00	0.08	0.37	0.09	0.00
Floyd County:						
Beta	**14458420.28**	8348279.78	0.00	0.01	-1043475.35	**-1211.09**
T-Test	3.75	1.58	-0.38	0.54	-0.26	-3.10
P-Value	0.00	0.13	0.71	0.59	0.80	0.00

The removal of trend from the independent variables also affected the previously reported goodness-of-fit measures. The new goodness-of-fit measures after correction for multicollinearity are reported in Table 51.

Table 51. OLS Regression Goodness-of-Fit Measures without Trend

	R^2	$Rbar^2$	F-Statistic
Gaines County:	.7819	.7430	20.0783
Lamb County:	.6767	.6190	11.7233
Dallam County:	.7899	.7524	21.0561
Hale County:	.7279	.6793	14.9778
Floyd County:	.8450	.8173	30.5187

Serial Correlation

Serial correlation, also known as autocorrelation, occurs when the error terms from different time periods are correlated with each other. According to Kennedy (2003) autocorrelated disturbances are also described as the event when off-diagonal elements in the variance-covariance matrix of disturbance terms are nonzero. Serial correlation may affect the accuracy of test statistics making it difficult to determine if a variable is significant. Serial correlation is often an issue when dealing with panel or time-series data. Several causes of serial correlation are spatial autocorrelation, prolonged influence of shocks, inertia, data manipulation, or misspecification (Kennedy 1998). The Durbin-Watson (DW) statistic was used to test for the presence of first order autocorrelation. The formula for calculating the DW statistic is as follows:

$$DW = \frac{\sum_{t=2}^{n}(\hat{u}_t - \hat{u}_{t-1})^2}{\sum_{t=1}^{n}\hat{u}_t^{\,2}}$$

This statistic is tested against the null hypothesis that autocorrelation is not present which occurs when the DW statistic is approximately 2.0. When the DW statistic gets farther away from 2 it indicates that autocorrelation or serial correlation is present (Kennedy 1998). The statistical software program SAS was used to test the models for serial correlation (SAS Institute Inc. 2010a). The DW statistics for first order autocorrelation are presented in Table 52.

Table 52. Durbin-Watson Statistics

	DW Statistic
Gaines County:	**.7886**
Lamb County:	**1.0484**
Dallam County:	**1.1265**
Hale County:	1.6461
Floyd County:	1.4505

The above results indicate that first order positive autocorrelation is likely present in the Gaines, Lamb, and Dallam County models. Savin and White (1977) created a table of critical values for upper and lower DW statistics (Savin and White 1977). Gaines, Lamb, and Dallam Counties exhibit positive autocorrelation based on the DW statistics being less than the lower bound critical value at 5% significance. Negative autocorrelation is not present in any of the models. It was determined that something must be done to correct for the positive autocorrelation present in Gaines, Lamb, and Dallam Counties. The statistical software program SAS has a procedure that can be used to correct for autocorrelated errors. This procedure is known as the AUTOREG procedure. SAS employs the Yule-Walker method to correct for autocorrelation. This method is also known by other names. It has been called the estimated generalized least squares (EGLS) method, the two-step full transform method, or Prais-Winsten method. For these models the Yule-Walker method was used in a stepwise autoregressive process. In SAS software, maximum likelihood estimates are produced after the order of the model is selected based on significance tests of Yule-Walker estimates (SAS Institute Inc. 2010b). The new DW statistics that resulted from re-estimating the regressions for Gaines, Lamb, and Dallam Counties are reported in Table 53. The R-squared measures that resulted from re-estimating the regressions are presented in Table 54.

Table 53. Durbin-Watson statistics after Serial Correlation Correction

	DW statistic before re-estimation	DW statistic after re-estimation
Gaines County:	0.7886	1.9165
Lamb County:	1.0484	1.8581
Dallam County:	1.1265	1.8410

Table 54. R-Squared Measures after Serial Correlation Correction

	R^2 Before	R^2 After
Gaines County:	0.7819	0.9219
Lamb County:	0.6767	0.8023
Dallam County:	0.7899	0.8382

Overall, correcting the regressions for serial correlation increased the total amount of variability explained by the models. In Gaines County R^2 increased from 0.7819 up to 0.9219. Lamb County had an R^2 of 0.6767 which was increased to 0.8023 after correction. Dallam County also realized a higher R^2 value of 0.8382 up from 0.7899. Serial Correlation also changed the betas, t-statistics, and p-values for the three county models. The new parameter results are presented in Table 55.

Table 55. Parameter Results after Serial Correlation Correction

	Intercept	CRP	Farm Income	Government Payments	D*CRP	Population
Gaines County:						
Beta	-20047880	**33136684**	-0.0159	-0.0171	4085164	2092
T-Test	-1.05	2.16	-0.96	-0.71	0.41	1.64
P-Value	0.3011	0.0400	0.3444	0.4865	0.6882	0.1132
Lamb County:						
Beta	21250865	10460588	0.0038	0.0364	600685	-871.90
T-Test	0.86	0.52	0.19	1.08	0.06	-0.62
P-Value	0.3949	0.6052	0.8507	0.2905	.9558	0.5427
Dallam County:						
Beta	-11919167	**24091939**	0.0112	**0.0715**	843876	2004
T-Test	-1.68	3.10	0.85	2.16	0.10	1.84
P-Value	0.1039	0.0045	0.4040	0.0398	0.9205	0.0769

Prior to adjustments being made for serial correlation, the significant independent variables in the Gaines County model were the percentage of cropland enrolled in CRP, government payments to farmers, and the interaction term representing the time period immediately following CRP implementation. After adjustments were made, the only significant variable was the percentage of cropland enrolled in CRP. In Lamb County, farm income and government payments were the only two significant variables prior to adjustment. After serial correlation corrections, there were no significant variables at the 95% confidence level. In the original regression for Dallam County, the percentage of cropland enrolled in CRP, government payments, and population were significant. In the model corrected for serial correlation, only the percentage of cropland enrolled in CRP and government payments remained significant at the 95% confidence level.

Heteroskedasticity

In a regression model, the errors should have a constant variance for all observations. This condition is known as homoskedasticity. This condition must be met to ensure that OLS is BLUE (best linear unbiased estimator). If this condition is not met, the regression is said to exhibit heteroskedasticy. Heteroskedasticity is the condition where the variance of the error terms are not constant (Wooldridge 2008). Heteroskedasticity does not affect parameter estimates because coefficients should remain unbiased; however, it does bias variance which results in t-statistics that should be used with caution (Pindyck and Rubinfeld 1991). For this study, the Breusch-Pagan test was used to test for the presence of heteroskedasticity. This test uses a Lagrange Multiplier (LM) statistic that is distributed chi-squared. The Breusch-Pagan test assumes a null hypothesis of homoskedasticity. The null hypothesis is rejected if the LM statistic is greater than the critical value. The LM statistics and p-values associated with each of the five regression models are reported in Table 56.

Table 56. Breusch-Pagan Test Results

	LM Statistic	Pr > LM
Gaines County:	**10.2966**	**0.0013**
Lamb County:	1.5000	0.2207
Dallam County	1.6418	0.2001
Hale County:	0.0152	0.9018
Floyd County:	0.0283	0.8663

The Breusch-Pagan test indicates that we fail to reject the null hypothesis of homoscedasticity for Lamb, Dallam, Hale, and Floyd Counties. Unfortunately null hypothesis was rejected for Gaines County indicating the presence of heteroskedasticity. According to Kennedy (2003), a major strength and drawback to the Breusch-Pagan test is its generality. The strength is that prior knowledge of the functional form of heteroskedasticity doesn't have to be known to run the test. The disadvantage is that if heteroskedasticity is detected by the test, it does not indicate its functional form. If functional form is known, more powerful heteroskedasticity tests could be utilized (Kennedy 1998). As previously stated, heteroskedasticity affects the trustworthiness of t-statistics. Therefore, the significance of independent variables for the Gaines County model should be used with caution until adjustments are made to generate a robust variance-covariance matrix and corrected t-statistics.

4.2.3. Results

The purpose of using OLS regression to examine the economic implications of CRP was to determine if CRP has had a significant measurable impact on the agricultural service industry earnings. Based on the significance of independent variables in this model, one could determine if it would be useful to conduct further research to determine a specific magnitude of impact. Of the five counties modeled, three of the county models indicated that CRP has played a significant role in the agricultural service industry. Detailed results for each of the five counties will be discussed in this section.

Gaines County

The OLS regression for Gaines County included five independent variables: percentage of cropland enrolled in CRP, farm income, government payments to farmers, an interaction term that represented the first five years after CRP began, and population. The final results for Gaines County are re-stated in Table 57. The final R-Squared value for this model was 0.9219 indicating that a large amount of variability was explained by the independent variables.

Table 57. Gaines County Results

	Intercept	CRP	Farm Income	Government Payments	D*CRP	Population
Gaines County:						
Beta	-20047880	**33136684**	-0.0159	-0.0171	4085164	2092
T-Test	-1.05	2.16	-0.96	-0.71	0.41	1.64
P-Value	0.3011	0.0400	0.3444	0.4865	0.6882	0.1132

In model validation it was discovered that multicollinearity was likely an issue based on a VIF greater than 10 for the variables CRP and Trend. It was determined that the trend variable should be removed from the model to correct this issue. Further model validation tests also indicated that the model had issues with positive autocorrelation based on a low Durbin-Watson Statistic. The model was corrected for serial correlation. A major issue that was discovered in this model was the likely presence of heteroskedasticity; therefore, the significance of independent variables for the Gaines County model should be used with caution until adjustments are made to generate a robust variance-covariance matrix and corrected t-statistics.

Overall, the results indicate that the percentage of total cropland enrolled in CRP has had a significant measurable impact on the agricultural services industry. An interesting observation is that the coefficient on the CRP variable is positive. This implies that as the amount of CRP land in a county increases, so too does the annual earnings of the agricultural services industry in Gaines County. Once again it should be noted that further work should be conducted to correct for possible heteroskedasticity.

Lamb County

The OLS regression for Lamb County included five independent variables: percentage of cropland enrolled in CRP, farm income, government payments to farmers, an interaction term that represented the first five years after CRP began, and population. The final results for Lamb County are re-stated in Table 58. The final R-Squared value for this model was 0.8023 indicating that a large amount of variability was explained by the independent variables.

Table 58. Lamb County Results

	Intercept	CRP	Farm Income	Government Payments	D*CRP	Population
Lamb County:						
Beta	21250865	10460588	0.0038	0.0364	600685	-871.90
T-Test	0.86	0.52	0.19	1.08	0.06	-0.62
P-Value	0.3949	0.6052	0.8507	0.2905	.9558	0.5427

In model validation it was discovered that multicollinearity was likely an issue based on a VIF greater than 10 for the variables CRP, population, and trend. It was determined that the trend variable should be removed from the model to correct this issue. After trend was removed from the model, the VIF was still greater than 10 for the CRP and population variables indicating that multicollinearity could still be an issue. This is important to note because it may cause the standard errors of the CRP and population variables to be too large which may lead one to falsely conclude that these two variables do not have a significant linear relationship with the agricultural service industry earnings.

Further model validation tests also indicated that the model had issues with positive autocorrelation based on a low Durbin-Watson Statistic. The model was corrected for serial correlation. The Breusch-Pagan test was used to test for heteroskedasticity, and it was concluded that heteroskedasticity was not present.

Overall, the OLS regression results show that none of the independent variables chosen have a significant linear relationship with the annual earnings of agricultural services in Lamb County. Once again it should be noted that further work should be conducted to correct for possible multicollinearity.

Dallam County

The OLS regression for Dallam County included five independent variables: percentage of cropland enrolled in CRP, farm income, government payments to farmers, an interaction term that represented the first five years after CRP began, and population. The final results for Dallam County are re-stated in Table 59. The final R-Squared value for this model was 0.8382 indicating that a large amount of variability was explained by the independent variables.

Table 59. Dallam County Results

	Intercept	CRP	Farm Income	Government Payments	D*CRP	Population
Dallam County:						
Beta	-11919167	**24091939**	0.0112	**0.0715**	843876	2004
T-Test	-1.68	3.10	0.85	2.16	0.10	1.84
P-Value	0.1039	0.0045	0.4040	0.0398	0.9205	0.0769

In model validation it was discovered that multicollinearity was likely an issue based on a VIF greater than 10 for the CRP variable and very close to 10 (9.55) for the trend variable. It was determined that the trend variable should be removed from the model to correct this issue. Further model validation tests also indicated that the model had issues with positive autocorrelation based on a low Durbin-Watson Statistic. The model was corrected for serial correlation. The Breusch-Pagan test was used to test for heteroskedasticity, and it was concluded that heteroskedasticity was not present.

Overall, the results indicate that the percentage of total cropland enrolled in CRP has had a significant measurable impact on the agricultural services industry. An interesting observation is that the coefficient on the CRP variable is positive. This implies that as the amount of CRP land in a county increases, so too does the annual earnings of the agricultural services industry in Gaines County. The variable representing government program payments to farmers was also significant and positive. This implies that as the government payments to farmers increase annual earnings of the agricultural services in Dallam County also increase.

Hale County

The OLS regression for Hale County included five independent variables: percentage of cropland enrolled in CRP, farm income, government payments to farmers, an interaction term that represented the first five years after CRP began, and population. The final results for Hale County are re-stated in Table 60. The final R-Squared value for this model was 0.7279 indicating that a fair amount of variability was explained by the independent variables. This R-Squared value was somewhat lower than it would have been preferred. This is more than likely due to the fact that there is a city in Hale County with more than 20,000 residents. Plainview has a population of 21,389 according to 2009 U.S. Census estimates (Texas Association of Counties, CIP 2010g).

Table 60. Hale County Results

	Intercept	CRP	Farm Income	Government Payments	D*CRP	Population
Hale County:						
Beta	**-122511974**	**57105735**	-0.02	0.03	-18832956	**3627**
T-Test	-4.40	5.76	-1.83	0.90	-1.78	4.84
P-Value	0.00	0.00	0.08	0.37	0.09	0.00

In model validation it was discovered that multicollinearity was likely an issue based on a VIF greater than 10 for the CRP and trend variables. It was determined that the trend variable should be removed from the model to correct this issue. The model was checked for serial correlation. The Durbin-Watson statistics indicated that serial correlation was not present. The Breusch-Pagan test was used to test for heteroskedasticity, and it was concluded that heteroskedasticity was not present.

Overall, the results indicate that the percentage of total cropland enrolled in CRP has had a significant measurable impact on the agricultural services industry. An interesting observation is that the coefficient on the CRP variable is positive. This implies that as the amount of CRP land in a county increases, so too does the annual earnings of the agricultural services industry in Gaines County. The variable representing population was also significant and positive. This implies that as the population in Hale County increases, annual earnings of the agricultural services also increase.

Floyd County

The OLS regression for Floyd County included five independent variables: percentage of cropland enrolled in CRP, farm income, government payments to farmers, an interaction term that represented the first five years after CRP began, and population. The final results for Hale County are re-stated in Table 61. The final R-Squared value for this model was 0.8450 indicating that a large amount of variability was explained by the independent variables.

Table 61. Floyd County Results

	Intercept	CRP	Farm Income	Government Payments	D*CRP	Population
Floyd County:						
Beta	**14458420**	8348280	0.00	0.01	-1043475	**-1211**
T-Test	3.75	1.58	-0.38	0.54	-0.26	-3.10
P-Value	0.00	0.13	0.71	0.59	0.80	0.00

In model validation it was discovered that multicollinearity was likely an issue based on a VIF greater than 10 for the CRP, population, and trend variables. It was determined that the trend variable should be removed from the model to correct this issue. The model was checked for serial correlation. The Durbin-Watson statistics indicated that serial correlation was not present. The Breusch-Pagan test was used to test for heteroskedasticity, and it was concluded that heteroskedasticity was not present.

Overall, the results indicate that the only significant independent variable was the population in Floyd County. The coefficient for the population variable is negative which implies that as population increases, annual earnings of the agricultural services in Floyd County decrease. The percentage of total cropland enrolled in CRP was not found to be significant.

CHAPTER V

CONCLUSIONS

This research focused primarily on the ten counties in Texas having the most acres of CRP enrollment. The study area consisted of Gaines, Deaf Smith, Lamb, Hale, Floyd, Dallam, Hockley, Terry, Castro, and Swisher Counties. CRP has become increasingly important in Texas due to the high level of program participation particularly in the high plains of Texas. Due to the high volume of CRP contracts in Texas, there is also a seemingly large amount of CRP contracts that will expire particularly in the next five years. As these contracts expire, it becomes very important for landowners to fully evaluate the options that are available for future land use. The decisions that these landowners make may also positively or negatively impact the communities in which they live. Understanding the role that CRP plays in local economies may also become very important in the decision-making process.

5.1. The CRP Enrollment Decision

The objective of this research was twofold. First, and the primary objective, was to provide landowners in these counties with a comprehensive list of options available after CRP contract expiration. This objective was accomplished by identifying four viable options for landowners. The options were identified as re-enrollment in CRP, conversion back into crop production, lease land to a tenant as rangeland, or lease land to a tenant as cropland. Latin Hypercube simulation was used to generate a stochastic value for probable net returns per acre for the four options for each of the ten counties located in the study area. The four options were then evaluated based on a variety of methods typically used to rank risky alternatives for a risk-averse landowner. Risky options were evaluated based on mean, standard deviation, worst-case scenario, best-case scenario, relative risk, mean-variance, cumulative distribution functions, SDRF, SERF, and Stoplight Chart rankings.

All ten counties selected re-enrollment in CRP as the most preferred alternative for ranking based on mean, standard deviation, worst-case scenario, relative risk, mean-variance, and cumulative distribution functions. All counties also selected conversion to crop production as the most preferred alternative when evaluated based on a best-case scenario. These results are reasonable because re-enrollment in CRP is “sure thing” money in the form of government rental payments whereas dryland crop production has inherently higher risk due to weather events, crop failure, government policies, prices, etc. Dryland crop production could result in negative net returns per acre or extremely high net returns per acre depending on the crop year and the variables that affect yield, price, and cost of production. Simply put, dryland crop production has the potential for the highest net returns per acre as well as the potential for the lowest net returns per acre.

Ranking the risky alternatives for a risk averse landowner also returned very similar results. The SDRF and SERF ranking methods both selected CRP enrollment as the most preferred option followed by leasing as cropland, leasing as rangeland, and finally as least preferred dryland crop production. The only county that did not return results in this order was Floyd County which ranked dryland crop production only slightly higher than leasing as rangeland. The ranking in Floyd County is likely due to the historically high dryland cotton production yields.

The Stoplight ranking method set thresholds for a favorable outcome and an unfavorable outcome. Any iteration that resulted in a value above $10 net return per acre was classified as “good.” An iteration that returned a negative value was judged as “bad.” This ranking method indicated a 100% chance of realizing a favorable outcome for re-enrollment in CRP and leasing to a tenant as cropland. The option of leasing land to a tenant as rangeland returned a 34-50% chance of realizing a net return of $10 or greater. There was no chance of realizing negative net returns with this option. Dryland crop production had the most variability. The chance of realizing a net return of $10 or greater ranged from 12 – 47%. However, the downside risk was relatively high ranging from a 50 – 86% chance or realizing a negative net return per acre.

Overall, the results indicate that CRP enrollment is the most preferred option for landowners if the opportunity exists to re-enroll land in CRP. CRP rental payments from the government are typically higher than rental payments received from tenants who lease land for crop production or as rangeland. Dryland crop production, while it can return very high net returns per acre, also has the highest amount of risk involved. However, it is important to note that the best ranking method and decision is dependent on the specific decision maker and situation.

There are several limitations associated with this model. First, historical data for the average price, yield, and cost of production were used to generate estimates for each county. The typical or average situation may not apply to all landowners. The AgriLife

Extension Budgets that were used to generate net returns per acre for dryland crop production could certainly be individualized for a specific landowner. A second limitation is that all decision makers were assumed to be risk averse. Individual landowners may have differing risk and income preferences not accounted for by this model. A final limitation results from not accounting for non-economic factors that may influence the decision-making process.

There are several areas that could be explored for further research. First, it would be beneficial to conduct price sensitivity analysis on the cropland production option. This model used historic prices to generate net returns per acre. In the past year, cotton prices have reached historic highs. These increased profits could make dryland crop production a more attractive option. The model should also be examined under differing scenarios where the CRP enrollment rate is lower than historic averages. In some circumstances a landowner may have to share a percentage of total CRP rental payments with former tenants under the Landlord and Tenant Provisions. This provision would cause CRP rental rates to be lower and may cause the option to re-enroll land in CRP less attractive to landowners.

5.2. Economic Impacts

The second objective of the research was to determine if there are measurable economic impacts to the agricultural services industry associated with CRP enrollment. This objective was accomplished by using OLS regression models. The models were only run for five of the ten counties in the study area due to a lack of data reported by the Bureau of Economic Analysis. An OLS regression was created for Gaines, Lamb, Dallam, Hale, and Floyd Counties. Annual earnings of the agricultural services industry was the dependent variable. The models included five independent variables: percentage of cropland enrolled in CRP, farm income, government payments to farmers, an interaction term that represented the first five years after CRP began, and population.

There are also several limitations associated with this part of the research as well as opportunities for future research. The Gaines County model indicated the presence of heteroskedasticity and the Lamb County model indicated the possible presence of multicollinearity. Adjustments should be made for both of these issues before further research is conducted. A second limitation resulted from lack of full data reported. The Bureau of Economic Analysis does not report information if doing so might violate the privacy of a business establishment. Lack of data prevented the modeling of five counties in the study area. Another limitation to this approach is the possibility of inadvertently omitting an important variable from the model. If an important variable is omitted from the model it could result in the bias of beta parameters.

Based on the significance of independent variables in this model, one could determine if it would be useful to conduct further research to determine a specific magnitude of impact. T-statistics for each independent variable was used to determine significance at the 95% confidence level. Of the five counties modeled, the Gaines, Dallam, and Hale County models indicated that CRP has played a significant role in the annual earnings of the agricultural services industry. The results suggest that there would be a benefit to conducting further research to determine a quantifiable impact. Suggested methods include the use of an input-output model or a computable generable equilibrium model in order to fully account for the complexity of relationships that exist within an economic system. Either approach would be capable of generating a reliable, quantifiable magnitude of impact resulting from CRP enrollment.

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APPENDIX A

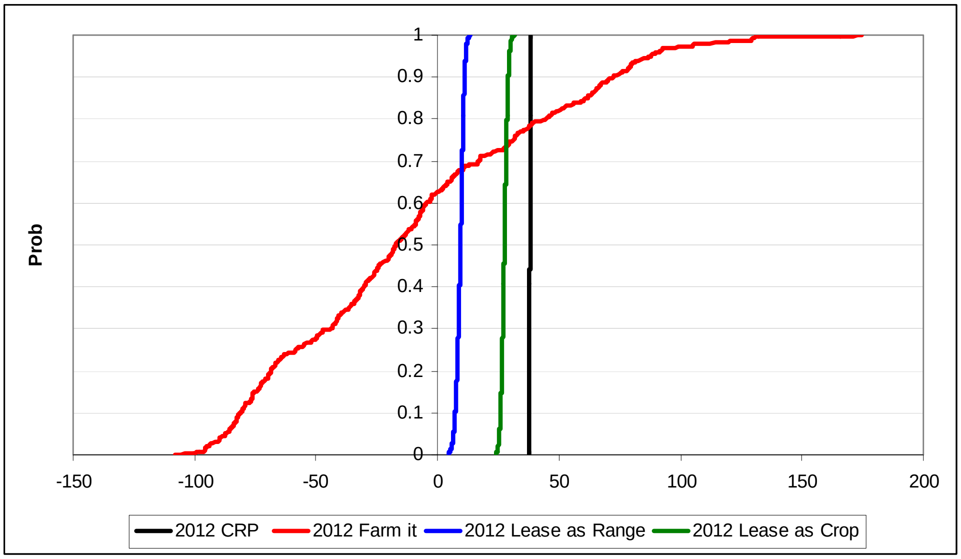


Figure A1. Deaf Smith County 2012 returns per acre, cumulative distribution function

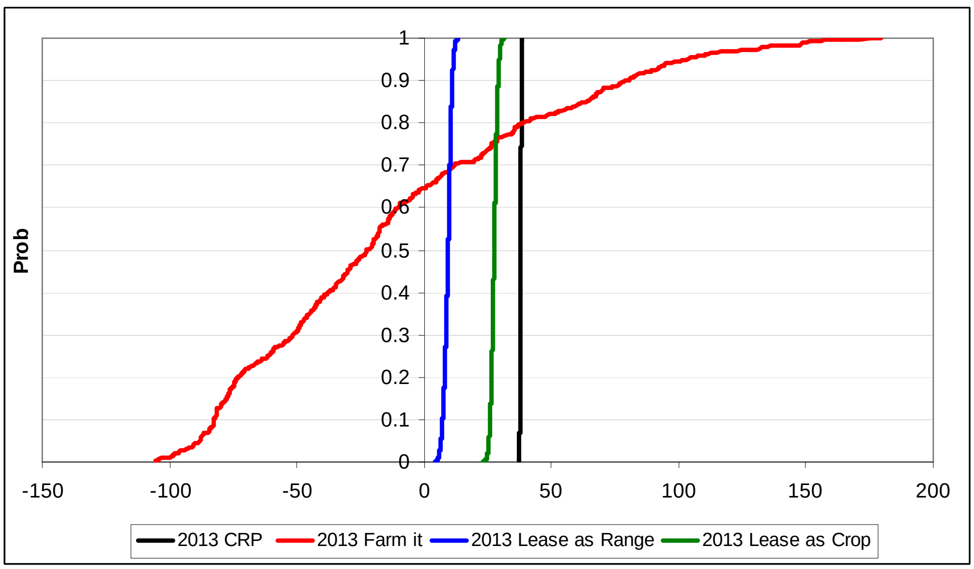


Figure A2. Deaf Smith County 2013 returns per acre, cumulative distribution function

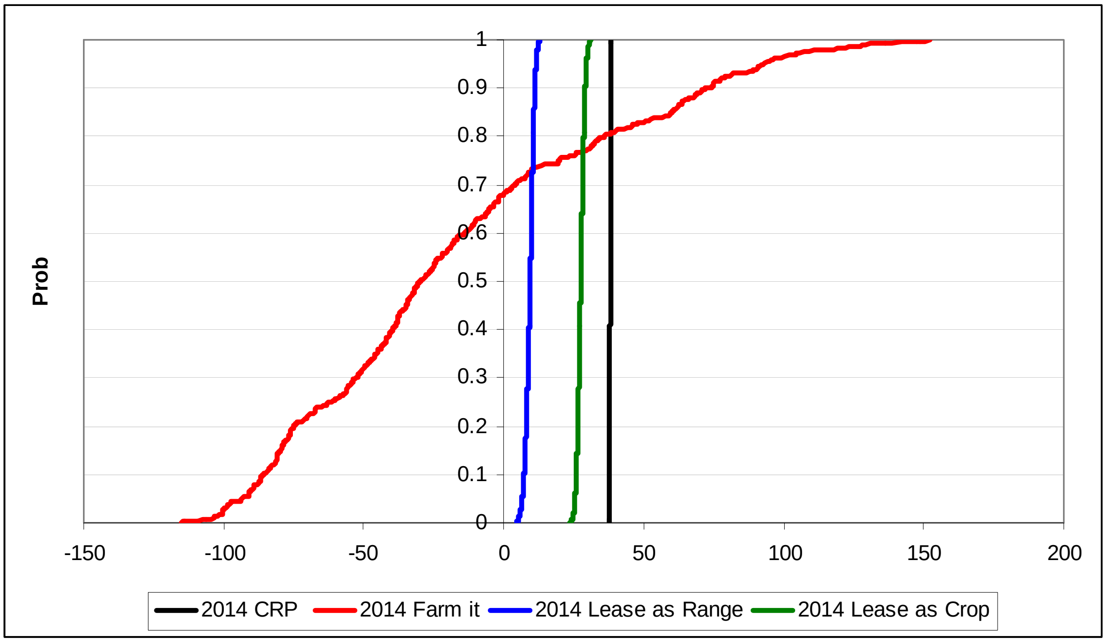


Figure A3. Deaf Smith County 2014 returns per acre, cumulative distribution function

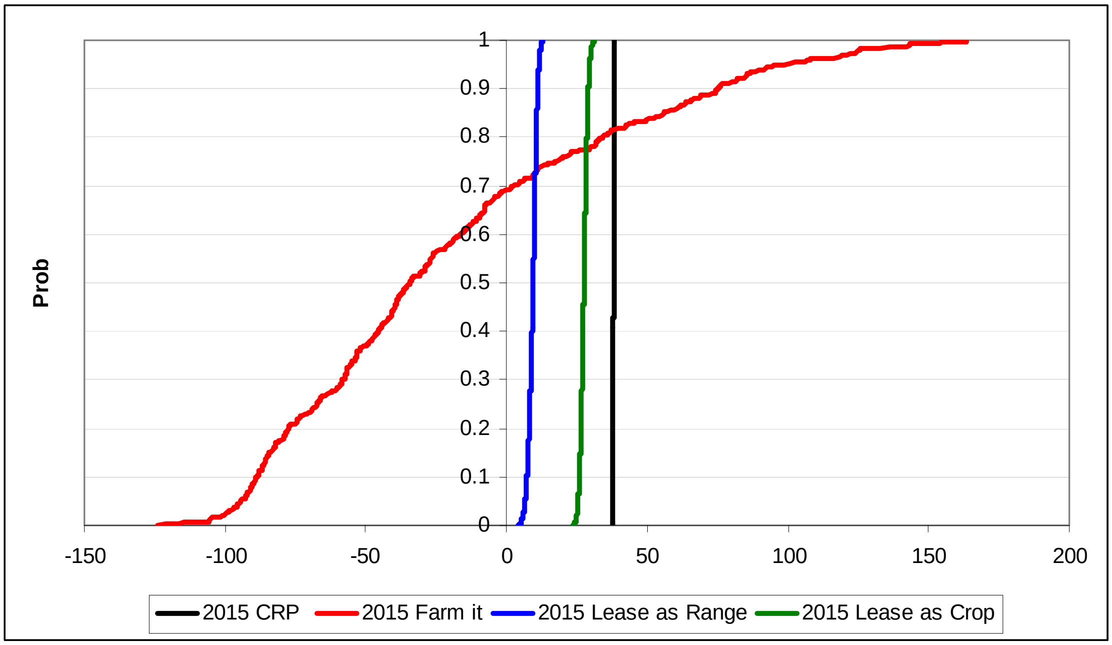


Figure A4. Deaf Smith County 2015 returns per acre, cumulative distribution function

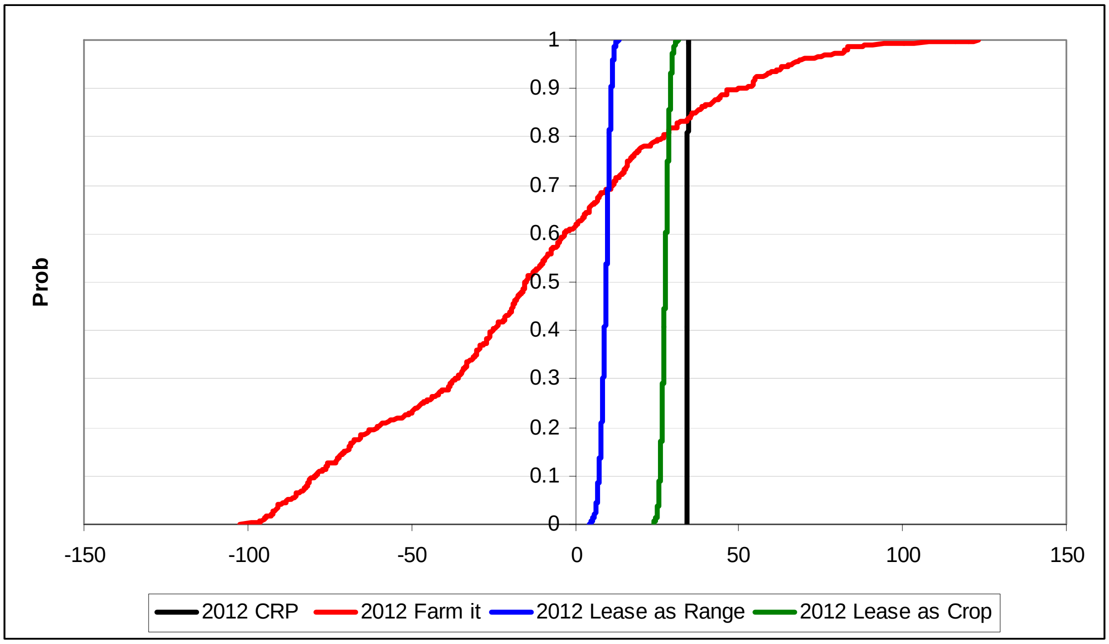


Figure A5. Dallam County 2012 returns per acre, cumulative distribution function

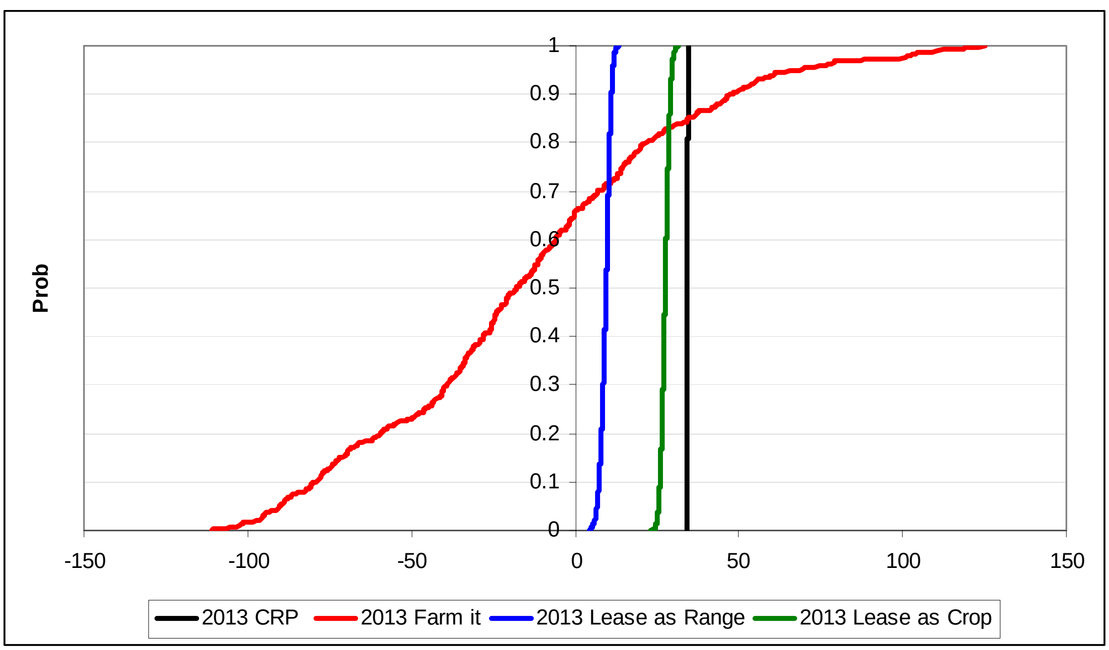


Figure A6. Dallam County 2013 returns per acre, cumulative distribution function

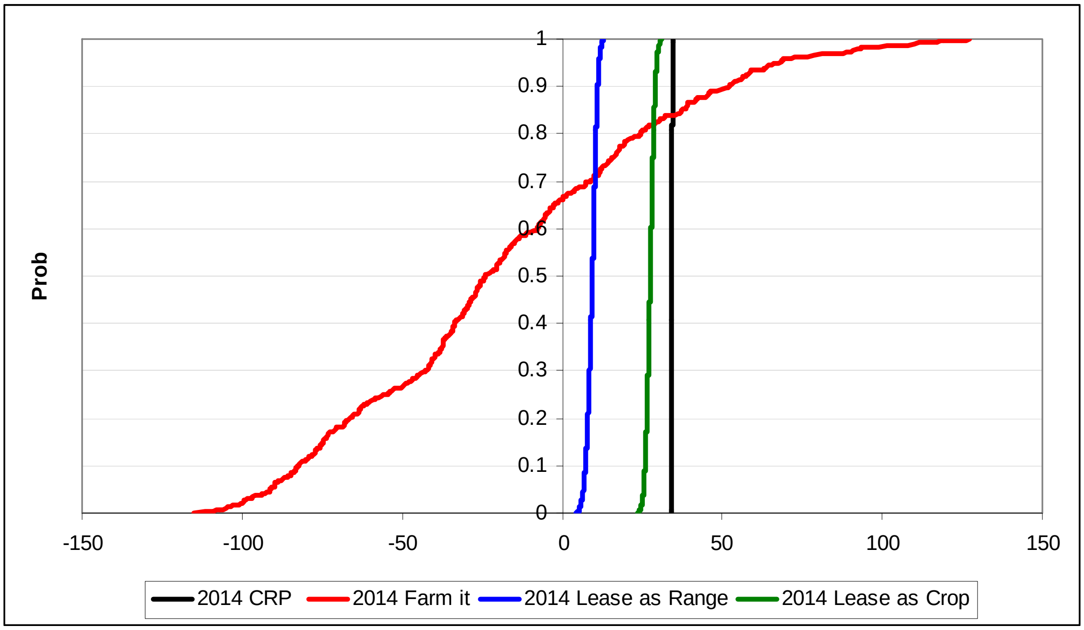


Figure A7. Dallam County 2014 returns per acre, cumulative distribution function

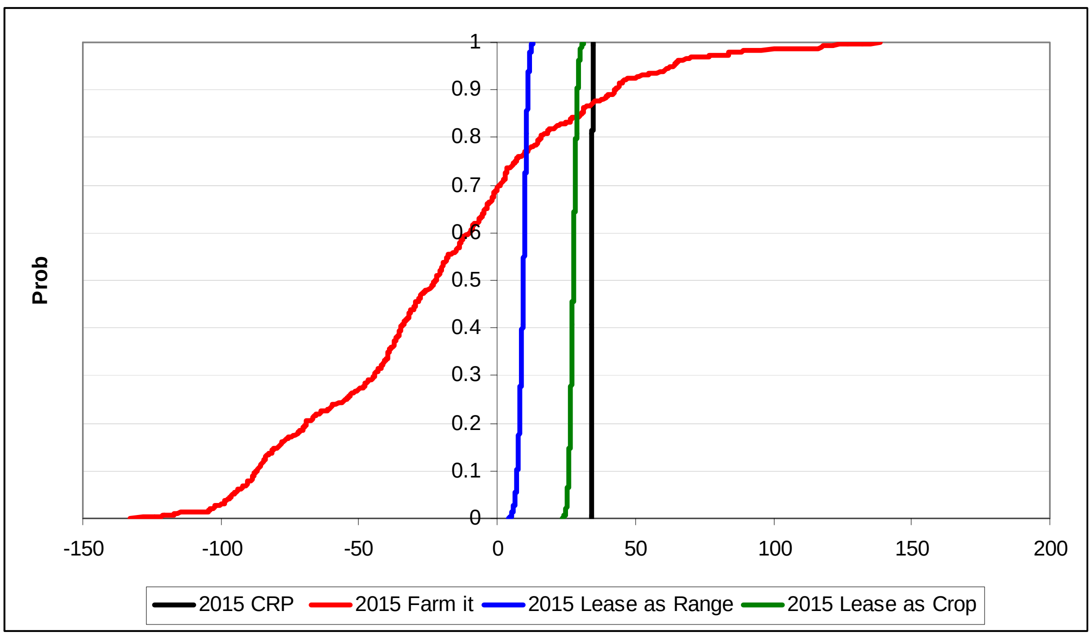


Figure A8. Dallam County 2015 returns per acre, cumulative distribution function

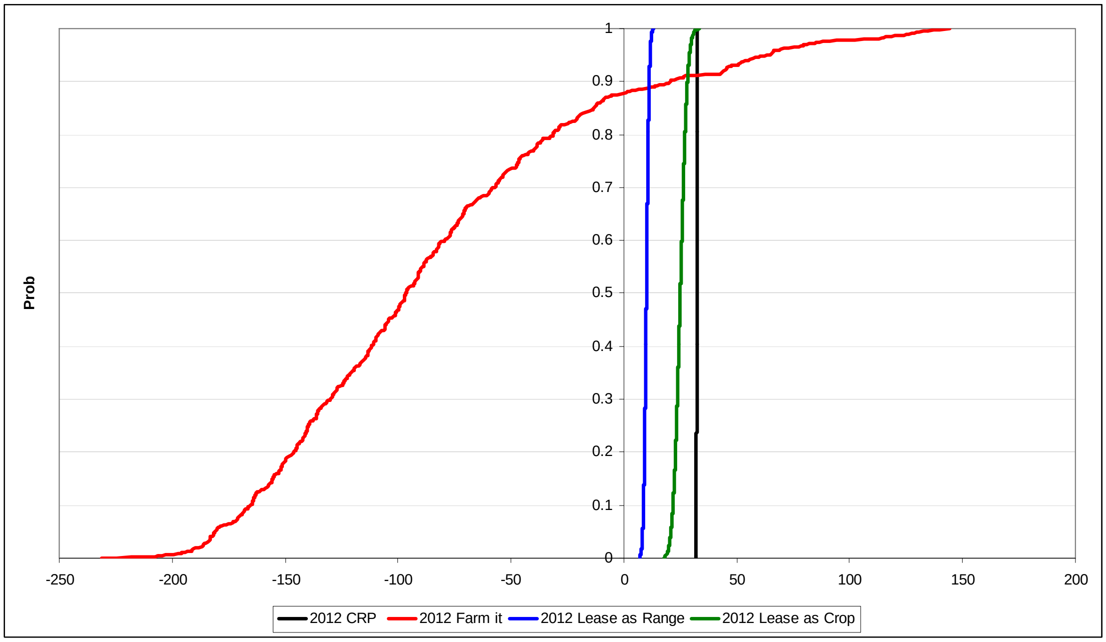


Figure A9. Gaines County 2012 returns per acre, cumulative distribution function

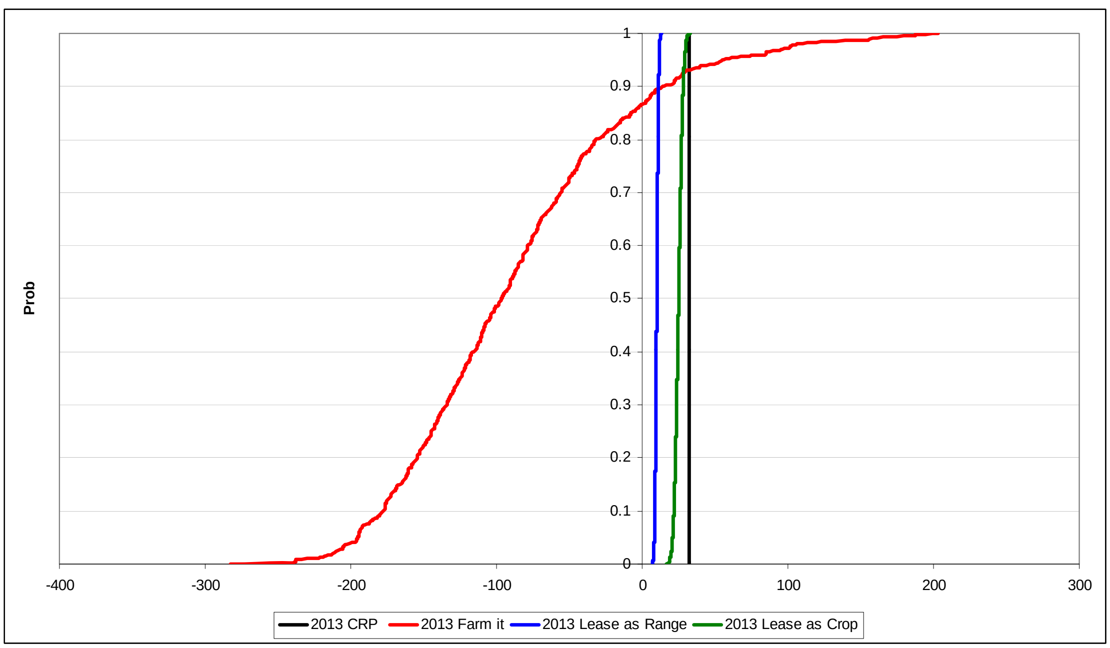


Figure A10. Gaines County 2013 returns per acre, cumulative distribution function

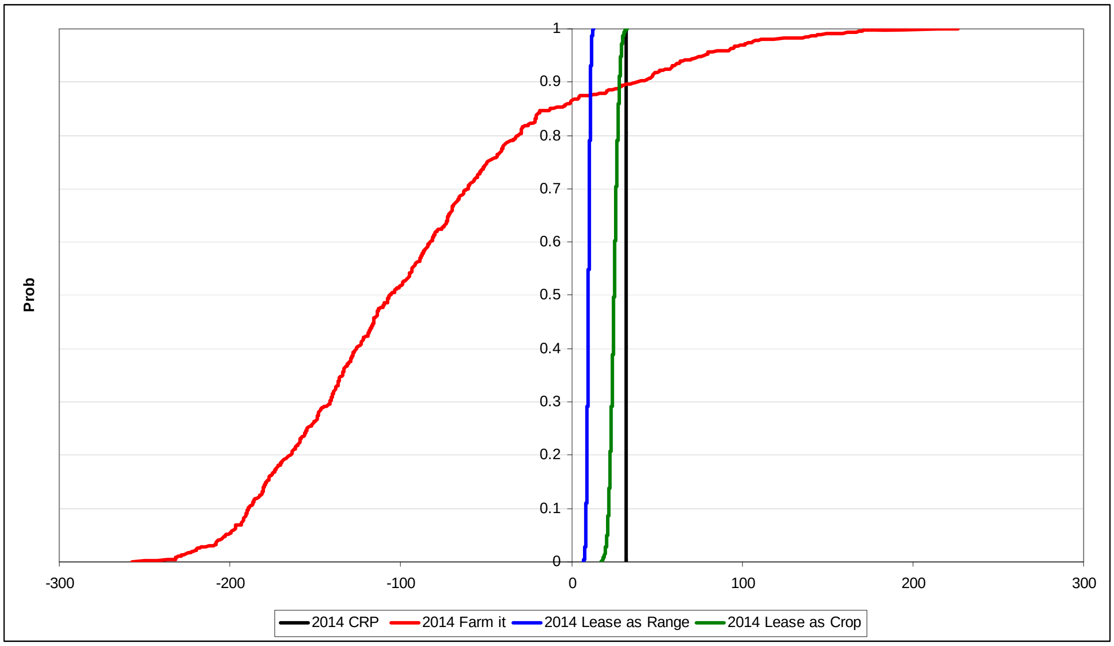


Figure A11. Gaines County 2014 returns per acre, cumulative distribution function

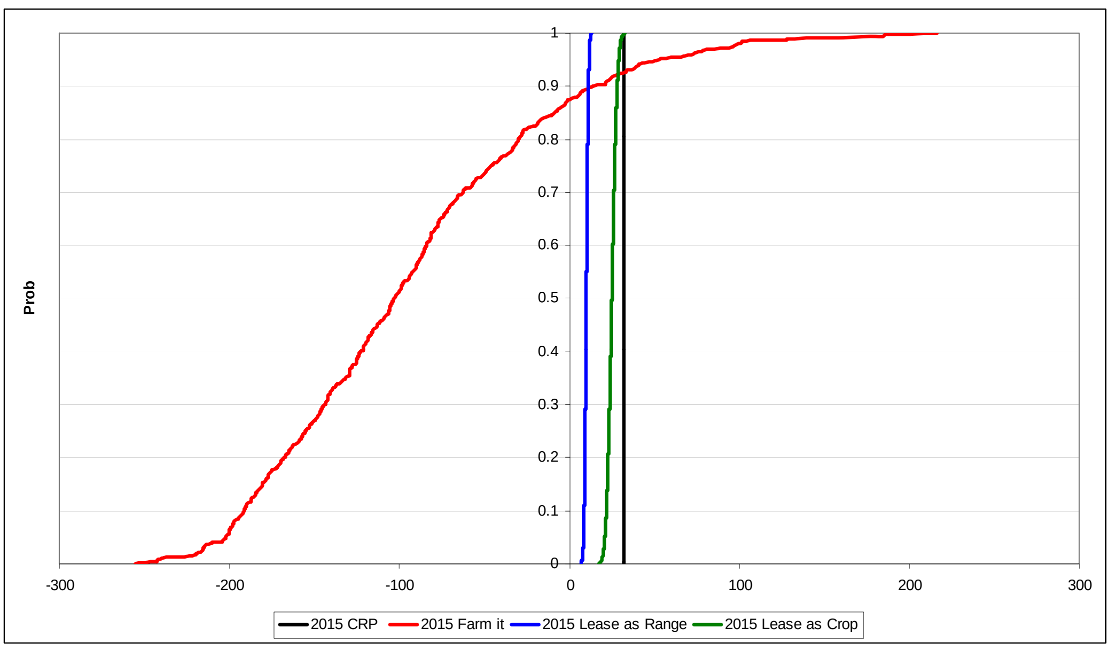


Figure A12. Gaines County 2015 returns per acre, cumulative distribution function

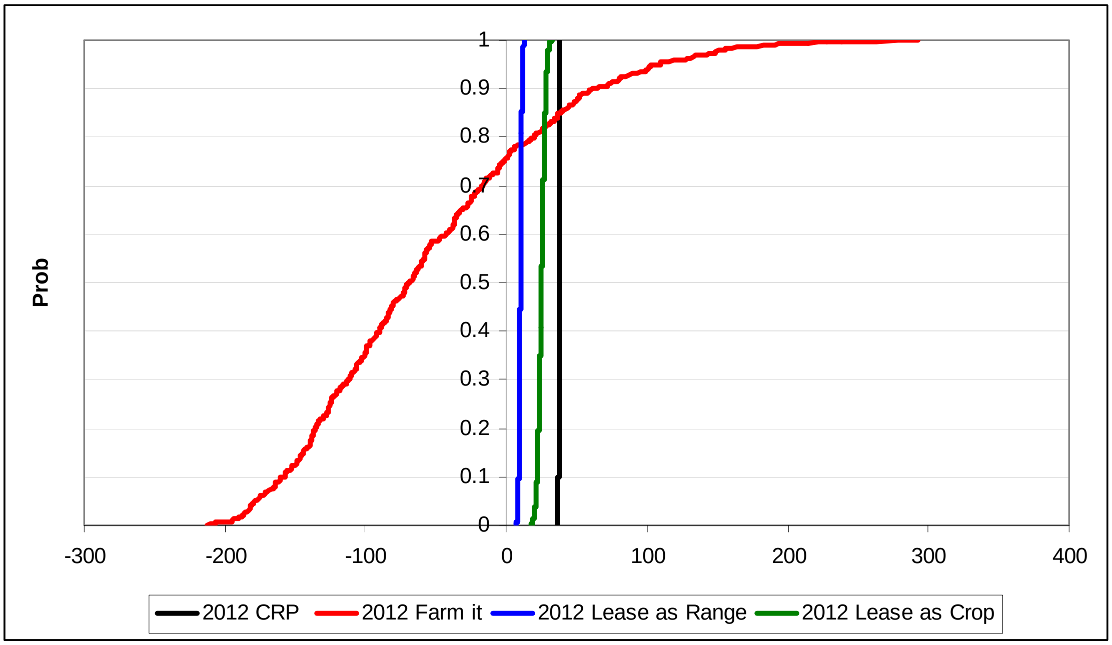


Figure A13. Lamb County 2012 returns per acre, cumulative distribution function

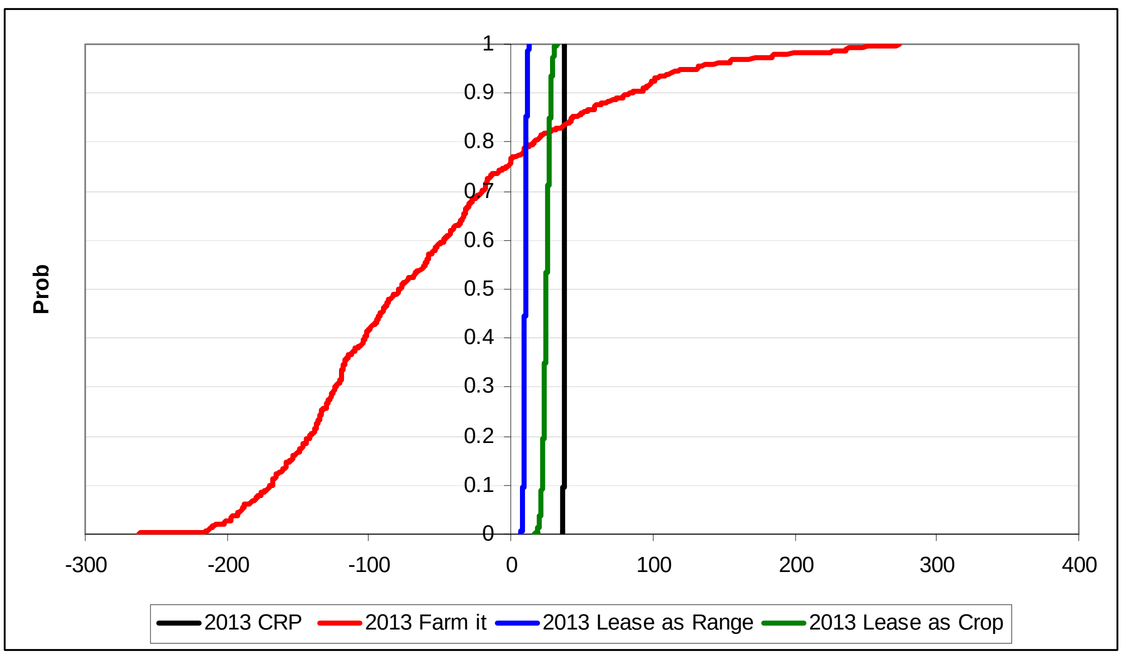


Figure A14. Lamb County 2013 returns per acre, cumulative distribution function

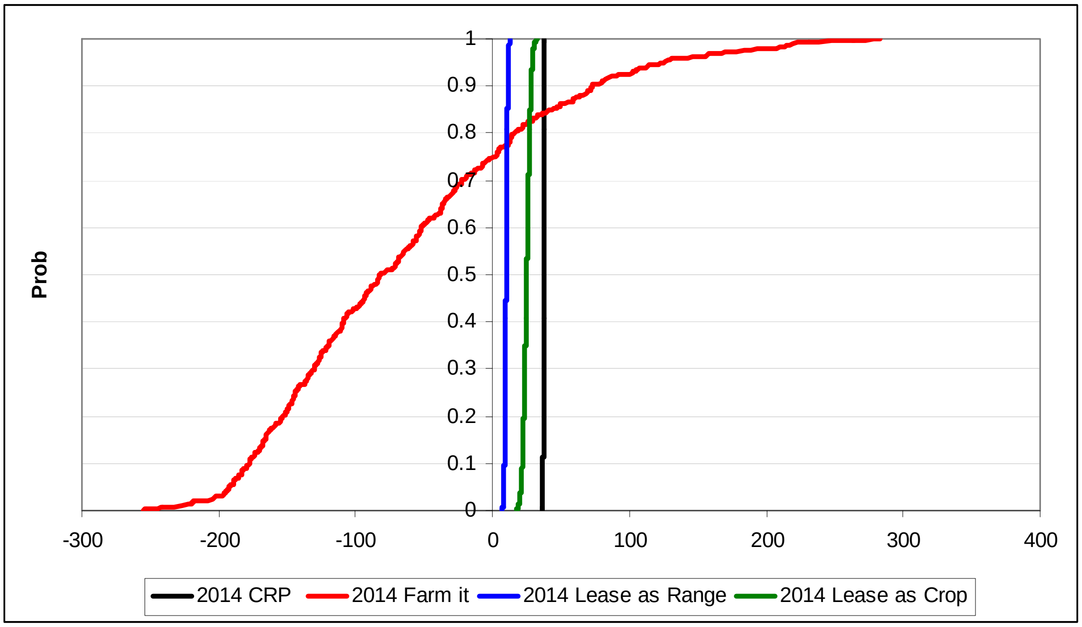


Figure A15. Lamb County 2014 returns per acre, cumulative distribution function

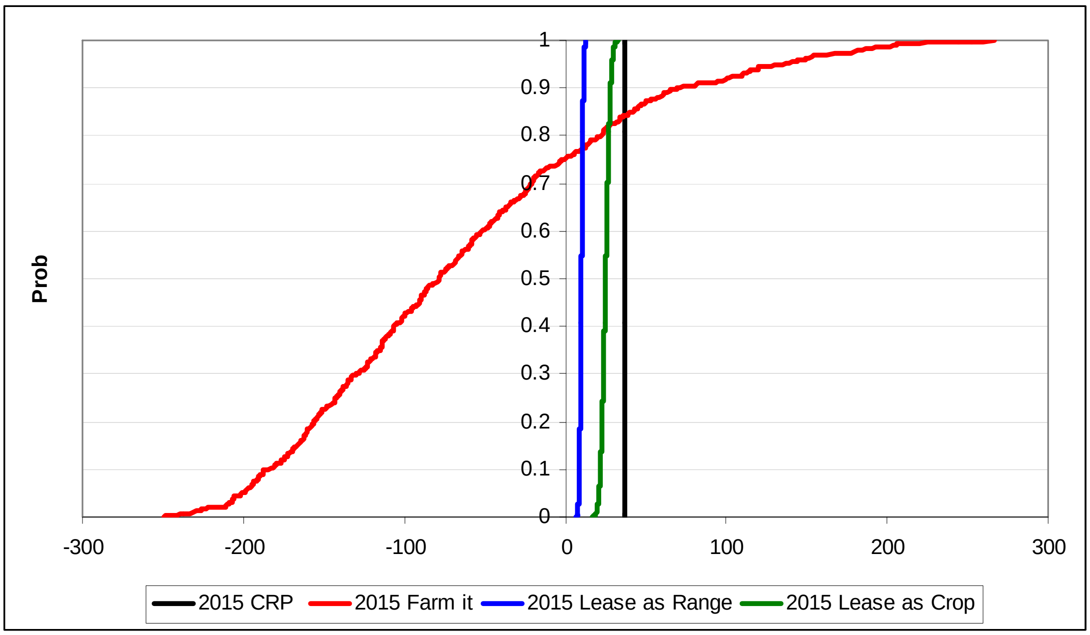


Figure A16. Lamb County 2015 returns per acre, cumulative distribution function

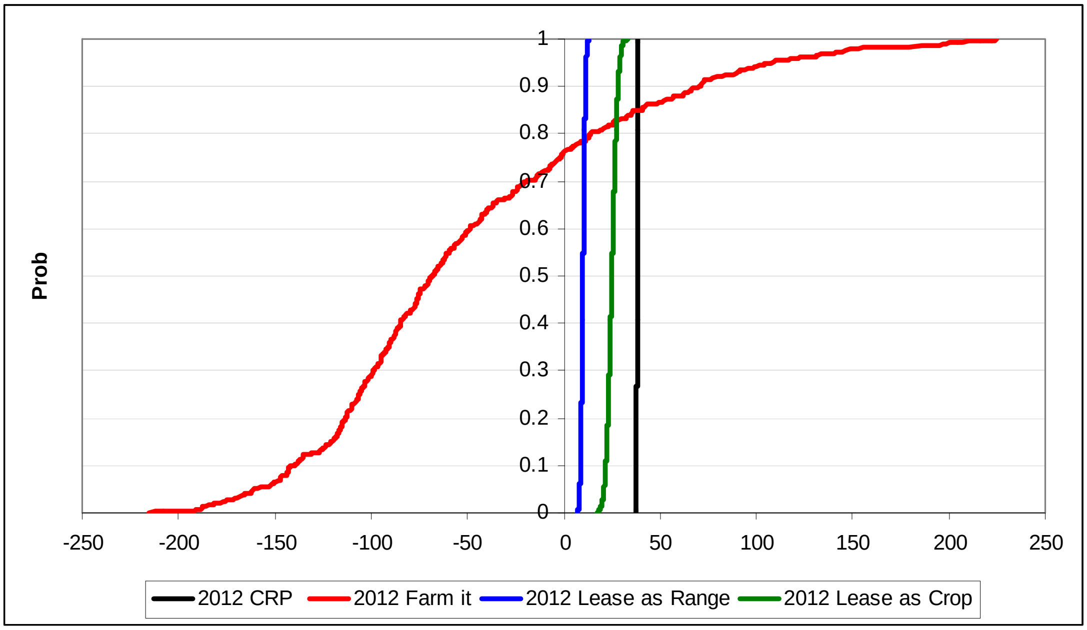


Figure A17. Hale County 2012 returns per acre, cumulative distribution function

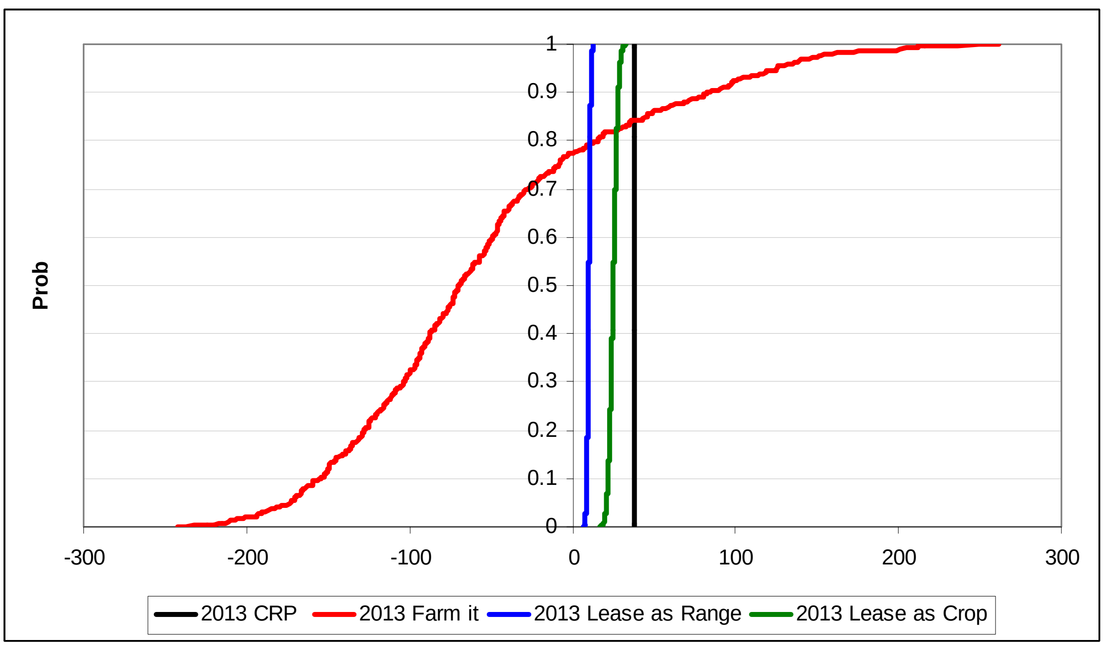


Figure A18. Hale County 2013 returns per acre, cumulative distribution function

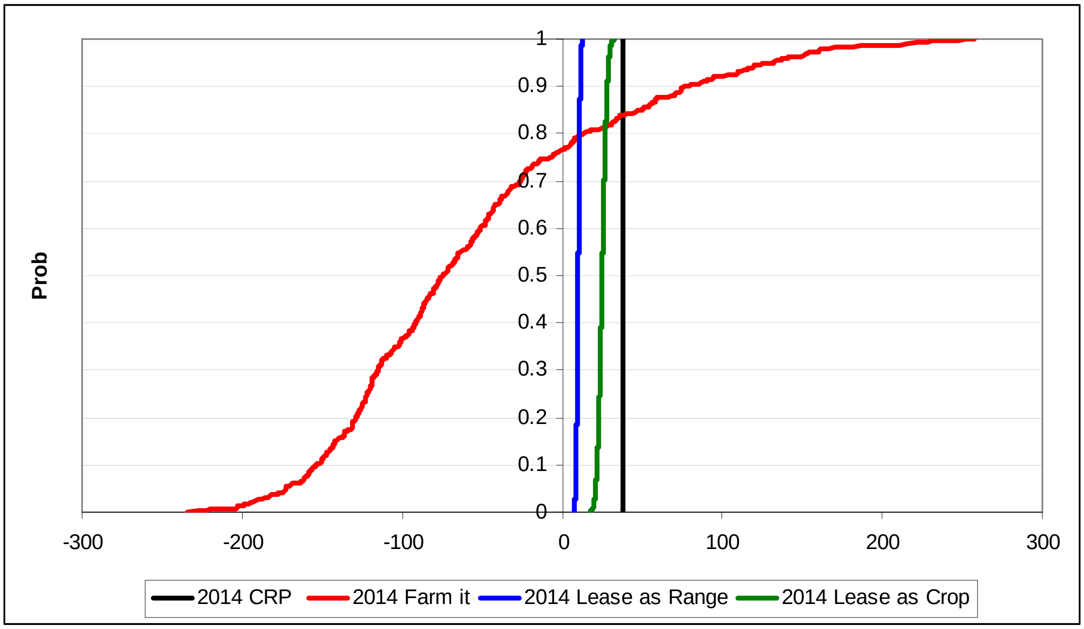


Figure A19. Hale County 2014 returns per acre, cumulative distribution function

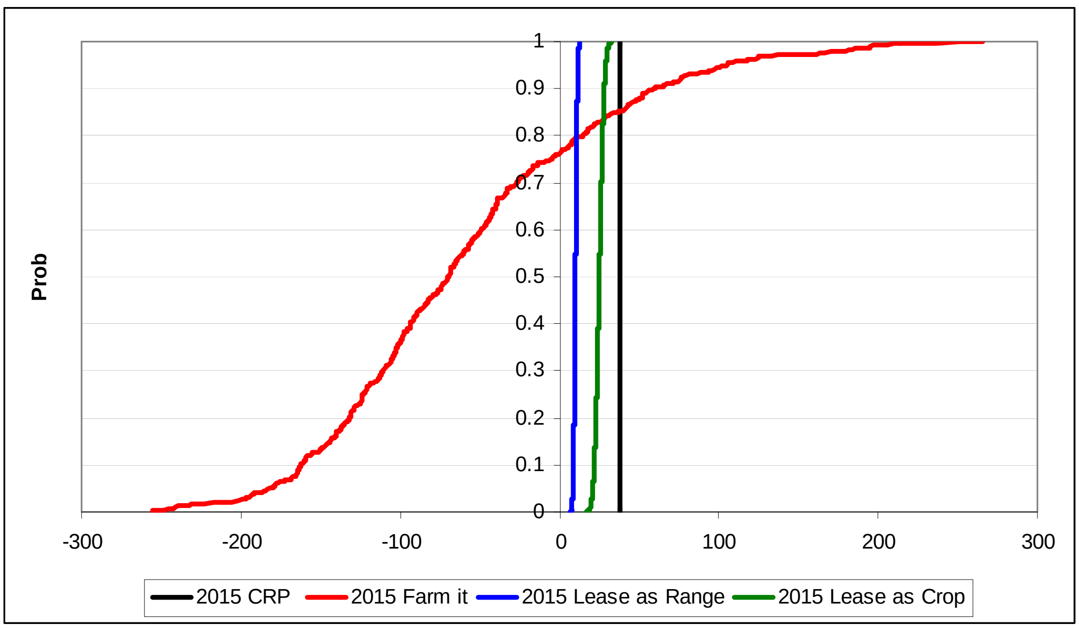


Figure A20. Hale County 2015 returns per acre, cumulative distribution function

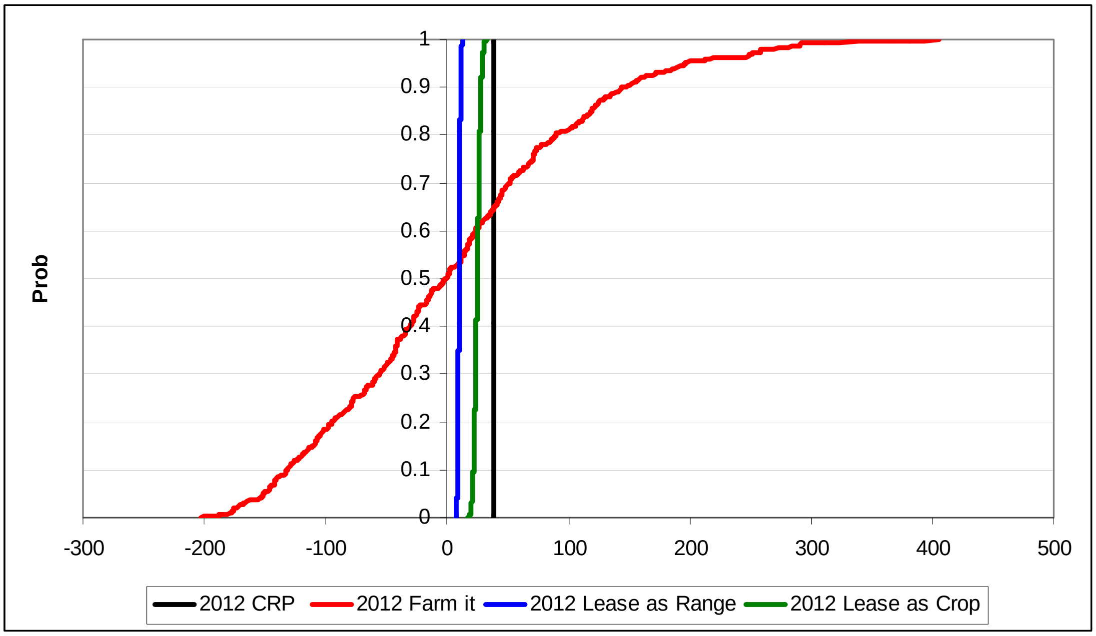


Figure A21. Floyd County 2012 returns per acre, cumulative distribution function

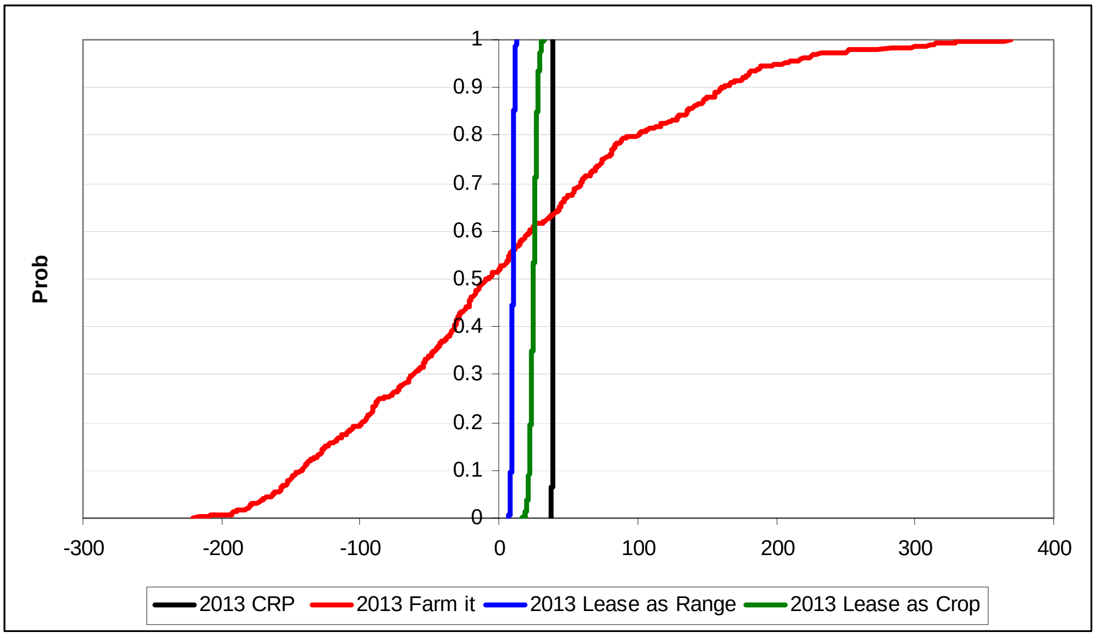


Figure A22. Floyd County 2013 returns per acre, cumulative distribution function

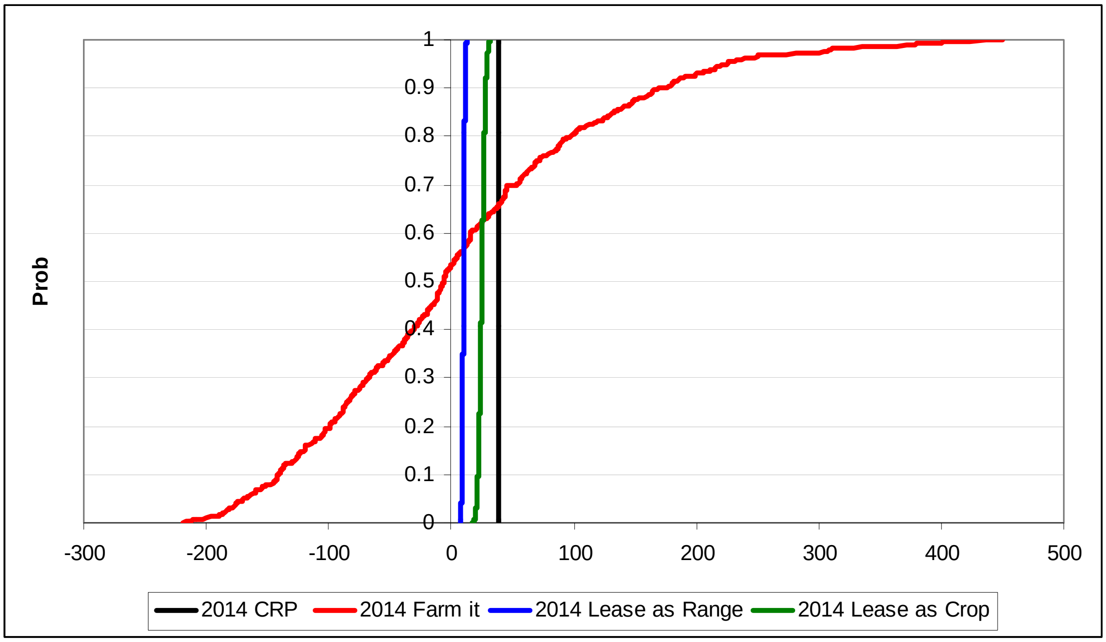


Figure A23. Floyd County 2014 returns per acre, cumulative distribution function

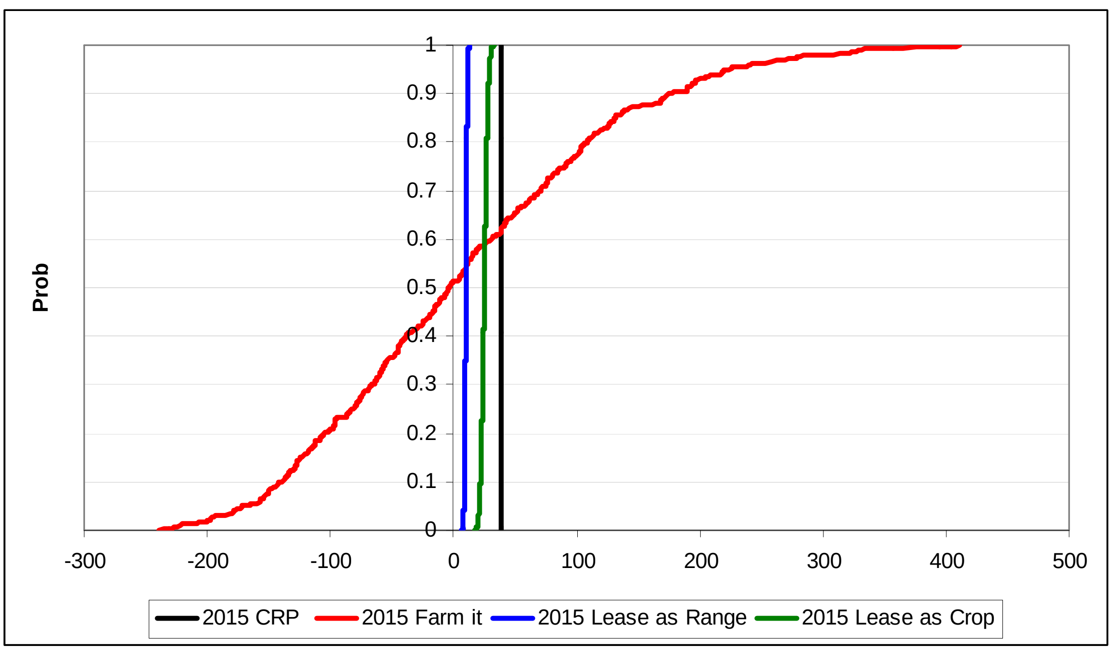


Figure A24. Floyd County 2015 returns per acre, cumulative distribution function

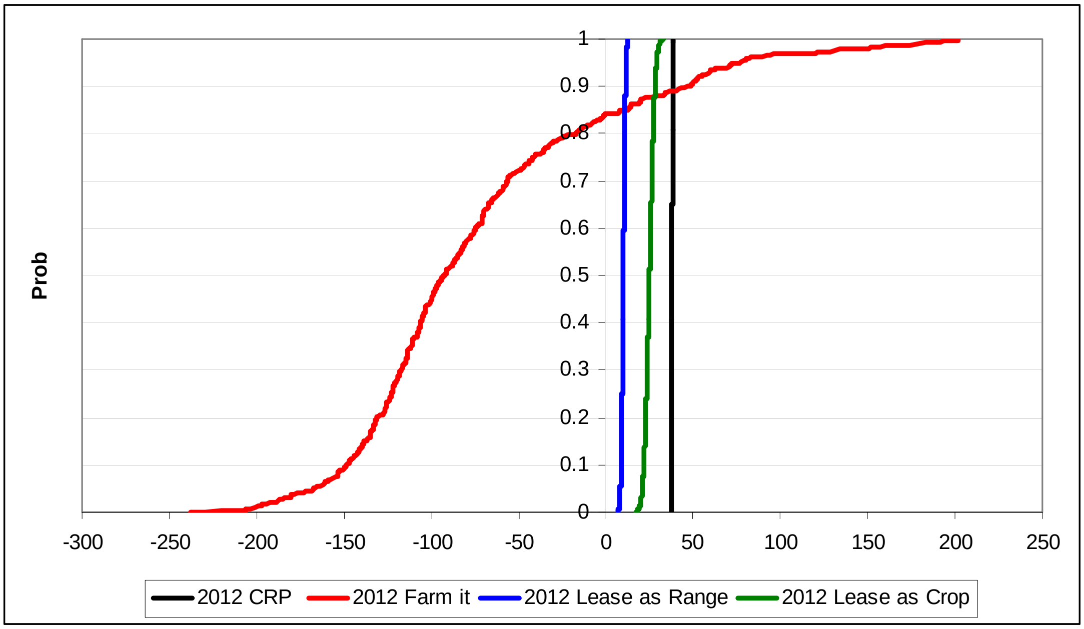


Figure A25. Hockley County 2012 returns per acre, cumulative distribution function

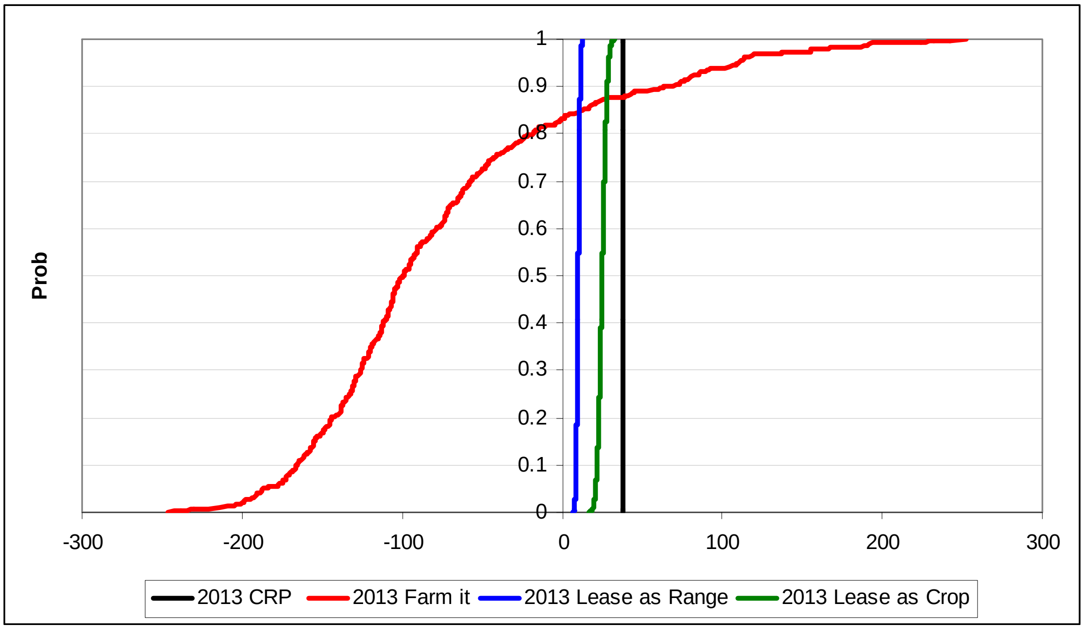


Figure A26. Hockley County 2013 returns per acre, cumulative distribution function

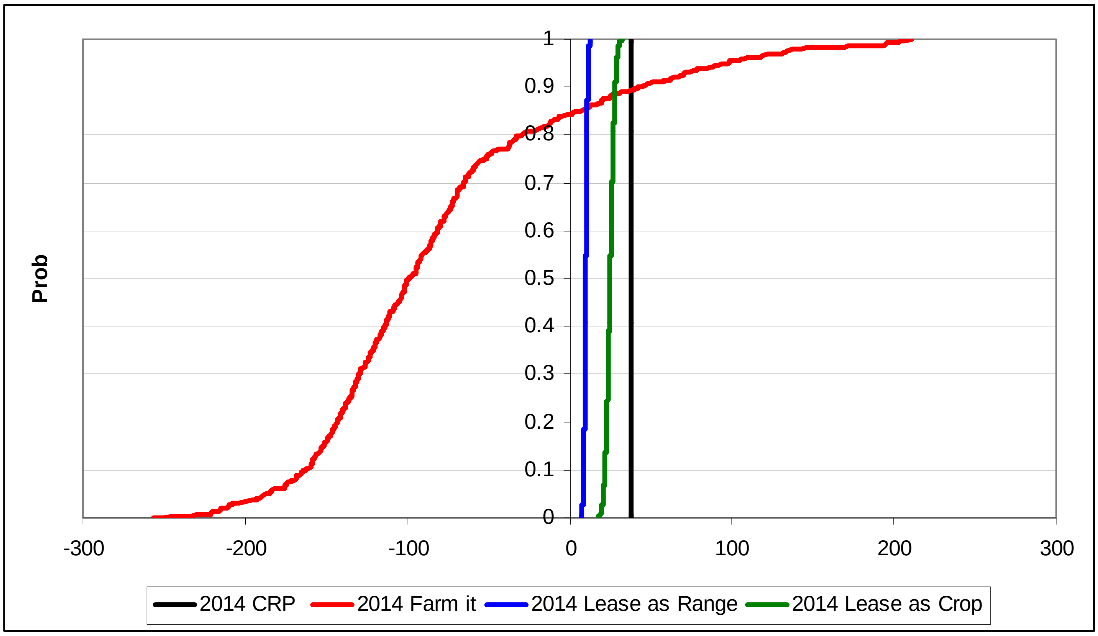


Figure A27. Hockley County 2014 returns per acre, cumulative distribution function

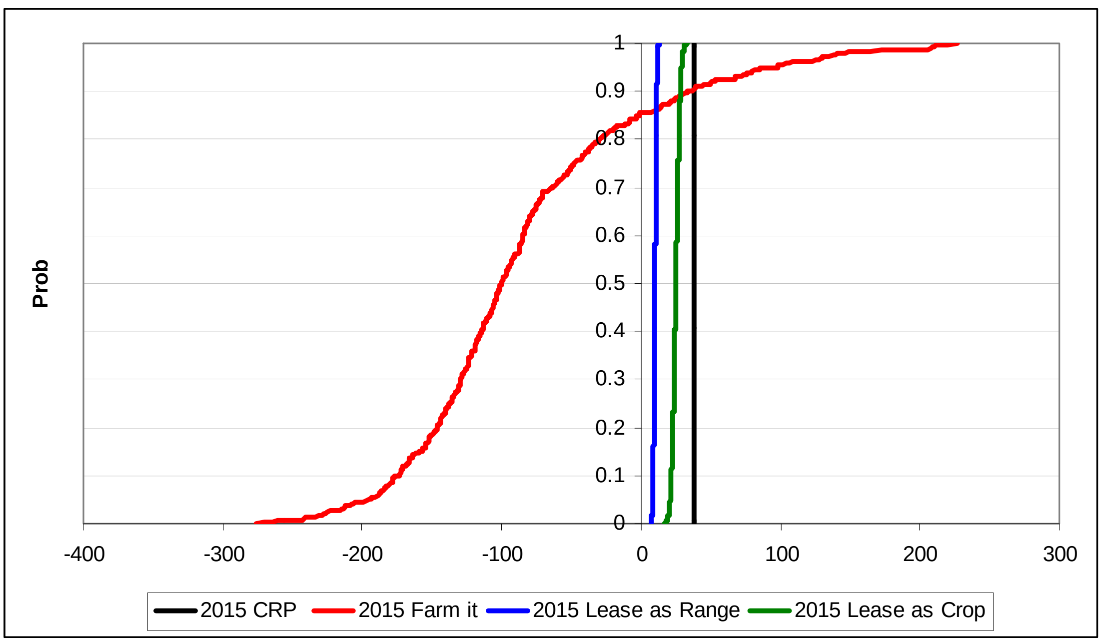
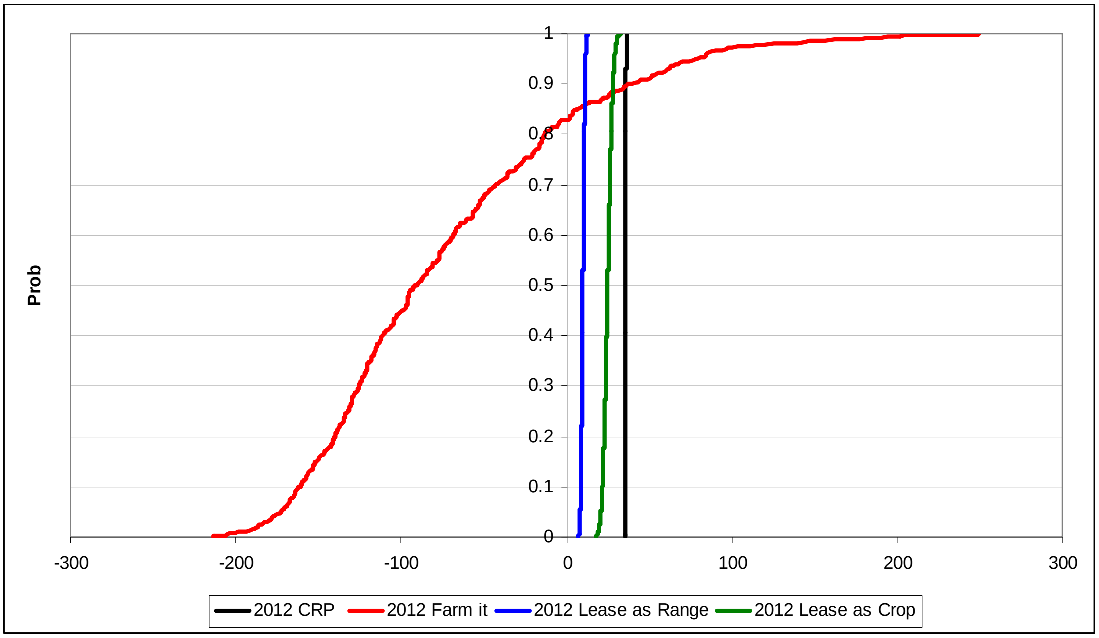


Figure A28. Hockley County 2015 returns per acre, cumulative distribution function



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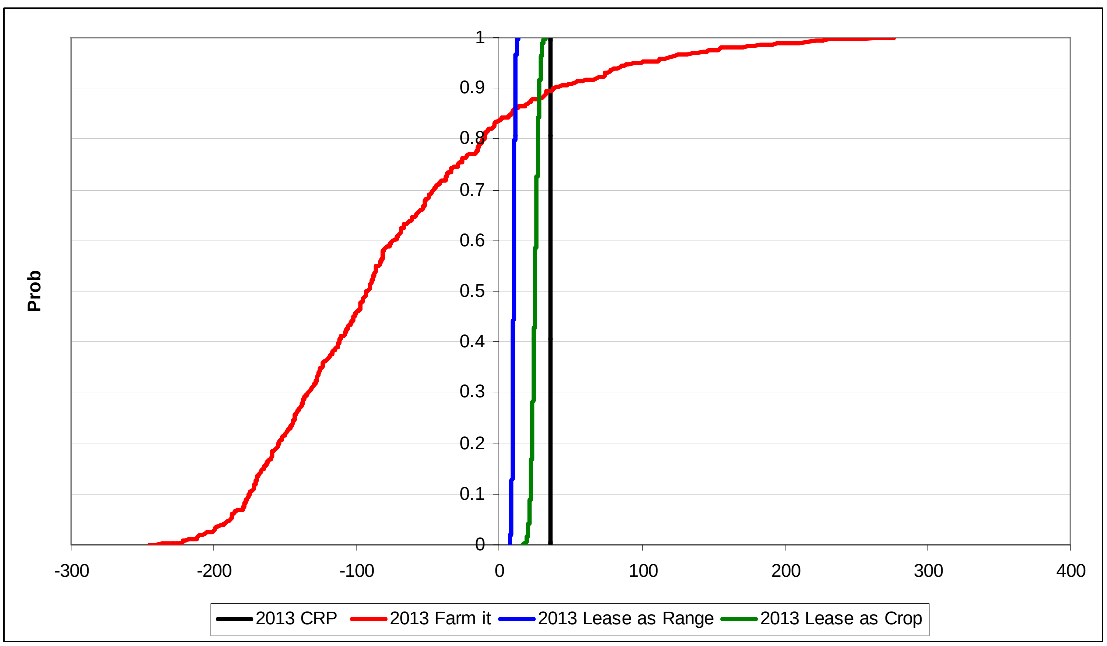

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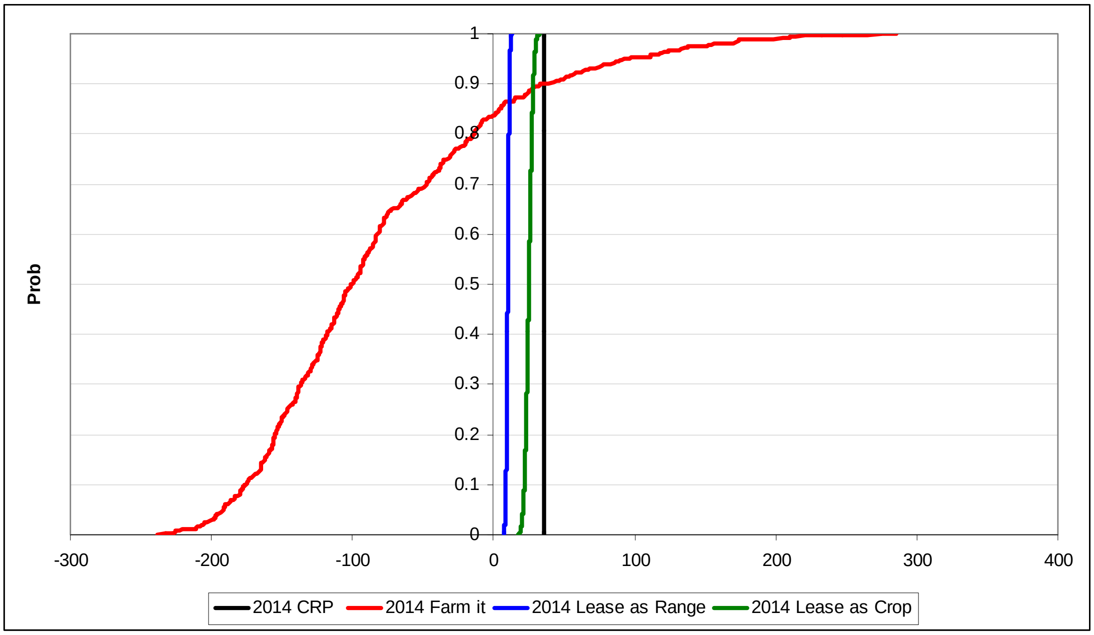
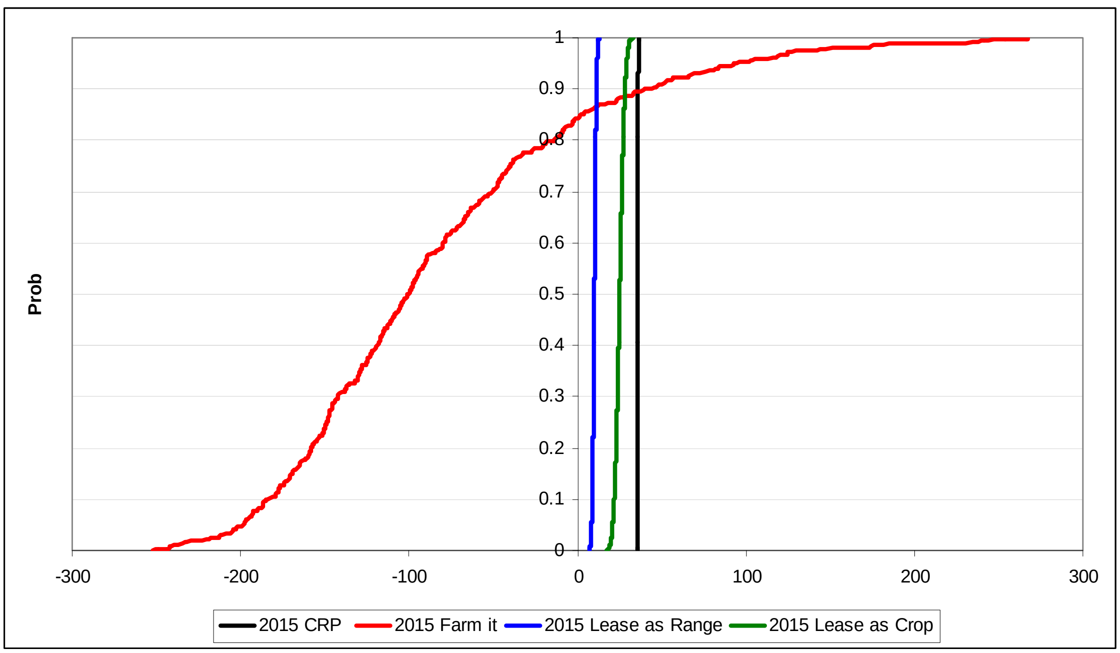


Figure A31. Terry County 2014 returns per acre, cumulative distribution function



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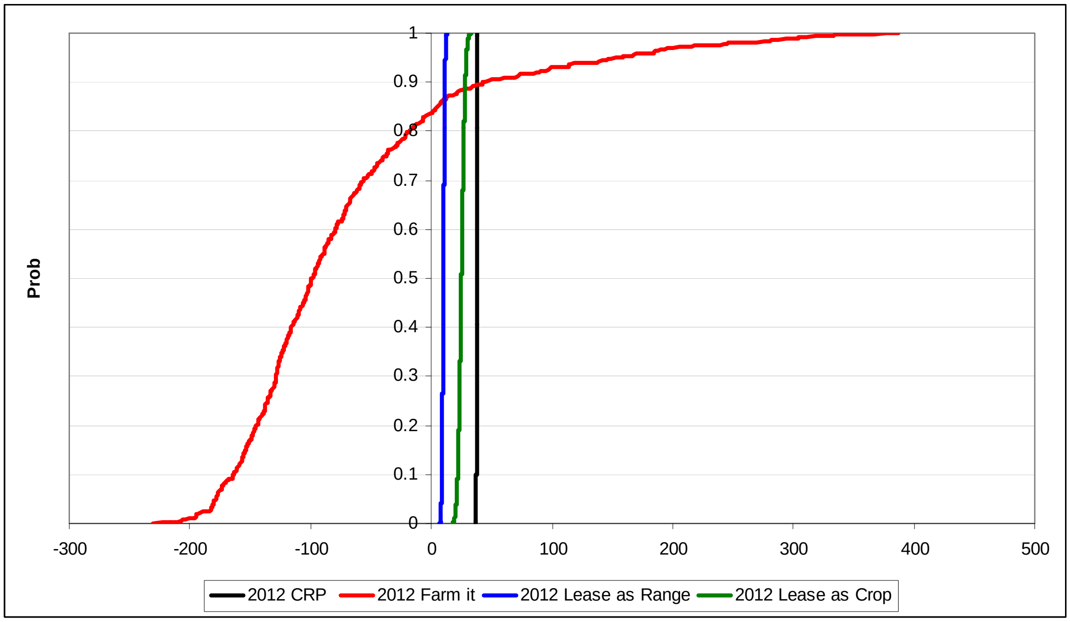

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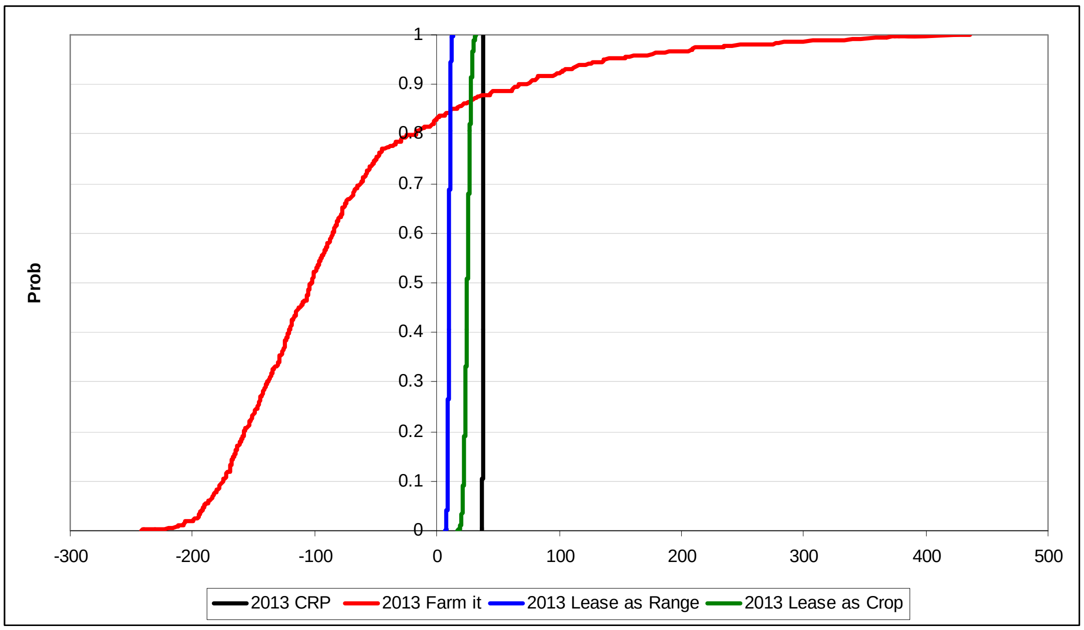

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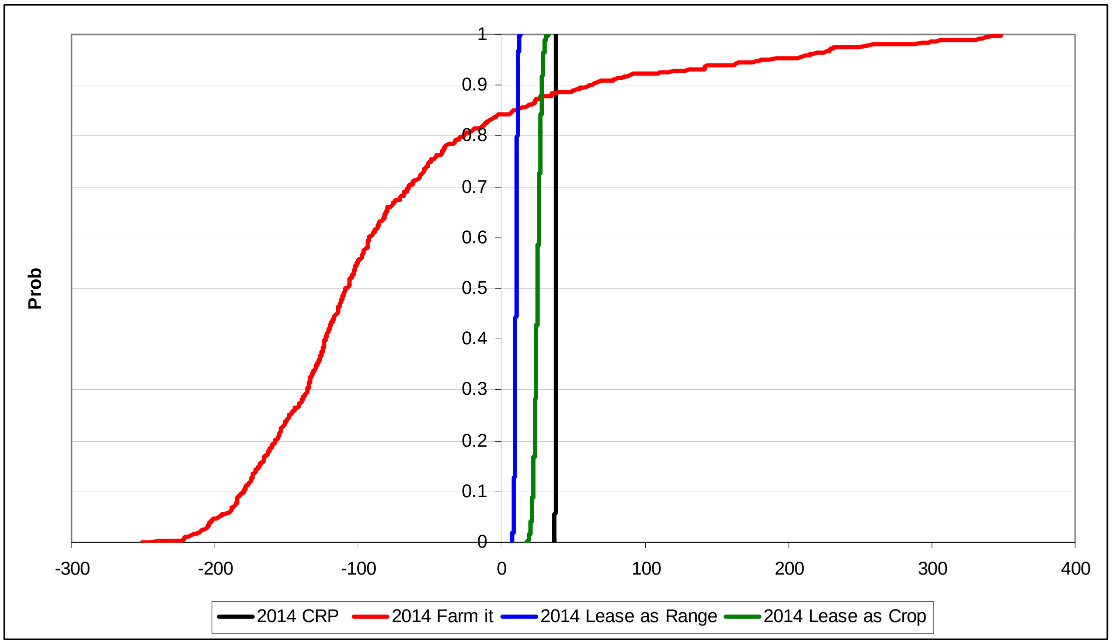

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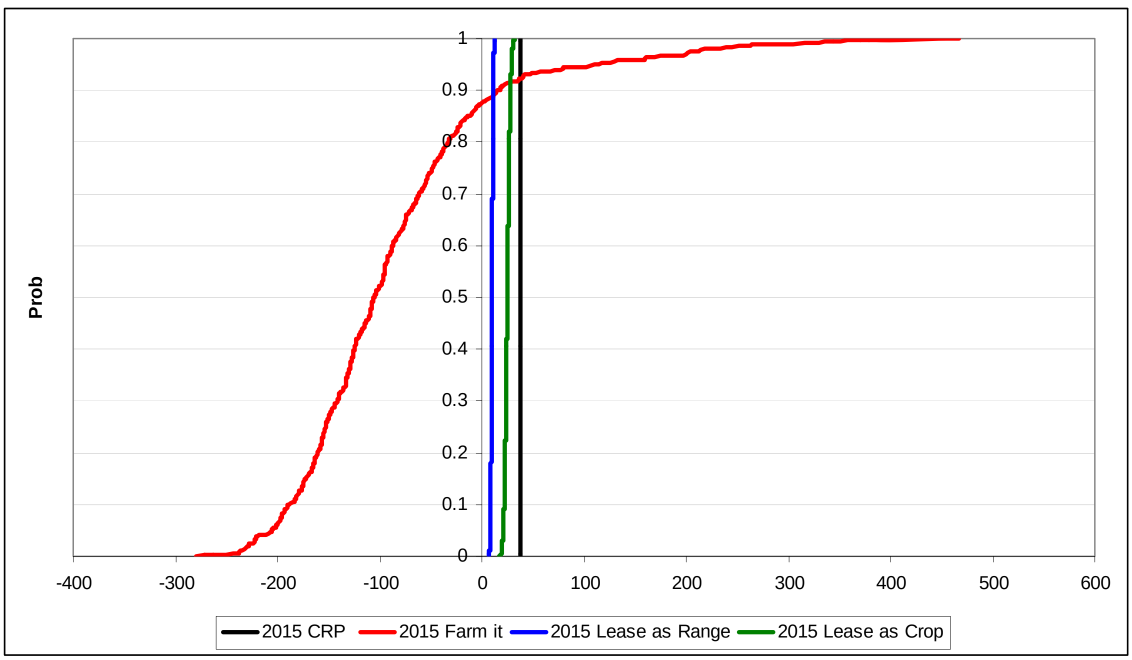


Figure A36. Castro County 2015 returns per acre, cumulative distribution function

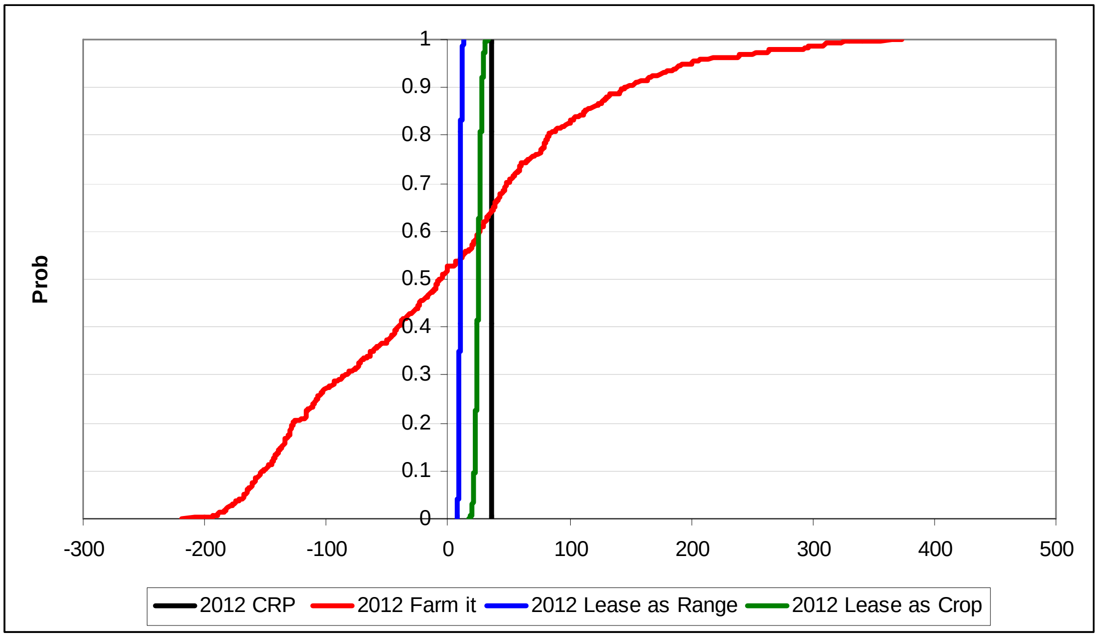


Figure A37. Swisher County 2012 returns per acre, cumulative distribution function

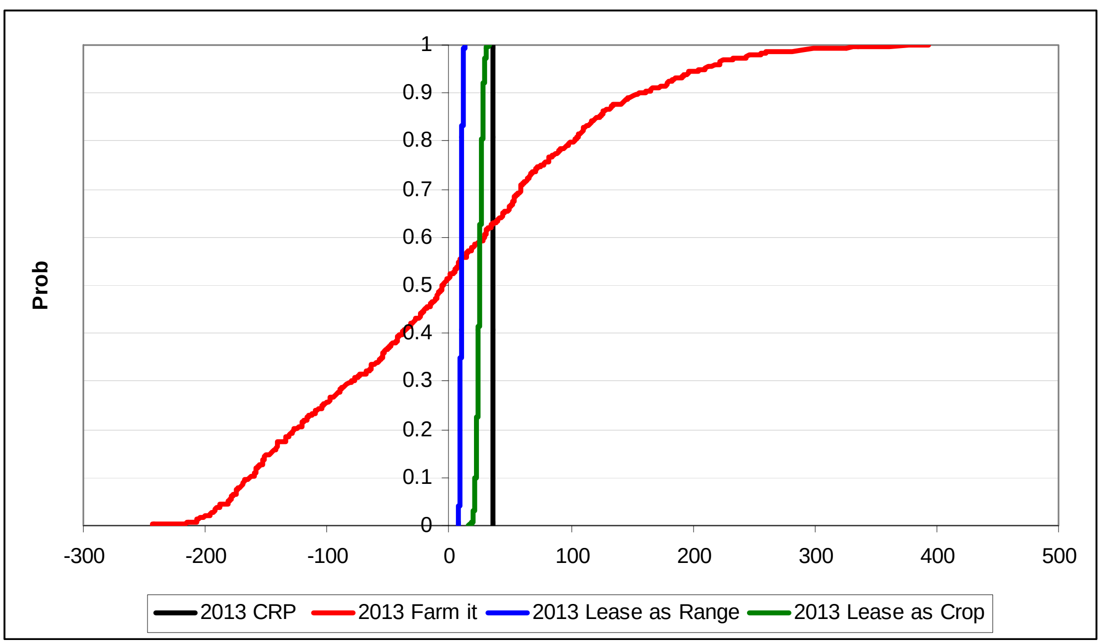
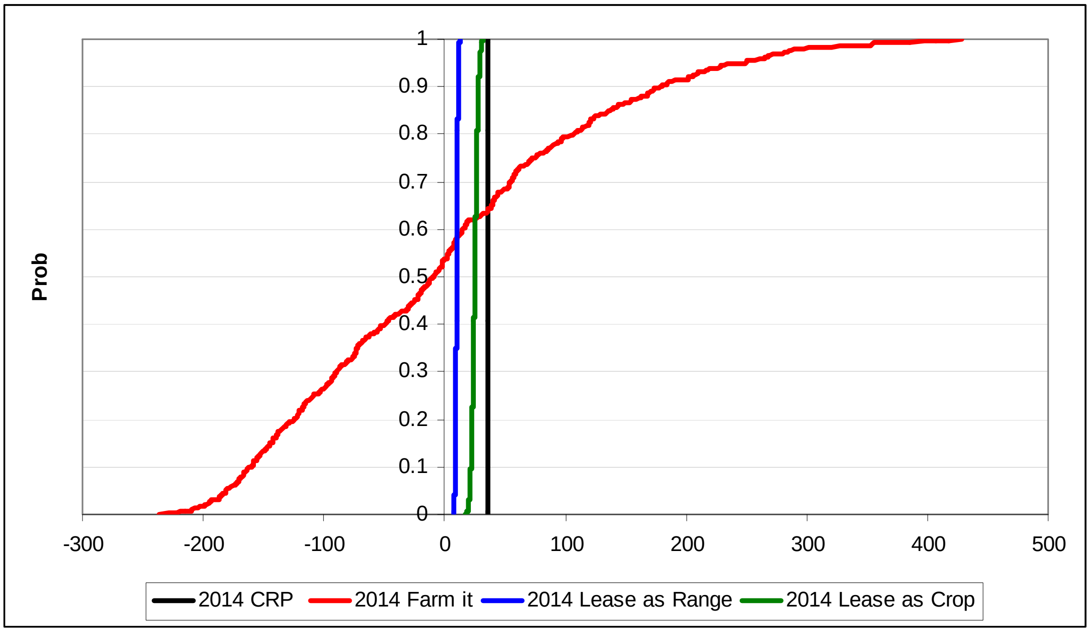


Figure A38. Swisher County 2013 returns per acre, cumulative distribution function



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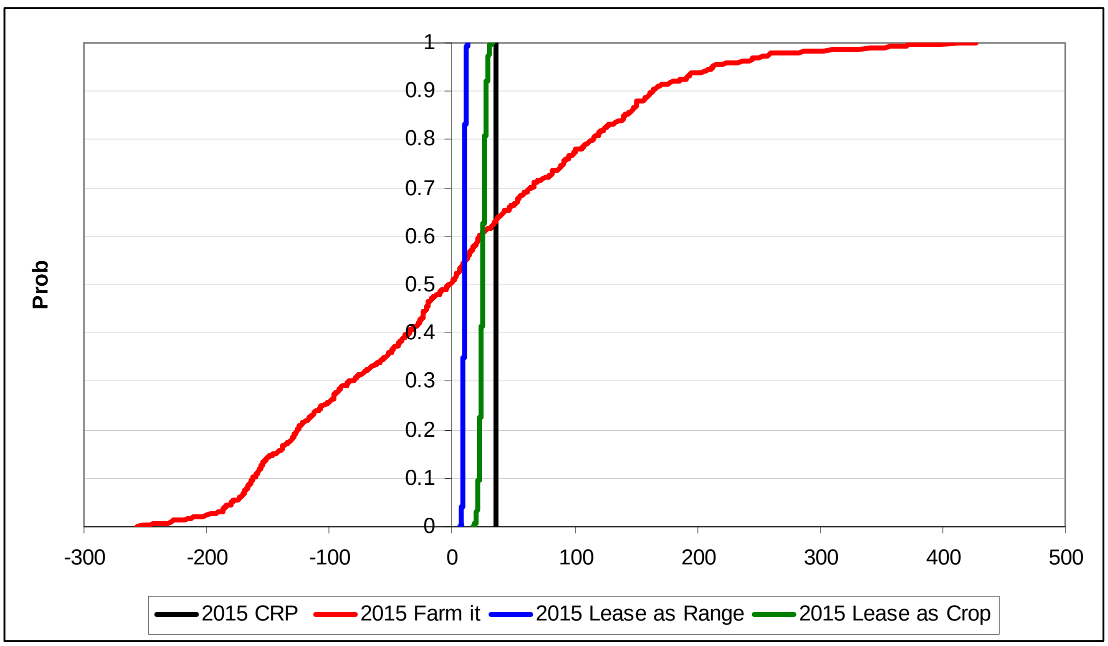

Figure A40. Swisher County 2015 returns per acre, cumulative distribution function

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