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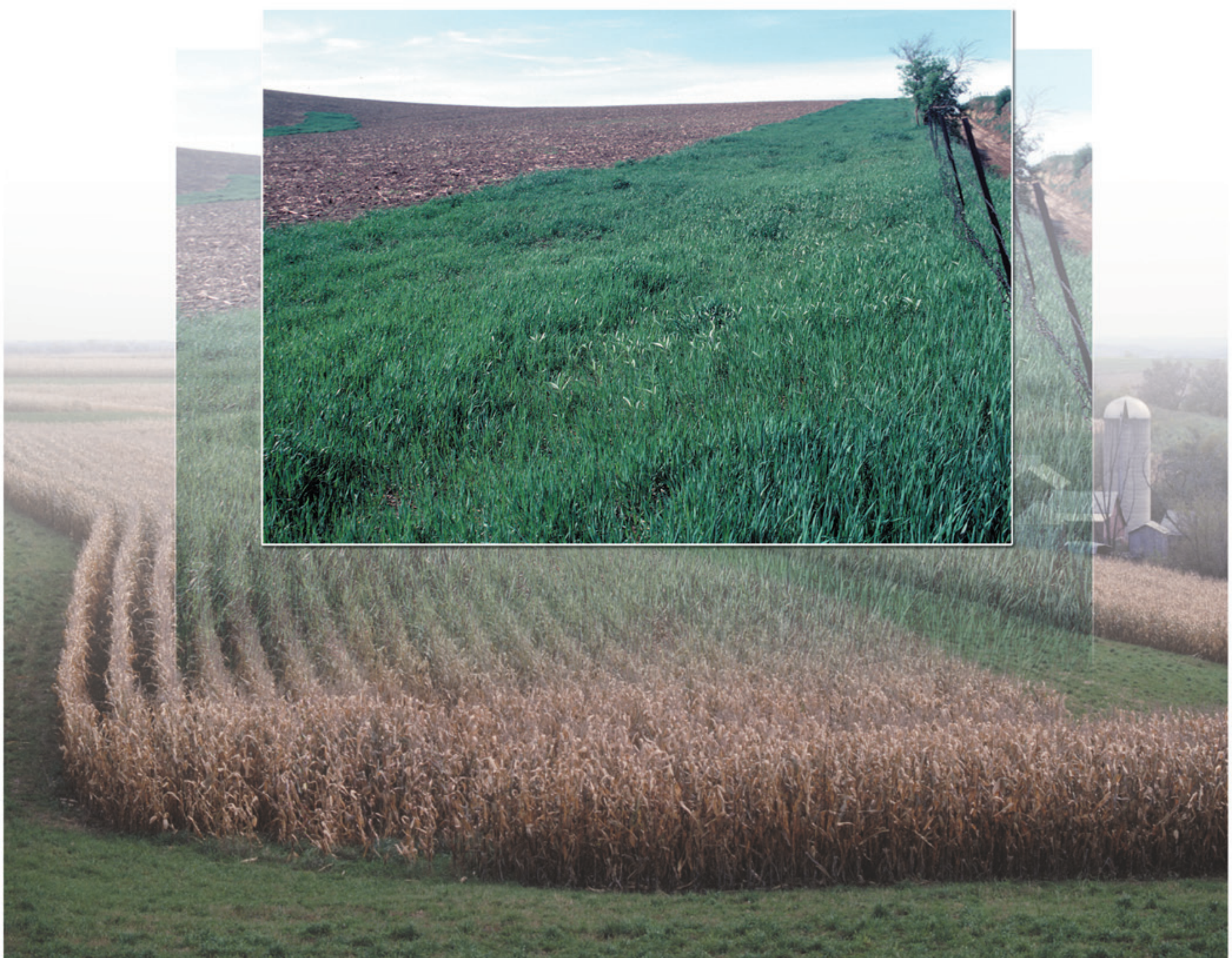

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The Influence of Rising Commodity Prices on the Conservation Reserve Program

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Abstract

This report considers how increased commodity prices might influence enrollment in and benefits from the Conservation Reserve Program (CRP) using two complementary models: a *likely-to-bid* model that uses National Resources Inventory data to simulate offers to the general signup portion of the CRP and an *opt-out* model that simulates retention of current CRP contracts. Under several higher crop price scenarios, including one that incorporates 15 billion gallons of crop-based biofuels production, maintaining the CRP as currently configured will lead to significant expenditure increases. If constraints are placed on increasing rental rates, it might be possible to meet enrollment goals with moderate increases in CRP rental rates—but this will mean accepting lower average Environmental Benefits Index scores as landowners with profitable but environmentally sensitive lands choose not to enroll.

Keywords: CRP, ethanol, commodity prices, likely to bid, REAP.

Contents

Summary

What Is the Issue?

The Conservation Reserve Program (CRP) is a voluntary program that enables farmers to retire farmland for conservation in exchange for rental payments. After a period of relative stability, the CRP is now facing a number of changes. The 2008 Farm Act reduced the CRP's maximum enrollment to 32 million acres—4.6 million acres less than the program's peak acreage in 2007. Moreover, higher commodity prices since 2006 are likely to lead to increases in cropland rental rates and inflate CRP program costs. If high prices become the norm, landowner interest in CRP may wane as they weigh the expected returns to farming against the CRP payment, particularly if CRP rental rates do not keep up with market rental rates. This could lead to fewer acres being offered to the program, with a commensurate drop in ecosystem services.

What Did the Study Find?

Using a computer simulation, the authors of this report demonstrate that, in an era of elevated crop prices, maintaining the CRP's acreage, and the environmental benefits it provides, will require higher program payments.

- If commodity prices and CRP rental rates prevalent in 2007 were maintained over the long term (commodity prices that are higher than when most CRP contracts enrolled) the quantity and quality of land offered to the program would decline. An increase in these 2007 rental rates by 60 percent would largely offset the long-term impact of the higher prices, albeit with a corresponding increase in program costs.

- Given the established interest in the program and its longstanding popularity with landowners, if USDA's policy of using prevailing rental rates were altered, it might be possible to meet acreage goals with moderate increases in payment rates. But this would mean accepting offers providing fewer environmental benefits, as landowners with environmentally sensitive, but increasingly profitable, lands choose to withhold their land from the program.

- Any additional impacts caused by an increase in crop-based ethanol production from 6.5 to 15 billion gallons per year would be relatively minor. For example, given a 60-percent increase in CRP rental rates, the model predicts 2 million fewer acres (about 5 percent of the current total) offered to the program over the long term and a 2-percent reduction in environmental benefits (as measured by the CRP's Environmental Benefit Index). When considering currently enrolled CRP acres, this expansion in ethanol production leads to about 200,000 acres leaving the program.

- Using the unusually high crop prices seen in summer 2008, the model shows a large response by CRP participants. Maintaining the CRP payments at their current level results in fewer acres offered to the program, making it unlikely that the program could reach its goal of 32 million acres. Over the long term, to enroll acreage that would maintain

the environmental benefits currently provided by the program would require roughly doubling CRP rental rates.

- If a robust carbon market permitted all CRP enrollees to also sell carbon offsets from their retired land, the impacts of increased commodity prices on the costs of CRP could be substantially reduced.

How Was the Study Conducted?

We use two modeling strategies. A *likely-to-bid* model predicts what the CRP would look like if the program were to start from scratch and enroll the entire acreage in one hypothetical signup— it is a steady-state model that starts with postulated prices, which are assumed to stay constant, and predicts what the CRP will look like over the long term. An *opt-out* model treats current acreage as a given, and predicts which acres would be withdrawn and converted to which crops under different price and rental payment levels.

Each model has inherent strengths and limitations that are partially compensated for in the other approach.

- The Economic Research Service's *likely-to-bid* model (LTB) is a simulation model that predicts how representative parcels of land will respond to a CRP program under varying circumstances. As part of the methodology, the LTB predicts factor scores for the Environmental Benefits Index (EBI).

- Contract data on all currently enrolled CRP acreage is the basis of the *opt-out* model. Contract data contain for each contract the actual value of CRP payments, the maximum payment permitted, and the EBI factors.

Several scenarios that illustrate possible market and program situations are constructed. The scenarios incorporate moderate and high price increases over historical trends. For scenarios that consider the impacts of increasing ethanol production to 15 billion gallons per year, the Regional Agriculture and Environment Programming model (REAP) was used to determine prices and crop shares. The mitigating effects of increasing CRP rental payments are included as another factor in the scenarios. Offered and accepted acres, average Environmental Benefits Index scores, forgone agricultural revenue, average rental payments, and regional distribution of CRP acreage are computed for each scenario.

Introduction

The Conservation Reserve Program (CRP) is one of the USDA's largest environmental programs. Now over 25 years old, the CRP is a voluntary program that pays landowners to convert environmentally sensitive cropland to grass, tree, and wetland covers. CRP contracts cover a multi-year period, with significant penalties for withdrawing before the contract expires. Originally established to protect soil quality, the CRP's primary goals now include water and air quality protection and the enhancement of wildlife habitat.[1]

[1]A summary of the CRP's enrollment, with an overview of the program's environmental impact, can be found at USDA's Farm Service Agency website: http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=rns-css

The CRP uses competitive bidding to select which lands to enroll in its general signup. Since landowner interest in the CRP is influenced by a number of external factors, the makeup of the CRP will change as market forces, and program policies, change. For example, a jump in commodity prices could reduce acreage offers, both new and renewing. On the other hand, if the USDA increases per-acre rental rates, it could counteract the effects of increased commodity prices. Or the USDA could change its ranking criteria and alter the types of land accepted into the program. In either case, the regional distribution of CRP acreage, the types of benefits these acres produce, and the cost of the program would likely change.

The goal of this report is to investigate what could happen to the CRP under alternative assumptions about commodity price increases and alternative assumptions about management of the programs. We focus on several questions, including:

- How might high prices affect the makeup of the CRP? The past few years witnessed a boom in agricultural commodity prices—a boom that corresponded with the growth in the production of biofuels. Even though prices have dropped from their summer 2008 peaks, they are still substantially higher than when most existing CRP contracts were signed

- How might further increases in the production of corn-based ethanol affect the CRP?

- How would higher CRP rental rates affect program expenditures and the types of land enrolled?

- How will the reduction in the size of the CRP affect the program? The 2008 Farm Act capped the CRP at 32 million acres, versus nearly 37 million acres in 2007. In reducing the size of future signups or allowing enrolled acres to opt out, which regions or classes of land are likely to be less prominent in CRP?

- How might offset markets for carbon dioxide (CO_2) affect CRP enrollment and costs?

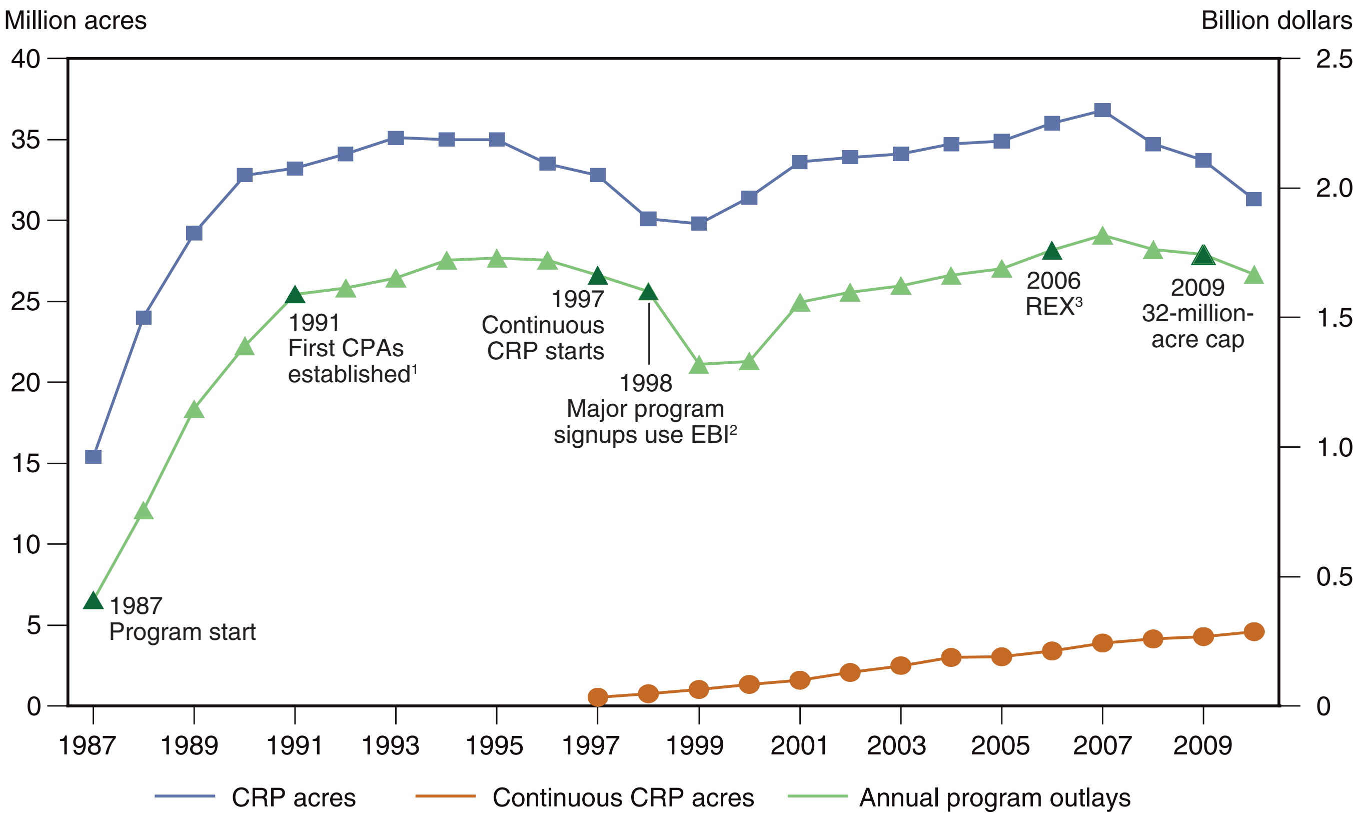
The Conservation Reserve Program: Background

The Conservation Reserve Program (CRP), established by the Food Security Act of 1985, enables eligible landowners to remove land from crop production in exchange for a fixed payment over a fixed period. By 1990, 32.8 million acres were enrolled in 10- or 15-year contracts. Initially, the criteria for enrollment were largely based on soil erosion potential, and nearly all acres that fulfilled crop history and other eligibility requirements were accepted.[2]

By 1997, many of the early CRP contracts were expiring, leading to several large general signups that enrolled 27 million acres through 1999. Unlike the initial signups, CRP offers were ranked on several criteria, with soil erosion, water quality, and wildlife habitat of equal importance. A newly created Environmental Benefits Index (EBI) used a number of factors—including soil erodibility, the land cover planted, and proximity to water bodies—to rank each offer. A cost factor was included that rewarded offers less costly to

[2]Figure 1 charts the timeline of yearly CRP acres, yearly expenditures, and yearly continuous CRP acres. For further detail on the history of the CRP, see http://www.ers.usda.gov/Briefing/ConservationPolicy/retirement.htm or http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=rns-css.

Figure 1
History of CRP: Acreage and expenditures, with important events



Source: USDA, Economic Research Service, using CRP contract data maintained by USDA's Farm Service Agency.
[1]CPA = Conservation Priority Areas
[2]EBI = Environmental Benefits Index
[3]REX = Re-enrollment and extension program.

USDA.[3] During these latter signups, interest in the program (as measured by total acres offered) exceeded enrollment limits. In 1997, only 70 percent of offers were accepted.[4]

The decade following the large general signups of 1997 witnessed CRP acreage fluctuating between 30 and 37 million acres, with signups ranging from 1 million to 4 million acres per signup. The EBI continued to be used, with minor modifications. A more significant change was the advent of "continuous CRP." Starting in 1996 and now comprising about 4 million acres, continuous CRP accepts lands that meet more stringent eligibility criteria, both in terms of location and cover crop. Acres can be enrolled in a continuous signup at any time and are noncompetitive (if an offer is eligible, it is automatically accepted). In addition, the program tends to both pay higher rental rates and offer targeted incentives for continuous CRP acres.

Program expenditures have been fairly steady throughout the program's history, increasing from $1.5 billion in 1990 to $1.9 billion in 2007 (in nominal dollars). The CRP's per-acre rental payments are closely related to non-irrigated cropland rental rates, which were relatively stable in the years following 1997.[5]

However, beginning in 2006 there were several changes that influenced the program. First, over 16 million acres of CRP land enrolled in 1997 were set to expire in 2007. For several reasons, including administrative efficiency, the USDA sought to stagger the timing of these expirations. Hence, in 2006 USDA offered 2- to 5-year re-enrollments and extensions to owners of contracts covering 27 million acres scheduled to leave the program between 2007 and 2010. Contract holders covering about 23 million acres (83 percent) accepted.

Second, the Food, Conservation, and Energy Act of 2008 (2008 Farm Act) capped CRP enrollment at 32 million acres. This was achieved as of October 1, 2009, by permitting approximately 2 million acres in expiring contracts to leave the program without an offer to renew or extend.

Last, starting in 2007 agricultural prices rose significantly, reaching a peak in the summer of 2008.[6] For example, corn prices jumped from $3.03 in the 2006 market year to $4.20 in the 2007 market year, and then further increased to $5.40 in the summer of 2008. Although prices have subsequently moderated, the factors underlying the increase have not disappeared.[7]

Increasing Commodity Prices and the CRP

Given USDA predictions[8] of high commodity prices for the next several years (relative to price levels throughout the CRP's history), the opportunity costs of retiring cropland are likely to remain high. This could dampen landowner willingness to enroll in the CRP's general signup (SWCS, 2008).

Several authors have considered the price-enrollment relationship. Secchi et al. (2009) used the EPIC model to estimate the environmental impacts of changes in CRP enrollment in Iowa due to increasing commodity prices. They conclude that under higher commodity prices, "maintaining current levels of environmental quality will require substantially higher spending

[3]The EBI is an additive index that includes both environmental components and cost components. High-cost offers receive fewer points in the cost component. Hence, all else held equal, more productive land (that is, likely to have high offer prices) will have lower EBI scores and is less likely to be accepted into the program. Note that cost enters "linearly"—the EBI is not used to create a cost-benefit index. This tends to reduce the positive (negative) impact on EBI scores of very low (high) bids.

[4]In the large 1997 signups, about 60 percent of the 22 million acres offered to the program was from already enrolled land. However, such lands were not given precedence—the EBI scores were used to rank all offers.

[5]USDA's National Agricultural Statistics Service (NASS) reports a rent production index (with a 1990 value of 100) that reached 136 in 1997, and then varied between 113 and 129 for the next several years. In 2006 and 2007 this index rose, reaching 151 in 2007 (http://www.nass.usda.gov/Publications/Ag_Statistics/2008/CHAP09.PDF). Average corn prices were $2.43/bushel in 1997, ranged from $1.94 to $2.42 between 1998 and 2005, and then rose to $3.04/bushel in 2006 (http://www.nass.usda.gov/Publications/Ag_Statistics/2008/Chap01.pdf).

[6]Abbot et al. (2008) identified three broad forces driving food price increases: change in production and consumption of key commodities, the depreciation of the dollar, and growth in biofuels production. Trostle (2008) identifies a similar set of factors and also notes adverse weather and policy responses.

[7]USDA projections show crop prices staying high through 2020.

[8]For example, USDA's February 2010 Agriculture Baseline Projection predicts fairly constant commodity prices that are greater than prices (between 1998 and 2005) when most current CRP contracts were enrolled (http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1192).

levels," and argue for a targeted approach. To counteract the risk of higher crop prices' eroding the CRP's ability to protect ecologically sensitive lands, Baker and Galik (2009) argue for several program modifications to increase income flows from CRP lands, such as allowing the sale of carbon offset credits.[9] Although the commodity prices have dropped from the peaks reached in the summer of 2008, the impact of higher prices on the CRP's effectiveness and attractiveness is still a concern. This report investigates the implications of probable USDA actions (such as increasing rental rates), and potential USDA modifications to the program, such as selective retention of current CRP lands, and the consequences of an active market for carbon payments.

[9]While USDA currently allows the sale of carbon offset credits on land enrolled in the CRP, existing and proposed carbon "cap-and-trade" programs generally consider CRP land ineligible to participate in carbon offset sales.

Modeling CRP Enrollment

To examine how enrollment for the CRP general signup might change as prices and other factors change, we use two modeling strategies. Our *likely-to-bid* (LTB) model predicts what the CRP's general signup acres would look like if the program were to start from scratch and enroll the entire acreage in one hypothetical signup. Our *opt-out* model treats current general signup acreage as a given and predicts which acres would withdraw given the chance of opting out.

- The ***likely-to-bid model (LTB)*** (see appendix 1, "Likely-To-Bid Model: Methodology") is a simulation model that predicts how representative parcels of land will respond to a CRP program under different circumstances. The LTB is a steady-state model: it starts with a postulated set of parameters (such as commodity prices, crop yields, and production costs), holds them constant, and predicts the long-term distribution of CRP acreage. It also predicts the environmental impacts of these acres, using predictions of factor scores in the CRP's Environmental Benefits Index (EBI).
- The ***opt-out model*** (see appendix 2) uses contract data on all CRP acreage, which contain for each contract the actual value of CRP payments, the maximum payment permitted, and the EBI factors.

In this analysis, we focus on acreage that will enter the program through general signups, and abstract from acreage enrolled via continuous signups. Since continuous signups offer higher rental payments than general signups, continuous signup acreage is less likely to be influenced by changes in commodity prices.

Both models have their strengths and weaknesses. The LTB model is national in scope, with disaggregated measures of land quality and other agriculturally important factors. However, its weaknesses include a dependence on increasingly dated data (much of it from 1997), the use of approximation when assigning EBI factor scores to representative parcels, and the use of imprecise rules to determine which representative parcels would actually be offered to the program.

The *opt-out* model uses actual CRP general signup contracts, which include precise measures of the EBI factors and rental rates. Modeling is based on actual rather than simulated participants. However, there are very limited data on land quality, which complicates estimates of the profitability of alternative uses of the land. And this dataset has no information on non-CRP land parcels.

Scenarios for Analysis

Our analysis of possible changes to CRP general signup enrollment is based on four scenarios (table 1).

- A *Baseline* that captures conditions when most CRP contracts were enrolled. This is a "one-shot" simulation that uses 2005 crop prices in order to calibrate the LTB model (it is not associated with USDA's published baseline).
- A *MediumPrice* scenario that reflects moderate price levels—we use prices prevalent in 2007.[10]
- A stylized *RFS (Renewable Fuels Standard)* scenario that captures price impacts of increasing ethanol production from 6.5 billion gallons to 15 billion gallons.[11]
- A *HighPrice* scenario that reflects a high price regime—using prices prevalent in the summer of 2008.

These scenarios were developed based on historical commodity prices and may or may not reflect USDA's current price projections.[12] They are meant to illustrate the relationships between commodity prices and CRP enrollment and should not be considered projections of future trends. The commodity prices used in the scenarios increase as one moves from the *Baseline* to the *HighPrice* scenarios. For example, corn prices are almost 190 percent higher in the *MediumPrice* scenario than in the *Baseline*, and 140 percent higher in the *HighPrice* than in the *MediumPrice* scenario (table 2). Some commodity prices in the RFC scenario are somewhat higher than those in the *MediumPrice* scenario—for example, corn price is 12 percent higher, but soybean prices are basically unchanged.

For each scenario, two variants are analyzed: one that uses 2007 CRP rental rates and a second that captures CRP rental rates increases (given changes in cropland rental rates) via an across-the-board increase in these 2007 rates.

Given the 2008 Farm Act's changes to the CRP, all scenarios use a target of 30 million general signup acres. As of early 2009, there were about 33.6 million acres of CRP land: 29.5 million in general signup and 4 million in continuous signup. By fall 2009, the CRP's enrollment had shrunk to around 31 million acres (with 27 million in general signup). Thus, although the use of a 30-million-acre target may overstate the size of CRP's general signup over the next several years, it is predicated on past levels of enrollment and allows for consideration of alternative future targets.

To compare scenarios, the following set of metrics is used.

- ***Offered acres.*** In general, the more acres that are offered, the better the choices available to CRP administrators.
- ***Average environmental score per accepted acre (EEBI)***. The EEBI is the EBI without the cost factor. While not an ideal measure of the real environmental impact of CRP land retirement, it captures several environ-

[10]Note that 2007 prices are similar to prices seen in the spring of 2010.

[11]The choice of 15 billion gallons of crop-based ethanol is predicated on targets set in the 2015 Renewable Fuel Standard. In this research, we abstract from biodiesel, cellulosic, and other varieties of biofuels.

[12]These scenarios focus on the impacts of possible price increases. USDA's February 2010 projections (http://usda.mannlib.cornell.edu/MannUsda/viewStaticPage.do?url=http://usda.mannlib.cornell.edu/usda/ers/94005/./2010/index.html) predict a mild, short-term decline in commodity prices. However, these projected prices stay near the price levels used in our *MediumPrice* scenario.

Table 1
Description of scenarios

The following describes the scenarios used in the LTB and opt-out models. Table 2 details the commodity prices used in these scenarios.

Scenario	Description
Baseline	This scenario serves as a baseline that reflects circumstances that prevailed before the recent increase in crop prices. Specifically, this scenario uses commodity prices, production costs, soil rental rates, and EBI factors extant in 2005. The baseline captures historical conditions, such as measures of environmental benefits, that one can contrast with what the CRP would provide as prices and policies change. Furthermore, comparison of baseline results to actual CRP offers and contracts indicates the accuracy of the LTB model.
MediumPrice	This scenario reflects a continuation of current conditions. Specifically, its uses commodity prices, production costs, CRP rental rates, and EBI factors extant in 2007. Note that 2007 prices are similar to prices observed in spring 2010 (as are rental rates and EBI factor scores). Furthermore, prices in 2007 incorporate the impacts of 6.5 billion gallons of ethanol production.
MediumPrice variant: higher rental rates *(MediumPrice adjusted)*	Same as the *MediumPrice* scenario, but includes an across-the-board increase in CRP rental rates of 60%. This represents a possible response by USDA to increased commodity payments, hence increased non-irrigated cropland crop rental rates.
Increase crop-based ethanol production to 15 billion gallons *(RFS)*	To consider impacts of increased ethanol production as mandated by the Renewable Fuel Standard (RFS), we use the REAP (BRDi, 2008) model to generate estimates of prices that may prevail if crop-based ethanol production increases from 6.5 billion to 15 billion gallons. These are combined with production costs, EBI factor scores, and CRP rental rates used in the *MediumPrice* scenario.
RFS variant: increased rental rates *(RFS adjusted)*	Same as *RFS*, but includes an across-the-board increase in CRP rental rates of 60%.
HighPrice	This scenario reflects a possible high-price environment. It is based on prices observed in summer 2008, along with production costs, EBI factor scores, and CRP rental rates used in the *MediumPrice* scenario.
HighPrice variant: much higher rental rates (HighPrice large adjusted)	Same as *HighPrice*, but includes an across-the-board increase in CRP rental rates of 120%.

Notes: LTB = likely to bid, EBI = Environmental Benefits Index, REAP = Regional Environment and Agriculture Programming model, RFS = Renewable Fuel Standard.

Table 2
Prices used in scenarios (and their variants)

Scenario	Corn	Sorghum	Wheat	Soybeans	Cotton
	----------------------------$/bu----------------------------				*$/bale*
Baseline	2.00	1.86	3.42	5.66	208.00
MediumPrice	3.39	3.21	6.08	9.00	254.00
RFS	3.80	3.32	6.13	9.03	257.00
HighPrice	5.40	4.90	7.25	12.25	364.00

Notes: The same prices are used in the *adjusted* and *large adjusted* variants of each scenario. RFS = Renewable Fuels Standard.

mental attributes and applies weights whose magnitudes reflect the value CRP administrators place on different environmental services/attributes.

- ***Forgone net agricultural revenue.*** This is a measure of the social costs of the program in terms of lost agricultural production.
- ***Rental payments (total and per acre)***. This is the cost of the program to the Government.
- ***Regional distribution of CRP acres.*** This is how CRP acres occur across the 10 farm production regions (http://www.ers.usda.gov/briefing/arms/resourceregions/resourceregions.htm).

Influence of Prices: *Likely-To-Bid* Model

We begin by comparing the performance of the LTB model with the actual data from CRP contracts and offers (table 3). For the *Baseline* scenario, the LTB predicts that 51.9 million acres would be offered (with a hypothetical CRP signup from scratch), which is quite close to the 49.2 million acres offered between 1997 and 2007.[13] Thus, the model's ability to replicate observed results is qualitatively reasonable, though not precise.

- The *Baseline* overpredicts EEBI scores by about 10 percent, but does a good job of predicting actual contract rental rates.
- Comparison of the regional distribution of acres (table 4) indicates that the rank order of regions identified by the *Baseline* is close to the actual order.
- The *Baseline* indicates that, on average, over 35 percent ($19/acre) of an offer's estimated rent ($47/acre average) is a premium over the LTB model's predicted net returns ($28/acre on average) from that parcel. Kirwan et al. (2008) find that estimated premiums constitute 10-40 percent of the program's rental payouts. Since the LTB assumes no competitive bidding (all landowners request their maximum rental payment), it is not surprising that the model estimates a premium toward the upper end of this range.

When judging the validity of the *Baseline* model, one must consider that both contracts and offers are spread over a 10-year period (1997-2007). Over this time span, commodity prices, input costs, and EBI criteria were mostly stable, but did change in minor ways. Thus, it would be unlikely for the *Baseline* (a "one-shot" simulation, using 2005 prices) to precisely match any summary statistic on actual contracts or offers.[14]

[13]The LTB identifies about 212 million eligible acres, based on cropping history, soil erodibility, and location.

[14] The results from the Baseline suggest that, to the extent the underlying simulations are biased, so too will be our simulated results. However, since these biases are constant across simulations, comparisons of differences across simulations (where each simulation reflects a different scenario) are likely to reduce these biases. Therefore, the results from the LTB model are best viewed as indicators of broad trends that reveal useful insights.

Table 3
CRP general signup contracts and offers: actual and likely-to-bid predictions under the *Baseline* scenario

		Acres	EEBI score and normalized[4]	Forgone net agricultural revenue	Rental payments
		Million	*Average/acre*	*----Average $/acre----*	
Actual	Contracts[1]	32.6	173 (0.43)	n.a.	45
	Offers[2]	49.2	150 (0.37)	n.a.	45
Baseline	Contracts[3]	30.0	188 (0.48)	28	47
LTB	Offers[3]	51.9	165 (0.42)	32	51

Source: USDA/Farm Service Agency contract and offer files, and likely-to-bid (LTB) simulation results.
n.a.-Not applicable
[1] General signup contracts as of March 2008.
[2] The Offers row aggregates actual offers to the CRP that were received in general signups 15 through 33 (conducted between 1997 and 2007).
[3] Both LTB rows are predicted values derived from the LTB model under the *Baseline* scenario.
[4] Since the Environmental Benefits Index (EBI) factor weights varied over time (for example, the N6 "CPA" factor was dropped after signup 20), the normalized EEBI score is used. This is the EEBI score divided by the maximum number of EEBI points available in that signup. For the LTB simulations, the signup 26-33 maximum (395) is used as the normalizing value.

Table 4

Geographic distribution of general signup CRP acres: actual and likely-to-bid (LTB) predictions under the *Baseline* scenario

		Farm Production Region									
		NE	AP	SE	DE	CB	LS	NP	SP	MT	PA
		Share of acres									
Actual	Contracts	0.3	1.8	2.8	3.4	12.4	7.3	25.2	15.7	23.8	7.1
	Offers	0.4	2.2	3.5	3.3	12.6	7.7	27.7	15.9	21.0	5.9
Baseline LTB	Contracts	1.0	4.4	4.9	3.2	13.5	12.5	26.9	10.5	18.1	1.5
	Offers	1.3	4.4	3.5	2.7	12.7	13.4	32.4	10.6	14.6	4.2

Source: USDA/Farm Service Agency contract and offer files, and LTB simulation results.
Note: Due to rounding, rows may not add to 100 percent.
NE = Northeast: New Hampshire, Pennsylvania, Maine, Maryland, Rhode Island, Massachusetts, Delaware, Connecticut, Vermont, New York, New Jersey.
AP = Appalachia: West Virginia, Tennessee, North Carolina, Virginia, and Kentucky.
SE = Southeast: South Carolina, Alabama, Georgia, and Florida.
DE = Delta: Louisiana, Arkansas, and Mississippi.
CB = Corn Belt: Ohio, Iowa, Missouri, Indiana, and Illinois.
LS = Lake States: Minnesota, Michigan, and Wisconsin.
NP = Northern Plains: North Dakota, South Dakota, Kansas, and Nebraska.
SP = Southern Plains: Texas, Oklahoma.
MT = Mountain: Colorado, Utah, Arizona, New Mexico, Wyoming, Nevada, Idaho, and Montana.
PA = Pacific: Oregon, California, and Washington.

Table 5

LTB predictions of acres offered, and accepted, in the CRP general signup *MediumPrice*, *RFS*, and *HighPrice* scenarios

Scenario	Offered Acres	EEBI score[1] and normalized	Forgone net agricultural revenue[1]	Rental payments[1]
	Million	*Average/acre*	*Average $/acre*	
MediumPrice	28.8	161	34	64
MediumPrice adjusted	44.7	179	48	83
RFS adjusted	42.7	176	47	82
HighPrice	22.3	159	27	62
HighPrice large adjusted	43.4	175	56	101

[1]EEBI score, forgone net agricultural revenue, and rental payments are computed using the 30 million acres “accepted” by the LTB simulation.
LTB = likely to bid; EEBI = Environmental Benefits Index, without the cost factor; RFS = Renewable Fuel Standard.

Two variants of the *MediumPrice* scenario are examined: one that uses the 2007 CRP rental rates and a second that increases these rental rates across the board.[15] Far fewer acres (28.8 million) are offered in the first variant (which uses 2007 CRP rental rates) than in the *Baseline*, a result that we attribute to the run-up in prices that began in 2007. That is, the gap between a landowner’s projected revenue and CRP payments accounts for the fewer acres offered in the *MediumPrice* scenario. The second variant (the *MediumPrice adjusted* scenario) adjusts for this gap by raising CRP rental rates 60 percent, which causes offered acres to rebound to 45 million (table 5).[16]

Now consider our stylized *RFS adjusted* scenario, which accounts for commodity price impacts as ethanol output grows from 6.5 to 15 billion gallons, and which uses the same CRP rental rates as the *MediumPrice*

[15] CRP rental rates are based on a Soil Rental Rate (SRR). The SRR is a parcel-specific maximum bid that the USDA will accept. These values are based on measures of county averages of the rental rate for non-irrigated cropland. In general, the actual rent paid by the CRP is at, or near, the SRR (Kirwan et al., 2005).

[16]The results of other rental rate increases were in line with the 60-percent scenario. For example, with a 120-percent across-the-board increase, results (such as offered acres and average EEBI score) were close to the Baseline but at much higher costs.

adjusted scenario. Here, crop prices are slightly higher than in the *MediumPrice adjusted* scenario. Since per-acre CRP rental payments are the same in both scenarios, we would expect a slight contraction in offers under the *RFS adjusted* scenario, and in fact offered acres do decline about 2 million (table 5). The average EEBI score decreases by about 2 percent.

To further illuminate the impacts of increasing ethanol production, we track individual data points across the *MediumPrice adjusted* and the *RFS adjusted* scenarios (table 6):

- Of the 30 million accepted acres in both scenarios, about 1.8 million acres differ. That is, there are 28.2 million acres that are accepted under either scenario, and 1.78 million acres that are replaced in the *MediumPrice* adjusted scenario with different acres in the *RFS adjusted scenario.*

Choosing CRP Rental Rate Increases

Changes in commodity prices are likely to lead to changes in cropland rental rates. Since the USDA bases its CRP rental rates on county averages of non-irrigated cropland rents, changes in commodity prices will be reflected by changes in the CRP's rental rates.

However, as discussed in Appendix 3, just what these changes will be is uncertain. USDA's methodology to establish CRP rental rates combines surveyed values, such as provided by USDA's National Agricultural Statistics Service (http://quickstats.nass.usda.gov/?source_desc=SURVEY&commodity_desc=RENT&agg_level_desc=COUNTY), and feedback from county and State shareholders. Thus, it is not straightforward to predict what rental rates would be under different commodity price regimes.

Therefore, rather than attempting to construct detailed rental rate increases (say, that capture the possibility of higher increases in Iowa than in Texas), we use across-the-board proportional increases. While a number of levels were simulated, for brevity we present results from simulations that use a 60-percent across-the-board increase (i.e., the *MediumPrice adjusted*) and a 120-percent across-the-board increase (i.e., the *HighPrice large adjusted*).

The choice of 60 percent (and 120 percent) was predicated on overall plausibility: they yield predicted CRP enrollment that retains most of the program's current environmental characteristics without an implausible increase in program costs. That is: these rental rate increases are meant to represent a possible outcome, they are not meant to be an actual prediction of what will occur.

For comparison purposes, note that (using county averages) actual CRP rental rates increased by 33 percent between 2000 and 2008, and by 20 percent between 2008 and 2010.

Most importantly, although these across-the-board increases may not capture the actual increases that come to pass, they allow us to compare changes across simulations—comparisons that are the main goal of this research.

- Under the *RFS adjusted* scenario, exiting CRP acreage tends to be more productive land that received higher rent and delivered a higher EEBI. The new acres entering the program (as crop-based ethanol production ramps up) are more expensive (in terms of agricultural revenue and rental payments) than the average retained acre.

- New acres have lower average EEBI scores than either retained acres or exiting acres.[17]

In other words, the additional acres accepted under the *RFS adjusted* scenario are acres that failed to make the cut in the *MediumPrice adjusted* scenario, but become acceptable when higher quality, but more expensive, acres bypass the program due to a higher crop returns.

As ethanol production increases in the *RFS* scenario, CRP acreage declines by 6.5 percent in the Corn Belt and 3.5 percent in the Lake States, while increasing 3.8 percent in the Northern Plains (table 7). Thus, the impacts of higher prices in the *RFS adjusted* scenario are more pronounced in more productive regions.

[17]When considering a parcel of land eligible for the CRP, high environmental benefits (high EEBI scores) are not necessarily correlated with low soil productivity. However, lands accepted into the program are likely to display a positive correlation between productivity and environmental benefits: since productive lands are likely to have a large offer price, for the EBI score to be sufficiently high the land must also have a high EEBI score.

Table 6

Acres entering and leaving the CRP general signup as crop-based ethanol production increases to 15 billion gallons

	For acres that do not change as ethanol production increases[1]	For acres that enter the CRP as ethanol production increases	For acres that leave the CRP as ethanol production increases
Forgone net revenue (avg. $/acre)	47	61	137
Rental payments (avg. $/acre)	81	97	113
EEBI score (avg. score/acre)	178	147	192

[1] This table is based on a comparison of acres offered, and accepted, into the CRP general signup program under the *MediumPrice adjusted* scenario and the *RFS adjusted* scenario, using the LTB model. In each scenario, 30 million acres are accepted; 28.2 million acres are accepted in both scenarios, with 1.8 million acres differing.
Note: EEBI = Environmental Benefits Index, without the cost factor.

Table 7

Geographic distribution of acres: LTB model predictions of *MediumPrice adjusted*, *RFS adjusted*, and *HighPrice large adjusted* scenarios

	Farm Production Region[2]									
	NE	AP	SE	DE	CB	LS	NP	SP	MT	PA
	Percent of all CRP general signup acres									
MediumPrice adjusted	1.5	3.8	5.5	3.5	10.5	10.1	29.2	11.8	18.6	5.0
RFS adjusted	1.5	3.7	5.3	3.5	9.8	9.8	30.3	11.9	18.7	5.0
Percent change[1]	-1.6	-0.7	-3.0	1.0	-6.5	-3.5	3.8	0.1	0.5	0.4
HighPrice large adjusted	2.1	3.2	4.1	2.8	8.0	8.4	32.5	11.0	21.9	5.9
Percent change[1]	35	-15	-26	-21	-24	-17	11	-7.0	17	18

[1]Percent change in region, compared to the *MediumPrice adjusted* scenario.
[2]See table 4 for States in each region.
Notes: LTB = likely to bid, RFS = Renewable Fuels Standard.

We model the *HighPrice large adjusted* scenario using a 120-percent increase in CRP rental rates. Results here (in terms of offered acres and EEBI scores) are similar to the *MediumPrice adjusted* scenario (table 5), though average per-acre rental payments increase to $101/acre. When 2007 CRP rental rates are used (that is, rental rates are not adjusted to accommodate high crop prices), less than 30 million acres of land are offered to the program.[18]

In comparing the "transition" of acres from the *MediumPrice adjusted* to the *HighPrice large adjusted* scenario, substantive changes are evident (table 8). Of the 30 million accepted acres, 7 million acres differ between the two scenarios. Unlike with transitions between prior scenarios, forgone revenues are higher (not surprising, given the high crop prices), as are rental payments.[19] The land that enters under the *HighPrice large adjusted* scenario is both of lower agricultural productivity and lower environmental quality than the land that leaves.

In contrast to the comparison of *MediumPrice adjusted* and the *RFS adjusted* scenarios, regional shifts in CRP acres under the *HighPrice large adjusted* are substantial. The Southeast, Delta, Appalachia, Lake States, and Corn Belt regions lose from 15 to 26 percent of their enrolled acres, while acreage in the Northern Plains, Northeast, Mountain, and Pacific regions expands by 10-35 percent (table 7).

An interesting feature of the CRP is that the program's total allowable enrollment is capped, but there is no explicit budget cap. Nonetheless, program dollar outlays are a concern, as evidenced by inclusion of a cost factor in the EBI, so it is interesting to compare the budget/acreage impacts of the different scenarios.

[18]When per-acre CRP rental rates of the *MediumPrice adjusted* scenario are used in the *HighPrice* scenario, 33.6 million acres are offered, and the average EEBI score decreases.

[19]We also investigated a transition from the *Baseline* to the *HighPrice large adjusted* scenario. Compared to a *MediumPrice adjusted* to *High-Price large adjusted* transition, more acres leave the program (9.8 million acres), and acres that enter the CRP are cheaper but have substantially lower EEBI scores.

Table 8

Acres entering and leaving the CRP general signup under summer 2008 commodity price levels

	For acres that do not change as prices and rental rates increase[1]	For acres that enter the CRP as prices and rental rates increase	For acres that leave the CRP as prices and rental rates increase
Forgone net revenue (avg. $/acre)[2]	51	77	153
Rental payments (avg. $/acre)[2]	104	92	129
EEBI score (avg. score/acre)	178	163	179

[1] This table is based on a comparison of acres offered, and accepted, into the CRP general signup program under the *MediumPrice* adjusted scenario and the *HighPrice large adjusted* scenario, using the LTB model. In each scenario, 30 million acres are accepted; 23 million acres are accepted in both scenarios, with 7 million acres differing.

[2] Forgone agricultural revenue and rental payments are based on values from the *HighPrice large adjusted* scenario.

Note: EEBI = Environmental Benefits Index, without the cost factor.

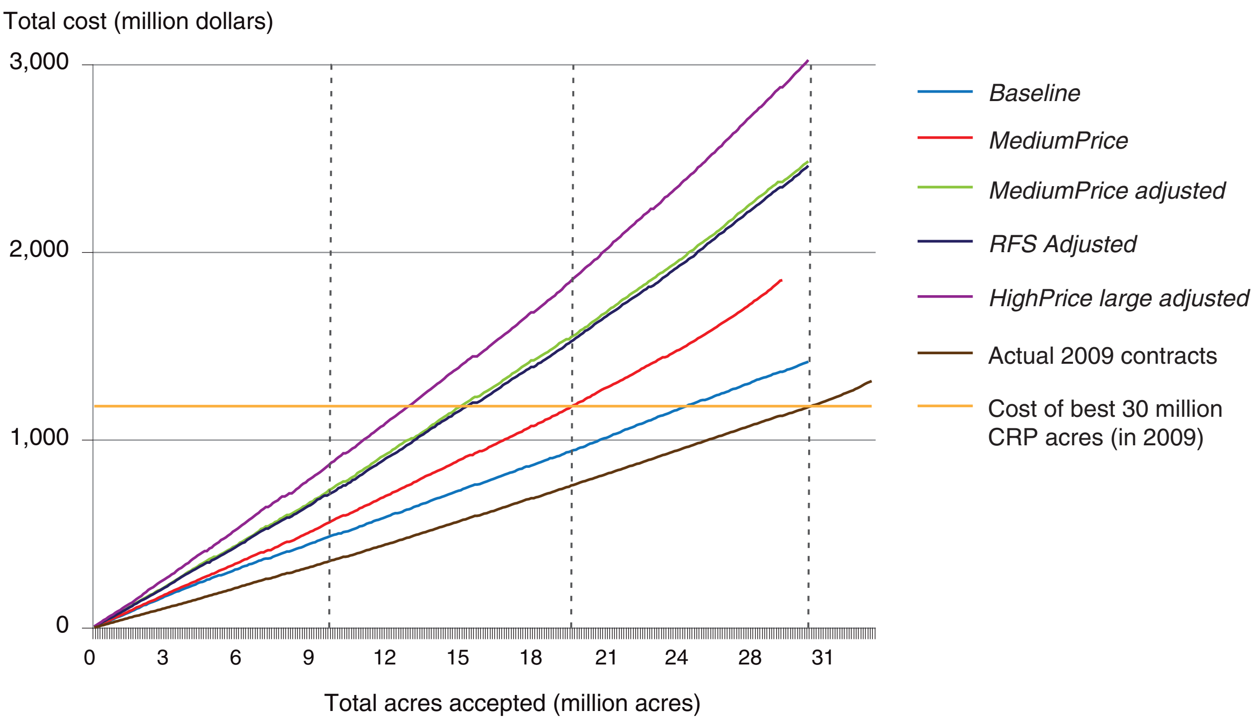
Figures 2 and 3 display results from five scenarios, along with results from actual CRP contracts as of March 2009. Each graph displays the impact of increasing the number of accepted acres (where acres with the highest EBI scores are accepted first). Each graph examines a single variable. Figure 2 shows the total costs of enrolling various acre levels. Figure 3 shows the average environmental component of the EBI score (the EEBI), per acre, at various acre levels.

Figure 2 illustrates that the contracts as of 2009 (many of them dating from 1997) are noticeably less costly than all the scenarios (though program costs are somewhat close to the *Baseline*). The *HighPrice large adjusted* scenario costs nearly three times as much as actual contracts when 30 million acres are enrolled. The *MediumPrice adjusted* and *RFS adjusted* scenarios (whose differences are due to projected changes in ethanol production) are quite similar.

What happens to general signup acreage if (say, due to budget pressures) 2009 funding levels were imposed? The 2009 contracts indicate that about $1.1 billion is spent on the “best” 30 million acres (in terms of EBI score). If this $1.1 billion could not be expanded, under the other scenarios CRP acreage would substantially decline. For example, in the *MediumPrice* scenario, only 20 million acres could be enrolled. And in the *MediumPrice adjusted* and *RFS adjusted* scenarios (where CRP rental rates are increased across the board), only about 15 million acres could be enrolled, with even

Figure 2

Total cost of CRP acquisitions at different acreages, for several scenarios



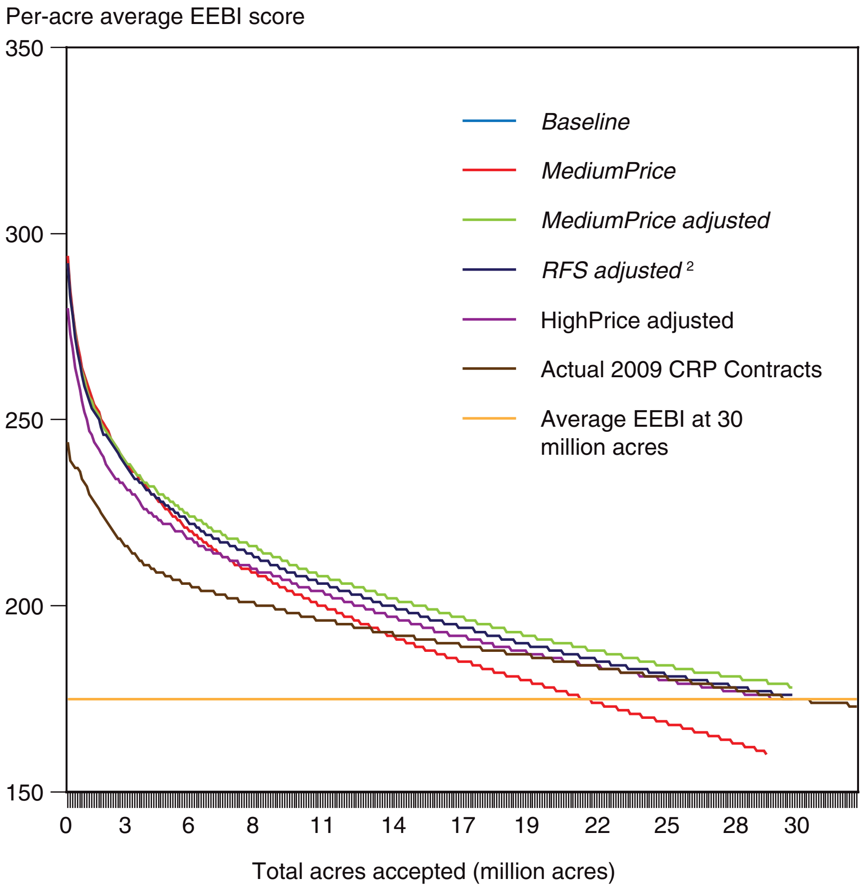
The vertical axis lists the total acquisition cost for a given acreage.

less should the commodity prices observed in summer 2008 (the *HighPrice large adjusted* scenario prices) be realized.

Conversely, what is the impact of adjusting CRP rental rates? Does offer quality improve? At all acreage levels, the "adjusted" scenarios yield per-acre EEBI scores between those of the 2009 contracts and the 2005 baseline (fig. 3). In fact, the "adjusted" scenarios are quite similar, which confirms that increasing rental payments can help maintain environmental dividends. It is also interesting to note what happens in the *MediumPrice* scenario (where no adjustments to CRP rental rates are made): not only is the 30-million-acre signup goal unobtainable, but the quality of enrolled acres (as measured by average EEBI score) is substantially lower than under current contracts.

Figure 3

Average per-acre EEBI[1] score at different CRP acreage levels, for several scenarios



The vertical axis lists the average EEBI across all acres, at a given acreage. For example, the graph for the MediumPrice scenario has a value of 176 at 21 million acres. This means that when the 21 million acres with the best EBI scores (in the MediumPrice scenario) are considered, their average EEBI score is 176.

[1]The EEBI is the Environmental Benefits Index (EBI) without the cost factor.

[2]The *RFS* (Renewable Fuels Standard) scenario reflects additional price impacts of heightened biofuels production.

Influence of Prices: *Opt-Out* Model

Although the *LTB* model does have appealing features (such as allowing new lands to enter), it ignores a key aspect of the CRP—that there are lands already in the program. And, these lands may be controlled by rural landowners who embrace the idea of land retirement and may behave differently than the average landowner.

In addition, CRP contracts are for 10 to 15 years, so the notion of "restarting the CRP from scratch" is unrealistic. More likely, owners of lands currently enrolled in the CRP may choose not to re-enroll when their contracts expire. Or, the USDA may enact a policy to let lands more easily opt out of the CRP if more production is deemed necessary.

Therefore, as a complement to the *LTB* model, we formulate an opt-out model that focuses on currently enrolled CRP acreage. This analysis uses yield and crop price information to assign a "crop" to every CRP contract (see appendix 2). This assignation is a prediction of the crop that the land would return to without the CRP. Unlike other analyses (Lubowski et al., 2008), idling land is not an option. The CRP land is assumed to return to some kind of crop production (perhaps with a few years' lag).

The *opt-out* model can indicate the consequences of releasing CRP acreage. For example, to meet increased demands for crops (say, due to a large expansion in crop-based ethanol production), one approach is to release CRP land before its scheduled expiration date—to allow contracted acres to opt out. If such a policy were enacted, what would be the consequences of releasing acreage at different levels? To address this question, we sort contracts that our models predict would be likely to opt out and examine the tradeoffs if more or fewer acres are allowed to opt out.

The *opt-out* model uses contract data as of March 2008.[20] It assigns acreage in all CRP contracts to a crop type and predicts what would happen to program acres if the CRP were to abruptly end. Using this prediction of probable crop choices on current CRP lands, the model then predicts which landowners would opt out of the program if costless exit were permitted. These opt-out predictions are informed by parcel-level estimates (derived from the LTB model) of the correlation between the profitability of the CRP (relative to crop production) and the probability of being enrolled in the CRP.

We first consider scenarios using the prices from the *MediumPrice* scenario. Commodity prices used in these scenarios are higher than those prevalent when CRP contracts were signed. Thus, under the assumption that CRP rental rates do not change, a significant number of acres—9.4 million or 30 percent of general signup acres as of March 2008—would leave the program if given the chance (table 9). Note that this analysis excludes the 4 million acres of continuous signup. By way of comparison, in 2006 CRP offered an extension option to CRP participants whose contracts were set to expire between 2007 and 2010. Approximately 15 percent of the acreage covered by these contracts (about 4 million out of 27 million) opted out.

[20]While not the most current contract data, March 2008 represents a time of relative stability in CRP contracts. Future analysis that examines re-enrollments and opt-outs of the 39th general signup, held in August 2010, may yield different insights.

The *opt-out* model predicts that about half of acres exiting CRP would go into wheat and about a quarter would become either corn or soybeans (table 9). The probability that a given acre will exit the CRP is a function of what crop type the model assigns to it. For example, for acres predicted to "return" to corn and soybeans, the opt-out rate is 32-35 percent, while for sorghum the rate is below 20 percent.

Next we consider the *RFS* scenario (table 10), which captures price increases due to expanding ethanol production from 6.5 billion to 15 billion gallons, without changing CRP rental rates from their 2007 levels. This expansion has a minor impact on CRP enrollment, with about 200,000 additional acres (from 9.4 to 9.63 million acres) choosing to leave the program. The most noticeable change is the 20-percent increase (from 32 to 39 percent) in the opt-out rate for acres assigned to corn, even though the share of exiting acres assigned to corn increases by a smaller amount.

Table 9

Acreage opting out of the general signup CRP by crop: *MediumPrice* scenario prices, with and without an increase in CRP per-acre rental rates

	Barley	Corn	Cotton	Oats	Sorghum	Soybeans	Wheat	Hay	Acres leaving *(million)*
Crop grown if CRP ended *(% of all current CRP acres)*[1]	3	13	3	1	3	12	50	15	
Share of above acres that would opt out of the CRP[2]	35	32	1	4	17	35	40	4	9.4
As above, with 60% increase in soil rental rates (*Medium-Price adjusted* scenario) [2]	17	11	1	2	11	20	26	2	5.9

[1] The first row is based on a crop prediction: each CRP contract is "assigned" a crop that would be grown if the CRP ceased to exist (see appendix 2 for a description).
[2] The second and third rows use this crop prediction and estimate what share of acres (that are assigned to a given crop) would opt out of the CRP. The second row uses CRP rental rates from the *MediumPrice* scenario, while the third row uses CRP rental rates used in the *MediumPrice adjusted* scenario.

Table 10

Acreage opting out of the general signup CRP by crop: *RFS* scenario prices, with and without an increase in CRP per-acre rental rates

	Barley	Corn	Cotton	Oats	Sorghum	Soybeans	Wheat	Hay	Acres leaving *(million)*
Crop grown if CRP ended *(% of all current CRP acres)*[1]	3	15	3	1	4	11	48	15	
Share of above acres that would opt out of the CRP[2]	35	39	1	4	17	35	40	5	9.6
As above, with with 60% increase in soil rental rates (*RFS adjusted* scenario)[2]	17	25	1	2	11	19	27	3	6.3

[1] The first row is based on a crop prediction: each CRP contract is "assigned" a crop that would be grown if the CRP ceased to exist (see appendix 2 for a description).
[2] The second and third rows use this crop prediction and estimate what share of acres (that are assigned to a given crop) would opt out of the CRP. The second row uses CRP rental rates from the *RFS* scenario, while the third row uses CRP rental rates used in the *RFS adjusted* scenario.
Note: RFS = Renewable Fuel Standard.

Table 11

Acreage opting out of the general signup CRP by crop: *HighPrice* scenario, with and without an increase in CRP per-acre rental rates

	Barley	Corn	Cotton	Oats	Sorghum	Soybeans	Wheat	Hay	Acres leaving *(million)*
Crop grown if CRP ended *(% of all current CRP acres)*[1]	3	17	4	1	4	17	48	5	
Share of above acres that would opt out of the CRP[2]	51	38	0	9	17	43	42	1	11.1
As above, with with 120% increase in soil rental rates (*HighPrice* large adjusted scenario)[2]	25	20	0	1	9	17	15	1	4.6

[1]The first row is based on a crop prediction: each CRP contract is "assigned" a crop that would be grown if the CRP ceased to exist (see appendix 2 for a description).
[2] The second and third rows use this crop prediction and estimate what share of acres (that are assigned to a given crop) would opt out of the CRP. The second row uses CRP rental rates from the *HighPrice* scenario, while the third row uses CRP rental rates used in the *HighPrice adjusted* scenario.

If CRP rental rates are raised 60 percent (the *adjusted* scenarios), the number of acres that opt out is reduced in both the *MediumPrice* and *RFS* scenarios by about 35 percent. Except for corn, this level of reduction is consistent across crops. For corn, the use of higher rental rates causes far fewer acres to opt out in the *MediumPrice* scenario than in the RFS scenario, indicating the allure of biofuels-driven price increases for growing corn.

Under the *HighPrice* scenario, the model predicts that over 11 million acres (about 35 percent of total acres) would opt out. The most noticeable change from other scenarios is for soybeans, with more CRP acres predicted to go into soybeans, and more of these soybean acres predicted to opt out. Under the *HighPrice large adjusted* scenario (where rental rates are increased by 120 percent), the opt-out rate for all crops drops by more than 50 percent, with especially large changes in corn, soybean, and wheat opt-out rates.[21]

Results across scenarios indicate that much of the probable loss of CRP acres is likely due to price changes that have already happened, as indicated by the results under the *MediumPrice* scenarios. Additional changes, as reflected in the *RFS* and the *HighPrice* scenarios, increase opt-out rates somewhat, but much of this could be avoided with higher rental rates, albeit at higher overall program costs.

These findings reinforce the results from the *LTB* models. The impacts of current prices on CRP enrollment are substantial. Further price increases (and CRP effects) due to a large upswing in ethanol output are minor, while CRP impacts with crop prices as high as in summer 2008 are larger.

Since a likely goal of releasing CRP lands is to either increase commodity production or reduce program costs, our model allows the most productive land (having the highest rental rates) to be released first. The CRP's Rental Rate is a reasonable measure of productivity, so we sort acres that want to opt out by decreasing rental rate. Note that acres in continuous signup are not released; our analysis indicates that about 300,000 acres in continuous signup would be candidates to opt out.

[21]The absolute measure (of acres that opt out) is sensitive to a number of assumptions, in particular assumptions about how one models the relationship between the relative profitability of the CRP and the decision to offer land to the CRP. These results use a smoothed relationship that may overpredict the responsiveness of enrollment to profitability of agricultural production.

Tables 12 to 17 show the cumulative impacts of releasing different levels of acres from the CRP. For example, if 3 million acres are released under the *MediumPrice* scenario, the average EEBI of these 3 million acres is an estimated 184. If 5 million acres are released, the average EEBI drops to 173, implying that these additional 2 million acres provide fewer environmental benefits than the prior 3 million acres. In all cases, the first acres to opt out tend to go to corn. And, as more acres opt out, the share of wheat acres increases.

Table 12
Effects of allowing general signup CRP contacts to opt out: *MediumPrice* scenario

Cumulative acreage opting out[1]	Rental rate[2]	Annual cost decline[3]	EEBI per acre[4]	Corn share per acre[5]	Corn yield per acre[6]	Wheat share[5]	Wheat yield per acre[6]
Million acres	*$/acre*	*$ millions*		*Percent*	*Bushels*	*Percent*	*Bushels*
1	69	88	203	44	141	14	61
3	39	194	184	28	132	37	50
5	32	265	173	19	131	53	41
8	23	348	163	13	128	65	35
9.4	7	377	161	12	127	68	33

Note: Average per-acre rental rate (SRR) for all CRP contracts is $47. EEBI = Environmental Benefits Index, without the cost factor.
[1] Acres interested in opting out, sorted by descending soil rental rates (SRR). For example, the 2nd row refers to the 3 million "highest SRR" acres that would opt out.
[2] The soil rental rate (SRR) of the n millionth acre. Thus, the 8 millionth acre opting out has a SRR of 23.
[3] Cumulative expenditure (over n million acres). For example, if 8 million acres were allowed to opt out, total CRP expenditures would decline by $348 million/year.
[4] The average EEBI (across n million acres). For example, if 8 million acres were allowed to opt out, their average EEBI score would be 163.
[5] The percent (of n million acres) that go into corn [wheat]. For example, if 3 million acres were allowed to opt out, then 28% [37%] of these acres would go into corn/wheat.
[6] Average corn/wheat yield (across n million acres). For example, if 3 million acres were allowed to opt out, the average corn [wheat] yield (of the acres that go into corn/wheat) would be 132 bushels [50 bushels] per acre.

Table 13
Effects of allowing general signup CRP contacts to opt out: *RFS* scenario

Cumulative acreage opting out[1]	Rental rate[2]	Annual cost decline[3]	EEBI per acre[4]	Corn share per acre[5]	Corn yield per acre[6]	Wheat share[5]	Wheat yield per acre[6]
Million acres	*$/acre*	*$ millions*		*Percent*	*Bushels*	*Percent*	*Bushels*
1	71	91	204	52	141	11	60
3	41	202	187	37	131	30	51
5	32	274	175	25	129	48	41
8	24	360	165	18	126	60	35
9.6	7	395	161	15	125	64	32

Notes: Average per-acre rental rate is $47. RFS = Renewable Fuel Standard, EEBI = Environmental Benefits Index, without the cost factor.
[1] Acres interested in opting out, sorted by descending soil rental rates (SRR). For example, the 2nd row refers to the 3 million "highest SRR" acres that would opt out.
[2] The soil rental rate (SRR) of the n millionth acre. Thus, the 8 millionth acre opting out has a SRR of 24.
[3] Cumulative expenditure (over n million acres). For example, if 8 million acres were allowed to opt out, total CRP expenditures would decline by $360 million/year.
[4] The average EEBI (across n million acres). For example, if 8 million acres were allowed to opt out, their average EEBI score would be 165.
[5] The percent (of n million acres) that go into corn [wheat]. For example, if 3 million acres were allowed to opt out, then 37% [30%] of these acres would go into corn [wheat].
[6] Average corn/wheat yield (across n million acres). For example, if 3 million acres were allowed to opt out, the average corn [wheat] yield (of the acres that go into corn/wheat) would be 131 bushels [51 bushels] per acre.

Comparing across price scenarios, as prices increase (from *MediumPrice* to *RFS* to *HighPrice*), the number of opt-out acres increases (although by a relatively small amount in the *MediumPrice* to *RFS* case). Other statistics are less affected, though corn acres increase slightly (at low opt-out acreage) as one moves to higher price scenarios (i.e., from *MediumPrice* to *RFS*).

Comparing across different variants of each scenario, an increase in CRP rental rates reduces the number of opt-out acres, at higher program cost. In terms of proportional change, the *HighPrice large adjusted* scenario shows

Table 14

Effects of allowing general signup CRP contacts to opt out: *HighPrice* scenario

Cumulative acreage opting out[1]	Rental rate[2]	Annual cost decline[3]	EEBI per acre[4]	Corn share per acre[5]	Corn yield per acre[6]	Wheat share[5]	Wheat yield per acre[6]
Million acres	*$/acre*	*$ million*		*Percent*	*Bushels*	*Percent*	*Bushels*
1	80	100	209	56	151	03	65
3	52	231	195	39	138	15	60
5	36	316	183	28	135	32	47
8	28	412	171	19	133	48	38
11.1	7	486	164	15	131	58	33

Notes: Average per-acre rental rate is $47. EEBI = Environmental Benefits Index, without the cost factor.

[1] Acres interested in opting out, sorted by descending soil rental rates (SRR). For example, the 2nd row refers to the 3 million "highest SRR" acres that would opt out.

[2] The soil rental rate (SRR) of the n millionth acre. Thus, the 8 millionth acre opting out has a SRR of 28.

[3] Cumulative expenditure (over n million acres). For example, if 8 million acres were allowed to opt out, total CRP expenditures would decline by $412 million/year.

[4] The average EEBI (across n million acres). For example, if 8 million acres were allowed to opt out, their average EEBI score would be 171.

[5] The percent (of n million acres) that go into corn [wheat]. For example, if 3 million acres were allowed to opt out, then 39% [15%] of these acres would go into corn/wheat.

[6] Average corn/wheat yield (across n million acres). For example, if 3 million acres were allowed to opt out, the average corn [wheat] yield (of the acres that go into corn/wheat) would be 138 bushels [60 bushels] per acre.

Table 15

Effects of allowing general signup CRP contacts to opt out: *MediumPrice adjusted* scenario

Cumulative acreage opting out[1]	Rental rate[2]	Annual cost decline[3]	EEBI per acre[4]	Corn share per acre[5]	Corn yield per acre[6]	Wheat share[5]	Wheat yield per acre[6]
Million acres	*$/acre*	*$ millions*		*Percent*	*Bushels*	*Percent*	*Bushels*
1	82	115	192	32	129	28	57
3	50	237	171	15	128	59	40
4	44	285	166	13	127	64	36
5.9	11	358	158	09	125	72	32

Notes: Average per-acre rental rate is $78. EEBI = Environmental Benefits Index, without the cost factor.

[1] Acres interested in opting out, sorted by descending soil rental rates (SRR). For example, the 2nd row refers to the 3 million "highest SRR" acres that would opt out.

[2] The soil rental rate (SRR) of the n millionth acre. Thus, the 4 millionth acre opting out has a SRR of 44.

[3] Cumulative expenditure (over n million acres). For example, if 4 million acres were allowed to opt out, total CRP expenditures would decline by $285 million/year.

[4] The average EEBI (across n million acres). For example, if 4 million acres were allowed to opt out, their average EEBI score would be 166.

[5] The percent (of n million acres) that go into corn [wheat]. For example, if 3 million acres were allowed to opt out, then 15% [59%] of these acres would go into corn/wheat.

[6] Average corn/wheat yield (across n million acres). For example, if 3 million acres were allowed to opt out, the average corn [wheat] yield (of the acres that go into corn/wheat) would be 128 bushels [40 bushels] per acre.

the most dramatic within-scenario reduction. Interestingly, across all three pairs of scenarios the cost savings (of the opted-out acres) are roughly the same: larger across-the-board increases in CRP rental rates means fewer acres opt out, but each opted-out acre has a higher average SRR. Increasing the SRR multiplier also seems to reduce the corn share (at a given level of opt-out acres). For example, in the *RFS adjusted scenario*, at 2 million opted-out acres, the corn proportion is 26 percent; in the *RFS* (without a higher SRR) scenario, it is 37 percent. Again, corn growers may be more sensitive to changes in relative net returns in a volatile price environment.

Table 16

Effects of allowing general signup CRP contacts to opt out: *RFS adjusted* scenario

Cumulative acreage opting out[1]	Rental rate[2]	Annual cost decline[3]	EEBI per acre[4]	Corn share per acre[5]	Corn yield per acre[6]	Wheat share[5]	Wheat yield per acre[6]
Million acres	*$/acre*	*$ millions*		*Percent*	*Bushels*	*Percent*	*Bushels*
1	93	125	197	50	132	18	58
3	52	257	174	26	128	50	41
5	40	350	164	18	126	62	35
6.3	11	395	160	15	124	67	32

Notes: Average per-acre rental rate is $78. RFS = Renewable Fuel Standard; EEBI = Environmental Benefits Index, without the cost factor.
[1] Acres interested in opting out, sorted by descending soil rental rates (SRR). For example, the 2nd row refers to the 3 million “highest SRR” acres that would opt out.
[2] The soil rental rate (SRR) of the n millionth acre. Thus, the 5 millionth acre opting out has a SRR of 40.
[3] Cumulative expenditure (over n million acres). For example, if 5 million acres were allowed to opt out, total CRP expenditures would decline by $350 million/year.
[4] The average EEBI (across n million acres). For example, if 8 million acres were allowed to opt out, their average EEBI score would be 164.
[5] The percent (of n million acres) that go into corn [wheat]. For example, if 3 million acres were allowed to opt out, then 26% [50%] of these acres would go into corn/wheat.
[6] Average corn/wheat yield (across n million acres). For example, if 3 million acres were allowed to opt out, the average corn [wheat] yield (of the acres that go into corn/wheat) would be 132 bushels [41 bushels] per acre.

Table 17

Effects of allowing general signup CRP contacts to opt out *HighPrice large adjusted* scenario

Cumulative acreage opting out[1]	Rental rate[2]	Annual cost decline[3]	EEBI per acre[4]	Corn share per acre[5]	Corn yield per acre[6]	Wheat share[5]	Wheat yield per acre[6]
Million acres	*$/acre*	*$ millions*		*Percent*	*Bushels*	*Percent*	*Bushels*
1	131	179	198	48	139	9	61
3	65	352	174	25	132	39	39
5	52	411	167	21	131	47	34
4.6	15	441	164	18	130	52	32

Notes: Average per-acre rental rate is $103. EEBI = Environmental Benefits Index, without the cost factor.
[1] Acres interested in opting out, sorted by descending soil rental rates (SRR). For example, the 2nd row refers to the 3 million “highest SRR” acres that would opt out.
[2] The soil rental rate (SRR) of the n millionth acre. Thus, the 5 millionth acre opting out has a SRR of 52.
[3] Cumulative expenditure (over n million acres). For example, if 5 million acres were allowed to opt out, total CRP expenditures would decline by $411 million/year.
[4] The average EEBI (across n million acres). For example, if 5 million acres were allowed to opt out, their average EEBI score would be 167.
[5] The percent (of n million acres) that go into corn [wheat]. For example, if 3 million acres were allowed to opt out, then 25% [39%] of these acres would go into corn/wheat.
[6] Average corn/wheat yield (across n million acres). For example, if 3 million acres were allowed to opt out, the average corn [wheat] yield (of the acres that go into corn/wheat) would be 132 bushels [39 bushels] per acre.

How Might a CO_2 Offset Program Influence CRP Participation?

Even without commodity prices higher than those used in the *MediumPrice* scenario, our results indicate that a substantial increase in program expenditures (for example, from $48 to $86 per acre) would be required to maintain the CRP in something close to its present configuration. Other funding mechanisms could reduce costs—we consider payments for carbon sequestration as an example.

In particular, land retirement (along with suitable land cover and management) can lead to carbon sequestration (Pineiro et al., 2009). Conceivably, lands that enroll in the CRP could generate GHG offsets that could be sold (by the landowner). While issues of leakage and additionality may complicate implementation (Baker and Galik, 2009), let us assume that landowners are allowed to sell the carbon sequestration of their retired acres, as measured by the yearly difference in carbon storage when in a conserving practice versus carbon storage (or release) in a continuous crop.[22]

The *LTB* model is used, starting with prices and rental rates from the *MediumPrice* scenario. Sequestration rates by farm production region, which measure the additional carbon that conversion from a continuous crop to CRP would entail (table 18), are assigned to all data points in the *LTB* model. This sequestration is treated as a marketable carbon offset. Thus, a CRP acre will receive both a rental payment from USDA and a carbon offset payment from whoever purchases it.[23]

Three scenarios are examined. The first represents a consensus price for carbon offsets, and the latter two are selected to achieve results, in terms of EEBI scores and offered acres, that are similar to the current CRP.

[22]To reiterate, we abstract from issues of leakage, additionality, and permanence. Also, the CRP's EBI does contain a small carbon sequestration factor. In these models, this factor is kept constant (so that carbon sequestration does not affect EBI scores significantly).

The sequestration rate is specific to a multi-State crop production region. It does not depend on what crop is being grown, nor does it incorporate parcel-specific soil information.

Table 18
CRP acreage characteristics under the *MediumPrice* scenario, with an active carbon market

	Offered acres	Average EEBI score	GHG offset revenue	Forgone agricultural revenue	Rental payments
	Million	*Average/acre*	----------------	*Average $/acre*	----------------
$25/mt CO_2 price, 1.0 x soil rental rate	37.1	181	16	42	58
$30/mt CO_2 price, 1.3 x soil rental rate	46.9	191	19	53	70
$50/mt CO_2 price, 1.0 x soil rental rate	45.5	190	31.6	51	55
MediumPrice adjusted	44.7	179	..	48	83

Note: Columns 2-5 are based on the "best" 30 million acres that the model accepts into the CRP.
The increased carbon sequestration rate, compared to continuous agriculture, per acre of CRP are from Eve et al. (2002); with values—in metric tons (mt) per acre—that range between 0.29 (for the Mountain farm production region) to 0.74 (for the Delta farm production region).
EEBI = Environmental Benefits Index, without the cost factor. GHG = greenhouse gas.

1. A CO_2 price of $25/ton, with no increase in rental rates;
2. A CO_2 price of $30/ton, with a 30-percent increase in rental rates; and
3. A CO_2 price of $50/ton, with no increase in rental rates.

If CO_2 prices were as high as $50/ton, the CRP would be largely unaffected by higher commodity prices, even without an increase in rental rates (table 18). At $30/ton (along with a 30-percent increase in rental rates), the *LTB* predicts environmental benefits similar to the $50/ton scenario, but with a 27-percent increase in program costs (from $55 to $70 per acre). Total revenue per acre (rental rate plus offset revenue) in both these scenarios is $87-$89/acre, which is near the $83 rental value of the *MediumPrice adjusted* scenario.

Conclusions

In this study, we examine how high commodity prices may affect the Conservation Reserve Program. As a voluntary program, landowners choose whether to offer their land to the program or to engage in agricultural production. Higher crop prices, as observed in summer 2008 or subsequent to mandated increases in crop-based ethanol production, are likely to sway some landowners in favor of agricultural production over conservation.

The impacts of a change in the economic environment depend on a number of factors. Of course, the magnitude of price changes matters. So does the reaction of the USDA program administrators, such as by increasing per-acre CRP rental rates as per-acre agricultural profits rise. The future goals of the program also matter, as CRP size is diminished and as the more closely targeted continuous signup portion of the program grows in importance. Also, commodity price changes influence not only the amount but the quality of lands offered: their agricultural productivity, environmental benefits, and geographic location.

We consider these issues using two modeling strategies. The *likely-to-bid (LTB)* model simulates what the CRP would look like if it were to start from scratch. The *opt-out* model takes current CRP contracts as a given, then simulates which enrollees would opt out of the program if given the opportunity. Both strategies have their strengths and weaknesses, and together offer complementary perspectives on the impacts of price changes.

With a mandated increase in biofuels production, one scenario (*RFS*) simulates the impact on crop prices due to higher crop-based ethanol output. Another scenario (*HighPrice*) incorporates the high prices observed in summer 2008, should crop prices settle at this higher level due to increased demand or other factors.

One key finding is that increased ethanol output would have small additional impacts on the CRP. Using the *LTB* model, offered acres drop by about 2 million acres (5 percent), and environmental benefits (as measured by the environmental component of EBI scores) decrease by about 2 percent. The *opt-out* model tells a similar story, with about 200,000 additional acres leaving the program.

Overall, these results are commensurate with the relatively small change in prices predicted by the REAP model (Biomass Research and Development Initiative, 2008) for this increase in ethanol production. However, these impacts are on top of impacts due to the high commodity prices of the last 3 years. We find that restarting the CRP, under prices and CRP rental rates similar to those currently observed (*MediumPrice* scenario), would lead to significant drops in offered acres and EBI scores and an increase in program costs. We also find that, if contracts were allowed to opt out (without any penalty), almost one-third might do so under the *MediumPrice* scenario.

Thus, in a new era of elevated crop prices—even without an increase in ethanol production—maintaining the CRP as currently configured will require an increase in rental payments. Given the established interest in the program, it might be possible to meet enrollment goals (say, 30 million acres of general signup) with moderate increases in CRP rental rates. But this will likely mean accepting lower average EBI scores, as landowners with profitable but environmentally sensitive lands choose not to offer their land to the program.

With a goal of maintaining the current attributes of retired acres, the *LTB* model finds that in the *MediumPrice* scenario, program costs will almost double (from about $45/acre to about $85/acre). In a similar vein, the opt-out model indicates that this level of rental rate increase reduces the number of acres that choose to opt out by about one-third.

Comparison of enrollment schedules demonstrates that if expenditures are capped at current levels and CRP rental rates are held constant, acreage enrollment will decline precipitously. Increasing the rental rate can offset this decline and lead to enrollment of acreage with environmental benefits comparable to current contracts, but at substantially higher program expenditures. In all scenarios, the *opt-out* model suggests that opt-out acres are most likely to end up in corn. However, as the level of acres allowed to opt out increases, wheat dominates.

If carbon offsets could be sold by CRP enrollees, and if additionality concerns are ignored, the impacts of increased prices on CRP enrollment costs could be substantially reduced. For example, at a price of $50/ton of sequestered carbon dioxide, CRP acreage would be mostly retained, with a minor (about 16-percent) increase in cost.

In summary, as crop prices rise, the composition and environmental attributes of CRP acreage can be maintained so long as rental rates are updated to reflect current crop prices. Such an updating will not be cheap, and within 10 years (as existing contracts expire) may almost double program costs. To the extent such an increase in rental rates does not occur, the program is likely to see fewer acres offered, with a commensurate decrease in the EBI scores of accepted acres.

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Appendix 1
Likely-To-Bid Model: Methodology

The *likely-to-bid* (LTB) model, developed jointly by USDA's Economic Research Service (ERS) and Farm Service Agency (FSA), uses data from a number of sources. Field-specific data on land use and land quality are from the 1997 National Resources Inventory (NRI). NRI data are collected and maintained by USDA's Natural Resources Conservation Service (NRCS) for more than 800,000 points of land throughout the contiguous United States.

For each NRI data point, the LTB model determines CRP eligibility using point-specific information on cropping history, soil erodibility, location (within a conservation priority area), and other factors.

For these eligible points, the LTB assigns or calculates:

(1) Farm Service Agency (FSA) per-acre soil rental rate (SRR),

(2) an estimate of net returns to agricultural production, and

(3) an estimate of the Environmental Benefits Index (EBI) score.

The SRR is computed using average non-irrigated cropland rental rates for the county (obtained from USDA's National Agricultural Statistics Service (NASS)), adjusted for soil quality using the Soil Rating for Plant Growth (SRPG) obtained from NRCS. Using NRI cropping history data, agricultural net returns (NRET) are estimated using State-level information on crop prices (NASS), production costs (ERS), and other information (such as hay prices).

The ratio of soil rental rate over agricultural net returns (SRR/NRET) is used to determine whether the landowner would be interested in CRP enrollment. If the ratio exceeds a region-specific threshold value, the landowner is assumed to be "interested" in the program—he or she is "likely to bid." For most of the country, a threshold value of 0.8 is used to reflect the fact that CRP returns are risk free. That is, the model assumes that risk-averse producers would be willing to accept a lower return in exchange for the reduction in risk realized through CRP enrollment. In some regions, however, land has significant "option" value—such as the value of converting lands to housing or commercial development. Land cannot be sold or converted to another use while a CRP contract is in force. To account for lost option value, threshold values are set at 1.3 in the Northeast and 1.2 in the Appalachian States.

To determine the EBI score, a prediction of the value for each of the EBI factors is required. For most factors, NRI variables can be used to compute factor scores. For example, the EBI's soil erodibility factor can be assigned using the NRI's water (and wind) erodibility variables. Similarly, the NRI sample point's location can be used to assign a value to the water quality zone factor.

Since it depends on specific practices applied, the EBI wildlife factor cannot be exogenously assigned. Therefore, the LTB model assigns conservation practices to each NRI point using information on eligible practices and geography, such as whether the point is located in a State conservation priority area. Practices are chosen to replicate the observed distribution of practices in the CRP as of 2005. Once practices are assigned, the EBI wildlife factor scores can be calculated.

Last, the cost factor component of the EBI is based on the SRR assigned to the point of land sampled by the NRI. We assume that "landowners" of these "representative parcels" would ask for the maximum allowed rent (the SRR). While landowners can ask for less than this maximum (and thereby increase the size of the cost factor), in actual practice most landowners do not reduce their offer. Over the last several signups, the average bid in CRP offers (as a share of the parcel's SRR) has been over 95 percent.

Threshold Values in the *LTB* Model

The LTB model treats NRI points as parcels of land whose landowners may be interested in the CRP. The LTB assumes that its prediction of net agricultural returns more accurately measures landowner profits than the soil rental rate (SRR) assigned to a parcel. Given this assumption, the LTB finds parcels where the net agricultural returns are low, relative to what the CRP would offer in rental payments, and assumes that owners of these parcels will take advantage of this discrepancy and offer the parcel to the program. If the SRR were a perfect predictor of net agricultural returns, then the LTB would predict that all (or none) of the eligible acres would be offered to the program.

Several factors can yield low net agricultural returns. For example, using 2005 data, the model finds a weak correlation (0.21) between low soil quality (as measured by the SRPG) and willingness to enroll. This implies that the SRR does not fully capture the effects of soil quality when it is lower than the county average.

The use of the 0.8 (and 1.2 and 1.3) thresholds is based on historical use of the LTB (to help determine an EBI cutoff in several general signups). These values, while not entirely arbitrary, are not derived by a formal modeling process. That is, the LTB model does not reference actual CRP contracts. Calibrating the LTB model with actual contract and offer data, with a goal of deriving point-specific thresholds, would be a real improvement. However, a number of calibration methods were attempted, none of which yielded clearly superior results.1

Thus, the ad hoc (but honored by prior use) thresholds (0.8 for most of the country) are used. While this is not an ideal approach,[2] it should not seriously bias the overall results obtained from comparing simulations. (Unless landowner behavior changes dramatically as commodity prices change, differences across simulations should be relatively robust to the exact choice of thresholds.)

[1]A serious difficulty is presented by the existence of county caps (by law, no more than 25 percent of a county's cropland may be enrolled in the CRP). These caps are constraining; for example, LTB discards almost a third of "interested" parcels due to county cap reasons.

[2] Solutions to these and other modeling issues should become more precise as more recent data (such as 2007 NRI data) become available.

Once the environmental factors (or the EEBI) and the cost factor have been assigned, a full EBI score is computed for each NRI point. The NRI points are then sorted by decreasing EBI score so that the "first accepted acres" are from sample points with the highest EBI scores. A high score could be due to a low SRR (a large cost component score) or from high environmental values (high EEBI score). Moreover, a point of land with high agricultural productivity (a high SRR) will have a high EBI score only if it has high environmental attributes (a high EEBI). This implies that "accepted" points with high SRRs will also have high EEBIs.

The *LTB* model can be used for scenario analysis by varying what EBI score to use as a cutoff level, and by changing variables that affect allocation of NRI points to the simulated CRP. These variations include estimates of SRR values, crop prices, crop yields, crop variable costs, and the EBI factor weights. *LTB* simulations can be compared statistically, say by examining average EBI scores of accepted acres, at a national or regional level. By combining simulations, one can also simulate land-use changes, such as the distribution of land (NRI points) moving into or out of the CRP.

The *LTB* model is run once per scenario. Additional robustness could be achieved by running the model several times per scenario and averaging the results, with each run distinguished solely by different draws of the random numbers used at several steps (i.e., to assign a practice to a NRI data point). However, given the intrinsic size of the NRI (800,000 points), a single run should capture the "law of large numbers" benefits that would be provided by multiple runs on a smaller dataset. Hence, the *LTB* is run only once per simulation. Note that to focus on changes of interest (say, increasing commodity prices), where random values are used (i.e., assigning wildlife factor points), the values used (for a given point) are the same across simulations.

Appendix 2: *Opt-Out* Model: Methodology

The CRP is in place. Evidence suggests that many enrollees have been happy with the program. For example, in 2007 when enrollees were offered the chance to extend their contracts (from 2 to 5 years), with some offered immediate re-enrollment (for 10 years), about 85 percent of all enrollees accepted. While these offers occurred prior to the run-up in crop prices, the rate of acceptance does suggest that the attitudes of current CRP contract holders might be different than those of non-contract holders.

Therefore, using general models to measure changes in the CRP (as prices change) may miss important details on probable participants, details that may be captured by working with actual CRP contracts.

However, CRP contract data lack crucial information. In particular, no variable indicates what contract holders would do with their land if it were not in the CRP.

To analyze the impacts of changes in commodity prices, in the *opt-out* model we compare future agricultural profits to current CRP rents. As agricultural profits increase, a greater share of land currently in the CRP may revert back to crops. So, computing agricultural profits for the non-CRP alternatives (for every contract) is necessary, requiring a guess as to which crop would be grown on the land in the absence of the program.

To formulate this guess, where possible, we use the REAP model to guide us. In particular, we posit some scenario (say, changed prices), modify the REAP model accordingly, and use the resulting REAP predictions to help assign CRP contracts to crop choices.

REAP is a partial-equilibrium model that determines U.S. regional crop and livestock production levels and national prices for 10 major crops and several livestock and agricultural product categories (Johansson et al., 2007). Import, export, and storage flows are included.

The following describes this "REAP-based" assignment of contracts to crops:

1. For a given scenario (say, the RFS-mandated increase in biofuels production), REAP is used to predict the distribution of crop shares (for all cropland acres).
    a. For each of several crop types, a predicted "cropland share" is computed. This is the share of cropland acres (in a REAP region) that are in this crop type.
    b. A separate schedule of cropland shares is computed for each of the 46 different REAP regions.
    c. The REAP scenario also provides estimates of the prices and variable costs for each crop type (on a national basis).
    d. The crop types are barley, corn, cotton, oats, sorghum, soybeans, wheat, and hay.

2. County-level yield information is derived from NASS statistics (averaged between 2000 and 2005).

3. Relative productivity (RP) information is derived for each contract. This measures how much more (or less) productive this contract is than its county average (for the year of the contract).

   RP is defined as: ContractSRR/AverageSRR_inCountyYear

   Example:

   Contract JXT13 in county 19037 has an SRR of 135

   The average SRR in county 19037 is 144

   Then: RP = 135/144 =0.87

   Thus, if the average soybean yield in 19037 is 50 bu/acre

   then contract JXT13's predicted soybean yield is 0.87 * 50 = 43.5.

4. To account for the possibility that acres in the CRP tend to be systematically different from observationally equivalent acres not in the CRP, State-specific adjustment factors are computed for each crop type (see box, "Computing an Adjustment Factor").

5. Compute an adjusted crop share, using the REAP share (from step 1) and the State-specific adjustment factor (from step 4) for each crop type. These are normalized to sum to 1.0. Note that all points in a REAP region will have the same adjusted crop share values.

6. Each NRI point is located within a REAP region and randomly assigned a crop, such that the assigned distribution of crops equals the predicted REAP-region crop shares.

7. Using price and variable cost information associated with the REAP scenario, yield information (from NASS statistics) for this crop (chosen in step 6) and a contract's RP (from step 3), compute net agricultural returns for this randomly assigned "crop."

8. Compare the net agricultural returns from step 7 to the contract's scenario-specific SRR. If the net agricultural returns are sufficiently high, this contract is assumed to want to "opt out" of the CRP (or not re-enroll) and will go into the randomly assigned crop (assigned in step 6). The determination of "sufficiently high" is based on a State-specific probability of enrollment schedule (see box "Computing a Probability of Enrollment Schedule").

Computing an Adjustment Factor

It is possible that acres actually in the CRP are systematically different from identical (in terms of land characteristics) acres that are not in the CRP. To account for this possibility, NRI data are used to compute differences in cropland shares between CRP and non-CRP lands. These differences are then used to compute adjustment factors.

For each State, an adjustment factor for each crop type is computed using the following algorithm:

1. Divide the 1997 NRI into CRP points and cropland points (discard points not in one of these categories).

2. For points that are in the CRP in 1997, look up the land use in 1982 (pre-CRP), and compute (State-specific) crop shares for each type t (t=corn, wheat, etc.):

   $inCRPShare_t$ = 1997 CRP acres in crop t in 1982 / total 1997 CRP acres

3. For the 1997 non-CRP acres, do the same (compute crop shares)

   $nonCRPShare_t$ = 1997 nonCRP acres in crop t in 1982 / total 1997 nonCRP acres

4. For each crop type (t), compute an adjustment factor:

   $crpAdjust_t = inCRPshare_t / nonCRPshare_t$

For example, if a State's CRP acres had a high share of corn in 1982 (if $inCRPshare_{corn} > nonCRPshare_{corn}$), then one might expect that CRP acres in this State are more likely to go into corn than the State's typical cropland acre.

The $crpAdjust_t$ adjustment reflects systematic differences between CRP and non-CRP lands. Values greater than 1.0 indicate crops that the CRP land was more likely to have been from (based on State-level trends), and hence more likely to return to.

The construction of this adjustment factor assumes that 1982 land uses are reflective of what might happen 25 years later. Since agronomic and economic factors have changed (i.e., average corn yield has increased from about 110 to 150 bu/acre), one may question the validity of this measure.

However, this measure considers the relative relationship between CRP and non-CRP land, in terms of overall agricultural productivity. If this has not changed significantly, this adjustment factor is likely to be valid. Such constancy, between CRP vs. non-CRP, is much more plausible.

Computing a Probability-of-Enrollment Schedule

How can one determine whether a contract will stay in the CRP should its agricultural profits, or soil rental rate, change? While a generic rule of thumb could be used, such as the "0.8" factor used in the LTB model, a more data-driven approach is available. This approach uses farm production region-specific probability-of-enrollment schedules that are calculated as follows:

Step 1. For each CRP contract, 2005 information is used to generate baseline information.

a) Cropland share information (averaged across farm production regions (FPR) using NASS data from 2000 to 2005) is used to assign each CRP contract to a crop. This is similar to the REAP method described in the *Opt-out* methodology, with actual crop shares used rather than REAP predictions.

b) 2005 commodity price and variable-cost information are then used to compute a baseline netAgReturnContract (net agricultural profit) for this contract.

Basically, this is a guess as to what the profitability of this contracted land would have been in 2005, if the contract had not been in the CRP.

Step 2. Compute probability-of-enrollment schedules. A separate schedule is computed for each FPR.

a) Using the predictions from an LTB model run with 2005 price information, retain all NRI points deemed eligible for the CRP. For these "eligible-for-CRP points," extract the point's Soil Rental Rate (SRRNRI) and net agricultural return (netAgReturnNRI). Note that both of these are computed by the LTB model.

b) Compute an SRR profitability ratio for each eligible NRI point:

SRRprofit= SRRNRI / netAgReturnNRI.

c) Recode SRRprofit to a class (from 1 to 50):

SRRprofitClass= int(SRRprofit/0.1).

Note that an SRRprofitClass of "1" means "SRR is much less than agricultural profit," while a value of 50 means "SRR is much higher than agricultural profit."

d) For all NRI points in each of the n=1..10 farm production regions, and for c=1..50 (c is a SrrProfitClass computed in step 2c), compute:

$probEnroll_n(c)$ = CRP acres in class c in FPR n / all cropland acres in class in FPR n

To compute the numerator, we use an NRI variable that indicates whether a point is enrolled in the CRP.

Each probEnrolln is smoothed (across c=1..50), and forced to be non-decreasing.[1]

This yields 10 FPR specific schedules that relate the relative profitability of the CRP (the SRRprofitClass) to a probability of being in the CRP (the probEnroll).

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[1]That is, probEnrolln is adjusted so that the predicted probability of enrolling never decreases as the SRRprofitClass increases. In some regions, this is not always the case. Thus, this adjustment represents a fairly strong assumption: that (*ceteris paribus*) increasing the relative profitability of CRP enrollment will never lead to a reduction in enrollment probability.

Step 3. For each contract, compute baseProbEnroll.

a) Using the contract's actual SRR, and the contract's 2005 netAgReturnContract (derived in step 1b), compute cc: the 2005 SRRprofitClass for this contract.

b) Using the appropriate (FPR-specific) schedule computed in step 2e, compute baseProbEnroll=probEnroll_n (cc).

This baseProbEnroll is used in the next step to help construct a *retain* probability for a contract, given new conditions (say, new prices).

Step 4. Given a new scenario, for every contract:

a) Predict a new SRR and a new netAgReturnContract (using the crop assigned to this contract in step 1a).

b) Using these, calculate a new SRRprofitClass.

c) Using this new SRRprofitClass and the appropriate (FPR-specific) probEnrolln schedule, look up a scenarioProbEnroll.

d) Create a normalized probability that a contract stays in the CRP:

ProbRetain= scenarioProbEnroll/ baseProbEnroll.

e) If probRetain>1, set it equal to 1.0; otherwise, use probRetain to randomly decide if this contract stays in the CRP.

Basically, probRetain is the probability that this contract will stay in the CRP under this new scenario.

The underlying notion is that contracts currently in the program may be unusual and not necessarily typical of all lands. For example,

- Contract XX, which is in FPR 1, has an srrProfitClass of 18.
- In FPR 1, probEnroll1 (18) = 20%.
- Since this landowner is enrolled, and since only 20% of "similar" landowners in FPR 1 are enrolled: then this landowner is more interested in enrolling than (at least) 80% of other similar landowners.
- Assume that under a new scenario the contract's srrProfitClass equals 15, and probEnroll1(15)= 15%; then probRetain=15/20 = 0.75.

This implies that 75 percent of the time this landowner will stay in the program. In other words, the 15 percent to 20 percent most "interested" landowners will now want to drop out of the program (which is a quarter of contracts that *ceteris paribus* were in profit class 18). Given our lack of further information on this contract, that means a quarter of the time the contract will want out (or, three-quarters of the time the contract will not want out).

Opt-Out Model: Modifications under the *HighPrice* Scenario

The REAP-based model provides a fairly rigorous means of predicting what crops CRP contracts would go into if the program were to end. Because REAP is an equilibrium model that employs average yields and other market factors, it is unable to predict the potential distribution of crops when prices fall well outside the range of baseline prices driven by factors that are not included in the model. In particular, we could not tweak the REAP model to generate the summer 2008 prices (that were used in the *HighPrice* scenarios). Thus, for the *HighPrice* scenario, the above methodology was modified.

The modification to the above (REAP-based) methodology occurs in the computation of crop shares for each contract (step 1 above). A "weighted" combination of observed county-specific crop shares, and crop profitability, is used to predict these crop shares.

(A) *Compute current land shares (LS).*

a. NASS data from 2000 to 2006 are used to predict State-specific crop acreage shares for each of the major crops. Specifically, land shares are computed by dividing the statewide acreage in each crop by total cropland (and averaging over the several years of data).

b. As described in step 4 above, a "CRP adjustment factor" is applied to these crop acreage shares.

c. The shares are normalized to sum to 1.0

(B) *Generate a normalized profitability metric (PT)*

a. As described in steps 2 and 3 above, county-specific yield information and contract-specific RP are used to compute contract-specific yields for each of several crops.

b. Price and cost information (for the scenario of interest) is combined with these yields to predict crop-specific profitability (for each contract).

c. The three crops with the highest predicted profit are retained, and a normalized ratio of "profit rate" is computed for each of these crops.

Example:

Assume that contract UK512 has the following net returns (per acre):

Corn: 50

Soybeans: 30

Sorghum: 10

Hay: 15

Wheat: 100

The top three are corn, soybeans, and wheat. The sum of profits is used as a normalizer: 50+20+100=180.

The "normalized profit ratio" would be:

Corn: 50/180 = 28%

Soybeans: 30/180 = 17%

Wheat: 100/180= 55%

This normalized profit ratio is an ad hoc metric, a proxy for the probability that a given crop would be the most profitable choice. An order statistic would generate rankings based on the variability of net returns for each crop on each point. Unfortunately, data of the requisite scope and detail to compute such theoretically superior models are not readily available.

(C) *Combine land shares and normalized profitability*

To allow both profitability and current land share to influence probabilities, a "weighted" combination is used:

$$prob_i = {LS_i * PT_i} \Big/ {\sum_m LS_m * PT_m}$$

Where:

$Prob_i$ = probability that contract goes into crop type i

LS_i = land share in crop type i, this county (from step A);

PT_i = "normalized profit" share in crop type i, this county (from step B);

m = the sum is over all eight crops.

This crop assignation probability is then used in the same way as the REAP assignation—a crop type is assigned to each contract by randomly drawing a number and comparing it to the crop assignation probabilities, profits are estimated under the new price scenario, and this profit is used to generate a probability of enrollment.

Appendix 3: The CRP's Soil Rental Rate

CRP rental rates are based on a Soil Rental Rate (SRR) that is assigned to every parcel offered to the program. The SRR is the maximum amount the landowner can request. In practice, most landowners request a payment equal to, or close to, the assigned SRR.

The SRR is constructed using two components:

1. The ***average rental rate for non-irrigated cropland for the county*** the offered land is located in. For most of the history of the CRP, the average rental rate was derived from the USDA's Land Value Survey. Starting in 2008, a special NASS survey is used to compute county average rental rates for use in the CRP. Since rental rates can fluctuate, a moving average (over several prior years) is used to compute the average cropland rental rate for use in SRR computations.

2. A ***soil-specific adjustment factor***. This is used to increase (or decrease) the county average rental rate by as much as 50 percent. These adjustments are based on measures of crop productivity that are specific to soil types, and are normalized by the average soil productivity across the county. Thus, acres on soils whose crop productivity is greater than the county average will have an SRR greater than the county average cropland rental rate.

Commodity prices do not have a direct impact on the SRR. Rather, changes in commodity prices (or other factors, such as input prices) will affect the profitability of farming. If land markets are competitive, a portion of these changes should be transmitted to rental markets for agricultural lands. The size and speed of this transmission depends on the transience of price changes and the market power of renters versus landowners (Parks et al., 2003).