Mitigating Climate Change with the Conservation Reserve Program (CRP): The Role of Carbon Credits and CRP Redesign

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ABSTRACT

With the emergence of carbon credit markets in the United States the presence of carbon credit payments to CRP land will affect farmers' willingness to enroll or re-enroll their land into the CRP. This paper examines how the Environmental Benefit Index (EBI) could be redesigned to enhance the CRP's impact on climate change mitigation through carbon sequestration and how the CRP may interact with the emerging carbon credit markets. We Investigate the impact of different CRP enrollment mechanism redesigns on the program enrollment outcomes such as carbon benefits, other environmental benefits, CRP acreage, and program cost-effectiveness. Specifically, we examine how increasing the weight assigned to carbon benefits in the EBI will re-shape the CRP enrollment outcomes. We also study how CRP rental payments and carbon credit payments incorporated in the EBI would affect CRP enrollment outcomes. We find that under various EBI redesign scenarios and various weights of carbon sequestration EBI factor N5d that there are substantial changes in terms land offer acceptance and CRP acreage change.

Keywords: Carbon sequestration benefits, Conservation Reserve Program, Redesign

JEL codes: Q15, Q24

1. Introduction

The discussion on the development of carbon credit markets in the United States has gained momentum in recent years. In February 2021, the United States re-entered the Paris Agreement, an international treaty on climate change intent on reducing greenhouse gas emissions and global warming, which 193 parties have adopted. Under the Paris Agreement, The United States has set ambitious goals for mitigating greenhouse gas (GHG) emissions. The potential contribution of agriculture to reaching the climate goals has attracted much attention (Bonnie et al., 2020; Elder, 2021). The Conservation Reserve Program (CRP) in the U.S. is one of the world's most extensive voluntary conservation programs. It is managed by the Farm Service Agency (FSA) under the United States Department of Agriculture (USDA); as of May 2021, 20.7 million acres of land are enrolled in the program. One of the underlying expectations of the CRP is to enhance the ability of U.S. agriculture to mitigate climate change (Farm Service Agency (FSA), 2021a,b). The CRP has been responding to this expectation in various ways. The FSA recently provided up to a 10 percent increase in rental payments for CRP parcels that adopt climate-smart practices (e.g., establishing permanent grasses) (FSA 2021a,c). However, many questions regarding the effectiveness of CRP in mitigating GHG emissions remain. Essential ones include: 1) what the magnitude of carbon benefits (GHG mitigation and carbon sequestration) of the CRP is? 2) when making CRP enrollment decisions, how will farmers respond to changes in payments from the program or the emerging carbon credit markets? Furthermore, 3) how can the CRP enrollment mechanism be improved to produce more considerable carbon benefits? This paper aims to answer these three questions by synergizing soil organic carbon measurement strengths, ecological system modeling, farmer survey, and economic analysis.

2. CRP and Carbon Credit Market

Established by the Food Security Act of 1985, the CRP retires environmentally sensitive land from active agricultural production and plant species to improve environmental health and quality, such as grass or trees, for 10 to 15 years. The CRP pays farmers annual rental payments for retiring land from agricultural production and implementing conservation practices. With an average annual rental payment rate of $83/acre, the program's outlay is currently about $1.7 billion per year (FSA, 2021d). Land enrolled in the CRP reduces GHG emissions caused by farming practices (Robertson et al., 2000; Gelfand et al., 2011) and sequesters carbon into soil (De et al., 2020). One way of balancing the CRP and emerging carbon credit markets to mitigate climate change is to quantify these carbon savings and soil organic carbon (SOC) sequestration caused by the CRP. The development of carbon credit markets that offer payments for carbon benefits allows farmers to earn additional revenues from their CRP land and for the CRP to reduce its program outlays (Bruner and Brokish 2021). For instance, if farmers can obtain and sell carbon credits from their CRP land by sequestering CO2 or reducing GHG emissions, CRP managers may have some freedom to reduce program rental payment rates while still keeping the enrollment acreage unchanged.

Since its establishment, the CRP has constantly evolved to meet the needs of changing market conditions and environmental concerns over time (Hellerstein, 2017; USDA, 2020). In 1990, multiple environmental factors were introduced, and the concept of the Environmental Benefits Index (EBI) was used to balance environmental gains with program costs. Each CRP offer is assigned an EBI value by the FSA during an enrollment period and offers with EBI values greater than a national EBI cut-off value will be enrolled in the CRP[1]. As the crux of the

[1] There are two significant types of enrollments in the CRP: General enrollment and continuous enrollment. The former allows farmers to enroll their land during specified signup periods to compete for acceptance. In contrast, the latter is non-competitive and allows farmers to enroll their environmentally sensitive land in CRP (Stubbs, 2014). In

CRP enrollment mechanism, the EBI has been changed a few times to adapt to technological and institutional constraints and environmental benefit targeting (Hamilton 2012, ch. 2; Hellerstein, 2017; Jacobs, 2010). Notably, starting in 2003 (signup #26), carbon sequestration benefits of CRP land were included in the EBI to reflect the increasing interest in agricultural carbon sequestration during that time. However, since its inclusion, carbon sequestration benefits have only accounted for up to 10 EBI points among the maximum total of 395 non-cost EBI points, about 2.5% (Jacobs, 2010; FSA, 2021a). As Cattaneo et al. (2006, pp. 4-5) pointed out, the design of the EBI allowed program managers to adjust the maximum EBI points (the weights) assigned to a specific environmental benefit to reflect changed relative values of environmental benefits to society. Given the urgency of climate change mitigation, it is reasonable to consider increasing the maximum EBI points assigned to carbon sequestration benefits in the current design of EBI.

Because of the complexity of the CRP, a change in the enrollment mechanism can produce different environmental and economic implications across geographical regions. For the general signups from 1991-to 1995, the EBI design used rental payments to calculate benefit-cost ratios for program enrollment (Osborn, 1993; Ribaudo et al., 2001; Jacobs et al., 2014). Commencing with the Federal Agriculture Improvement and Reform Act of 1996, the EBI underwent significant changes, and this benefit-cost ratio approach was discontinued. Instead, CRP rental payments were added to environmental components after a linear transformation, with larger rental payments implying lower EBI values. This additive approach remained to date and has been criticized for resulting in low cost-efficiency of the CRP (Miao et al., 2016).

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this paper, we focus on general enrollment because it covers the majority of CRP land. As of May 2021, the CRP consisted of 11.3 million acres of general enrollment and 6.3 million continuous enrollment (FSA, 2020).

Moreover, how the potential carbon credit payments might be incorporated into the EBI will affect CRP enrollment's environmental and geographical configurations. Therefore, a careful examination of the CRP enrollment mechanism (EBI) considering environmental benefits and cost factors is needed. This paper investigates the impact of different CRP enrollment mechanism redesigns on the program enrollment outcomes such as carbon, other environmental benefits, CRP acreage, and program cost-effectiveness. Specifically, we will examine how increasing the weight assigned to carbon benefits in the EBI will re-shape the CRP enrollment outcomes. We will also study how CRP rental and carbon credit payments incorporated into the EBI affect CRP enrollment outcomes. Overall, we wish to investigate how to utilize the CRP to better mitigate GHG emissions by quantifying the program's GHG mitigation potential under various enrollment mechanism designs and evaluating its cost-effectiveness in the presence of carbon credit payments.

3. CRP enrollment mechanism designs

Most CRP land is enrolled through a competitive bidding process during general signup periods, designated periods of a few weeks in a year when farmers are invited to submit applications to enroll their cropland. Since the CRP's inception in 1985, the efficiency of its land enrollment designs and associated environmental and economic impacts have attracted scrutiny. Reichelderfer and Boggess (1988) and Ribaudo (1989) argue that the CRP enrollment design used in the first nine signups maximized enrolled acres instead of environmental benefits. Babcock et al. (1996, 1997) compare three different enrollment designs under a budget constraint. They show that the magnitude of efficiency loss under suboptimal designs depends on the variability of, and the correlation between, environmental benefits of CRP offers, and rental payments requested in these offers. Wu, Zilberman, and Babcock (2001) study how the three alternative designs considered in Babcock et al. (1996, 1997) are preferred by different interest groups. However, none of these studies have considered the cost-effectiveness of the current EBI design. Although Hellerstein et al. (2015) and Cramton et al. (2021) focus on the cost-effectiveness of the current EBI design, they mainly investigate the effects of setting a maximum CRP payment rate on the cost-effectiveness of the CRP by applying auction theory and economic experiments. Two studies are most relevant to the CRP redesigns considered in the proposed project. The first is by Cattaneo et al. (2006), where the authors find that fine-tuning the EBI index weights will only slightly affect the CRP outcomes.

In contrast, significant changes (e.g., >20%) in the weights will significantly change the CRP outcomes. Although intuitive, their conclusions show that "if new information suggests that an alternative mix of environmental improvements is preferred, program outcomes can be affected by larger changes in weights" (Cattaneo et al. 2006, page v). However, the authors did not mainly focus on the EBI weight for carbon benefits. Therefore, it is unclear whether their findings apply to carbon benefits, which is the center of this study. Another limitation of Cattaneo et al.'s (2006) study is that their analysis is based on the current EBI design. Whether the findings will hold under alternate, more cost-effective EBI designs are unknown. This project will answer this question.

The second study is by Miao et al. (2016), in which the authors show that, although it tries to balance environmental benefits with rental costs, the current EBI design is not cost-effective and can be interpreted as an effort to maximize net benefit per acre, targeted where benefits measured in index points are assumed to be commensurate with land rental rates. They illustrate that a cost-effective enrollment criterion requires benefit-cost ratio targeting to maximize environmental benefit per dollar spent. Therefore, they identify a cost-effective EBI and examine how crop insurance premium subsidy savings can be included in the current and cost-effective EBI designs. They then simulate alternative EBI designs' environmental and budgetary consequences using contract-level CRP offer data in Signup #26 (occurred in 2003) and Signup #41 (occurred in 2011) across the contiguous United States. Their simulation results show that adopting a cost-effective EBI design and incorporating crop insurance subsidies into the EBI would significantly increase CRP acreage, total environmental benefits, and savings on crop insurance subsidies while leaving government outlay unchanged. Different from Miao et al. (2016), that examines the interaction between the CRP and the federal crop insurance program, this paper focuses on the possible interaction between the CRP and the carbon credit markets and examines how changes in EBI weights for carbon sequestration affect the CRP enrollment outcomes under various EBI designs.

When the CRP was first established in 1985, its two primary goals were to reduce soil erosion and curb agricultural commodity surplus (USDA, 2020). As a result, the program focused on quickly enrolling acres for the first nine signups between 1986 and 1989. Its enrollment consistently maximized total acreage for a budget outlay (Reichelderfer & Boggess, 1988; Ribaudo, 1989). Expressly, any eligible CRP offer would be accepted if the requested rental payment was lower than the rent ceiling, determined after bids were submitted. After the Food, Agriculture, Conservation, and Trade Act of 1990, an Environmental Benefits (EBI) design based on a benefit-cost ratio was created to improve CRP enrollment efficiency. It did so by maximizing environmental benefits per dollar of cost, although the specific design of the EBI was not publicly disclosed (Osborn, 1993; Jacobs et al., 2014).After the Federal Agriculture Improvement and Reform Act of 1996, the EBI underwent significant changes culminating in the current EBI design, where environmental benefits of a CRP offer are aggregated linearly, and farmers' CRP rental payments are added environmental components after a linear transformation. The environmental benefits included in the current EBI are wildlife benefits, water quality benefits, erosion reduction, enduring benefits, and air quality benefits, where the former three types of benefits are assigned the same weights (maximum 100 points each), and the latter two are assigned a smaller weight (maximum 50 and 45 points, respectively). Carbon sequestration benefits are included in the air quality benefits and only account for up to 10 points[2]. Let EEBI denote the EBI points for environmental benefits of an offer and r denote the rent per acre requested in this offer. The EBI points of this offer under the current CRP specification can be written as:

$$EBI = EEBI + f(r) + c \tag{1}$$

where $f(r) = a \times (1 - r/b)$ is a linear function which transforms rental rate, r; parameters a and b are determined by the program administrator based on actual offer data in a signup period, indicating that they are unknown to farmers when CRP enrollment offers are made; and finally, c is the extra bonus points that are a relatively small numbers reflecting how much the requested rental rate is below the maximum payments that FSA is willing to offer. For each CRP offer, by using equation (1), the FSA assigns an EBI value to the offer based on the offer’s environmental benefit factor and rental payment requested by the farmer. Then all offers are ranked according to their EBI values and offers with EBI values no less than the cut-off EBI value will be enrolled into the CRP. Intuitively, suppose the weight assigned to carbon sequestration benefits is increased in the EBI design. In that case, CRP offers with larger carbon sequestration capacity will be more likely to be enrolled in the CRP.

[2] (see FSA (2021c) for details about the EBI factors and their points used in the most recent signup period).

4. Empirical Approach

We aim to investigate to what extent an increase in the weight will enhance the capacity of the CRP to sequester carbon and the economic and environmental implications of such an increase under various EBI designs.

To investigate how to utilize the CRP to better mitigate GHG emissions we first define the EBI design in equation (1) as the benchmark EBI (denoted as EBI_0 . That is, we have:

$$EBI_0 = EEBI + f(r) + c.$$

where $EEBI^{'}$ denotes the new EEBI after the weight of carbon benefits is modified and p denote carbon credit payment rate ($/acre/year). Then, deviating from the benchmark EBI design, we consider the following four alternative of EBI designs:

$$EBI_1 = EEBI^{'} + f(r) + c, \tag{2}$$

$$EBI_2 = EEBI^{'} + f(r-p) + c, \tag{3}$$

$$EBI_3 = (EEBI^{'} + c)/r, \tag{4}$$

$$EBI_4 = (EEBI^{'} + c)/(r-p), \tag{5}$$

Note that EBI_1 in equation (2) is the same as the benchmark EBI_0 except that the weight for carbon benefits is increased to a new level. Both EBI_0 and EBI_1 ignore the potential carbon credit payments in the EBI design (i.e., carbon credit payment rate, *p*, is missing in equations (1) and (2)). Different from EBI_1, EBI_2 in equation (3) considers the carbon credit payments that a CRP land tract may receive and deducts them from CRP rental payments. In other words, under EBI_2, CRP rental payment rate is max [0,r-p]. Unlike EBI_1 and EBI_2 that combine the CRP rent with environmental benefits after a linear transformation of the rent, EBI_3 and EBI_4 are simply obtaining benefit-to-cost ratios. The difference between EBI_3 and EBI_4 is that under EBI_3 the carbon credit payments are ignored whereas under EBI_4 the CRP rental payment rate is adjusted based on the amount of carbon credit payments. Miao et al. (2016) shows that EBI_1 and EBI_2 are consistent with maximizing environmental benefits with a linear adjustment of program costs subject to an acreage constraint, whereas EBI_3 and EBI_4 are consistent with maximizing environmental benefits subject to a budget constraint. The numerical simulation under will be based on equations (1) to (5) and CRP contract-level data in a specific general signup (e.g., signup #54 occurred in 2020, under which farmers made 56,788 offers). The dataset includes each CRP offer's detailed EBI points under each environmental benefit factor and EBI points associated with costs, as well as the rental rate requested by farmers. It also indicates whether or not the FSA accepted an offer. Here we use EBI_1 in equation (2) as an example to describe the procedure of obtaining enrollment outcomes under a new EBI design. First, based on the contract-level data, we calculate EEBI' for each offer under the new weight assigned to the carbon benefit factor. Then we insert EEBI' into equation (2) and obtain EBI_1 under this specific new weight for carbon benefits for each CRP offer. We then rank all offers in this signup according to their values of EBI_1. Offers with larger values will be enrolled into the CRP until the total enrolled acreage equals the enrolled acreage under that signup. We then calculate the environmental benefits and total program payments associated with the accepted offers under EBI_1 and compare them with enrollment outcomes under EBI_0 to quantify the impact of changes in EBI. Similar procedures can be used to study the impact of adopting EBI_2, EBI_3, or EBI_4 on CRP enrollment outcomes. The carbon credit payment rate, p, will be calculated based on different carbon prices ranging from \$10/Mg to \$100/Mg with \$10 increment and on carbon benefits for each CRP offer based on the simulation results. We will also consider ten different weights for carbon benefits, starting from 10 (the status quo) with a 10-point increment up to 100.

5. CRP Enrollment Data

We will obtain county-level CRP enrollment data for signups 54 and 56 through our collaborators at USDA/ERS. The CRP enrollment data includes detailed information such as enrolled acreage, rental payments, acceptance status, and EBI point for each environmental factor. We provide descriptive statistics for both signup 54 and 56 in Tables 1 and Table 2 respectively. For the signup 54 dataset we have a total of 56,788 observations. The average acreage enrolled under this signup 67.6 acres per county and the average rental payment requested by landowners was $94.81. The county average EBI score under Signup 54 was 273 EBI points. In signup 56 we have 22,603 county level observations. Under signup 56 average county acreage enrolled was around 89.15 acres per county and average rental payment amount requested by landowners was $94.46. For this signup county EBI points averaged to 235 EBI points.

6. Simulation Results Signup 54

We present our simulation results for each of our scenarios in Table 3 and Table 4. Table 3 depicts the simulation results for twelve scenarios under signup 54. The first column of Table 3 represents our baseline scenario which reflects the current EBI design outlined in equation (1). Scenarios (2)-(5) reflect the EBI design changes outlined in equations (2)-(5) respectively. In our first four scenarios we doubled the weight of carbon sequestration benefits from a maximum of 10 points to a maximum of 20 points, The carbon sequestration EBI factor in our baseline and first four scenarios are reflected by n5d and n5d2 respectively. We set the value of *p*, which reflects the carbon credit payment to landowners in scenarios (3) and (4) to be $15 per acre. We use a value of $15 carbon credit payment to landowners in each additional simulation as well, currently we do not consider any other carbon credit payment level to landowners. Under the baseline scenario we see that a total of 52,992 offers are accepted in signup 54 under the current EBI design. These accepted offers under the baseline scenario account for 3,418,589 enrolled CRP acres and total payment outlay to landowners for these acres is around $5,153,244. For our baseline scenario our weighted average EBI points for the carbon sequestration factor is 3.70 points. In Table 3 for scenario 1 we do not see any big changes in terms of offers accepted, acreage accepted, or payment to landowners. We also observe similar weighted average EBI factors for the baseline and scenario 1. This is expected as the only difference between the baseline scenario and scenario 1 is the change in the weight of the carbon sequestration EBI factor. Under scenario 1 when we double the weight of carbon sequestration benefits, we see that the carbon sequestration benefits are simply double that of our baseline scenario estimate. The greatest change we observe is under scenario 3. In scenario 3 we are obtaining benefit to cost ratios using equation (4) and under this scenario we ignore the carbon credit payment to landowners. Under scenario 3 accepted offers decreased significantly from the baseline scenario (a reduction of 51,097 offers) and we see significant decrease in terms of the change in acreage (a reduction of 3,135,560 acres) and payment amount (reduced to $33,977). The change in carbon benefits under scenario 3 is less than double of the baseline scenario at 6.49 weighted average EBI points.

In the next set of simulations scenarios (5) – (8) we re-estimate our CRP redesigns (equations (2)-(4)) once more this inflating the maximum points of carbon sequestration even higher to a maximum of 50 points. Similarly, to the first set of simulations after inflating carbon sequestration points even higher we still observe the greatest changes under equation (4) represented Scenario 7 in the second part of Table 3. Under scenario 7 we see a similar size reduction in accepted offers from the baseline scenario (a reduction of 51,071 offers) and in terms of the changes in acreage we see a reduction of 3,134,525 acres with a payment reduction to $34,322. Under scenario 7 we see a increase in the weighted average EEBI points from the baseline scenario from 179.40 to 192.51 EEBI points respectively. Our value for the weighted average carbon sequestration points in scenario 7 is represented by N5d5 and has increased to 16.41 EBI points up from the 3.70 EBI points in the baseline scenario.

In the last set of simulations in the third section of Table 3 we increase the weight of carbon sequestration points even higher to a maximum of 100 points. These simulations are reflected in Scenarios (9)-(12) in Table 3. In our third set of simulations, we see the most significant changes from the baseline scenario in scenarios (9) and (11). Scenario (9) is similar to the baseline scenario except with the weight of carbon sequestration benefits increased to reflect and maximum of 100 points. The weighted average EEBI points in scenario (9) increased significantly from the baseline scenario to299.51 from 179.40. We see a significant impact on the number of offers accepted under this scenario a reduction of 51,615 offers accounting for an acreage reduction of 3,366,800 acres and a decrease in payment outlays of $170,916. Here we also see carbon sequestration weighted average EBI points increase to 54.03 up from 3.70 in our baseline scenario. As in our previous scenarios looking at equation (4) we see similar size reductions in Scenario 11 which is based on equation (4).

7. Simulation Results Signup 56

Table 4 depicts the simulation results for twelve scenarios under signup 56. Here we run all of the same simulation as we did in signup 54 but now, we switch our dataset to reflect signup 56.

Under the baseline scenario for signup 56 we see that a total of 20,459 offers accepted under the current EBI design. These accepted offers under the baseline scenario for signup 56 account for 1,877,412 enrolled CRP acres and total payment outlay to landowners is 1,896,389. For our baseline scenario our weighted average EBI points for the carbon sequestration factor is 3.49 points. For scenario 1 we once again do not see any significant changes in terms of offers or acreage accepted, or payment to landowners, and we observe similar weighted average EBI factors for the baseline scenario and scenario 1. We observe substantial changes when we observe scenarios (2)-(4). In each of these scenarios we observe a large reduction in the number of offer changes and accepted acreage and payment amount. Similarly, when we increase the weight of carbon benefits to a maximum of 50 points in our second set of simulations in the second section of Table 4, we observe a similar impact in scenarios (6)-(8). Here we see a sizable drop off in terms of the number of offers accepted, however, under scenario (50 and (6) we observe a positive change in the number of acres accepted. In the last set of simulations scenarios (9) –(12) we observe sizable drop off in offers changed in each scenario with large decreases in the number of accepted acres under scenarios (9), (11), and (12). When compared with our simulation results from signup 54 it appears that the results from signup 56 have significant changes in terms of offers and acreage accepted under our simulations. Changes in offers and acreage and EBI factors from our simulation results may be easier to understand through maps which we will create to help visualize the impacts of our simulation results clearer.

8. Conclusion

So far in our analysis we have been able to capture changes in CRP enrollment by simulating various EBI redesigns utilizing contract-level CRP data. Currently the results of the paper are preliminary and much more analysis will need to be conducted to fully realize the research objective of the paper. Some limitations we must consider are the differences in carbon sequestration practices across regions. Carbon sequestration practices on CRP lands will vary from state to state and field level data on carbon sequestration levels on CRP lands will help provide a better picture of the regional characteristics of CRP lands and the potential impact EBI redesigns may impact different regions. Another thing to consider is the amount of carbon sequestration benefits that can be attributed to factors outside of just carbon sequestration benefits. Practices from other EBI factors such as water quality benefits or wildlife habitat benefits may include some practices that also attribute to carbon sequestration benefits. So perhaps some further discussion is required on what other factors besides carbon sequestration EBI factor also have some impact on carbon sequestration on CRP lands. There is still much analysis and discussion to consider at the current stage of the project that hope to address in future versions of the paper.

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Table 1. Signup 54 Descriptive Statistics

Variable	Description	Average
n1	Wildlife habitat benefits (10 to 100 Points)	60.80
n2	Water quality benefits (0 to 100 Points)	55.02
n3	Erosion Factor (0 to 100 Points)	52.74
n4	Enduring Benefits (0 to 50 Points)	8.26
n5	Air Quality Benefits (3 to 45 Points)	16.41
n6	Cost	80.66
n1a	Wildlife Habitat Cover Benefits (10 to 50 points)	41.63
n1b	Wildlife Enhancement (0, 5 or 20 points)	6.69
n1c	Wildlife Priority Zones (0 or 30 points)	12.48
n2a	Location (0 or 30 points)	15.32
n2b	Groundwater quality (0 to 25 points)	8.84
n2c	Surface water quality (0 to 45 points)	30.86
n5a	Wind Erosion Impacts (0 to 25 points)	11.80
n5b	Wind Erosion Soils List (0 or 5 points)	0.16
n5c	Air Quality Zones (0 or 5 points)	0.31
n5d	Carbon Sequestration (3 to 10 points)	4.14
n5d2	Carbon Sequestration (6 to 20 points)	8.27
n5d5	Carbon Sequestration (15 to 50 points)	20.69
n5d10	Carbon Sequestration (30 to 100 points)	41.37
n6a	Cost (point value determined after end of enrollment)	75.62
n6b	Offer Less Than Maximum Payment Rate (0 to 25 points)	5.04
crpacre	number of acres enrolled	67.61
SRR	maximum county soil rental rate	98.29
offer	rental payment requested by landowner	94.81
ebitot	Total EBI points	273.89
total obs.	Total county enrollments under CRP Signup 54	56788

Table 2. Signup 56 Descriptive Statistics

Variable	Description	Average
n1	Wildlife habitat benefits (10 to 100 Points)	46.14
n2	Water quality benefits (0 to 100 Points)	45.13
n3	Erosion Factor (0 to 100 Points)	45.63
n4	Enduring Benefits (0 to 50 Points)	5.94
n5	Air Quality Benefits (3 to 45 Points)	12.74
n6	Cost	79.57
n1a	Wildlife Habitat Cover Benefits (10 to 50 points)	36.62
n1b	Wildlife Enhancement (0, 5 or 20 points)	1.73
n1c	Wildlife Priority Zones (0 or 30 points)	7.79
n2a	Location (0 or 30 points)	10.79
n2b	Groundwater quality (0 to 25 points)	8.24
n2c	Surface water quality (0 to 45 points)	26.10
n5a	Wind Erosion Impacts (0 to 25 points)	8.03
n5b	Wind Erosion Soils List (0 or 5 points)	0.19
n5c	Air Quality Zones (0 or 5 points)	0.51
n5d	Carbon Sequestration (3 to 10 points)	4.01
n5d2	Carbon Sequestration (6 to 20 points)	8.02
n5d5	Carbon Sequestration (15 to 50 points)	20.06
n5d10	Carbon Sequestration (30 to 100 points)	40.12
n6a	Cost (point value determined after end of enrollment)	75.80
n6b	Offer Less Than Maximum Payment Rate (0 to 25 points)	3.77
crpacre	number of acres enrolled	89.15
SRR	maximum county soil rental rate	97.29
offer	rental payment requested by landowner	94.46
ebitot	Total EBI points	235.14
total obs.	Total county enrollments under CRP Signup 56	22603

Table 3. Signup 54 Simulation Results

Variables	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
offers accepted	52992	53046	55598	1895	55598
offers changed		54	2606	-51097	2606
acres accepted	3418589.6	321.3100241	236201.21	-3135559.77	236201.21
acres changed		3418910.91	3654790.81	283029.8301	3654790.81
payment	5153244.09	5157140.05	5359808.77	33977.10003	5359808.77
EEBI weighted	179.40	179.40	171.12	193.24	171.12
N1 weighted	56.49	56.47	53.37	61.85	53.37
N2 weighted	44.66	44.68	42.84	40.60	42.84
N3 weighted	54.35	54.34	51.57	67.93	51.57
N4 weighted	4.70	4.71	4.42	1.39	4.42
N5 weighted	19.20	19.19	18.93	21.47	18.93
N1a weighted	41.02	41.01	39.28	42.43	39.28
N1b weighted	4.49	4.49	4.17	2.00	4.17
N1c weighted	10.97	10.97	9.91	17.42	9.91
N2a weighted	14.81	14.81	13.85	19.67	13.85
N2b weighted	7.32	7.32	7.14	7.08	7.14
N2c weighted	22.53	22.54	21.85	13.85	21.85
N5a weighted	14.22	14.21	14.06	17.02	14.06
N5b weighted	0.47	0.47	0.46	0.03	0.46
N5c weighted	0.81	0.81	0.75	1.18	0.75
N5d weighted	**3.70**				
N5d2 weighted		**7.40**	**7.33**	**6.49**	**7.33**

Variables	Scenario 5	Scenario 6	Scenario 7	Scenario 8
offers accepted	53154	55583	1921	55583
offers changed	162	2591	-51071	2591
acres accepted	2482.959962	232970.98	-3134525.18	232970.98
acres changed	3421072.56	3651560.58	284064.4201	3651560.58
payment	5165100.59	5359405.9	34322.57002	5359405.9
EEBI weighted	179.35	171.16	192.51	171.16
N1 weighted	56.44	53.37	61.47	53.37
N2 weighted	44.70	42.84	40.46	42.84
N3 weighted	54.30	51.60	67.66	51.60
N4 weighted	4.74	4.42	1.52	4.42
N5 weighted	19.18	18.92	21.40	18.92
N1a weighted	40.98	39.28	42.27	39.28
N1b weighted	4.49	4.18	1.97	4.18
N1c weighted	10.96	9.92	17.24	9.92
N2a weighted	14.81	13.84	19.51	13.84
N2b weighted	7.33	7.14	7.11	7.14
N2c weighted	22.56	21.86	13.84	21.86
N5a weighted	14.19	14.05	16.93	14.05
N5b weighted	0.47	0.46	0.03	0.46
N5c weighted	0.81	0.74	1.17	0.74
N5d5 weighted	**18.55**	**18.34**	**16.41**	**18.34**

Variables	Scenario 9	Scenario 10	Scenario 11	Scenario 12
offers accepted	1377	55562	1954	55562
offers changed	-51615	2570	-51038	2570
acres accepted	-3366800.67	230190.71	-3133109.65	230190.71
acres changed	51788.92997	3648780.31	285479.9502	3648780.31
payment	170916.09	5358873.21	34715.38002	5358873.21
EEBI weighted	299.51	171.19	190.80	171.2
N1 weighted	90.29	53.37	60.72	53.4
N2 weighted	81.21	42.85	40.22	42.9
N3 weighted	92.91	51.63	66.93	51.6
N4 weighted	15.88	4.42	1.68	4.4
N5 weighted	19.23	18.92	21.25	18.9
N1a weighted	49.55	39.27	41.99	39.3
N1b weighted	10.83	4.18	1.91	4.2
N1c weighted	29.91	9.92	16.81	9.9
N2a weighted	29.73	13.83	19.22	13.8
N2b weighted	11.49	7.15	7.15	7.1
N2c weighted	39.99	21.87	13.84	21.9
N5a weighted	11.27	14.05	16.77	14.1
N5b weighted	1.59	0.46	0.03	0.5
N5c weighted	0.97	0.74	1.12	0.7
N5d10 weighted	**54.03**	**36.68**	**33.32**	**36.7**

Table 4. Signup 56 Simulation Results

Variables	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
offers accepted	20459	20499	375	507	375
offers changed		40	-20084	-19952	-20084
acres accepted	1877412.43	150.37	-1809936.3	-1792629.67	-1809936.3
acres changed		1877562.8	67476.13	84782.76	67476.13
payment	1896389.17	1900782.25	9787.72	10654.96	9787.72
EEBI weighted	154.20	154.22	104.42	185.95	104.42
N1 weighted	47.07	47.05	36.68	61.15	36.68
N2 weighted	37.61	37.63	24.07	38.41	24.07
N3 weighted	51.49	51.48	27.85	67.79	27.85
N4 weighted	2.64	2.66	0.42	0.29	0.42
N5 weighted	15.40	15.40	15.41	18.31	15.41
N1a weighted	37.39	37.37	34.09	45.02	34.09
N1b weighted	0.94	0.94	0.37	0.15	0.37
N1c weighted	8.74	8.74	2.21	15.98	2.21
N2a weighted	12.81	12.80	7.24	18.32	7.24
N2b weighted	7.13	7.14	5.89	8.14	5.89
N2c weighted	17.67	17.69	10.95	11.95	10.95
N5a weighted	10.39	10.39	11.07	14.11	11.07
N5b weighted	0.45	0.45	0.15	0.01	0.15
N5c weighted	1.07	1.07	0.98	1.03	0.98
N5d weighted	**3.49**				
N5d2 weighted		**6.99**	**6.41**	**6.32**	**6.41**

Variables	Scenario 5	Scenario 6	Scenario 7	Scenario 8
offers accepted	20575	16493	511	375
offers changed	116	-3966	-19948	-20084
acres accepted	86.62	146.14	-1792051.54	-1809936.3
acres changed	1877499.05	1877558.57	85360.89	67476.13
payment	1910831.41	953835.46	10697.29	9787.72
EEBI weighted	154.21	146.07	185.49	104.42
N1 weighted	47.05	44.43	60.53	36.68
N2 weighted	37.64	34.87	38.17	24.07
N3 weighted	51.44	48.99	68.13	27.85
N4 weighted	2.69	2.22	0.41	0.42
N5 weighted	15.40	15.56	18.25	15.41
N1a weighted	37.38	35.67	44.79	34.09
N1b weighted	0.94	0.63	0.15	0.37
N1c weighted	8.74	8.13	15.59	2.21
N2a weighted	12.80	12.14	17.98	7.24
N2b weighted	7.15	6.78	8.14	5.89
N2c weighted	17.70	15.95	12.05	10.95
N5a weighted	10.38	10.57	14.02	11.07
N5b weighted	0.45	0.47	0.01	0.15
N5c weighted	1.07	1.07	1.02	0.98
N5d5 weighted	**17.53**	**17.28**	**15.99**	**16.01**

Variables	Scenario 9	Scenario 10	Scenario 11	Scenario 12
offers accepted	207	16495	527	375
offers changed	-20252	-3964	-19932	-20084
acres accepted	-1859180.75	160.2	-1791376.4	-1809936.3
acres changed	18231.68	1877572.63	86036.03	67476.13
payment	22276.95	954106.6	10966.43	9787.72
EEBI weighted	279.76	146.07	184.08	104.4
N1 weighted	77.58	44.43	59.57	36.7
N2 weighted	83.66	34.87	37.72	24.1
N3 weighted	91.24	48.99	68.15	27.8
N4 weighted	4.38	2.22	0.58	0.4
N5 weighted	22.91	15.56	18.07	15.4
N1a weighted	46.91	35.67	44.45	34.1
N1b weighted	1.14	0.63	0.16	0.4
N1c weighted	29.53	8.13	14.95	2.2
N2a weighted	29.91	12.14	17.58	7.2
N2b weighted	12.37	6.78	8.08	5.9
N2c weighted	41.37	15.95	12.06	10.9
N5a weighted	12.43	10.57	13.80	11.1
N5b weighted	3.65	0.47	0.01	0.2
N5c weighted	3.06	1.07	1.01	1.0
N5d10 weighted	**37.66**	**34.55**	**32.53**	**32.0**