Incorporating Crop Insurance Subsidies into Conservation Reserve Program (CRP) Design

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A quick overview of CRP

CRP is the largest conservation program in U.S. agriculture

- about 27 million acres enrolled as of 2013 at an annual budget of $2 billion;
- was initiated in 1985;
- has been studied extensively;
- generally considered a successful program in providing multiple environmental benefits .

Current challenges of CRP

Strong demand for food and biofuel puts pressure to draw more land into production.

- Total enrollment cap reduced from 39.2 to 32 million acres in the 2008 farm bill; might be further reduced to 25 in the next bill.
- Current enrollment is 10 million acres less than peak.

High crop prices also mean that farmers will be less willing to enroll land in CRP.

Increasing CRP rental rates gives landowners more incentives but adds strain on federal budget.

Crop insurance today

Crop insurance is set to become the pillar of farm support.

- more than 250 million acres covered with more than $75 billion liability in recent years.
- predicted to cost about $8.9 billion per year over 2013-2022.
- Pays about 60 of premiums in subsidies.

It was not as important in the 80s, or 90s, or even at the beginning of the century.

Insurance premium, CRP rent, and cash rent

	North Dakota					Iowa			
Year	Premium	Premium Subsidy	CRP Rent	Cash Rent		Premium	Premium Subsidy	CRP Rent	Cash Rent
2002	18.7	11.0	33.1	36.5		14.9	8.0	100.8	120
2003	22.8	13.3	33.1	36.5		16.2	8.7	101.9	122
2004	28.7	16.7	33.0	37.5		20.8	11.3	103.4	126
2005	30.8	17.9	33.1	39.0		17.2	9.4	104.3	131
2006	55.6	32.3	33.1	39.0		20.8	11.2	105.3	133
2007	55.6	32.3	33.2	41.0		36.7	19.7	106.2	150
2008	78.5	45.9	33.7	42.5		49.0	26.4	110.9	170
2009	66.6	43.6	34.0	45.5		42.3	24.3	115.8	175
2010	56.4	37.5	34.9	46.5		33.4	19.5	120.1	176
2011	82.6	55.3	36.2	51.5		56.6	32.4	128.1	196
2012	76.5	52.8	37.6	58.0		48.7	28.2	131.6	235

CRP and crop insurance interaction

We focus on one direct interaction:

- When land is enrolled in CRP, the crop insurance subsidies that the land was receiving when in production are avoided.

Avoided subsidies have direct budgetary impacts→reducing federal budget outlays.

Avoided subsidies change the relative competitiveness of fields→which CRP offers should be accepted into CRP can differ.

How can crop insurance subsidies be incorporated?

We first look at how CRP selects parcels to enroll in the program.

We focus on general sign-ups that use a competitive mechanism based on Environmental Benefit Index.

How current EBI works?

EBI rewards environmental benefits the land offers: wildlife habitat, water and air quality, reduced erosion, carbon sequestration

Enrollment costs are also considered in EBI: *Ceteris paribus*,

higher costs ➔ lower EBI ➔ less likely to be accepted

Omitted in the costs is premium subsidies for crop insurance that is saved when the cropland is enrolled in CRP.

How the omission might matter?

High concentration of CRP acres in S. Corn Belt, East Dakotas, Montana, S. Great Plains.

These are largely marginal cropland regions where CRP enrollment costs are low and benefits may be relatively high.

Environmentally sensitive lands are often more risky which means higher premiums.

What we do

Identify how crop insurance savings can be included in a modified EBI

Examine the objectives implied by the current EBI targeting and contrast it with cost-effective targeting.

- Consider impacts of incorporating subsidies when different targeting criteria are used.

Estimate environmental and budgetary impacts of incorporating subsidies.

The formulation of current EBI

$$\mathrm{EBI} = \mathrm{EEBI} + f(r_k) + \text{extra bonus points},$$

$$\textit{where}, \quad f(r_k) = a\left(1 - \frac{r_k}{b}\right)$$

sign-up number	15	16	18	20	26	29	33	39	41
(sign-up year)	(1997)	(1997)	(1998)	(1999)	(2003)	(2004)	(2006)	(2010)	(2011)
Cost component Parameter values	a=190 b=165	a=125 b=165	a=125 b=165	a=125 b=165	a=125 b=185	a=125 b=185	a=125 b=204	a=125 b=220	a=125 b=220
Maximum of cost components	200	150	150	150	150	150	150	150	150
Maximum of EEBI	400	410	410	410	395	395	395	395	395
Maximum of EBI	600	560	560	560	545	545	545	545	545
EBI cut-off for acceptance	259	247	245	246	269	248	242	200	221

The implied objective

The current EBI is consistent with the following optimization problem.

Maximize environmental benefits with a linear adjustment of costs, subject to an acreage constraint.

$$\max_{\boldsymbol{h} \subseteq \mathcal{P}(\Omega)} \sum_{k \in \boldsymbol{h}} a_k \times \left[e_k + f(r_k) \right],$$

$$\text{s.t.} \quad \sum_{k \in \boldsymbol{h}} a_k \leq \bar{A},$$

Key characteristics of current EBI formula

It assumes that benefits and a transformation of rental rate are measured on comparable units such that summing the two terms is a meaningful operation.

It is a form of benefit targeting which we refer to as “pseudo net benefits per acre targeting” or simply “pseudo benefit targeting”

Cost effective targeting

Cost-effective targeting maximizes environmental benefits for a given budget, i.e.,

$$\max_{\mathcal{h} \subseteq \mathcal{P}(\Omega)} \sum_{k \in \mathcal{h}} a_k e_k,$$

$$\text{s.t.} \quad \sum_{k \in \mathcal{h}} a_k r_k \leq \bar{M}.$$

The implied selection criterion is:

$$\begin{cases} \text{enroll if} & e_k / r_k \geq \lambda_2; \\ \text{not enroll if} & e_k / r_k < \lambda_2. \end{cases}$$

Incorporating crop insurance subsidies

Pseudo net benefit per acre targeting

$$\max_{\boldsymbol{h}\subseteq\mathcal{P}(\Omega)} \sum_{k\in\boldsymbol{h}} a_k \times \left[e_k + f\left(r_k - \mathrm{s}_k\right)\right],$$

$$\text{s.t.} \quad \sum_{k\in\boldsymbol{h}} a_k \leq \bar{A},$$

Cost effective targeting

$$\max_{\boldsymbol{h}\subseteq\mathcal{P}(\Omega)} \sum_{k\in\boldsymbol{h}} a_k e_k,$$

$$\text{s.t.} \quad \sum_{k\in\boldsymbol{h}} a_k \left(r_k - s_k\right) \leq \bar{M}.$$

Four scenarios

We have 4 scenarios: two types of targeting each of which is considered with or without the incorporation of crop insurance subsidies.

Baseline (p*seudo net benefits targeting*) : $\mathrm{EBI}_0 = \mathrm{EEBI} + \mathrm{a} \times (1 - r_k / \mathrm{b})$,

Scenario 1 (*adjusted pseudo net benefits targeting*) : $\mathrm{EBI}_1 = \mathrm{EEBI} + \mathrm{a} \times [1 - (r_k - s_k) / \mathrm{b}]$,

Scenario 2 (*cost effecgtive targeting*): $\mathrm{EBI}_2 = (\mathrm{EEBI}) / r_k$,

Scenario 3 (*adjusted cost effective targeting*) : $\mathrm{EBI}_3 = (\mathrm{EEBI}) / (r_k - s_k)$,

The direct effects of considering s_k in the problems

For both pseudo benefit targeting and cost effective targeting, acres with higher crop insurance subsidies will become more competitive in CRP enrollment process.

It now matters how we calculate the budget of enrolled CRP acres

- "total CRP rental payments" vs "net budget" (the latter is the former subtracted by total crop insurance subsidies saved.)

Data

CRP contract level data

- Sign-up 26 held in 2003 and sign-up 41 held in 2011
- Variables include EEBI, weighted average soil rental rate, and rental rate requested

RMA unit level data

- For year 2003 and 2011, variables include rate yield, premium, and premium subsides

Cannot link these two datasets directly and so a quintile matching procedure is used.

Summarize statistics

We next present two tables of summary statistics for CRP and RMA, respectively.

	Offered					accepted			
States	NO. of Offers	Total Acres	Ave. Rent	Ave. EEBI		Accepted offers (%)	Total Acres	Ave. Rent	Ave. EEBI
Sign-up 26									
IL	7.74	208.8	86	206		64%	132.7	83	229
IN	2.76	74.5	83	193		54%	38.2	79	219
IA	7.13	242.8	106	212		52%	127.4	101	241
KS	6.63	466.9	42	183		63%	293.6	41	202
MI	3.01	99.3	65	169		41%	41.8	64	195
MN	4.43	155.7	59	181		54%	79.5	62	210
MO	3.96	197.6	68	203		77%	154.0	67	214
NE	2.97	158.7	56	183		57%	81.4	61	217
ND	3.02	250.1	35	132		9%	21.3	29	174
OH	3.17	102.0	79	186		48%	49.0	76	206
SD	2.20	178.4	42	143		15%	29.6	33	172
WS	3.96	101.7	63	189		66%	63.1	66	218
All	50.96	2,236.4	62	181		54%	1,111.7	64	213
Sign-up 41									
IL	1.99	46.0	127	184		74%	35.4	121	196
IN	0.46	10.0	128	176		69%	6.8	127	197
IA	2.00	51.7	167	234		83%	45.4	164	242
KS	4.84	404.2	41	157		83%	336.6	41	168
MI	0.30	6.4	82	150		67%	4.1	81	172
MN	1.64	83.2	69	125		53%	33.2	77	169
MO	2.85	134.4	111	223		95%	128.7	112	228
NE	1.41	105.3	64	177		78%	86.7	59	188
ND	2.39	228.6	39	110		45%	114.0	36	143
OH	0.21	4.7	95	167		73%	3.3	93	187
SD	0.84	78.4	49	130		51%	47.0	45	156
WS	1.01	22.0	98	190		86%	19.2	99	201
All	19.94	1,174.9	64	158		75%	860.4	66	181

	corn					wheat		
States	NO. of Units	Acres (millions)	Premium ($/acre)	Subsidy ($/acre)	NO. of Units	Acres (millions)	Premium ($/acre)	Subsidy ($/acre)
Year 2003								
IL	148,562	10.8	12	6	11,275	0.5	8	5
IN	62,740	4.1	15	8	4,066	0.2	7	4
IA	167,339	13.5	12	7	131	0.0	12	7
KS	45,458	3.8	12	6	176,867	15.2	7	4
MI	19,316	1.3	14	8	7,178	0.3	9	5
MN	85,188	7.4	15	9	18,121	2.0	12	7
MO	42,348	3.3	13	8	10,467	0.6	6	4
NE	132,763	10.2	14	7	34,643	2.5	8	5
ND	18,584	1.7	18	11	108,686	11.5	9	5
OH	42,692	2.5	15	8	10,771	0.4	6	4
SD	63,143	5.4	15	9	33,595	3.9	10	6
WS	36,780	2.0	19	11	2,045	0.1	12	7
All	864,913	66.0	14	7	417,845	37.2	8	5
Year 2011								
IL	165,720	10.8	38	22	14,341	0.6	31	20
IN	70,306	4.1	48	28	6,081	0.3	32	19
IA	176,911	13.5	43	25	244	0.0	40	24
KS	74,988	3.8	40	25	144,258	12.9	21	13
MI	30,019	1.3	51	35	9,692	0.5	31	20
MN	107,444	7.4	49	31	17,209	1.7	44	30
MO	52,575	3.3	49	32	10,806	0.7	23	15
NE	146,215	10.2	42	25	25,911	2.0	21	12
ND	39,143	1.7	69	46	117,137	11.6	35	23
OH	52,388	2.5	52	32	14,790	0.6	27	16
SD	86,722	5.4	55	37	34,034	3.6	35	23
WS	54,207	2.0	67	44	6,037	0.2	37	24
All	1056638	66.0	46	28	400,540	34.7	29	18

Assessing the impacts of incorporating the insurance factor

Total savings in crop insurance subsidies

Total environmental benefits achieved

Total program costs

Total acreage

The enrollment status of each field

The geographical pattern of impacts

The impacts on enrollment criteria

		Formula	Value based on average of variables	
			Sign-up 26	Sign-up 41
Comparing pseudo benefit targeting with and without adjustment	$EBI_1 - EBI_0$	$(a/b)*s$	3.33	15.20
	Difference in %	$\frac{(a/b)*s}{EBI_0}$	1.11%	5.59%
Comparing cost effective targeting with and without adjustment	$EBI_3 - EBI_2$	$\frac{EEBI + c}{r*(r-s)}$	0.28	1.42
	Difference in %	$\frac{s}{r-s}$	8.35%	51.69%

Different enrollment levels

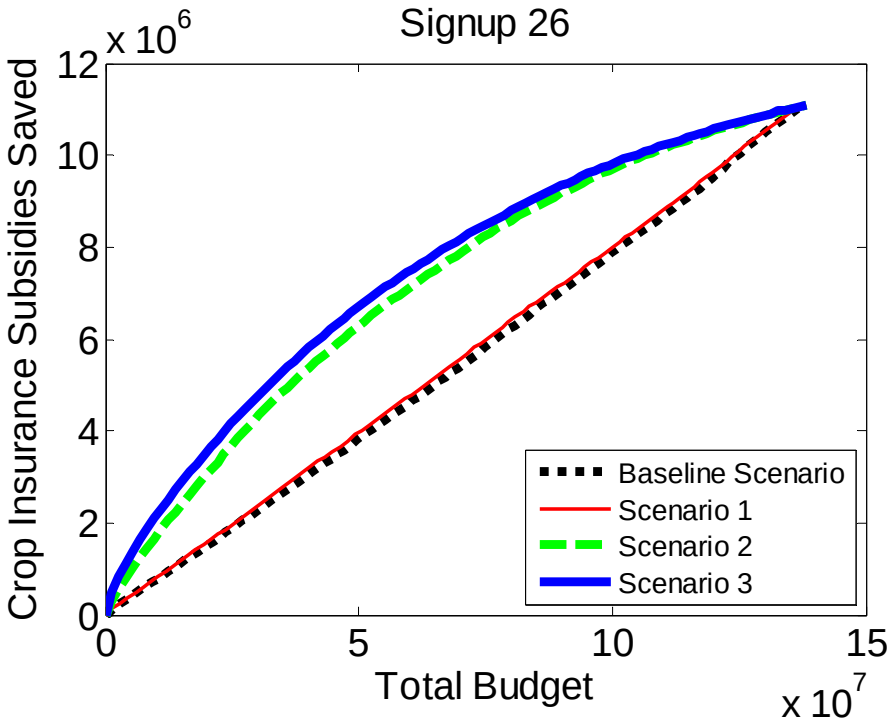
The percentage of offers that can be accepted in CRP is important.

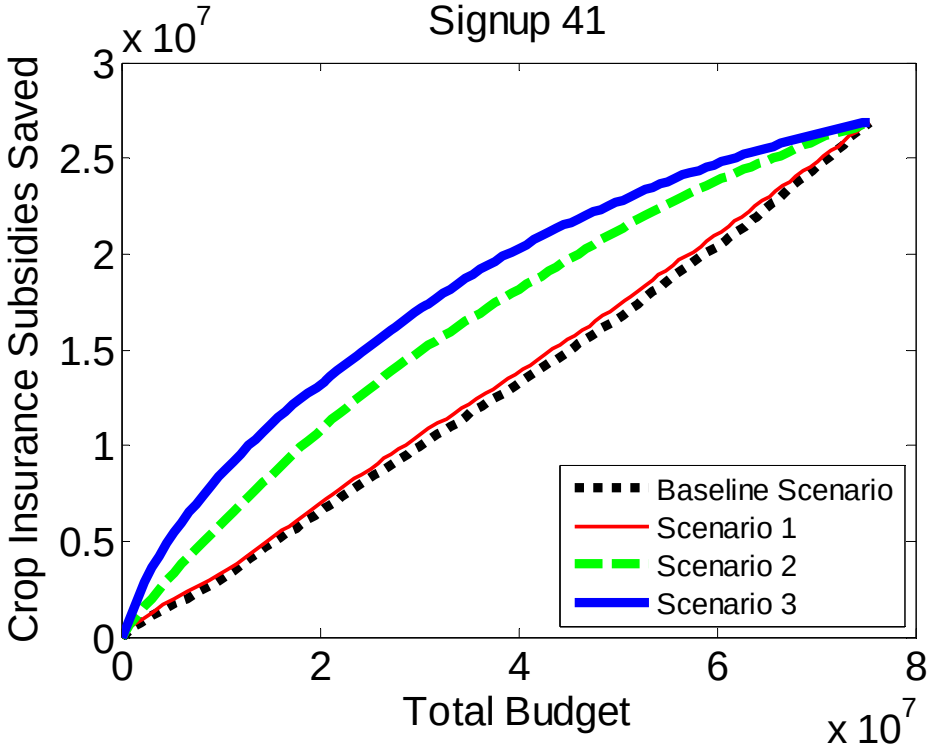
- The higher the acceptance rate, the less selective the program is, and the more likely we will observe smaller impacts.

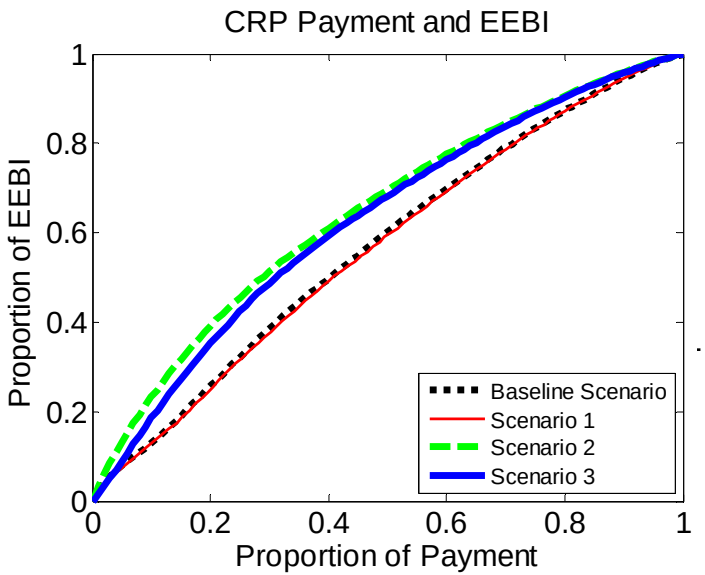
We consider two types of enrollment levels.

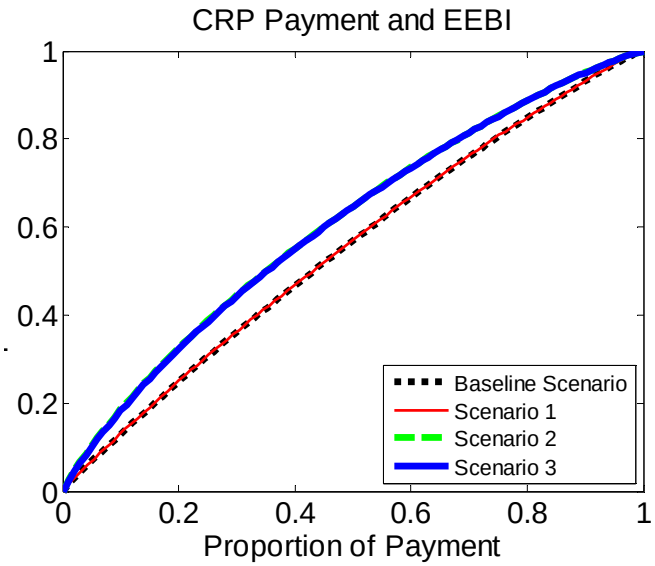
- One fixed at the baseline enrollment level
- One with varying enrollment levels (represented by Lorenz curves).

	Comparison I		Comparison II		Comparison III	
	Baseline	Scenario 1	Scenario 2	Scenario 3	Baseline	Scenario 3
	Actual numbers	Difference (%)	Actual numbers	Difference (%)		Difference (in %)
Sign-up 26						
Total acres enrolled (acres)	1,111,714	-	1,481,249	0.94%		34.51%
Total payment per year ($)	71,520,912	-0.66%	71,513,578	-		-
Insurance subsidy saved per year($)	5,475,197	3.07%	7,982,500	3.54%		51.15%
Total EEBI	236,905,327	0.06%	268,779,785	-0.12%		13.32%
Average EEBI per acre	213.1	0.05%	181	-0.56%		-15.53%
Average EEBI per dollar	3.31	0.72%	3.76	-0.13%		13.32%
Acres that change status (acres)*	-	4.53%	853,898	6.15%		81.54%
sign-up 41						
Total acres enrolled (acres)	860,445	-	1,021,166	1.84%		20.87%
Total payment per year ($)	57,003,666	0.18%	56,999,718	0.01%		0.00%
Insurance subsidy saved per year($)	19,347,534	3.02%	23,115,120	4.59%		24.96%
Total EEBI	155,816,320	-0.09%	163,667,056	-0.54%		4.47%
Average EEBI per acre	181.1	-0.11%	160	-1.88%		-13.31%
Average EEBI per dollar	2.73	-0.28%	2.87	-0.55%		4.47%
Acres that change status (acres)*	-	4.57%	280,223	17.36%		38.22%


Signup 26
x 10^6
Crop Insurance Subsidies Saved
0
2
4
6
8
10
12
0
5
10
15
Total Budget
x 10^7
Baseline Scenario
Scenario 1
Scenario 2
Scenario 3


Signup 41
x 10^7
Crop Insurance Subsidies Saved
0
0.5
1
1.5
2
2.5
3
0
2
4
6
8
Total Budget
x 10^7
Baseline Scenario
Scenario 1
Scenario 2
Scenario 3


CRP Payment and EEBI
Proportion of EEBI
Proportion of Payment
0
0.2
0.4
0.6
0.8
1
Baseline Scenario
Scenario 1
Scenario 2
Scenario 3


CRP Payment and EEBI
Proportion of Payment
0
0.2
0.4
0.6
0.8
1
Baseline Scenario
Scenario 1
Scenario 2
Scenario 3

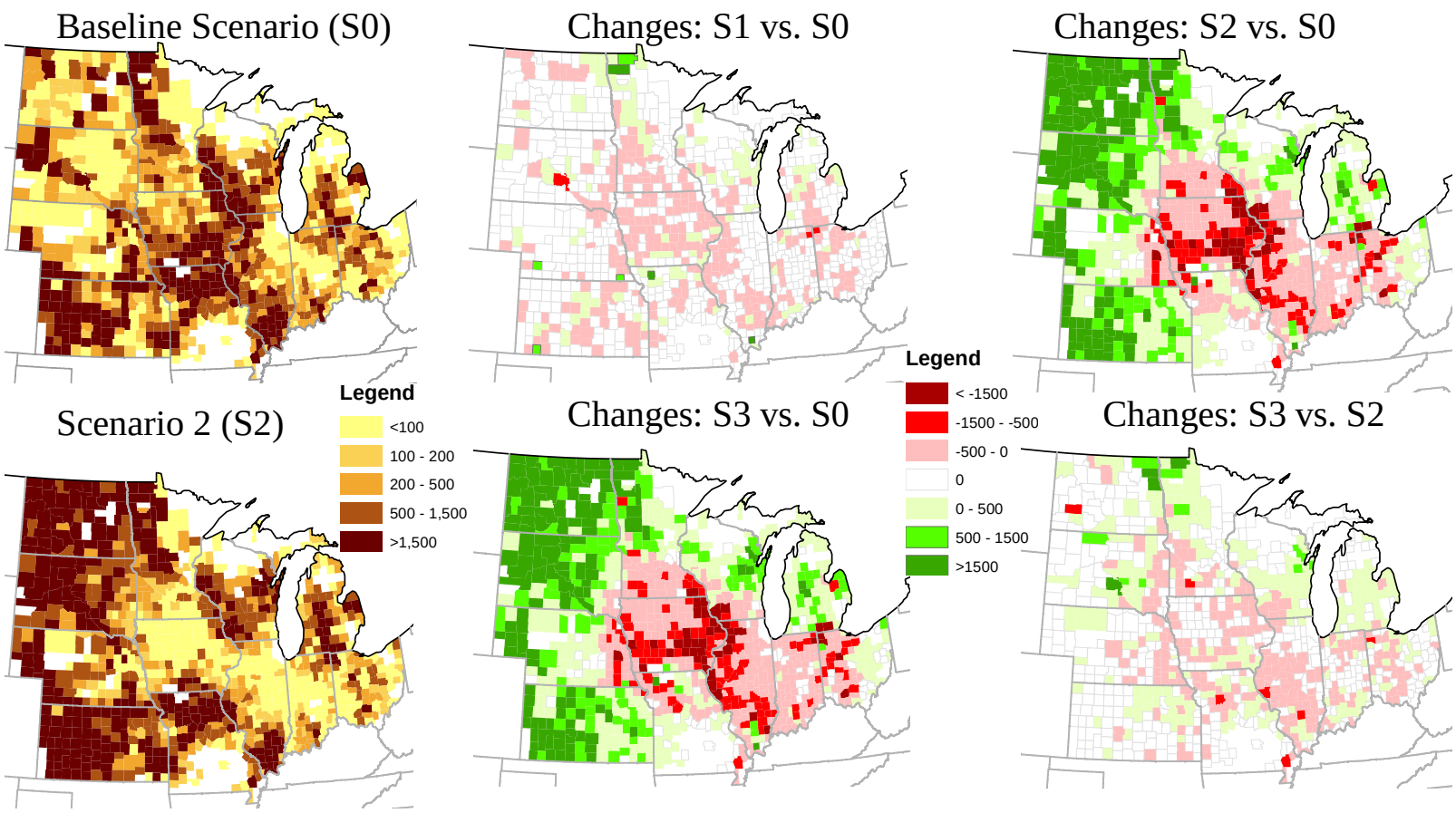


Figure 3. County-Level CRP Acreage and Comparisons of Acreage between Scenarios (Signup 26)
Note: The two maps in the left column is the absolute CRP acreage under Baseline Scenario and Scenario 2, respectively. Maps in the middle and the right columns are CRP acreage differences between scenarios. For example, the upper middle map depicts the CRP acreage change in each county under Scenario 1 when compared with that under Baseline Scenario (i.e., S0). A positive number (colored as greens) means that CRP acreage under Scenario 1 is greater than that under Baseline Scenario. Unit is in acres for all six maps. Under Scenarios 3 the CRP payment is r_k instead of r_k – s_k.

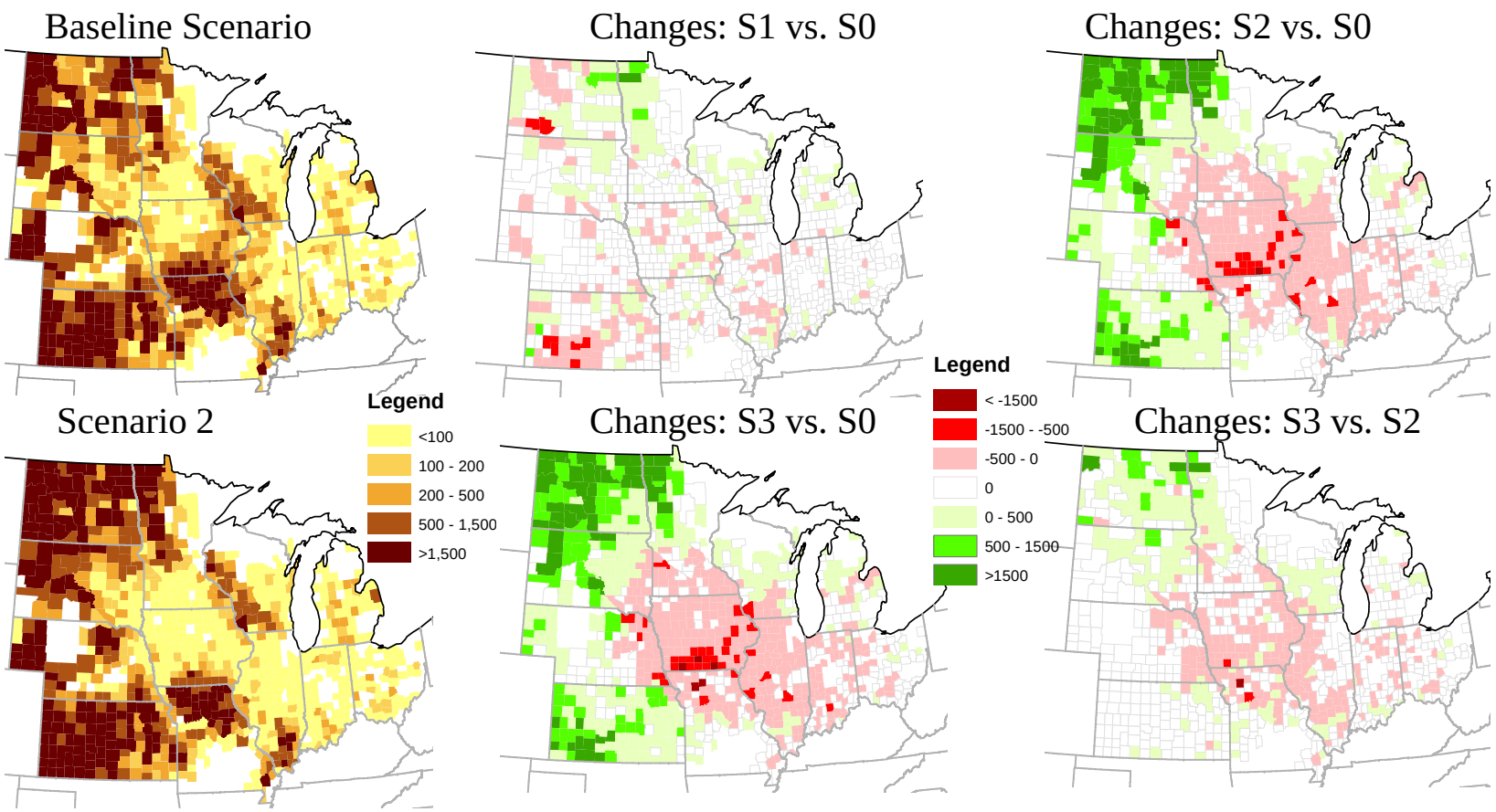


Figure 4. County-Level CRP Acreage and Comparisons of Acreage between Scenarios (Signup 41)
Note: The two maps in the left column is the absolute CRP acreage under Baseline Scenario and Scenario 2, respectively. Maps in the middle and the right columns are CRP acreage differences between scenarios. For example, the upper middle map depicts the CRP acreage change in each county under Scenario 1 when compared with that under Baseline Scenario (i.e., S0). A positive number (colored as greens) means that CRP acreage under Scenario 1 is greater than that under Baseline Scenario. Unit is in acres for all six maps. Under Scenarios 3 the CRP payment is r_k instead of r_k – s_k.

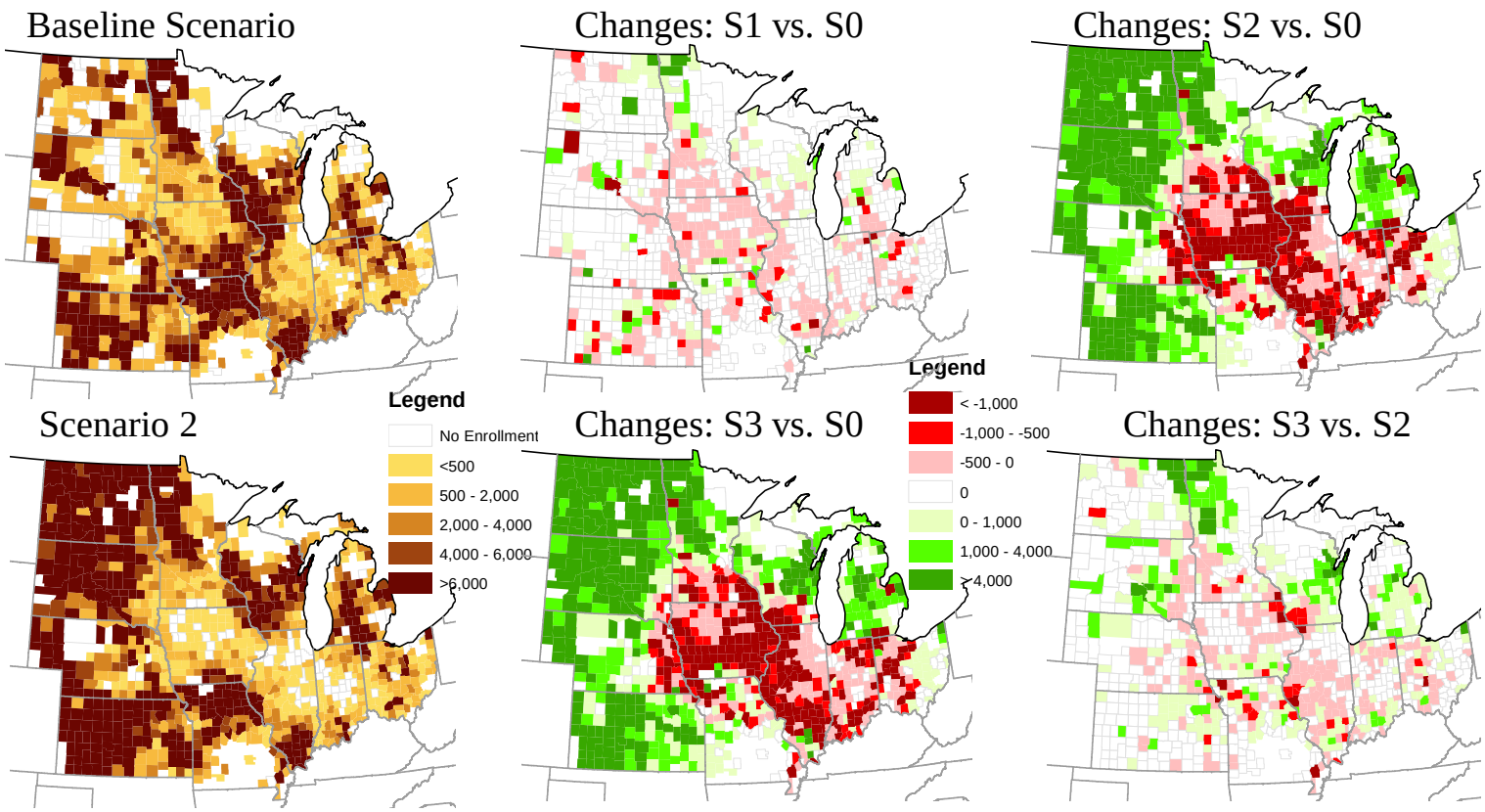


Figure 5. Crop Insurance Subsidy Savings and Comparisons of the Savings between Scenarios (Signup 26)
Note: The two maps in the left column is the absolute crop insurance subsidy savings under Baseline Scenario and Scenario 2, respectively. Maps in the middle and the right columns are differences in the savings between scenarios. For example, the upper middle map depicts the subsidy saving changes in each county under Scenario 1 when compared with that under Baseline Scenario (i.e., S0). A positive number (colored as greens) means that CRP acreage under Scenario 1 is greater than that under Baseline Scenario. Unit is in dollars per year for all six maps. Under Scenarios 3 the CRP payment is r_k instead of r_k – s_k.

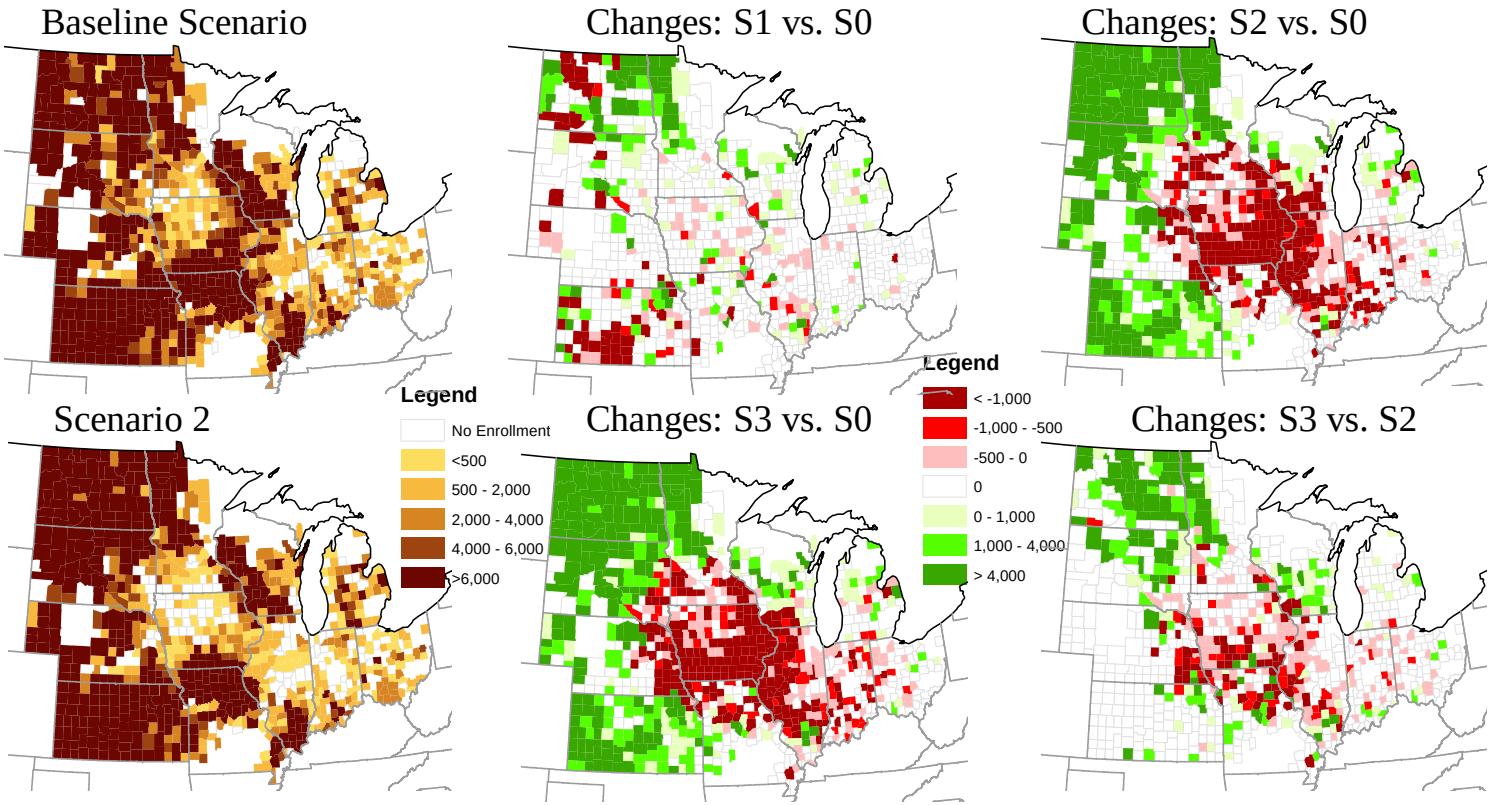


Figure 6. Crop Insurance Subsidy Savings and Comparisons of the Savings between Scenarios (Signup 41)

Note: The two maps in the left column is the absolute crop insurance subsidy savings under Baseline Scenario and Scenario 2, respectively. Maps in the middle and the right columns are differences in the savings between scenarios. For example, the upper middle map depicts the subsidy saving changes in each county under Scenario 1 when compared with that under Baseline Scenario (i.e., S0). A positive number (colored as greens) means that CRP acreage under Scenario 1 is greater than that under Baseline Scenario. Unit is in dollars per year for all six maps. Under Scenarios 3 the CRP payment is r_k instead of r_k – s_k.

Concluding remarks

Avoided crop insurance subsidies are significant.

Impacts of incorporating crop insurance subsidies on CRP enrollment depend on targeting approaches.

- With current targeting mechanism, impacts are small.
- With cost effective targeting, impacts are larger.

Geographical patterns can be significantly affected.

Caveats:

- no general equilibrium feedback to take into account market responses;
- a national study could show larger impacts, esp. geographical configuration.