

Appendix D. Payments Subject to Conservation Compliance

We consider four broad types of payments that are subject to Compliance under the 2014 Farm Act: commodity program payments, crop insurance premium subsidies, disaster assistance, and conservation programs. Other programs are also subject to Compliance sanction (e.g., farm loan programs) but they tend to be relatively small and affect a relatively small number of producers and are not considered in our analysis.

Commodity Programs

Commodity programs provide payments to producers based on current or past production of “covered” crops. Covered crops include feed grains (corn, sorghum, barley, and oats); oilseeds (soybeans, sunflower, canola, etc.); rice; wheat; peanuts; pulse crops (dry peas, lentils, chickpeas); and cotton. Oilseeds and peanuts were not covered crops until 2002. Cotton is no longer a covered crop under the 2014 Farm Act. In this analysis, we consider six major crops: corn, soybeans, wheat, cotton, grain sorghum, and barley.

Table D1 lists programs available for farmers under the 2008 and 2014 Farm Acts. Only one type of commodity payment, the Marketing Loan Benefit (MLB), is available to producers under both the 2008 and 2014 Acts, although many of the 2014 programs are similar to 2008 programs. Under both bills, farmers were required to make one-time (irrevocable) elections to receive payments under more traditional mechanisms that compensate farmers for low prices (Countercyclical Payments under the 2008 Act; Price Loss Coverage under the 2014 Act) and relatively new approaches where payments are triggered by low revenue rather than low price (Average Crop Revenue Election (ACRE) under the 2008 Act; Agricultural Risk Coverage (ARC) individual and county options under the 2014 Act).

Because commodity programs and crop prices are dramatically different under the 2008 and 2014 Farm Acts, a simple comparison of actual payments could be misleading. While payments under the 2014 Act are higher than under the 2008 Act (at least so far), lower crop prices may have triggered higher payments even if the 2008 Act had been extended. To estimate the expected value of commodity payments, we use a simulation model. Nearly all commodity program payments are triggered when crop prices or crop revenue drop below a benchmark

level, effectively truncating the distributions of crop prices or revenues, depending on the program. To estimate expected payments, we (1) look only at farms that have commodity program “base acreage,” (2) develop empirical joint distributions of crop prices and yields using farm-specific and county data, and (3) estimate average payments for a range of 2008 and 2014 Act programs over all points in the price-yield distribution. We estimate payments under all 2008 and 2014 programs for low-, medium-, and high-price scenarios (see table D3).

Table D1

Commodity programs in the 2008 and 2014 Farm Acts

		2008	2014	Conditions
Marketing Loan Benefits	MLB	x	x	Loan rates differ for wheat
Direct Payments	DP	x		Producers selecting ACRE received no CCP, Reduced DP, and Reduced MLB
Countercyclical Payments	CCP	x		
Average Crop Revenue Election	ACRE	x		
Price Loss Coverage	PLC		x	Producers chose PLC, ARC-CO, or ARC-IC
Agricultural Risk Coverage—Individual	ARC-IC		x	
Agricultural Risk Coverage—County	ARC-CO		x	

Source: USDA, Economic Research Service.

Base acreage is required for farm commodity program payments. In general, base acreage depends on past plantings, although the exact rules governing allocation of base acreage have changed periodically. Farm-level base acreage data for the 2013 crop year were obtained from the Farm Service Agency (FSA), which administers farm commodity programs. For most (but not all) commodity programs, payments are calculated using base acreage. For most (but not all) programs, payments do not depend on planted acreage, and planted acreage is not restricted by base acreage. Producers are not required to plant crops to maintain base acreage.

The most significant base acreage change in the 2014 Farm Act excludes cotton from the list of “covered” crops. Rather than eliminate cotton base acres, cotton base has become “generic” base and can be used as base acreage for the remaining covered crops under certain conditions.

Payments can be made on regular base regardless of covered crop acreage. For example, payments

can be made on corn base even if the producer grows no corn. Generic base, however, can be used for covered crops only to the extent covered crops are planted. For producers who plant a single covered crop, generic base is attributed to the planted crop, except that attributed generic base acreage cannot exceed planted acreage:

$$b_i^t = b_i + b_g \quad \text{if } a_i > b_g$$

$$b_i^t = b_i + a_i \quad \text{if } a_i \leq b_g$$

where b_i^t , is total base for covered crop i after reallocation of generic base, b_i is regular base, a_i is planted acreage, and b_g is generic base (sum of all 2013 cotton base on farm). For producers who plant more than one covered crop, generic base is attributed to the planted crops in proportion to planted acres, except that attributed generic base acreage cannot exceed planted acreage:

$$b_i^t = b_i + \frac{a_i}{\sum_i a_i} b_g \quad \text{if } \sum_i a_i > b_g$$

$$b_i^t = b_i + a_i \quad \text{if } \sum_i a_i \leq b_g$$

All allocation of generic base happens within an FSA administrative farm.

Farm program yields are based on past yields and help determine the size of most commodity payments. Payment yields were initially based on yields during the early 1980s, but the more recent Farm Acts (including 2014) allow farmers to update yields with more recent data. Farm-level data on program yields are also obtained from FSA.

The empirical price-yield distributions are based on information available to farmers at the beginning of 2014, including crop yield data through 2013. The distributions are based largely on previous research by Cooper (2009a, 2009b), Claassen, Cooper, and Carriazo (2011), and Claassen et al. (2011).

Yield distributions are derived from an expected yield and a set of yield deviations that are combined to create a k -dimensional empirical distribution. Each yield distribution is based on up to 38 years of yield data (1975-2013). The yield distribution vector includes K elements defined as:

$$(1) \quad \hat{y}_{ifk} = y_{if}^e (\Delta y_{ik} + 1) + \varepsilon_{ifk}$$

where

- y_{if}^e is the expected farm-level yield,
- Δy_{ik} is the yield deviation from a long-term trend, expressed as a proportion, based on county data (county notation suppressed), and
- $\varepsilon_{ifk} = h_{ifk} \sigma_i (\alpha_i - 1)$, where $h_{ifk} \sim N(0,1)$, σ_i is the county-level standard deviation of yield for crop i around a linear trend line, $\sigma_i = \sqrt{\sigma_i^2} = \sqrt{\text{var}(y_{i,2013}^T \Delta y_{ik})}$, and α_i is a yield inflation factor (if $\alpha_i = 1$, farm-level yields have the county standard deviation, and when $\alpha_i > 1$, the farm-level yield standard deviation is higher than the county-level).

Expected yields are county trend yields adjusted for farm-level productivity using deviations based on CCP yields:

$$(2) \quad y_{if}^e = y_{i,2013}^T + y_{i,2013}^T (y_{if}^{ccp} - \bar{y}_i^{ccp}) / \bar{y}_i^{ccp}$$

where

- $y_{i,2013}^T$ is the 2013 trend yield for the county (a linear trend fitted using K observations),
- y_{if}^{ccp} is the countercyclical payment yield for farm f , and
- \bar{y}_i^{ccp} is the base-acreage-weighted average CCP yield for FSA farms within a single county.

County-level yield deviations in equation (1) are the difference between the observed yield and the trend yield divided by the trend yield:

$$(3) \quad \Delta y_{ik} = (y_{ik} - y_{ik}^T) / y_{ik}^T,$$

where

- y_{ik} is the realized (county) yield, and
- y_{ik}^T is the trend yield for the county.

Because farming operations can have land in more than one county, the county with the largest acreage for a specific crop is selected to represent the farming operation.

The yield inflation factor, α_{ic} (part of ε_{ifk} in equation (1)) for each county, is chosen so that:

$$(3) \quad \min_{\alpha_i} \left\{ \left(\omega(y_i^{aph}) - K^{-1} \sum_k \max \left(1 - \frac{y_{i,2013}^T (\Delta y_{ik} + 1) + \varepsilon_{ik}(\alpha_i)}{0.65 y_{i,2013}^T}, 0 \right) \right)^2 \right\},$$

where $\omega(y_i^{aph})$ is the insurance premium rate (\$/\$ liability) for 65-percent coverage (excluding the fixed-rate load). The insurance premium rate is calculated using RMA county actuarial data for 2014:

$$\begin{aligned} \omega(y_i^{aph}) &= 0.88 \omega_i^{ref} * (y_i^{aph} / y_i^{ref})^{x_i} \quad \text{if } 0.5 \leq (y_i^{aph} / y_i^{ref}) \leq 1.5 \\ &= 0.88 \omega_i^{ref} * 0.5^{x_i} \quad \text{if } (y_i^{aph} / y_i^{ref}) \leq 0.5 \\ &= 0.88 \omega_i^{ref} * 1.5^{x_i} \quad \text{if } 1.5 \leq (y_i^{aph} / y_i^{ref}) \end{aligned}$$

where

- ω_i^{ref} is the RMA reference rate,

- y_i^{aph} is the farm-specific APH yield (estimated as a 10-year average of actual county yields),
- y_i^{ref} is the RMA reference yield, and
- x_i is the RMA exponent (all actuarial variables are county-specific; the county subscripts are suppressed to avoid clutter).

Multiplying the reference rate by 0.88 removes the disaster reserve load. The result (0.88 times the RMA reference rate) is the county unloaded rate (Coble et al., 2010), which represents RMA’s estimate of the county-level loss risk for crop i . We constrain the yield inflation factor to be less than or equal to 5 ($\alpha_i \leq 5$).

Table D2
Estimates of yield inflation factors

Crop	Number of counties	Mean	Standard deviation	10th percentile	90th percentile
Barley	478	3.56	0.98	2.3	4.9
Corn	2,131	3.03	1.09	1.6	4.7
Cotton	645	3.24	0.98	2	4.7
Sorghum	895	3.52	0.93	2.2	4.8
Soybeans	1,451	3.23	0.96	2.1	4.7
Wheat	2,252	3.40	0.95	2.2	4.8

Source: USDA, Economic Research Service.

County-average yields for barley, corn, cotton, sorghum, soybeans, and wheat for up to 38 annual yield observations for each crop/county for 1975-2013 were obtained from the National Agricultural Statistics Service (USDA-NASS, 2016b). Yield data for a given county were retained only when there were 30 or more observations available for a given crop and practice in a given county. When possible, missing county-level yield data was imputed using Agricultural Statistics District (ASD) average yields. ASD yields were used only when a practice-specific ASD yield (irrigated or nonirrigated) was available or the data suggested that the overall ASD average yield was based largely a single practice (at least 80 percent of acres in a specific

practice). No yield distribution was developed for crop/county combinations with fewer than 34 yield observations.

The price distribution vector for crop i , denoted \hat{p}_i , contains K elements defined as:

$$(4) \quad \hat{p}_{ik} = p_i^e (\Delta p_{ik} + 1),$$

where p_i^e is the expected price for the overall distribution (see table D3 for price scenarios),

$\Delta p_{ik} = \frac{p_{ik} - p_{ik}^e}{p_{ik}^e}$ is the k th price deviation, p_{ik} is the k th realized price, and p_{ik}^e is the k th expected

price. Expected prices (table D3) are drawn from RMA base prices for 2004 crops (low price), 2010 (medium price) and 2013 (high price). RMA base prices are specified as the average of daily closing prices during a pre-planting month for a postharvest month futures contract. For example, the expected price of corn is the average of daily closing prices during February for the December CME Group corn contract. Realized prices are specified as the average of daily closing prices for a month during harvest for a postharvest month futures contract (e.g., October for the CME Group December corn contract).

Table D3

Crop price scenarios for Compliance analysis

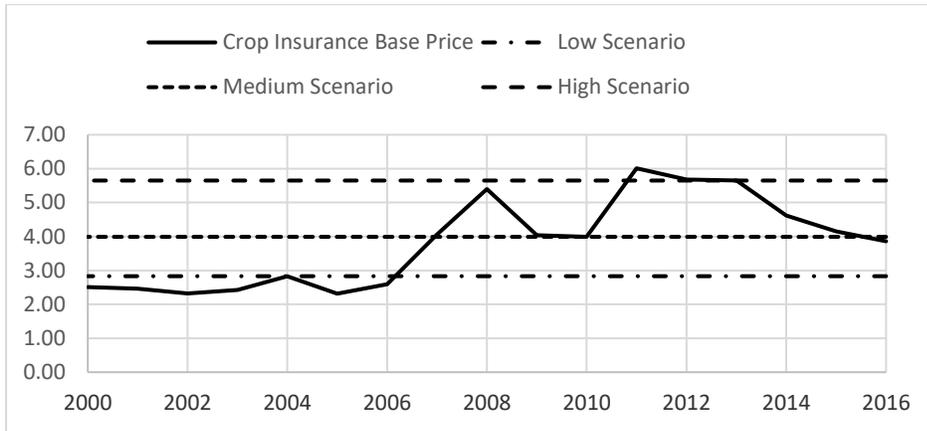
	Crop insurance base (expected) prices					
	Barley	Corn	Cotton	Sorghum	Soybeans	Wheat
Low price	3.28	2.83	0.68	2.8	6.72	3.4
Medium price	4.27	3.99	0.72	3.79	9.23	5.42
High price	5.25	5.65	0.81	5.28	12.87	8.78

Source: USDA, Economic Research Service.

Figure D1

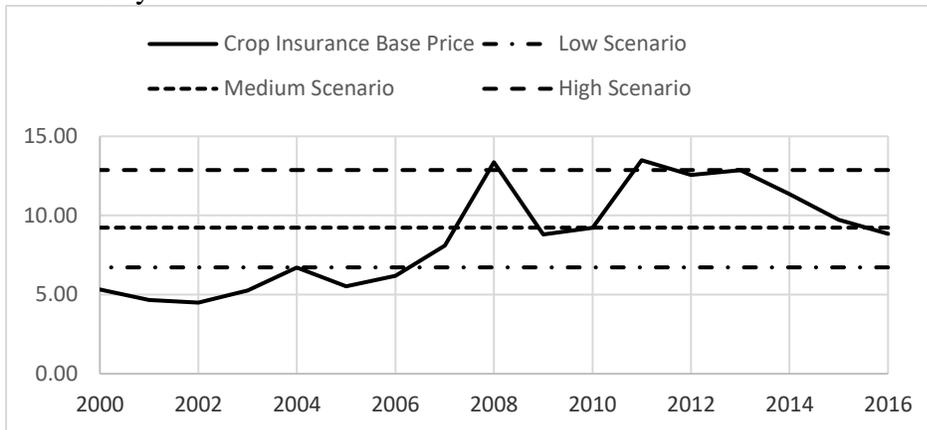
Crop price scenarios and crop insurance base prices, 2000-16

a. Corn



Source: USDA, Economic Research Service.

b. Soybeans

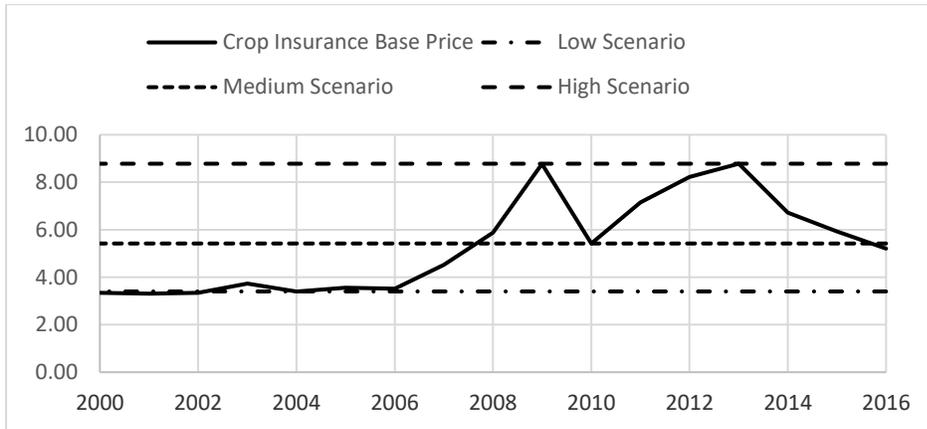


Source: USDA, Economic Research Service.

Figure D1 (continued)

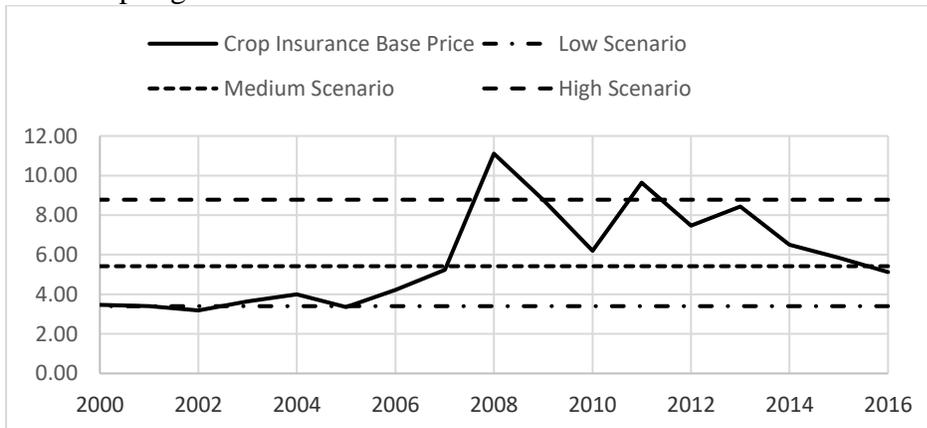
Crop price scenarios and crop insurance base prices 2000-16

c. Winter Wheat



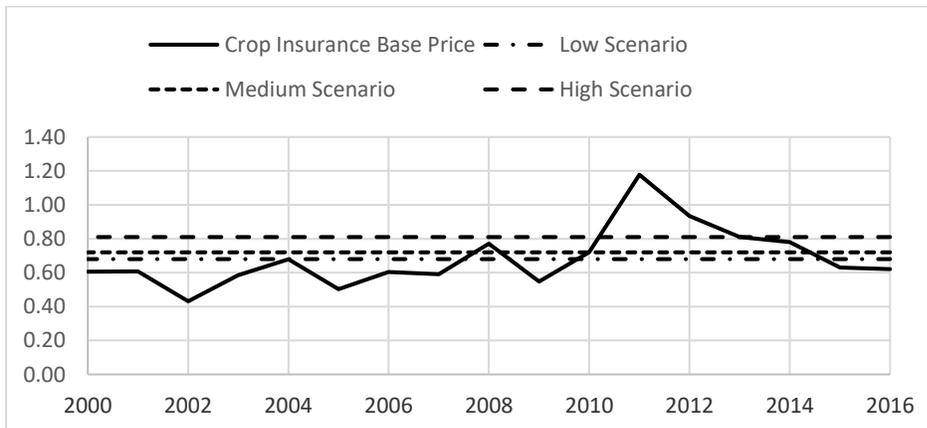
Source: USDA, Economic Research Service.

d. Spring Wheat



Source: USDA, Economic Research Service.

e. Cotton

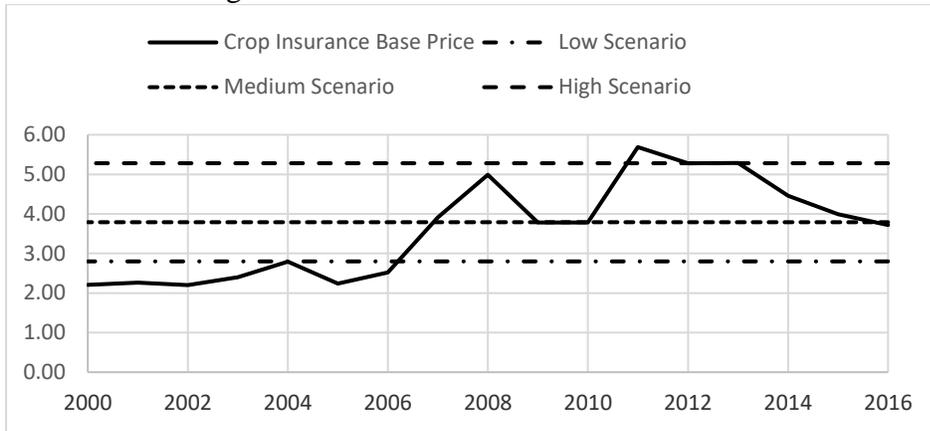


Source: USDA, Economic Research Service.

Figure D1 (continued)

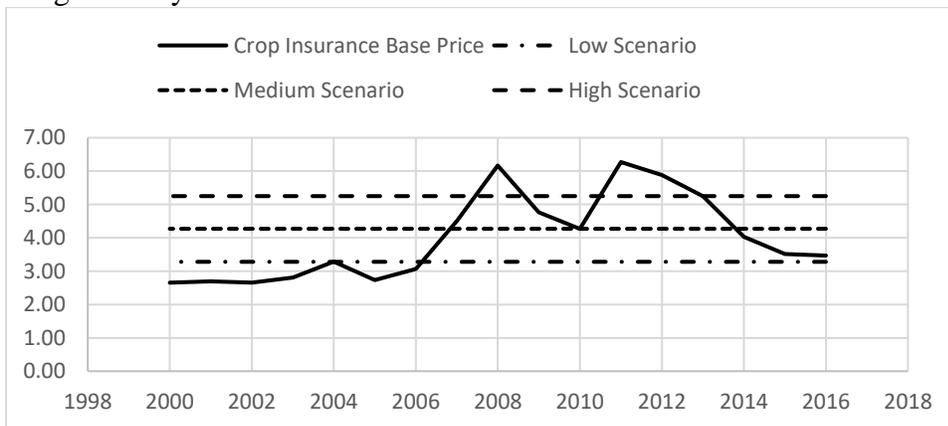
Crop price scenarios and crop insurance base prices 2000-16

f. Grain Sorghum



Source: USDA, Economic Research Service.

g. Barley



Source: USDA, Economic Research Service.

To obtain cash prices, expected prices are adjusted for expected basis, which we estimate as the 5-year average difference between the harvest month futures price (e.g., October for corn) for a postharvest futures contract (December for corn) and the harvest month cash price (October for corn). So, for 2013, the expected basis is the average difference between the harvest-time futures and cash prices for 2008-2012. The difference is subtracted from the expected price.

Market year average (MYA) prices are important in the calculation of commodity program payments. The MYA price for a commodity is the market sales-weighted average price for the

marketing year, roughly the period from harvest to harvest. The distribution of MYA prices is developed using the deviation of the MYA from the harvest-time (realized) price:

$$\hat{p}_{ik}^{mya} = p_i^e (\Delta p_i^{mya} + 1)$$

where $\Delta p_{ik}^{mya} = \frac{p_{ik}^{mya} - p_{ik}^e}{p_{ik}^e}$ $\Delta p_{ik}^{sap} = \frac{p_{ik}^{sap} - p_{ik}^e}{p_{ik}^e}$, where p_i^{mya} is the MYA price for year k . We use

basis adjustments, as described above, for p_i^e and p_{ik}^e ; p_{ik}^{mya} is already a cash price, so no basis adjustment is made.

Overall, roughly 15 percent of reported acres and 12 percent of base acres are located on farms where county yield data is not available for the crop in question (table D4). Without yields, yield-price distributions cannot be developed and expected payments for programs that depend on crop yields cannot be estimated. These programs include Marketing Loan Benefits (MLB), Average Crop Revenue Election (ACRE), Supplemental Revenue Assistance (SURE), and Agricultural Risk Coverage (ARC), and the Stacked Income Protection Plan (STAX). Programs that do not depend on yield data include Direct Payments (DP), Countercyclical Payments (CCP), and Price Loss Coverage (PLC).

On a small number of farms, representing roughly 1 percent of reported acreage and base acres, all yields are missing. For these farms, the value of payments that depend on crop yields cannot be estimated and overall Compliance incentives may be underestimated to the extent that these farms would have received yield-dependent payments.

The balance of missing yield data is on farms where yield data is available for some, but not all, crops with reported acres or base acres. On these farms, we scale up payment estimates for crops that do have yield data to cover the reported acres or base acres for crops without yield data. For example, our estimate of ARC payments (see next section for more detail on estimation) for farm f is:

$$ARC_f = \frac{\sum_i b_{if}^t \sum_{i \in Y} E(ARC_{if})}{\sum_{i \in Y} b_{if}^t},$$

where Y is the set of crops with yield data for farm f . On the right-hand side, the numerator is total base acreage on farm f multiplied by the estimated expected ARC payment for crops with yield data, while the denominator is total base acreage for crops with yield data. Similar adjustments are made for other programs where payments depend on reported acreage, 2013 base acreage, or 2014 base acreage (2013 base acreage with generic base reallocated).

Table D4

Acres on farming operations with missing yield data

	Extent of missing yield data			Total
	None	Some	All	
Farm operations	153,771	62,622	2,298	218,691
	All Acres			
Reported	39,615,564	57,277,788	995,997	97,889,350
Base (2013)	43,793,214	64,386,872	1,144,270	109,324,356
Base, generic reallocated	41,866,670	61,611,296	971,323	104,449,289
	Acres with missing yields			
Reported	0	13,763,682	995,997	14,759,679
Base (2013)	0	11,448,600	1,144,270	12,592,870
Base, generic reallocated	0	11,270,873	971,323	12,242,196
	Percent of total of all acres			
Reported	0	14	1	15
Base (2013)	0	10	1	12
Base, generic reallocated	0	11	1	12

Source: USDA, Economic Research Service.

Commodity Program Payments

Participation in farm commodity programs is very high among producers who hold base acreage. For producers with base acreage, the cost of program participation is often very low (Conservation Compliance is a cost of participation for producers who crop HEL or have wetlands they would prefer to drain).

Marketing Loan Benefits (1996-). Marketing loans protect participating farmers against prices below the loan rate. Farmers could receive a payment equal to the difference between the market price and the loan rate, multiplied by actual production. To be eligible for MLB, producers must be eligible for other commodity payments that depend on base acreage, but payments are based on actual production and are not constrained by base acreage or program yields. The expected marketing loan benefits is

$$E(MLB_f) = \sum_i a_{if} E(MLB_{if})$$

$$E(MLB_{if}) = K^{-1} \sum_k MLB_{ifk}$$

$$MLB_{ifk} = \max((p_i^{loan} - \hat{p}_{ik}) \hat{y}_{ifk}, 0)$$

where p_i^{loan} is the marketing loan rate (table D5). Note that marketing loan benefits are only available to producers who have commodity program base acreage ($b_{if} > 0$).

Table D5

Farm program payment parameters

Rate	Barley	Corn	Cotton	Sorghum	Soybeans	Wheat
2008 Farm Act (in 2013)						
Direct Payment rate	0.24	0.28	0.0667	0.35	0.44	0.52
Countercyclical Payment target price	2.63	2.63	0.7125	2.63	6.00	4.17
Loan rate , 2013	1.95	1.95	0.5192	1.95	5.00	2.75
2014 Farm Act						
Price Loss Coverage reference prices	4.95	3.70	na	3.95	8.40	5.50
Loan rate, 2014	1.95	1.95	0.5192	1.95	5.00	2.94

Source: USDA, Economic Research Service, based on USDA, Farm Service Agency factsheets

Direct Payments (2008-2013). These are based on a fixed rate per bushel and paid on the direct payment program yield and a proportion of base acreage:

$$DP_f = \sum_i b_{if} DP_{if}$$

$$DP_{if} = 0.85 p_i^{dp} y_{if}^{dp}$$

Where b_{if} is base acreage on farm f for crop i , p_i^{dp} is the direct payment rate (table D5) for crop i , and y_{if}^{dp} is the direct payment yield on farm f .

Countercyclical Payments (2008-2013). Payments were made when the “effective” price of a covered crop dropped below a preset target price. The effective price is the market price or the loan rate, whichever is higher, plus the direct payment rate. Farmers could receive payments equal to the difference between the target price and the effective price, multiplied by the CCP program yield and 85 percent of base acreage:

$$E(CCP_f) = \sum_i b_{if} E(CCP_{if})$$

$$E(CCP_{if}) = K^{-1} \sum_k CCP_{ifk}$$

$$CCP_{ifk} = 0.85 \max(p_i^{cp} - (\max(p_{ik}^{mya}, p_i^{nloan}) + p_i^{dp}), 0) y_{fi}^{cp}$$

Where p_i^{cp} is the CCP target price for crop i (table D5), p_{ik}^{mya} is the national market-year average price, p_i^{nloan} is the national average loan rate, and y_{fi}^{cp} is the countercyclical payment yield on farm f for crop i . For more information:

http://www.fsa.usda.gov/Internet/FSA_File/dcp2008.pdf

Average Crop Revenue Election (ACRE) (2009-2013). Under the 2008 Farm Act, producers could opt for the ACRE program. ACRE payments were triggered only if both State- and farm-level conditions were met. Producers who opted for ACRE also agreed to give up 20 percent of direct payments, all countercyclical payments, and to accept a 20-percent lower loan rate for the purpose of calculating marketing loan benefits.

State condition: $0.9 p_{ik}^{mya2} y_{isk}^a > \max(p_{ik}^{mya2}, 0.7 p_i^{nloan}) \hat{y}_{isk}$

Where p_{ik}^{mya2} is a 2-year national market year average price:

$$p_{ik}^{mya2} = \frac{p_{ik-1}^{mya} + p_{ik-2}^{mya}}{2},$$

y_{isk}^a is a 5-year Olympic state average yield (high and low yield removed)

$$y_{isk}^a = \frac{\sum_{z=1}^5 \hat{y}_{is,k-z} - \min(\hat{y}_{is,k-1} \dots \hat{y}_{is,k-5}) - \max(\hat{y}_{is,k-1} \dots \hat{y}_{is,k-5})}{3},$$

p_{ik}^{mya} is the national market year average price, and \hat{y}_{isk} is the State-average actual yield.

Farm condition: $p_{ik}^{mya2} y_{ifk}^a + \rho_{if} > \max(p_{ik}^{mya}, 0.7 p_i^{loan}) \hat{y}_{ifk}$

where y_{ifk}^a is the 5-year Olympic farm average yield (high and low yield removed)

$$y_{ifk}^a = \frac{\sum_{z=1}^5 \hat{y}_{if,k-z} - \min(\hat{y}_{if,k-1} \dots \hat{y}_{if,k-5}) - \max(\hat{y}_{if,k-1} \dots \hat{y}_{if,k-5})}{3},$$

and ρ_{if} is the per-acre crop insurance premium paid by the producer.

If both conditions are met, the expected ACRE payment is:

$$E(ACRE_f) = \sum_i \phi_f^{ACRE} a_{if}^{ACRE} E(ACRE_{if})$$

$$E(ACRE_{if}) = K^{-1} \sum_k ACRE_{ifk}$$

$$ACRE_{ifk} = 0.85(y_{ifk}^a / y_{isk}^a) \max(\min(0.9 p_{ik}^{mya2} y_{isk}^a - \max(p_{ik}^{mya}, 0.7 p_i^{loan}) \hat{y}_{isk}, 0.25(0.9 p_{ik}^{mya} y_{isk}^a)), 0)$$

where $\phi_f^{ACRE} = 1$ if ACRE was elected by the producer (= 0 otherwise) and a_{if}^{ACRE} is the acreage of crop i on farm f , except that acreage cannot exceed total commodity base acreage on the farm.

2014 Farm Act “Packages.” Crop insurance and commodity choices are tied together in the sense that choices made about commodity program participation affect the availability of some insurance options.

- Corn, soybean, wheat, barley, and sorghum producers select one of three options:
 - Price Loss Coverage (PLC) plus Supplemental Coverage Option (SCO) (see “Crop Insurance Premium Subsidies”),
 - County Agricultural Revenue Coverage (ARC-CO), or
 - Individual Agricultural Revenue Coverage (ARC-IC)).
- Cotton producers can choose
 - Stacked Income Protection Plan (STAX) (see “Crop Insurance Premium Subsidies”)
 or

- Supplemental Coverage Option (SCO).

Table D6

Base acreage enrolled in 2014 Farm Act commodity programs

	Base acres (1,000)	Percent enrolled by program		
		PLC	ARC-CO	ARC-IC
Barley	5,186	74.8	21.7	3.5
Corn	96,768	6.6	93.1	0.3
Grain sorghum	8,979	66.4	33.4	0.2
Soybeans	54,515	3.1	96.6	0.4
Wheat	63,699	42.5	55.6	2.0
Five crops	229,148	19.6	79.5	0.9

Source: USDA, Economic Research Service, based on USDA, Farm Service Agency data.

Price Loss Coverage (2014-). Price loss coverage is widely selected on substantial portions of barley, sorghum, and wheat base acreage. Less than 10 percent of corn and soybean base is enrolled in PLC. PLC is similar to CCP except that direct payments are not considered (they were not authorized in the 2014 Farm Act) and reference prices are higher than the target prices used with CCP. Expected PLC benefits are:

$$E(CCP_f) = \sum_i b_{if} E(CCP_{if})$$

$$E(CCP_{if}) = K^{-1} \sum_k CCP_{ifk}$$

$$CCP_{ifk} = 0.85 \max(p_i^{ccp} - (\max(p_{ik}^{mya}, p_i^{nloan}) + p_i^{dp}), 0) y_{fi}^{ccp}$$

where p_i^{plc} is the reference price for crop i (table D5) and $b_{if,14}$ is base acreage for 2014 and later (generic base allocated to other crops).

County Agriculture Risk Coverage (ARC-CO 2014-). County ARC coverage is the most popular commodity program choice, accounting for almost 80 percent of all base acreage. More than 90 percent of corn and soybean base acres are in ARC-CO. Producers can select PLC or ARC-CO on a crop-by-crop basis.

County ARC is based on crop-specific revenue. A payment can be made when corn revenue falls below 86 percent of 5-year average revenue for the county, even if overall crop revenue for the county does not fall below 86 percent of 5-year average overall county crop revenue. A payment cannot exceed 10 percent of 5-year average county crop revenue. Payment is available on 85 percent of base acreage, computed as:

$$E(ARC_f) = \sum_i b_{if,14} E(ARC_{if})$$

$$E(ARC_{if}) = K^{-1} \sum_k ARC_{ifk}$$

$$ARC_{ifk} = 0.85 \max\left(\min\left((0.86 p_{ik}^a y_{ick}^a - \max(\hat{p}_{ik}, p_i^{nloan}) \hat{y}_{ick}\right), 0.1(p_{ik}^a y_{ick}^a)\right), 0\right)$$

p_{ik}^a is a 5-year average of past national average prices with highest and lowest values removed. For prices lower than the reference price, the reference price is used:

$$p_{ik}^a = \frac{\sum_{z=1}^5 \hat{p}_{i,k-z}^m - \min(\hat{p}_{i,k-1}^m \dots \hat{p}_{i,k-5}^m) - \max(\hat{p}_{i,k-1}^m \dots \hat{p}_{i,k-5}^m)}{3}$$

where $\hat{p}_{ik}^m = \max(\hat{p}_{ik}, p_i^r)$, y_{ick}^a is a 5-year Olympic average of past county-level level yields. For yields lower than 70 percent of the county T-yield, 70 percent of the county T-yield is substituted:

$$y_{ick}^a = \frac{\sum_{z=1}^5 \hat{y}_{ic,k-z}^m - \min(\hat{y}_{ic,k-1}^m \dots \hat{y}_{ic,k-5}^m) - \max(\hat{y}_{ic,k-1}^m \dots \hat{y}_{ic,k-5}^m)}{3}$$

where $\hat{y}_{ick}^m = \max(\hat{y}_{ick}, y_i^{trans})$, \hat{y}_{ick} is element k of the county yield distribution (not re-centered to match farm expected yield and variance not inflated; $\hat{y}_{ick} = y_{i,2013}^T (\Delta y_{ik} + 1)$).

Individual Agriculture Risk Coverage (ARC-IC 2014-). ARC individual coverage is selected on only about 1 percent of base acreage (table D6). Producers who choose ARC-IC must choose

ARC-IC for all crops. Because it was chosen very infrequently, we do not model ARC-IC. For farms that selected ARC-IC, we substitute ARC-CO for all crops.

Crop Insurance Premium Subsidies

Crop insurance premium subsidies are subject to Compliance under the 2014 Farm Act (beginning with the 2015 crop year) but were not subject to Compliance under the 2008 Farm Act. Premium subsidies are calculated as a percentage of the total premium. The subsidy rate depends on the coverage level and the unit structure selected by the producer. A crop insurance unit is a collection of fields that are treated as a single unit for the purpose of calculating crop insurance premiums, calculating losses, and paying out indemnities. Lower coverage levels carry higher subsidies, while crop insurance units that cover a larger portion of the farm also have higher subsidy rates.

Table D7

Crop insurance premium subsidy rates for selected insurance plans

Insurance plan	Coverage level (Percent)								
	CAT	50	55	60	65	70	75	80	85
Basic and optional units	100	67	64	64	59	59	55	48	38
Enterprise units	--	80	80	80	80	80	77	68	53
Whole farm units	--	80	80	80	80	80	80	71	56

CAT = catastrophic coverage.

Source: USDA, Economic Research Service based on USDA, Risk Management Agency data.

The USDA Farm Service Agency (FSA) and the USDA Risk Management Agency (RMA) linked RMA data on crop insurance risk premiums, producer premiums, insured acreage, and crop insurance liability by crop insurance plan, crop, and irrigation status to FSA administrative farms. Because producer crop insurance units do not always exactly coincide with FSA farms, the unit-level data on crop insurance was attached to each FSA Common Land Unit (CLU) that was part of the crop insurance unit. Duplicate records were eliminated by removing records with duplicates on operation ID, crop insurance plan, crop, irrigation status, producer premium, risk premium, net insured acreage, and crop insurance liability. For farming operations that include

more than one crop insurance unit per crop/irrigation combination, we sum premiums, acreages, and liability within each farming operation, crop, and irrigation combination.

We assume that producers continue to purchase the same crop insurance products, at the same coverage levels, for the same type of units under the 2014 farm bill as they did in 2013. This assumption recognizes the difficulty in modeling crop insurance plan and coverage levels. We also note that basic crop insurance products and subsidy levels were largely unchanged by the 2014 Farm Act (Coble et al., 2014).¹ We do, however, adjust subsidy amounts for variation in expected crop prices across economic scenarios. The premium subsidy is a linear function of crop price and can easily be adjusted for alternate assumptions about crop price, given our assumption that crop insurance products and coverage levels remain the same. The price-adjusted subsidy is:

$$s_{if}^{net} = (p_i^e / p_{i,2013}^b)(\rho_{if}^t - \rho_{if}),$$

Where s_{if}^{net} is the net subsidy, p_i^e is the expected price (the crop insurance base price for a given economic scenario), $p_{i,2013}^b$ is the crop insurance base price for 2013 (the year of the original data), ρ_{if}^t is the total premium for farm f and crop i , and ρ_{if} is the producer-paid premium for farm f and crop i .

Crop insurance net insured acreage reported by RMA does not always match FSA-reported acreage. In modeling Compliance incentives, we estimate farmwide crop insurance subsidies by crop and irrigation, adjusted to avoid exceeding FSA reported acres for any farm, crop, irrigation combination where acres were reported to FSA in 2013. First, we estimate the premium subsidy per acre implied by RMA data. We then multiply the subsidy per acre by FSA-reported acreage or net insured acreage, depending on the relationship between reported and insured acres:

$$\text{if } a_{if} > 0 \text{ and } a_{if}^{net} > a_{if} \text{ then } s_{if} = a_{if}(s_{if}^{net} / a_{if}^{net})$$

¹The Supplemental Coverage Option (SCO) and Stacked Income Protection (STAX) are exceptions; see next section.

if $a_{if} > 0$ and $a_{if}^{net} \leq a_{ii}$ then $s_{if} = s_{if}^{net}$

if $a_{if} = 0$ and $a_{if}^{net} > 0$ then $s_{if} = s_{if}^{net}$

where a_{if} is FSA-reported acreage, a_{if}^{net} is RMA net insured acreage, and s_{if} is the subsidy for crop i and farm f . Implicitly, we assume that reported acreage for any given crop is the full acreage for the farm (on crops for which farms report acreage) and impose the constraint that insured acreage cannot exceed total acreage. Our procedure may underestimate premium subsidies on farms that insured more acres than they reported to FSA in 2013 for any specific crop/irrigation combination.

New Insurance Products Under the 2014 Farm Act. The 2014 Farm Act created the Supplemental Coverage Option (SCO) and the Stacked Income Protection Plan (STAX). SCO is available only to producers who select Price Loss Coverage (rather than one version of Agricultural Revenue Coverage). SCO can be purchased only in conjunction with other insurance. STAX is for cotton producers only and can be purchased as a standalone product, separate from other crop insurance coverage.

Supplemental Coverage Option (2015-). Because its purchase was very limited in 2015, SCO is not modeled. Most corn and soybean producers selected ARC-CO coverage and are ineligible for SCO. Even among barley, sorghum, and wheat producers, where PLC is more common, SCO accounted for a very small percentage of crop insurance premium subsidies: less than 2 percent for wheat and less than 1 percent for sorghum and barley (table D8).

Table D8

SCO and STAX subsidies by crop, 2015 crop year

	Total Subsidy	SCO subsidy	Percent SCO	STAX Subsidy	Percent STAX
Wheat	806,283,554	15,348,427	1.90		
Cotton	453,758,635	138,643	0.03	74,946,588	16.52
Corn	2,232,333,408	3,716,690	0.17		
Sorghum	165,699,394	1,425,573	0.86		
Soybeans	1,297,230,669	2,195,584	0.17		
Barley	45,065,960	172,289	0.38		
Total	5,000,371,620	22,997,206	0.46		

SCO = Supplemental Coverage Option; STAX = Stacked Income Protection Plan.

Source: USDA, Economic Research Service based on USDA, Risk Management Agency Summary of Business data.

Stacked Income Protection Plan (2015-). In contrast to SCO, STAX accounted for more than 16 percent of crop insurance subsidies to cotton producers in 2015 (table D8). STAX data on individual producers are not available. We simulate STAX subsidies by assuming that premiums are actuarially fair using the price and yield distribution created for simulating commodity payments. STAX covers up to 20 percent of revenue loss for an area (county), depending on the STAX coverage level and the coverage level for other crop insurance purchased by the producer. The STAX coverage level can be 0.90, 0.85, 0.80, or 0.75. The indemnity is the guarantee less actual area revenue. The maximum payment is the difference between the STAX coverage level and 0.70, or the coverage level of other insurance multiplied by the expected revenue. The premium subsidy is 80 percent.

$$E(STAX_f) = \phi_{if}^{stax} a_{stax,f} 0.8E(I_{f,stax})$$

Where ϕ_{if}^{stax} is the proportion of eligible acreage where STAX is purchased, $E(I_{f,stax})$ is the expected per-acre indemnity for STAX, and $a_{stax,f}$ is acreage eligible for STAX.

Eligible acreage is either FSA-reported acreage or RMA net insured acreage. Because FSA and RMA acreages do not always match in farming operations, we make the following assumptions:

$$\text{if } a_{\text{cotton},f} > 0 \text{ and } a_{\text{cotton},f}^{\text{net}} > a_{\text{cotton},f} \text{ then } a_f^{\text{stax}} = a_{\text{cotton},f}$$

$$\text{if } a_{\text{cotton},f} > 0 \text{ and } a_{\text{cotton},f}^{\text{net}} \leq a_{\text{cotton},f} \text{ then } a_f^{\text{stax}} = a_{\text{cotton},f}^{\text{net}}$$

$$\text{if } a_{\text{cotton},f} = 0 \text{ and } a_{\text{cotton},f}^{\text{net}} > 0 \text{ then } a_f^{\text{stax}} = a_{\text{cotton},f}^{\text{net}}$$

where $a_{\text{cotton},f}$ is FSA reported acreage for cotton and $a_{\text{cotton},f}^{\text{net}}$ is net insured cotton acreage.

Implicitly, we assume that cotton acreage on the farm is reported acreage. When insured acreage is greater than reported acreage and reported acreage is greater than zero, we use reported acreage as acreage eligible for STAX (farmers cannot insure more acres than they have in cotton). When insured acreage is less than reported acreage, we use insured acreage as eligible acreage (farmers can insure fewer acres than they have in cotton). Finally, if reported acreage is zero and net insured acreage is positive, we assume that STAX-eligible acreage is net insured acreage (that is, cotton was produced but cotton acreage was not reported to FSA).

For STAX, the expected indemnity is:

$$E(I_{f,\text{stax}}) = K^{-1} \sum_k I_{f,\text{stax},k}$$

$$I_{f,\text{stax},k} = \max\left(\min\left((\varphi_f \theta_{f,\text{stax}} p_i^b y_{ic}^b - \hat{p}_{ik} \hat{y}_{ick}), (\theta_{f,\text{stax}} - \max(\theta_{fi}, 0.7)) p_i^b y_{ic}^b\right), 0\right)$$

The indemnity is the guarantee level less actual revenue: $\varphi_f \theta_{f,\text{stax}} p_i^b y_{ic}^b - \hat{p}_{ik} \hat{y}_{ick}$ with a minimum of zero and a maximum of $(\theta_{f,\text{stax}} - \max(\theta_{fi}, 0.7)) p_i^b y_{ic}^b$,

Where p_i^b is the crop insurance base price; y_{ic}^b is the expected county average yield (10 year average of county yields); $\theta_{f,\text{STAX}}$ is the STAX coverage level (90, 85, 80, or 75 percent) selected

on farm f ; φ_f is the protection factor (selected by the producer in the range 0.8-1.2) selected on farm f ; and θ_{fi} is the coverage level for other insurance selected on farm f .

STAX participation rates (the proportion of total cotton acreage enrolled) by State are used to determine the portion of acres insured with STAX on each farm in a given State. Because cotton acreage data is available only from the agriculture census, we use 2012 data on harvested cotton acreage to approximate 2015 planted acreage. A STAX coverage level of 90 percent and a protection factor of 1 are assumed. The coverage level for other crop insurance products is important in determining STAX coverage. These data, however, were not included in the FSA-RMA data. For each combination of farming operation, crop, irrigation, and crop insurance plan, we use county-level data to determine the most frequently purchased level of coverage for each insurance plan. Where a single farm used more than one plan for a single crop/irrigation combination, we used the plan that covers the largest number of acres on the farm (we have farm-specific data on crop insurance plans but not coverage levels).

Disaster Assistance

Supplemental Revenue Assistance (SURE) (2009-2012). SURE was available only to producers who purchased crop insurance for all crops. Once a disaster is declared, the SURE payment was made when whole-farm revenue dropped below a revenue guarantee:

$$E(D_f) = K^{-1} \sum_k \max(0.60(G_{fk} - R_{fk}), 0)$$

$$D_{fk} = \max(0.60(G_{fk} - R_{fk}), 0)$$

where G_{fk} is the SURE guarantee and R_{fk} is total farm revenue. The SURE guarantee depended on the level of crop insurance coverage purchased by the producer, expected prices, and the producer's APH yield, but was limited to no more than 90 percent of expected revenue:

$$G_{fk} = \min \left(1.2 \sum_i (a_{fi} \theta_{fi} p_i^e y_{fi}^{aph}), 0.90 \sum_i a_{fi} p_i^e \max(y_{fi}^{aph}, y_{fi}^{ccp}) \right)$$

where y_{fi}^{ccp} is the farm's countercyclical payment program yield. Total farm revenue (for crops) includes market revenue, crop insurance indemnities, and commodity program payments:

$$R_{fk} = \sum_i a_{fi} (\hat{p}_{ik} \hat{y}_{ik} + I_{fik} + MLB_{fik}) + 0.15 DP_f + CCP_{fk},$$

where I_{fik} is the indemnity for crop i and insurance plan m (one insurance plan is preselected for each crop).

Farmers could choose from a wide range of insurance products, although a handful of products dominate the market for major crop commodities. The most common is Revenue Protection (RP), which covers producers against yield loss and intraseason price declines or increases (the revenue guarantee is based on the higher of the base (planting time) price or the harvest-time (realized) price):

$$I_{fi,RP,k} = \max((\theta_{fi} \max(\hat{p}_{ik}, p_i^b) y_{fi}^{aph} - \hat{p}_{ik} \hat{y}_{fik}), 0),$$

where $I_{fi,RP,k}$ is the indemnity per unit of land, θ_{fi} is the coverage level selected by the producer (approximated as above), p_i^b is the crop insurance base price, and y_{fi}^{aph} is the farm's APH yield.

Other popular products include RP with the harvest price exclusion (RPHPE):

$$I_{fi,RPHPE,k} = \max((\theta_{fi} p_i^b y_{fi}^{aph} - \hat{p}_{ik} \hat{y}_{fik}), 0);$$

Yield Protection (YP):

$$I_{fi,YP,k} = \max(\pi p_i^b (\theta_{fi} y_{fi}^{aph} - \hat{y}_{fik}), 0),$$

where π is the level of price coverage (=1 in this analysis); and

Catastrophic (CAT) coverage:

$$I_{fi,CAT,k} = \max(0.55 p_i^b (0.5 y_{fi}^{aph} - \hat{y}_{ifk}), 0).$$

Conservation Payments

Conservation payments from the Conservation Reserve Program (CRP), the Environmental Quality Incentives Program (EQIP), and the Conservation Stewardship Program (CSP) are also identified for individual FSA farms. CRP contracts are already aligned with FSA farms, and CRP payments can be easily merged with other FSA data. CRP annual payments are estimated as CRP acreage multiplied by the per-acre annual payment rate. We estimate annual payments to match the annual estimates for commodity and other programs. Because a violation of Conservation Compliance (on non-CRP land) is not a violation of the CRP contract, the Compliance violation triggers suspension of CRP payments but does not require repayment of previous payments. Data are aggregated to farming operations and then merged to farm operation-level data.

EQIP and CSP program contracts are also identified by FSA farm number but typically cover entire farming operations. Data may thus be repeated across FSA farms that are part of the same farming operation. After merging the data by farm number, we removed repeated observations. For both programs, we select contracts that were active in 2013. For EQIP, our estimate of the annualized payment is equal to remaining (unpaid) obligated funds divided by the number of years remaining in the contract. For CSP, our estimate of the annualized payment is the total obligation divided by the total number of years (5) in the contract.

Conservation payments often cover some portion of opportunity or out-of-pocket costs producers incur in retiring land from crop production, installing structural conservation practices, or transitioning to new management practices. As such, the effect of Compliance sanctions could vary across producers depending on circumstances. For those already enrolled in a conservation program, Compliance violation may mean the loss of some payments, even though conservation costs have been incurred. In CRP, because a Compliance violation is not a violation of the contract, annual payments could be suspended but the contract is still in force—the land cannot be returned to crop production without refunding previous payments. For producers who are not conservation program participants but could be at some future time, the loss of eligibility for conservation programs would mean that future conservation practices would have to be adopted without support.

Appendix E. Conservation Practice Cost and Use

Conservation practice adoption costs for structural and vegetative practices are based on State averages estimated by USDA's Natural Resources Conservation Service (NRCS). Cost estimates include both "upfront" or amortized costs of installing structural or vegetative practices, annual operation and maintenance costs for these practices, and recurring annual costs for management practices (with a 1-year practice life). For structural and vegetative practices with a life of more than 1 year, we annualize the cost using:

$$ACC = \frac{Amort}{1+\alpha} + \frac{OM\alpha}{(1+r)^L},$$

where ACC is annual conservation cost, $Amort$ is the cost installation cost to be amortized over the life of the practice, OM is annual operation and maintenance costs, r is the discount rate, L is the practice life in years, and $\alpha = \frac{1-(1+r)^{-(L-1)}}{r}$.

While the cost of applying conservation practices to a specific field may vary widely depending on climate, soil, topography, and other factors that can vary within States, these data can be helpful in developing broad regional estimates of soil conservation costs on highly erodible land (HEL).

Conservation Practice Use: Conservation practice use is derived from individual fields surveyed for the Conservation Effect Assessment Program (CEAP). For each surveyed field, HEL status is defined at the NRI point (located within the field) using the erodibility index. (Some NRI points located in fields that are designated as highly erodible for the purpose of Conservation Compliance are not located on highly erodible land as defined by the erodibility index at the NRI point.)

For most practices in figure 22, the practice is identified directly in the data. For tillage and conservation cropping, some additional assumptions are necessary. CEAP survey data on field operations and the associated Soil Tillage Intensity Rating (STIR) are used to sort tillage practices into one of five groups. The CEAP data include crop history for the survey year and 2 previous years. NRCS staff calculated the STIR for each field operation. We characterize tillage for each year (summing over operation-specific STIR ratings) to get the annual STIR rating, then categorized each field into one of three tillage practices:

- Conventional tillage—At least one crop in rotation has a STIR of 80 or greater,
- Mulch till—All crops in rotation have a STIR of 80 or less, or
- No till—All crops in rotation have a STIR of 20 or less.

CEAP survey data on cropping history is used to identify conservation crop rotations. A conservation rotation can address a diverse set of resource concerns, including soil erosion, building soil organic matter, uptake of excess soil nitrogen, reducing pest pressures, crop diversity, and wildlife habitat, among other concerns. For the purpose of Conservation Compliance, we focus on soil erosion control as a primary objective. Using the 3-year cropping history provided in CEAP data, we classify a rotation as a “conservation rotation” when the rotation includes one “high-residue” crop, more than one crop species (cover crops and double cropping count), and one crop with lower nutrient needs.

For each crop, a residue rating is assigned by NRCS ranging from 0.25 to 4. Low-residue field crops (e.g., soybeans, cotton) are assigned a rating of 1. High-residue annual crops—including corn, wheat, sorghum, and barley—are assigned a rating of 2. Perennial crops such as alfalfa and other grass or hay have residue ratings of 4. A conservation rotation has (1) an average residue rating *greater than* 1.5 (a simple corn-soybean rotation would *not* qualify as a conservation rotation), (2) at least one lower nutrient crop (all legumes and perennial crops), and (3) more than one crop in the rotation (a cover crop qualifies).