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Conservation Compliance: How Farmer Incentives Are Changing in the Crop Insurance Era

Roger Claassen, Maria Bowman, Vince Breneman, Tara Wade, Ryan Williams, Jacob Fooks, LeRoy Hansen, Rich Iovanna, and Chuck Loesch

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Abstract

Conservation Compliance ties eligibility for most Federal farm program benefits to soil and wetland conservation. To be eligible for farm program benefits, farmers must apply an approved soil conservation system on highly erodible cropland (Highly Erodible Land Conservation, or HELC) and refrain from draining wetlands (Wetland Conservation, or WC). Conservation Compliance is effective when the incentive—the farm program benefits that could be lost due to noncompliance—exceeds the cost of meeting soil and wetland conservation requirements. HELC significantly reduced soil erosion on highly erodible cropland and may have also encouraged erosion reduction on land not subject to HELC. Compliance incentives (farm program benefits) under the Agricultural Act of 2014 are found to (1) vary widely across farms with cropland in HEL (highly erodible land) fields, (2) approximate the overall level of incentive that would have been provided under an extension of the 2008 Farm Act (although incentives changed significantly on many farms), and (3) be significantly lower on many farms if crop insurance premium subsidies were not subject to Conservation Compliance. Compliance incentives for WC, although measured only in the Prairie Pothole region of the Northern Plains, are clearly larger than Compliance costs for an estimated 75 percent of wetlands that are already cropped or have characteristics (e.g., productivity, topography) that are favorable to crop production.

Keywords: Conservation Compliance, Highly Erodible Land Conservation, soil erosion, Wetland Conservation, farm programs, crop insurance, commodity programs

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A report summary from the Economic Research Service July 2017

Conservation Compliance: How Farmer Incentives Are Changing in the Crop Insurance Era

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What Is the Issue?

Conservation Compliance provisions in Farm Bill legislation link farm program benefits to soil and wetland conservation. The Highly Erodible Land Compliance (HELC) provision requires farm program participants to apply approved soil conservation systems on cropland in fields designated by USDA as highly erodible. The Wetland Conservation (WC) provision requires farm program participants to refrain from draining wetlands. Farmers who fail to meet Compliance requirements risk becoming ineligible for most agriculture-related Federal benefits. Conservation Compliance is effective in reducing soil erosion and conserving wetlands when the incentive—the farm program benefits that could be lost due to noncompliance—exceeds the cost of meeting soil and wetland conservation requirements.

In this report, we address two broad questions. First, how have HELC requirements affected soil erosion over the past 30 years? Soil erosion was sharply reduced on cropland subject to HELC and not subject to HELC. How much soil erosion reduction can be attributed directly to HELC? Second, how did the 2014 Farm Act change incentives for meeting Conservation Compliance requirements? The 2014 Act ended Direct Payments, re-linked crop insurance premium subsidies to Compliance, and created several new commodity and crop insurance programs. In aggregate, farm program benefits under the 2014 Act could be as high or higher than under the 2008 Farm Act; but for individual farms, the shift toward a crop insurance-oriented policy could increase or decrease Compliance incentives.

What Did the Study Find?

Between 1982 and 1997, soil erosion reductions for cropland highly erodible for water were significantly larger in fields subject to HELC (39 percent, or 6.6 tons per acre) than those not subject to HELC (24 percent, or 3.9 tons per acre). For cropland highly erodible for wind, the difference was smaller: a reduction of 3.8 tons per acre (from land subject to Compliance) versus 2.3 tons per acre (from land not subject to Compliance). Soil erosion rates on highly erodible cultivated cropland were largely unchanged between 1997 and 2012.

Under both the 2008 and 2014 Farm Acts, the strength of Compliance incentives varies widely among farms because the level of farm program benefits subject to Compliance and the cost of meeting Compliance requirements vary among farms. Compliance incentives (farm program benefits subject to Compliance) also depend on crop prices. Most commodity payments are triggered by low prices or low revenue. Crop insurance premium subsidies, on the other hand, rise with crop prices because higher prices increase the value of the insured crop. We estimate farm-level Compliance incentives using three crop price scenarios:

- In our "medium" price scenario (based on crop prices in 2010), an estimated 27 percent (25 million acres) of cropland in HEL fields is on farms where Compliance incentives are clearly large enough to offset the Compliance cost. Compliance incentives are relatively low on farms that include 28 percent (27 million acres) of land subject to HELC. Roughly 10 percent of cropland in HEL fields (9 million acres) is on farms that receive no Compliance incentives. A continuation of the 2008 Farm Act (as implemented in 2013) would have resulted in a similar distribution of Compliance incentives across cropland in HEL fields.
- In our "low" price scenario (based on crop prices in 2004), Compliance incentives are relatively large because commodity payments are larger. The 2014 Act delivers slightly stronger Compliance incentives than would have been realized under the 2008 Act because the crop prices that trigger some commodity payments are higher in the 2014 Act (e.g., the reference price for Price Loss Coverage) than in the 2008 Act (e.g., the target price for Countercyclical Payments).
- In our "high" price scenario (based on crop prices in 2013), Compliance incentives are similar to the medium-price scenario. Incentives are slightly higher under the 2008 Act because farmers received Direct Payments even when prices or revenue were high. Under the 2014 Act, crop insurance premium subsidies, which rise as crop prices rise, partially offset lower commodity payments at higher prices.

Crop insurance premium subsidies are an important part of Compliance incentives under the 2014 Act. Severing the link between Conservation Compliance and crop insurance premium subsidies would mean a 65-percent increase in the amount of highly erodible land on farms where Compliance incentives are relatively low. The change in Compliance incentives is much larger when crop prices (and premium subsidies) are high and much smaller when crop prices are low.

National results, however, mask significant changes in farm-level Compliance incentives. For example, in our medium-price scenario, 27 million acres (29 percent) of cropland in HEL fields are located on farms where Compliance incentives are at least 25 percent lower than they would have been under the 2008 Act (for example, portions of the Corn Belt). Conversely, roughly 18 million acres (20 percent) of cropland in HEL fields are on farms where Compliance incentives are at least 25 percent higher than they would have been under the 2008 Act (for example, much of the Northern Plains).

Severing the link between crop insurance and Compliance would increase the number of farms where Compliance incentives decline. In our medium-price scenario, when crop insurance premium subsidies are linked to HELC (as under the 2014 Act), less than 10 million acres of cropland in HEL fields are on farms that would experience a 50-percent or larger decline in Compliance incentives. If crop insurance premium subsidies were not subject to Compliance, more than 40 million acres of cropland in HEL fields would be on farms where overall Compliance incentives declined by 50 percent or more.

Data limitations restrict analysis of Wetland Conservation to the Prairie Pothole States (Iowa, Minnesota, Montana, North Dakota, and South Dakota), where WC incentives are strong. An estimated 75 percent of "potentially convertible" wetlands (with productivity similar to existing cropland) are on farms where Compliance incentives are very likely to be "high" under the medium-price scenario. About 10 percent of wetlands are on farms that do not receive benefits subject to Compliance sanction.

How Was the Study Conducted?

A statistical model is used to estimate the effect of Conservation Compliance on soil erosion reduction for land that is and is not subject to HELC. Data on soil erosion for specific "points of land" are available at 5-year intervals between 1982 and 2012 from the National Resources Inventory (NRI), conducted by USDA's Natural Resources Conservation Service. The dataset includes only those NRI points that are located on tracts with commodity program base acreage that were continuously cropped during 1982-2012.

To estimate Compliance incentives for individual farms, a mix of survey, USDA administrative, and biophysical data is used. The NRI provides statistically reliable estimates of land subject to HELC and WC. Multiple USDA administrative and biophysical databases are used to estimate the strength of Compliance incentives, using two farm-level metrics: Compliance incentives per acre of land subject to Compliance (e.g., cropland in HEL fields or wetland) and Compliance incentives per acre of land subject to Compliance relative to the cropland rental rate (an upper bound on Compliance costs).

Conservation Compliance: How Farmer Incentives Are Changing in the Crop Insurance Era

Conservation Compliance History, Economics, and Requirements

Conservation Compliance ties eligibility for most Federal farm program benefits to soil and wetland conservation. Most Federal farm program benefits—including farm income support, crop disaster payments, conservation payments, crop insurance premium subsidies, and USDA farm loans and loan guarantees—are subject to Compliance sanction. To maintain eligibility, farmers must (1) apply an approved soil conservation system (one or more soil conservation practices) on highly erodible land (HEL) used for cultivated crops (Highly Erodible Land Conservation, or HELC) and (2) refrain from draining wetlands (Wetland Conservation, or WC).

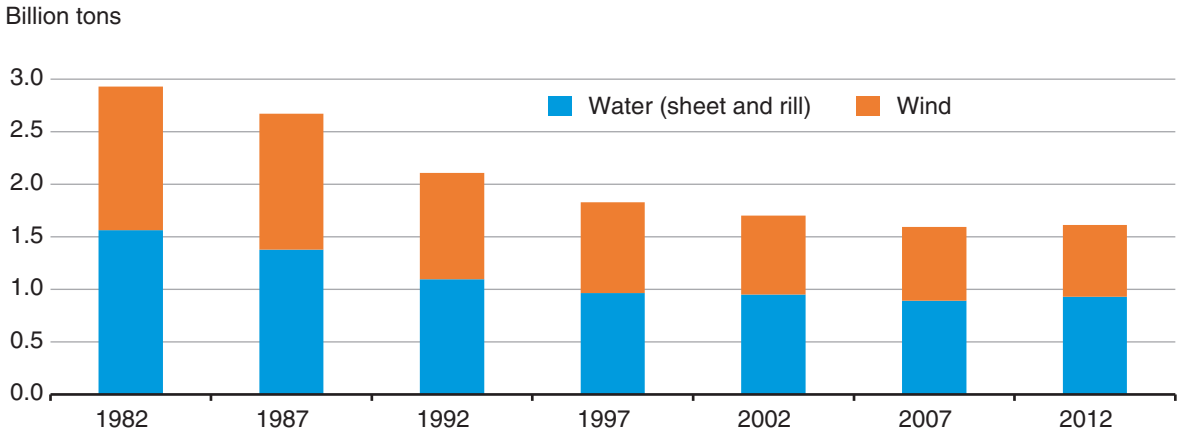
In this report, we address two broad questions. First, how have HELC requirements affected soil erosion over the past 30 years? Although soil erosion was sharply reduced on land subject to HELC, significant erosion reduction was also realized on cropland *not* subject to HELC. We estimate the extent to which soil erosion reductions on land subject to HELC exceed reductions on similar land not subject to HELC, thereby isolating soil erosion reductions directly attributable to HELC.

Second, how did the 2014 Farm Act change incentives for meeting Conservation Compliance requirements? Total farm program benefits could be as high or higher under the 2014 Farm Act as under the 2008 Farm Act. For individual farms, however, the 2014 Act's emphasis on subsidized crop insurance could significantly increase or decrease Compliance incentives (farm program benefits).

Conservation Compliance History. Conservation Compliance was enacted in 1985 to improve environmental quality by reducing soil erosion (and offsite damage due to sedimentation) and preventing the loss of wetlands. Compliance provisions help ensure that farm support programs work in harmony with USDA conservation programs. Without Compliance, farm support programs could encourage producers to drain wetland or farm highly erodible land (without taking steps to limit soil erosion) even as conservation programs encourage farmers to adopt soil conservation practices, retire environmentally sensitive land, and protect wetlands. As a conservation policy tool, Compliance uses farm program benefits as an incentive to encourage soil conservation and discourage wetland drainage for crop production.

HELC implementation coincided with a large reduction in soil erosion on U.S. cropland. Between 1982 and 2012, soil erosion on cultivated cropland declined by 45 percent, from 2.9 billion tons in 1982 to 1.6 billion tons in 2012 (fig. 1). The decline in overall soil erosion reflects the use of less erosive crop production practices (i.e., conservation tillage, conservation crop rotations) but also a decline in the amount of land in cultivated crop production. Much of the erosion gains were realized between 1982 and 1997, years that closely bracketed the implementation of Conservation Compliance. Previous ERS research shows that about 25 percent of the 1982-97 reduction in cropland erosion occurred on HEL in cultivated crop production (Claassen et al., 2004).

Figure 1
Soil erosion on cultivated cropland, 1982-2012



Source: USDA, Economic Research Service analysis of the Natural Resources Conservation Service's National Resources Inventory (NRI) data.

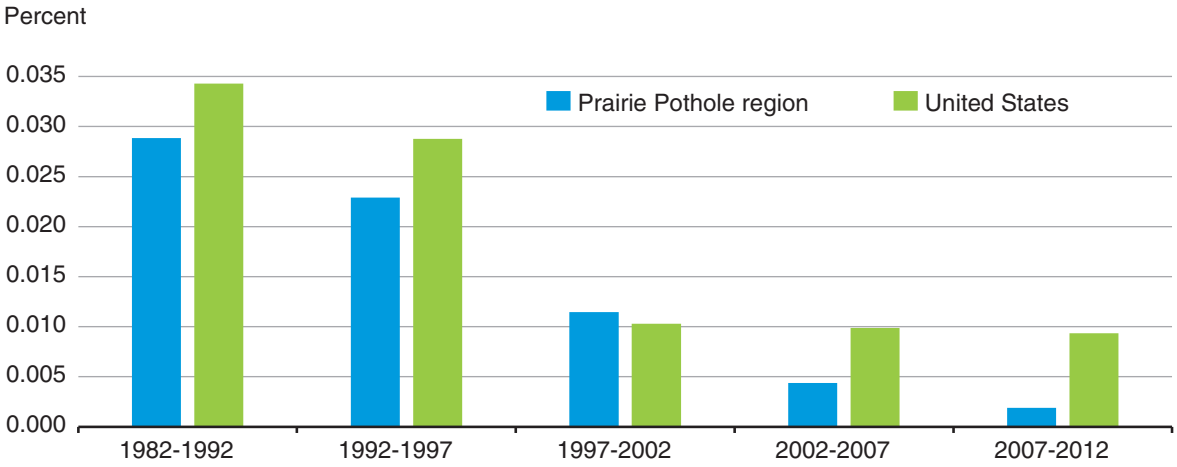
Wetland Conservation (WC) implementation also coincided with a slowing of wetland loss to agricultural production, although the timing of the slowdown was not as pegged to WC implementation as was the reduction in soil erosion and HELC. According to National Resources Inventory (NRI) data maintained by USDA's Natural Resources Conservation Service, between 1982 and 2012, 0.63 percent of wetlands were drained for agricultural use. In the Prairie Pothole States (Iowa, Montana, Minnesota, North Dakota, and South Dakota), where small, isolated wetlands are critical habitat for ducks and other migratory birds, 0.49 percent were drained for agricultural production (fig. 2). After 1997, wetland conversion rates declined, particularly in the Prairie Pothole Region.

When Is Conservation Compliance Effective? In the most straightforward terms, farmers are likely to meet Conservation Compliance requirements when the Compliance incentive—the farm program benefits they could lose due to noncompliance—exceeds the cost of meeting Compliance requirements. Producers and landowners who violate either HELC or WC on any part of their farm could become ineligible for *all* agriculture-related benefits associated with the farm, not just benefits on the land where the violation occurred. So, decisions about meeting Compliance requirements are based on incentives and costs for the entire farming operation.

A large share of Compliance incentives can be traced to three categories of Federal farm programs: commodity programs, crop insurance premium subsidies, and conservation programs. Participation and benefits received vary widely across regions and individual farms. About 36 percent of U.S. farms received commodity payments, crop insurance premium subsidies, or conservation payments in 2010 (Claassen, 2012). However, 93 percent of cultivated cropland (in 2012) was on farms that received commodity payments or crop insurance premium subsidies (see Appendix B), indicating that such benefits tend to accrue to larger farms.

The farm-level cost of Conservation Compliance depends on the farmwide extent of land subject to HELC and WC and the cost of meeting Compliance requirements on these lands (table 1). On cropland in HEL fields, the cost of HELC is the cost of maintaining an approved conservation system. On HEL that is not in crop production, the cost of HELC is income forgone on land that could have been profitably converted to crop production in the absence of HELC, less any cost associated with

Figure 2
Average annual share of wetlands converted for agricultural use, 1982-2012



Source: USDA, Economic Research Service analysis of the Natural Resources Conservation Service's National Resources Inventory (NRI) data.

Table 1
Conservation compliance costs

Land type	Cost
HEL, cropped	+ Ongoing cost of applying approved conservation system
HEL, not cropped	+ Profit foregone from crop production – Profit from noncrop use (e.g., hay or grazing) – Land conversion costs
Wetland, cropped	+ Profit forgone from higher yields with full drainage + Nuisance costs of farming around in-field wetlands – Cost of drainage
Wetland, not cropped	+ Profit foregone from crop production – Profit from noncrop use (e.g., hay or grazing) – Drainage and land conversion costs.

Source: USDA, Economic Research Service.

land-use change and the profit that would have been earned in a noncrop use (e.g., hay or grazing). For land that cannot be profitably converted to crop production, the cost of Compliance is zero.

The cost of WC is the income forgone on wetland that could have been profitably drained in the absence of wetland conservation requirements, less the cost of draining land and otherwise preparing it for crop production. When wetlands are located within fields (as is common in the Prairie Pothole Region), the cost of not draining can also include the "nuisance" cost of farming around wetlands (Gelso et al., 2008). For wetland where drainage and conversion to crop production would not be profitable, the effective cost of the WC requirement is zero.

Because meeting Conservation Compliance requirements can prompt long-term decisions on land use or investment in soil conservation practices, we assume that farmers consider Compliance

benefits and costs over more than a single year. Because farmers vary in terms of time horizon and expectations about future prices and production costs, individuals facing similar circumstances could make different decisions about Compliance. Nonetheless, as the level of farm program benefits rises relative to Compliance cost, the likelihood of meeting Compliance requirements also rises.

At a broader level, the effectiveness of Compliance as an environmental policy instrument depends on the extent to which highly erodible land and wetlands are located on farms where Compliance incentives are large enough to be effective. Given that most farm program benefits are not designed to achieve environmental outcomes (conservation programs are a notable exception)[1], such benefits are unlikely to align with farms that include large areas of HEL or wetland that are already cropped (or could be profitably converted to crop production in the absence of Conservation Compliance).

Giannakas and Kaplan (2005) argue that producers subject to Conservation Compliance have some incentive to avoid Compliance costs while misrepresenting their actions to remain eligible for farm program benefits. The researchers provide both theoretical and empirical evidence that farmers become more likely to meet Compliance requirements (less likely to misrepresent actions) as Compliance incentives rise, Compliance costs decline, or the probability of detection rises. Esseks and colleagues (1997) also show that farmers who believe the probability of detection is low are less likely to meet Compliance requirements.[2] Schnepf (2012) argues that the probability of detection is low because only a small proportion of land subject to Compliance is spot-checked by USDA staff in any given year. For example, only 0.3-1.3 percent of land subject to Compliance was spot-checked annually between 1997 and 2006 (Schnepf, 2012).

Finally, the effectiveness of Compliance incentives may be reduced by the use of graduated penalties (the discretion to impose penalties smaller than the loss of all Compliance-linked benefits) and other variances and exceptions (Stubbs, 2012). While these provisions give flexibility to program administrators, the use of graduated penalties and exceptions may alter farmers' expectations about the ultimate cost of noncompliance and could reduce the likelihood of actual compliance on some farms.

Compliance Requirements and Implementation. On highly erodible cropland that was farmed prior to December 23, 1985, soil conservation plans were required by 1990 and soil conservation systems (specified by conservation plans) had to be fully implemented by 1995. On highly erodible land converted to crop production after the 1985 Farm Act, producers are required to immediately implement a soil conservation system based on an approved conservation plan.

Soil conservation systems are a practice or set of practices, applied together, to reduce soil erosion on a specific field. For land that was in production when the 1985 Farm Act was signed, conservation plans were based on both the severity of the erosion hazard and on the cost of the plan. Initially, plans were to be designed to reduce soil erosion to the soil loss tolerance or "T" level—a soil erosion rate low enough to prevent damage to soil productivity over the long term (Li et al., 2009). During the conservation planning phase of HELC implementation, absolute adherence to the "T" standard was relaxed on fields where reducing erosion to T would have imposed costs large enough to drive land out of crop production. In addition to costs, the change reflects questions about the scientific basis of the "T" level (Cook, 1982; Johnson, 1987) and recognition that the offsite damages of

[1] Conservation programs, which account for annual spending of roughly $5 billion, are targeted to achieve environmental outcomes, although not all of the funds go to farms with highly erodible cropland or wetland.

[2] In "Evolution of Compliance Incentives," we provide information on Compliance incentives (farm program payments) and costs and show that Compliance incentives vary widely across farms.

soil erosion (e.g., impaired water quality) were generally larger than damages to soil productivity (Hansen and Ribaudo, 2008, Ribaudo et al., 1989). Offsite damages can be mitigated even if soil erosion is not reduced to "T" on every field.

Initial HELC plans included more than 1,600 different combinations of conservation practices; however, 51 percent of all plans included 1 or more of only 3 practices: conservation crop rotation, crop residue management, and conservation tillage (Claassen et al., 2004). Conservation plans written after 1996 must propose systems that yield a 75-percent reduction in soil erosion (from the pre-Compliance levels) or an erosion rate of no more than 2T, whichever is lower. Many pre-1996 conservation plans are still in place and can be transferred to new owners or producers, even if they do not meet post-1996 standards.

Land is subject to HELC based on a field-by-field determination. Highly erodible land (HEL) has an erodibility index (EI) of 8 or greater. For a specific location, the EI is a ratio of the (1) estimated annual rate of soil erosion on land that is clean-tilled throughout the year to the (2) soil loss tolerance (T). This ratio captures both the inherent vulnerability of the land to soil erosion (given climate, soil, and topography) and the natural regenerative capacity of the soil (although, as noted, the scientific basis for determining T is subject to debate). A field is designated as highly erodible when it includes at least 33.3 percent, or at least 50 acres, of highly erodible land. USDA determinations rely on soil survey data to classify each individual type of soil (map unit) in the field as highly erodible, not highly erodible, or potentially highly erodible. Where the classification of potentially highly erodible soils is critical to the HEL determination, a field visit is required (USDA, NRCS, 2010). The classification of each soil (map unit) has been frozen since January 1, 1990.

The 2012 National Resources Inventory (NRI) indicates that 83.1 million acres of cultivated cropland, about 27 percent of the U.S. total, meet the definition of HEL (EI ≥ 8). NRI points that fall on highly erodible land may or may not be included in fields that have been determined to be highly erodible for the purpose of HELC (table 2). We estimate that 92.8 million acres of cultivated cropland are in common land units (CLUs)[3] that have been determined by USDA to include enough HEL to be subject to HELC. Of cropland in CLUs subject to HELC, 60.4 million acres (65 percent) have an erodibility index of 8 or greater. The balance of cultivated HEL (with EI ≥ 8), 22.7 million acres, is in fields that do *not* meet the definition of an HEL field and, therefore, are not subject to

Table 2
Cultivated cropland by HEL and Compliance status

	All land	EI ≥ 8	Share EI≥8
	Acres (1,000)		*%*
HEL determination	92,759	60,424	65
No HEL determination	217,563	22,724	10
Total	310,322	83,148	27

Source: USDA, Economic Research Service analysis of USDA's Natural Resources Conservation Service National Resources Inventory and USDA's Farm Service Agency data.

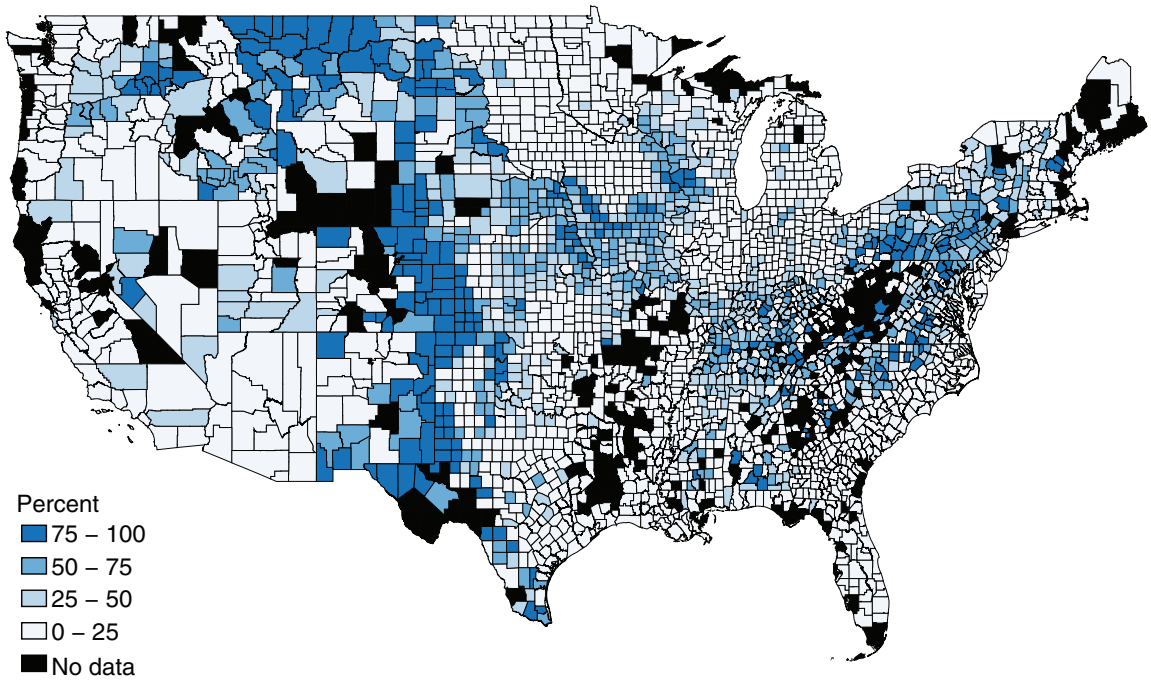
[3] A Common Land Unit (CLU) is the smallest unit of land that has a permanent, contiguous boundary; a common land cover and land management; a common owner; and a common producer on agricultural land associated with USDA farm programs. CLU boundaries are delineated from relatively permanent features such as fence lines, roads, and/or waterways. For more information, see FSA's Handbook on Common Land Units. For detail on mapping NRI points to CLUs, see Appendix B.

HELC. Cultivated cropland in HEL fields account for a high proportion of cropland in the Western Plains, parts of the upper Midwest (e.g., Iowa, Missouri, and Wisconsin), and along the Appalachian Mountains (fig. 3).

Compliance may also affect some noncropped land in HEL fields if these lands would have been cropped in the absence of the HELC sanction. Because there is no formal USDA HEL determination on most noncropped land, we estimate an HEL determination from soil-specific measures of soil erodibility gleaned from the Environmental Benefits Index (EBI) database of the Conservation Reserve Program (CRP).[4]

Defining land that is "potentially convertible" to crop production is a greater challenge. Much depends on the characteristics of specific tracts of land, including the ease and cost of conversion, soil productivity, climate, and topography. We consider land potentially convertible if (1) it is in a noncultivated crop (i.e., hay, orchards), pasture, range, or the CRP; and (2) has a Land Capability Class (LCC) of 1 or 2 *or* an LCC of 3 and field-level productivity equal to or greater than the county median for cropland.[5] To measure soil productivity, we use the National Commodity Crop Productivity Index (NCCPI; Dobos et al., 2012). NCCPI is used by USDA to adjust county-average land rental rates for variation in field-level productivity in determining bid caps in the CRP. Our

Figure 3
Cultivated cropland in HEL fields



Note: Percent of cultivated cropland in common land units with HEL determination.
Source: USDA, Economic Research Service analysis of the Natural Resources Conservation Service's National Resources Inventory and Farm Service Agency data.

[4] The EBI database includes data needed to estimate the erodibility index, for each soil, for all land with a Land Capability Classification (LCC) of 1-4.

[5] The LCC has been found to be an effective predictor of land use in a number of previous studies (e.g., Stephens et al., 2008; Lubowski et al., 2008; Rashford et al., 2011).

criteria identify lands that are similar to other land that is already in cultivated crops (see Appendix A for more detail).

In 2012, an estimated 52.0 million acres met our criteria for "potentially convertible" land that is located within an HEL field. While crop production is likely feasible on these lands, it is impossible to know how much it will be used for crop production in the future. Nor do we suggest that other land cannot or will not eventually be used for cultivated crops. This distinction provides only a general measure of the extent of land with good potential as cropland, should future economic conditions warrant it. NRI data also show that only 20 million of the 52 million acres identified above were used in cultivated crop production between 1982 and 2012. Also of note, cultivated cropland acreage declined by 49.8 million acres between 1982 and 2012 (including CRP enrollment), and increased only slightly (by roughly 4 million acres) during 2007-12, a period of high crop prices (USDA-NRCS, 2015). Therefore, we consider 52 million acres a generous estimate of cropland potential.

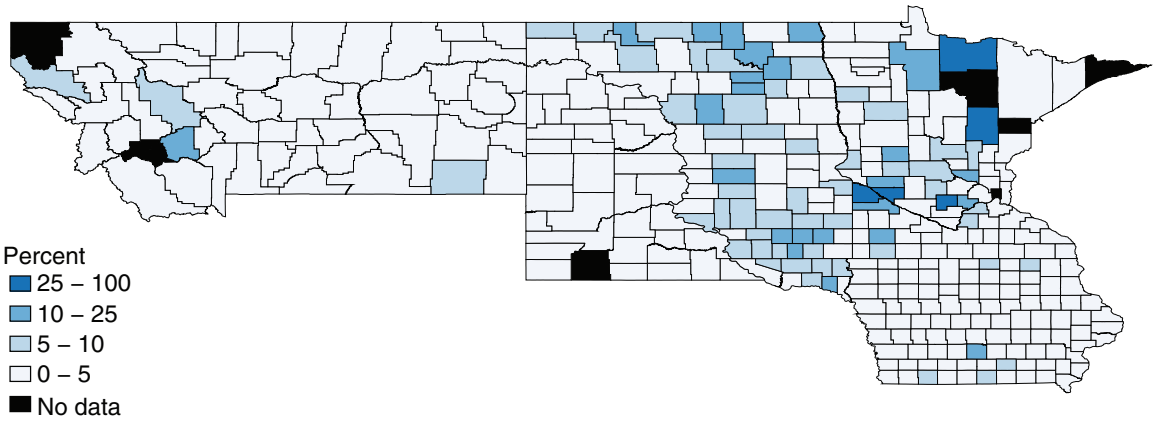
The Wetland Conservation (WC) provision also took effect as soon as the 1985 Act was signed. Farmers and landowners are in violation of WC if (1) crops are planted on land converted after December 23, 1985, or (2) wetland was drained, dredged, or filled after November 28, 1990, to make crop production possible. Wetlands that had already been drained (or partially drained) by December 23, 1985, can be farmed without restriction and drainage systems can be maintained or replaced, but drainage capacity cannot be increased (USDA-NRCS, 2012). Wetlands that are naturally dry enough to be cropped (at least in some years) can be used for crop production so long as the land is not manipulated in a way that would affect wetland status. WC exemptions are available for minimal effects, artificial wetlands (e.g., fish ponds, flooding for rice production), conversions caused by a third party, or natural conditions (such as drought) that make crop production on wetlands feasible without drainage.

The NRI identifies wetlands based on the Cowardin system. A specific location is classified as wetland only if it has one or more of the following attributes: (1) at least periodically, the land supports predominantly hydrophytes (water loving plants); (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year (Cowardin et al., 1979). When people think of wetlands, they commonly think of swamps and marshes but other landscapes are wetlands too. Most wetlands are defined by two features. First, the soils are wet often enough to support wetland biota and constrain agricultural use. Second, wetlands need not be flooded in all years but, when flooded, water levels do not exceed 3 feet.

For WC, data limitations require that we limit our analysis to five States in the Prairie Pothole Region (PPR): Iowa, Minnesota, Montana, North Dakota, and South Dakota. "Potentially convertible" wetland includes wetland that is already in crop production (because it is dry enough in some years to farm). Improved drainage on wetland that is already cropped may improve crop yields and increase the number of years during which crops can actually be grown. Draining wetlands located within fields can also reduce or eliminate the "nuisance" cost of farming around wetlands (Gelso et al., 2008). For wetland that is not already cropped, our definition of potentially convertible wetlands includes noncropped wetlands that have (1) seasonal hydrology and (2) LCC of 1 or 2, or LCC of 3 and CLU average productivity equal to or higher than the median productivity of other cropland in the same county (fig. 4).

Figure 4

Potentially convertible wetland as a proportion of cultivated cropland, Prairie Pothole



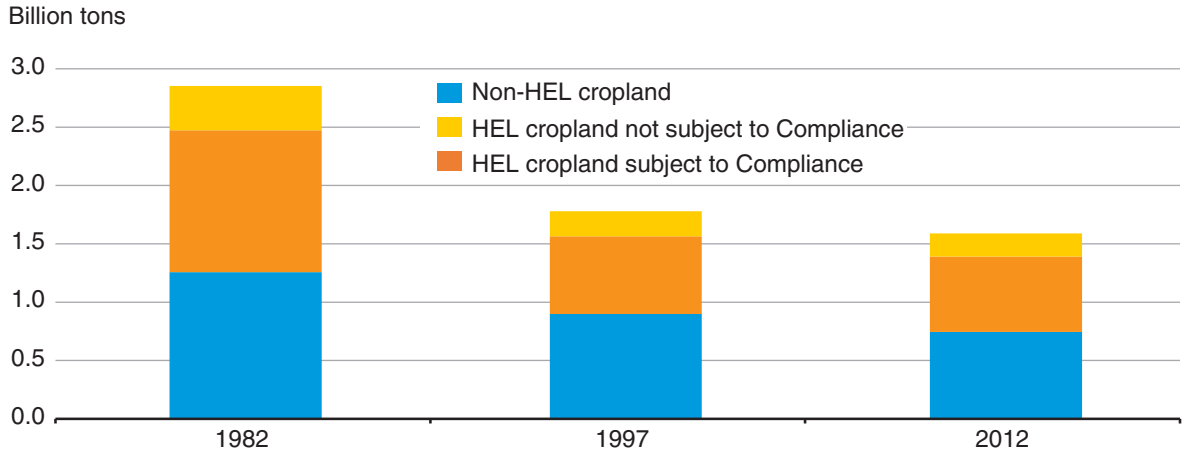
Source: USDA, Economic Research Service analysis of Natural Resources Conservation Service's National Resources Inventory data.

Conservation Compliance and Soil Conservation, 1982-2012

Total annual erosion has been declining on cultivated cropland since 1982, when USDA's Natural Resources Conservation Service first began developing national estimates of wind and water erosion as part of the National Resources Inventory (NRI).[6] Between 1982 and 1997, when Conservation Compliance provisions were newly implemented, total erosion on cultivated cropland declined from 2.9 billion tons to 1.8 billion tons per year, a 38-percent reduction. Between 1997 and 2012, the declines were smaller; total erosion on cultivated cropland was 1.6 billion tons in 2012 (fig. 5). Though highly erodible land accounts for less than 30 percent of all cultivated cropland, more than half of all erosion in 1982 was on highly erodible land (NRI points with an erodibility index greater than 8), and more than 75 percent of highly erodible land in 1982 was subject to Compliance (in a field designated as HEL by USDA, as defined in "Conservation Compliance and Soil Conservation, 1982-2012"). The greatest decrease in soil erosion rates over 1982-2012 also occurred on highly erodible cultivated cropland in fields determined to be HEL.

The bars in figure 5 represent total soil erosion on cultivated cropland in each year. The bars in figure 6 show erosion on cultivated cropland that was (1) cultivated in both periods, (2) converted to crop production between the early and late years, and (3) converted to a noncrop use (including into CRP or out of cultivation) between the early and late years. Figure 7 shows the same information for highly erodible land in an HEL field (subject to HELC).

Figure 5
Annual soil erosion on cultivated cropland in 1982, 1997, and 2012

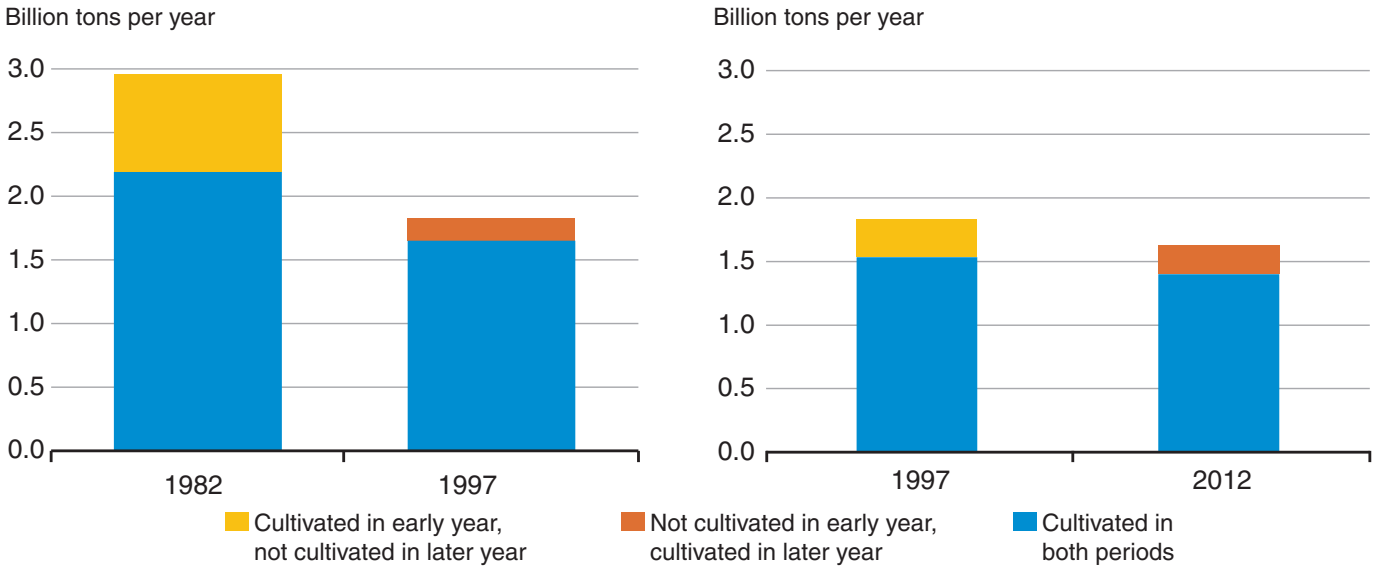


Note: HEL (highly erodible land) cropland subject to Compliance includes erosion from fields that were designated by USDA's Farm Service Agency as highly erodible but that may or may not have had FSA base acres or received payments through USDA programs subject to Compliance sanction.
Source: USDA, Economic Research Service using the Natural Resources Conservation Service's National Resources Inventory data.

[6] The NRI is an area-frame survey that includes data on land use, land quality, and land condition at more than 800,000 points of land, collected at 5-year intervals over 1982-2012. NRI provides a statistically representative sample of the entire land base, identifying land by use (cropland, pasture, etc.) and providing (or linking to) information on soil erosion, the inherent erodibility of soils, wetland area, wetland type, topography, and soil productivity. For more information, see Appendix A.

Figure 6

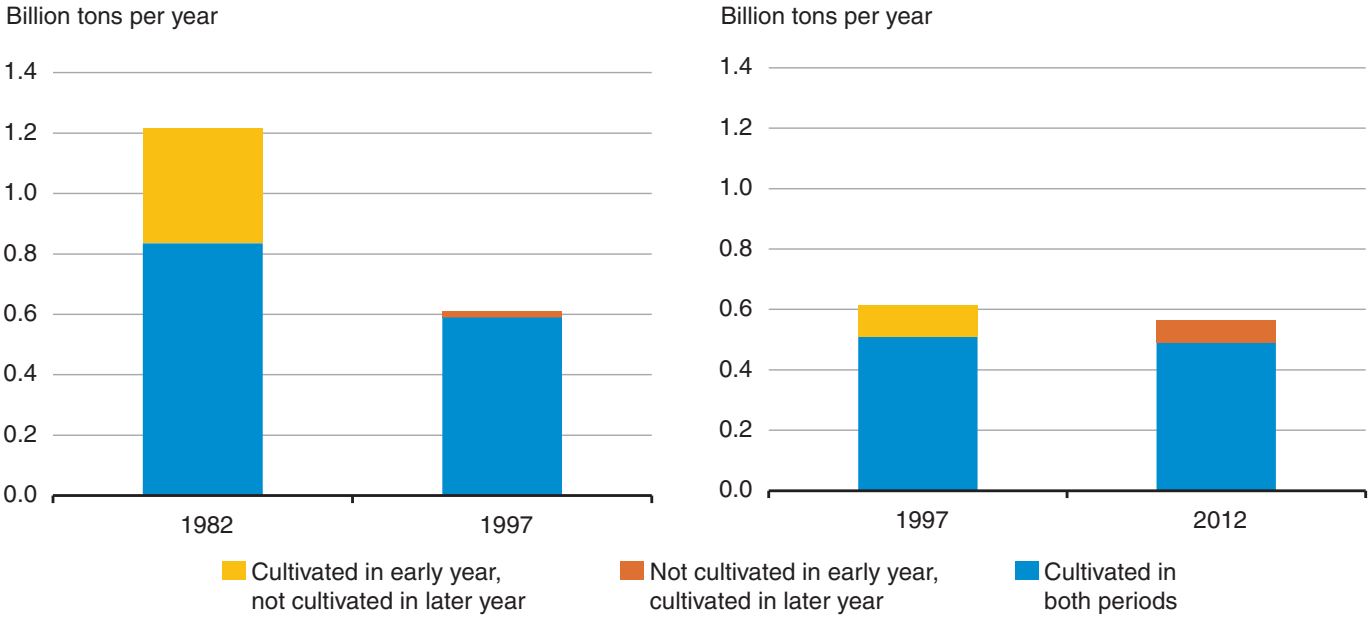
Annual soil erosion on cultivated cropland in 1982 and 1997, and in 1997 and 2012



Source: USDA, Economic Research Service analysis of Natural Resources Conservation Service's National Resources Inventory data.

Figure 7

Annual soil erosion on cultivated cropland that is highly erodible and located in HEL fields (subject to HELC) in 1982 and 1997, and in 1997 and 2012



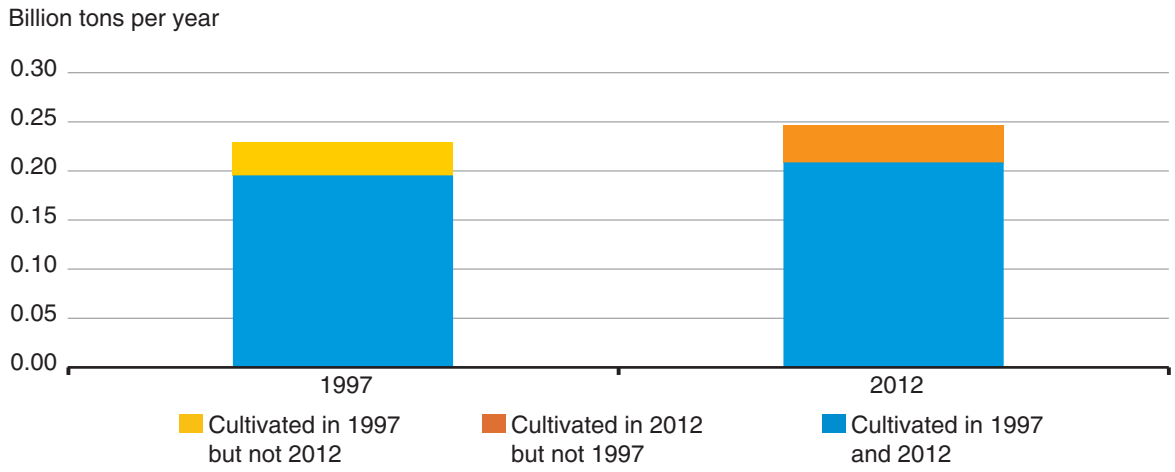
Note: The blue bars in the left graph correspond to total erosion from roughly 54 million acres of land that was cultivated in both periods, and the blue bars in the right graph correspond to erosion on roughly 51 million acres.
Source: USDA, Economic Research Service analysis of Natural Resources Conservation Service's National Resources Inventory data.

While a large share of erosion reductions occurred on land that was cultivated in both periods (the blue bars), changes in land use also contributed to changes in erosion rates as land transitioned from cropland out of cultivation and into the CRP or other land uses, or from the CRP or other uses into cultivation. In 1982, more than 398 million tons of soil erosion (~13 percent of all soil erosion on cultivated cropland) were on cropland that had transitioned into the CRP in 1997. For highly erodible cropland, roughly 22 percent of erosion on cultivated cropland in 1982 was on land that had transitioned to CRP by 1997. In contrast, by 2012 70 million tons of erosion occurred on cropland that had been enrolled in the CRP in 1997. These erosion reductions, however, cannot be attributed to HELC because HELC requirements were designed to avoid forcing land out of cultivated crop production, (see box, "Why Are Some NRI Points That Are Highly Erodible Subject to Compliance, But Not Others?").

The direct effect of HELC is confined to cultivated cropland in HEL fields. On highly erodible cultivated cropland located in fields determined to be highly erodible land and, therefore, subject to HELC requirements, soil erosion dropped from 1.2 billion tons in 1982 to 0.7 billion tons in 1997, a 42-percent reduction. Aggregate erosion change, however, masks considerable variation in soil erosion rate changes. For example, ***water*** erosion on cultivated cropland that is highly erodible for water and subject to Compliance (in a field designated as HEL by USDA) increased in 2012 relative to 1997 (fig. 8), although these increases were more than offset by declines in wind erosion.

Likewise, erosion rate changes vary spatially during both the 1982-1997 and 1997-2012 spans, with some of the greatest decreases in water erosion occurring between 1982 and 1997 in the Corn Belt. The greatest decreases in county-level wind erosion averages occurred in the Great Plains between 1982 and 1997. For highly erodible land that was in an HEL field and remained in cultivation during the two periods, we see widespread (although not universal) declines in county-average soil erosion due to water during 1982-1997 but widespread—although modest—increases in county-average soil erosion (tons/acres/year) due to water during 1997-2012 (fig. 9). For wind erosion, the pattern of change is similar.

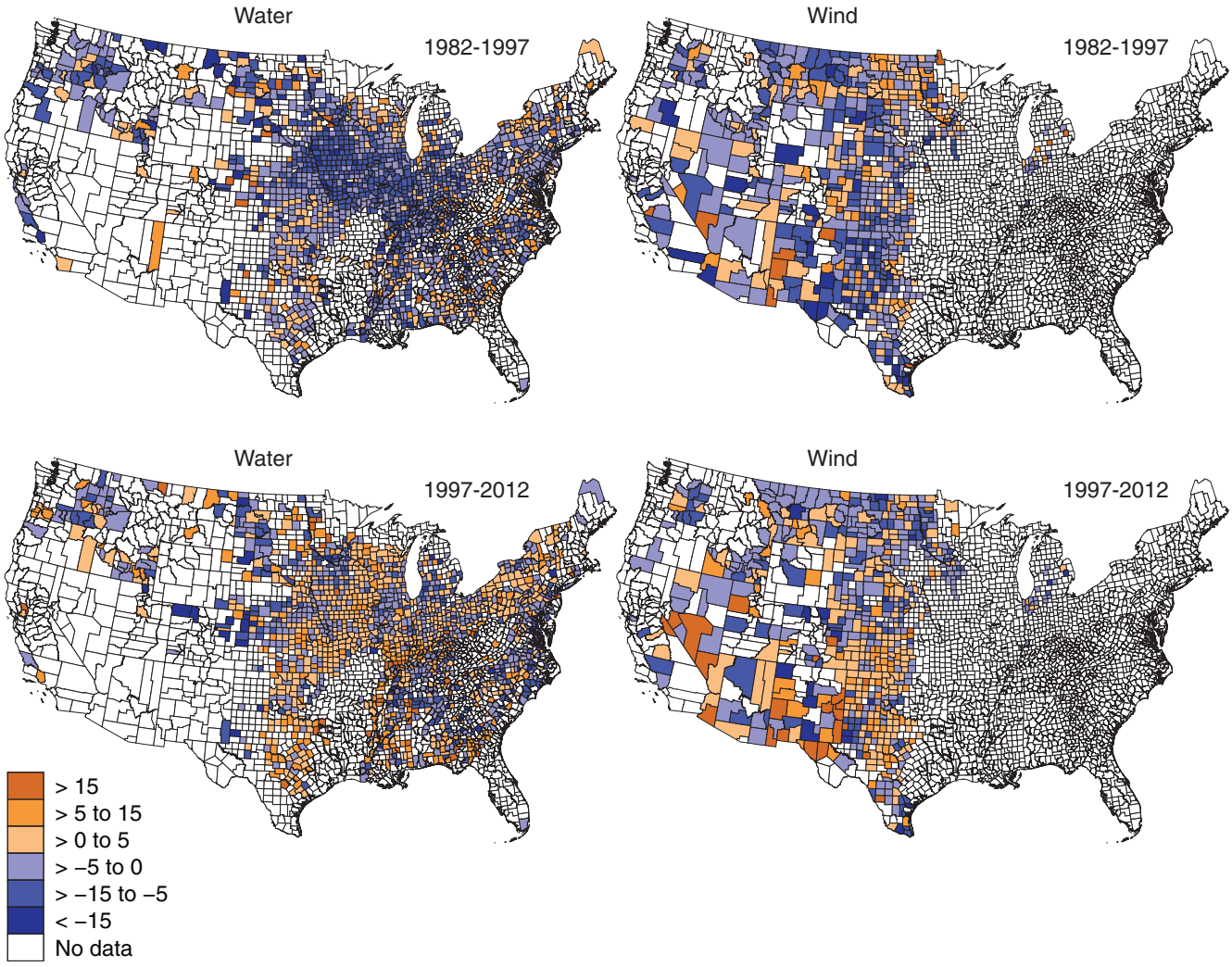
Figure 8
Sheet and rill erosion due to water on cultivated cropland that is highly erodible and located in HEL fields (subject to HELC) in 1997 and 2012



Note: The blue bars show an increase in water erosion on approximately 21 million highly erodible acres that were cultivated in both periods.

Figure 9

Average changes in annual erosion (tons/acre/year) between 1982 and 1997 and 1997 and 2012 for cultivated cropland highly erodible for water and wind



Note: For each map, the change is for land that was in cultivated cropland in both periods (i.e. for the 1982-1997 period, the map contains averages only for NRI points that were in cultivated cropland in 1982 and in 1997).
Source: USDA, Economic Research Service analysis of Natural Resources Conservation Service's National Resources Inventory data.

Estimating the impact of Conservation Compliance on erosion. Soil erosion rates declined broadly during the implementation period for HELC. Although HELC applied only to land in fields determined to meet HELC criteria, soil erosion also declined on cultivated cropland not subject to Compliance. Because of the broad decline in erosion rates, it is difficult to identify how much soil erosion reduction is attributable to HELC and how much resulted from "spillover" effects or would have happened even without the Compliance stricture.

To estimate the impact of HEL Compliance provisions on erosion between 1982 and 2012 (during and after Compliance implementation), we use a regression model to look at the impact of HELC (a field being designated as highly erodible by USDA) on annual erosion. Controlling for farm operation size, biophysical characteristics, the inherent erodibility of the soil, and other NRI-point and farm-level characteristics and factors common across regions, we estimate the impact of a field-level

HEL designation on changes in erosion at the NRI point (see box, "Why Are Some NRI Points That Are Highly Erodible Subject to Compliance, But Not Others?").

HEL designation is found to have a statistically significant impact on reducing erosion on highly erodible cropland (land with an erodibility index of 8 or greater in HEL fields) between 1982 and 1997. For land that was (1) in continuous crop production (1982-2012), (2) associated with commodity program base acres (the largest source of Compliance incentives), and (3) highly erodible for water, being in an HEL-designated field reduced predicted annual erosion by an estimated 2.7 tons/acre when compared to highly erodible cultivated cropland not in an HEL-designated field, a statistically significant difference. During 1982-1997, soil erosion was reduced by 6.6 tons per acre on cropland highly erodible for water that was subject to HELC, 69 percent larger than the 3.9 tons per acre reduction on cropland highly erodible for water that was not subject to HELC (fig 10).

On land that was designated as highly erodible for wind, the average soil erosion reduction on land in an HEL field was an estimated 3.2 tons/acre, 41 percent larger than the 2.3-tons/acre reduction on similar land that is not in an HEL field (fig. 11). However, the difference between the HEL fields and non-HEL fields—about 0.9 ton per acre—is not statistically significantly different from zero. So, while the analysis does show large and significant erosion reductions for cropland that is highly erodible for wind, the erosion reductions on wind-erodible cropland in an HEL field were not significantly larger than for cropland that was not in an HEL field. As such, we are not confident that these predicted differences in erosion reductions between the two groups are due to Conservation Compliance.

During 1997-2012, HELC requirements were unchanged for most cultivated cropland that was already in production in 1985. So, a critical question is whether soil conservation gains were maintained over this latter period. On cultivated cropland that is highly erodible for water or wind, the model predicts no significant change from 1997 to 2012 in annual soil erosion, regardless of whether the land was subject to HELC. Variable descriptions, descriptive statistics, and full regression results are presented in Appendix C.

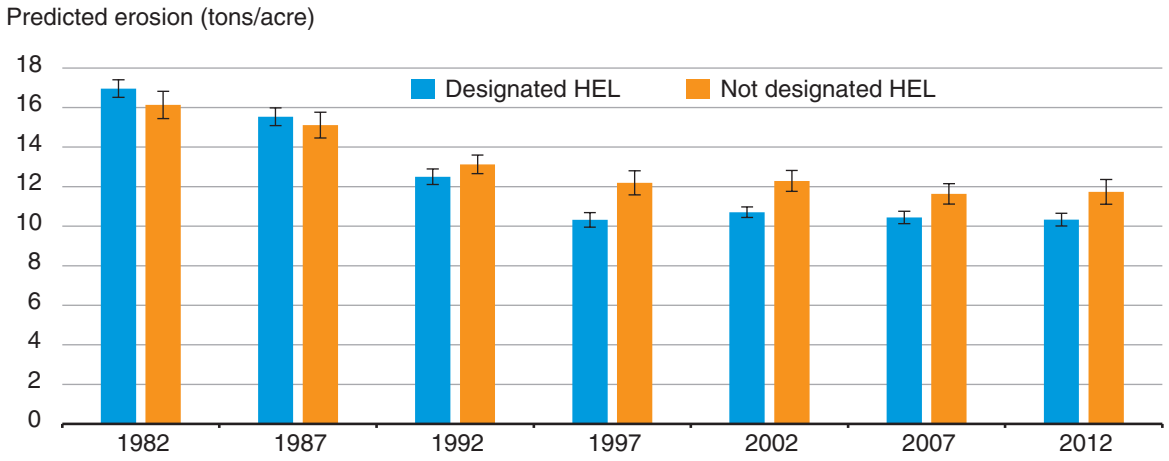
Although erosion declined across the board during the implementation period for HELC (1982-97), our results suggest that Compliance had a significant and additional effect on erosion on highly erodible land during the period. After 1997, these reductions appear to have been maintained.

Why Are Some NRI Points That Are Highly Erodible Subject to Compliance, But Not Others?

Erosion rates and erodibility indices in the National Resources Inventory are calculated at the NRI point. A highly erodible NRI point has an erodibility index greater than or equal to 8. In contrast, the HEL designation made by USDA's Farm Service Agency is based on the amount of highly erodible land within a field. If a field contains more than one-third, or 50 acres, of highly erodible land, it qualifies as highly erodible for Compliance purposes. This means that some NRI points are highly erodible and located within highly erodible fields, while other points are highly erodible but not located in fields designated as highly erodible. This allows us to compare erosion at similar NRI points, some of which are subject to Compliance while others are not.

Figure 10

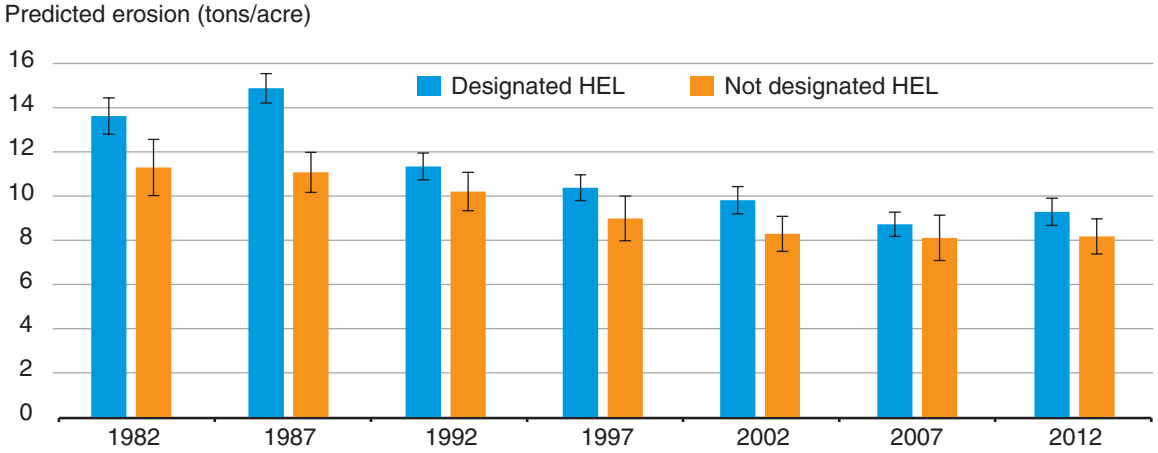
Predicted erosion for National Resources Inventory points in cultivated cropland that was highly erodible for water, 1982-2012



Notes: HEL = highly erodible land. The height of the bar is the soil erosion estimate. The error bars represent a 95-percent confidence interval. Erosion reduction is the difference in height of the bars over time.
Source: USDA, Economic Research Service.

Figure 11

Predicted erosion for National Resources Inventory points in cultivated cropland that was highly erodible for wind, 1982-2012



Notes: HEL = highly erodible land. The height of the bar is the soil erosion estimate. The error bars represent a 95-percent confidence interval. Erosion reduction is the difference in height of the bars over time.
Source: USDA, Economic Research Service.

Evolution of Compliance Incentives

Maintaining the soil conservation gains under Conservation Compliance requires the continued fashioning of sufficient and suitable incentives—farm program benefits that can be withheld from producers who violate Highly Erodible Land Conservation (HELC) or Wetland Conservation (WC) provisions. The Agricultural Act of 2014 altered Compliance incentives by (1) ending Direct Payments to producers, (2) ending formal crop disaster assistance,[7] (3) adding crop insurance premium subsidies to the list of payments subject to withdrawal in the event of a Compliance violation, and (4) creating or modifying other programs in order to cover losses not usually covered by crop insurance (sometimes referred to as "shallow" losses).

Crop insurance premium subsidies were subject to Compliance sanction under the 1985 Farm Act, but were removed from Compliance by the 1996 Farm Act to encourage crop insurance purchase. The 2014 Farm Act reversal reflects the increasing importance of crop insurance in the package of benefits provided to farmers by the Federal Government. Since the mid-1990s, premium subsidy rates have increased significantly (the average subsidy is roughly 60 percent) and participation has grown to cover 80 percent or more of the four most widely grown crops (corn, soybeans, wheat, and cotton) (Shields, 2015).

The 2014 Farm Act also offers a series of new programs, including Price Loss Coverage (PLC), Agricultural Revenue Coverage (ARC), the Stacked Income Protection Plan (STAX; cotton producers only) and a Supplemental Coverage Option (SCO). PLC is similar to the Countercyclical Payment Program (CCP) under the 2008 Act. ARC, STAX, and SCO are shallow-loss programs designed to supplement regular crop insurance.

Upon passage of the 2014 Farm Act, spending projections for 2015-18 suggested that farm program payments that form the core of Compliance incentives under the 2014 Act could be larger than Compliance-bound payments under the 2008 Act (USDA-ERS, 2014). This aggregate measure of Compliance incentives, however, may mask significant farm-level variation in Compliance incentives. Eliminating Direct Payments and relinking crop insurance subsidies to Compliance could result in a significant regional shift in Compliance incentives (Claassen, 2012). Consequently, some farms could see an increase in Compliance incentives under the 2014 Act (compared to a continuation of the 2008 Farm Act), while others could see a decline in incentives.

In this chapter, we (1) develop farm-level estimates of Compliance incentives under the 2008 and 2014 Farm Acts, (2) show how these incentives are distributed across land subject to HELC and WC, and (3) show how the distribution of payments would be altered if crop insurance premium subsidies were no longer subject to Compliance (fig. 12) (see box, "Major Programs Subject to Compliance Under the 2008 and 2014 Farm Acts").

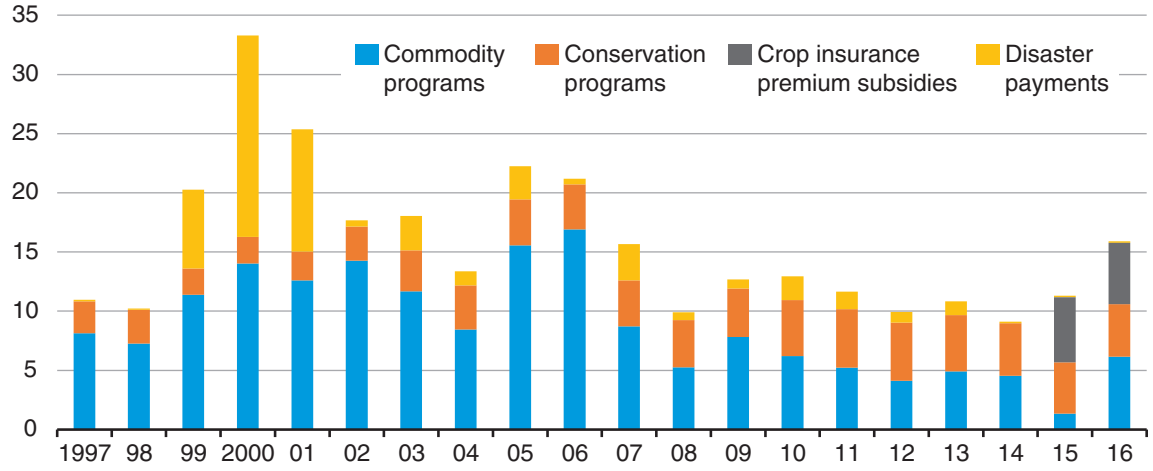
Evaluating Compliance Incentives

To obtain statistically reliable estimates of agricultural land subject to Compliance (highly erodible land or wetland), regardless of participation in Government programs, we use the National

[7] Ad hoc disaster assistance is still possible and can be approved in response to future disaster.

Figure 12
Compliance incentives by fiscal year, 1997-2016

$ Billion (2012)



Source: USDA, Economic Research Service analysis of USDA's Office of Budget and Policy Analysis data.

Resources Inventory (NRI).[8] To characterize the Conservation Compliance incentive at individual NRI points, we link NRI points to farming operations defined using USDA administrative data (see Appendix B for details). A farming operation is defined as a collection of fields under common management. Not every farming operation includes an NRI point, but many operations include more than one NRI point. Our data include more than 200,000 farms that are linked to 1 or more NRI points and account for roughly 40 percent of land in the 6 most widely grown crops (corn, soybeans, wheat, cotton, sorghum, and barley). For each of these farms, we estimate commodity payments, crop insurance premium subsidies, and conservation payments under the 2008 and 2014 Farm Acts.

Ideally, the farm-level Compliance incentive would be characterized relative to the farmwide cost of meeting Compliance requirements. For NRI points that fall on land subject to HELC or WC where farm-level Compliance incentives exceed Compliance cost, Conservation Compliance is likely to be effective. Where Compliance incentives fall short of Compliance cost, the effectiveness of Compliance is less certain.

Farm-level data on Compliance incentives are developed using USDA administrative data (see next section and Appendix D online). Farm-level data on Compliance costs, however, are not available. We normalize farm-level Compliance incentives in two ways to facilitate cross-farm comparison and account for at least part of the likely variation in Compliance costs:

- **Compliance incentives per acre of land subject to Compliance—**that is, total farmwide payments divided by the number of acres subject to HELC or WC. This normalization recognizes that farmwide conservation costs depend on the number of acres that are subject to HELC or WC. More acres generally mean higher costs.

[8] The NRI is an area-frame survey that includes data on land use, land quality, and land condition at more than 800,000 points of land located in 300,000 primary sampling units, collected at 5-year intervals. Just over 500,000 NRI points fall on agricultural land (cropland, pasture, range, and forest linked to USDA administrative farms). For more information, see Appendix A.

Major Programs Subject to Compliance Under the 2008 and 2014 Farm Acts

Commodity programs support farm income by providing payments to producers of "covered" crops when prices or revenue fall below predetermined benchmark levels (see Appendix D for full detail). Covered crops include feed grains (corn, sorghum, barley, and oats); oilseeds (soybeans, sunflower, canola, etc.); rice; wheat; peanuts; and pulse crops (dry peas, lentils, chickpeas). Cotton was a covered crop under the 2008 Farm Act but not under the 2014 Act.

Commodity programs were changed considerably by the 2014 Farm Act. Nonetheless, many of the 2014 programs are similar to 2008 programs. Price Loss Coverage (PLC) under the 2014 Act, for example, is similar to the Countercyclical Payment Program (CCP) under the 2008 Act. 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 (CCP, PLC) 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). The 2008 Farm Act also included a crop disaster assistance program that was not continued in the 2014 Act. The Marketing Loan Benefit (MLB) was available to producers under the 2008 Farm Act and continues under the 2014 Act.

Base acreage is required for commodity program payments. In general, base acreage depends on past plantings of covered crops, although the exact rules governing allocation of base acreage have changed periodically. The most significant change in the 2014 Farm Act excludes cotton from the list of "covered" crops. Cotton base acres were redesignated as "generic" base and can be used as base acreage for other covered crops under certain conditions (see Appendix D).

Conservation programs encourage farmers to adopt practices that conserve resources and reduce the environmental impact of agricultural production. The three largest conservation programs, the Environmental Quality Incentives Program (EQIP), the Conservation Stewardship Program (CSP), and the Conservation Reserve Program (CRP) accounted for more than 80 percent of USDA conservation spending in 2013. These programs were in place under the 2008 and 2014 Farm Acts, although each of these programs underwent modest changes in the 2014 Act.

A wide range of crop insurance products is available to farmers under both the 2008 and 2014 Act, but premium subsidies were not subject to Compliance sanction under the 2008 Act. The Supplemental Coverage Option and Stacked Income Protection (cotton only) products were added by the 2014 Farm Act to help provide protection for "shallow" losses. See Appendix D online for full detail.

—continued

Major Programs subject to Compliance under the 2008 and 2014 Farm Acts—continued

Major commodity, crop insurance, and conservation programs in the 2008 and 2014 Farm Acts

		2008	2014	Conditions
Commodity programs				
Marketing Loan Benefits	MLB	x	x	Loan rates differ for wheat
Direct Payments	DP	x		
Countercyclical Payments	CCP	x		
Average Crop Revenue Election	ACRE	x		No CCP, Reduced DP, MLB
Price Loss Coverage	PLC		x	Chose PLC, ARC-CO, or ARC-IC
Agricultural Risk Coverage—Individual	ARC-IC		x	
Agricultural Risk Coverage—County	ARC-CO		x	
Disaster programs				
Supplemental Revenue Assistance	SURE	x		Producer must buy crop insurance to be eligible
Conservation programs				
Environmental Quality Incentives Program	EQIP	x	x	
Conservation Stewardship Program	CSP	x	x	
Conservation Reserve Program	CRP	x	x	
Crop insurance				
Yield and Revenue Coverage	--	x[1]	x	Many insurance products
Supplemental Coverage Option	SCO		x	Only PLC participants
Stacked Income Protection	STAX		x	Only cotton producers

Note: Chart includes only those programs that are actually modeled (see Appendix D, online) or were new in the 2014 Farm Act. Agricultural Risk Coverage-Individual and the Supplemental Coverage Option are not modeled because of low participation.
[1]Crop insurance was available under the 2008 Farm Act, but premium subsidies were not subject to Compliance sanction.
Source: USDA, Economic Research Service.

- **Compliance incentives per acre of land subject to Compliance, relative to cropland rental rates.** Cropland rental rates are a proxy for crop profits. Crop profit on land subject to Compliance is generally an upper bound on Compliance costs. For HEL or wetland that is not in crop production but could be profitably cropped without Compliance, crop profits are an upper bound because net profit forgone is crop profit less any land conversion cost and profit from an existing land use (e.g., grazing). For HEL that was already in crop production in 1985, HELC allowed producers to use conservation systems that limited cost to avoid driving land out of crop production. Compliance costs that exceeded crop profit would have driven land out of crop production. To normalize per-acre farm program benefits, we divide by the local cropland rental rate.

Cropland rental rates[9] are based on the county Soil Rental Rate for the Conservation Reserve Program (CRP), adjusted to farm-specific soil productivity using the National Commodity Crop Productivity Index (NCCPI) maintained by USDA's Natural Resources Conservation Service.

Estimating farm-level Compliance incentives. We estimate the change in Compliance incentives from the 2008 Farm Act to the 2014 Farm Act for more than 200,000 farming operations that include NRI points. Benefits modeled include commodity program payments, crop insurance premium subsidies, conservation program payments, and disaster assistance under the Supplemental Revenue Assistance (SURE) program. Full details are in online Appendix D.

Because crop prices are different under the 2008 and 2014 Farm Acts, a comparison of actual commodity program payments under both acts could be misleading. For a better comparison, we use a simulation model to estimate payments under the 2014 Act and compare them to payments that would have been made under an extension of 2008 Act programs, using three crop price scenarios. Nearly all commodity program and disaster payments are triggered when a crop price or crop revenue drops below a benchmark level. To estimate an "expected" value for payments, we (1) look only at farms that have commodity program "base acreage," (2) consider farm-level one-time program participation decisions,[10] (3) develop farm-level empirical distributions of crop prices and yields, and (4) estimate average payments for 2008 and 2014 Act programs over all points in the distribution.

Farm-level crop insurance premium subsidies are based on administrative data for 2013, adjusted for crop prices. Crop insurance subsidies are directly and linearly related to crop prices—if premium rates are unchanged and farmers continue to purchase the same type of crop insurance and level of coverage as they did in 2013. While these conditions are not always met, crop insurance products are similar under the 2008 and 2014 Farm Acts, so farmers can continue to purchase products that existed in 2013. To adjust subsidies to various price scenarios, we divide the farm- and crop-specific subsidy by the 2013 crop insurance base price and multiply by the base price for the (low, medium, or high) price scenario. See Appendix D for full details.

We use three crop price scenarios (table 3) that correspond roughly to crop prices in 2004 (low), 2010 (medium), and 2013 (high). The low, medium, and high prices are selected to span the range of crop prices between 2000 and 2016. Figure 13 shows 2000-2016 prices against our scenario prices for corn (the comparison is similar for other crops, see the Appendix D). Farm program payment parameters under the 2008 and 2014 Farm Acts are shown in table 4.

Finally, conservation payment data are from the three largest USDA conservation programs: the Conservation Reserve Program (CRP), the Environmental Quality Incentives Program (EQIP), and the Conservation Stewardship Program (CSP). In 2013, these programs accounted for about 84

[9] Cropland rental rates are not a perfect proxy for profit. In areas where HEL accounts for a large share of cultivated cropland, rental rates may reflect some part of Compliance cost, making rental rates lower than pre-Compliance profit. The extent to which farmers can pass these costs through to landowners depends largely on local competition for land. Even if 100 percent of Compliance cost can be passed along to landowners in the form of lower cropland rental rates, the rental value of land in crop production will be an upper bound on Compliance incentive needed to fully cover Compliance costs so long as Compliance cost is less than 50 percent of pre-Compliance profit.

[10] Under the 2008 Farm Act, farmers could make a one-time choice to participate in the Average Crop Revenue Election (ACRE) program in exchange for reduced Direct Payments, marketing loan benefits, and Countercyclical Payments. Under the 2014 Farm Act, a producer could make a one-time choice between Agricultural Revenue Coverage (ARC; county- or farm-specific versions) and Price Loss Coverage (PLC).

Table 3

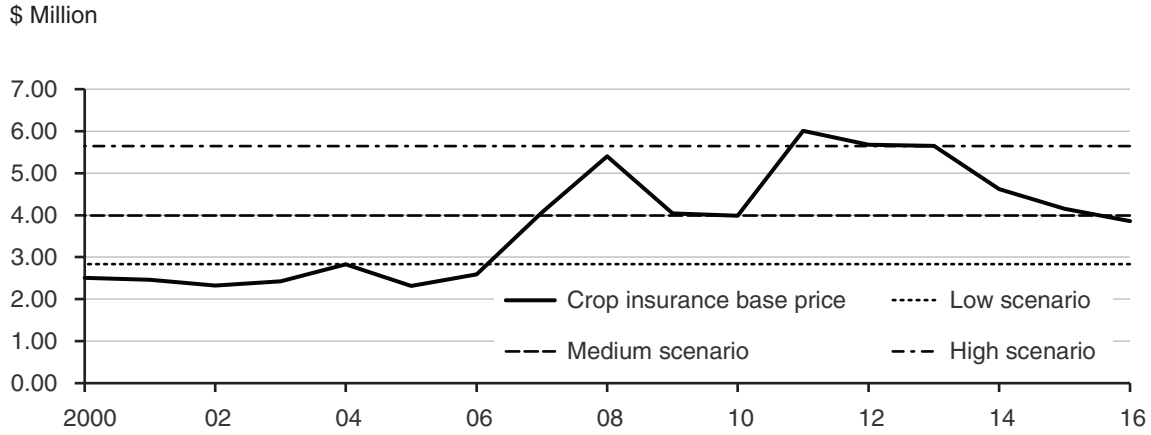
Price scenarios for Compliance analysis

	Crop insurance base (expected) prices ($/bu.)					
	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 13

Corn prices for 2000-2016 with low, medium, and high scenario prices



Source: USDA, Economic Research Service.

Table 4

Farm program payment parameters

		2008 Farm Act (2013)			2014 Farm Act	
Crop	Unit	DP rate	CCP target price	Loan rate	PLC reference price	Loan rate
Barley	$/bu	0.24	2.63	1.95	4.95	1.95
Corn	$/bu	0.28	2.63	1.95	3.7	1.95
Cotton	$/lb	0.0667	0.7125	0.5192	--	0.5192
Sorghum	$/bu	0.35	2.63	1.95	3.95	1.95
Soybeans	$/bu	0.44	6	5	8.4	5
Wheat	$/bu	0.52	4.17	2.75	5.5	2.94

Notes: DP = Direct Payment; CCP = Countercyclical Payment; PLC = Price Loss Coverage. -- = Not applicable.
Source: USDA, Economic Research Service.

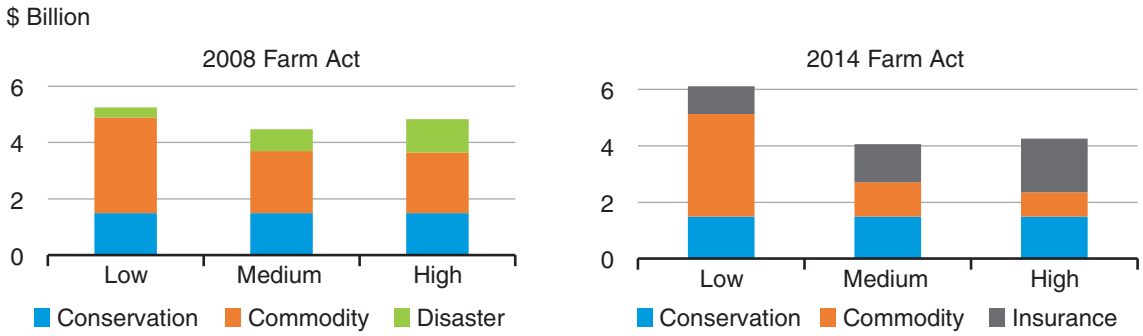
percent of USDA funding for conservation programs that provide financial assistance to farmers. For contracts that were active in 2013, we estimate an average annual payment for each program equal to total contract obligations divided by the number of years in the contract. These average annual payments are summed across programs to create a farm-level annual average payment. Although the 2014 Farm Act consolidated programs, program functions and funding levels are similar under the 2008 and 2014 Farm Acts.

Our estimate of total expected conservation payments, commodity payments, and crop insurance premium subsidies on modeled farming operations is $4-6 billion, depending on the Farm Act and price scenario (figure 14). Given that farming operations including one or more NRI points account for roughly 40 percent of cultivated cropland, these payments imply overall farm program payments of $10-15 billion. In March 2016, the Congressional Budget Office projected spending of about $12 billion per year on all farms over the course of the 2014 Farm Act.

When compared to the 2008 Farm Act, estimated farm program benefits (Compliance incentives) under the 2014 Act are higher in the low-price scenario but lower in the medium- and high-price scenarios. Higher benefits in the low-price scenario likely reflect higher payments for programs that compensate farmers for low prices or low revenue. For example, Price Loss Coverage (PLC) payments are triggered when crop prices drop below the applicable reference prices, which are higher than the target prices that were used to trigger Countercyclical Payments (CCP) under the 2008 Farm Act (table 4). Although most corn and soybean producers elected ARC-county coverage and are not eligible for PLC, the PLC reference prices are also the lowest prices that could be used to calculate the level of revenue that triggers an ARC payment. In the medium- and high-price scenarios under the 2008 Act, commodity payments are mostly Direct Payments, which did not depend on current production or prices. Under the 2014 Act, commodity payments mostly compensate farmers for low price or low revenue, so spending on commodity program payments can be much smaller than under the 2008 Act in years when crop prices are high.

In contrast, crop insurance premium subsidies rise as prices rise. Higher prices mean higher crop insurance liability, higher liability means higher premiums, and higher premiums mean higher premium subsidies for a given insurance product and coverage level. In the high-price scenario, crop insurance premium subsidies are a particularly large share of overall payments that could be subject to Compliance sanction. As a Compliance incentive, the premium subsidies help offset the loss of incentives from commodity programs when crop prices are high.

Figure 14
Expected farm program benefits (Compliance incentives) by price scenario



Source: USDA, Economic Research Service.

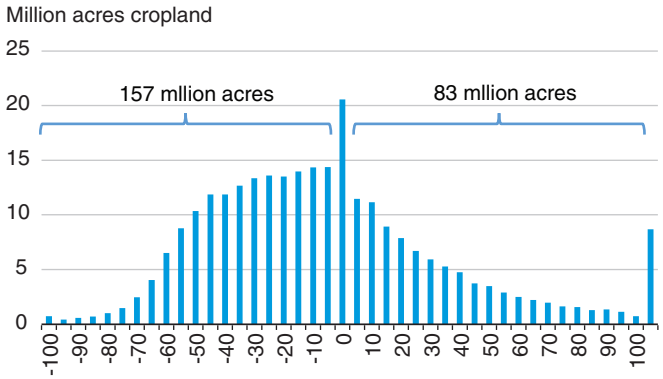
Change in Compliance incentives between the 2008 and 2014 Farm Acts. While the overall level of estimated Compliance incentives is similar across farm bills, the programs that generate the benefits subject to Compliance sanction have changed considerably, changing the distribution of Compliance incentives across farms and regions. The loss of Direct Payments means a loss of commodity payments on many farms. Depending on crop prices (or crop revenue), some farms may receive ARC or PLC payments that offset part or all of the loss in Direct Payments.

For the medium-price scenario, we estimate that Compliance incentives will change very little (+/-2.5 percent) on farms including a total of 20 million acres of cultivated cropland (6.5 percent; fig 15a) and 6.5 million acres of cropland in HEL fields (7.1 percent; fig. 15b). On these farms, conservation programs account for more than 85 percent of Compliance incentives (which are assumed to be constant across farm bills).

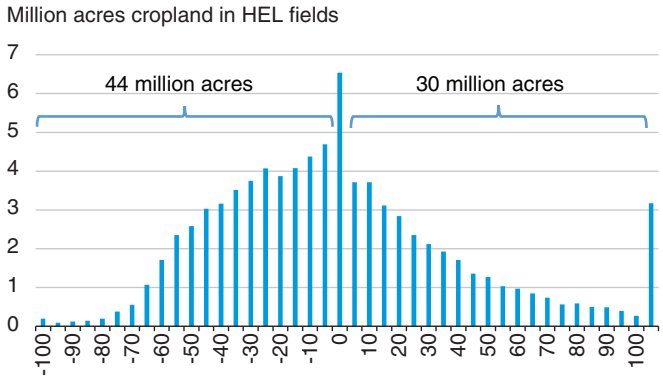
For the medium-price scenario, we estimate that Compliance incentives decline on farms that include 157 million acres (57 percent; fig 15a) of cultivated cropland and 44 million acres (48 percent; fig 15b) of cultivated cropland in HEL fields. Farms where estimated Compliance incen-

Figure 15
Change in Compliance incentives, 2014 Farm Act versus the 2008 Farm Act

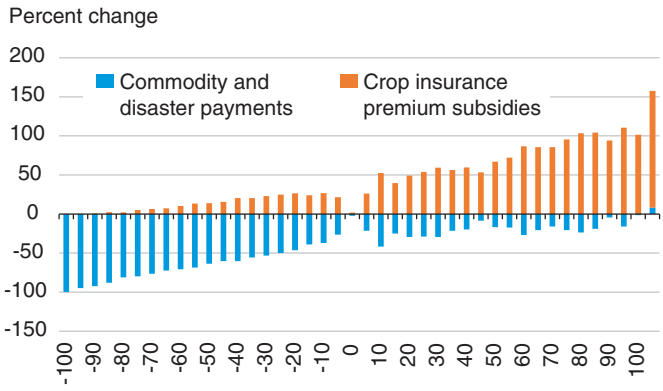
a. Cultivated cropland, medium prices



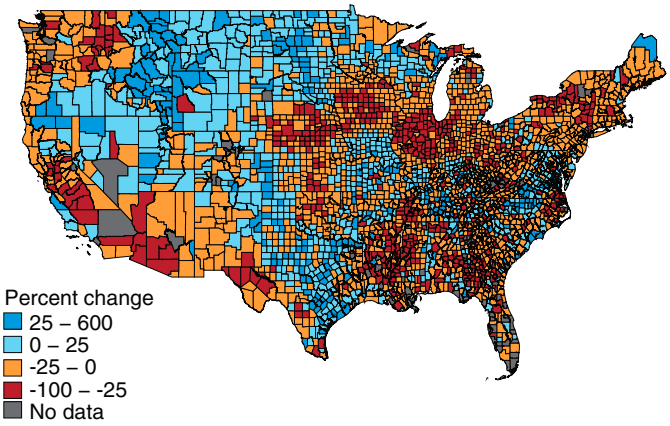
b. Cultivated cropland in HEL fields, medium prices



c. Benefit change by program type, medium prices



d. Benefit change by county, medium prices



Notes: HEL = highly erodible land. In parts a, b, c, e, f, g, i, j, and k, each bar represents a span of 5 percentage points. For example, the bar for zero change represents farms where the change in payments was -2.5 to 2.5 percent. The last bar on the right-hand side in parts a, b, c, e, f, g, i, j, and k captures all land on farms with an increase of more than 100 percent.

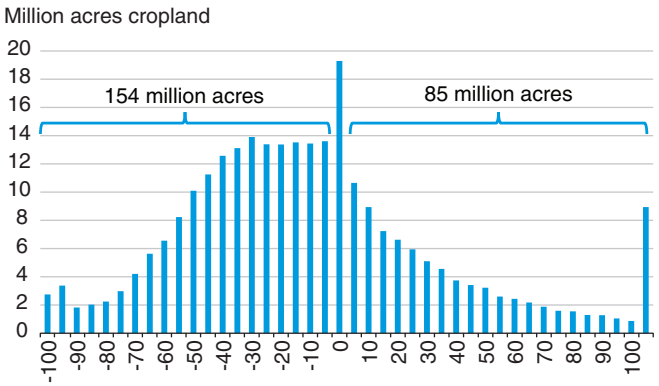
—continued

tives decline more than 25 percent include 100 million acres (32 percent; fig. 15a) of cultivated cropland and 27 million acres (29 percent; fig. 15b) of cultivated cropland in HEL fields. Farms where Compliance incentives decline by more than 50 percent include 37 million acres (12 percent; fig 15a) of cultivated cropland and 9 million acres (10 percent; fig. 15b) of cultivated cropland in HEL fields. In general, large reductions in estimated Compliance incentives occur on operations where commodity payments declined and were not fully offset by crop insurance subsidies. On farms where estimated Compliance incentives are higher under the 2014 Act, increases are largely due to crop insurance premium subsidies (fig. 15c).

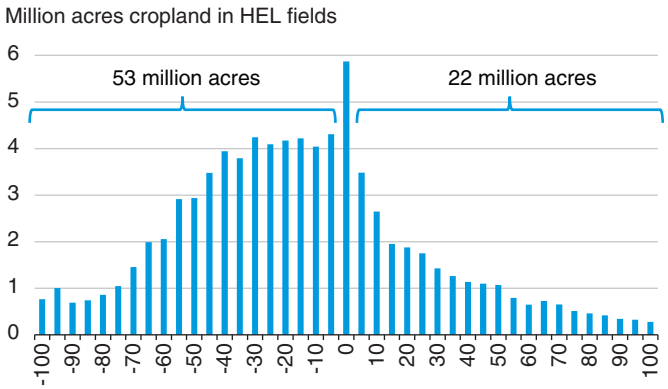
Regionally, under the medium-price scenario, declines in Compliance incentives occur in areas where farms received high Direct Payments under the 2008 Farm Act but low crop insurance subsidies (in much of the Corn Belt, for example; fig. 15d). Compliance incentives are higher under the 2014 Act in regions where crop insurance is prevalent (e.g., the Dakotas) or where producers elected Price Loss Coverage over Agricultural Revenue Coverage (e.g., many wheat and barley producers).

Figure 15
Change in Compliance incentives, 2014 Farm Act versus the 2008 Farm Act—continued

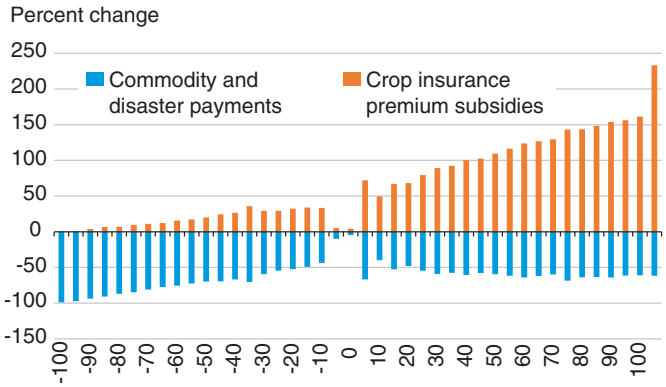
e. Cultivated cropland, high prices



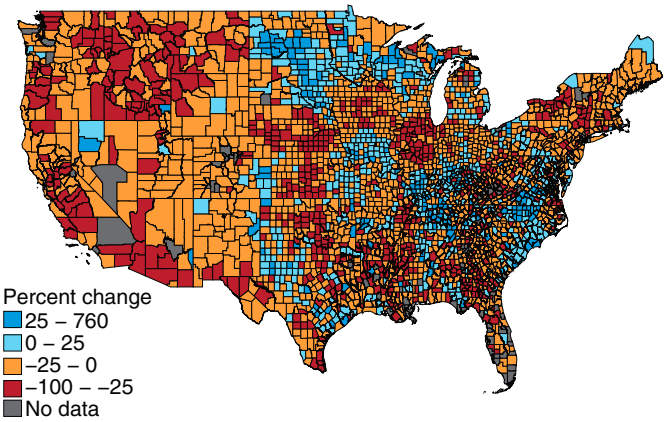
f. Cultivated cropland in HEL fields, high prices



g. Benefit change by program type, high prices



h. Benefit change by county, high prices



Notes: HEL = highly erodible land. In parts a, b, c, e, f, g, i, j, and k, each bar represents a span of 5 percentage points. For example, the bar for zero change represents farms where the change in payments was -2.5 to 2.5 percent. The last bar on the right-hand side in parts a, b, c, e, f, g, i, j, and k captures all land on farms with an increase of more than 100 percent.

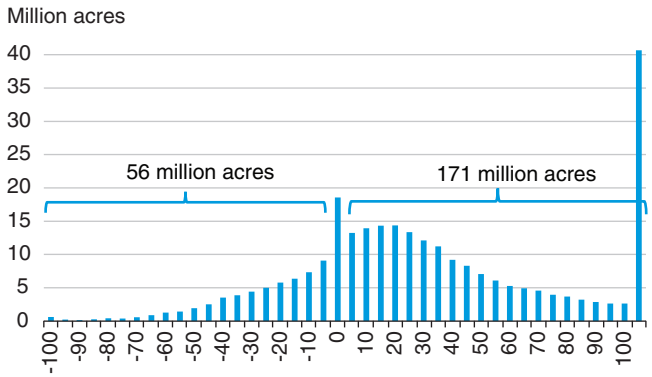
—continued

For the high-price scenario, Compliance incentives decline on many farms. A majority of cultivated cropland and cultivated cropland in HEL fields is on farms where Compliance incentives are lower than they would have been under the 2008 Farm Act (fig. 15e, f). With high prices, commodity payments are lower under the 2014 Act than they would have been under the 2008 Act (fig. 15g). Crop insurance premium subsidies, which rise with crop prices (all other things equal), are higher under the high-price scenario and more than offset the loss of commodity payments on some farms where Compliance incentives increase (fig. 15g). Regionally, Compliance incentives rise in areas where crop insurance premium subsidies are particularly large (e.g., parts of the Dakotas; fig. 15h).

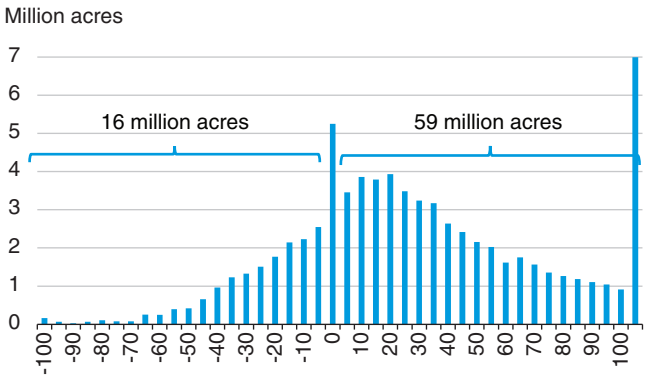
In the low-price scenario, a significant majority of cultivated cropland and cultivated cropland in HEL fields is located on farms where Compliance incentives are higher than they would have been under the 2008 Act (fig. 15i, j). Higher Compliance incentives are due in part to relatively high commodity payments on many farms. Nonetheless, commodity payments are stable or even lower on some farms than they would have been under the 2008 Act (fig. 15k). Crop insurance premium subsidies are rela-

Figure 15
Change in Compliance incentives, 2014 Farm Act versus the 2008 Farm Act—continued

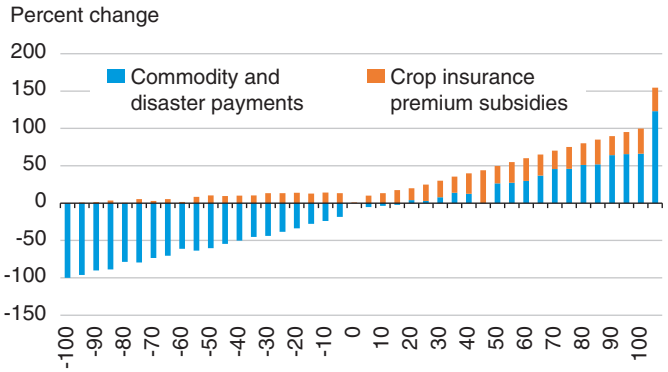
i. Cultivated cropland, low prices



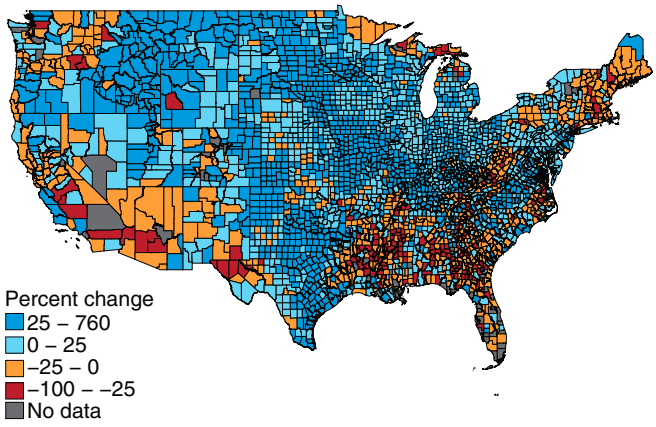
j. Cultivated cropland in HEL fields, low prices



k. Benefit change by program type, low prices



l. Benefit change by county, low prices



Notes: HEL = highly erodible land. In parts a, b, c, e, f, g, i, j, and k, each bar represents a span of 5 percentage points. For example, the bar for zero change represents farms where the change in payments was -2.5 to 2.5 percent. The last bar on the right-hand side in parts a, b, c, e, f, g, i, j, and k captures all land on farms with an increase of more than 100 percent.
Source: USDA, Economic Research Service.

tively modest when prices are low but still contribute to the overall Compliance incentive on farms where incentives are higher than they would have been under the 2008 Act (fig. 15k).

Compliance Incentives and Land Subject to HELC

We analyze HELC using two definitions of "land subject to Compliance." First, we consider only cultivated cropland in HEL fields, implicitly assuming that HELC is not preventing land from entering crop production. This scenario is reasonable given the long, steady decline in cultivated cropland acreage since the mid-1980s and the minimal rise in cultivated cropland during 2007-2012 (about 4 million acres; NRCS, 2015), despite a sustained period of high crop prices beginning in 2007. Second, we consider cultivated cropland and "potentially convertible" land in HEL fields. Wetlands are not included because farm-level wetland acreage cannot be defined outside of Prairie Pothole States.

Figure 16a shows the distribution of cultivated cropland in HEL fields by Compliance incentives per acre of cropland in HEL fields, given the medium-price scenario, for the (1) 2008 Act, (2) 2014 Act, and (3) 2014 Act without crop insurance premium subsidies. Although subsidies are subject to Compliance under the 2014 Farm Act, the "no insurance subsidy" scenario shows the effect of crop insurance premium subsidies on Compliance incentives given commodity program changes in the 2014 Act. For all three policy scenarios, roughly 9 million acres of cropland in HEL fields (10 percent of cropland in HEL fields) are on farms with zero Compliance incentive.

Figure 16b shows the distribution of cultivated cropland in HEL fields by Compliance incentives per dollar of cropland rental value in HEL fields (hereafter $/$ of rental value). Under the 2014 Act, roughly 25 million acres (28 percent) of cropland in HEL fields have Compliance incentives > $1/$ of rental value. On these farms, Compliance incentives are likely to exceed Compliance costs. Another 27 million acres (30 percent) are on farms with relatively small Compliance incentives ($0-0.4/$ of rental value, not including farms with zero payments). The remaining cropland in HEL fields (29 million acres; 32 percent) is on farms with Compliance incentives ranging from 40 cents to $1 per dollar of rental value.

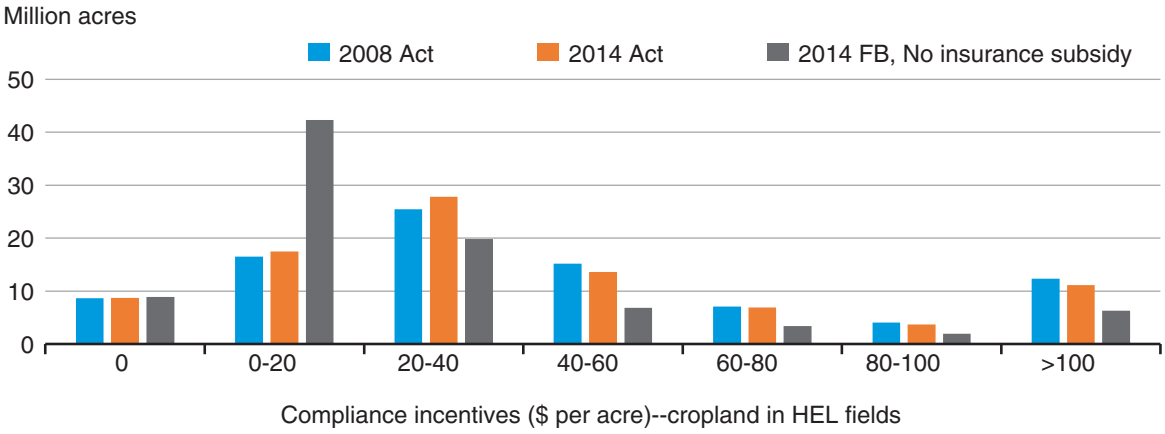
Spatially, the highest density of land with relatively low Compliance incentives is in the western Corn Belt (eastern Nebraska, northern Missouri, Iowa, Wisconsin, and western Illinois) (fig. 17). These areas include some of the highest rates of sheet and rill erosion (tons/acre/year) in the Nation (NRCS, 2015). Other areas with high concentrations of cropland in HEL fields and relatively low Compliance incentives include the Palouse region (eastern Washington), some counties in the Plains States, and some areas along the Appalachian Mountains (parts of Tennessee, Kentucky, Illinois, Indiana, Ohio, Pennsylvania, and New York).

On farms with relatively low Compliance incentives, a large majority of cropland is in HEL fields. For farms with benefits of $0-0.4/$ of rental value, more than 75 percent of cropland is in HEL fields. In fact, on farms with benefits ranging from zero to 1 dollar per dollar of rental value, more than 70 percent of cropland is in HEL fields. In the Corn Belt, relatively low Compliance incentives per dollar of rental value also reflect high cropland rental rates.

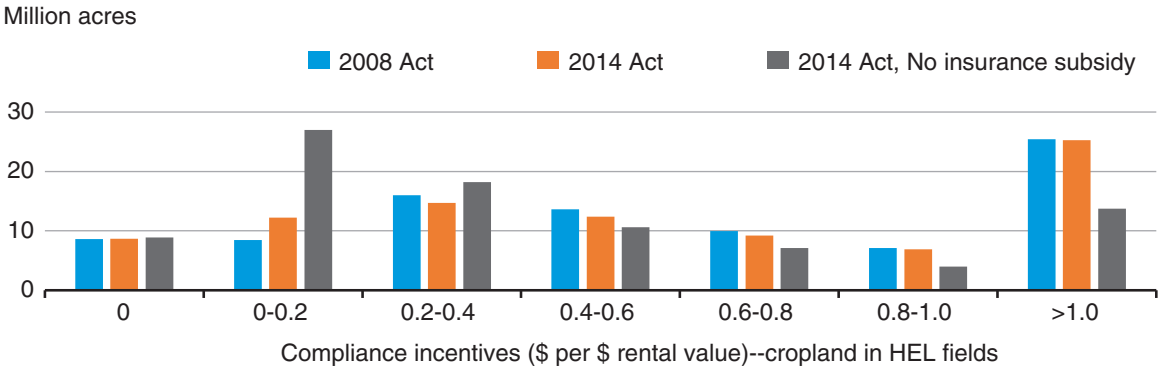
If crop insurance premium subsidies were not subject to Compliance sanction—as under the 1996, 2002, and 2008 Farm Acts—Compliance incentives would be lower on farms that purchase crop insurance. Declining Compliance incentives overall increase the proportion of cropland in HEL fields with low incentives. The number of acres with small incentives ($0-0.4/$ of rental value)

Figure 16
Distribution of cropland in HEL fields[1] by farm-level Compliance incentives—medium-price scenario

a. Benefits per acre



b. Benefits per dollar of rental value



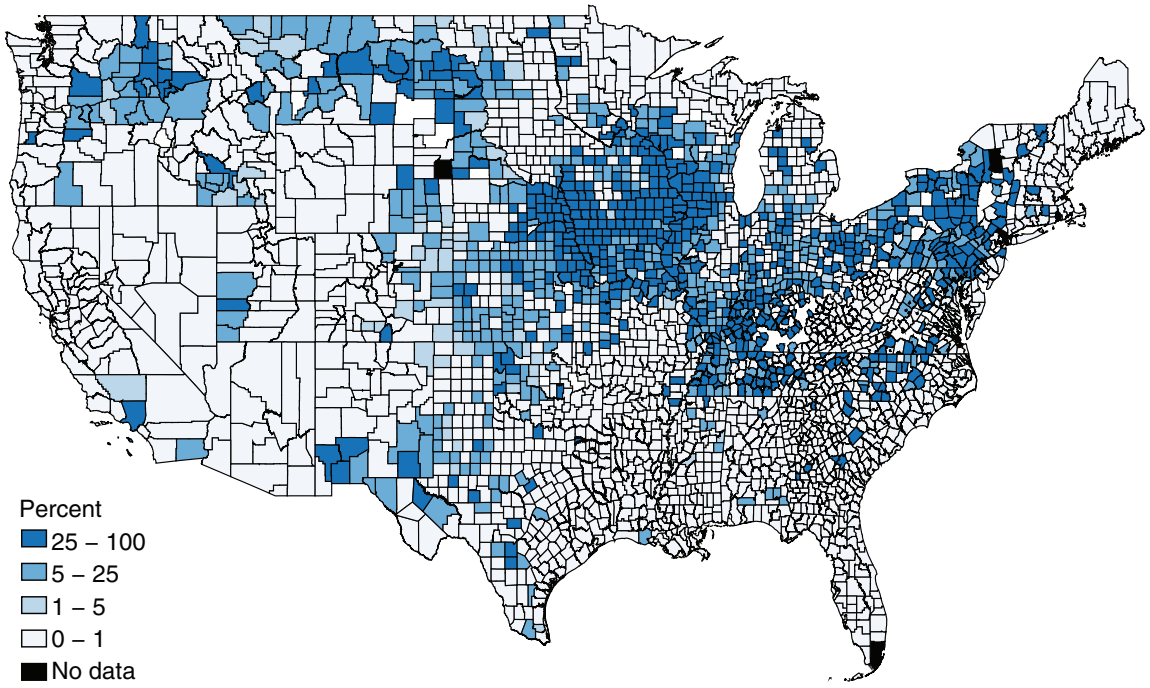
[1]Represents 89.3 million acres of 92.8 million acres of cropland in HEL fields identified in the National Resources Inventory data. Excluded acres are on farms where missing data prevented us from estimating farm-level metrics for Compliance incentives. HEL = highly erodible land.
Source: USDA, Economic Research Service.

increases roughly 65 percent, from 27 million to 45 million acres. The number of acres with Compliance incentives that are likely to exceed Compliance costs (>$1.0/$ of rental value) falls from more than 25 million acres to less than 14 million acres, a decline of 44 percent (fig. 16b).

Under the 2014 Farm Act, a majority of cropland in HEL fields is on farms where Compliance incentives are smaller than they would have been under the 2008 Act, given the medium-price scenario (fig. 18). In the absence of crop insurance premium subsidies, a much larger share of cropland in HEL fields would be on farms where Compliance incentives are lower and the size of the declines would be larger than they would have been under 2008 programs. When crop insurance premium subsidies are linked to Compliance (as under the 2014 Act, blue bars in figure 18), less than 10 million acres are on farms that would experience a 50-percent or larger decline in Compliance incentives. If premium subsidies were not subject to Compliance (orange bars in figure 18), more than 40 million acres of cropland in HEL fields would be on farms where Compliance incentives

Figure 17

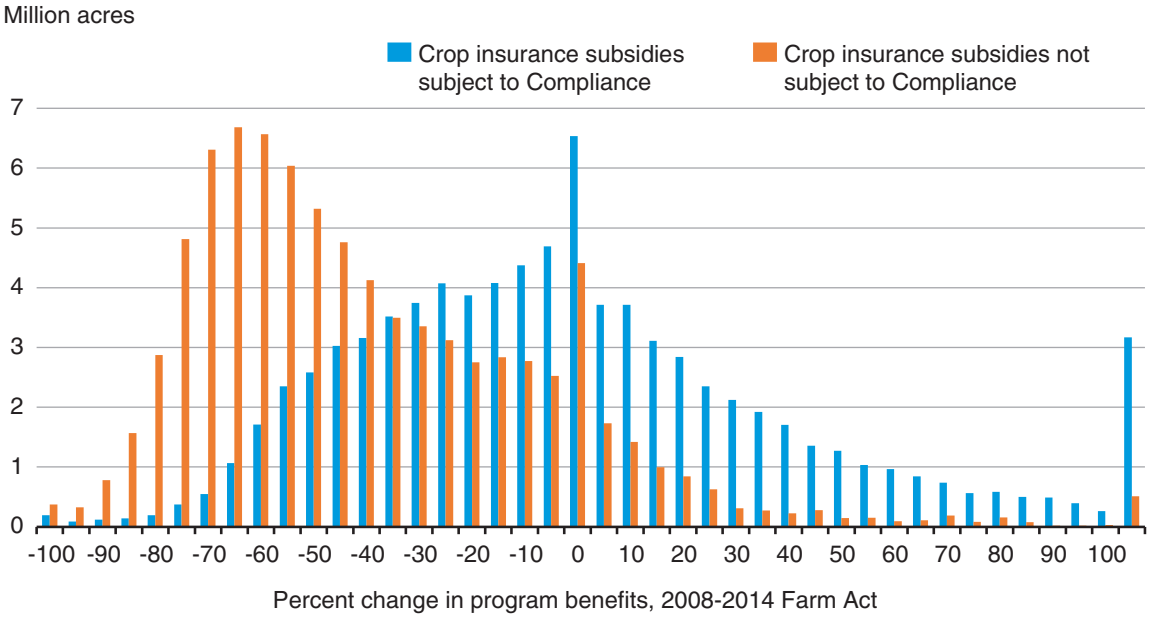
Share of cropland in HEL fields with low Compliance incentives ($0-0.4/$ of rental value)



HEL = highly erodible land.
Source: USDA Economic Research Service.

Figure 18

Distribution of change in Compliance incentives on farms with land subject to HELC—2014 Act and 2014 Act with crop insurance premium subsidies not subject to Compliance, medium-price scenario



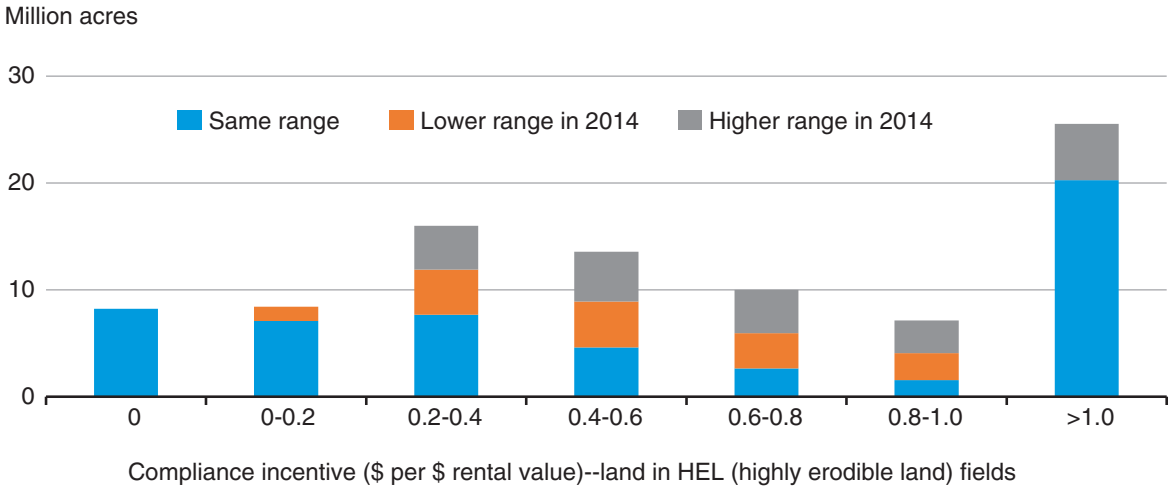
HELC = Highly Erodible Land Conservation.
Source: USDA, Economic Research Service.

declined by 50 percent or more between the two acts. For the “no insurance subsidy scenario,” the shift in HELC incentives is a bit larger when crop prices are high and much smaller when crop prices are low.

While Compliance incentives are similar between acts when aggregated to the national level, summary results (fig. 16) mask large changes to incentives on individual farms. While there is no change for farms not receiving farm program benefits, roughly 20 percent of farms with per-acre benefits of $0-0.2/$ of rental value would have been in a higher range of benefits under the 2008 Act (fig. 19). For land in the four ranges encompassing $0.2-1.0/$ of rental value, at least 50 percent would have been in a higher or lower payment range under the 2008 Act. On farms where Compliance incentives increase, the likelihood of noncompliance is reduced.[11] On farms where Compliance incentives decline, particularly where 2014 per-acre incentives are low ($0-0.4/$ of rental value), the likelihood of noncompliance is increased, although the effect of the decline in Compliance incentives cannot be estimated without detailed information on the farm-level cost of meeting Compliance requirements.

The distribution of cropland in HEL fields across Compliance incentive ranges is sensitive to crop prices, as suggested by the discussion of farm program benefits. In the low-price scenario, commodity payments and Compliance incentives are high. More than 42 million acres of cropland in HEL fields (47 percent) are on farms where Compliance incentives per dollar of rental value are greater than $1 in the low-price scenario (fig. 20a), up from 25 million acres in the medium-price scenario. On these farms, Compliance incentives are strong when crop prices are low. On farms where Compliance incentives per dollar of rental value range from 0 to 40 cents, cropland in HEL fields drops to 15 million acres (17 percent) from 27 million acres in the medium-price scenario.

Figure 19
Change in Compliance incentives between 2008 and 2014 Acts

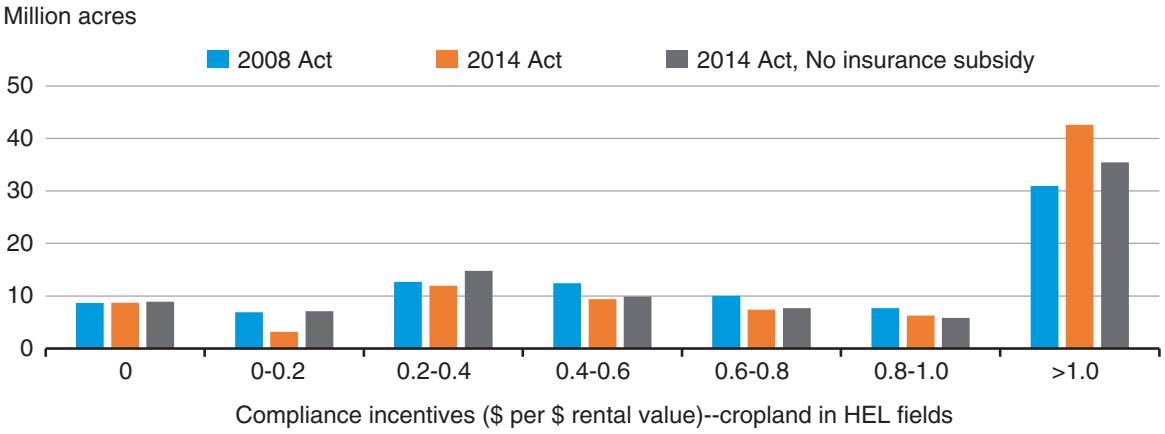


Source: USDA, Economic Research Service.

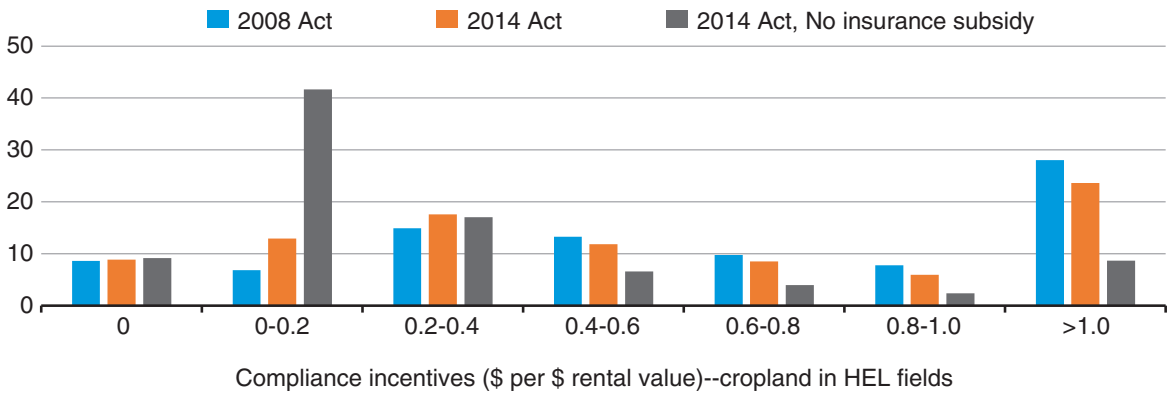
[11] Giannakas and Kaplan (2005) provide both theoretical and empirical evidence that farmers become more likely to meet Compliance requirement (less likely to misrepresent actions) as Compliance incentives rise, Compliance costs decline, or the probability of detection rises. See "Conservation Compliance History, Economics, and Requirements" for more detail.

Figure 20
Distribution of cropland on HEL fields by farm-level HELC incentives—low-price and high-price scenarios

a. Low-price scenario



b. High-price scenario

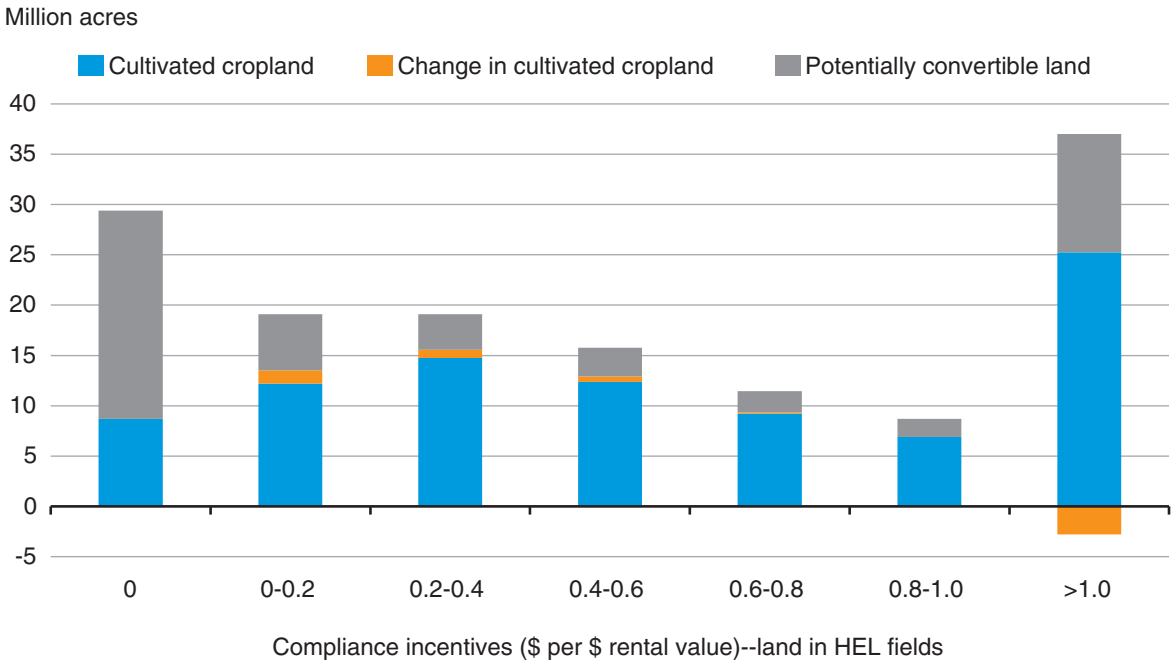


HELC = Highly Erodible Land Conservation.
Source: USDA, Economic Research Service.

In the high-price scenario, the distribution of cropland in HEL fields across Compliance incentive ranges is similar to the medium-price scenario. Farms with Compliance incentives >$1.0/$ of rental value account for about 24 million acres of cropland in HEL fields, versus 25 million acres under medium prices. Farms with Compliance incentives of $0-0.4/$ of rental value account for about 30 million acres of cropland in HEL fields (fig. 20b), versus 27 million acres under medium prices. Because premium subsidies for crop insurance rise with crop prices, they constitute more of the Compliance incentive when crop prices are high. If premium subsidies were not subject to Compliance (given the high-price scenario), cropland in HEL fields with Compliance incentives >$1.0/$ of rental value under the 2014 Act would fall from 24 million acres to 9 million acres (10 percent of cropland in HEL fields), while land with Compliance incentives of $0-0.4/$ of rental value would rise from 30 million acres to 59 million acres (66 percent of cropland in HEL fields).

Considering "potentially convertible" land as well as cultivated cropland in HEL fields, an additional 21 million acres occur on farms that do not receive farm program benefits (have zero Compliance

Figure 21
Distribution of cropland and potentially convertible land in HEL fields by farm program benefits under the 2014 Farm Act, medium-price scenario



HEL = highly erodible land.
Source: USDA, Economic Research Service using NRCS National Resources Inventory data.

incentive) (fig. 21). These lands tend to occur on farming operations that have a relatively small portion of their land in cultivated crop production (35 percent, on average). It is likely that these farms focus more heavily on livestock than crop production. Nearly 12 million potentially convertible wetland acres occur on farms with Compliance incentives >$1/$ of rental value on land subject to HELC. These lands tend to occur on farms where cultivated crops and other potentially convertible land in HEL fields account for a relatively small portion of overall land (15 percent). The remaining land (about 18 million acres) is distributed across other Compliance incentive ranges. On these farms, a relatively high proportion of land is subject to Compliance: 65-84 percent of cultivated cropland and 30-60 percent of all agricultural land.

Because of the additional land subject to Compliance, Compliance incentives on cultivated cropland may also change. Our analysis shows that these changes are relatively small. Roughly 2.7 million acres (3 percent) of cultivated cropland shift from the high Compliance incentive category (>$1/$ of rental value) to lower Compliance incentive ranges, particularly $0-0.2/$ of rental value (fig. 21), when potentially convertible HEL land is subject to Compliance. These changes reflect the fact that existing Compliance incentives are spread across a larger acreage.

Estimating the average per-acre costs of implementing soil conservation practices. We do not observe the farm-level costs of implementing conservation practices that are included in Compliance plans. However, the adequacy of Compliance incentives depends on the cost of maintaining soil conservation systems on cultivated cropland subject to HELC. As noted earlier, Compliance plans on land already in crop production in 1985 were designed to limit cost and avoid driving land out of crop production. In 1997, almost half of all Compliance plans were made up of only three practices: conservation cropping, conservation tillage, and crop residue use (Claassen et al., 2004), although

Table 5
Description of soil conservation practices

Practice	Type of erosion addressed	Description
Conservation crop rotation	Water/wind	Growing a planned sequence of various crops on the same piece of land for conservation purposes.
Mulch-till/Strip-till/No-till	Water/wind	Limiting soil disturbance to manage the amount, orientation, and distribution of crop and plant residue on the soil surface
Residue management, seasonal	Water/wind	Managing plant residues on the soil surface during part of the year while growing crops in a clean-tilled seedbed
Contour farming	Water	Using ridges and furrows formed by tillage, planting, and other farming operations to change the direction of runoff from directly downslope to around the hillslope
Contour buffer strips	Water	Narrow strips of conservation cover established around the hill slope, and alternated down the slope with wider cropped strips that are farmed on the contour
Grassed waterway	Water	A channel established with suitable vegetation to convey surface water at a nonerosive velocity
Strip cropping	Water/wind	Rotations of row crops, forages, small grains, or fallow in a systematic arrangement of equal-width strips across a field
Terraces	Water	An earth embankment or a combination ridge-and-channel constructed across the field slope to reduce erosion
Herbaceous wind barriers	Wind	Herbaceous vegetation established in narrow strips within the field to reduce erosion

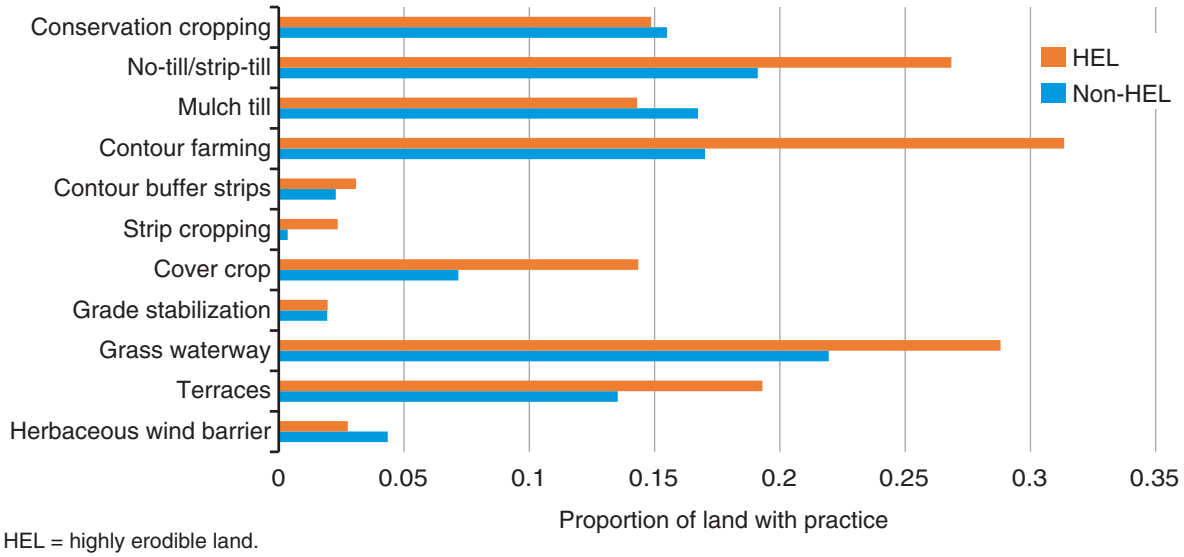
Source: USDA, Economic Research Service based on USDA, Natural Resources Conservation Service conservation practice standards.

many other practices have been used in Compliance plans (see table 5 for definitions of practices). Other practices commonly used on highly erodible cropland include contour farming, cover crops, mulch till, grass waterways, and terraces (fig. 22). While 20 years has elapsed since the 1997 status review, many of these soil conservation systems could still be in effect. Once approved as meeting HELC requirements, soil conservation systems for specific fields can be continued intact by a new landowner or renter.

Many practices in use on highly erodible land in crop production are conservation management practices, the net cost of which depends on a complex set of factors. Conservation tillage, for example, involves reducing tillage so that at least 30 percent of the soil surface is covered by residue at planting time. Conservation tillage can increase costs or reduce crop revenue because planting into a residue-covered field may (1) require new or modified planting equipment; (2) delay planting if residue slows soil drying in cold, wet conditions (with potential yield reductions); and (3) require more extensive use of herbicides to control weeds that could have been controlled, in part, by tillage. On the other hand, conservation tillage can reduce the cost of fuel, labor, and tillage machinery. Reduced tillage (or no-till) can also conserve soil moisture (Ding et al., 2009) and improve yields in dry years. Any reduction in soil erosion due to reduced tillage (or other soil conservation practices)

Figure 22

Use of selected soil conservation practices on HEL and non-HEL in crop production, 2003-06



HEL = highly erodible land.

Source: USDA Economic Research Service analysis of the Natural Resources Conservation Service's Conservation Effects Assessment Program survey data for 2003-06.

can preserve soil depth and productivity, safeguarding producer investment in land. Other conservation management practices have a similarly complex calculus of cost and returns.

The cost of installing and maintaining structural and vegetative practices also varies across farms and fields. For example, the cost of installing terraces rises as field slope and slope length increase. Unlike management practices, structural and vegetative practices are always costly in the short run.

Though farm-level costs for conservation practices are not available, USDA conservation program payments (financial assistance) can provide some insight. USDA working land programs—including the Environmental Quality Incentives Program (EQIP) and the Conservation Stewardship Program—can support a wide range of conservation practices addressing a wide range of resource concerns (e.g., soil quality, water quality).

Since the relationship between financial assistance and practice costs varies by program, we drew data from EQIP only. EQIP payments for conservation practices typically used to control water or wind erosion (table 5) can reflect several categories of (estimated) cost: materials, equipment for installation, labor, acquisition of technical knowledge, and forgone income for practices that take land out of production (e.g., grassed waterways). Payments can cover *up to* 75 percent of estimated costs for cost categories except forgone income, which payments can fully cover.

In EQIP, producers adopting a conservation management practice can receive an annual payment for up to 3 years to help ease the transition to use of the new practice(s). When the payments end, producers are free to continue or discontinue the practice. So these payments do not necessarily represent an individual farm's adoption costs, but they do indicate what participating farmers are willing to accept to adopt conservation practices, at least for a period of several years.

Table 6 shows the distribution of annual payments that program participants were willing to accept for applying some common soil conservation management practices, based on payment data for the Environmental Quality Incentives Program (EQIP) during 2010-13. The wide range of adoption

Table 6
EQIP incentive payments for selected soil conservation management practices, 2010-13

Practice	Number of payments	Average ($/acre)	Percentiles ($/acre)				
			10	25	50	75	90
Conservation crop rotation	6,725	54.28	3.16	5.69	20	70.11	142.12
No-till/Strip-till	9,173	22.88	11	14.72	21.13	27.03	35.2
Contour farming	61	8.61	6	6	6	10	13
Crop residue use	586	18.06	2.82	2.82	11.25	40	40
Mulch till	2,008	20.99	6	12.27	21.1	29.3	35

Source: USDA, Economic Research Service analysis of USDA, Natural Resources Conservation Service Environmental Quality Incentives Program (EQIP) contract data for 2010-13.

costs for many practices likely reflects widely differing climatic conditions, soils, topography, and crops. Some practices—particularly conservation crop rotation—have an extremely wide range of payment levels. At the high end, conservation cropping payments in excess of $100 per acre suggest that prescribed rotations include years with very low-value or unharvested crops.

Of course, many farmers have been willing to adopt at least some conservation management practices without payments, suggesting that some farmers see a net benefit from the practice itself. The use of conservation tillage, for example, has increased significantly since HELC implementation. The Conservation Tillage Information Center (CTIC) reports that conservation tillage expanded from 25 percent of cropland in 1990 to more than 40 percent in 2008. No-till increased from 5 percent to 25 percent of cropland over the same period. Based on ARMS data for 2009-11 (the Agricultural Resource Management Survey, conducted by USDA's Economic Research Service and National Agricultural Statistics Service), roughly 90 percent of farmers who adopted conservation tillage report receiving no payments for the practice (Claassen et al., 2014).

Table 7 shows State-level cost estimates for some common structural and vegetative practices, including terraces, grassed waterways, and herbaceous wind barriers, developed by USDA's Natural Resources Conservation Service (NRCS). These are annualized estimates of full practice adoption and maintenance costs over the life of the practice (up to 15 years)—farmers who receive payments under EQIP would receive only a portion of this amount. While these practices have relatively low annual costs, they require a large initial investment. Median annual costs range from $11.50 to $25 per acre. Again, farm- and field-specific costs can vary widely, and individual producers are likely to use relatively inexpensive practices when complying with HELC requirements.

Given that farmers have significant control over the practices included in their conservation plans, we assume that they select practices that are relatively inexpensive (or even profitable) to apply on their own farms. In fact, at least some of the practices applied on fields subject to HELC were also applied to highly erodible cropland *not* subject to HELC (not located in a field determined to be HEL) and to cropland that is not highly erodible. Between 1982 and 1997, for land that is highly erodible due to rainfall (sheet and rill) erosion, the average soil erosion reduction was 6.6 tons/acre/year on land subject to HELC and 3.9 tons/acre/year on land **not** subject to HELC. On land that is highly erodible due to wind erosion, the average soil erosion reduction was 3.8 tons/acre/year on land subject to HELC, and 2.3 tons/acre/year on land that is **not** subject to HELC. These results suggest that farmers see at least some of the HELC-required practices as profitable, suggesting their continuation even on farms where Compliance incentives decline significantly.

Table 7
NRCS estimated costs for selected soil conservation structural and vegetative practices, 2010

Practice	Average ($/acre)	Percentiles ($/acre)				
		10	25	50	75	90
Grassed waterway	9.76	2.85	2.85	11.47	14.32	14.32
Terrace	19.14	14.86	14.86	16.56	19.66	30.71
Herbaceous wind barriers	23.59	24.83	24.83	24.83	24.83	24.83

Source: USDA Economic Research Service analysis of USDA Natural Resources Conservation Service data (see online Appendix E for details).

Compliance Incentives and Land Subject to Wetland Conservation

Our analysis of Wetland Compliance (WC) incentives is limited to the Prairie Pothole States (Iowa, Montana, Minnesota, North Dakota, and South Dakota). Critical data from the National Wetlands Inventory (NWI), used to define farm-level wetland acreage, are available only for these States.

To measure the strength of Compliance incentives on farms with potentially convertible wetland, we use two normalized measures of Compliance incentives: (1) farm-level Compliance incentives per acre of land subject to Compliance (potentially convertible wetland and cropland in HEL fields), and (2) farm-level Compliance incentives per acre of land subject to Compliance divided by the farm-specific cropland rental rate. These measures recognize that farmers can incur Compliance costs on both wetland and highly erodible land.[12]

In general, Compliance incentives are strong in the Prairie Pothole Region. Under the 2014 Farm Act, roughly 2.6 million acres of potentially convertible wetland (75 percent) are on farms where Compliance incentives are >$1/$ of rental value on potentially convertible wetland plus cropland in HEL fields (fig. 23b). On these farms, Compliance incentives exceed the potential value of wetland in crop production, not counting drainage costs or profit forgone from a previous land use (e.g., grazing), if any. Roughly 375,000 acres of potentially convertible wetland (11 percent) are estimated to be on farms that did not receive farm program benefits (have no Compliance incentives), while 475,000 acres (14 percent) are on farms with Compliance incentives in the range of $0-1/$ of rental value.

The distribution of Compliance incentives across potentially convertible wetland would be very similar for the 2008 Act and the 2014 Act. For the 2014 Act without crop insurance premium subsidies, however, the area of potentially convertible wetlands with Compliance incentives in the range of $0-1/$ of rental value would rise from 480,000 acres to roughly 820,000 acres, about 24 percent of potentially convertible wetland (fig. 23b).

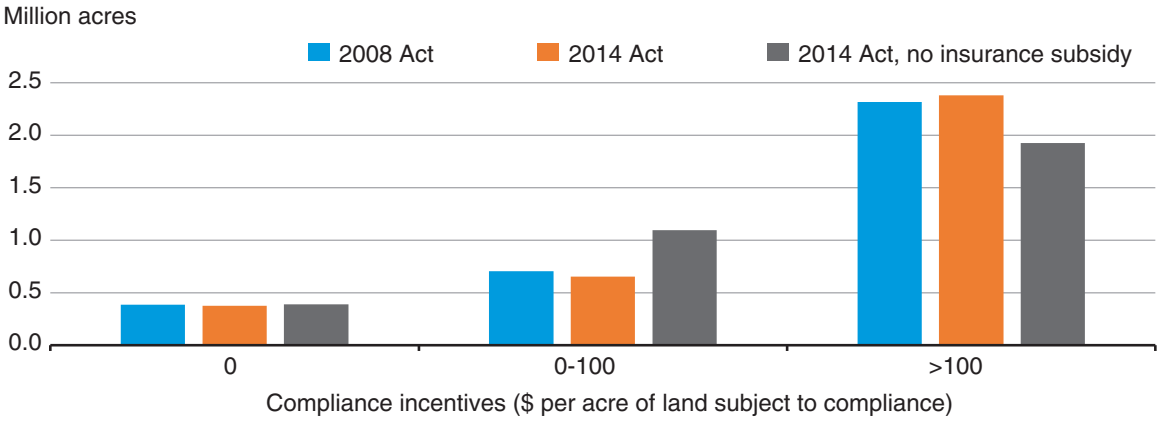
Our results are only moderately sensitive to price change (fig. 24). In the low-price scenario, Compliance incentives rise and the number of acres on farms with Compliance incentives (under the 2014 Act) in the range of $0-1/$ of rental value falls from 475,000 acres to roughly 330,000 acres. Because premium subsidies fall with crop prices, the role of crop insurance is very small when crop prices are low. In the high-price scenario, the number of potentially convertible wetland acres on

[12] Potentially convertible wetland acreage was not included in our analysis of HELC because farm-level estimates of wetland acreage are not available outside of the Prairie Pothole States.

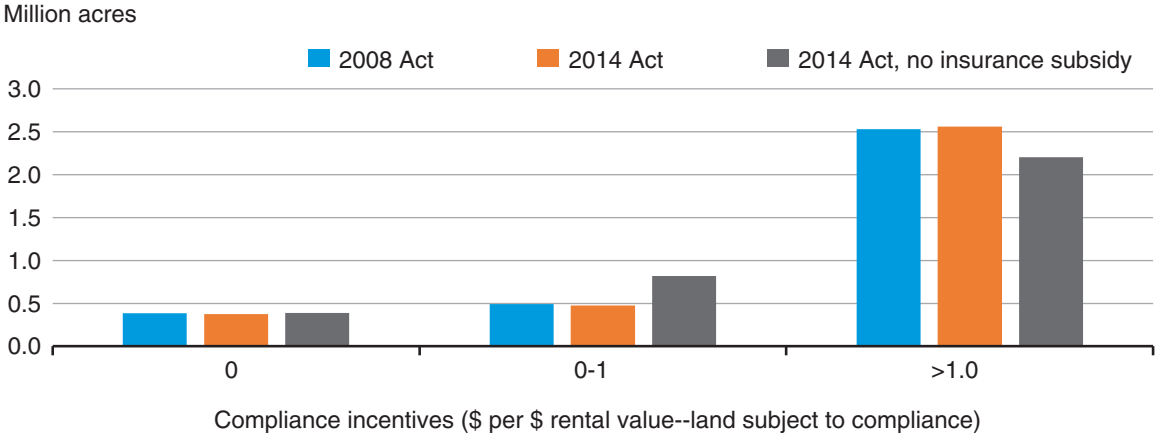
Figure 23

Distribution of potentially convertible wetlands[1] across farm-level Compliance incentives—medium-price scenario

a. Benefits per acre



b. Benefits per dollar of rental value



[1]Represents 3.41 million acres of 3.54 million acres of wetland identified in the National Resources Inventory data. Excluded acres are on farms where missing data prevented us from estimating farm-level metrics for Compliance incentives.
Source: USDA, Economic Research Service.

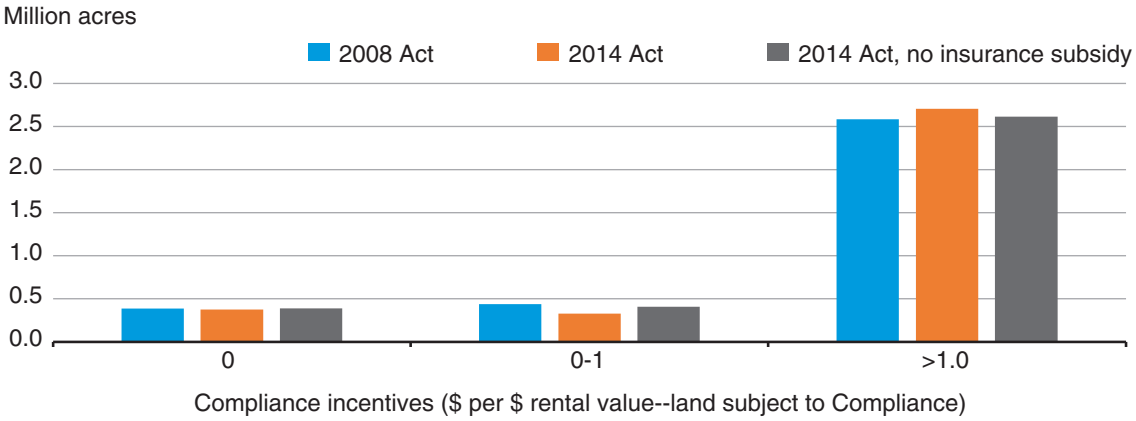
farms with Compliance incentives of $0-1/$ of rental value is roughly the same as in the medium-price scenario. As in the HELC analysis, crop insurance subsidies are meaningful when crop prices are high. If premium subsidies were not subject to Compliance, the number of potentially convertible wetland acres on farms with Compliance incentives in the range of $0-1/$ of rental value doubles to just over 1 million (fig. 24).

On farms where Compliance incentives are strong, only a small portion of land is subject to Compliance. This means that the Compliance costs for the whole farm are low relative to the expected benefits of complying. On farms with Compliance incentives >$1.0/$ of rental value, less than 10 percent of land is subject to either WC or HELC. On farms with Compliance incentives in the range of $0-1/$ of rental value, nearly 60 percent of land is subject to WC or HELC. Areas with high concentrations of cropland in HEL fields tend not to be located in the Prairie Pothole States and, therefore, do not exert a strong influence on our wetland analysis.

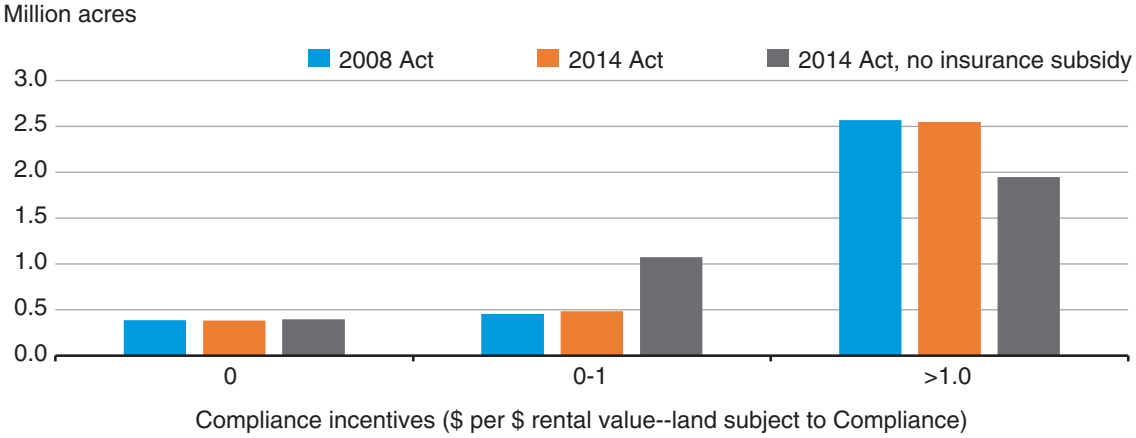
Figure 24

Distribution of potentially convertible wetlands[1] across farm-level Compliance incentives—low- and high-price scenario

a. Low prices



b. High prices



[1]Represents 3.41 million acres of 3.54 million acres of wetland identified in the National Resources Inventory data. Excluded acres are on farms where missing data prevented us from estimating farm-level metrics for Compliance incentives.
Source: USDA, Economic Research Service.

Conclusions

Our analysis shows that Highly Erodible Land Conservation (HELC) has contributed significantly to the reduction in soil erosion on highly erodible cultivated cropland. On cropland that is highly erodible for water, erosion reduction was roughly 70 percent larger on highly erodible land in fields subject to HELC than for highly erodible land in fields not subject to HELC. While soil erosion was reduced on all types of cultivated cropland over 1982-2012, including land where Compliance did not apply, HELC clearly played a role. The ultimate size of that role depends on whether erosion reductions on land not subject to HELC were "spillover" effects of Compliance requirements or whether the trend toward soil erosion reduction had already begun but was accelerated by HELC. If the former, practices required by HELC were also applied to other land. If the latter, practices that would have been applied in any case were adopted more quickly and more extensively on land subject to HELC than they would have been in the absence of HELC.

How strong are Conservation Compliance incentives? While the lack of farm-level data on Compliance costs precludes a definitive answer, our research does suggest how Compliance incentives are distributed across land subject to Compliance and how those incentives changed under the 2014 Farm Act. The effectiveness of Compliance incentives can be limited by Compliance provisions that limit penalties or implementation strategies that make detection of violations less likely.

At the national level, Compliance incentives are comparable to what they would have been under a continuation of the 2008 Farm Act (fig. 25a). Under the 2008 Act, Direct Payments were an important component of the Compliance incentive. These payments were substantial and did not vary with production or prices, providing a strong, stable core of Compliance incentives. In aggregate, the reduction in Compliance incentives due to the end of Direct Payments under the 2014 Act is largely offset by new commodity programs and the relinking of crop insurance premium subsidies to Compliance. In the 2014 Act, the combination of commodity payments and crop insurance premium subsidies also ensures that Compliance incentives are strong over a wide range of crop prices (fig. 25c). Commodity payments under the 2014 Act are triggered by low prices or low revenue and produce relatively large Compliance incentives. When crop prices are at medium or high levels and expected commodity payments are relatively low, crop insurance premium subsidies rise to maintain incentives.

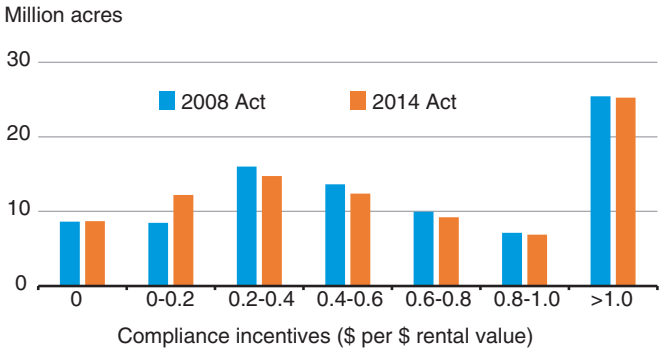
Under the 2014 Act, Compliance incentives vary widely across farms with cropland in HEL fields. In our medium-price scenario, for example, 27 percent (25 million acres) of cropland in HEL fields is on farms where Compliance incentives are "high" (program benefits exceed the crop rental value of land subject to HELC; fig. 25a). Roughly 28 percent (27 million acres) of cropland in HEL fields is on farms with "low" Compliance incentives (more than zero but less than 40 cents per dollar of crop rental value).

A critical factor driving the farm-level variation in Compliance incentives is the land base of individual farms. On farms where 80 percent of cropland is in HEL fields, farm program benefits are likely to be small relative to the area of land where a soil conservation plan is required and the overall cost of meeting Compliance requirements. In some parts of the Corn Belt, for example, Compliance incentives will always be relatively modest given the high concentration of HEL fields.

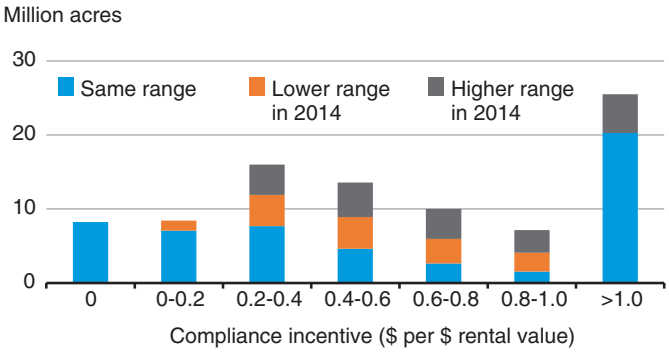
National results showing that Compliance incentives are similar under the 2008 and 2014 Farm Acts mask considerable variation in the effect of the 2014 Farm Act on Compliance incentives (fig. 25b).

Figure 25
Summary of Compliance incentives for highly erodible cropland

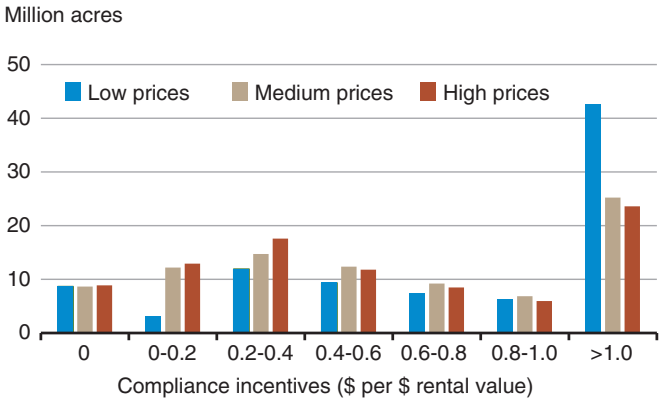
a. 2014 Act Compliance incentives are similar to 2008 Act (medium prices)



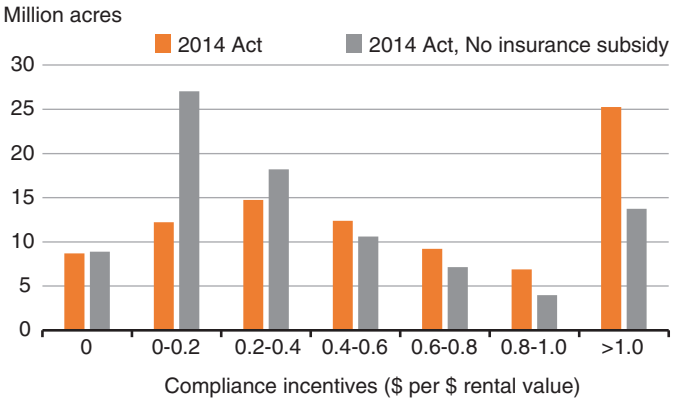
b. Aggregate results mask significant changes in farm-level Compliance incentives (medium prices)



c. 2014 Act Compliance incentives vary with crop prices



d. Crop insurance premium subsidies and Compliance incentives



Source: USDA, Economic Research Service.

On farms where Compliance incentives include commodity payments, crop insurance premium subsidies, or both, large changes in incentives are possible. Where Direct Payments were large under previous farm bills and crop insurance is a relatively small share of Compliance incentives (e.g., much of the Corn Belt), the expected value of Compliance incentives is lower under the 2014 Act than it would have been under a continuation of the 2008 Act. Where crop insurance premium subsidies are high (e.g., much of the Northern Plains), the opposite is often true—Compliance incentives are higher under the 2014 Act. In many cases, the effect of the 2014 Act depends on the level of crop prices. When crop prices are low and commodity payments are high, most cropland in HEL fields is on farms where Compliance incentives are higher under the 2014 Act. When prices are higher, most cropland in HEL fields is on farms where Compliance incentives are lower than they would have been under an extension of the 2008 Act.

Our analysis of HELC costs shows that the cost of some soil conservation practices could be covered by Compliance-linked farm program benefits. Because we lack field-specific data on HELC soil conservation systems, however, it is not possible to specify HELC costs or determine their exact relationship to Compliance incentives. The fact that large erosion reductions have occurred on crop-

land both subject to and not subject to Compliance suggests that soil conserving practices came into broad use even as HELC was implemented. Even if HELC was the push needed for some farmers to adopt better practices, it is unlikely that all soil conservation practices required by HELC would be discontinued in its absence, although some loss of soil conservation would be likely.

For farms that include potentially convertible wetland, at least in the Prairie Pothole Region, Compliance incentives are strong. Roughly 75 percent of wetlands in 5 Prairie Pothole States are on farms with "high" Compliance incentives (>$1.0/$ rental value of land subject to Compliance). This proportion varies little in response to crop price changes.

Wetland Conservation incentives are strong because farms subject to WC in the Prairie Pothole have a relatively small proportion of total cropland subject to Compliance requirements. (When acreage subject to Compliance is small relative to total cropland and the number of acres on which crop insurance or commodity payments could be received, Compliance costs are likely to be low relative to benefits.) For farms with "high" Compliance incentives, wetland and cropland in HEL fields are only about 9 percent of cultivated cropland. For farms with incentives between zero and $1.0/$ of rental value for land subject to Compliance, land subject to Compliance is less than 60 percent of cultivated cropland. In the heart of the Prairie Pothole (including significant parts of North and South Dakota), farms also receive relatively high crop insurance premium subsidies.

Finally, crop insurance premium subsidies are an important part of the Compliance incentive, particularly on farms with land subject to HELC. If the link between crop insurance premium subsidies and Compliance were severed, the Compliance incentives would decline on many farms. Under the medium-price scenarios, the number of acres with small incentives ($0-0.4/$ of rental value, not including farms with zero payments) increases roughly 65 percent, from 27 million acres to 45 million acres (fig. 25d). The number of acres with Compliance incentives that are likely to exceed Compliance costs (>$1.0/$ of rental value) falls from more than 25 million acres to less than 14 million acres, a decline of 44 percent.

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Appendix A. National Resources Inventory (NRI) Data

The basic unit of observation is the National Resources Inventory (NRI) point. The NRI is an area-frame survey that includes data on land use, land quality, and land condition at more than 800,000 points of land at 5-year intervals between 1982 and 2012. NRI provides a statistically representative sample of the entire land base, identifying land by use (cropland, pasture, etc.) and providing (or linking to) information on soil erosion (cropland and Conservation Reserve Program (CRP) only), the inherent erodibility of soils (cropland and CRP only), wetland area, wetland type, topography, and soil productivity. At each point in cropland (or CRP), the annual rate of rainfall (water) soil erosion is estimated using the Universal Soil Loss Equation (before 2006) or the Revised Universal Soil Loss Equation 2 (2008-12) or a combination (2006-07) (NRCS, 2015). Wind erosion is estimated using the Wind Erosion Equation (NRCS, 2015). NRI surveys land regardless of producer participation in USDA or other government programs, making it possible to estimate the area of highly erodible land and wetland on farms that are not identified in USDA administrative data and, therefore, do not receive Federal agricultural benefits (and have no Compliance incentives).

The NRI is a stratified area frame sample. Nusser and Goebel (1997) describe the stratum, primary sampling unit (PSU), and point design. The sample is based largely on the Public Land Survey (PLS), which divides the Nation into 6-mile-square blocks.[13] For NRI, each of these units is further divided into strata that cover 2-by 6-mile areas. Within each strata, ½-mile-square (160-acre) blocks are selected as primary sampling units. The sampling rate varies from 2 percent to 6 percent, depending on heterogeneity of the landscape and the importance of features to be captured. Within each PSU, observations are typically made at three points although the number of points can vary. NRI data include roughly 300,000 PSUs that, in turn, include about 800,000 points. Because the sampling rate varies, the number of acres represented also varies and is roughly equal to the inverse probability of selection although the weights can be adjusted to ensure that estimates match other land-use information. Data are collected through site visits, interpretation of aerial photography, USDA administrative records, and farmer or landowner interviews (USDA-NRCS, 2009).

NRI points used for modeling include all (1) cultivated cropland, (2) noncultivated cropland, (3) pasture, (4) CRP, and (5) rangeland/forest points associated with an FSA farm number, for a total of 511,038 points. The pasture, range, and forest are included largely because of the possibility of conservation program payments, which are subject to Compliance sanction. Only a subset of these points is potentially subject to Compliance requirements:

- Cultivated cropland in fields determined to be highly erodible by USDA,
- Noncultivated land in fields determined to be highly erodible but defined as "potentially convertible," and
- Wetlands defined as "potentially convertible."

To determine whether an individual NRI point is subject to Highly Erodible Land Compliance (HELC), we link NRI points to Common Land Unit (CLU)-level data on USDA HEL determinations obtained from USDA's Farm Service Agency.

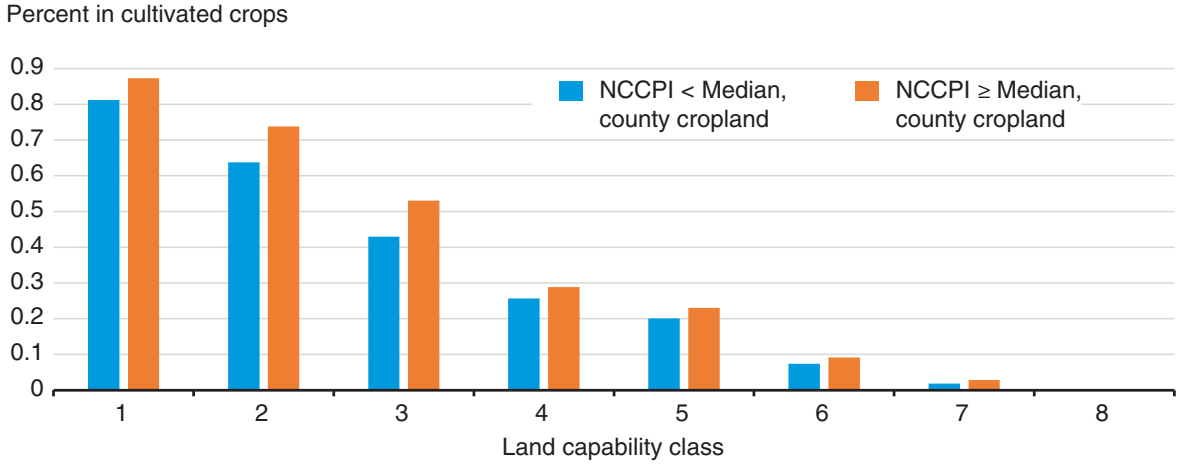
[13] In areas where land is not surveyed using the PLS system a virtual grid is used to define PSUs.

Because there is no formal USDA HEL determination on most noncropped land, we estimate an HEL determination from soil-specific measures of the erodibility index gleaned from the CRP Environmental Benefits Index (EBI) database. The CLU is defined as highly erodible for the purpose of HELC when it contains at least 33 percent or 50 acres of HEL soils (with an erodibility index of 8 or greater). We consider land "potentially convertible" if (1) the reported acreage specifies a nonculti-vated crop, grass, or the CRP and (2) has a Land Capability Class (LCC) of 1 or 2 or an LCC of 3 and field-level productivity equal to or greater than the county median for cropland. Our criteria indicate only that these lands are similar to other land that is already in cultivated crops (fig. A1).

Defining land that could be converted to crop production is a challenge. A great deal depends on the characteristics of specific tracts of land, including the ease (and cost) of drainage, productivity of the soil, topography, and climate. A number of authors have shown that the Land Capability Classification (LCC; USDA-SCS, 1961) is a good indicator of cropland potential (e.g., Stephens et al., 2008; Lubowski et al., 2008; Rashford et al., 2011). The NRI data show that the proportion of land in cultivation declines steadily as LCC increases. Within each LCC, cropland use also varies by the underlying productivity of the soil, as measured by the National Commodity Crop Productivity Index (NCCPI; Dobos et al., 2012). A majority of land in LCC 1 and 2 is cultivated for crop produc-tion, along with roughly half of LCC 3 land (fig. A1). A minority of land with an LCC of 4 or higher is used for cultivated crops.

Although any assumption is subjective, we assume that "potentially convertible" wetland includes all (1) cropped wetlands and (2) noncropped wetlands with (a) seasonal hydrology and (b) Land Capability Class (LCC) ≤ 2 or LCC = 3, with productivity greater than or equal to the county median, as measured by the National Commodity Crop Productivity Index (NCCPI). Although NCCPI applies only to nonirrigated cropland, we believe that the vast majority of potentially convertible noncropland is nonirrigated as most irrigated land is already in crop production.

Figure A1
Proportion of land in cultivated crops by Land Capability Class (LCC) and the National Commodity Crop Productivity Index (NCCPI)



Source: USDA, Economic Research Service analysis of data from the Natural Resources Conservation Service's National Resources Inventory (NRI) and Soil Survey Geographic Database (SSURGO).

Appendix B. Farming Operations

We use USDA Farm Service Agency (FSA) administrative data from 2013 to model farming operations that include National Resources Inventory (NRI) points. Farming operations are defined as a collection of Common Land Units (CLUs), which are roughly equivalent to fields. A CLU is the smallest unit of land that has a permanent, contiguous boundary, a common land cover and land management, a common owner, and a common producer on agricultural land associated with USDA farm programs. CLU boundaries are delineated from relatively permanent features such as fence lines, roads, and/or waterways.[14] Each CLU is located within a "tract"—a contiguous plot of land that is under single ownership and management. Each tract is located within an FSA administrative farm, which may include a number of tracts managed as a single entity for the purpose of farm program participation. FSA farms are administrative units designed to facilitate farm program implementation and typically include tracts of land under single ownership and operational control. Actual farming operations can be single FSA administrative farms, but they often encompass more than one FSA farm and can include dozens of FSA farms that are managed as a unit by one or more farm operators.

To develop our NRI-based sample of farms, we linked NRI points to FSA CLUs. Of the 511,348 NRI points that fall on land in agricultural use, 487,779 are located within a defined CLU. These CLUs link directly to a total of 258,506 FSA administrative farms (roughly 1.9 NRI points per administrative farm). Given that three NRI points are typically located within a single ½-mile-square (160-acre) area, it is not surprising that there is, on average, more than one point per FSA administrative farm (see Appendix A and Nusser and Goebel (1997) for more information on the NRI sample design). Most land in major agricultural States was originally divided into 160-acre parcels, and these "quarter sections" continue to be a common unit of land, although parcels of 80 acres and 40 acres are also common. Given that NRI Primary Sampling Units (PSUs) include only about 4 percent of U.S. non-Federal land (Nusser and Goebel, 1997), it is not surprising that NRI points are located in only 258,506 (roughly 5 percent) of more than 5 million FSA administrative farms.

Because many farming operations are made up of more than one FSA administrative farm, we link the FSA administrative farms that include NRI points to other FSA administrative farms that are part of the same farming operation. These additional FSA farms may or may not include NRI points but are part of the overall farming operation and, therefore, relevant to decisions about Conservation Compliance.

Links between FSA administrative farms are made using a three-step process. First, associations between operators and FSA administrative farms are identified from the 2013 customer ID codes. FSA customer codes identify individual customers by customer type (e.g., owner, operator, owner-operator) associated with each FSA farm. Only a single operator is associated with each FSA farm. Because we seek to identify networks that are farming operations (i.e., land under common management), we rely only on customer IDs that are classified as "operators" or "owner-operators." Links based on the association between landowners and FSA farms could result in networks that (incorrectly) encompass two or more farming operations to the extent that individual landowners rent land to more than one farming operation.

[14] For more information see FSA Handbook on Common Land Units.

Second, a set of links among FSA farms is developed by identifying all pairs of FSA farms associated with the same customer ID (operator). For example, a single operator associated with four FSA administrative farms (say, farms A, B, C, and D) would result in six unique links (AB, AC, AD, BC, BD, and CD). Finally, "operation IDs" are assigned to each unique network of FSA-farms based on the links created from customer IDs.[15]

Using the network analysis, the 258,506 FSA administrative farms that link directly to NRI points were linked to a total of 1,153,118 FSA administrative farms that form 218,420 farming operations, an average of 5.6 FSA farms per farming operation. Roughly 130,000 farming operations reported acreage to FSA in 2013 (implying participation in a USDA program), including more than 112,000 operations reporting some type of cultivated (annual) crop and more than 98,000 that reported growing one or more of the six most widely grown crops (corn, soybeans, wheat, cotton, sorghum, and barley). Roughly 17,000 farming operations reported only grassland or noncultivated crops (e.g., hay, orchards, tree nuts). The remaining operations (roughly 88,000) did not report any acreage to FSA (and, therefore, did not participate in any USDA program in 2013). More than 23,000 NRI points do not link to FSA data, so we assume they are on farms that do not participate in any Federal farm programs.

For the farming operations created from FSA administrative farms, a total of 100.4 million acres (40 percent of NASS-reported acreage (USDA-NASS, 2016b)) of the 6 major crops were reported in 2013, an average of 1,019 acres per farm in 1 or more of these 6 crops. On a crop-by-crop basis, the farming operations account for 36-48 percent of the six major crops (table B1). Base acreage of 109.3 million acres (6 crops) was associated with 133,560 farming operations, an average of 819 acres per operation.

FSA administrative data include information needed to estimate farm program benefits subject to Conservation Compliance, including:

- Reported acreage—the acreage of each crop grown each year, as well as acreage enrolled in some USDA programs (e.g., the Conservation Reserve Program).
- Base acreage—acreage of wheat, feedgrains, upland cotton, rice, oilseeds, pulse crops, or peanuts that are eligible for commodity program payments.
- Payment yields—"yields of record" used in calculating certain commodity payments.
- Crop insurance purchase and subsidy information.

Using 2012 NRI data linked to farming operations, we estimate the proportion of cropland and other agricultural lands located on farms that (1) were in the FSA farm database in 2013, (2) included commodity program base acreage in 2013, or (3) purchased crop insurance in 2013 (table B2). A large share of agricultural land is included in farming operations/FSA administrative farms, including 98 percent of cultivated cropland, 89 percent of noncultivated cropland, 85 percent of pasture, 80 percent of rangeland, and 99 percent of CRP. Smaller shares of land are located in farming operations and FSA administrative farms that include at least some farm program base acreage, which is necessary for participation in farm commodity programs. Farming operations that have farm program base acreage include: 93 percent of cultivated cropland, 60 percent of nonculti-

[15] This process may not capture the full range of FSA farms included in a single farming operation. Large operations often include multiple operators. If FSA farms are associated with different operators within the same operation, our procedure may result in under-aggregations of FSA farms.

Table B1a

Reported acreage on FSA administrative farms linked directly to at least one National Resources Inventory (NRI) point

	Reported acres			Percent of NASS planted acres	
	FSA farms at NRI point	Network of FSA farms	NASS planted acres	FSA farms at NRI point	Network of FSA farms
Barley	804,595	1,599,462	3,528,000	22.8	45.3
Corn	14,276,062	37,918,418	95,365,000	15.0	39.8
Cotton	1,652,617	4,865,146	10,206,000	16.2	47.7
Sorghum	1,104,154	2,919,279	8,076,000	13.7	36.1
Soybeans	10,901,818	28,510,703	76,840,000	14.2	37.1
Wheat	10,566,799	24,619,537	56,236,000	18.8	43.8
Six crops	39,306,046	100,432,545	250,251,000	15.7	40.1

Table B1b

Base acreage on FSA administrative farms linked directly to at least one NRI point

	Base acres			Percent of base acres	
	FSA farms at NRI point	Network of FSA farms	Total base acreage	FSA farms at NRI point	Network of FSA farms
Barley	2,303,713	4,178,532	8,722,000	26.4	47.9
Corn	14,173,403	34,995,125	83,933,000	16.9	41.7
Cotton	3,682,112	9,172,352	17,771,000	20.7	51.6
Sorghum	2,207,490	5,257,571	11,628,000	19.0	45.2
Soybeans	8,275,117	21,318,972	49,847,000	16.6	42.8
Wheat	16,290,974	34,401,805	73,554,000	22.1	46.8
Six crops	46,932,808	109,324,356	245,455,000	19.1	44.5

Source: USDA, Economic Research Service analysis of USDA, Farm Service Agency (FSA) and National Agricultural Statistics Service (NASS) data.

vated cropland, 46 percent of pasture, 38 percent of rangeland, and 70 percent of CRP. If farms were comprised only of FSA farms that include NRI points, percentages would be slightly lower because farming operations encompass more land. Finally, the share of land in farms that purchased crop insurance is lower than the share in farms with base acreage. Note, however, that the share of land with either base acreage or crop insurance is only slightly higher than the share of land in farms with base acreage. Most farms that purchase crop insurance also have base acreage.

Table B2

NRI acreage by land use with acres in FSA farms, farms with base acreage, and farms with insured acres

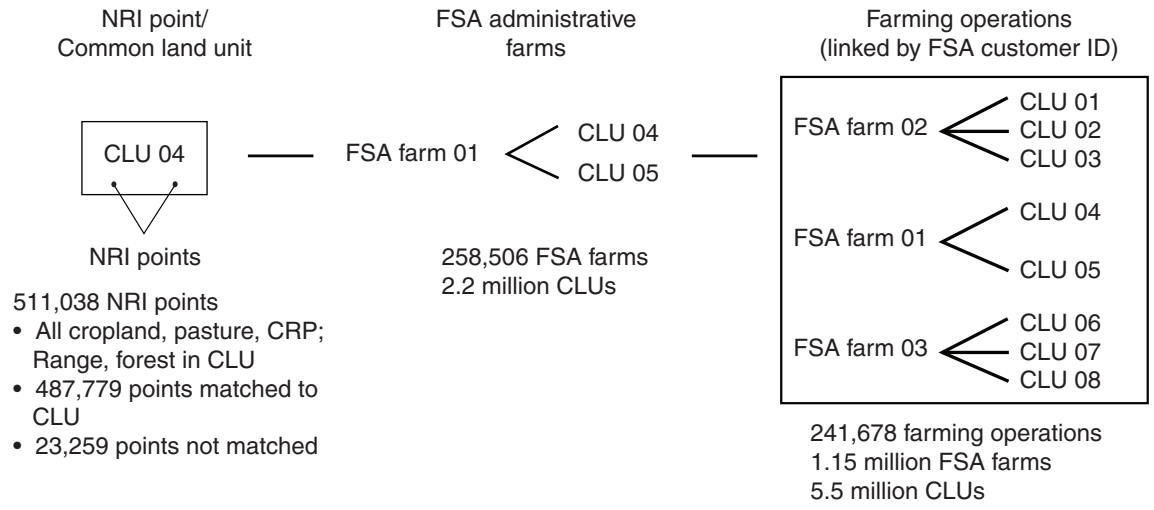
	All NRI land		In an FSA farm		With base acreage		With crop insurance		With base or crop insurance	
NRI land use	Number	Acres (1,000)	Acres (1,000)	% of NRI	Acres (1,000)	% of NRI	Acres (1,000)	% of NRI	Acres (1,000)	% of NRI
Farming operations										
Cultivated cropland	180,415	310,322	302,893	98	287,314	93	236,087	76	287,856	93
Noncultivated crop	32,034	52,404	46,710	89	31,519	60	14,884	28	31,863	61
Pasture	77,298	121,138	103,002	85	55,507	46	26,645	22	56,180	46
Range	122,080	405,777	322,961	80	153,277	38	72,199	18	154,116	38
Forest	236,229	413,337	187,827	45	78,130	19	37,555	9	79,253	19
CRP	10,653	24,222	23,906	99	18,355	76	10,528	43	18,404	76
FSA farms										
Cultivated cropland	180,415	310,322	302,893	98	282,491	91	221,117	71	284,594	92
Noncultivated crop	32,034	52,404	46,710	89	27,883	53	11,990	23	28,731	55
Pasture	77,298	121,138	103,002	85	45,315	37	20,545	17	46,884	39
Range	122,080	405,777	322,961	80	102,818	25	45,922	11	104,343	26
Forest	236,229	413,337	187,827	45	56,391	14	27,790	7	58,656	14
CRP	10,653	24,222	23,906	99	16,143	67	8,184	34	16,312	67

Note: CRP = Conservation Reserve Program.

Source: USDA, Economic Research Service analysis of National Resources Inventory (NRI) and Farm Service Agency (FSA) administrative data.

Figure B1

Linking National Resources Inventory (NRI) points to farming operations



Notes: CLU = common land unit; FSA = Farm Service Agency.

Source: USDA, Economic Research Service.

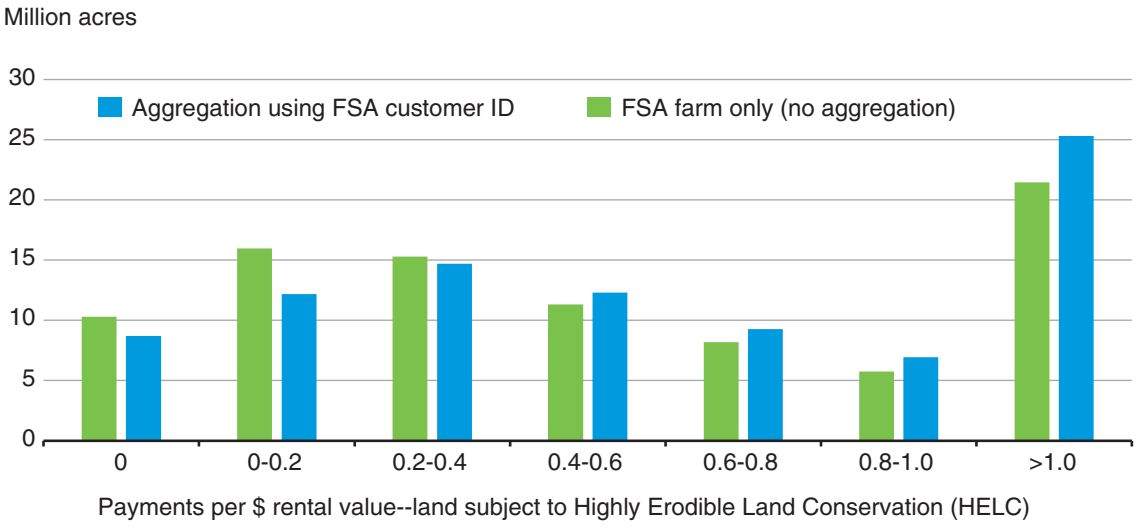
The Effect of Aggregating FSA Administrative Farms

Aggregating FSA administrative farms to farming operations provides a more accurate assessment of farmwide Compliance incentives than could be obtained by using individual FSA administrative farms. By aggregating administrative farms, we recognize that payments associated with some administrative farms provide Compliance incentives to other administrative farms that may include highly erodible land or wetland. Analysis on administrative farms, without aggregation, would underestimate the strength of Compliance incentives.

To see how large this effect would be, we re-estimated the distribution of cropland in highly erodible land (HEL) fields across Compliance incentives, assuming that Compliance incentives could come only from the FSA administrative farms where the HEL fields are located. Our results show that the number of acres on farms without farm program benefits rises from 8.7 million to 10.3 million. The number of acres on farms with benefits in the range 0-0.4 $/$ of rental value also rises from 27 million to 31 million. Cropland in HEL fields on farms with Compliance incentives >1 $/$ of rental value falls from 25 million acres to 21 million acres.

Box figure B1

Comparison of analysis using aggregated farming operations and Farm Service Agency (FSA) administrative farms



Source: USDA, Economic Research Service using NRCS National Resources Inventory data.

For each of the 5.5 million common land units linked to a farming operation, we also link data on land quality and condition, similar to those available from the NRI, including Land Capability Classification (LCC), soil productivity (National Commodity Crop Productivity Index, NCCPI), topography (mean, standard deviation of slope), and HEL status. Information on HEL status is available for most cropland but not for most pasture and rangeland.

CLU-level wetland acreage data are based on the National Wetlands Inventory (NWI) and the NASS Cropland Data Layer (CDL) (USDA-NASS, 2016a). The NWI was established by the U.S. Fish and Wildlife Service (FWS) for conducting a nationwide inventory of U.S. wetlands to provide biolo-

gists and others with information on the distribution, area, and type of wetlands. NWI provides digital maps of wetland boundaries and classification information for each individual wetland basin (Cowardin et al., 1979). NWI data are available only for States that include part of the Prairie Pothole Region, limiting our analysis to these States (Iowa, Montana, Minnesota, North Dakota, and South Dakota).

CLU-level data on wetland acreage, wetland basins, and wetland type are developed by overlaying the digital NWI map with a 30-meter grid and assigning wetland status (binary) and water regime code (A-J). Each cell is further classified as cropped or noncropped by overlaying the Cropland Data Layer (CDL) with the same 30-meter grid. For each CLU, we estimate total wetland acreage and number of wetland basins for each of six categories defined by cropland status and three categories of hydrology based on water regime modifiers: permanent and semi-permanent wetlands (water regimes F, G, and H), temporary/seasonal wetlands (A, B, C, and J), and saturated wetlands (D, E). We assume that wetland conversion is easier (less expensive) for land that is already dry enough to be cropped (at least in some seasons) and where wetlands are seasonal (dry some part of most years).

LCC and NCCPI are obtained from the Soil Survey Geographic Database (SSURGO). SSURGO map units are small, often subfield areas that may contain one to three major components (soils) and some minor components. Digital maps provide unit boundaries and are linked to information about the component soils and their properties for each map unit. SSURGO data is overlaid with a 30-meter grid (each cell is roughly 0.22 acres), and each cell is assigned a single value for LCC and NCCPI.

Farm operation-level estimates of cultivated cropland in HEL fields are based on FSA-reported acreage data for each CLU and USDA HEL determination, and also by CLU, as described in Appendix A. Our farming operation-level estimate of HEL in cultivated crops is the sum of CLU-level acreages for individual "cultivated" crops (e.g., corn, soybeans, wheat, cotton, sorghum, barley, canola, sunflower, etc., not including the second crop on double-cropped land), in CLUs that have been determined to be HEL for the purpose of Highly Erodible Land Conservation (HELC).

HEL and wetland that are not in crop production but have productivity and topography similar to existing cropland could be converted to crop production. To the extent that Compliance is keeping these lands out of crop production, meeting Compliance requirements is costly. Although we argue that these lands are *potentially convertible* for crop production, particularly in the absence of Compliance requirements, we do not suggest that these lands will be converted in the absence of Compliance requirements.

A farm-level estimate of "potentially convertible" wetland is developed from CLU-level estimates, based on the same criteria used to determine whether an NRI wetland point is subject to Compliance. We include all (1) cropped wetlands and (2) noncropped wetlands with (a) seasonal hydrology and (b) Land Capability Class (LCC) ≤ 2 or LCC = 3, with productivity greater than or equal to the county median, as measured by the NCCPI. The CLU is assumed to meet the LCC ≤ 2 criteria when the median LCC is less than or equal to 2. The CLU is assumed to have met the LCC = 3 criteria when the median LCC = 3. The NCCPI criteria is met when the average NCCPI for the CLU is greater than or equal to the county median NCCPI for cropland. In the Prairie Pothole, on the farms we model, there are roughly 2.6 million acres of potentially convertible wetland, including 1 million acres of cropped wetland.

Because there is no formal USDA HEL determination on most noncropped land, we estimate an HEL determination from soil-specific measures of the erodibility index gleaned from the CRP Environmental Benefits Index (EBI) database. The CLU is defined as highly erodible for the purpose of HELC when it contains at least 33 percent or 50 acres of HEL soils (with an erodibility index of 8 or greater). We consider land "potentially convertible" if (1) the reported acreage specifies a noncultivated crop, grass, or the CRP and (2) has a Land Capability Class (LCC) of 1 or 2 or an LCC of 3 and field-level productivity equal to or greater than the county median for cropland. Our criteria indicate only that these lands are similar to other land that is already in cultivated crops (see Appendix A for more detail).

Appendix C. Conservation Compliance and Soil Conservation

Table C1
Variables used in the regression model for "Conservation Compliance and Soil Conservation, 1982-2012"

Variable used	Source	Description
Annual erosion per acre	NRCS National Resources Inventory (NRI)	Erosion in tons/acre/year calculated at the NRI point using the Universal Soil Loss Equation (for water erosion) or Wind Erosion Equation (for wind erosion). This calculation is only present for points in cropland, pasture, or CRP in a given year.
Percent not imputed in 1987	NRCS (NRI)	Percent of NRI points where 1987 data is not imputed. The 1987 survey assessed only a subset of NRI points (Schnepf and Flanagan, 2016).
Farm size (in acres)	FSA Administrative data	Farm operation size in acres (see appendix B).
Median land capability class (LCC)	Soil Survey Geographic Database (SSURGO)	Classification system developed by NRCS to describe land suitability for cultivation, where class 1 has no restrictions for cultivation, and class 8 is not suitable for cultivation, for pasture, or as rangeland.
Mean National Commodity Crop Productivity Index (NCCPI)	SSURGO	Index developed by NRCS using soil, climate, and other landscape factors to describe soil productivity for non-irrigated commodity crop cultivation. Range is 0 (low productivity) to 100 (high productivity).
Standard deviation of slope	SSURGO	The standard deviation of the slope of the field containing the NRI point.
Wind erodibility index in 1982	NRCS (NRI)	Erodibility index for the Wind Erosion Equation at the NRI point in 1982 (before implementation of conservation compliance).
Water erodibility index in 1982	NRCS (NRI)	Erodibility index for the Universal Soil Loss Equation at the NRI point in 1982 (before implementation of conservation compliance).
Highly erodible for wind	NRCS (NRI)	Erodibility index for the Wind Erosion Equation at the NRI point in 1982 was >= 8 (before implementation of conservation compliance).
Highly erodible for water	NRCS (NRI)	Erodibility index for the Universal Soil Loss Equation at the NRI point in 1982 was >=8 (before implementation of conservation compliance).

All variables were merged to NRI points, such that the dataset could be structured as a panel with observations for every NRI year (1982, 1987, 1992, 1997, 2002, 2007, 2012).
NRCS = Natural Resources Conservation Service; FSA = Farm Service Agency.
Source: USDA, Economic Research Service.

Table C2

Descriptive statistics for variables used in the regression model ("Conservation Compliance and Soil Conservation, 1982-2012") for the full sample of NRI points in cultivated cropland with base acreage, as well as for points highly erodible for *water* in HEL fields subject to Compliance and points that were not highly erodible

Variable	Full sample n=105,531	NRI point highly erodible for water and field not designated as highly erodible n=3,571			NRI point highly erodible for water and field designated as highly erodible n=8,859		
	Mean (SE)	*Mean (SE)*	*Min*	*Max*	*Mean (SE)*	*Min*	*Max*
Annual erosion per acre (in tons—mean over all NRI years)	5.83 (0.04)	11.66 (0.24)	0.06	119.42	12.96 (0.18)	0.05	222.25
Percent not imputed in 1987	0.33 (0.00)	0.51 (0.01)	0	1	0.47 (0.01)	0	1
Farm size (in acres)	122.98 (1.32)	78.13 (2.12)	0.8	941	87.39 (4.11)	0.2	9024.13
Median land capability class	2.47 (0.01)	2.41 (0.03)	1	7	2.96 (0.02)	1	8
Mean NCCPI	0.50 (0.00)	0.58 (0.01)	0	0.98	0.55 (0.00)	0	0.98
Standard deviation of slope	0.81 (0.00)	1.02 (0.03)	0	8.84	1.47 (0.02)	0	10.17
Wind erodibility index in 1982	3.49 (0.03)	1.34 (0.12)	0	55.90	1.46 (0.07)	0	72.8
Water erodibility index in 1982	3.66 (0.03)	13.73 (0.21)	8	109.70	18.78 (0.23)	8	170.1
Highly erodible for wind	0.14 (0.00)	0.05 (0.01)	0	1	0.05 (0.00)	0	1
Highly erodible for water*	0.11 (0.00)						

HEL = highly erodible land. NCCPI = National Commodity Crop Productivity Commodity; NRI = National Resources Inventory. All means and standard errors are computed using NRI sample weights and the full set of 29 jackknife replicate weights, respectively.

*All NRI points in subsample are highly erodible for water.

Source: USDA, Economic Research Service.

Table C3

Descriptive statistics for variables used in the regression model ("Conservation Compliance and Soil Conservation, 1982-2012") for the full sample of NRI points in cultivated cropland with base acreage, as well as for points highly erodible for *wind* in HEL fields subject to Compliance and points that were not highly erodible

Variable	Full sample n=105,531	NRI point highly erodible for wind and field not designated as highly erodible n=2,123			NRI point highly erodible for wind and field designated as highly erodible n=8,366		
	Mean (SE)	*Mean (SE)*	*Min*	*Max*	*Mean (SE)*	*Min*	*Max*
Annual erosion per acre (in tons—mean over all NRI years)	5.83 (0.04)	8.76 (0.34)	0	234.59	11.23 (0.31)	0	216.53
Percent not imputed in 1987	0.33 (0.00)	0.39 (0.02)	0	1	0.43 (0.01)	0	1
Farm size (in acres)	122.98 (1.32)	183.79 (10.81)	0.57	67117.30	220.45 (7.17)	0.1	9024.13
Median land capability class	2.47 (0.01)	3.01 (0.06)	1	7	3.26 (0.02)	1	7
Mean NCCPI	0.50 (0.00)	0.28 (0.00)	0	0.88	0.25 (0.00)	0	0.8
Standard deviation of slope	0.81 (0.00)	0.83 (0.02)	0	16.87	0.78 (0.01)	0.05	4.64
Wind erodibility index in 1982	3.49 (0.03)	11.92 (0.26)	8	86	13.27 (0.17)	8	111.8
Water erodibility index in 1982	3.66 (0.03)	2.61 (0.15)	0	49	1.78 (0.05)	0	37.6
Highly erodible for wind*	0.14 (0.00)						
Highly erodible for water	0.11 (0.00)	0.05 (0.01)	0	1	0.03 (0.00)	0	1

NCCPI = National Commodity Crop Productivity Index; NRI = National Resources Inventory. All means and standard errors computed using NRI sample weights and the full set of 29 jackknife replicate weights, respectively.

*All NRI points in subsample are highly erodible for wind.

Source: USDA, Economic Research Service.

Table C4

Full regression results for model estimating change in erosion rates on cultivated cropland with base acreage, 1982-2012

	Coeff.	SE
Year		
1987	-0.82***	0.23
1992	-0.63***	0.03
1997	-0.99***	0.03
2002	-1.21***	0.03
2007	-1.44***	0.03
2012	-1.57***	0.03
Region		
Southeast	1.80***	0.15
Midwest	1.84***	0.14
Northern Plains	-0.88***	0.24
South Central	2.15***	0.18
West	0.98***	0.27
No 1987 data imputed and year =1987	0.98***	0.25
All 1987 data imputed and year =1987	-0.93**	0.45
Some 1987 data imputed and year =1987	0.54**	0.23
Farm size	0.00	0.00
Median Land Capability Class		
2	0.30***	0.09
3	-0.17	0.11
4	1.78***	0.24
5	0.00	0.64
6	-0.36	0.54
7	-0.71	0.71
8	-0.59	0.41
Mean NCCPI	-0.66***	0.24
StDev Slope	0.08	0.05
Wind EI in 1982	0.83***	0.05
Water EI in 1982	0.42***	0.02
NRI point highly erodible for wind in 1982	-2.09***	0.69
NRI point highly erodible for water in 1982	5.13***	0.30
Field highly erodible and year =1982	0.14	0.16
Field highly erodible and year =1987	0.16	0.12
Field highly erodible and year =1992	-0.35***	0.09
Field highly erodible and year =1997	-0.60***	0.12
Field highly erodible and year = 2002	-0.26***	0.10
Field highly erodible and year = 2007	-0.14	0.09
Field highly erodible and year = 2012	-0.14*	0.07

—continued

Table C4

Full regression results for model estimating change in erosion rates on cultivated cropland with base acreage, 1982-2012—continued

	Coeff.	SE
Field highly erodible, NRI point highly erodible for wind in 1982, and year =1982	2.17***	0.70
Field not highly erodible, NRI point highly erodible for wind in 1982, and year =1982	(base)	
Field highly erodible, NRI point highly erodible for water in 1982, and year =1982	0.59	0.37
Field not highly erodible, NRI point highly erodible for water in 1982, and year =1982	(base)	
Field highly erodible, NRI point was highly erodible for wind in 1982, and year =1987	3.31***	0.67
Field not highly erodible, NRI point highly erodible for wind in 1982, and year =1987	-0.34***	0.48
Field highly erodible, NRI point highly erodible for water in 1982, and year =1987	-1.07***	0.34
Field not highly erodible, NRI point highly erodible for water in 1982, and year =1987	-1.16***	0.25
Field highly erodible, NRI point highly erodible for wind in 1982, and year =1992	1.12	0.70
Field not highly erodible, NRI point highly erodible for wind in 1982, and year =1992	-0.38	0.49
Field highly erodible, NRI point highly erodible for water in 1982, and year =1992	-2.71***	0.35
Field not highly erodible, NRI point highly erodible for water in 1982, and year =1992	-2.36***	0.26
Field highly erodible, NRI point highly erodible for wind in 1982, and year =1997	0.83	0.59
Field not highly erodible, NRI point highly erodible for wind in 1982, and year =1997	-1.22**	0.57
Field highly erodible, NRI point highly erodible for water in 1982, and year =1997	-4.26***	0.37
Field not highly erodible, NRI point highly erodible for water in 1982, and year =1997	-2.89***	0.22
Field highly erodible, NRI point highly erodible for wind in 1982, and year= 2002	0.13	0.61
Field not highly erodible, NRI point highly erodible for wind in 1982, and year = 2002	-1.70***	0.51
Field highly erodible, NRI point highly erodible for water in 1982, and year = 2002	-3.95***	0.35
Field not highly erodible, NRI point highly erodible for water in 1982, and year = 2002	-2.55***	0.28
Field highly erodible, NRI point highly erodible for wind in 1982, and year = 2007	-0.84	0.65
Field not highly erodible, NRI point highly erodible for wind in 1982, and year = 2007	-1.59**	0.61
Field highly erodible, NRI point highly erodible for water in 1982, and year = 2007	-4.07***	0.40

—continued

Table C4

Full regression results for model estimating change in erosion rates on cultivated cropland with base acreage, 1982-2012—continued

	Coeff.	SE
Field not highly erodible, NRI point highly erodible for water in 1982, and year = 2007	-2.98***	0.30
Field highly erodible, NRI point highly erodible for wind in 1982, and year = 2012	-0.16	0.69
Field not highly erodible, NRI point highly erodible for wind in 1982, and year=2012	-1.45**	0.56
Field highly erodible, NRI point highly erodible for water in 1982, and year = 2012	-4.08***	0.36
Field not highly erodible, NRI point highly erodible for water in 1982, and year = 2012	-2.76***	0.36
Constant	1.22***	0.25
Number of observations	738,717 (over 7 years)	
R^2	0.33	

Notes: *<0.10, **<0.05, ***<0.01. NCCPI = National Commodity Crop Productivity Index; NRI = National Resources Inventory. EI = Environmental Index.

Source: USDA, Economic Research Service.

Dependent variable is annual erosion in tons/acre/year at the NRI point. Regression is weighted by the NRI sample weights, and coefficient standard errors are estimated using the full set of 29 jackknife replicate weights. These models were used for making all predictions in figures 10 and 11. For NRI points that were highly erodible for wind (fig. 10) and water (fig. 11), the charts show predictions for points located in fields designated as HEL and subject to Compliance (blue bars) and points located in fields not designated as HEL and not subject to Compliance (orange bars). These predictions were calculated using the Stata "margins" command with the subpop and "at" options specified to predict for points in each category.

Potential for Omitted Variable Bias

Ideally, we would have included several additional variables in the regression presented in table C4, such as farm operator characteristics (education, age, farming experience) as well as variables that account for farm production or conservation practices, such as adoption of irrigation, tile drainage, and tillage practices. We can assume that much of the impact of Conservation Compliance on soil erosion is actually occurring through changes in the adoption of these practices, such as conservation tillage, no-till, or changed cropping practices. If we had more information about these practices in the dataset, we could look more closely at the impact of Conservation Compliance on farmer behavior. However, it is unlikely that these omitted variables affect the treatment variable in this regression—whether a field is designated as highly erodible by NRCS and FSA—since that determination is based upon biophysical criteria (see box on p. 13, "Why Are Some NRI Points That Are Highly Erodible Subject to Compliance, But Not Others?").