United States Department of Agriculture

Natural Resources Conservation Service

Conservation Effects Assessment Project (CEAP)-Cropland

November 2017

Effects of Conservation Practices on Water Erosion and Loss of Sediment at the Edge of the Field

A National Assessment Based on the 2003-06 CEAP Survey and APEX Modeling Databases

Suggested Citation: U.S. Department of Agriculture, Natural Resources Conservation Service. 2017. Effects of Conservation Practices on Water Erosion and Loss of Sediment at the Edge of the Field: A National Assessment Based on the 2003-06 CEAP Survey and APEX Modeling Databases. 74 pp.

The Conservation Effects Assessment Project (CEAP)—Strengthening the science base for natural resource conservation

The Conservation Effects Assessment Project (CEAP) was initiated by USDA's Natural Resources Conservation Service (NRCS), Agricultural Research Service (ARS), and National Institute of Food and Agriculture (NIFA) [formerly known as Cooperative State Research, Education, and Extension Service (CSREES)] in 2002 as a means to analyze societal and environmental benefits gained from the 2002 Farm Bill's substantial increase in conservation program funding. The CEAP-1 survey was conducted on agricultural lands across the United States in 2003-06. The goals of CEAP-1 were to estimate conservation benefits for reporting at the national and regional levels and to establish the scientific understanding of the effects and benefits of conservation practices at the watershed scale. As CEAP evolved, the scope was expanded to assess the impacts and efficacy of various conservation practices on maintaining and improving soil and water quality at regional, national, and watershed scales.

CEAP activities are organized into three interconnected efforts:

- *Bibliographies, literature reviews, and scientific workshops* to establish what is known about the environmental effects of conservation practices at the field and watershed scale.
- *National and regional assessments* to estimate the environmental effects and benefits of conservation practices on the landscape and to estimate conservation treatment needs. The four components of the national and regional assessment effort are *Cropland*; *Wetlands*; *Grazing Lands*, including rangeland, pastureland, and grazed forestland; and *Wildlife*.
- *Watershed studies* to provide in-depth quantification of water quality and soil quality impacts of conservation practices at the local level and to provide insight on what practices are most effective and where they are needed within a watershed to achieve environmental goals.

CEAP-1 benchmark results, currently published for 12 watersheds, provide a scientific basis for interpreting conservation practice implementation impacts and identifying remaining conservation practice needs. These reports continue to inform decision-makers, policymakers, and the public on the environmental and societal benefits of conservation practice use. CEAP-2, the second national survey of agricultural lands across the United States, is currently underway, with sampling occurring in 2015 and 2016.

Additional information on the scope of the project can be found at http://www.nrcs.usda.gov/technical/nri/ceap/.

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This report was prepared for NRCS by Robert Kellogg on October 29, 2016.

Scope of This Report

The first CEAP national assessment was conducted using farmer survey data collected in 2003-06, where results were reported for Water Resource Regions that represented the major drainage basins in the United States. These reports were published by NRCS and are available online at http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/ceap/pub/.

A second CEAP national assessment is underway and will produce an updated national assessment using farmer survey data collected in 2015-16. For this updated CEAP national assessment, newly defined CEAP production regions will serve as the basis for the assessment. The 12 CEAP production regions were derived specifically for use with the 2015-16 survey data to draw sharper distinctions among regions with respect to the prevalent land use, cropping systems, climate, soils characteristics, and, consequently, conservation practice use and effectiveness. The 12 regions are:

Region number	Region name
1	Northwest Coastal
2	California Coastal
3	Northwest Non-Coastal
4	Southwest Non-Coastal
5	Northern Plains
6	Southern Plains
7	North Central and Midwest
8	South Central
9	Lower Mississippi and Texas Gulf Coast
10	Northeast
11	East Central
12	Southeast Coastal Plain

The purpose of this report is to present the previously published 2003-06 results formatted for the new CEAP production regions. The APEX modeling data for each of the 2003-06 CEAP sample points remain unchanged, as do the rules of analysis as presented in the 12 CEAP regional publications summarizing the 2003-06 findings by major drainage basins. ***The only change is that the 2003-06 CEAP sample points are aggregated into different groupings for this report,*** and consequently, the sample acreage weight for each sample point has been adjusted to reproduce the 2003 NRI acreage by cropping system for the 12 new CEAP production regions.

Only the 2003-06 CEAP sample points used in the previously published CEAP reports could be incorporated into the revised assessment. The additional sample points for the "West" region—368 sample points—could not be used because the full set of APEX modeling results were not available. In addition, after assigning the remaining 18,323 sample points to the 12 new CEAP production regions, four of the new regions did not have enough 2003-06 sample points to support a regional representation. The four regions for which data summaries ***could not be and are not presented*** here are:

Region number	Region name
1	Northwest Coastal
2	California Coastal
4	Southwest Non-Coastal
8	South Central

The regional summary results reported herein represent what NRCS ***would have published*** based on the 2003-06 survey data had 2003-06 results been summarized according to the new CEAP production regions. In the course of assessing the 2015-16 results, NRCS staff will compare findings to the 2003-06 survey data, but will re-estimate APEX model results for the 2003-06 data using the most recent version of the APEX model and will incorporate additional upgrades in methods and refinements in ancillary datasets such as weather and soils to be as comparable as possible to methods and data used for assessing the 2015-16 results. Thus, those forthcoming results for 2003-06 will differ from findings reported herein.

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Summary of Findings

The purpose of this report is to assess how effective conservation practices are in reducing erosion and edge-of-field sediment loss from water erosion on cultivated cropland acres. The 2003-06 CEAP farmer survey data and APEX simulation modeling results for cultivated cropland acres were used to make the assessment. Results for 2003-06 are available for 17,918 CEAP sample points, a subset of the National Resources Inventory (NRI) sample points. Regional results are summarized for eight newly defined CEAP production regions.

To what extent are conservation practices used to control water erosion and edge-of-field sediment loss?

Water erosion control practices include structural practices, residue, and tillage management (annual practices).

About 38 percent of cultivated cropland acres had one or more of these structural erosion control practices in 2003-06:

- Overland flow practices (terraces, contour buffer strips, contour farming, stripcropping, and contour stripcropping) were the most prevalent; 26 percent of cultivated cropland acres had some kind of overland flow practice installed.
- Concentrated flow control practices (grassed waterways, grade stabilization structures, diversions, and other structures for water control) were used on 21 percent of cultivated cropland acres.
- Edge-of-field buffering and filtering practices (riparian forest buffers, riparian herbaceous cover, filter strips, field borders) were in much lower use in 2003-06, reported to be in use on only 5 percent of cultivated cropland acres.

Structural practices were most prevalent in the East Central (11) region, where 58 percent of cultivated cropland acres had one or more water erosion control practice. Structural practices were least prevalent in the Lower Mississippi and Texas Gulf Coast (9) region and the Northern Plains (5) region, where only 20-22 percent of cultivated cropland acres had one or more water erosion control practice.

Most cropland acres meet criteria for either mulch till or no-till in 2003-06. For all eight regions combined:

- About 32 percent of cultivated cropland acres met the tillage intensity criteria for no-till.
- About 50 percent of cultivated cropland acres met the tillage intensity criteria for mulch till.
- About 7 percent of cropped acres did not meet criteria for mulch till or no-till but used reduced tillage on some crops in the rotation.
- Only about 10 percent of the cropped acres were conventionally tilled.

No-till was used most often in two regions: the East Central (11) region, where 52 percent of cultivated cropland met criteria for no-till; and the Northern Plains (5) region, where 47 percent of cultivated cropland met criteria for no-till. Use of mulch till was common in all eight regions. Mulch till was most prevalent in the Northwest Non-Coastal (3) region, where 62 percent of cultivated cropland acres met criteria for mulch till. Use of continuous conventional tillage was highest in the Southern Plains (6) region, where 26 percent of cultivated cropland acres are conventionally tilled.

For all eight regions combined, 94 percent of cultivated cropland acres had some kind of practice to control water erosion:

- 34 percent had one or more structural practice and some form of reduced tillage.
- 55 percent had some form of reduced tillage but no structural practices.
- 4 percent had one or more structural practice but no reduced tillage.
- Only 6 percent had no reduced tillage and no structural practices.

How much erosion and edge-of-field sediment loss is there on cultivated cropland acres?

Sheet and rill erosion, which is the detachment and movement of soil particles within the field that occurs during rainfall events, averaged 0.65 tons per acre per year for all eight regions combined, after taking into account the use of conservation practices to control water erosion. According to the model simulation results, sheet and rill erosion rates were lowest for the three westernmost regions, which have the lowest levels of precipitation and irrigation water use and the smallest amount of surface water runoff—the Northwest Non-Coastal (3) region, the Northern Plains (5) region, and the Southern Plains (6) region. In contrast, the average annual sheet and rill erosion rate exceeded 1 ton per acre per year in these three regions:

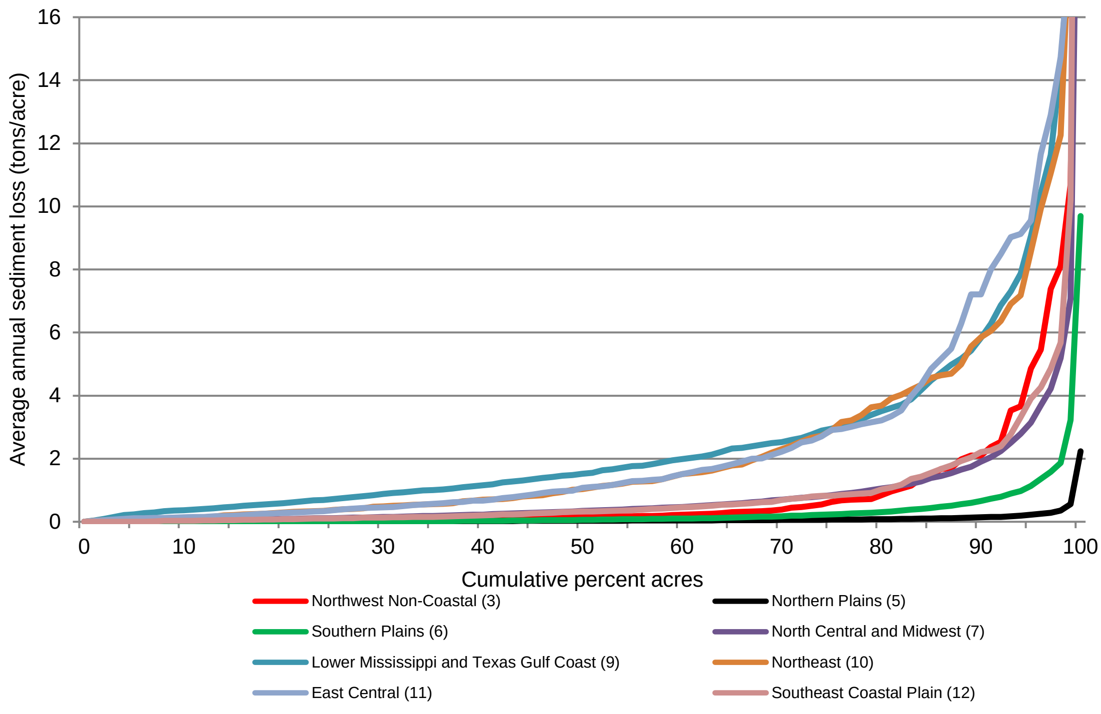
- the East Central (11) region, with an average annual rate of 1.7 tons per acre per year,
- the Lower Mississippi and Texas Gulf Coast (9) region, with an average annual rate of 1.6 tons per acre per year, and
- the Northeast (10) region, with an average annual rate of 1.4 tons per acre per year.

Sediment loss, which is the portion of the sheet and rill eroded material that is transported beyond the edge of the field and settles offsite as well as some sediment that originates from gully erosion processes, averaged 0.79 tons per acre per year for cultivated cropland acres in all eight regions. Sediment loss was highest in the Lower Mississippi and Texas Gulf Coast (9) region, averaging 2.66 tons per acre per year. This region also had the largest amount of precipitation and irrigation water applied and the largest amount of surface water runoff per year. Average annual sediment loss for cropped acres was only slightly lower for two other regions—the East Central (11) region, with an average of 2.52 tons per acre per year, and the Northeast (10) region, with an average of 2.36 tons per acre per year.

Average annual sediment loss estimates in the Northern Plains (5) and Southern Plains (6) regions were low for all but a very few cultivated cropland acres. The dominant erosion cause in these regions is generally wind. The average annual sediment loss was only 0.06 tons per acre per year in the Northern Plains (5) region and only 0.26 tons per acre per year in the Southern Plains (6) region. The remaining three regions averaged less than 1 ton per acre per year of sediment loss for all cropped acres, but average annual sediment loss exceeded 2 tons per acre per year for about 10 percent of the cultivated cropland acres in these three regions.

The regional cumulative distributions of sediment loss estimates shown in the figure below illustrate the extent to which sediment loss concerns vary among the eight production regions, after accounting for the benefits of conservation practices in use in 2003-06.

Comparison of cumulative acre distributions of average annual sediment loss from water erosion for CEAP sample points in the eight production regions.



Overall, about 10 percent of all cropped acres in the eight regions—totaling 28.4 million acres— have average annual sediment loss estimates greater than 2 tons per acre per year. Acres having sediment loss rates at the edge of the field greater than 2 tons per acre per year are generally considered to require additional conservation treatment. Losses above these levels are treated as unacceptable based on what could be realistically achieved with today's production and conservation technologies. About two-thirds of these acres with excessive edge-of-field sediment losses are concentrated in two regions:

- the North Central and Midwest (7) region, where 9 percent of cropped acres (11.0 million acres) had average annual sediment loss estimates of more than 2 tons per acre per year, and
- the Lower Mississippi and Texas Gulf Coast (9) region, where 40 percent of cropped acres (8.4 million acres) had average annual sediment loss estimates of more than 2 tons per acre per year.

Two other regions had a high proportion of cropped acres with excessive sediment loss rates:

- the Northeast (10) region, where 32 percent of cropped acres (2.2 million acres) had average annual sediment loss estimates of more than 2 tons per acre per year, and
- the East Central (11) region, where 33 percent of cropped acres (2.8 million acres) had average annual sediment loss estimates of more than 2 tons per acre per year.

The remaining four regions each accounted for less than 5 percent of the 28.4 million acres with average annual sediment loss estimates greater than 2 tons per acre per year.

To what extent do conservation practices <u>reduce</u> erosion and edge-of-field sediment loss?

Sheet and rill erosion. Model simulations show that the average annual reduction in sheet and rill erosion due to the use of conservation practices averaged 0.485 tons per acre per year over all cultivated cropland acres in the eight regions, representing a 43-percent reduction. The East Central (11) region had the highest average annual reductions—1.23 tons per acre per year averaged over all cultivated cropland acres, representing a 42-percent reduction. This region also had the highest percentage of cropped acres with one or more structural practice and the highest percentage of cropped acres meeting criteria for no-till. The North Central and Midwest (7) region had the highest <u>percent</u> reduction due to conservation practices—52 percent for HEL acres and 48 percent for non-HEL acres.

The smallest reductions in sheet and rill erosion in terms of average tons per acre per year due to conservation practices were for cultivated cropland acres in the three westernmost and driest regions—the Northwest Non-Coastal (3) region, the Northern Plains (5) region, and the Southern Plains (6) region. The Northwest Non-Coastal (3) region and the Lower Mississippi and Texas Gulf Coast (9) region had the lowest <u>percent</u> reductions—23 percent reduction in sheet and rill erosion rates due to conservation practices for cultivated cropland acres in each region.

Sediment loss. According to the model simulations, the use of conservation practices has reduced average annual sediment loss from water erosion by 54 percent for cultivated cropland acres in all eight regions. Reductions in sediment loss are much higher for some acres than others, reflecting both the level of treatment and the inherent erodibility of the soil. For about half of the cultivated cropland acres in the eight regions, the average annual sediment loss reduction due to practices was less than 0.2 tons per acre per year. In contrast, about 25 percent had average annual reductions in sediment loss greater than 1 ton per acre per year and the top 10 percent had reductions greater than 2.7 tons per acre per year.

Conservation practices were most effective in reducing sediment loss from water erosion in the East Central (11) region, which also had the largest reductions in sheet and rill erosion. In this region, the average annual reduction in sediment loss was 2.83 tons per acre per year—a 53-percent reduction. The region with the smallest reduction in sediment loss due to conservation practice use was the Northern Plains (5) region, where the average annual reduction in sediment loss was only 0.07 tons per acre per year, which nevertheless represented a 53-percent reduction because of the very low sediment loss in this region. The remaining regions had average annual reductions in sediment loss ranging from 0.66 tons per acre per year for the Southern Plains (6) region to 1.74 tons per acre per year in the Northeast (10) region.

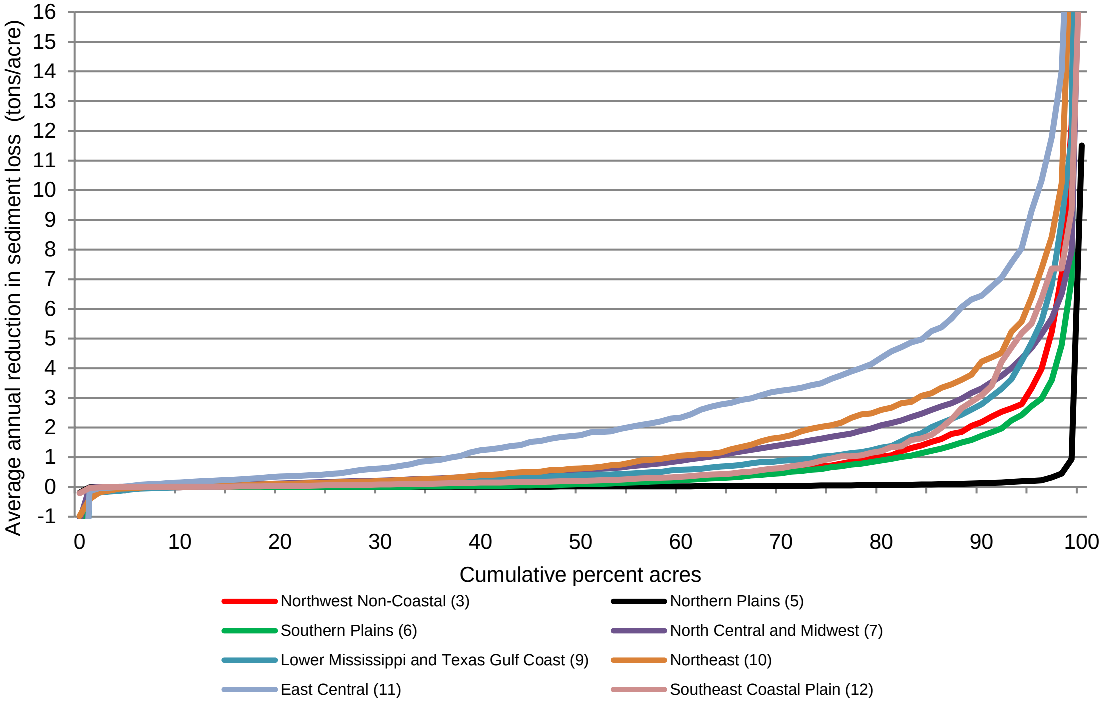
The Southern Plains (6) region and North Central and Midwest (7) region had the largest percent reduction—72 percent and 61 percent, respectively—in sediment loss rates for cultivated cropland acres due to conservation practices. The Lower Mississippi and Texas Gulf Coast (9) region had the smallest percent reduction in sediment loss rates due to conservation practices—30 percent.

The differences and similarities in the effectiveness of conservation practices on sediment loss among regions are best illustrated by comparing the cumulative acre distributions of average annual reductions, shown in the figure below. Again, the East Central (11) region stands out as benefitting most from conservation practices. About 62 percent of the cropped acres in this region had reductions in edge-of-field sediment loss of 1 or more ton per acre per year due to conservation practice use. About 45 percent of the cropped acres had reductions of 2 or more tons per acre per year and 22 percent of the cropped acres had reductions of 4 or more tons per acre per year.

In contrast, the Northern Plains (5) region stands out as having the least benefit from the use of conservation practices for control of sediment loss from water erosion, primarily because of the generally low potential for surface water runoff in the region. In this region, 95 percent of the cropped acres had reductions of less than 0.2 tons per acre per year from the use of conservation practices.

The remaining six regions had little or no benefit from the use of conservation practices for over half of the acres but had significant benefits for some acres. Reductions in sediment loss for acres with the highest reductions—those acres that were treated the most for erosion control—ranged to above 5 tons per acre per year for at least some acres in all 6 regions.

Comparison of cumulative acre distributions of average annual <u>reductions</u> in sediment loss from water erosion due to conservation practices for CEAP sample points in the eight production regions.



Introduction

Conservation practices have been used in the United States to control water erosion since the 1930s and 1940s. Hugh Hammond Bennett, the founder and first chief of the Soil Conservation Service (now Natural Resources Conservation Service) instilled in the national ethic the need to treat every acre to its potential by controlling soil erosion and surface water runoff. Land shaping structural practices (such as terraces, contour farming, and stripcropping) and sediment control structures were widely adopted during these early years. Conservation tillage emerged in the 1960s and 1970s as a key management practice for enhancing soil quality and further reducing soil erosion on cropland. Today, conservation tillage is widely used either alone or in combination with structural practices to control water erosion and sediment loss from farm fields.

Forms of water erosion include sheet and rill, ephemeral gully, classical gully, and streambank. Each type is associated with the progressive concentration of runoff water into channels leading downslope.

The first stage of water erosion is sheet and rill erosion. Sheet and rill erosion is the detachment and movement of soil particles within the field that occurs during rainfall events. Controlling sheet and rill erosion is important for sustaining soil productivity and preventing soil from leaving the field.

Sediment loss includes the portion of the sheet and rill eroded material that is transported beyond the edge of the field and settles offsite as well as some sediment that originates from gully erosion processes. Sediment is composed of detached and transported soil minerals, organic matter, plant and animal residues, and associated chemical and biological compounds.

NRCS has previously published a series of regional reports that assess the effects of conservation practices on reducing water erosion and sediment loss from farm fields.[1] These reports used a statistical sampling and modeling approach to estimate the effects of conservation practices. The National Resources Inventory (NRI) provided the statistical framework and soils data. Information on farming activities and conservation practices during the period 2003–06 was obtained for a subset of NRI sample points, and a field-level physical process simulation model called APEX was used to estimate losses of soil, nutrients, and pesticides at the edge of the field. The assessment was done using a common set of criteria and protocols applied to all regions in the country to provide a systematic, consistent, and comparable assessment at the national level. Survey data and modeling results were reported for Water Resource Regions that represented the major drainage basins in the United States.

The purpose of this report is to re-assess and summarize how effective conservation practices are in reducing sheet and rill erosion and sediment loss from farm fields due to water erosion at both the national and regional levels. For this assessment, the 2003–06 survey data and APEX modeling results were aggregated according to the new CEAP production regions, shown in figure 1.

Sufficient sample size was available to conduct this reassessment for 8 of the 12 production regions, representing a total of 290 million cultivated cropland acres (table 1 and fig. 2). This coverage represents 95 percent of the 305 million total acres of cultivated cropland in the United States in 2003, according to the 2003 NRI. As shown in figure 2, the bulk of the cultivated cropland (79 percent) is found in three regions—

- the North Central and Midwest (7) region, with 41 percent of the cultivated cropland in the eight regions,
- the Southern Plains (6) region, with 22 percent, and
- the Northern Plains (5) region, with 16 percent.

Results are reported for each of the eight regions and for all eight regions combined. Because the bulk of the cultivated cropland is found in the three regions listed above, the results reported for the eight regions combined largely reflect results for the combination of these three regions.

[1] http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/ceap/pub/

Figure 1. New CEAP production regions (boundaries defined by 8-digit hydrologic unit codes).

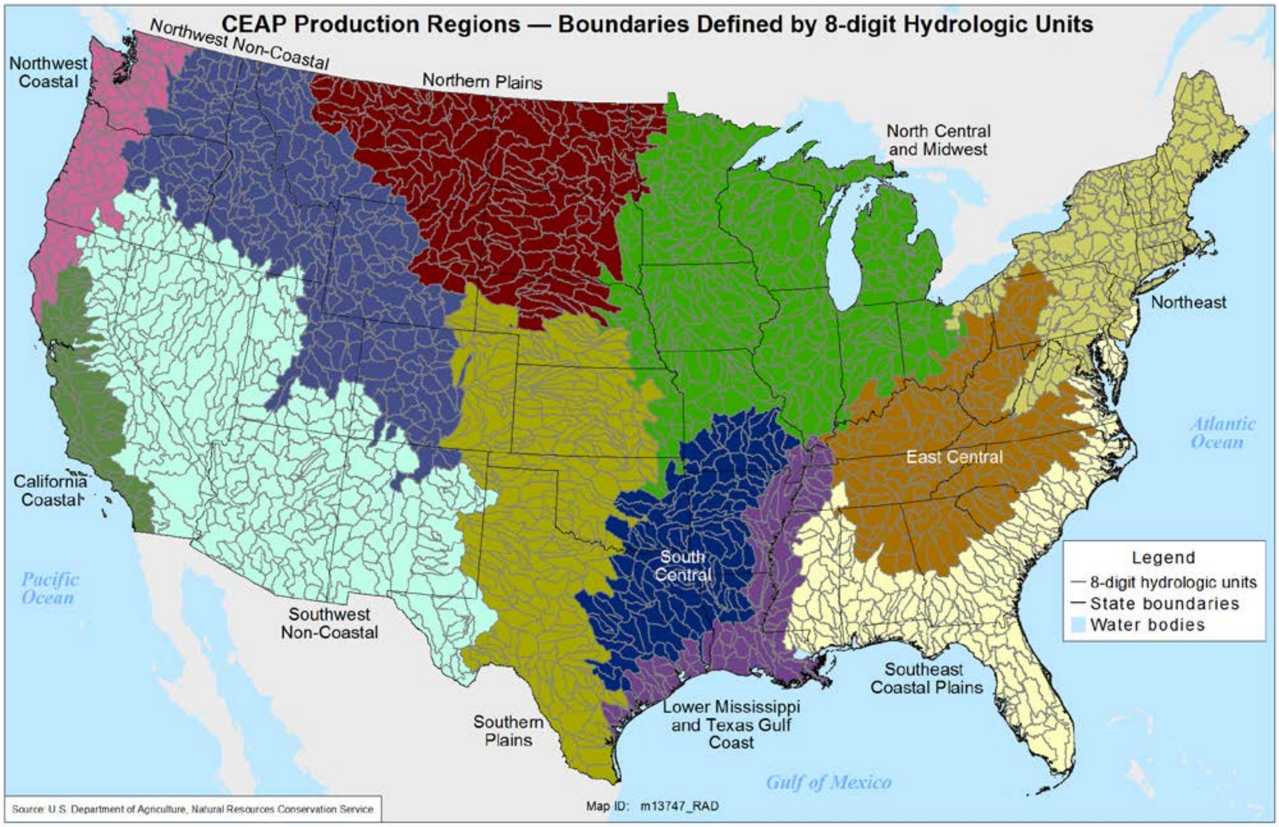
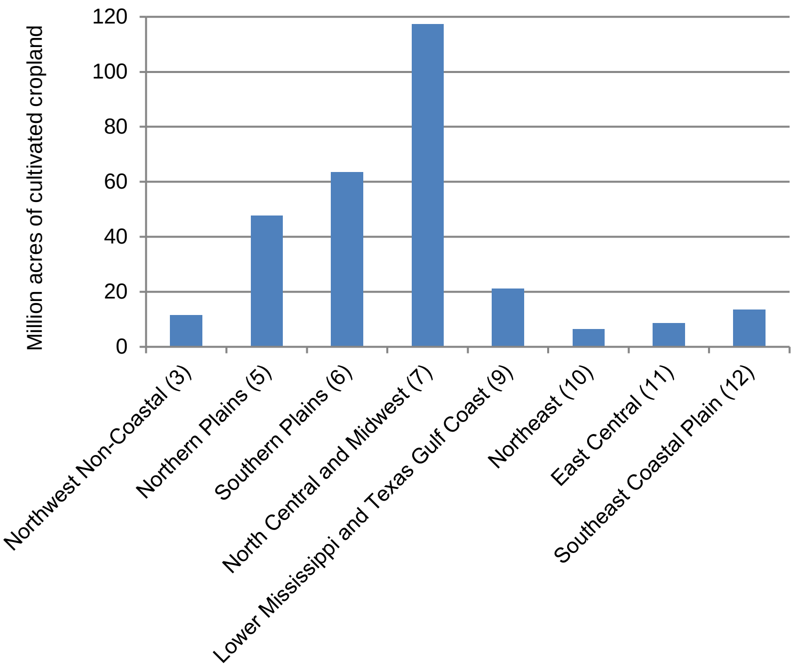


Table 1. Cultivated cropland acreage estimates for the 2003–06 CEAP sample for eight CEAP production regions, derived from the 2003 NRI.

CEAP production region	Number of 2003–06 CEAP sample points	Cultivated cropland acres based on 2003 NRI	Percent of total acres
Northwest Non-Coastal (3)	817	11,477,012	4
Northern Plains (5)	1,518	47,688,900	16
Southern Plains (6)	2,606	63,563,684	22
North Central and Midwest (7)	8,065	117,423,200	41
Lower Mississippi and Texas Gulf Coast (9)	1,820	21,162,500	7
Northeast (10)	888	6,547,500	2
East Central (11)	915	8,723,200	3
Southeast Coastal Plain (12)	1,289	13,502,000	5
All eight regions	17,918	290,087,996	100

Note: See Appendix A for documentation of how the original CEAP sample weights for the 2003-06 CEAP sample were adjusted to represent cultivated cropland acreage for the new CEAP production regions.

Figure 2. Cultivated cropland acreage derived from the 2003 NRI for the eight CEAP production regions covered in this report.



Use of Conservation Practices to Control Water Erosion

Erosion control practices include residue and tillage management (annual practices) and structural practices which, once implemented, are usually kept in place for several years (figs. 6 & 7).

Structural Practices

Data on structural practices for the farm field associated with each CEAP sample point were obtained from four sources.

1. **The NRI-CEAP Cropland Survey** included questions about the presence of 12 types of structural practices: terraces, grassed waterways, vegetative buffers (in-field), hedgerow plantings, riparian forest buffers, riparian herbaceous buffers, windbreaks or herbaceous wind barriers, contour buffers (in-field), field borders, filter strips, critical area planting, and grade stabilization structures.

2. For fields with conservation plans, **NRCS field offices** provided data on all structural practices included in the plans.

3. **The USDA-Farm Service Agency** (FSA) provided practice information for fields that were enrolled in the Continuous CRP for these structural practices: contour grass strips, filter strips, grassed waterways, riparian buffers (trees), and field windbreaks (Alex Barbarika, USDA/FSA, personal communication).

4. **The 2003 NRI** provided additional information for practices that could be reliably identified from aerial photography as part of the NRI data collection process. These practices include contour buffer strips, contour farming, contour stripcropping, field stripcropping, terraces, cross wind stripcropping, cross wind trap strips, diversions, field borders, filter strips, grassed waterways or outlets, hedgerow planting, herbaceous wind barriers, riparian forest buffers, and windbreak or shelterbelt establishment.

Structural practices evaluated in the APEX model include—

- in-field practices for water erosion control, divided into two groups:
  - practices that control overland flow (terraces, contour buffer strips, contour farming, stripcropping, contour stripcropping), and
  - practices that control concentrated flow (grassed waterways, grade stabilization structures, diversions, and other structures for water control); and
- edge-of-field practices for buffering and filtering surface runoff before it leaves the field (riparian forest buffers, riparian herbaceous cover, filter strips, field borders.)

Structural practices for erosion control are in widespread use on cultivated cropland acres. Overall, about 38 percent of cultivated cropland acres had one or more structural erosion control practice in 2003-06 (table 2). Overland flow practices were the most prevalent; 26 percent of cultivated cropland acres had some kind of overland flow practice installed. Concentrated flow control practices were used on 21 percent of cultivated cropland acres. Edge-of-field buffering and filtering practices were in much lower use in 2003-06, reported to be in use on only 5 percent of cultivated cropland acres for all eight regions.

Cultivated cropland acres designated as HEL (Highly Erodible Land)[2] had slightly lower proportions of acres treated with structural practices as non-HEL in 2003-06 for all 8 regions combined (table 2). Acres designated as HEL represent about 29 percent of all cultivated cropland acres in the eight regions. For HEL in all eight regions, about 34 percent of acres had one or more water erosion control practice. Overland flow practices were used on 21 percent of HEL cropped acres; concentrated flow control practices were used on 18 percent; and edge-of-field buffering and filtering practices were in use on only 6 percent.

However, HEL is much more concentrated in some regions than others, as shown in figure 3. About half of the cultivated cropland acres in three regions are HEL: the Northwest Non-Coastal (3) region, the Northeast (10) region, and the East Central (11) region.

Not all cultivated cropland acres require structural conservation practices. Acres that are essentially flat with permeable soil types are more prone to infiltration of water and have a low potential for erosion. About 63 percent of cultivated cropland acres in the eight regions have field slopes of 2 percent or less, some of which may not need to be treated with structural practices. The prevalence of field slopes of 2 percent or less varies from region to region, as shown in figure 4. Regions with the most acres with field slopes of 2 percent or less are:

- the Lower Mississippi and Texas Gulf Coast (9) region, with 91 percent;
- the Southern Plains (6) region, with 79 percent; and
- the Southeast Coastal Plain (12) region, with 73 percent.

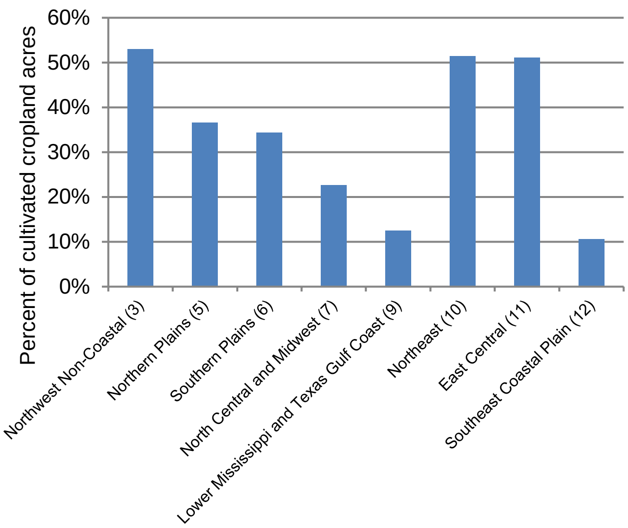
[2] Soils are classified as HEL if they have an erodibility index (EI) score of 8 or higher. A numerical expression of the potential of a soil to erode, EI considers the physical and chemical properties of the soil and climatic conditions where it is located. EI is derived from the Sheet and Rill Erosion Equation USLE and the Wind Erosion Equation WEQ. The higher the index, the greater the investment needed to maintain the sustainability of the soil resource base if intensively cropped. HEL acres have a higher vulnerability to erosion due to the forces of wind or water.

Table 2. Structural erosion control practices in use in 2003-06, by region and for all regions combined—percent of Highly-Erodible land (HEL), percent of non-HEL, and percent of all cultivated cropland acres.

	Overland flow control practices*			Concentrated flow control practices**			Edge-of-field buffering and filtering practices***			One or more structural erosion control practices		
	% of HEL	% of Non-HEL	% of all acres	% of HEL	% of Non-HEL	% of all acres	% of HEL	% of Non-HEL	% of all acres	% of HEL	% of Non-HEL	% of all acres
Production region												
Northwest Non-Coastal (3)	15	29	22	8	20	14	7	5	6	25	43	34
Northern Plains (5)	11	17	13	10	14	12	2	0	2	19	28	22
Southern Plains (6)	42	39	41	18	16	17	2	1	2	46	42	44
North Central and Midwest (7)	16	48	23	23	50	29	10	8	9	37	70	45
Lower Mississippi and Texas Gulf Coast (9)	9	31	12	9	24	11	3	7	3	17	45	20
Northeast (10)	22	50	36	7	20	14	6	5	5	29	56	43
East Central (11)	26	55	41	22	41	32	9	6	8	43	72	58
Southeast Coastal Plain (12)	22	41	24	11	31	13	6	5	6	29	49	31
All eight regions	21	38	26	18	29	21	6	4	5	34	50	38

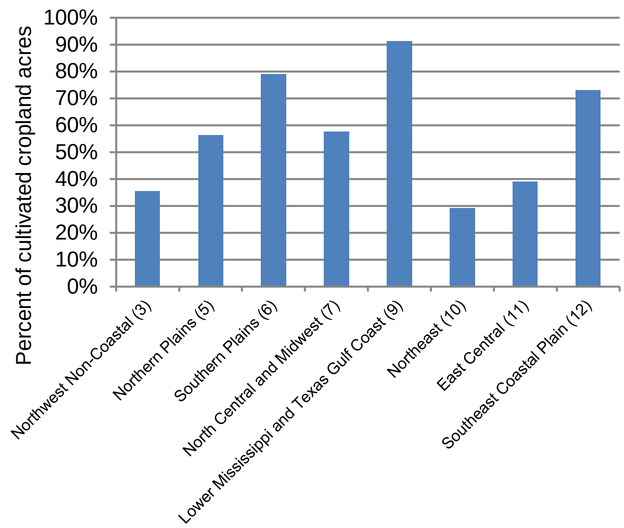
* Includes terraces, contour buffer strips, contour farming, stripcropping, contour stripcropping, field border, and in-field vegetative barriers.
** Includes Grassed waterways, grade stabilization structures, diversions, and other structures for water control.
*** Includes Riparian forest buffers, riparian herbaceous buffers, and filter strips
Source: Conservation practice use as reported in the 2003-06 NRI-CEAP Cropland Survey and other sources and subsequently used in the APEX simulation modeling.

Figure 3. Percent of cultivated cropland classified as HEL (Highly-Erodible Land), by region.



Note: For all eight regions combined, HEL represents 29 percent of cultivated cropland acres.

Figure 4. Percent of cultivated cropland with field slopes of 2 percent or less, by region.



Note: For all eight regions combined, 63 percent of cultivated cropland acres have field slopes of 2 percent or less.

Structural practices were most prevalent in the East Central (11) region (table 2 and fig. 5), where 58 percent of cultivated cropland acres had one or more water erosion control practice in 2003-06. Structural practices were least prevalent in the Lower Mississippi and Texas Gulf Coast (9) region and the Northern Plains (5) region, where only 20-22 percent of cultivated cropland acres had one or more water erosion control practice in 2003-06.

Figure 5. Percent of cultivated cropland with one or more structural practice, by region.

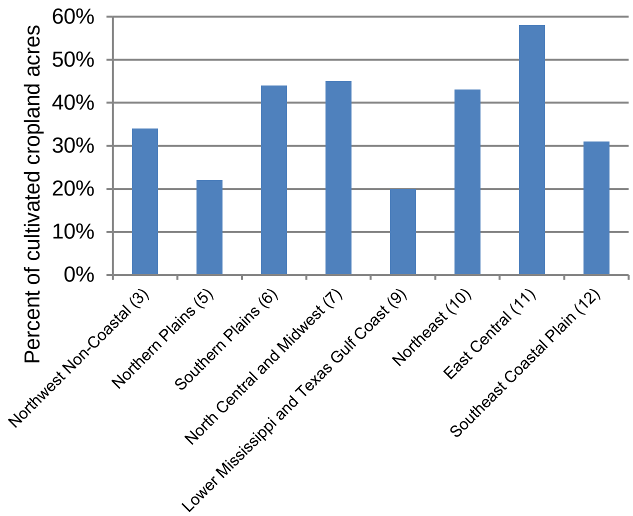


Table 2 shows that, for most regions, non-HEL acres are treated with structural practices at higher proportions than HEL acres. For example, in the North Central and Midwest (7) region, overland flow practices were used on 48 percent of non-HEL acres but only 16 percent of HEL acres. Similarly, concentrated flow control practices were used on 50 percent of non-HEL cropped acres in this region but only 23 percent of HEL acres. HEL acres accounted for 23 percent of the cultivated cropland acres in this region.

Figure 6. Structural practices involve engineering designs and provide long-term protection.

The Southern Plains (6) region was the only region where HEL acres were treated with structural practices at a higher proportion than non-HEL acres for one or more structural conservation practice—46 percent of HEL acres versus 42 percent for non-HEL acres (table 2). HEL acres accounted for 34 percent of the cultivated cropland acres in this region.

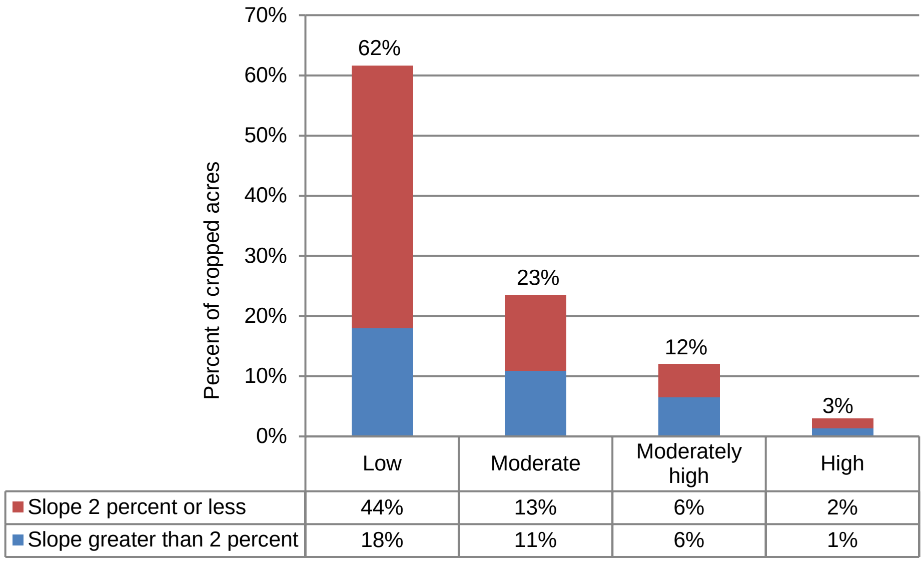
To better represent the overall level of erosion control that the various combinations of structural practice use represents, four levels of conservation treatment (high, moderately high, moderate, and low) were defined for each sample point, as follows.

- **High treatment**: Edge-of-field mitigation *and* at least one in-field structural practice (concentrated flow or overland flow practice) required.
- **Moderately high treatment**: Either edge-of-field mitigation required or both concentrated flow and overland flow practices required.
- **Moderate treatment**: No edge-of-field mitigation, either concentrated flow or overland flow practices required.
- **Low treatment**: No edge-of-field or in-field structural practices required.

For the eight regions combined, only about 3 percent of cropped acres have a "high" level of treatment (combination of edge-of-field buffering or filtering and at least one in-field structural practice) (fig. 8 and table 3). Another 12 percent of cultivated cropland acres have a "moderately high" level of treatment, which could be achieved for some acres with edge-of-field buffering and filtering practices alone. The 62 percent of acres with a "low" level of treatment did not have any structural practice use, but this group includes 44 percent of cropped acres in the eight regions where field slopes were 2 percent or less.

Figure 7. Annual practices such as conservation tillage are effective but require decisions to reapply each year.

Figure 8. Percent of cropped acres at four conservation treatment levels for structural practices, all eight regions combined.



Criteria for four levels of treatment with structural conservation practices are:

- **High treatment**: Edge-of-field mitigation *and* at least one in-field structural practice (concentrated flow or overland flow practice) required.
- **Moderately high treatment**: Either edge-of-field mitigation required or both concentrated flow and overland flow practices required.
- **Moderate treatment**: No edge-of-field mitigation, either concentrated flow or overland flow practices required.
- **Low treatment**: No edge-of-field or in-field structural practices required.

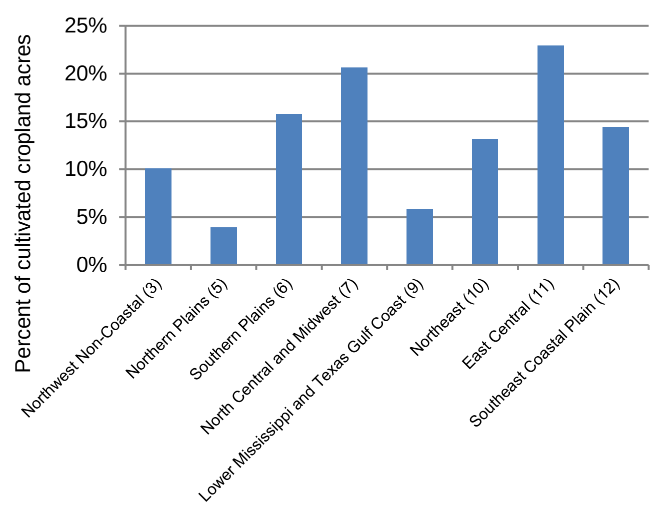
Table 3. Percent of cropped acres at four conservative treatment levels for structural practices, by region.

	Low	Moderate	Moderately high	High
Production region				
Northwest Non-Coastal (3)	66	24	7	3
Northern Plains (5)	78	18	3	1
Southern Plains (6)	56	29	15	1
North Central and Midwest (7)	55	24	16	5
Lower Mississippi and Texas Gulf Coast (9)	80	15	4	2
Northeast (10)	57	30	10	4
East Central (11)	42	35	18	5
Southeast Coastal Plain (12)	69	17	12	3
All eight regions	62	23	12	3

Two regions stand out as having more structural practice use than the other regions—the East Central (11) region and the North Central and Midwest (7) region (table 3 and fig. 9). The East Central (11) region had 23 percent of cropped acres in the “high” or “moderately high” level of structural practice treatment, including 5 percent with a “high” level of treatment. This region is one of the three regions with about half of cropped acres designated as HEL (fig. 3), and had 61 percent of cropped acres with field slopes more than 2 percent (fig. 4). The North Central and Midwest (7) region had 21 percent of cropped acres in the “high” or “moderately high” level of structural practice treatment, including 5 percent with a “high” level of treatment.

Two regions have the lowest level of structural practice use—the Northern Plains (5) region and the Lower Mississippi and Texas Gulf Coast (9) region (table 3 and fig. 9). The Lower Mississippi and Texas Gulf Coast (9) region also has 91 percent of cropped acres with field slopes of 2 percent or less and only 12 percent of acres designated as HEL (fig. 4).

Figure 9. Percent of cultivated cropland with “high” or “moderately high” levels of conservation treatment with structural practices, by region.



Conservation Tillage and Residue Management Practices

Model simulation of the use of conservation tillage and residue management practices were based on the field operations and machinery types reported in the NRI-CEAP Cropland Survey for each sample point. The survey obtained information on the timing, type, and frequency of each tillage implement used during the previous 3 years, including the crop to which the tillage operation applied. Model outcomes affected by tillage practices, such as erosion and runoff, were determined using APEX processes of the daily tillage activities as reported in the survey.

To evaluate the level of conservation tillage and residue management, the Soil Tillage Intensity Rating (STIR)[3] was used for tillage intensity, and gains or losses in soil organic carbon (based on model simulation results) were used as an indicator of residue management.

Tillage intensity. STIR values represent the soil disturbance intensity, which was estimated for each crop at each sample point.[4] The soil disturbance intensity is a function of the kinds of tillage, the frequency of tillage, and the depth of tillage. STIR values were calculated for each crop and for each of the 3 years covered by the NRI-CEAP Cropland Survey (accounting for multiple crops or cover crops).

STIR criteria used to define four levels of tillage intensity were as follows:

- No-till—average annual STIR over all crop years in the rotation is less than 30;
- Mulch till—average annual STIR over all crop years in the rotation is between 30 and 100;
- Some reduced tillage—STIR values indicate there was some reduced tillage on some crops in the rotation but the average annual tillage intensity is greater than criteria for mulch till; and
- Continuous conventional tillage—the STIR value for every crop year in the rotation is more than 100.

Figure 10. No-till protects soil and reduces runoff.

Most cropland acres met criteria for either mulch till or no-till. For all eight regions combined, about 32 percent of cultivated cropland acres met the tillage intensity criteria for no-till, including 42 percent of HEL acres and 28 percent of non-HEL acres (table 4). About 50 percent of cultivated cropland acres met the tillage intensity criteria for mulch till, including 42 percent of HEL acres and 54 percent of non-HEL acres. About 7 percent of cropped acres did not meet criteria for mulch till or no-till, but had reduced tillage on some crops in the rotation. Only about 10 percent of the cropped acres in all eight regions were conventionally tilled in 2003-06.

No-till was in most use in two regions (table 4 and fig. 12):

- the East Central (11) region, where 52 percent of cultivated cropland met criteria for no-till, including 51 percent of HEL acres, and
- the Northern Plains (5) region, where 47 percent of cultivated cropland met criteria for no-till, including 63 percent of HEL acres.

No-till was used on less than 20 percent of cropped acres in two regions—the Northwest Non-Coastal (3) region and the Southern Plains (6) region (fig.10).

Use of mulch till was common in all eight regions (table 4 and fig. 13). Mulch till was most prevalent in the Northwest Non-Coastal (3) region, where 62 percent of cultivated cropland acres met criteria for mulch till, including 64 percent of HEL acres. Mulch till was least prevalent in the East Central (11) region, where only 35 percent of cultivated cropland acres met criteria for mulch till (fig. 13).

Use of continuous conventional tillage (fig. 11) was highest in the Southern Plains (6) region, where 26 percent of the cultivated cropland acres are conventionally tilled (table 4).

Figure 11. Conventional tillage leaves soil unprotected.

[3] A description of the Soil Tillage Intensity Rating (STIR) can be found on the NRCS website.

[4] Percent residue cover was not used to evaluate no-till or mulch till because this criterion is not included in the current NRCS practice standard for Residue and Tillage Management. Residue is, however, factored into erosion and runoff estimates in APEX.

Table 4. Conservation tillage use in 2003-06, by region and for all regions combined—percent of Highly-Erodible Land (HEL), percent of non-HEL, and percent of all cultivated cropland acres.

	No-till*			Mulch till**			Some reduced tillage***			Continuous conventional tillage****		
	% of HEL	% of Non-HEL	% of all acres	% of HEL	% of Non-HEL	% of all acres	% of HEL	% of Non-HEL	% of all acres	% of HEL	% of Non-HEL	% of all acres
Production region												
Northwest Non-Coastal (3)	21	16	19	64	60	62	9	14	11	6	10	8
Northern Plains (5)	63	38	47	30	46	40	5	11	9	2	6	4
Southern Plains (6)	18	20	19	47	45	46	9	9	9	26	26	26
North Central and Midwest (7)	52	29	34	43	61	57	3	5	5	2	5	4
Lower Mississippi and Texas Gulf Coast (9)	50	21	24	34	57	54	5	8	7	12	15	14
Northeast (10)	27	19	23	51	59	55	8	13	10	14	9	12
East Central (11)	51	53	52	33	38	35	10	5	8	6	4	5
Southeast Coastal Plain (12)	31	33	32	55	48	49	8	8	8	5	12	11
All eight regions	42	28	32	42	54	50	6	8	7	10	11	10

* Average annual Soil Tillage Intensity Rating (STIR) over all crop years in the rotation is less than 30.
** Average annual Soil Tillage Intensity Rating (STIR) over all crop years in the rotation is between 30 and 100.
*** Reduced tillage on some crops in rotation but average annual tillage intensity greater than criteria for mulch till.
**** Soil Tillage Intensity Rating (STIR) for every crop year in the rotation is more than 100.
Note: Percent residue cover was not used to determine no-till or mulch till.
Source: Conservation tillage levels were derived from field operations as reported in the 2003-06 NRI-CEAP Cropland Survey and subsequently used in the APEX simulation modeling.

Figure 12. Percent of cultivated cropland meeting STIR criteria for no-till, by region.

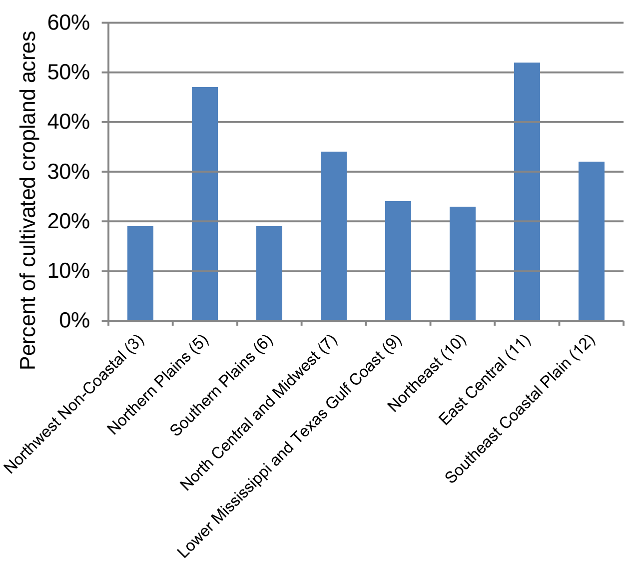
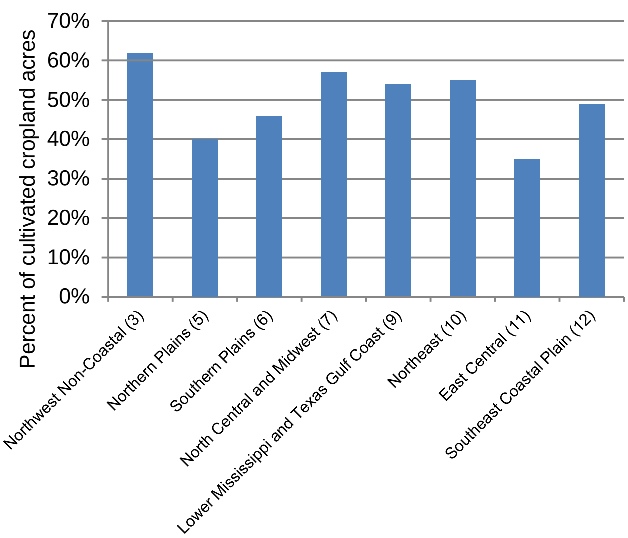


Figure 13. Percent of cultivated cropland acres meeting STIR criteria for mulch till, by region.



Soil organic carbon. The average annual change in soil organic carbon was used as an indicator of residue management. Higher levels of residue are correlated with increasing rates of soil organic carbon accumulation in the soil over time. Soil organic carbon improves water holding capacity and reduces erodibility through enhanced soil aggregate stability. Removal of residue by the farmer decreases this benefit.

In the APEX model simulation, the daily level of soil organic carbon is tracked and included in the model output. The annual change is calculated as the difference between the end-of-year carbon value and the beginning-of-year carbon value for each of the 47 years in the model simulation. (If soil organic carbon was decreasing in a given year, the value for that year would be negative.) The average annual change in soil organic carbon in pounds per acre is determined as the mean over the 47 years of model simulation results for each sample point.

Residue management was considered to be “good” for a sample point if the average annual change in soil organic carbon was positive, indicating soil organic carbon was increasing every year, on average. It was considered to be “poor” if the average annual change in soil organic carbon was negative, indicating soil organic carbon was decreasing every year, on average.

According to the simulation model results, 51 percent of cultivated cropland acres had gains in soil organic carbon for all eight regions combined (table 5 and fig. 14). However, some regions had indications of much better residue management than other regions (fig. 15). The North Central and Midwest (7) region had by far the highest percentage of acres gaining in soil organic carbon—73 percent. The lowest percentages were in two regions—the Southeast Coastal Plain (12) region with 23 percent and the Northeast (10) region with 27 percent. Percentages of cultivated cropland acres gaining in soil organic carbon for the remaining regions ranged from 33 to 44 percent.

Table 5. Percent of cultivated cropland acres gaining in soil organic carbon, by region.

	Percent
Northwest Non-Coastal (3)	33
Northern Plains (5)	44
Southern Plains (6)	34
North Central and Midwest (7)	73
Lower Mississippi and Texas Gulf Coast (9)	35
Northeast (10)	27
East Central (11)	43
Southeast Coastal Plain (12)	23
All eight regions	51

Figure 14. Distribution of average annual change in soil organic carbon for sample points in all eight regions.

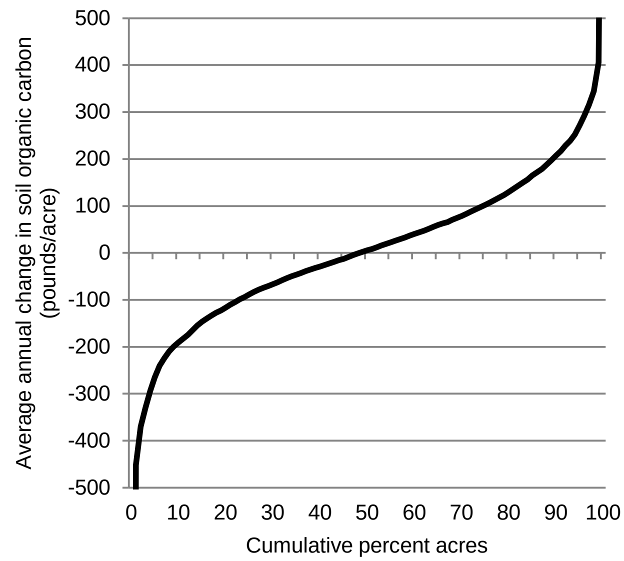
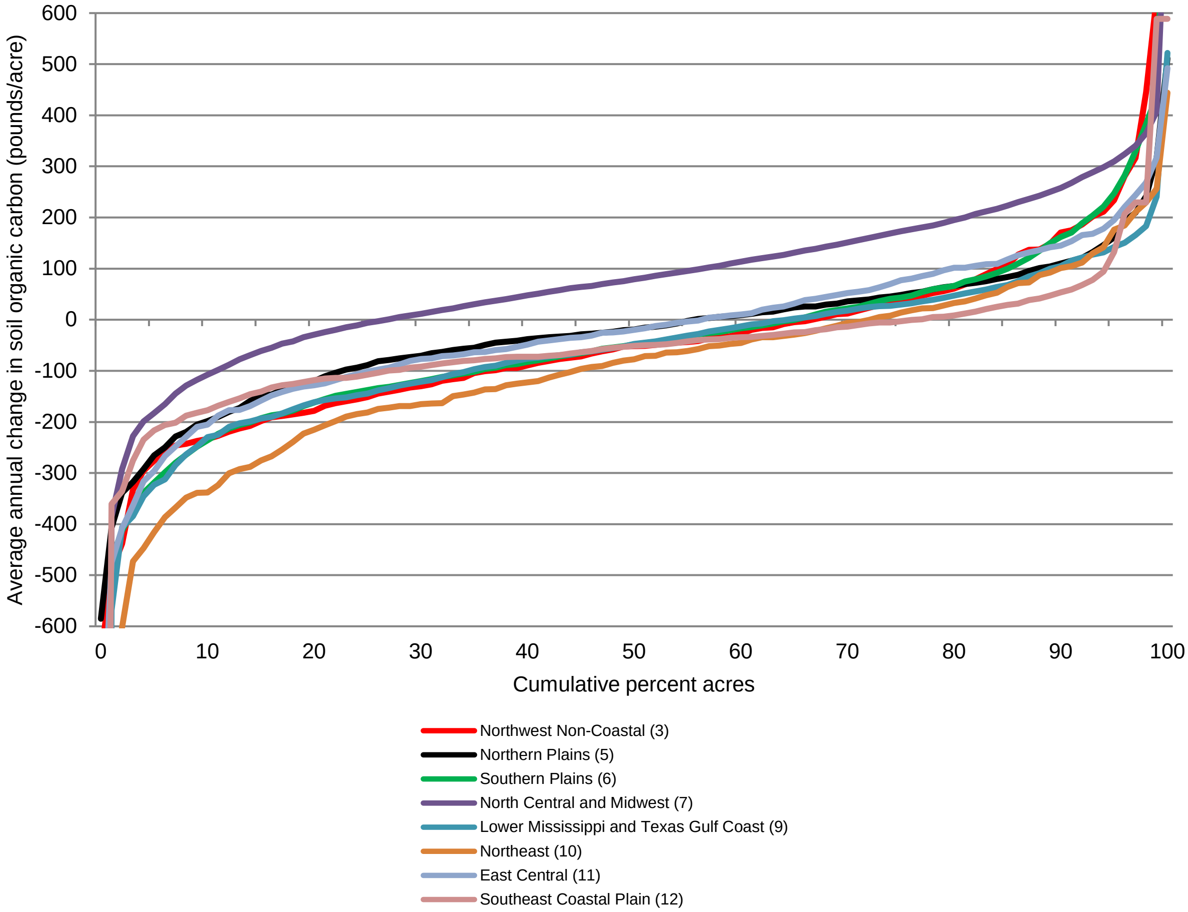


Figure 15. Distributions of average annual change in soil organic carbon for sample points in each of the eight regions.



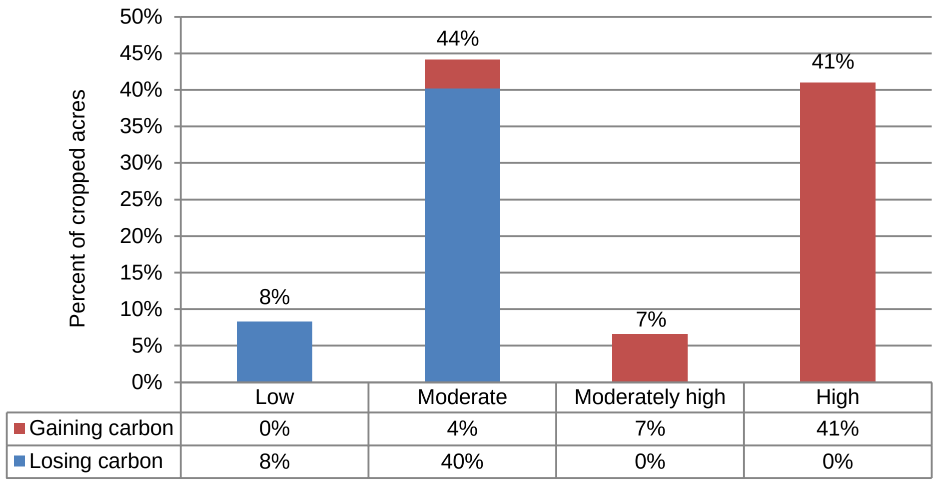
Conservation treatment levels. As was done for structural practices, four levels of conservation treatment (high, moderately high, moderate, or low) were defined for conservation tillage use at each sample point. The criteria combined tillage intensity and residue management, where residue management was represented by the change in the average annual soil organic carbon level derived from the APEX simulation model.[5] Criteria for four levels of treatment with conservation tillage management are:

- **High treatment**: *All crops* meet tillage intensity criteria for either no-till or mulch till and crop rotation is gaining soil organic carbon.
- **Moderately high treatment**: *Average annual* tillage intensity meets criteria for mulch till or no-till and crop rotation is gaining soil organic carbon; some crops in rotation exceed tillage intensity criteria for mulch till.
- **Moderate treatment**: Some crops have reduced tillage but rotation is losing soil organic carbon, or crop rotation is gaining soil organic carbon and the *average annual* tillage intensity exceeds criteria for mulch till.
- **Low treatment**: Continuous conventional tillage and crop rotation is losing soil organic carbon.

For the eight regions combined, 41 percent of acres had a "high" level of tillage and residue management (fig. 16, table 6). Another 7 percent had a "moderately high" level. The "high" and "moderately high" treatment levels represent the 48 percent of cropped acres that meet tillage intensity criteria for either no-till or mulch till with gains in soil organic carbon. Only 8 percent had a "low" treatment level, since few acres had continuous conventional tillage and were also losing soil organic carbon. The remaining 44 percent had a "moderate" treatment level. These were acres that had some kind of reduced tillage but less than mulch till; most acres in this treatment level are losing soil organic carbon.

[5] STIR values in combination with carbon trends are in line with the use of the Soil Conditioning Index (SCI), which approximates the primary criteria for NRCS residue management standards. The NRCS practice standard, as applied at the field, may include other considerations to meet site-specific resource concerns that are not considered in this evaluation.

Figure 16. Percent of cropped acres at four conservation treatment levels for tillage and residue management practices, all eight regions combined.



Criteria for four levels of treatment with tillage management are:

- **High treatment**: *All crops* meet tillage intensity criteria for either no-till or mulch till and crop rotation is gaining soil organic carbon.
- **Moderately high treatment**: *Average annual* tillage intensity meets criteria for mulch till or no-till and crop rotation is gaining soil organic carbon; some crops in rotation exceed tillage intensity criteria for mulch till.
- **Moderate treatment**: Some crops have reduced tillage but rotation is losing soil organic carbon, or crop rotation is gaining soil organic carbon and tillage intensity exceeds criteria for mulch till.
- **Low treatment**: Continuous conventional tillage and crop rotation is losing soil organic carbon.

Table 6. Percent of cropped acres at four conservation treatment levels for tillage and residue management practices, by region.

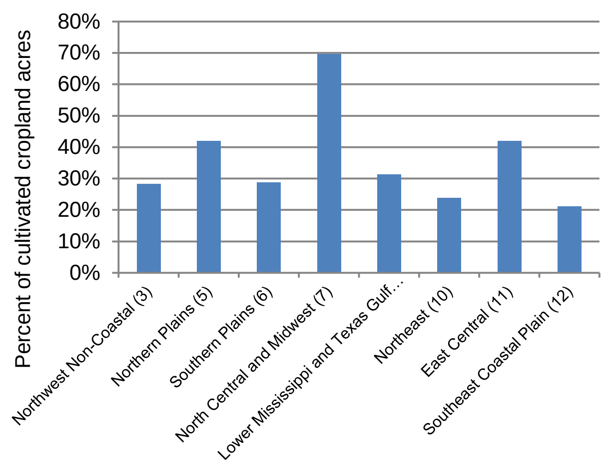
	Low	Moderate	Moderately high	High
Production region				
Northwest Non-Coastal (3)	5	66	9	20
Northern Plains (5)	3	55	4	38
Southern Plains (6)	22	50	5	23
North Central and Midwest (7)	3	28	8	61
Lower Mississippi and Texas Gulf Coast (9)	12	56	5	26
Northeast (10)	10	67	9	15
East Central (11)	5	53	7	35
Southeast Coastal Plain (12)	10	69	7	14
All eight regions	8	44	7	41

The North Central and Midwest (7) region stands apart from other regions with a "high" treatment level for 61 percent of cultivated cropland acres and 69 percent of acres with either a "high" or "moderately high" treatment level (table 6 and fig. 17).

Two regions had the lowest percentages of cropped acres with either a "high" or "moderately high" treatment level—the Southeast Coastal Plain (12) region with 21 percent and the Northeast (10) region with 24 percent. These are also the two regions that had the lowest percentages of acres gaining soil organic carbon (table 5).

Percentages of cropped acres with either a "high" or "moderately high" treatment level for the remaining regions ranged from 28 to 42 percent (fig. 17).

Figure 17. Percent of cultivated cropland with "high" or "moderately high" levels of conservation treatment for tillage and residue management practices, by region.



Combinations of Water Erosion Control Practices

For all eight regions combined, 94 percent of cultivated cropland acres had some kind of practice use to control water erosion—

- 34 percent had one or more structural practice and some form of reduced tillage,
- 55 percent had some form of reduced tillage but no structural practices,
- 4 percent had one or more structural practice but no reduced tillage, and
- only 6 percent had no reduced tillage and no structural practices.

There are important regional differences in the use of these practices, as shown in previous sections, but at least one water erosion control practice is used on nearly all cultivated cropland acres in each region (table 7). The East Central (11) region had at least one water erosion control practice on 99 percent of the cultivated cropland acres in that region. The North Central and Midwest (7) region had at least one water erosion control practice on 97 percent of cropped acres. Even the region with the least percentage of treated acres—87 percent for the Southern Plains (6) region—still had most acres treated, including 31 percent of the acres with one or more structural practice and some form of reduced tillage.

To evaluate the overall level of conservation treatment for water erosion control, four conservation treatment levels were defined for each sample point (high, moderately high, moderate, or low), as was done for each of the two practice groups in figure 6 for structural practices and in figure 12 for tillage and residue management.

If the field slope for the sample point was 2 percent or less, the water erosion control treatment level was set equal to the tillage and residue management treatment level. Thus, the presence of structural practices on these sample points did not affect the water erosion control treatment level, as tillage and residue management practices would provide adequate treatment. This criterion applied to 63 percent of cultivated cropland acres for all eight regions combined, and for proportions of cultivated cropland acres by region as shown previously in figure 4.

For the remaining acres where the field slope was greater than 2 percent, water erosion control treatment levels were determined based on combinations of the conservation treatment levels for structural practices (fig. 6) and the conservation treatment levels for tillage and residue management practices (fig. 12). Scores were first assigned to each treatment level as follows: high=4, moderately high=3, moderate=2, and low=1. The water erosion control treatment level was then defined as follows:

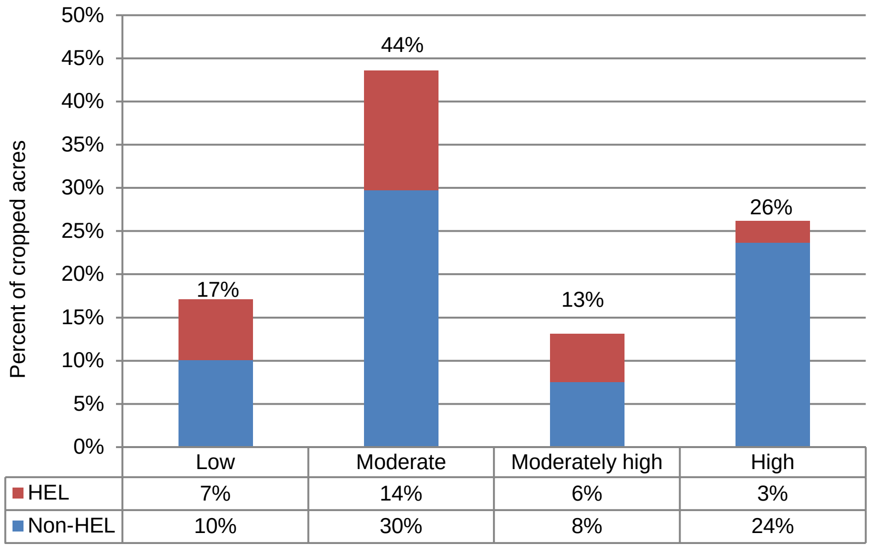
- **High treatment**: Sum of scores is equal to 8. (High treatment level for both structural practices and tillage and residue management practices).
- **Moderately high treatment**: Sum of scores equal to 6 or 7.
- **Moderate treatment**: Sum of scores equal to 4 or 5.
- **Low treatment**: Sum of scores equal to 2 or 3.

The percentages of cropped acres at each of these four conservation treatment levels for water erosion control are presented in figure 18 and table 8 for all eight regions combined. About 26 percent of cultivated cropland acres had a "high" level of water erosion control treatment. A "high" level of water erosion control treatment was shown by model simulations to reduce sediment losses to acceptable levels for nearly all cropped acres. Another 13 percent of cultivated cropland acres had a "moderately high" level of water erosion control treatment.

Table 7. Percent of cropped acres with combinations of structural practices and residue and tillage management practices, by region.

	Percent of acres with one or more structural practice and some form of reduced tillage	Percent of acres with some form of reduced tillage but no structural practices	Percent of acres with one or more structural practice only	Percent of acres with no structural practices and no reduced tillage
Production region				
Northwest Non-Coastal (3)	33	60	2	6
Northern Plains (5)	22	74	<1	4
Southern Plains (6)	31	42	13	13
North Central and Midwest (7)	43	52	1	3
Lower Mississippi and Texas Gulf Coast (9)	17	68	3	11
Northeast (10)	37	51	6	6
East Central (11)	53	41	4	1
Southeast Coastal Plain (12)	28	61	3	8
All eight regions	34	55	4	6

Figure 18. Percent of cropped acres at four conservation treatment levels for water erosion control, all eight regions combined.



See text for criteria used to define the four water erosion control treatment levels.

Table 8. Percent of cropped acres at four conservation treatment levels for water erosion control, by region.

	Low	Moderate	Moderately high	High
Production region				
Northwest Non-Coastal (3)	33	47	14	6
Northern Plains (5)	20	54	6	20
Southern Plains (6)	24	50	8	18
North Central and Midwest (7)	10	31	20	39
Lower Mississippi and Texas Gulf Coast (9)	15	54	6	25
Northeast (10)	33	49	12	6
East Central (11)	14	52	17	17
Southeast Coastal Plain (12)	21	60	9	10
All eight regions	17	44	13	26

About 44 percent of cultivated cropland acres had a "moderate" level of water erosion control treatment, and 17 percent had a "low" level of water erosion control treatment.

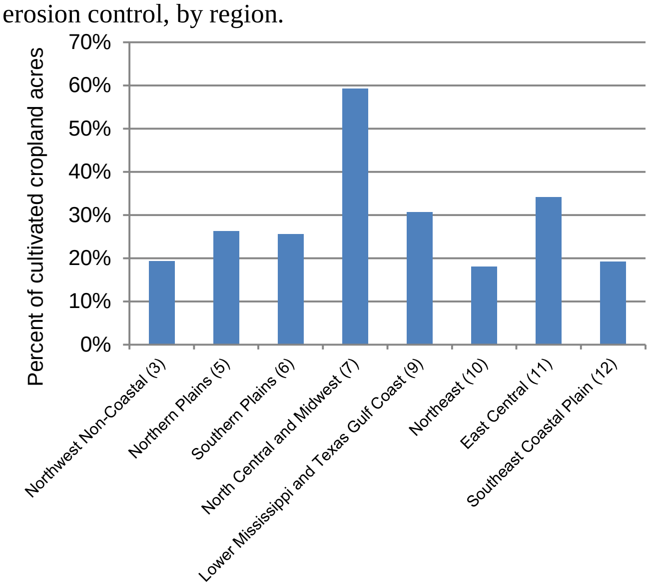
The North Central and Midwest (7) region has the best coverage of all eight regions in providing water erosion control treatment for cultivated cropland acres (fig. 19). About 59 percent of cultivated cropland acres have a "high" or "moderately high" level of conservation treatment for water erosion control in this region.

Three regions have the least coverage of all eight regions in providing water erosion control treatment for cultivated cropland acres (fig. 19). Only 18-20 percent of cultivated cropland acres have a "high" or "moderately high" level of conservation treatment for water erosion control in:

- the Northeast (10) region,
- the Southeast Coastal Plain (12) region, and
- the Northwest Non-Coastal (3) region.

For the remaining regions, the percentage of cultivated cropland acres with "high" or "moderately high" levels of conservation treatment for water erosion control ranges from 26 to 34 percent.

Figure 19. Percent of cultivated cropland acres with "high" or "moderately high" levels of conservation treatment for water erosion control, by region.



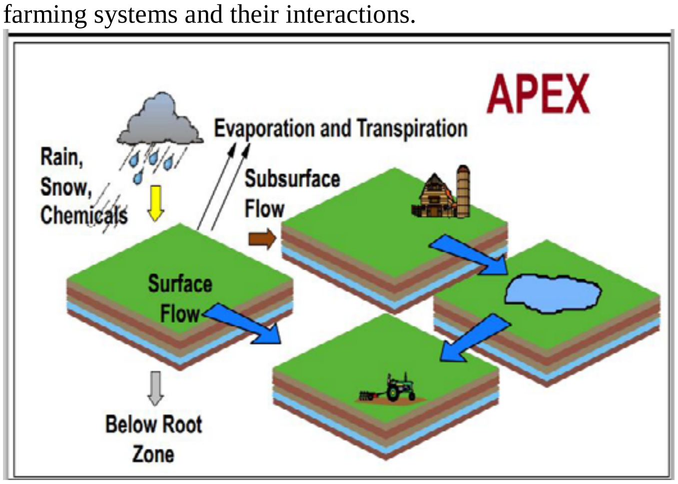
APEX Modeling and the Baseline Scenario

Sheet and rill erosion and the loss of sediment from farm fields was estimated using a field-scale physical process model—the Agricultural Policy Environmental Extender (APEX)—which simulates the day-to-day farming activities, wind and water erosion, loss or gain of soil organic carbon, and edge-of-field losses of soil, nutrients, and pesticides (figs. 20 and 21).

APEX simulates all of the basic biological, chemical, hydrological, and meteorological processes of farming systems and their interactions. Soil erosion is simulated over time, including wind erosion, sheet and rill erosion, and the loss of sediment beyond the edge of the field. The nitrogen, phosphorus, and carbon cycles are simulated, including chemical transformations in the soil that affect their availability for plant growth or for transport from the field.

On a daily basis, APEX simulates the farming operations used to grow crops, such as planting, tillage before and after planting, application of nutrients and pesticides, application of manure, irrigation, and harvest. Weather events and their interaction with crop cover and soil properties are simulated; these events affect crop growth and the fate and transport of water and chemicals through the soil profile and over land to the edge of the field. Over time, the chemical makeup and physical structure of the soil may change, which in turn affect crop yields and environmental outcomes. Crop residue remaining on the field after harvest is transformed into organic matter. Organic matter may build up in the soil over time, or it may degrade, depending on climatic conditions, cropping systems, and management.

Figure 20. The APEX model simulates the basic biological, chemical, hydrological, and meteorological processes of farming systems and their interactions.



The APEX component for water-induced erosion simulates erosion caused by rainfall, runoff, and irrigation. APEX contains eight equations capable of simulating rainfall and runoff erosion: universal soil loss equation (USLE); Onstad-Foster modification of the USLE; revised universal soil loss equation (RUSLE); RUSLE2; the modified universal soil loss equation (MUSLE); two variations of MUSLE; and a MUSLE function that accepts input coefficients. In any given simulation, only one of the equations interacts with other APEX components. For this study, a modified version of MUSLE, called MUST, was used for this purpose.[6]

The model variant MUST have an internal sediment delivery ratio to estimate the amount of eroded soil that actually leaves the boundaries of the field. A large percentage of the eroded material is redistributed and deposited within the field or trapped by buffers and other conservation practices and does not leave the boundary of the field, which is taken into account in the sediment delivery calculation. The estimate also includes some gully erosion and some ephemeral gully erosion. For this reason, sediment loss rates can exceed sheet and rill erosion rates in some cases.

Estimates of sediment loss from water erosion do not include wind-eroded material that is subsequently deposited along field borders or in ditches and transported as sediment with rainfall and runoff events. The current state of water erosion modeling does not include sediment displaced from the field by wind. (However, wind eroded material incorporated into the soil with tillage or biological activity prior to a runoff event would be included.)

A baseline scenario consists of APEX model simulation results that account for cropping patterns, farming activities, and conservation practices as reported in the NRI-CEAP Cropland Survey for 2003-06. Model simulation results for the baseline scenario therefore reflect the mix of treated and untreated acres for the time period 2003-06.

Figure 21. On-the-farm surveys were used to collect data for the computer simulations.

Weather is the predominant factor determining the loss of soil and pesticides from farm fields. To capture the effects of

[6] For the study on the Texas Gulf Basin, the APEX model was set up to estimate sediment loss using MUSLE as the specified driver in APEX. This change was necessary to achieve better calibration of instream sediment loads in streams and rivers in this region when running the SWAT model as part of the modeling to estimate offsite effects of conservation practices.

weather, the baseline scenario was simulated using 47 years of actual daily weather data for the time period 1960 through 2006. In the model simulations, weather is the only input variable that changes year to year. Since only the cropping patterns and practices for the 2003–06 time period were simulated, model estimates of losses from farm fields are *not actual* loses for each of these 47 years. Rather, the yearly model estimates, when aggregated over the 47 years, provide estimates of what would be expected at a sample point over the long-term in the future if weather continues to vary as it has in the past. Thus, we report model simulation estimates of *what would be expected after accounting for weather variability* so as to best inform program and policy decision makers on what has been accomplished and what remains to be done.

All model results reported herein are in terms of the 47-year averages at each sample point. For every model output, the 47-year average is first calculated for each sample point, and then more aggregated statistics are determined for the full set or a subset of sample points. Estimates determined by aggregating over sample points are always weighted by the acreage weight associated with each sample point (see Appendix A).

For example, APEX model results showed that sediment loss for the baseline scenario was 0.79 tons per acre per year, on average, for all cultivated cropland acres in the eight regions. This estimate was calculated as follows:

1. First, the annual sediment loss was obtained from APEX model output at each sample point for each of the 47 years of model simulation data.
2. Second, the average annual loss at each of the 17,918 CEAP sample points was calculated as the mean of the 47 years of sediment loss estimates.
3. Then the acreage-weighted mean of these average annual estimates over all sample points was calculated, representing the mean of the average annual amount of sediment loss from farm fields—0.79 tons per acre per year.

In addition to reporting the mean of the average annual estimates, various percentiles of the distribution of average annual estimates are also presented. For example, the median of the average annual values is sometimes reported, representing the average annual estimate for the sample point where half of the acres have higher values and half have lower values—the 50th percentile value. Cumulative distributions are also shown so as to represent the variability among the average annual estimates within the sample; these distributions are obtained using the percentile values for each percentile from 1 to 100.

Water Sources and Water Loss Pathways

Water is a potent force that interacts with or drives almost all environmental processes acting within an agricultural production system. Hydrologic conditions prevalent in each production region are critical to understanding the estimates of water erosion and sediment loss from farm fields in those regions. The APEX model simulates hydrologic processes at the field scale—precipitation, irrigation, evapotranspiration, surface water runoff, infiltration, and percolation beyond the bottom of the soil profile.

Precipitation and irrigation—the sources of water for a field—vary substantially among the eight production regions, as shown in table 9 and figures 22 and 23. Cultivated cropland in the Northern Plains (5) region and the Northwest Non-Coastal (3) region have the lowest precipitation, averaging about 17 inches per year for the 47 years simulated with APEX. Irrigation is widely used on cultivated cropland in the Northwest Non-Coastal (3) region (37 percent of cultivated cropland acres), averaging an additional 17 inches of water per acre on irrigated acres (table 9).

Precipitation is highest for cultivated cropland acres in the Lower Mississippi and Texas Gulf Coast (9) region and the Southeast Coastal Plain (12) region, averaging about 50 inches per year in each region. Nearly half of the cultivated cropland acres in the Lower Mississippi and Texas Gulf Coast (9) region are also irrigated, averaging an additional 19 inches of water per year on irrigated acres (table 9).

About 20 percent of cultivated cropland acres in the Southeast Coastal Plain (12) region are also irrigated, averaging an additional 17 inches of water per year on irrigated acres.

Figure 22. Water sources—precipitation and irrigation water applied—for farm fields, as represented in the APEX model simulations.

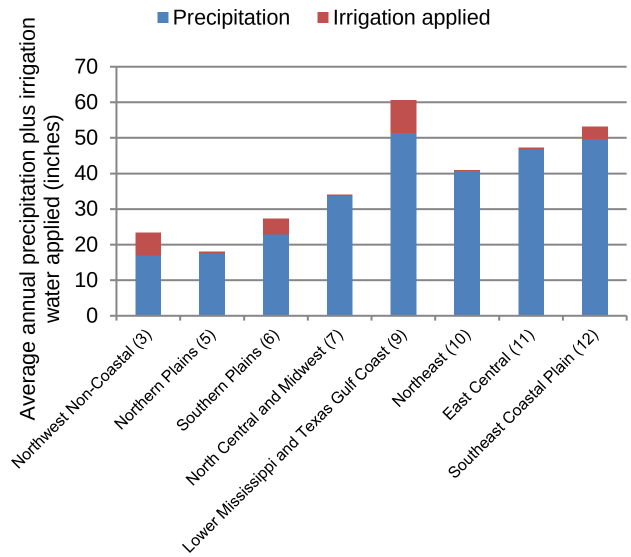


Figure 23. Distributions of average annual water sources (precipitation plus irrigation water applied) for CEAP sample points in eight production regions.

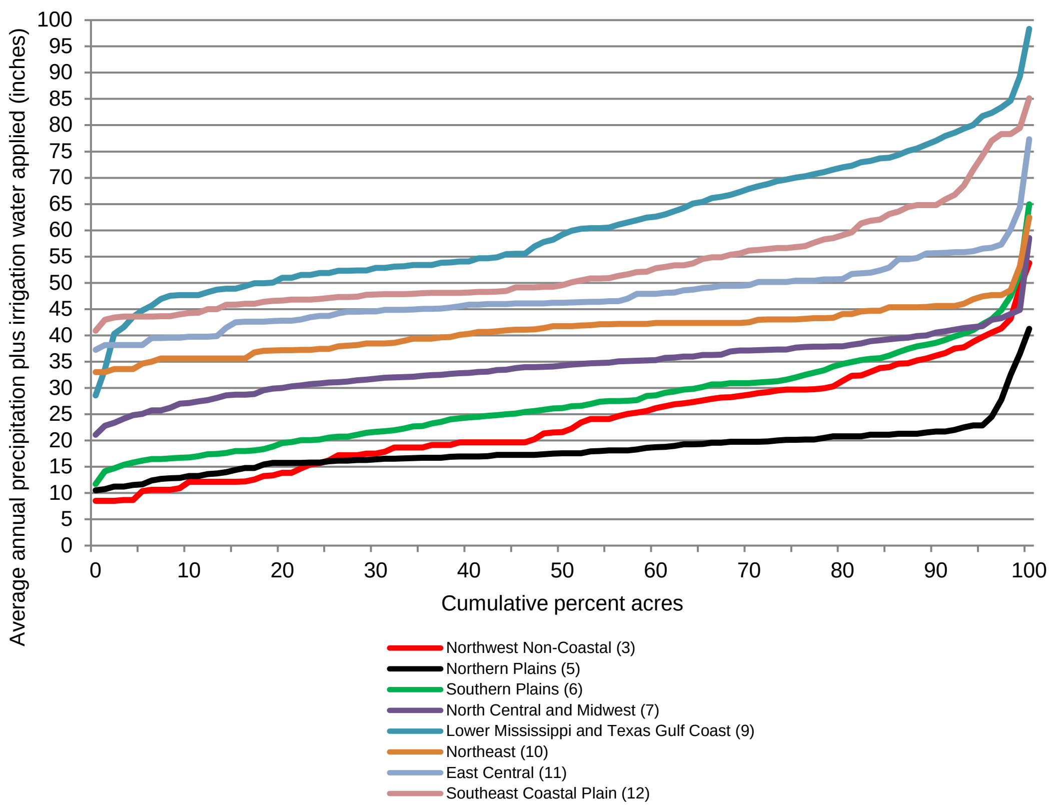


Table 9. Water sources and water loss for cultivated cropland, as represented in the APEX model simulations.

	Northwest Non-Coastal (3)	Northern Plains (5)	Southern Plains (6)	North Central and Midwest (7)
Water sources				
Non-irrigated cultivated cropland acres				
Percent of acres non-irrigated	63%	96%	74%	96%
Average annual precipitation (inches)				
Mean	18	18	24	34
20-to-80 percentile range	12-23	16-20	18-29	30-38
Irrigated cultivated cropland acres				
Percent of acres irrigated	37%	4%	26%	4%
Average annual precipitation (inches)				
Mean	15	18	21	31
20-to-80 percentile range	11-19	15-24	17-25	26-36
Average annual irrigation water applied (inches)				
Mean	17	13	17	10
20-to-80 percentile range	11-23	10-18	11-21	7-13
Water loss pathways				
Average annual evapotranspiration (inches)				
Mean	17.3	16.3	23.2	23.5
Percent of all 3 loss pathways	79%	90%	87%	69%
20-to-80 percentile range	12.1-22.6	14.0-18.5	17.9-27.2	21.5-25.5
Average annual surface water runoff (inches)				
Mean	1.7	0.7	1.4	4.3
Percent of all 3 loss pathways	8%	4%	5%	13%
20-to-80 percentile range	0.4-2.9	0.3-0.9	0.2-2.3	2.3-6.1
Average annual subsurface water flows (inches)				
Mean	2.9	1.2	2.2	6.4
Percent of all 3 loss pathways	13%	7%	8%	19%
20-to-80 percentile range	0.3-5.3	0.1-1.9	<0.1-3.8	3.9-8.6

Table 9.—continued.

	Lower Mississippi and Texas Gulf Coast (9)	Northeast (10)	East Central (11)	Southeast Coastal Plain (12)
Water sources				
Non-irrigated cultivated cropland acres				
Percent of acres non-irrigated	52%	98%	96%	80%
Average annual precipitation (inches)				
Mean	52	41	47	50
20-to-80 percentile range	48-56	37-43	43-50	46-55
Irrigated cultivated cropland acres				
Percent of acres irrigated	48%	2%	4%	20%
Average annual precipitation (inches)				
Mean	51	44	46	50
20-to-80 percentile range	48-54	42-46	45-48	47-52
Average annual irrigation water applied (inches)				
Mean	19	8	13	17
20-to-80 percentile range	12-26	3-11	9-16	13-25
Water loss pathways				
Average annual evapotranspiration				
Mean (inches)	36.4	25.5	28.7	32.6
Percent of all 3 loss pathways	61%	62%	60%	59%
20-to-80 percentile range (inches)	31.4-41.8	22.6-28.2	25.2-32.0	29.0-36.0
Average annual surface water runoff				
Mean (inches)	13.1	6.1	8.2	6.0
Percent of all 3 loss pathways	22%	15%	17%	11%
20-to-80 percentile range (inches)	10.5-15.6	4.2-7.9	4.8-11.3	3.2-8.1
Average annual subsurface water flows				
Mean (inches)	10.0	9.4	10.8	16.3
Percent of all 3 loss pathways	17%	23%	23%	30%
20-to-80 percentile range (inches)	6.8-13.4	7.7-11.1	8.5-12.5	10.2-20.9

Source: APEX simulation modeling results based on 2003-06 CEAP survey information on farming practices.

Most of the water that leaves the field is lost through evaporation and transpiration (evapotranspiration) (table 9). On average, about 80-90 percent of the water loss for cultivated cropland acres is through evapotranspiration in the three westernmost regions—the Northwest Non-Coastal (3) region, the Northern Plains (5) region, and the Southern Plains (6) region. About 69 percent of the water loss for cultivated cropland acres is through evapotranspiration in the North Central and Midwest (7) region. For the remaining four regions, evapotranspiration accounts for about 60 percent of the water loss from cultivated cropland acres.

The remaining water loss from farm fields is either surface water runoff or water that infiltrates into the soil and then is transported from the field through various subsurface flow pathways.[7] The APEX model simulations show that, overall, more water is lost through subsurface flow pathways than as surface water runoff for all but one region—the Lower Mississippi and Texas Gulf Coast (9) region (table 9 and figs. 24 and 25). Subsurface flow pathways include—

- deep percolation to groundwater, including groundwater return flow to surface water, (fig.26)
- subsurface flow that is intercepted by tile drains or drainage ditches, when present, and
- lateral subsurface outflow or quick-return flow that emerges as surface water runoff, such as natural seeps.

The Southeast Coastal Plain (12) region has the largest amount of water lost through subsurface flow pathways—16 inches per year, on average, which is nearly three times higher than the amount lost as surface water runoff in that region.

Surface water runoff directly effects sheet and rill erosion and edge-of-field sediment loss from farm fields. For all eight regions combined, average annual surface water runoff was 3.8 inches per year. Surface water runoff is highest in the Lower Mississippi and Texas Gulf Coast (9) region, where it averages 13.1 inches per year (table 9 and fig. 24). It is lowest in the three westernmost and driest regions—the Northern Plains (5) region, the Southern Plains (6) region, and the Northwest Non-Coastal (3) region—where it averaged less than 2 inches per year. In the remaining four regions, the average annual surface water runoff ranges from a low of 4.3 inches per year in the North Central and Midwest (7) region to a high of 8.2 inches per year in the East Central (11) region.

Figure 24. Mean of the average annual surface water runoff from farm fields, by production region.

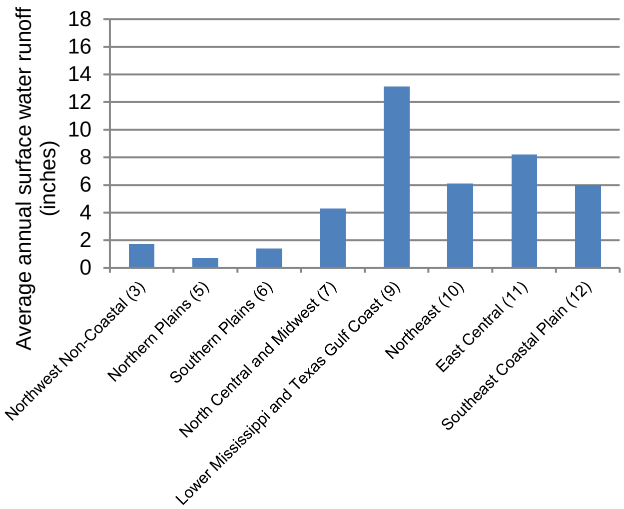


Figure 25. Mean of the average annual loss of water from farm fields through subsurface water flows, by production region.

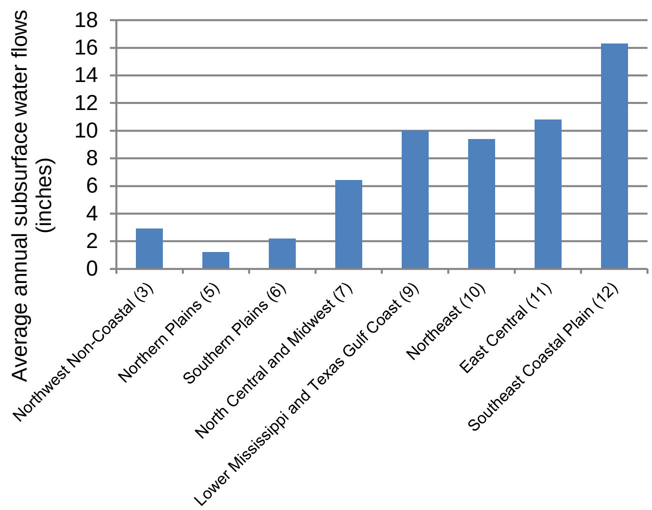
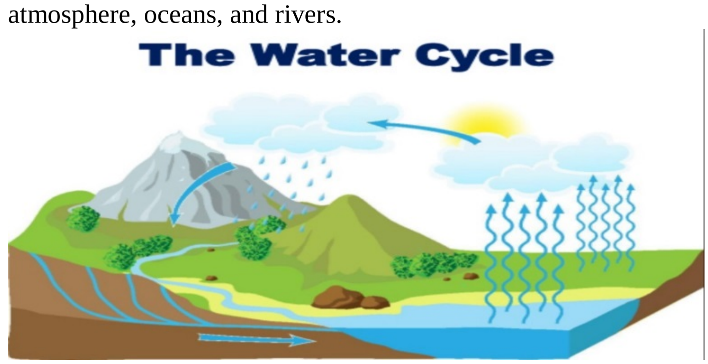


Figure 26. The process by which water circulates between the atmosphere, oceans, and rivers.



[7] Model simulations did not include increased infiltration for some structural practices—model parameter settings conservatively prevented infiltration of run-on water and its dissolved contaminants in conservation buffers including field borders, filter strips and riparian forest buffers.

Water Erosion and Sediment Loss

Sheet and Rill Erosion

Sheet and rill erosion, which is the detachment and movement of soil particles within the field that occurs during rainfall events, was modeled in APEX using the Revised Universal Soil Loss Equation (RUSLE). Model simulation estimates of sheet and rill erosion rates based on 2003-06 CEAP survey information on farming practices are presented in table 10 and figures 27-29. These are values for the baseline scenario, which incorporates the benefits of the erosion control practices summarized in the previous chapter.

For all eight regions combined, the mean of the average annual sheet and rill erosion rate was 0.649 ton per acre per year (table 10). The median value—0.234 ton per acre per year—was much lower, however, indicating that the distribution mostly has much lower values than the mean and that there are a few acres with very high values. Erosion rates on HEL acres were much higher, averaging 1.036 tons per acre per year over all acres. This compares to a mean average annual rate for non-HEL acres of only 0.491 ton per acre per year for all acres.

According to the model simulation results, the mean of the average annual sheet and rill erosion rate exceeded 1 ton per acre per year in these three regions, averaged over all acres in each region (table 10, fig. 28):

- the East Central (11) region, with an average annual rate of 1.7 tons per acre per year,
- the Lower Mississippi and Texas Gulf Coast (9) region, with an average annual rate of 1.6 tons per acre per year, and
- the Northeast (10) region, with an average annual rate of 1.4 tons per acre per year.

Three regions stand out as having the highest sheet and rill erosion rates for HEL acres—the three regions with the highest annual precipitation and irrigation water use (see fig. 4). Average rates for HEL acres exceeded 2 tons per acre per year in these three regions (table 10, fig. 28):

- the Lower Mississippi and Texas Gulf Coast (9) region, with an average annual rate of 4.4 tons per acre per year for HEL acres,
- the Southeast Coastal Plain (12) region, with an average annual rate of 3.2 tons per acre per year for HEL acres, and
- the East Central (11) region, with an average annual rate of 2.4 tons per acre per year for HEL acres.

For non-HEL acres, average rates exceeded 1 ton per acre per year in two regions (table 10, fig. 29):

- the Lower Mississippi and Texas Gulf Coast (9) region, with an average annual rate of 1.25 tons per acre per year for non-HEL acres, and
- the East Central (11) region, with an average annual rate of 1.01 ton per acre per year for non-HEL acres.

Figure 27. Mean of the average annual sheet and rill erosion for all cultivated cropland acres, by region.

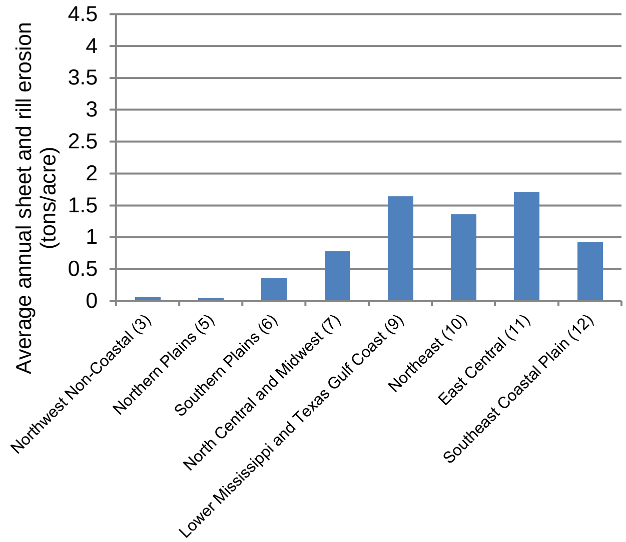


Figure 28. Mean of the average annual sheet and rill erosion for HEL acres, by region.

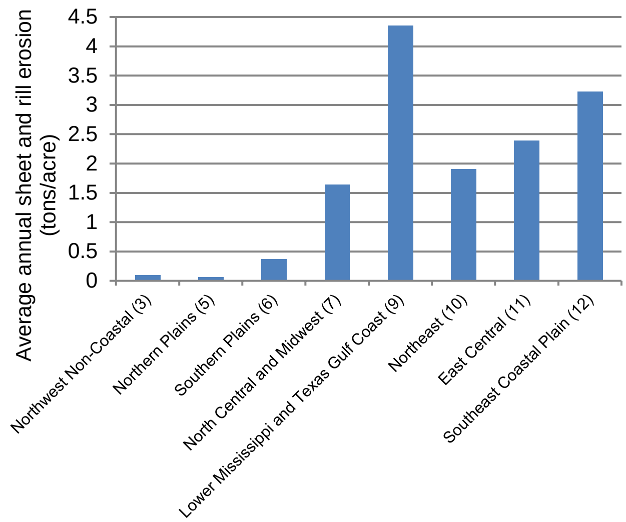
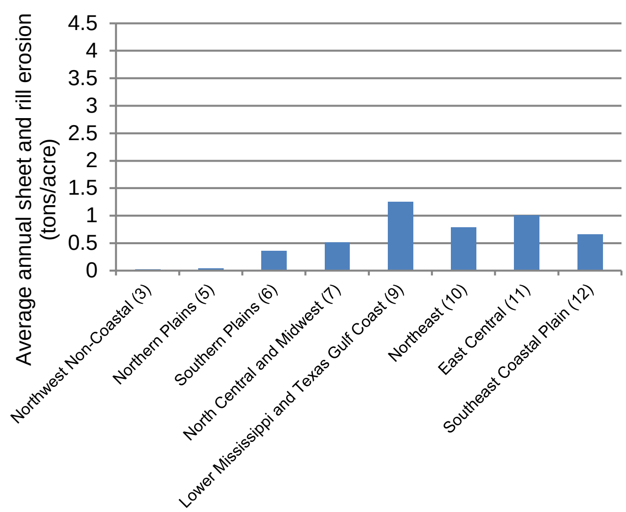


Figure 29. Mean of the average annual sheet and rill erosion for non-HEL acres, by region.



Sheet and rill erosion rates were lowest for the three westernmost regions, which have the lowest levels of precipitation and irrigation water use (fig. 23) and the smallest amount of surface water runoff (fig. 24). Average annual rates of sheet and rill erosion for all cropped acres in these regions are:

- 0.051 ton per acre per year in the Northern Plains (5) region,
- 0.064 ton per acre per year in the Northwest Non-Coastal (3) region, and
- 0.363 ton per acre per year in the Southern Plains (6) region.

Table 10. Average annual sheet and rill erosion (tons/acre),* by region.

	Mean	Median	20th percentile	80th percentile
	All cultivated cropland acres			
Production region				
Northwest Non-Coastal (3)	0.064	0.007	0.000	0.051
Northern Plains (5)	0.051	0.016	0.002	0.070
Southern Plains (6)	0.363	0.124	0.013	0.533
North Central and Midwest (7)	0.774	0.422	0.132	1.145
Lower Mississippi and Texas Gulf Coast (9)	1.638	0.899	0.290	2.088
Northeast (10)	1.357	0.879	0.349	2.071
East Central (11)	1.716	1.022	0.356	2.749
Southeast Coastal Plain (12)	0.932	0.350	0.100	1.199
All eight regions	0.649	0.234	0.026	0.943
	HEL acres			
Production region				
Northwest Non-Coastal (3)	0.095	0.012	0.001	0.085
Northern Plains (5)	0.068	0.017	0.002	0.087
Southern Plains (6)	0.374	0.086	0.007	0.536
North Central and Midwest (7)	1.645	1.162	0.438	2.635
Lower Mississippi and Texas Gulf Coast (9)	4.354	2.740	1.301	6.234
Northeast (10)	1.900	1.493	0.723	2.793
East Central (11)	2.393	1.723	0.658	4.067
Southeast Coastal Plain (12)	3.227	1.356	0.499	4.208
All eight regions	1.036	0.301	0.013	1.706
	Non-HEL acres			
Production region				
Northwest Non-Coastal (3)	0.029	0.003	0.000	0.028
Northern Plains (5)	0.041	0.016	0.002	0.062
Southern Plains (6)	0.357	0.147	0.018	0.527
North Central and Midwest (7)	0.518	0.324	0.113	0.822
Lower Mississippi and Texas Gulf Coast (9)	1.250	0.756	0.256	1.823
Northeast (10)	0.782	0.499	0.216	1.015
East Central (11)	1.009	0.646	0.250	1.275
Southeast Coastal Plain (12)	0.661	0.303	0.088	1.010
All eight regions	0.491	0.223	0.032	0.751

* Estimated using the Revised Universal Soil Loss Equation (RUSLE).
Source: APEX simulation modeling results based on 2003-06 CEAP survey information on farming practices.

Edge-of-Field Sediment Loss from Water Erosion

Sediment loss, as estimated with APEX for this study, is the portion of the sheet and rill eroded material that is transported beyond the edge of the field and settles offsite as well as some sediment that originates from gully erosion processes. Acres with characteristics such as steeper slopes and soil types that promote surface water runoff are more vulnerable than other acres to sediment losses beyond the edge of the field.

According to the APEX model simulations, the mean of the average annual sediment loss estimates for cultivated cropland acres in all eight regions was 0.79 ton per acre per year (table 11). Sediment loss for HEL acres averaged 1.40 tons per acre per year, compared to only 0.55 tons per acre for non-HEL acres.

The median value for sediment loss for all acres—0.185—is much lower than the mean, indicating that the distribution of average annual estimates consists mostly of acres with low average annual sediment loss, in part due to the ameliorating effects of erosion control practices in use in 2003-06. In contrast, a few acres have very large losses; these are acres that are more vulnerable to erosion than other acres, such as HEL acres, and are inadequately treated with conservation practices. As shown in figure 30, about 77 percent of the cropped acres have average annual sediment loss estimates less than the mean of 0.79 tons per acre per year. Ten percent of cropped acres have average annual sediment loss above 2 tons per acre per year. Three percent have average annual sediment loss above 5 tons per acre per year.

Sediment loss is highest in the Lower Mississippi and Texas Gulf Coast (9) region, averaging 2.66 tons per acre per year for cultivated cropland (table 10 and figure 31. This region also had the largest amount of precipitation and irrigation water applied (fig. 22) and the largest amount of surface water runoff per year (fig. 24). Sediment loss averaged higher in this region for both HEL and non-HEL than in any of the other regions (table 10 and figs. 32 and 33).

Figure 30. Distribution of average annual sediment loss from water erosion (tons/acre) for sample points in all eight regions.

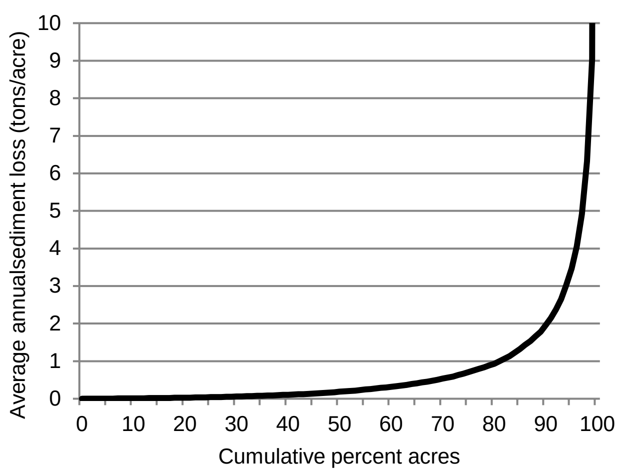


Figure 31. Mean of the average annual sediment loss from water erosion, all cultivated cropland acres, by region.

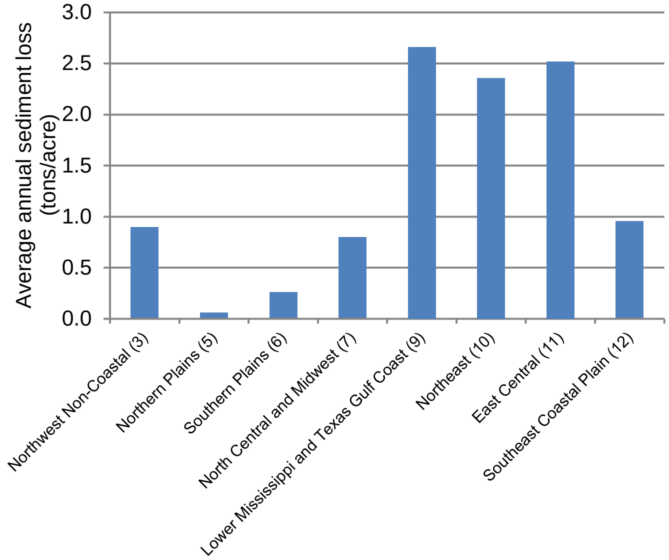


Figure 31. Mean of the average annual sediment loss from water erosion, HEL acres, by region.

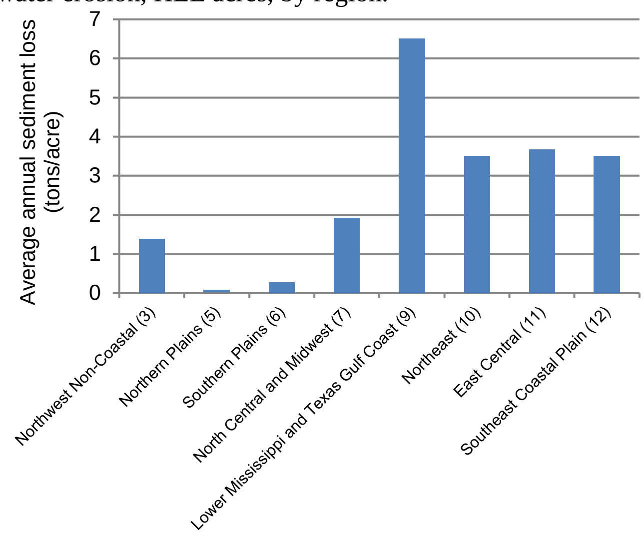


Figure 33. Mean of the average annual sediment loss from water erosion, non-HEL acres, by region.

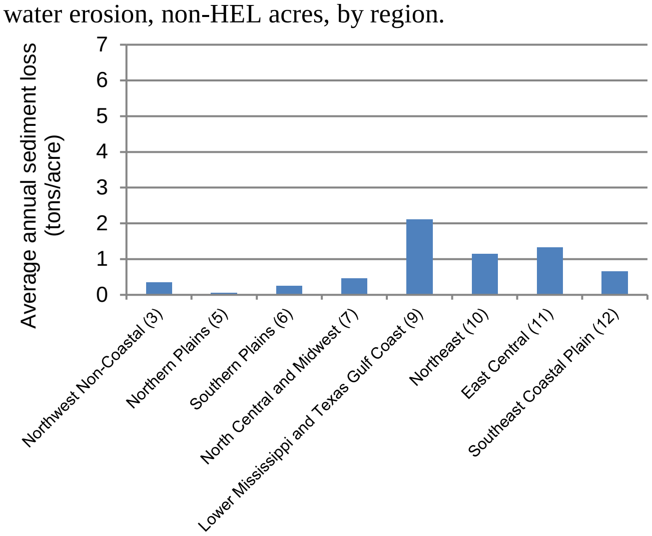


Table 11. Average annual sediment loss at edge of field from water erosion (tons/acre),* by region.

	Mean	Median	20th percentile	80th percentile
	All cultivated cropland acres			
Production region				
Northwest Non-Coastal (3)	0.901	0.144	0.026	0.840
Northern Plains (5)	0.063	0.032	0.010	0.081
Southern Plains (6)	0.260	0.057	0.008	0.307
North Central and Midwest (7)	0.797	0.340	0.091	1.050
Lower Mississippi and Texas Gulf Coast (9)	2.663	1.519	0.588	3.512
Northeast (10)	2.360	1.035	0.290	3.686
East Central (11)	2.523	1.073	0.286	3.213
Southeast Coastal Plain (12)	0.960	0.321	0.079	1.028
All eight regions	0.793	0.185	0.029	0.934
	HEL acres			
Production region				
Northwest Non-Coastal (3)	1.385	0.248	0.045	1.715
Northern Plains (5)	0.089	0.043	0.009	0.117
Southern Plains (6)	0.274	0.045	0.005	0.313
North Central and Midwest (7)	1.921	1.078	0.287	2.940
Lower Mississippi and Texas Gulf Coast (9)	6.500	3.666	1.646	9.278
Northeast (10)	3.505	2.079	0.593	5.268
East Central (11)	3.675	1.998	0.450	6.831
Southeast Coastal Plain (12)	3.503	1.335	0.359	4.189
All eight regions	1.399	0.250	0.024	1.913
	Non-HEL acres			
Production region				
Northwest Non-Coastal (3)	0.354	0.077	0.017	0.307
Northern Plains (5)	0.048	0.028	0.010	0.065
Southern Plains (6)	0.253	0.067	0.010	0.301
North Central and Midwest (7)	0.467	0.258	0.076	0.713
Lower Mississippi and Texas Gulf Coast (9)	2.115	1.373	0.550	2.990
Northeast (10)	1.147	0.562	0.207	1.511
East Central (11)	1.320	0.644	0.187	1.508
Southeast Coastal Plain (12)	0.659	0.274	0.073	0.836
All eight regions	0.547	0.170	0.030	0.739

*Estimated using MUSS, which includes some sediment from gully erosion. See text.
Source: APEX simulation modeling results based on 2003-06 CEAP survey information on farming practices.

Average annual sediment loss for cropped acres was only slightly lower for two other regions—the East Central (11) region, with an average of 2.52 tons per acre per year, and the Northeast (10) region, with an average of 2.36 tons per acre per year (table 11 and fig. 31).

The distributions of the average annual sediment loss (tons/acre) for sample points in each of the eight production regions are contrasted in figure 34, which demonstrates the extent to which these three regions stand out as having the highest sediment losses at the edge of the field. Figure 34 shows that 32-40 percent of cultivated acres in these three regions exceeded 2 tons per acre per year.

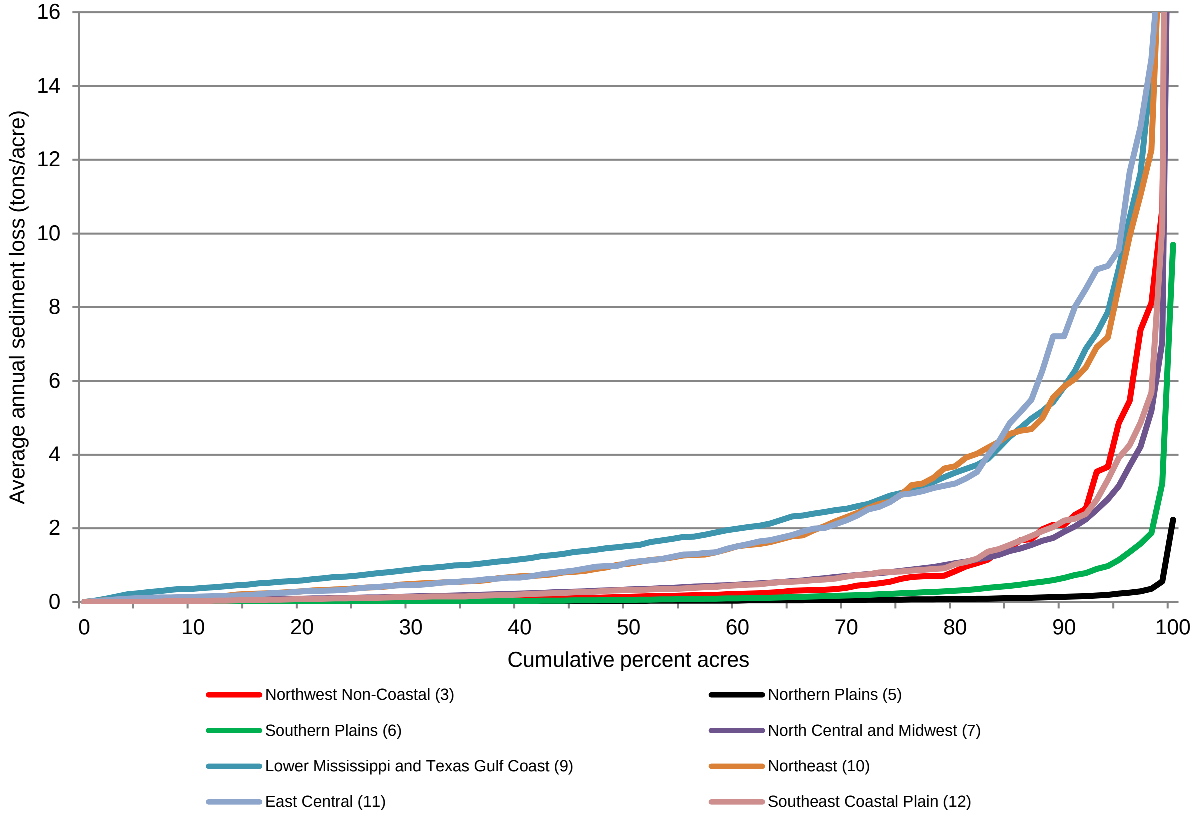
Average annual sediment loss estimates in the Northern Plains (5) and Southern Plains (6) regions were low for all but a very few cultivated cropland acres (figs. 31-33). The average annual sediment loss was only 0.06 ton per acre per year in the Northern Plains (5) region and only 0.26 ton per acre per year in the Southern Plains (6) region.

The remaining three regions averaged less than 1 ton per acre per year of sediment loss for all cropped acres (table 11 and figure 31), but figure 34 shows that annual average sediment loss exceeds 2 tons per acre per year for between 9 and 12 percent of cultivated cropland acres in these three regions.

The largest of the losses shown in figure 34 are a combination of inadequate conservation treatment and a high intrinsic propensity for erosion determined by high slopes, soil types that erode more easily, and higher levels of precipitation and/or irrigation water applied. The smallest of the losses are acres that are essentially flat with permeable soil types that are more prone to infiltration than surface water runoff, or they are adequately treated with conservation practices.

Adequate conservation treatment consists of combinations of conservation practices that treat the specific inherent vulnerability factors associated with each field.

Figure 34. Distributions of average annual sediment loss from water erosion for CEAP sample points in eight production regions.



Criteria were defined for four soil runoff potentials to characterize the inherent vulnerability for water erosion to occur. These criteria are presented in Appendix B. The criteria were then used to define the soil runoff potential at each sample point.[8] For all eight regions combined, about 10 percent of the cultivated cropland acres have a "high" soil runoff potential, most of which are HEL acres (fig. 35). Another 19 percent have a moderately high soil runoff potential, more than half of which are HEL acres. The majority of acres—53 percent—have a "low" soil runoff potential. (A significant proportion of acres with a "low" soil runoff potential are also HEL acres, shown in figure 35. These are primarily HEL acres in the drier regions and are designated as HEL because of a high vulnerability to wind erosion.)

Average annual sediment loss estimates were determined for the each of four water erosion control treatment levels (presented in the previous chapter) at each of the four soil runoff potentials to provide further insight on what factors were most responsible for the level of sediment loss estimated in the model simulation. This resulted in a 4-by-4 matrix with 16 cells where each cell consisted of a mean value of sediment loss (or other metric) for a specific subset of sample points.

Table 12 provides estimates of acres and the average annual sediment loss for each of the 16 cells for all eight regions combined. Whereas the mean of the average annual sediment loss was 0.79 ton per acre per year for all cropped acres in all eight regions, the mean steadily increased as the soil runoff potential increased from "low" to "high." The mean of the average annual sediment loss was (table 12)—

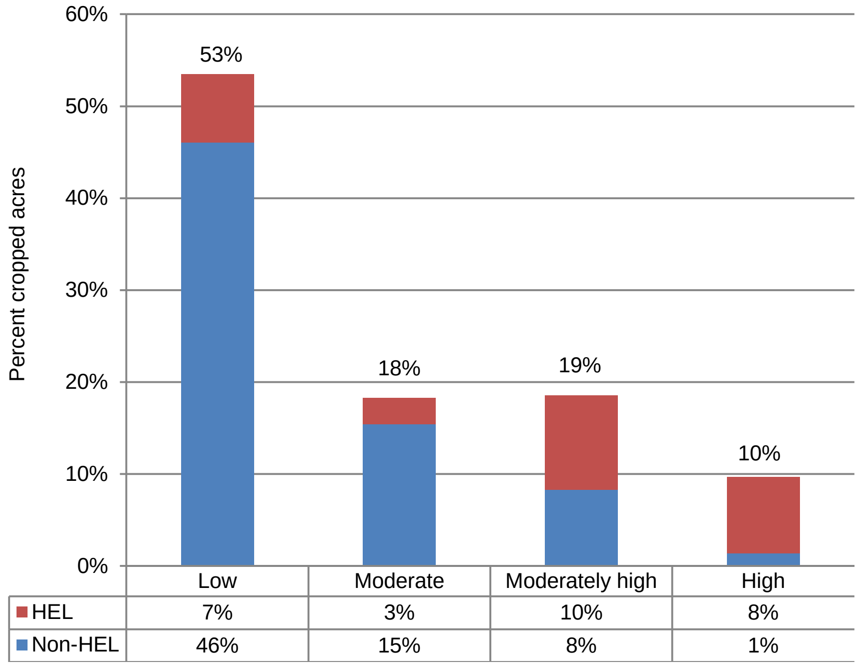
- 0.33 ton per acre per year for cropped acres with a "low" soil runoff potential;
- 0.82 ton per acre per year for cropped acres with a "moderate" soil runoff potential;
- 1.17 tons per acre per year for cropped acres with a "moderately high" soil runoff potential; and
- 2.55 tons per acre per year for cropped acres with a "high" soil runoff potential.

Similarly, the mean steadily decreased with increasing levels of conservation treatment for water erosion control. The mean of the average annual sediment loss was (table 12)—

- 1.62 tons per acre per year for cropped acres with a "low" level of treatment;
- 0.83 ton per acre per year for cropped acres with a "moderate" level of treatment;
- 0.58 ton per acre per year for cropped acres with a "moderately high" level of treatment; and
- 0.29 ton per acre per year for cropped acres with a "high" level of treatment.

[8] Soil runoff potentials were used with conservation treatment levels to estimate conservation treatment needs in the previously published CEAP reports for each water resource region.

Figure 35. Soil runoff potential for cultivated cropland acres, all eight regions combined.



Note: Criteria for defining the soil runoff potentials are presented in Appendix B.

Table 12. Breakdown of cultivated cropland acres and sediment loss estimates into 16 combinations of four soil runoff potentials and four conservation treatment levels for erosion control, all eight regions combined.

	Conservation treatment levels for water erosion control				
Soil runoff potential	Low	Moderate	Moderately high	High	All
Estimated cropped acres					
Low	20,673,500	67,778,306	14,298,015	52,429,344	155,179,165
Moderate	9,478,846	22,841,115	5,258,714	15,415,863	52,994,537
Moderately high	12,559,544	23,857,638	9,833,312	7,538,449	53,788,943
High	6,823,780	12,015,683	8,683,707	602,181	28,125,352
All	49,535,671	126,492,743	38,073,747	75,985,836	290,087,997
Percent of cropped acres					
Low	7.1%	23.4%	4.9%	18.1%	53.5%
Moderate	3.3%	7.9%	1.8%	5.3%	18.3%
Moderately high	4.3%	8.2%	3.4%	2.6%	18.5%
High	2.4%	4.1%	3.0%	0.2%	9.7%
All	17.1%	43.6%	13.1%	26.2%	100.0%
Sediment loss estimates for the baseline scenario (average annual tons/acre)					
Low	0.599	0.359	0.293	0.211	0.335
Moderate	1.113	1.017	0.531	0.456	0.823
Moderately high	2.165	1.074	0.624	0.534	1.171
High	4.441	2.696	1.021	0.097	2.547
All	1.624	0.835	0.577	0.292	0.793
Percent of acres in baseline scenario with average annual sediment loss more than 2 tons/acre					
Low	6%	4%	2%	1%	3%
Moderate	14%	16%	5%	3%	11%
Moderately high	30%	16%	6%	2%	16%
High	54%	44%	12%	0%	36%
All	20%	12%	6%	1%	10%

Table 12 also shows that the mean steadily decreased with increasing levels of conservation treatment for groups of acres at each soil runoff potential. The highest average annual sediment loss shown in the table 12 matrix—4.44 tons per acre per year—was for acres with a "low" level of conservation treatment for water erosion control and a 'high" soil runoff potential.

At the "high" level of conservation treatment, average annual sediment losses were low at all soil runoff potentials, ranging from 0.10 to 0.53 tons per acre per year. (The increasing trend in sediment loss with increasing levels of soil runoff potentials breaks down for the "high" level of conservation treatment because at that level all the acres would be expected to be adequately treated.) At the "high" level of treatment, all crops meet criteria for either no-till or mulch till, have increasing soil organic carbon, and, if the field slope is greater than 2 percent, also have at least one edge-of-field mitigation practice and one in-field concentrated flow or overland flow practice.

Table 12 also presents the percentage of acres in each of the 16 cells of the 4-by-4 matrix that exceed 2 tons per acre per year of sediment loss as a guide to determining the extent of cropped acres with excessive edge-of-field losses. Sediment loss rates at the edge of the field greater than 2 tons per acre per year are generally considered to be unacceptable and require additional conservation treatment. [9]

About 10 percent of all cultivated cropland acres in the eight regions—totaling 28.4 million acres—have average annual sediment loss estimates greater than 2 tons per acre per year (table 12 and fig. 30). Most of these acres are concentrated in the four groups of acres with "low" or "moderate" levels of conservation treatment and "high" or "moderately high" soil runoff potentials. For example, 54 percent of the acres with a "low" conservation treatment level and a "high" soil runoff potential have average annual sediment loss estimates greater than 2 tons per acre per year (table 12).

The four matrixes in table 12 are repeated in tables 13-20 for each of the regions. The decreasing trend in sediment loss with increasing levels of conservation treatment and the increasing trend in sediment loss with increasing levels of soil runoff potentials shown in table 12 for all eight regions combined also held up for each of the eight regions. The trends are not as strong in some regions because one or more of the soil runoff potentials or conservation treatment levels are represented by too few acres to make reliable comparisons.

Nevertheless, these matrixes clearly show that the lowest rates of sediment loss are for acres with the higher levels of conservation treatment for erosion control when the inherent soil runoff vulnerability is taken into account.

Some of the most striking examples include:

- Average annual sediment loss of 4.7 tons per acre per year for acres with a "high" soil runoff potential and a "low" treatment level compared to 0.10 ton per acre per year for acres with a "high" treatment level and the same soil runoff potential in the North Central and Midwest (7) region (table 16);
- Average annual sediment loss of 7.9 tons per acre per year for acres with a "moderately high" soil runoff potential and a "low" treatment level compared to 1.6 tons per acre per year for acres with a "high" treatment level and the same soil runoff potential in the Lower Mississippi and Texas Gulf Coast (9) region (table 17) (only a few acres had a "high" soil runoff potential in this region); and
- Average annual sediment loss of 10.4 tons per acre per year for acres with a "high" soil runoff potential and a "low" treatment level compared to 1.1 tons per acre per year for acres with a "moderately high" treatment level and the same soil runoff potential in the East Central (11) region (table 19) (only a few acres had a "high" treatment level and a "high" soil runoff potential in this region).

About two-thirds of the 28.4 million acres with average annual sediment loss estimates greater than 2 tons per acre per year are concentrated in two regions—

- the North Central and Midwest (7) region, where 9 percent of cropped acres (11.0 million acres) had average annual sediment loss estimates of more than 2 tons per acre per year, and
- the Lower Mississippi and Texas Gulf Coast (9) region, where 40 percent of cropped acres (8.4 million acres) had average annual sediment loss estimates of more than 2 tons per acre per year.

Two other regions had a high proportion of cropped acres with excessive sediment loss rates, but together accounted for only 18 percent of the 28.4 million acres with average annual sediment loss estimates greater than 2 tons per acre per year.—

- the Northeast (10) region, where 32 percent of cropped acres (2.2 million acres) had average annual sediment loss estimates of more than 2 tons per acre per year, and
- the East Central (11) region, where 33 percent of cropped acres (2.8 million acres) had average annual sediment loss estimates of more than 2 tons per acre per year.

The remaining four regions each accounted for less than 5 percent of 28.4 million acres with average annual sediment loss estimates greater than 2 tons per acre per year.

[9] In previous CEAP reports, acceptable levels for edge-of-field sediment loss, nitrogen loss, and phosphorus loss were used to estimate conservation treatment needs. Losses above these levels were treated as unacceptable levels of loss based on what could be realistically achieved with today's production and conservation technologies.

Table 13. Breakdown of cultivated cropland acres and sediment loss estimates into 16 combinations of four soil runoff potentials and four conservation treatment levels for erosion control, the Northwest Non-Coastal (3) region.

	Conservation treatment levels for water erosion control				
Soil runoff potential	Low	Moderate	Moderately high	High	All
Estimated cropped acres					
Low	955,273	2,497,331	572,438	549,692	4,574,735
Moderate	108,178	169,086	6,659	0	283,923
Moderately high	1,349,411	1,229,666	273,473	83,858	2,936,408
High	1,383,360	1,550,619	713,422	34,545	3,681,946
All	3,796,222	5,446,703	1,565,993	668,095	11,477,012
Percent of cropped acres					
Low	8%	22%	5%	5%	40%
Moderate	1%	1%	<1%	0%	2%
Moderately high	12%	11%	2%	1%	26%
High	12%	14%	6%	<1%	32%
All	33%	47%	14%	6%	100%
Sediment loss estimates for the baseline scenario (average annual tons/acre)					
Low	0.343	0.169	0.108	0.057	0.184
Moderate	0.432	0.179	0.145	NA	0.274
Moderately high	1.123	0.438	0.069	0.320	0.715
High	2.992	1.831	0.483	0.029	1.989
All	1.588	0.703	0.272	0.089	0.901
Percent of acres in baseline scenario with average annual sediment loss more than 2 tons/acre					
Low	3%	1%	1%	0%	1%
Moderate	6%	0%	0%	0%	2%
Moderately high	14%	5%	0%	0%	8%
High	39%	31%	4%	0%	29%
All	20%	11%	2%	0%	12%

Table 14. Breakdown of cultivated cropland acres and sediment loss estimates into 16 combinations of four soil runoff potentials and four conservation treatment levels for erosion control, the Northern Plains (5) region.

	Conservation treatment levels for water erosion control				
Soil runoff potential	Low	Moderate	Moderately high	High	All
Estimated cropped acres					
Low	2,275,220	12,452,584	1,298,707	7,741,789	23,768,299
Moderate	2,477,184	5,297,142	648,509	1,006,058	9,428,893
Moderately high	3,485,157	6,176,204	616,904	965,410	11,243,675
High	1,197,343	1,793,128	257,560	0	3,248,032
All	9,434,904	25,719,059	2,821,681	9,713,257	47,688,900
Percent of cropped acres					
Low	5%	26%	3%	16%	50%
Moderate	5%	11%	1%	2%	20%
Moderately high	7%	13%	1%	2%	24%
High	3%	4%	1%	0%	7%
All	20%	54%	6%	20%	100%
Sediment loss estimates for the baseline scenario (average annual tons/acre)					
Low	0.049	0.037	0.031	0.017	0.031
Moderate	0.090	0.074	0.043	0.035	0.072
Moderately high	0.101	0.061	0.064	0.042	0.072
High	0.317	0.204	0.126	NA	0.239
All	0.113	0.062	0.049	0.021	0.063
Percent of acres in baseline scenario with average annual sediment loss more than 2 tons/acre					
Low	0%	<1%	0%	0%	<1%
Moderate	<1%	0%	0%	0%	<1%
Moderately high	0%	0%	0%	0%	0%
High	0%	0%	0%	0%	0%
All	<1%	<1%	0%	0%	<1%

Table 15. Breakdown of cultivated cropland acres and sediment loss estimates into 16 combinations of four soil runoff potentials and four conservation treatment levels for erosion control, the Southern Plains (6) region.

	Conservation treatment levels for water erosion control				
Soil runoff potential	Low	Moderate	Moderately high	High	All
Estimated cropped acres					
Low	10,458,887	24,174,260	3,346,653	9,514,665	47,494,465
Moderate	2,712,984	3,099,574	249,369	1,199,909	7,261,836
Moderately high	1,964,494	3,794,722	1,250,241	421,416	7,430,874
High	309,749	722,798	343,963	0	1,376,509
All	15,446,115	31,791,354	5,190,226	11,135,990	63,563,684
Percent of cropped acres					
Low	16%	38%	5%	15%	75%
Moderate	4%	5%	<1%	2%	11%
Moderately high	3%	6%	2%	1%	12%
High	<1%	1%	1%	0%	2%
All	24%	50%	8%	18%	100%
Sediment loss estimates for the baseline scenario (average annual tons/acre)					
Low	0.280	0.108	0.062	0.078	0.137
Moderate	0.823	0.384	0.105	0.125	0.496
Moderately high	1.318	0.620	0.382	0.146	0.737
High	1.863	0.387	0.267	na	0.689
All	0.539	0.202	0.154	0.086	0.260
Percent of acres in baseline scenario with average annual sediment loss more than 2 tons/acre					
Low	1%	0%	0%	0%	<1%
Moderate	8%	1%	0%	0%	3%
Moderately high	19%	5%	2%	0%	8%
High	30%	3%	0%	0%	8%
All	5%	1%	1%	0%	2%

Table 16. Breakdown of cultivated cropland acres and sediment loss estimates into 16 combinations of four soil runoff potentials and four conservation treatment levels for erosion control, the North Central and Midwest (7) region.

	Conservation treatment levels for water erosion control				
Soil runoff potential	Low	Moderate	Moderately high	High	All
Estimated cropped acres					
Low	3,328,724	15,837,412	6,802,497	30,281,429	56,250,063
Moderate	2,066,023	5,553,049	3,342,928	9,783,761	20,745,761
Moderately high	3,489,388	9,111,448	6,848,787	5,404,278	24,853,901
High	2,452,797	5,887,498	6,696,647	536,532	15,573,475
All	11,336,932	36,389,408	23,690,859	46,006,001	117,423,200
Percent of cropped acres					
Low	3%	13%	6%	26%	48%
Moderate	2%	5%	3%	8%	18%
Moderately high	3%	8%	6%	5%	21%
High	2%	5%	6%	<1%	13%
All	10%	31%	20%	39%	100%
Sediment loss estimates for the baseline scenario (average annual tons/acre)					
Low	0.498	0.370	0.363	0.246	0.310
Moderate	1.196	0.677	0.477	0.335	0.535
Moderately high	2.613	1.233	0.666	0.563	1.125
High	4.697	3.023	1.148	0.096	2.380
All	2.185	1.062	0.689	0.300	0.797
Percent of acres in baseline scenario with average annual sediment loss more than 2 tons/acre					
Low	3%	1%	1%	0%	1%
Moderate	14%	6%	2%	0%	3%
Moderately high	50%	18%	5%	0%	15%
High	72%	57%	14%	0%	39%
All	35%	15%	6%	0%	9%

Table 17. Breakdown of cultivated cropland acres and sediment loss estimates into 16 combinations of four soil runoff potentials and four conservation treatment levels for erosion control, the Lower Mississippi and Texas Gulf Coast (9) region.

	Conservation treatment levels for water erosion control				
Soil runoff potential	Low	Moderate	Moderately high	High	All
Estimated cropped acres					
Low	1,025,030	3,802,444	547,483	1,927,722	7,302,679
Moderate	1,351,639	6,324,252	528,211	3,033,323	11,237,424
Moderately high	734,318	1,103,263	122,754	282,781	2,243,116
High	152,483	172,572	54,226	0	379,281
All	3,263,470	11,402,531	1,252,674	5,243,825	21,162,500
Percent of cropped acres					
Low	5%	18%	3%	9%	35%
Moderate	6%	30%	2%	14%	53%
Moderately high	3%	5%	1%	1%	11%
High	1%	1%	<1%	0%	2%
All	15%	54%	6%	25%	100%
Sediment loss estimates for the baseline scenario (average annual tons/acre)					
Low	4.690	2.404	1.252	0.892	2.239
Moderate	2.949	2.189	1.737	1.128	1.973
Moderately high	7.860	5.386	2.259	1.562	5.543
High	18.744	13.860	2.702	na	14.228
All	5.339	2.746	1.618	1.064	2.663
Percent of acres in baseline scenario with average annual sediment loss more than 2 tons/acre					
Low	66%	42%	10%	14%	36%
Moderate	44%	42%	39%	14%	34%
Moderately high	70%	85%	51%	33%	72%
High	100%	90%	33%	0%	86%
All	59%	47%	27%	15%	40%

Table 18. Breakdown of cultivated cropland acres and sediment loss estimates into 16 combinations of four soil runoff potentials and four conservation treatment levels for erosion control, the Northeast (10) region.

	Conservation treatment levels for water erosion control				
Soil runoff potential	Low	Moderate	Moderately high	High	All
Estimated cropped acres					
Low	492,407	1,231,313	223,137	251,989	2,198,846
Moderate	236,447	346,810	178,990	44,947	807,195
Moderately high	769,481	721,964	170,423	53,305	1,715,173
High	686,324	876,341	244,079	19,542	1,826,286
All	2,184,660	3,176,428	816,629	369,783	6,547,500
Percent of cropped acres					
Low	8%	19%	3%	4%	34%
Moderate	4%	5%	3%	1%	12%
Moderately high	12%	11%	3%	1%	26%
High	10%	13%	4%	<1%	28%
All	33%	49%	12%	6%	100%
Sediment loss estimates for the baseline scenario (average annual tons/acre)					
Low	1.775	0.706	0.231	0.176	0.836
Moderate	2.555	0.953	0.595	0.326	1.308
Moderately high	3.658	1.357	0.475	0.213	2.266
High	7.232	4.031	0.705	0.130	4.748
All	4.237	1.798	0.503	0.197	2.360
Percent of acres in baseline scenario with average annual sediment loss more than 2 tons/acre					
Low	21%	4%	0%	0%	7%
Moderate	41%	9%	0%	0%	16%
Moderately high	62%	25%	2%	0%	38%
High	83%	70%	1%	0%	65%
All	57%	28%	1%	0%	32%

Table 19. Breakdown of cultivated cropland acres and sediment loss estimates into 16 combinations of four soil runoff potentials and four conservation treatment levels for erosion control, the East Central (11) region.

	Conservation treatment levels for water erosion control				
Soil runoff potential	Low	Moderate	Moderately high	High	All
Estimated cropped acres					
Low	159,991	1,516,909	380,199	1,025,759	3,082,859
Moderate	88,819	801,203	230,541	211,698	1,332,261
Moderately high	437,870	1,244,402	502,446	267,347	2,452,065
High	549,266	945,030	350,157	11,562	1,856,015
All	1,235,947	4,507,544	1,463,343	1,516,365	8,723,200
Percent of cropped acres					
Low	2%	17%	4%	12%	35%
Moderate	1%	9%	3%	2%	15%
Moderately high	5%	14%	6%	3%	28%
High	6%	11%	4%	<1%	21%
All	14%	52%	17%	17%	100%
Sediment loss estimates for the baseline scenario (average annual tons/acre)					
Low	2.324	0.888	0.596	0.657	0.849
Moderate	3.386	1.961	0.443	0.447	1.553
Moderately high	4.934	2.537	1.209	0.838	2.508
High	10.405	5.374	1.081	0.279	6.021
All	6.916	2.474	0.898	0.656	2.523
Percent of acres in baseline scenario with average annual sediment loss more than 2 tons/acre					
Low	30%	9%	0%	4%	7%
Moderate	51%	32%	4%	2%	24%
Moderately high	73%	50%	23%	8%	44%
High	94%	70%	16%	0%	66%
All	75%	37%	12%	4%	33%

Table 20. Breakdown of cultivated cropland acres and sediment loss estimates into 16 combinations of four soil runoff potentials and four conservation treatment levels for erosion control, the Southeast Coastal Plain (12) region.

	Conservation treatment levels for water erosion control				
Soil runoff potential	Low	Moderate	Moderately high	High	All
Estimated cropped acres					
Low	1,977,967	6,266,052	1,126,900	1,136,300	10,507,218
Moderate	437,570	1,249,999	73,508	136,166	1,897,243
Moderately high	329,425	475,969	48,283	60,054	913,731
High	92,459	67,697	23,652	0	183,808
All	2,837,421	8,059,717	1,272,342	1,332,519	13,502,000
Percent of cropped acres					
Low	15%	46%	8%	8%	78%
Moderate	3%	9%	1%	1%	14%
Moderately high	2%	4%	<1%	<1%	7%
High	1%	1%	<1%	0%	1%
All	21%	60%	9%	10%	100%
Sediment loss estimates for the baseline scenario (average annual tons/acre)					
Low	0.655	0.583	0.396	0.226	0.538
Moderate	1.571	1.688	0.190	0.266	1.501
Moderately high	8.729	2.209	1.510	2.969	4.573
High	1.670	1.585	0.718	na	1.516
All	1.767	0.859	0.432	0.354	0.960
Percent of acres in baseline scenario with average annual sediment loss more than 2 tons/acre					
Low	7%	5%	14%	1%	6%
Moderate	17%	28%	0%	0%	22%
Moderately high	57%	44%	33%	27%	47%
High	37%	28%	0%	0%	29%
All	15%	11%	14%	2%	11%

Effects of Conservation Practices

The No-Practice Scenario

The baseline results presented in previous sections include the benefits and effects of conservation practices in use in 2003-06. Program routines and parameter settings within the APEX model allow for simulation of the presence of structural erosion control practices, and tillage practices are represented by daily field operations simulated in the model.

To estimate the effects of these practices already represented in the baseline scenario, an alternative simulation was created by removing the practices or reversing their effects, called the "no-practice" scenario. The "no-practice" scenario simulates model results as if no conservation practices were in use but holds all other model inputs and parameters the same as in the baseline scenario. For example, to simulate "no practices" for sample points where some type of residue management is used, model simulations were conducted as if continuous conventional tillage had been used instead. Similarly, for sample points with structural conservation practices (buffers, terraces, grassed waterways, etc.), the no-practice scenario was simulated as if the practices were not present.

The effects of conservation practices are obtained by taking the difference in model results between the two scenarios at each sample point, and then aggregating over the points for national and regional estimates. The reduction in sediment loss, for example, is the sediment loss estimate for the no-practice scenario minus the sediment loss estimate for the baseline scenario. This calculation is made using the average annual values at each sample point. National level results are then obtained by calculating the acres-weighted mean of the average annual reduction over all the sample points in the eight production regions. The percent reduction is calculated by dividing the difference by the no-practice scenario estimate.

The no-practice scenario also included specific features to remove or reverse the effects of other practices not targeted specifically at reducing sediment loss, but which could have some effect on sediment loss:[10]

- Nutrient management practices, which could affect sediment loss through the relationship between crop growth (canopy development) and soil erosion.
- Cover crops, which could also affect soil erosion, but were not in common use in 2003-06.
- Irrigation management, which could increase sediment losses in the no-practice scenario where less efficient irrigation systems are simulated.

No-practice representation of structural practices. The no-practice field condition for structural practices is simply the removal of the structural practices from the modeling process. In addition, the soil condition is changed from "good" to "poor" for the determination of the runoff curve number for erosion prediction.

For overland flow practices such as terraces and contouring, which slow the flow of water across the field, the P factor of the USLE-based equation was increased to 1. Slope length was also changed to reflect the absence of these slope-interrupting practices.

For concentrated flow practices such as grassed waterways and grade stabilization structures, which are designed to prevent areas of concentrated flow from developing gullies, or to stabilize gullies that have developed, the no-practice protocol removes the structure or waterway and replaces it with a "ditch" as a separate subarea. This ditch, or channel, represents a gully. Sediment contributions from the gully will come from downcutting. (Headcutting and sloughing of the sides are not simulated in APEX.)

For edge-of-field practices such as buffers and filters, which occur outside the primary production area and act to mitigate sediment losses from the field, the no-practice protocol removes these areas and their management. The slope length is also restored to the undisturbed length that it would have been had the practices not been in place. (When simulating a buffer in APEX, the slope length reported in the NRI is adjusted.)

No-practice representation of conservation tillage. The no-practice tillage protocols are designed to remove the benefits of conservation tillage. For all crops grown with some kind of reduced tillage, the no-practice scenario simulates conventional tillage based on the STIR (Soil Tillage Intensity Rating) value. Conventional tillage for the purpose of estimating conservation benefits is defined as any crop grown with a STIR value above 100. Those crops grown with a STIR value of less than 100 in the baseline scenario had tillage operations added in the no-practice scenario. Two consecutive tandem disk operations were added prior to planting.[11] The tandem disk has a STIR value of 39 for a single use. Two consecutive disking operations will add 78 to the existing tillage intensity, which allows for more than 90 percent of the crops to exceed a STIR of 100 and yet maintain the unique suite and timing of operations for each crop in the rotation. These additional two tillage operations were inserted in the simulation one week prior to planting, one of the least vulnerable times for tillage operations because it is close to the time when vegetation will begin to provide cover and protection. In addition to adding tillage, the hydrologic condition for assignment of the runoff curve number was changed from "good" to "poor" on all points receiving additional tillage. Points that are conventionally tilled for all crops in the baseline condition scenario are also modeled with a "poor" hydrologic condition curve number.

[10] For more information on the representation of the no-practice scenario in the APEX model simulation, see the collection of previously published regional CEAP reports based on the 2003-06 survey database.

[11] The most common type of tillage operation in the survey was disking, and the most common disk used was a tandem disk for nearly all crops, in all regions, and for both dryland and irrigated agriculture.

Effects of Conservation Practices on Water Loss

Water loss from farm fields is a principle determinant of erosion and sediment loss. The effect of conservation practices on water loss is summarized in this section to provide a perspective on the results presented for erosion and sediment loss in the next section.

Model simulations indicate that conservation practices have reduced surface water runoff by an average of about 0.64 inch per year averaged over all acres, representing a 14-percent reduction nationally (table 21). The distributions of the average annual estimates of surface water runoff in the baseline scenario and the no-practice scenario are contrasted in figure 36. The distribution for the no-practice scenario shows what surface water runoff would be if there were no conservation practices in use—more surface water runoff and thus less subsurface flow and thus less soil moisture available for crop growth.

The average annual reductions in surface water runoff due to conservation practices range among the sample points from less than zero to above 5 or more inches per year (fig. 37). The variability in reductions due to practices reflects different levels of conservation treatment as well as differences in precipitation and inherent differences among acres for water to run off or infiltrate. Figure 37 shows that, for about 45 percent of the cultivated cropland acres in the eight regions, the effects of conservation practices on surface water runoff were very small—average annual reductions less than 0.2 inch per year. In contrast, the effects of practices were high for the top 15 percent, where surface water runoff was reduced by 1 inch or more per year due to the use of conservation practices.

About 10 percent of the acres had less surface water runoff in the no-practice scenario than in the baseline scenario resulting in the negative reductions shown in figure 37. In general, these gains in surface water runoff due to practices occur on soils with low to moderate potential for surface water runoff together with: (1) higher nutrient application rates in the no-practice scenario that result in more biomass production, which can reduce surface water runoff (typically rotations with hay or continuous corn); or (2) the additional tillage simulated in the no-practice scenario provided increased random roughness of the surface reducing runoff on nearly level landscapes with low crop residue rotations.

Most of the reductions in surface water runoff are re-routed to subsurface flow loss pathways, resulting in gains in subsurface flows for many acres due to the use of conservation practices. Model simulations indicate that conservation practices have increased the volume of water lost through subsurface flow pathways by an average annual amount of 0.5 inch per year, representing a 9-percent increase nationally (table 21). The re-routing of surface water to subsurface flows is shown graphically in figures 38 and 39. The baseline scenario curve in figure 39 shows higher subsurface flows than the no-practice curve. Figure 39 shows that the gain in subsurface flows due to conservation practices ranges among the sample points from an average of less than zero to 5 or more inches per year.

Figure 36. Distributions of average annual surface water runoff for the baseline and no-practice scenarios, all eight regions combined.

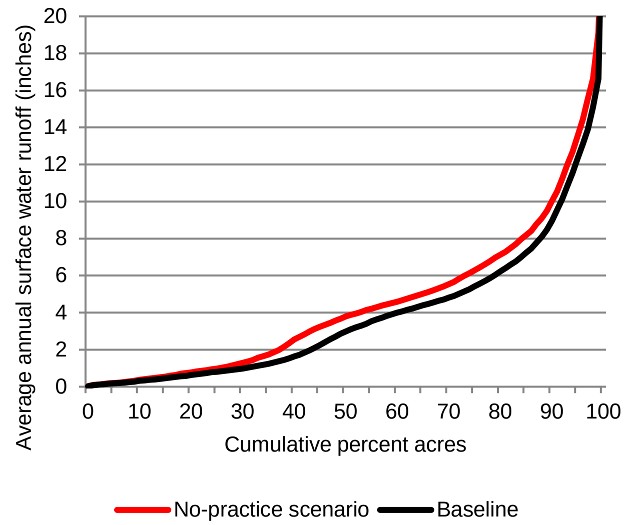
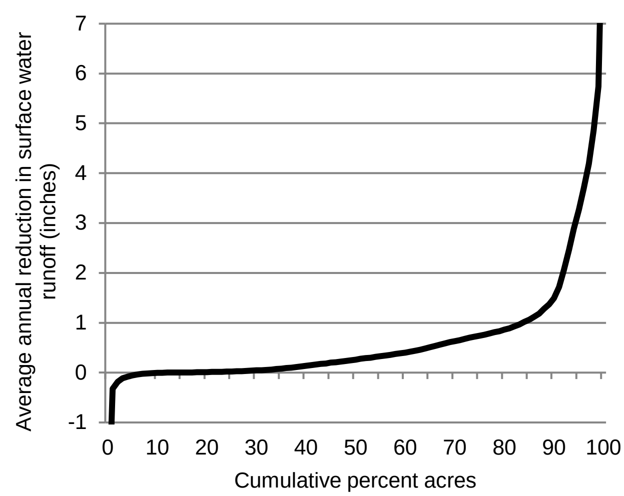


Figure 37. Distribution of average annual reductions in surface water runoff due to the use of conservation practices, all eight regions combined.



For about 30 percent of the cultivated cropland acres the effects of conservation practices on subsurface water flows were near zero. Conservation practice use resulted in gains ranging from 0.1 to 1.0 inch per year for about 45 percent of cultivated cropland acres. Gains were greater than 1 inch per year for only about 15 percent (fig. 39).

Model simulations showed that reductions in subsurface water flows (shown as negative gains in figure 39) occur on up to about 10 percent of cultivated cropland acres. These were mostly irrigated acres in areas where weather during the growing season was often hot and dry. In some of these situations, a significant portion of the surface water runoff that is re-routed through infiltration into the soil is taken up by the crop and thus does not contribute to any of the subsurface flow loss pathways. In addition, any ponding of irrigation water applied on nearly level landscapes would also be susceptible to greater rates of evaporation, further reducing the volume of water available for loss through subsurface flow pathways.

Table 21. Effects of conservation practices on water loss from farm fields.

	Baseline scenario	No-practice scenario	Reduction due to practices	Percent reduction
Northwest Non-Coastal (3) region				
Average annual surface water runoff (inches)	1.71	2.56	0.86	33%
Average annual subsurface water flow (inches)	2.94	2.89	-0.06*	-2%
Northern Plains (5) region				
Average annual surface water runoff (inches)	0.66	0.77	0.11	14%
Average annual subsurface water flow (inches)	1.19	1.03	-0.15*	-15%
Southern Plains (6) region				
Average annual surface water runoff (inches)	1.38	2.33	0.94	41%
Average annual subsurface water flow (inches)	2.19	2.12	-0.08*	-4%
North Central and Midwest (7) region				
Average annual surface water runoff (inches)	4.32	4.78	0.46	10%
Average annual subsurface water flow (inches)	6.42	5.74	-0.68*	-12%
Lower Mississippi and Texas Gulf Coast (9) region				
Average annual surface water runoff (inches)	13.07	14.63	1.56	11%
Average annual subsurface water flow (inches)	9.95	8.84	-1.11*	-13%
Northeast (10) region				
Average annual surface water runoff (inches)	6.11	6.59	0.48	7%
Average annual subsurface water flow (inches)	9.42	8.83	-0.60*	-7%
East Central (11) region				
Average annual surface water runoff (inches)	8.22	8.99	0.77	9%
Average annual subsurface water flow (inches)	10.82	10.00	-0.82*	-8%
Southeast Coastal Plain (12) region				
Average annual surface water runoff (inches)	6.02	6.98	0.95	14%
Average annual subsurface water flow (inches)	16.28	15.85	-0.44*	-3%
All eight regions combined				
Average annual surface water runoff (inches)	3.85	4.49	0.64	14%
Average annual subsurface water flow (inches)	5.41	4.96	-0.46*	-9%

* Represents gains in water lost in subsurface flow pathways because of re-routing of surface water runoff due to conservation practice use.

Figure 38. Distributions of average annual subsurface water flow for the baseline and no-practice scenarios, all eight regions combined.

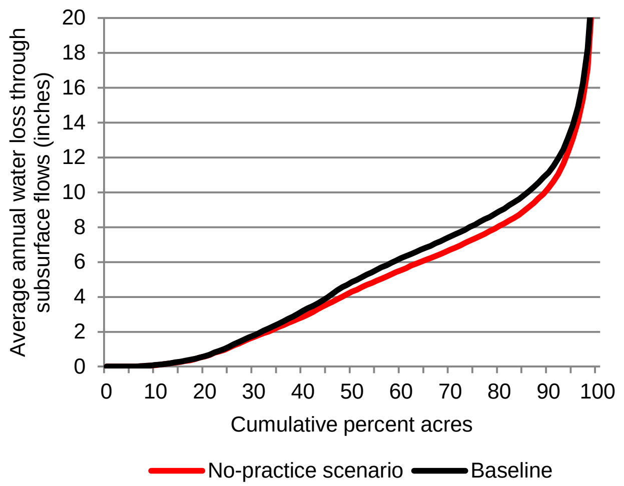
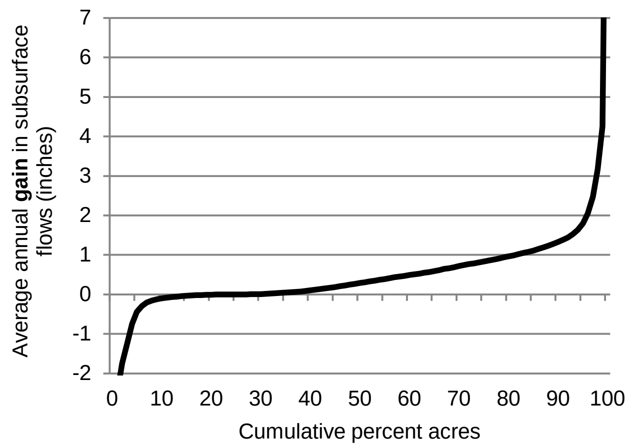


Figure 39. Distribution of average annual gain in subsurface water flows due to the use of conservation practices, all eight regions combined.



The effects of conservation practices on water loss from farm fields vary substantially across the eight production regions (table 21, figs. 41-44-).

Conservation practices have been the most effective in reducing surface water runoff in the Lower Mississippi and Texas Gulf Coast (9) region. The mean of the average annual reductions in surface water runoff due to conservation practices was 1.56 inches per year, representing an 11 percent reduction relative to the no-practice scenario (table 21 and fig. 41). This region also had the largest amount of surface water runoff in the baseline scenario. Figure 43 shows that about 60 percent of cropped acres in the Lower Mississippi and Texas Gulf Coast (9) region had average annual reductions in surface water runoff of 1 inch or more due to the use of conservation practices.

Reductions in surface water runoff were also significant in three other regions (table 21, fig. 41, and fig. 43):

- the Southeast Coastal Plain (12) region, where conservation practice use reduced surface water runoff by an average of 0.95 inches per year, representing a 14-percent reduction,
- the Southern Plains (6) region, where conservation practice use reduced surface water runoff by an average of 0.94 inches per year, representing a 41-percent reduction, and
- the Northwest Non-Coastal (3) region, where conservation practice use reduced surface water runoff by an average of 0.86 inches per year, representing a 33-percent reduction.

A significant portion of the reductions in surface water runoff for the Southern Plains (5) region, the Northwest Non-Coastal (3) region, and the Lower Mississippi and Texas Gulf Coast (9) region results from improvements in irrigation efficiency in those regions—the three regions with the highest proportions of irrigated acres (i.e., lower efficiency irrigation systems simulated in the no-practice scenario).

Conservation practices have been the least effective in reducing surface water runoff in the Northern Plains (5) region, where conservation practice use reduced surface water runoff only by an average of 0.11 inch per year. This region also had the smallest amount of surface water runoff in the baseline scenario. Figure 43 shows that, for this region, 95 percent of the cultivated cropland acres had reductions in surface water runoff less than 0.25 inch per year due to conservation practice use.

Conservation practices generally have been less effective on water lost through subsurface loss pathways (table 21, fig. 42, and fig. 44). On average, all eight regions had gains in subsurface flows from the re-routing of surface water runoff by conservation practice use, although some gains were very small.

The region with the largest gains in subsurface flows was the Lower Mississippi and Texas Gulf Coast (9) region, which also had the largest average reductions in surface water runoff and the most volume of water in subsurface flows in the baseline scenario. The mean of the average annual gains in subsurface water flows due to conservation practice use was 1.11 inches per year, representing a 13-percent reduction relative to the no-practice scenario (table 21 and fig. 42).

Three regions were the least effective in attaining gains in subsurface water flows due to conservation practice use (table 21, fig. 42, and fig. 44):

- the Northwest Non-Coastal (3) region, where conservation practice use increased subsurface water flows by an average of only 0.06 inch per year, representing a 2-percent increase relative to the no-practice scenario,
- the Southern Plains (6) region, where conservation practice use increased subsurface water flows by an average of only 0.08 inch per year, representing a 4-percent increase, and
- the Northern Plains (5) region, where conservation practice use increased subsurface water flows by an average of only 0.15 inch per year, representing a 15-percent increase— the highest percent increase among all the regions only because both the baseline and no-practice scenario values were so small.

Figure 40. Surface runoff carries soil, chemicals, and organic material off the field and into the drainage system.

Figure 41. Mean of the average annual reduction in surface water runoff due to the use of conservation practices, by region.

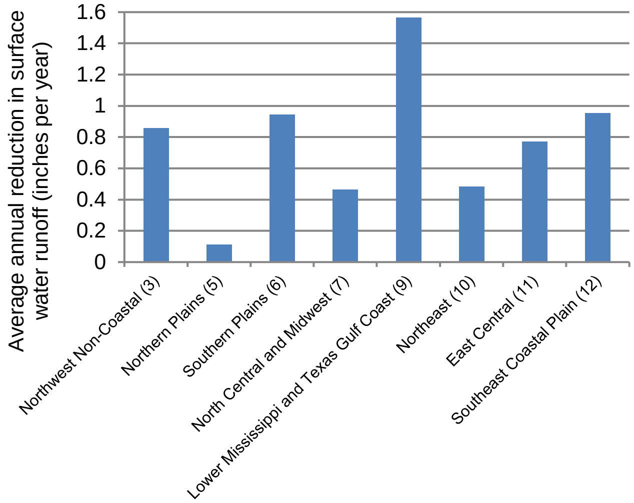


Figure 42. Mean of the average annual gains in subsurface water flows due to the use of conservation practices, by region.

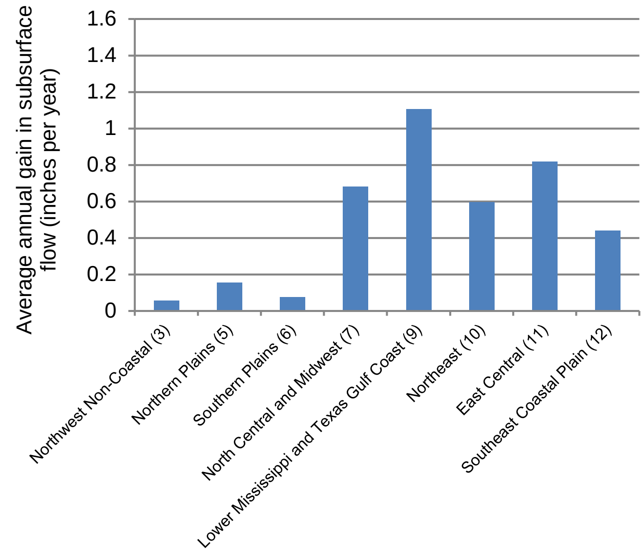


Figure 43. Distributions of average annual reductions in surface water runoff due to the use of conservation practices, representing CEAP sample points in eight production regions.

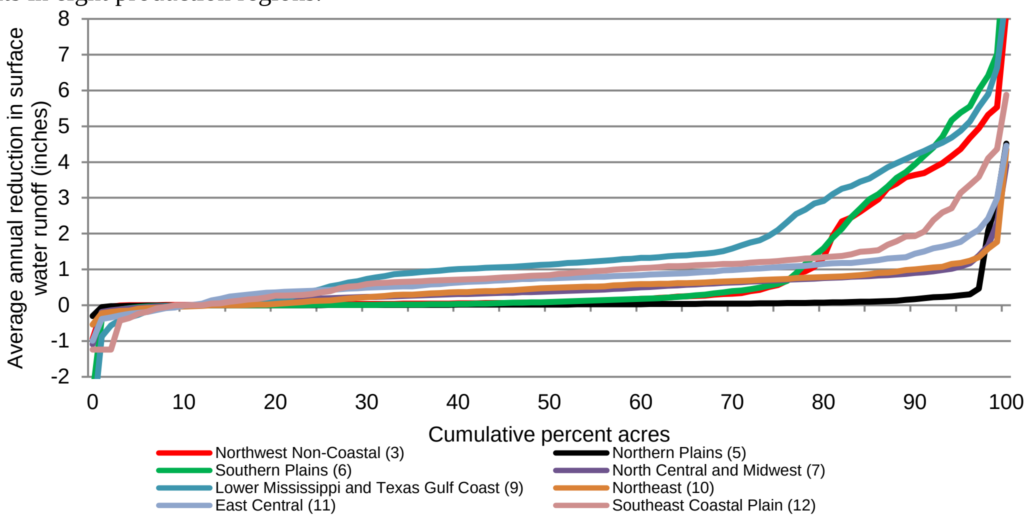
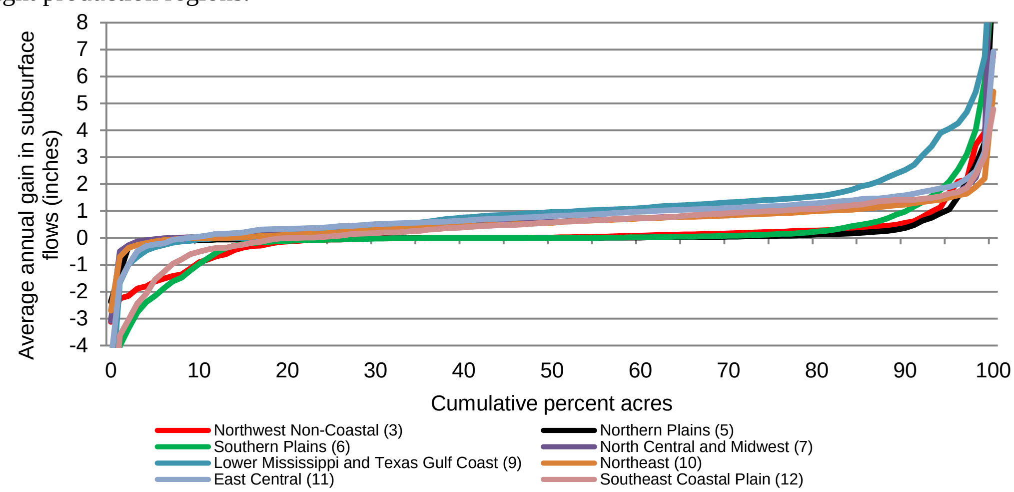


Figure 44. Distributions of average annual gains in subsurface flows due to the use of conservation practices, representing CEAP sample points in eight production regions.



Effects of Conservation Practices on Sheet and Rill Erosion

Model simulations show that the average annual reduction in sheet and rill erosion due to the use of conservation practices averaged 0.485 tons per acre per year over all cultivated cropland acres in the eight regions, reducing the average annual sheet and rill erosion from 1.134 tons per acre per year in the no-practice scenario to 0.649 ton per acre per year in the baseline scenario—a 43-percent reduction (table 22 & fig. 48). Reductions were much higher on HEL acres than on non-HEL acres, averaging 0.860 tons per acre per year on HEL acres compared to 0.332 tons per acre per year on non-HEL acres. The percent reduction, however, was about the same for both HEL and non-HEL acres, averaging 45 percent for HEL acres and 40 percent for non-HEL acres.

The effects of conservation practices varied among the eight regions. The East Central (11) region had the highest average annual reductions—1.23 tons per acre per year averaged over all cultivated cropland acres, representing a 42-percent reduction (table 22 and fig. 45). This region also had the highest percentage of cropped acres with one or more structural practice (fig. 5) and the highest percentage of cropped acres meeting STIR criteria for no-till (fig. 10).

The North Central and Midwest (7) region had the highest percent reduction due to conservation practices—52 percent for HEL acres and 48 percent for non-HEL acres (table 22).

In addition to the East Central (11) region and the North Central and Midwest (7) region, two other regions had large reductions in sheet and rill erosion on the HEL acres due to conservation practices used in those regions—the Lower Mississippi and Texas Gulf Coast (9) region, with an average annual reduction on HEL acres of 2.09 tons per acre per year, and the Southeast Coastal Plain (12) region, with an average annual reduction on HEL acres of 1.73 tons per acre per year. In these two regions, however, HEL acres accounted for only 11-12 percent of the cultivated cropland.

The smallest reductions in sheet and rill erosion due to conservation practices were for cultivated cropland acres in the three westernmost and driest regions—the Northwest Non-Coastal (3) region, the Northern Plains (5) region, and the Southern Plains (6) region (table 22 and figs. 45-47). These three regions had the lowest amount of surface water runoff (fig. 24), and the lowest sheet and rill erosion rates in both the no-practice scenario and the baseline scenario, on average (fig. 27 and table 22).

In terms of the percent reduction, the Northwest Non-Coastal (3) region and the Lower Mississippi and Texas Gulf Coast (9) region had the lowest—23 percent reduction in sheet and rill erosion rates for all cultivated cropland acres due to conservation practices.

Figure 45. Mean of the average annual reduction in sheet and rill erosion due to conservation practices for all cultivated cropland acres, by region.

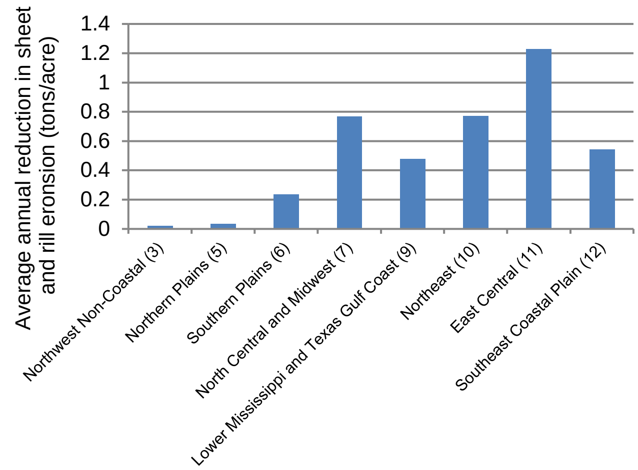


Figure 46. Mean of the average annual reduction in sheet and rill erosion due to conservation practices for HEL acres, by region.

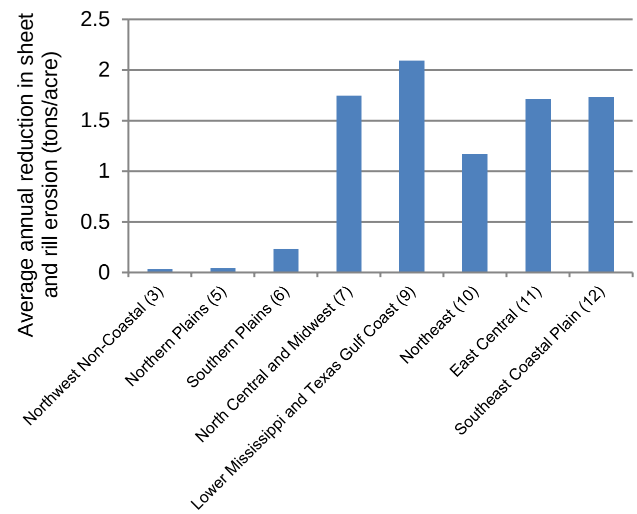


Figure 47. Mean of the average annual reduction in sheet and rill erosion due to conservation practices for non-HEL acres, by region.

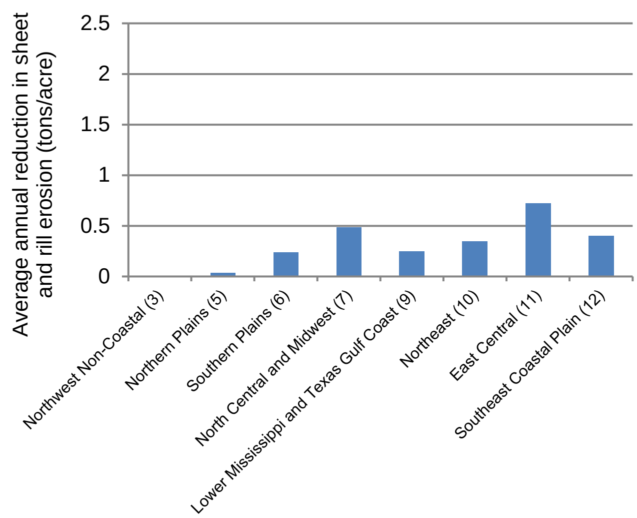


Table 22. Effects of conservation practices on sheet and rill erosion (RUSLE).

	Baseline scenario (tons/acre)	No-practice scenario (tons/acre)	Reduction due to practices (tons/acre)	Percent reduction
		All cultivated cropland acres		
Production region				
Northwest Non-Coastal (3)	0.064	0.084	0.020	23%
Northern Plains (5)	0.051	0.088	0.037	42%
Southern Plains (6)	0.363	0.600	0.237	40%
North Central and Midwest (7)	0.774	1.544	0.770	50%
Lower Mississippi and Texas Gulf Coast (9)	1.638	2.118	0.480	23%
Northeast (10)	1.357	2.128	0.771	36%
East Central (11)	1.716	2.945	1.229	42%
Southeast Coastal Plain (12)	0.932	1.474	0.542	37%
All eight regions	0.649	1.134	0.485	43%
		HEL acres		
Production region				
Northwest Non-Coastal (3)	0.095	0.126	0.031	24%
Northern Plains (5)	0.068	0.110	0.042	38%
Southern Plains (6)	0.374	0.609	0.235	39%
North Central and Midwest (7)	1.645	3.395	1.750	52%
Lower Mississippi and Texas Gulf Coast (9)	4.354	6.444	2.090	32%
Northeast (10)	1.900	3.071	1.171	38%
East Central (11)	2.393	4.105	1.711	42%
Southeast Coastal Plain (12)	3.227	4.961	1.734	35%
All eight regions	1.036	1.896	0.860	45%
		Non-HEL acres		
Production region				
Northwest Non-Coastal (3)	0.029	0.037	0.007	20%
Northern Plains (5)	0.041	0.075	0.034	45%
Southern Plains (6)	0.357	0.595	0.238	40%
North Central and Midwest (7)	0.518	1.001	0.483	48%
Lower Mississippi and Texas Gulf Coast (9)	1.250	1.500	0.250	17%
Northeast (10)	0.782	1.129	0.347	31%
East Central (11)	1.009	1.733	0.724	42%
Southeast Coastal Plain (12)	0.661	1.062	0.401	38%
All eight regions	0.491	0.823	0.332	40%

Source: APEX simulation modeling results based on 2003-06 CEAP survey information on farming practices.

Figure 48. Conservation practices keep the land covered so it is protected from erosion and excessive runoff that may pollute surface and groundwater.

Effects of Conservation Practices on Sediment Loss from Water Erosion

Model simulations indicate that the use of conservation practices has reduced average annual sediment loss from water erosion by 54 percent for cultivated cropland acres in all eight regions, including both treated and untreated acres (table 23). Without conservation practices, the average annual sediment loss for these acres would have been 1.74 tons per acre per year compared to 0.79 ton per acre average for the baseline scenario. The reduction in sediment loss due to the use of conservation practices averaged about 0.95 ton per acre per year.

Reductions in edge-of-field sediment loss due to conservation practices are much higher for HEL acres than for non-HEL acres, although the percent reduction is about the same (table 23). For HEL acres, the average annual reduction was 1.79 tons per acre per year, representing a 56-percent reduction. For non-HEL acres, the average annual reduction was 0.61 ton per acre per year, representing a 53-percent reduction.

The distributions of the average annual estimates of sediment loss in the baseline scenario and the no-practice scenario are contrasted in figure 49. Figure 49 shows that about 25 percent of the acres would have more than 2 tons per acre per year sediment loss without practices, on average, compared to 10 percent with conservation practices.

Reductions in sediment loss due to conservation practices are much higher for some acres than others, reflecting both the level of treatment and the inherent erodibility of the soil. For about half of the cultivated cropland acres in the eight regions, the average annual sediment loss reduction due to practices was less than 0.2 ton per acre per year (fig. 50). In contrast, about 25 percent had average annual reductions in sediment loss greater than 1 ton per acre per year and the top 10 percent had reductions greater than 2.7 tons per acre per year.

For 2 percent of the cultivated cropland acres, sediment loss estimates were higher in the baseline scenario than in the no-practice scenario, resulting in negative reductions due to use of conservation practices (fig. 50). These negative reductions in sediment loss are the result of tradeoffs in benefits of conservation practices previously discussed with respect to figure 3, where a small number of acres had negative reductions in surface water runoff due to use of conservation practices.

Figure 49. Distributions of average annual edge-of-field sediment loss from water erosion for the baseline and no-practice scenarios, all eight regions combined.

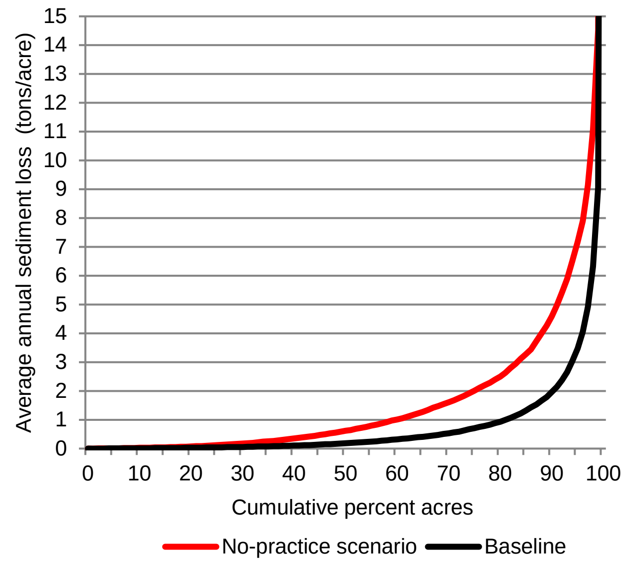


Figure 50. Distribution of average annual reduction in edge-of-field sediment loss from water erosion due to the use of conservation practices, all eight regions combined.

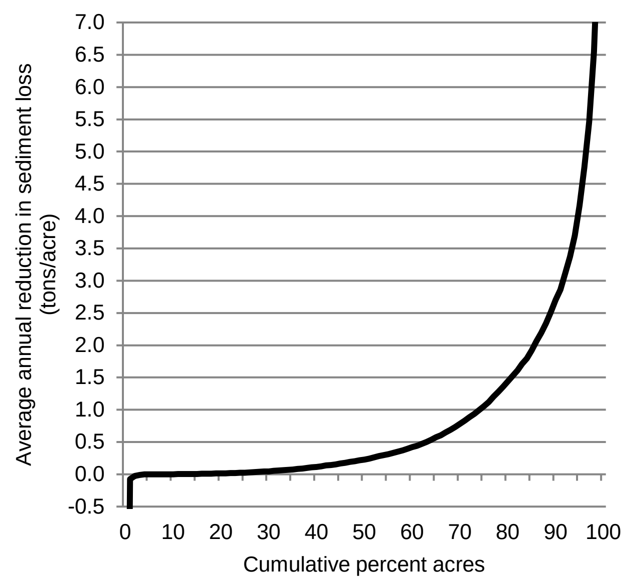


Table 23. Effects of conservation practices on sediment loss from water erosion.

	Baseline scenario (tons/acre)	No-practice scenario (tons/acre)	Reduction due to practices (tons/acre)	Percent reduction
		All cultivated cropland acres		
Production region				
Northwest Non-Coastal (3)	0.901	1.740	0.839	48%
Northern Plains (5)	0.063	0.135	0.072	53%
Southern Plains (6)	0.260	0.917	0.657	72%
North Central and Midwest (7)	0.797	2.044	1.248	61%
Lower Mississippi and Texas Gulf Coast (9)	2.663	3.797	1.135	30%
Northeast (10)	2.360	4.095	1.735	42%
East Central (11)	2.523	5.355	2.832	53%
Southeast Coastal Plain (12)	0.960	1.983	1.024	52%
All eight regions	0.793	1.742	0.949	54%
		HEL acres		
Production region				
Northwest Non-Coastal (3)	1.385	2.496	1.111	45%
Northern Plains (5)	0.089	0.191	0.103	54%
Southern Plains (6)	0.274	1.098	0.824	75%
North Central and Midwest (7)	1.921	4.923	3.002	61%
Lower Mississippi and Texas Gulf Coast (9)	6.500	10.933	4.433	41%
Northeast (10)	3.505	6.280	2.775	44%
East Central (11)	3.675	7.828	4.153	53%
Southeast Coastal Plain (12)	3.503	6.516	3.013	46%
All eight regions	1.399	3.191	1.792	56%
		Non-HEL acres		
Production region				
Northwest Non-Coastal (3)	0.354	0.886	0.532	60%
Northern Plains (5)	0.048	0.103	0.055	53%
Southern Plains (6)	0.253	0.823	0.570	69%
North Central and Midwest (7)	0.467	1.200	0.733	61%
Lower Mississippi and Texas Gulf Coast (9)	2.115	2.779	0.664	24%
Northeast (10)	1.147	1.782	0.635	36%
East Central (11)	1.320	2.771	1.451	52%
Southeast Coastal Plain (12)	0.659	1.448	0.789	54%
All eight regions	0.547	1.152	0.606	53%

Source: APEX simulation modeling results based on 2003-06 CEAP survey information on farming practices.

Conservation practices were most effective in reducing sediment loss from water erosion in the East Central (11) region (table 23 and fig. 51), which also had the largest reductions in sheet and rill erosion (fig. 45). In this region, the mean of the average annual reductions in sediment loss was 2.83 tons per acre per year. Conservation practices reduced average sediment loss from 5.36 tons per acre per year in the no-practice scenario to an average of 2.52 tons per acre per year in the baseline scenario—a 53-percent reduction. The average annual reduction in sediment loss averaged 4.15 tons per acre per year for HEL acres in this region and 1.45 tons per acre for non-HEL acres, representing a 53-percent and a 52-percent reduction, respectively (figs. 52 and 53).

The region with the smallest reductions in sediment loss due to conservation practice use was the Northern Plains (5) region, where the mean of the average annual reductions in sediment loss was only 0.07 ton per acre per year, which nevertheless represented a 53-percent reduction because of the very low sediment loss in both the baseline and the no-practice scenarios.

The remaining regions had mean average annual reductions in sediment loss ranging from 0.66 ton per acre per year for the Southern Plains (6) region to 1.74 tons per acre per year in the Northeast (10) region (table 23 and fig. 51).

In terms of the percent reduction, the Southern Plains (6) region and North Central and Midwest (7) region had the largest—72 percent and 61 percent reduction, respectively, in sediment loss rates for all cultivated cropland acres due to conservation practices. Percent reduction for the Southern Plains (6) region was slightly higher for HEL acres and slightly lower for non-HEL acres. Percent reductions for HEL acres and non-HEL acres in the North Central and Midwest (7) region were the same as for all cropped acres.

The Lower Mississippi and Texas Gulf Coast (9) region had the smallest percent reduction in sediment loss rates due to conservation practices—24 percent for non-HEL acres and 41 percent for HEL acres (table 23).

Figure 54 contrasts the distributions of the average annual reductions for all eight regions. Again, the East Central (11) region stands out as having the most benefit from use of conservation practices. About 62 percent of the cropped acres in this region had reductions in edge-of-field sediment loss of 1 or more ton per acre per year due to conservation practice use. About 45 percent of the cropped acres had reductions of 2 or more tons per acre per year and 22 percent of the cropped acres had reductions of 4 or more tons per acre per year.

In contrast, the Northern Plains (5) region stands out as having the least benefit from the use of conservation practices for control of sediment loss from water erosion, primarily because of the generally low potential for surface water runoff in the region (fig. 24). In this region, 95 percent of the cropped acres had reductions of less than 0.2 tons per acre per year due to the use of conservation practices (fig. 54).

Figure 51. Mean of the average annual reduction in edge-of-field sediment loss from water erosion due to conservation practices for all cultivated cropland acres, by region.

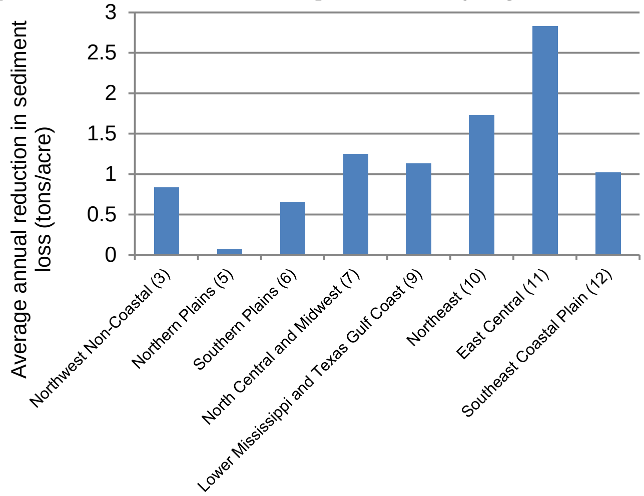


Figure 52. Mean of the average annual reduction in edge-of-field sediment loss from water erosion due to conservation practices for HEL acres, by region.

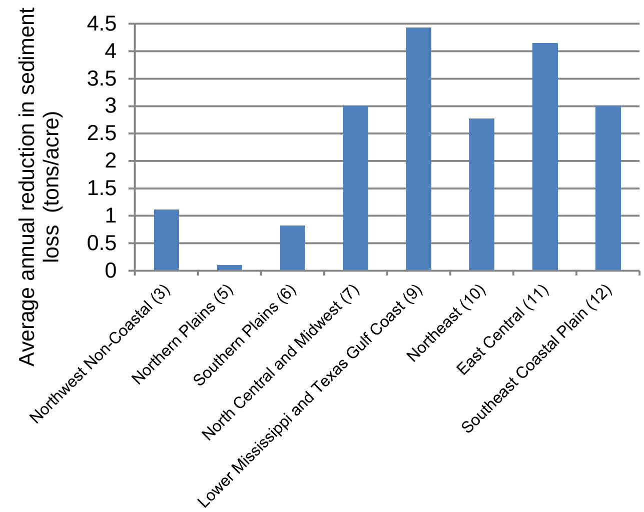


Figure 53. Mean of the average annual reduction in edge-of-field sediment loss from water erosion due to conservation practices for non-HEL acres, by region.

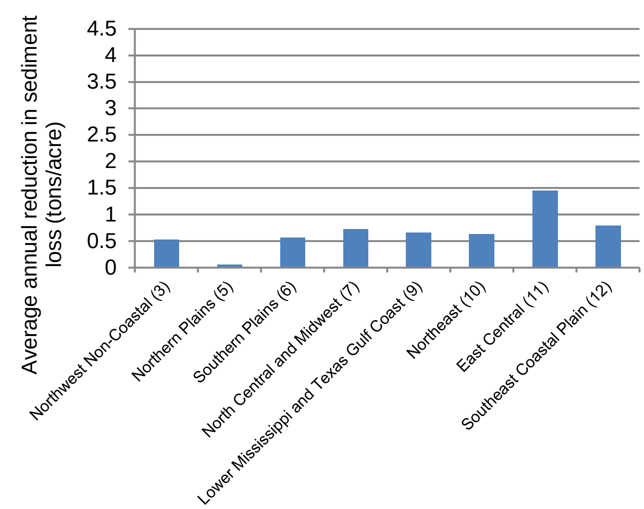
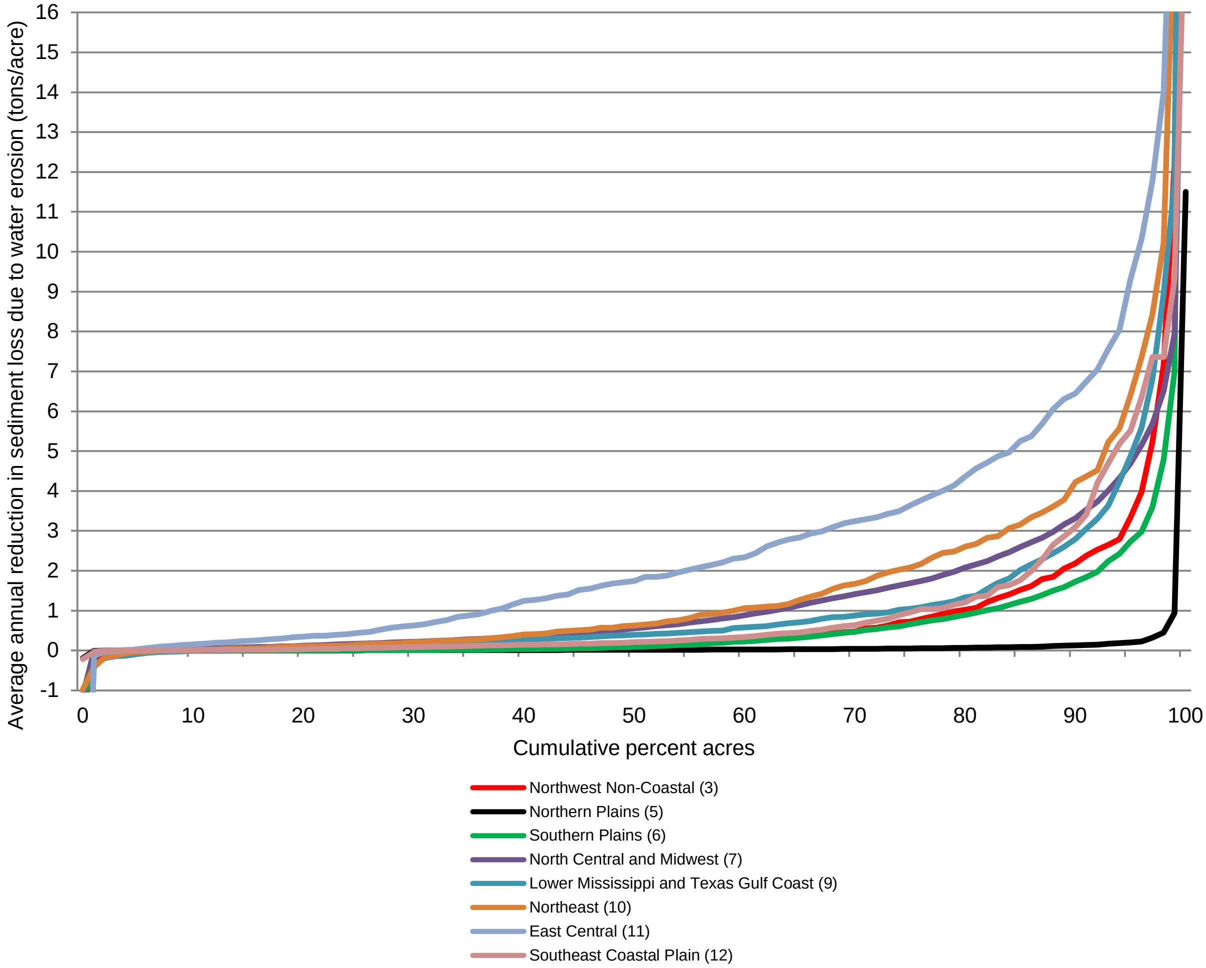


Figure 54. Distributions of average annual reductions in sediment loss from water erosion due to the use of conservation practices, representing CEAP sample points in eight production regions.



The remaining six regions had little or no benefit from the use of conservation practices for over half of the acres but had significant benefits for some acres (fig. 54). Reductions in sediment loss for acres with the highest reductions—those acres that were treated the most for erosion control—ranged to above 5 tons per acre per year for at least some acres in all 6 regions.

To extend the assessment of the effects of conservation practices further, average annual reductions in edge-of-field sediment loss from water erosion were estimated for the four soil runoff potentials and the four levels of water erosion control treatment, presented previously in table 12 for sediment loss in the baseline scenario. Table 24 presents estimates for the no-practice scenario and estimates of reductions in sediment loss due to conservation practices for all eight regions combined.

Sediment loss estimates for the no-practice scenario and reductions in sediment loss consistently increased as the soil runoff potential increased. Overall losses are highest for soils with the highest soil loss potential, and so reductions due to conservation practices are highest for these sample points as well. Mean average annual reductions due to conservation practice use for cultivated cropland acres in all eight regions were (table 24):

- 0.475 ton per acre per year for acres with a “low” soil runoff potential,
- 0.663 ton per acre per year for acres with a “moderate” soil runoff potential,
- 1.455 tons per acre per year for acres with a “moderately high” soil runoff potential, and
- 3.137 tons per acre per year for acres with a “high” soil runoff potential.

Decreasing trends in sediment loss estimates with increasing erosion control treatment levels for the no-practice scenario are not manifested consistently in the matrix, primarily because the model simulation was designed to remove or reverse the effects of conservation practices. Some weak trends can be seen, however, which may be due to the benefits of practices other than for erosion control that may be correlated with the erosion control treatment levels.

Average annual reductions in sediment loss tended to increase as treatment levels increased, but trends within soil runoff potentials were weak and not always consistent.

Percent reductions, however, strongly increased with increasing conservation treatment levels when the "high" and "moderately high" treatment levels are combined. Percent reductions due to conservation practice use for cultivated cropland acres in all eight regions were:

- 33 percent for acres with a "low" conservation treatment level,
- 51 percent for acres with a "moderate" conservation treatment level,
- 77 percent for acres with a "moderately high" conservation treatment level, and
- 70 percent for acres with a "high" conservation treatment level.

Percent reductions among the four soil runoff potentials within each treatment level did not vary much and trends were inconsistent.

The same trends are manifested for model simulation results for each of the eight regions, as shown in tables 25 through 32. In some regions, one or more combinations of soil runoff potential and conservation treatment levels consist of only a few sample points and so the estimates presented may be biased because of very small sample sizes.

Table 24. Breakdown of the effects of conservation practices on edge-of-field sediment loss from water erosion, estimates for 16 combinations of four soil runoff potentials and four conservation treatment levels for erosion control, cultivated cropland acres in all eight regions combined.

	Conservation treatment levels for water erosion control				
Soil runoff potential	Low	Moderate	Moderately high	High	All
Percent of cropped acres					
Low	7.1%	23.4%	4.9%	18.1%	53.5%
Moderate	3.3%	7.9%	1.8%	5.3%	18.3%
Moderately high	4.3%	8.2%	3.4%	2.6%	18.5%
High	2.4%	4.1%	3.0%	0.2%	9.7%
All	17.1%	43.6%	13.1%	26.2%	100.0%
Sediment loss estimates without conservation practices (no-practice scenario, average annual tons/acre)					
Low	1.058	0.738	1.014	0.748	0.810
Moderate	1.546	1.662	1.730	1.105	1.486
Moderately high	3.251	2.390	2.994	1.849	2.626
High	6.177	5.922	4.935	6.165	5.684
All	2.412	1.709	2.518	0.973	1.742
Reduction in sediment loss due to conservation practices (average annual tons/acre)					
Low	0.459	0.379	0.721	0.538	0.475
Moderate	0.432	0.645	1.199	0.649	0.663
Moderately high	1.085	1.316	2.370	1.315	1.455
High	1.735	3.226	3.914	6.068	3.137
All	0.789	0.874	1.941	0.681	0.949
Percent reduction in sediment loss due to conservation practices					
Low	43%	51%	71%	72%	59%
Moderate	28%	39%	69%	59%	45%
Moderately high	33%	55%	79%	71%	55%
High	28%	54%	79%	98%	55%
All	33%	51%	77%	70%	54%

Table 25. Breakdown of the effects of conservation practices on edge-of-field sediment loss from water erosion, estimates for 16 combinations of four soil runoff potentials and four conservation treatment levels for erosion control, cultivated cropland acres in the Northwest Non-Coastal (3) region.

	Conservation treatment levels for water erosion control				
Soil runoff potential	Low	Moderate	Moderately high	High	All
Percent of cropped acres					
Low	8%	22%	5%	5%	40%
Moderate	1%	1%	<1%	0%	2%
Moderately high	12%	11%	2%	1%	26%
High	12%	14%	6%	<1%	32%
All	33%	47%	14%	6%	100%
Sediment loss estimates without conservation practices (no-practice scenario, average annual tons/acre)					
Low	0.969	0.599	0.420	0.875	0.687
Moderate	1.803	0.881	0.150	NA	1.215
Moderately high	2.404	1.326	0.380	0.866	1.720
High	3.984	3.316	1.039	1.219	3.106
All	2.601	1.545	0.694	0.892	1.740
Reduction in sediment loss due to conservation practices (average annual tons/acre)					
Low	0.627	0.430	0.313	0.818	0.503
Moderate	1.371	0.702	0.005	NA	0.941
Moderately high	1.280	0.888	0.312	0.546	1.005
High	0.993	1.485	0.555	1.190	1.117
All	1.014	0.842	0.422	0.803	0.839
Percent reduction in sediment loss due to conservation practices					
Low	65%	72%	74%	93%	73%
Moderate	76%	80%	4%	NA	77%
Moderately high	53%	67%	82%	63%	58%
High	25%	45%	53%	98%	36%
All	39%	55%	61%	90%	48%

Table 26. Breakdown of the effects of conservation practices on edge-of-field sediment loss from water erosion, estimates for 16 combinations of four soil runoff potentials and four conservation treatment levels for erosion control, cultivated cropland acres in the Northern Plains (5) region.

	Conservation treatment levels for water erosion control				
Soil runoff potential	Low	Moderate	Moderately high	High	All
Percent of cropped acres					
Low	5%	26%	3%	16%	50%
Moderate	5%	11%	1%	2%	20%
Moderately high	7%	13%	1%	2%	24%
High	3%	4%	1%	0%	7%
All	20%	54%	6%	20%	100%
Sediment loss estimates without conservation practices (no-practice scenario, average annual tons/acre)					
Low	0.058	0.072	0.102	0.071	0.072
Moderate	0.109	0.145	0.121	0.088	0.128
Moderately high	0.162	0.122	0.154	0.109	0.135
High	0.518	0.727	0.364	NA	0.621
All	0.168	0.145	0.142	0.076	0.135
Reduction in sediment loss due to conservation practices (average annual tons/acre)					
Low	0.009	0.036	0.072	0.054	0.041
Moderate	0.019	0.071	0.078	0.054	0.056
Moderately high	0.061	0.061	0.089	0.067	0.063
High	0.201	0.523	0.238	NA	0.382
All	0.055	0.083	0.092	0.055	0.072
Percent reduction in sediment loss due to conservation practices					
Low	15%	49%	70%	76%	57%
Moderate	17%	49%	64%	61%	44%
Moderately high	38%	50%	58%	61%	47%
High	39%	72%	65%	NA	61%
All	33%	57%	65%	72%	53%

Table 27. Breakdown of the effects of conservation practices on edge-of-field sediment loss from water erosion, estimates for 16 combinations of four soil runoff potentials and four conservation treatment levels for erosion control, cultivated cropland acres in the Southern Plains (6) region.

	Conservation treatment levels for water erosion control				
Soil runoff potential	Low	Moderate	Moderately high	High	All
Percent of cropped acres					
Low	16%	38%	5%	15%	75%
Moderate	4%	5%	<1%	2%	11%
Moderately high	3%	6%	2%	1%	12%
High	<1%	1%	1%	0%	2%
All	24%	50%	8%	18%	100%
Sediment loss estimates without conservation practices (no-practice scenario, average annual tons/acre)					
Low	0.942	0.468	0.386	0.765	0.626
Moderate	1.317	1.040	0.550	0.962	1.114
Moderately high	2.725	1.732	2.218	1.151	2.043
High	6.662	3.454	2.107	NA	3.839
All	1.349	0.743	0.949	0.801	0.917
Reduction in sediment loss due to conservation practices (average annual tons/acre)					
Low	0.662	0.361	0.324	0.687	0.490
Moderate	0.494	0.656	0.445	0.836	0.618
Moderately high	1.407	1.113	1.836	1.005	1.306
High	4.799	3.066	1.840	NA	3.150
All	0.810	0.541	0.794	0.715	0.657
Percent reduction in sediment loss due to conservation practices					
Low	70%	77%	84%	90%	78%
Moderate	37%	63%	81%	87%	55%
Moderately high	52%	64%	83%	87%	64%
High	72%	89%	87%	NA	82%
All	60%	73%	84%	89%	72%

Table 28. Breakdown of the effects of conservation practices on edge-of-field sediment loss from water erosion, estimates for 16 combinations of four soil runoff potentials and four conservation treatment levels for erosion control, cultivated cropland acres in the North Central and Midwest (7) region.

	Conservation treatment levels for water erosion control				
Soil runoff potential	Low	Moderate	Moderately high	High	All
Percent of cropped acres					
Low	3%	13%	6%	26%	48%
Moderate	2%	5%	3%	8%	18%
Moderately high	3%	8%	6%	5%	21%
High	2%	5%	6%	<1%	13%
All	10%	31%	20%	39%	100%
Sediment loss estimates without conservation practices (no-practice scenario, average annual tons/acre)					
Low	0.689	0.731	1.217	0.823	0.837
Moderate	1.765	1.421	2.041	1.056	1.383
Moderately high	3.495	2.713	3.153	2.045	2.799
High	6.518	6.655	5.399	6.401	6.084
All	3.010	2.291	3.075	1.081	2.045
Reduction in sediment loss due to conservation practices (average annual tons/acre)					
Low	0.191	0.362	0.855	0.577	0.527
Moderate	0.569	0.744	1.564	0.722	0.848
Moderately high	0.882	1.480	2.487	1.482	1.674
High	1.821	3.632	4.251	6.304	3.705
All	0.825	1.229	2.386	0.781	1.248
Percent reduction in sediment loss due to conservation practices					
Low	28%	49%	70%	70%	63%
Moderate	32%	52%	77%	68%	61%
Moderately high	25%	55%	79%	72%	60%
High	28%	55%	79%	98%	61%
All	27%	54%	78%	72%	61%

Table 29. Breakdown of the effects of conservation practices on edge-of-field sediment loss from water erosion, estimates for 16 combinations of four soil runoff potentials and four conservation treatment levels for erosion control, cultivated cropland acres in the Lower Mississippi and Texas Gulf Coast (9) region.

	Conservation treatment levels for water erosion control				
Soil runoff potential	Low	Moderate	Moderately high	High	All
Percent of cropped acres					
Low	5%	18%	3%	9%	35%
Moderate	6%	30%	2%	14%	53%
Moderately high	3%	5%	1%	1%	11%
High	1%	1%	<1%	0%	2%
All	15%	54%	6%	25%	100%
Sediment loss estimates without conservation practices (no-practice scenario, average annual tons/acre)					
Low	5.206	3.241	1.882	1.495	2.954
Moderate	3.512	2.820	2.122	1.616	2.545
Moderately high	11.199	10.223	6.880	3.462	9.507
High	23.435	24.636	19.053	NA	23.355
All	6.704	4.007	3.216	1.671	3.797
Reduction in sediment loss due to conservation practices (average annual tons/acre)					
Low	0.516	0.837	0.630	0.603	0.715
Moderate	0.563	0.631	0.385	0.488	0.573
Moderately high	3.339	4.838	4.621	1.900	3.965
High	4.690	10.776	16.351	NA	9.126
All	1.365	1.260	1.598	0.607	1.135
Percent reduction in sediment loss due to conservation practices					
Low	10%	26%	33%	40%	24%
Moderate	16%	22%	18%	30%	23%
Moderately high	30%	47%	67%	55%	42%
High	20%	44%	86%	NA	39%
All	20%	31%	50%	36%	30%

Table 30. Breakdown of the effects of conservation practices on edge-of-field sediment loss from water erosion, estimates for 16 combinations of four soil runoff potentials and four conservation treatment levels for erosion control, cultivated cropland acres in the Northeast (10) region.

	Conservation treatment levels for water erosion control				
Soil runoff potential	Low	Moderate	Moderately high	High	All
Percent of cropped acres					
Low	8%	19%	3%	4%	34%
Moderate	4%	5%	3%	1%	12%
Moderately high	12%	11%	3%	1%	26%
High	10%	13%	4%	<1%	28%
All	33%	49%	12%	6%	100%
Sediment loss estimates without conservation practices (no-practice scenario, average annual tons/acre)					
Low	2.159	1.144	0.946	0.717	1.302
Moderate	3.214	1.970	1.804	0.788	2.232
Moderately high	6.342	2.519	3.456	3.118	4.346
High	9.177	7.754	6.275	3.645	8.047
All	5.951	3.370	3.250	1.227	4.095
Reduction in sediment loss due to conservation practices (average annual tons/acre)					
Low	0.383	0.438	0.714	0.542	0.466
Moderate	0.659	1.017	1.208	0.463	0.924
Moderately high	2.684	1.162	2.981	2.905	2.080
High	1.945	3.723	5.570	3.516	3.300
All	1.714	1.572	2.747	1.030	1.735
Percent reduction in sediment loss due to conservation practices					
Low	18%	38%	76%	75%	36%
Moderate	21%	52%	67%	59%	41%
Moderately high	42%	46%	86%	93%	48%
High	21%	48%	89%	96%	41%
All	29%	47%	85%	84%	42%

Table 31. Breakdown of the effects of conservation practices on sediment loss, estimates for 16 combinations of four soil runoff potentials and four conservation treatment levels for erosion control, cultivated cropland acres in the East Central (11) region.

		Conservation treatment levels for water erosion control				
	Soil runoff potential	Low	Moderate	Moderately high	High	All
Percent of cropped acres						
	Low	2%	17%	4%	12%	35%
	Moderate	1%	9%	3%	2%	15%
	Moderately high	5%	14%	6%	3%	28%
	High	6%	11%	4%	<1%	21%
	All	14%	52%	17%	17%	100%
Sediment loss estimates without conservation practices (no-practice scenario, average annual tons/acre)						
	Low	2.782	1.885	2.327	1.848	1.974
	Moderate	4.288	4.003	1.970	1.882	3.333
	Moderately high	6.665	6.022	6.122	3.051	5.833
	High	14.337	12.043	7.045	14.260	11.793
	All	9.401	5.533	4.703	2.159	5.355
Reduction in sediment loss due to conservation practices (average annual tons/acre)						
	Low	0.458	0.997	1.732	1.191	1.124
	Moderate	0.902	2.042	1.527	1.435	1.780
	Moderately high	1.731	3.485	4.913	2.213	3.326
	High	3.932	6.669	5.964	13.981	5.772
	All	2.485	3.059	3.804	1.503	2.832
Percent reduction in sediment loss due to conservation practices						
	Low	16%	53%	74%	64%	57%
	Moderate	21%	51%	77%	76%	53%
	Moderately high	26%	58%	80%	73%	57%
	High	27%	55%	85%	98%	49%
	All	26%	55%	81%	70%	53%

Table 32. Breakdown of the effects of conservation practices on sediment loss, estimates for 16 combinations of four soil runoff potentials and four conservation treatment levels for erosion control, cultivated cropland acres in the Southeast Coastal Plain (12) region.

		Conservation treatment levels for water erosion control				
	Soil runoff potential	Low	Moderate	Moderately high	High	All
Percent of cropped acres						
	Low	15%	46%	8%	8%	78%
	Moderate	3%	9%	1%	1%	14%
	Moderately high	2%	4%	<1%	<1%	7%
	High	1%	1%	<1%	0%	1%
	All	21%	60%	9%	10%	100%
Sediment loss estimates without conservation practices (no-practice scenario, average annual tons/acre)						
	Low	0.922	1.300	2.151	0.929	1.280
	Moderate	2.462	3.361	2.165	0.883	2.930
	Moderately high	10.475	5.809	7.537	4.346	7.486
	High	2.386	8.900	4.689	NA	5.082
	All	2.316	1.949	2.403	1.078	1.983
Reduction in sediment loss due to conservation practices (average annual tons/acre)						
	Low	0.267	0.717	1.755	0.704	0.742
	Moderate	0.891	1.673	1.976	0.617	1.429
	Moderately high	1.745	3.600	6.027	1.377	2.914
	High	0.716	7.315	3.971	NA	3.565
	All	0.549	1.091	1.971	0.725	1.024
Percent reduction in sediment loss due to conservation practices						
	Low	29%	55%	82%	76%	58%
	Moderate	36%	50%	91%	70%	49%
	Moderately high	17%	62%	80%	32%	39%
	High	30%	82%	85%	NA	70%
	All	24%	56%	82%	67%	52%

Appendix A: Adjustment of CEAP Sample Weights for the 2003-06 CEAP Sample for Use with the 12 New CEAP Production Regions

The first CEAP national assessment was based on a subset of NRI sample points from the 2003 NRI.[12] The 2001, 2002, and 2003 Annual NRI surveys were used to draw the sample.[13] The sample is statistically representative of cultivated cropland acres for the year 2003. Statistical sample weights were originally derived for each CEAP sample point so as to approximate acres reported in the 2003 NRI for similar cropping systems when aggregated to the 4-digit HUC level.

These original CEAP sample acreage weights, however, distort the cultivated cropland acreage estimates when the sample points are aggregated to geographic areas other than the 4-digit HUC. It was thus necessary to adjust the sample weights for reporting cultivated cropland acres by the new CEAP production regions.

Original Derivation of Cropping Systems

Cropping systems were originally derived based on the 2003 NRI database for cultivated cropland, as described in the CEAP documentation report "CEAP and NRI Cropping Systems 2008 Documentation."(A cropping system represents a suite of crops that is typically grown in the same field over a period of a few years.) This set of data (BROAD03=1) included 96,661 points representing 309,866,800 cultivated cropland acres. The five year crop sequence from 1999 through 2003 was used to derive the NRI cropping systems. Second crops (NRI variable name "scdcrpxx") were included when reported. NRI crop groups were simplified somewhat prior to developing cropping systems to help reduce the number of possible crop combinations. Oats was combined with "other close grown crops;" tobacco was combined with vegetables; summer fallow and idle cropland were combined; the three types of NRI hay were combined into one group; and the three types of NRI pasture were combined into one group.

A total of 62 cropping systems were derived as shown in Table A1. Except for single-crop systems, cropping systems were derived based on the dominant sets of crop sequences. The entire collection of NRI cultivated cropland points was used without consideration for regional dominance. Each of the single-crop systems (systems 2 through 23) was included regardless of how many samples were in the set to provide perspective on the frequency at which "continuous cropping" was present in the NRI. The simplest cropping systems that were mutually exclusive were identified first—through cropping system number 35. Subsequent cropping systems are not mutually exclusive as they depend on the order of operation. For example, cropping systems 40 and 41—rice with other crops—include a small number of points with hay. And, consequently, the following 6 hay systems (43-48) do not include any rice, nor do any of the remaining cropping systems. Similarly, cropping systems numbered above 50 do not include any hay. And so on. The order of operations was determined so as to preserve cropping systems that are important either for data analysis or for other uses. Some cropping systems consist of only a few points and represent less than 1 percent of the cultivated cropland acreage. These were retained to facilitate the derivation of the more aggregated primary cropping systems for use in reporting.

The last cropping system—number 100, at the bottom of the table—consists of 16 2003 NRI sample points that were either aquaculture or non-cultivated crops for all 5 years. This tiny set represents only 36,800 acres. These acres were excluded from the CEAP sample domain. Also shown in Table A1 are four other NRI cropping systems without representation in the CEAP samples—systems 20-23. These are combinations of either fallow and idle with no other crops, with hay only, with pasture only, or with hay and pasture only. The presence of either fallow or idle qualifies the sample as cultivated cropland according to the NRI land use classification rules. Since all the final CEAP samples include at least one close grown or row crop (with the exception of 43 samples with continuous annual hay which is typically a small grain hay), these systems are not represented by CEAP samples. This set (system 100) represents about 5 million acres. These acres were also excluded from the CEAP sample domain prior to derivation of the original CEAP sample weights.

Cropping systems were also derived originally for each CEAP sample point. The rules used for the 2003 NRI sample points were applied to the crops reported for each sample point in the CEAP survey. The number of CEAP sample points corresponding to the original NRI cropping systems is also shown in table A1.

The NRI-CEAP Cropland Survey reported 144 different specific crops grown at 18,691 final sample points. Specific crops were often a combination of crop species and crop use. For example, corn for grain and corn for silage and corn for seed were reported as separate crops in the survey database. These 144 specific crops were aggregated into 20 CEAP crop groups, shown in table A2, to correspond to the NRI crop groups. The crop groups used for NRI crop reporting are also shown in table A2.

While the majority of samples consist of a single crop for each of the three years, it is common to have 2 crops per year. In a few cases, more than 2 crops per year occur. The maximum number of crops reported per year ranged from 3 in 2005 to 5 in 2003 and 2004. Multiple harvests within a year were often reported as separate crops as well. In most cases, samples with 3 or more crops reported per year were instances of split fields, which were simplified by dropping the crops in the part of the field that did not correspond to the NRI cropping history.

[12] See "United States Department of Agriculture, Natural Resources Conservation Service. 2007.
2003 National Resources Inventory. http://www.nrcs.usda.gov/technical/nri."

[13] Information about the CEAP sample design is in "NRI-CEAP Cropland Survey Design and Statistical Documentation," available at http://www.nrcs.usda.gov/technical/nri/ceap.

The crop sequence for each CEAP sample point was converted to the simpler representation in terms of the 20 CEAP crop groups shown in table A2. Typical crop sequences look like the following:

	Year 1	Year 2	Year 3
Sample point A	CN_ _ _	SB_ _ _	CN_ _ _
Sample point B	CN_WH_ _	SB_WH _ _	CN_WH_ _
Sample point C	VT_VT_VT _	VT_VT_VT _	VT_VT_VT _
Sample point D	WH_HY_ _	HY_HY_ _	VT_SB_CG _
Sample point E	_SG_ _	FW_ _ _	_ _CT _

Sample E represents the case where crops were reported for a split field and subsequently edited by dropping some of the crops. Re-plantings were generally edited in the same manner.

Adjustment of acreage weights to represent the 12 new CEAP production regions

The original sample weights used for reporting 2003-06 CEAP findings in the first national assessment reports were adjusted so that, when aggregating over CEAP sample points to obtain estimates for CEAP production regions, the acreage estimates would correspond to the acreage estimates derived from the full 2003 NRI set of points for a set of major cropping systems within each production region.

The first step in this process was to define the "major" cropping systems—cropping systems suitable for reporting—within each of the 12 CEAP production regions (table A3). The original 62 cropping systems for the 2003 NRI and for the 2003-06 CEAP sample, as described above and listed in table A1, were retained without modification or adjustment. These were combined within each production region so that each major cropping system would have sufficient sample size to allow estimates to be reported. These major cropping systems by production region were derived both for the 2003 NRI points and the 2003-06 CEAP sample points using the same rules, and are presented in table A3.

For each production region and major cropping system, the sum of the original CEAP sample weights is compared to the 2003 NRI estimate of cultivated cropland acres in table A3. The ratio of the 2003 NRI acres to the sum of the original CEAP weights provides a multiplier which, when multiplied times the original CEAP sample weights at each sample point produces a set of adjusted weights that can be used to accurately aggregate CEAP sample results to the production region level for reporting.

Thus, aggregating over the CEAP sample point weights within each production region reproduces the estimates of cultivated cropland acreage that correspond to estimates from the full 2003 NRI, as shown in the following table.

PR ID	Number of 2003 NRI points	2003 cultivated cropland acres	Number of 2003-06 CEAP sample points*	Sum of adjusted CEAP sample weights
1	563	1,214,000	158	1,214,000
2	1,125	3,440,500	111	3,440,500
3	4,560	12,315,000	890	12,315,000
4	1,208	2,432,200	190	2,432,200
5	11,255	47,688,900	1,518	47,688,900
6	13,806	63,829,400	2,615	63,829,400
7	42,114	117,423,200	8,065	117,423,200
8	1,631	6,431,200	232	6,431,200
9	6,940	21,162,500	1,820	21,162,500
10	3,430	6,547,500	888	6,547,500
11	3,323	8,723,200	915	8,723,200
12	5,080	13,502,000	1,289	13,502,000
All 12 regions	95,035	304,709,600	18,691	304,709,600

* Includes 368 CEAP sample points in the "West" region.

As indicated earlier in this report, the CEAP sample points from the original "West" region—368 sample points—could not be used to summarize findings by the CEAP production regions because the full set of APEX modeling results were not available. Thus, the sum of the adjusted CEAP sample weights understates the cultivated cropland acres in four production regions (highlighted in yellow in the table below), as shown by comparing the table below to the table above.

Production region	Number of 2003-06 CEAP sample points*	Sum of adjusted CEAP sample weights
Northwest Coastal (1)	158	1,214,000
California Coastal (2)	0	0
Northwest Non-Coastal (3)	817	11,477,012
Southwest Non-Coastal (4)	15	155,242
Northern Plains (5)	1,518	47,688,900
Southern Plains (6)	2,606	63,563,684
North Central and Midwest (7)	8,065	117,423,200
South Central (8)	232	6,431,200
Lower Mississippi and Texas Gulf Coast (9)	1,820	21,162,500
Northeast (10)	888	6,547,500
East Central (11)	915	8,723,200
Southeast Coastal Plain (12)	1,289	13,502,000
All 12 regions	18,323	297,888,439

* Excludes 368 CEAP sample points in the "West" region that could not be used in the national assessments because the full set of APEX modeling results were not available.

Results for two of these production regions—the California Coastal region (2) and the Southwest Non-Coastal region (4)—were not included in this report because neither region had enough 2003-06 sample points to support a regional assessment. When the remaining 2 regions that did not have sufficient sample size are dropped from the table—the Northwest Coastal region (1) and the South Central region (8)—the regional and total estimates of cultivated cropland acres match those presented in table 1.

Table A1. Original cropping systems based on rules derived using the 2003 NRI and then applied to the 2003-06 CEAP sample points.

System number	Cropping system name (nricropsys5)	No. of 2003 NRI cultivated cropland points	2003 NRI acres	No. of CEAP sample points*
1	CN-SB only, w/wout FWID	33,797	94,516,400	7,122
2	corn only, w/wout FWID	3,446	9,668,600	1,196
3	soybean only, w/wout FWID	2,590	6,656,400	949
4	cotton only, w/wout FWID	2,432	8,747,200	715
5	sorghum only, w/wout FWID	538	2,239,400	68
6	wheat only, w/wout FWID	7,894	38,194,500	1,774
7	rice only, w/wout FWID	739	2,228,800	179
8	veg/tobacco only, w/wout FWID	666	1,363,600	90
9	peanuts only, w/wout FWID	96	346,100	16
10	sunflower only, w/wout FWID	10	23,800	3
11	sugar beet only, w/wout FWID	7	15,200	4
12	potato only, w/wout FWID	31	54,700	5
13	NRI other row only, w/wout FWID	364	1,216,300	70
14	barley only, w/wout FWID	316	996,400	87
15	NRI other close grown only, w/wout FWID	825	2,925,200	164
20	pasture only, with FWID	60	200,300	0
21	hay only, with FWID	176	662,500	0
22	pasture and hay only, with FWID	4	8,800	0
23	fallow and/or idle only	1,370	4,248,800	0
27	annual hay only, w/wout FWID (CEAP only)	0	0	43
30	CN-SB-WT only	5,856	15,613,100	1,005
31	SG-WT only	1,611	9,059,800	221
32	SB-WT only	2,158	6,889,600	617
33	CT-PN only	387	1,451,500	110
34	SB-CT only	558	1,742,200	116
35	CN-CT only	412	1,490,000	149
40	RI-SB w/wout other crops	1,428	4,853,600	293
41	RI w/wout other crops, no SB	108	379,200	31
43	HAY/PAST-CN-SB, w/wout other crops	2,794	7,081,000	78
44	HAY/PAST-CN-CLOSE, w/wout other crops (no SB)	1,255	3,364,300	109
45	HAY/PAST-CN, w/wout other crops (no SB, close)	2,536	7,180,600	362
46	HAY/PAST-SB, w/wout other crops (no CN)	960	2,525,700	90
47	HAY/PAST-CLOSE, w/wout other crops (no CN, SB)	2,200	7,306,600	308
48	HAY/PAST w/wout other crops (no CN-SB-close)	529	1,678,500	38
52	veg/tobacco and close grown only	570	2,038,700	212
53	veg/tobacco w/wout other row crops (some close)	2,345	6,727,400	318
60	mix of remaining close grown crops, no row	2,939	12,159,600	302
61	CN and close grown crops	1,862	7,239,600	496
62	SB and close grown crops	333	1,063,100	78
63	CN-SB and close grown crops	612	1,632,600	134
64	CT and close grown crops	602	2,393,700	105
65	SG and close grown crops	109	566,800	11
66	SF and close grown crops	1,267	4,951,500	120
67	PO and close grown crops	559	982,000	89
68	SU and close grown crops	229	616,800	61
69	PN and close grown crops	55	197,700	11
70	OTHROW and close grown crops	90	385,900	23
71	CT-PN and close grown crops	100	380,000	22
72	CT-SB and close grown crops	155	433,300	41
73	CT-CN and close grown crops	98	336,900	10
80	PO and other row crops (some close)	518	1,292,600	47
81	SU and other row crops (no PO)(some close)	671	2,702,500	64
82	SF and other row crops (no PO,SU)(some close)	1,075	4,039,700	65

Table A1. --**continued**

System number	Cropping system name (nricropsys5)	No. of 2003 NRI cultivated cropland points	2003 NRI acres	No. of CEAP sample points*
83	remaining CT-SG crop mixes (row and close)	868	3,618,600	85
84	remaining CT-PN-row and other crops	263	767,200	34
85	remaining CT-CN-row and other crops	416	1,202,400	41
86	remaining CN-SB-row and other crops	875	2,663,000	45
87	remaining CN-SG crop mixes (row and close)	556	2,364,200	75
88	remaining SB-SG crop mixes (row and close)	914	2,871,000	183
89	remaining NRI OTHROW-row and other crops	190	574,400	8
90	remaining PN-row and other crops	221	700,100	30
100	NRI crops are: 171, 5, 6, 2, 400, 900, or missing	16	36,800	0
	totals	96,661	309,866,800	18,722

Source: Table reprinted from "CEAP and NRI Cropping Systems 2008 Documentation."
* Included are 31 points that were later dropped from the 2003-06 final sample because of inadequate survey data to run the APEX model.

The following abbreviations are used in this table:

CN—corn
SB—soybean
FWID—fallow or idle
SG—sorghum
CT—cotton
PN—peanuts
RI—rice
PAST—pasture
CLOSE—any close grown crops, such as wheat, barley, oats, or grass seed
SU—sugar beets
SF—sunflower
OTHERROW—NRI "other row crop" category
PO—potato

Table A2. Crop groups used to define cropping systems (CEAP crops listed are those reported in the CEAP surveys).

Crop groups	Crop Group Abbrevia-tion	CEAP crop code	CEAP crop	NRI crop code	NRI crop
Row Crops					
Corn	CN	191	Corn, All	11	Corn
	CN	218	Corn, dry fodder, hogged	11	Corn
	CN	6	Corn, grain	11	Corn
	CN	38	Corn, seed	11	Corn
	CN	5	Corn, silage	11	Corn
	CN	7	Corn, white	11	Corn
	CN	19	Popcorn	11	Corn
	CN	2110	Sweet corn, fresh	11	Corn
	CN	4110	Sweet corn, processing	11	Corn
	CN	246	Sweet corn for seed	11	Corn
Sorghum	SG	192	Sorghum, All	12	Sorghum
	SG	25	Sorghum, grain	12	Sorghum
	SG	24	Sorghum, silage	12	Sorghum
Soybean	SB	26	Soybeans	13	Soybeans
Cotton	CT	282	Cotton, Pima	14	Cotton
	CT	281	Cotton, Upland	14	Cotton
Peanuts	PN	16	Peanuts	15	Peanuts
Sugar beets	SU	28	Sugar beets for sugar	17	Sugar beets
Potatoes	PO	20	Potatoes	18	Potatoes
Sugarcane	SC	29	Sugarcane for sugar	20	Other Row Crops
Sunflower	OS	148	Sunflower seed, non-oil	21	Sunflower
	OS	30	Sunflower seed, oil	21	Sunflower
Other row crops	OR	160	Guar	20	Other Row Crops
	OR	181	Kenaf	20	Other Row Crops
	OR	98	Safflower	20	Other Row Crops
Beans and Peas	BP	3	Beans, dry edible	19	Vegetables
	BP	2122	Green peas, Fresh	19	Vegetables
	BP	4122	Green peas, Processing	19	Vegetables
	BP	169	Lentils	19	Vegetables
	BP	268	Lima beans, dry	19	Vegetables
	BP	2115	Lima beans, fresh	19	Vegetables
	BP	4115	Lima beans, processing	19	Vegetables
	BP	197	Mung beans	19	Vegetables
	BP	123	Peas, all other	19	Vegetables
	BP	200	Peas, Austrian winter	19	Vegetables
	BP	124	Peas, black eye	19	Vegetables
	BP	125	Peas, cowpeas	19	Vegetables
	BP	17	Peas, dry edible	19	Vegetables
	BP	4131	Snap bean, processing	19	Vegetables
	BP	2131	Snap beans, fresh	19	Vegetables
	BP	243	Southern peas, cowpeas, etc	19	Vegetables

Table A2. –continued.

Crop groups	Crop Group Abbrevia-tion	CEAP crop code	CEAP crop	NRI crop code	NRI crop
Vegetables and Tobacco	VT	32	Tobacco, (other)	16	Tobacco
	VT	193	Tobacco, burley	16	Tobacco
	VT	196	Tobacco, flue-cured	16	Tobacco
	VT	103	Beets	19	Vegetables
	VT	104	Broccoli	19	Vegetables
	VT	105	Brussel sprouts	19	Vegetables
	VT	2106	Cabbage, Fresh	19	Vegetables
	VT	4106	Cabbage, Processing	19	Vegetables
	VT	4	Cantaloupe	19	Vegetables
	VT	107	Carrots	19	Vegetables
	VT	108	Cauliflower	19	Vegetables
	VT	109	Celery	19	Vegetables
	VT	249	Chinese cabbage	19	Vegetables
	VT	185	Collards	19	Vegetables
	VT	2111	Cucumbers, Fresh	19	Vegetables
	VT	4111	Cucumbers, Processing	19	Vegetables
	VT	112	Eggplant	19	Vegetables
	VT	114	Garlic	19	Vegetables
	VT	117	Lettuce, head	19	Vegetables
	VT	149	Lettuce, other	19	Vegetables
	VT	146	Lettuce, romaine	19	Vegetables
	VT	13	Melons, honeydew	19	Vegetables
	VT	187	Mustard greens	19	Vegetables
	VT	135	Onions, dehydrated	19	Vegetables
	VT	120	Onions, dry	19	Vegetables
	VT	126	Peppers, bell	19	Vegetables
	VT	127	Peppers, chili	19	Vegetables
	VT	244	Peppers, hot	19	Vegetables
	VT	128	Pumpkins	19	Vegetables
	VT	129	Radishes	19	Vegetables
	VT	4132	Spinach, processing	19	Vegetables
	VT	133	Squash, summer	19	Vegetables
	VT	150	Squash, winter	19	Vegetables
	VT	31	Sweet potatoes	19	Vegetables
	VT	2134	Tomatoes, fresh	19	Vegetables
	VT	4134	Tomatoes, processing	19	Vegetables
	VT	145	Turnips	19	Vegetables
	VT	236	Vegetables, other	19	Vegetables
	VT	37	Vegetables, seeds	19	Vegetables
	VT	33	Watermelons	19	Vegetables
Hay, Pasture, Fallow, and Idle					
Pasture	PS	316	Pasture as crop rotation	200	Pasture
Hay	HY	219	Sorghum, hay	12	Sorghum
	HY	310	Clover	144	Hay, all types
	HY	311	Grasses, other than clover	144	Hay, all types
	HY	226	Grass silage	144	Hay, all types
	HY	1	Hay, Alfalfa and alfalfa Mix	144	Hay, all types
	HY	232	Hay, Bahia	144	Hay, all types
	HY	231	Hay, Bermuda grass	144	Hay, all types
	HY	11	Hay, other	144	Hay, all types
	HY	217	Hay, small grain	144	Hay, all types
	HY	225	Hay, wild	144	Hay, all types
	HY	23	Silage & haylage	144	Hay, all types
	HY	180	Sorghum-sudan cross	144	Hay, all types
	HY	167	Sudan	144	Hay, all types
	HY	199	Teff	144	Hay, all types
	HY	39	Vetchseed, hairy	144	Hay, all types

Table A2. –continued.

Crop groups	Crop Group Abbrevia-tion	CEAP crop code	CEAP crop	NRI crop code	NRI crop
Fallow and Idle	FI	333	Idle or fallow (2003 only)		summer fallow or idle
	FW	333	Summer fallow	170	summer fallow
	ID	318	Idle cropland	180	Idle cropland
Close Grown Crops					
Wheat	WH	34	Wheat, All	111	wheat
	WH	172	Wheat, All, for seed	111	wheat
	WH	163	Wheat, durum	111	wheat
	WH	164	Wheat, other spring	111	wheat
	WH	165	Wheat, winter	111	wheat
Rice	RI	21	Rice	113	Rice
	RI	319	Rice, sweet	113	Rice
	RI	178	Rice, wild	113	Rice
Barley	BY	190	Barley, All	114	Barley
	BY	290	Barley, Feed	114	Barley
	BY	2	Barley, feed or malt	114	Barley
	BY	291	Barley, Malt	114	Barley
	BY	173	Barley, seed	114	Barley
Small grain crops	SM	15	Oats	112	Oats
	SM	84	Buckwheat	116	Other Close Grown
	SM	161	Emmer and spelt	116	Other Close Grown
	SM	22	Rye	116	Other Close Grown
	SM	162	Triticale	116	Other Close Grown
Other close grown crops	CG	35	Alfalfa seed	116	Other Close Grown
	CG	228	Bentgrass seed	116	Other Close Grown
	CG	229	Bermuda grass seed	116	Other Close Grown
	CG	40	Bluegrass seed	116	Other Close Grown
	CG	215	Bromegrass seed	116	Other Close Grown
	CG	85	Canola	116	Other Close Grown
	CG	153	Cilantro	116	Other Close Grown
	CG	194	Clover seed	116	Other Close Grown
	CG	214	Clover seed, crimson	116	Other Close Grown
	CG	43	Clover seed, red	116	Other Close Grown
	CG	203	Clover seed, white	116	Other Close Grown
	CG	317	Field and forage crops, Other	116	Other Close Grown
	CG	9	Flaxseed	116	Other Close Grown
	CG	10	Forage and green chop	116	Other Close Grown
	CG	138	Grass seed, other	116	Other Close Grown
	CG	41	Lespedeza seed	116	Other Close Grown
	CG	141	Millet	116	Other Close Grown
	CG	94	Mustard seed	116	Other Close Grown
	CG	42	Orchard grass seed	116	Other Close Grown
	CG	18	Peppermint	116	Other Close Grown
	CG	170	Rapeseed	116	Other Close Grown
	CG	136	Rye grass seed	116	Other Close Grown
	CG	168	Sage	116	Other Close Grown
	CG	44	Tall fescue seed	116	Other Close Grown
	CG	45	Timothy seed	116	Other Close Grown

Source: CEAP and NRI Cropping Systems 2008 Documentation

Table A3. Major cropping systems defined for the 12 new CEAP production regions (PRs), providing basis for sample weight adjustment.

Production region number	Major cropping system	No. of 2003-06 CEAP sample points	Sum of original CEAP sample weights	No. of 2003 NRI points	No. of 2003 cultivated cropland acres	PR and cropping system multiplier
1	Wheat only, w/wout FWID	21	233,823	63	183,400	0.784353
1	All Hay-crop mixes	15	70,038	100	192,900	2.7542188
1	Mix of remaining row crops only	19	81,362	37	50,600	0.6219115
1	Other close grown crops only	91	841,866	283	636,300	0.7558206
1	Remaining mix of row AND close crops	12	74,563	80	150,800	2.0224489
2	rice only, w/wout FWID	36	581,454	204	600,000	1.0318953
2	veg and/or tobacco only, w/wout FWID	14	263,136	184	353,300	1.3426508
2	Mix of remaining row crops only	20	855,671	196	928,400	1.0849962
2	Remaining mix of row AND close crops	24	741,178	242	730,400	0.9854581
2	Hay-crop mix or other close-grown crops	17	688,902	299	828,400	1.2024938
3	wheat only, w/wout FWID	336	5,237,699	1126	4,323,500	0.8254579
3	barley only, w/wout FWID	58	584,879	152	292,100	0.4994192
3	PO and close grown crops	75	634,265	504	756,400	1.1925613
3	Sugar beets with other crops	61	473,755	352	562,700	1.187745
3	All Hay-crop mixes	80	1,542,838	991	2,134,600	1.3835546
3	Mix of remaining row crops only	63	686,260	175	390,400	0.5688808
3	Other close grown crops only	97	1,339,580	796	2,855,800	2.1318618
3	Remaining mix of row AND close crops	120	1,814,434	464	999,500	0.5508606
4	cotton only, w/wout FWID	33	315,512	150	246,500	0.7812697
4	wheat only, w/wout FWID	27	318,336	177	328,700	1.0325573
4	CT and close grown crops	18	213,061	91	160,400	0.7528369
4	Sorghum and other row crops	21	366,192	156	255,900	0.6988145
4	Mix of remaining row crops only	19	265,831	104	169,500	0.6376231
4	Remaining mix of row AND close crops	28	337,811	65	142,500	0.4218336
4	Hay-crop mix or other close-grown crops	44	797,906	465	1,128,700	1.4145769
5	CN-SB only, w/wout FWID	205	5,077,059	1095	3,556,000	0.7004055
5	Corn only, w/wout FWID	41	1,042,354	129	404,800	0.3883518
5	Wheat only, w/wout FWID	395	12,739,650	1834	11,022,600	0.86522
5	SB-WT only	135	4,487,960	713	2,923,700	0.6514541
5	Vegetables/tobacco with close grown only	78	2,697,293	289	1,245,000	0.4615739
5	SF and close grown crops	96	3,117,644	1097	4,254,200	1.3645561
5	CN and/or SB with Close Grown	144	3,684,780	1191	4,222,000	1.1457945
5	CN and hay-other crop mix	22	501,285	307	934,200	1.8636116
5	Hay-crop mix no CN	51	1,667,861	536	2,601,700	1.5599022
5	Mix of remaining row crops only	52	1,420,458	375	1,040,900	0.7327918
5	Other close grown crops only	193	7,240,725	1863	8,232,900	1.1370271
5	Remaining mix of row AND close crops	106	3,770,622	1826	7,250,900	1.9229982
6	CN-SB only, w/wout FWID	201	4,052,440	1018	3,445,600	0.8502532
6	corn only, w/wout FWID	194	3,855,815	895	3,594,700	0.9322803
6	cotton only, w/wout FWID	235	4,429,286	847	3,681,900	0.8312627
6	sorghum only, w/wout FWID	50	1,644,806	351	1,471,200	0.8944522
6	wheat only, w/wout FWID	950	24,642,935	4194	20,594,400	0.8357121
6	SG-WT only	200	5,680,268	1513	8,670,200	1.5263717
6	CT-SG only	49	1,269,672	466	1,905,900	1.5010958
6	CT and close grown crops	69	1,483,395	385	1,739,500	1.1726479
6	CN and/or SB with Close Grown	222	5,849,459	1141	5,736,200	0.9806377
6	All Hay-crop mixes	123	3,255,042	575	2,329,300	0.7155976
6	Mix of remaining row crops only	126	2,638,555	822	3,195,900	1.2112313
6	Other close grown crops only	75	2,143,314	426	2,109,300	0.98413
6	Remaining mix of row AND close crops	121	3,123,913	1173	5,355,300	1.7142923

Table A3 –continued.

Production region number	Major cropping system	No. of 2003-06 CEAP sample points	Sum of original CEAP sample weights	No. of 2003 NRI points	No. of 2003 cultivated cropland acres	PR and cropping system multiplier
7	CN-SB only, w/wout FWID	5554	81,757,632	28865	81,191,400	0.9930743
7	corn only, w/wout FWID	536	8,103,601	1340	3,191,800	0.3938743
7	soybean only, w/wout FWID	334	4,287,452	736	1,652,700	0.3854737
7	CN-SB-WT only	492	5,858,610	3406	9,141,200	1.5603018
7	SB-WT only	289	3,867,223	688	1,784,300	0.4613905
7	vt with other row crops only	49	744,564	381	1,035,700	1.3910146
7	CN and/or SB with Close Grown	185	2,710,443	635	1,721,800	0.6352466
7	SB and SG with or w/out Close Grown	79	1,065,377	355	981,800	0.9215515
7	CN and hay-other crop mix	285	4,445,452	3630	10,539,000	2.3707378
7	Hay-crop mix no CN	133	2,039,617	719	2,117,100	1.0379889
7	Mix of remaining row crops only	57	780,461	743	2,112,000	2.7060945
7	Other close grown crops only	20	361,550	143	391,800	1.0836673
7	Remaining mix of row AND close crops	52	1,079,487	473	1,562,600	1.4475392
8	CN-SB only, w/wout FWID	19	335,271	70	253,600	0.7564032
8	wheat only, w/wout FWID	22	773,816	303	1,203,000	1.554633
8	RI and SB only, w/wout FWID	20	413,676	128	417,000	1.0080346
8	CN and/or SB with Close Grown	52	1,197,750	173	555,900	0.4641203
8	SG and other row drops	13	579,854	91	407,900	0.7034535
8	SG with close grown crops	12	343,465	58	258,900	0.7537885
8	Mix of remaining row crops only	35	1,015,273	384	1,622,500	1.5980927
8	Remaining mix of row AND close crops	28	658,856	147	525,500	0.7975946
8	Hay-crop mix or other close-grown crops	31	1,218,409	277	1,186,900	0.974139
9	CN-SB only, w/wout FWID	256	1,711,982	533	1,277,200	0.746036
9	soybean only, w/wout FWID	352	4,068,845	1094	3,014,800	0.7409474
9	cotton only, w/wout FWID	274	3,333,219	818	2,813,900	0.8441989
9	rice only, w/wout FWID	138	1,840,607	519	1,561,400	0.8483072
9	CN-CT only	66	864,269	194	708,100	0.8193051
9	RI and SB only, w/wout FWID	250	3,301,151	1003	3,332,100	1.0093753
9	CN and/or SB with Close Grown	156	1,400,057	741	1,913,100	1.3664443
9	CT and SB with or w/out other crops	85	891,576	548	1,665,500	1.8680407
9	Mix of remaining row crops only	168	2,608,114	777	2,665,500	1.0220029
9	Remaining mix of row AND close crops	47	534,980	494	1,686,100	3.1517095
9	Hay-crop mix or other close-grown crops	28	358,991	219	524,800	1.4618766
10	CN-SB only, w/wout FWID	211	1,284,297	519	824,600	0.6420634
10	corn only, w/wout FWID	216	1,558,268	541	988,300	0.6342296
10	soybean only, w/wout FWID	33	197,443	67	102,700	0.5201502
10	CN and/or SB with Close Grown	205	1,376,206	458	774,200	0.5625613
10	CN and hay-other crop mix	132	1,096,739	1414	3,025,600	2.7587228
10	Mix of remaining row crops only	37	329,959	169	280,600	0.85041
10	Remaining mix of row AND close crops	26	336,604	93	212,600	0.6316028
10	Hay-crop mix (no CN) or other close-grown crops	28	270,846	169	338,900	1.2512647
11	CN-SB only, w/wout FWID	391	3,405,230	981	2,393,900	0.7030068
11	corn only, w/wout FWID	73	697,777	187	499,200	0.715415
11	soybean only, w/wout FWID	74	791,430	210	514,400	0.6499631
11	CN and/or SB with Close Grown	156	1,687,548	586	1,640,800	0.9722983
11	CT w/ or w/out other row crops, no CGC	65	699,113	199	499,800	0.7149058
11	Mix of remaining row crops only	40	411,426	189	436,200	1.0602145
11	Remaining mix of row AND close crops	49	615,417	151	503,700	0.8184699
11	Hay-crop mix or other close-grown crops	67	856,114	820	2,235,200	2.6108665

Table A3 –continued.

Production region number	Major cropping system	No. of 2003-06 CEAP sample points	Sum of original CEAP sample weights	No. of 2003 NRI points	No. of 2003 cultivated cropland acres	PR and cropping system multiplier
12	CN-SB only, w/wout FWID	288	2,051,602	714	1,573,500	0.7669614
12	corn only, w/wout FWID	53	529,642	114	283,500	0.5352675
12	soybean only, w/wout FWID	113	961,076	254	678,300	0.7057718
12	cotton only, w/wout FWID	132	1,638,755	410	1,297,200	0.7915764
12	CT-PN only	90	1,666,829	231	820,600	0.4923121
12	vt with other row crops only	58	739,082	303	877,600	1.1874197
12	CN and/or SB with Close Grown	244	1,594,228	889	1,671,900	1.0487207
12	CT with other row crops, no close grown	96	1,016,299	429	1,198,600	1.1793775
12	CT and close grown, w/ or w/out other crops	51	547,265	186	627,400	1.1464291
12	Mix of remaining row crops only	79	1,617,572	747	2,122,600	1.3122139
12	Remaining mix of row AND close crops	64	688,055	383	1,056,800	1.5359234
12	Hay-crop mix or other close-grown crops	21	248,708	420	1,294,000	5.2028794
		18,691	304,342,099	95,035	304,709,600	

Appendix B: Intrinsic Vulnerability Factor for Soil Runoff

Not all acres require the same level of conservation treatment because of differences in inherent vulnerabilities due to soils and climate. Inherent vulnerability factors for surface runoff include soil properties that promote surface water runoff and erosion—soil hydrologic group, slope, and soil erodibility (the water erosion equation K-factor). Soil runoff potentials were estimated for each sample point on the basis of a single set of criteria for all regions and soils in the United States to allow for regional comparisons.

Four soil vulnerability levels are defined: high, moderately high, moderate, and low. A "high" soil potential indicates that the intrinsic vulnerability of the soil is high for surface water runoff, and that sediment loss at the edge of the field would be expected to be relatively high compared to other acres if there were no conservation practices in use. A "low" soil potential indicates that the intrinsic vulnerability of the soil is low for surface water runoff, and sediment loss at the edge of the field would be expected to be relatively low compared to other acres.

Criteria for four classes of soil runoff potential were derived using a combination of soil hydrologic group, percent slope, and K-factor, as shown in table B1.

Three regions have the highest percentages of acres with inherent vulnerability factors for surface runoff (fig. B1 and figs B2-B8):

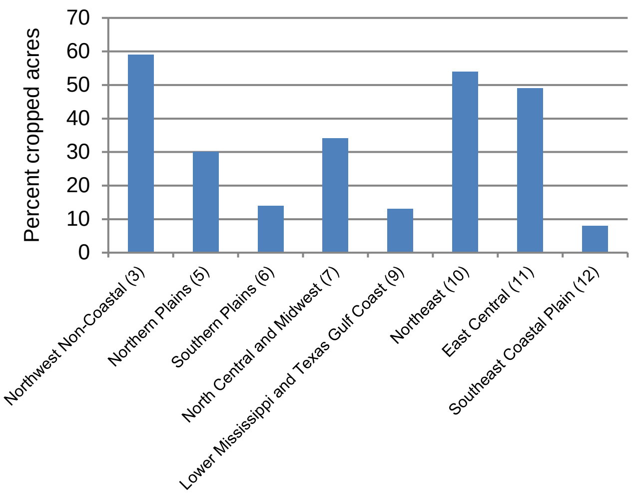
- the Northwest Non-Coastal (3) region, where 58 percent of the cultivated cropland acres have a "high" or "moderately high" soil runoff potential;
- the Northeast (10) region, where 54 percent of the cultivated cropland acres have a "high" or "moderately high" soil runoff potential; and
- the East Central (11) region, where 49 percent of the cultivated cropland acres have a "high" or "moderately high" soil runoff potential.

Three regions have few acres with inherent vulnerability factors for surface runoff (fig. B1):

- the Southeast Coastal Plain (12) region, where only 8 percent of the cultivated cropland acres have a "high" or "moderately high" soil runoff potential;
- the Lower Mississippi and Texas Gulf Coast (9) region, where only 9 percent of the cultivated cropland acres have a "high" or "moderately high" soil runoff potential; and
- the Southern Plains (6) region, where only 13 percent of the cultivated cropland acres have a "high" or "moderately high" soil runoff potential.

In the remaining two regions—the North Central and Midwest (7) region and the Northern Plains (5) region—about half of the cultivated cropland acres have a low soil runoff potential and the rest of the acres have varying levels of soil runoff vulnerabilities.

Figure B1. Percent cultivated cropland acres in each region with a "high" or "moderately high" soil runoff potential.



Figures B2 through B9 show the percentages of cultivated cropland acres in each region for each of the four levels of the soil runoff potential. Because a consistent set of criteria were used for all regions of the country, some soil vulnerability potentials are not well represented in every region.

Table B1. Criteria for the soil runoff potential.

Soil runoff potential	Acres with soil hydrologic group A	Acres with soil hydrologic group B	Acres with soil hydrologic group C	Acres with soil hydrologic group D
Low	All acres	Slope<4	Slope<2	Slope<2 and K-factor<0.28
Moderate	None	Slope >=4 and <=6 and K-factor<0.32	Slope >=2 and <=6 and K-factor<0.28	Slope<2 and K-factor>=0.28
Moderately high	None	Slope >=4 and <=6 and K-factor>=0.32	Slope >=2 and <=6 and K-factor>=0.28	Slope >=2 and <=4
High	None	Slope>6	Slope>6	Slope>4

Hydrologic soil groups are classified as:

Group A—sand, loamy sand, or sandy loam soils that have low runoff potential and high infiltration rates even when thoroughly wetted.

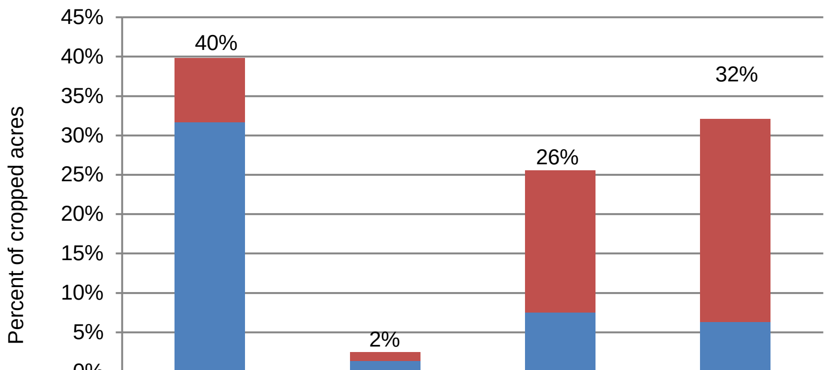
Group B—silt loam or loam soils that have moderate infiltration rates when thoroughly wetted.

Group C—sandy clay loam soils that have low infiltration rates when thoroughly wetted.

Group D—clay loam, silty clay loam, sandy clay, silty clay, or clay soils that have very low infiltration rates when thoroughly wetted.

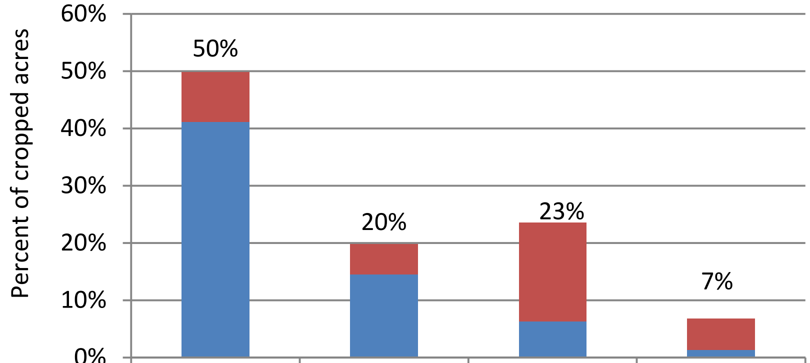
The K-factor is a relative index of susceptibility of bare, cultivated soil to particle detachment and transport by rainfall. It is determined by the composition of the soil, saturated hydraulic conductivity, and soil structure.

Figure B2. Soil runoff potential for cropped acres in the Northwest Non-Coastal (3) region.



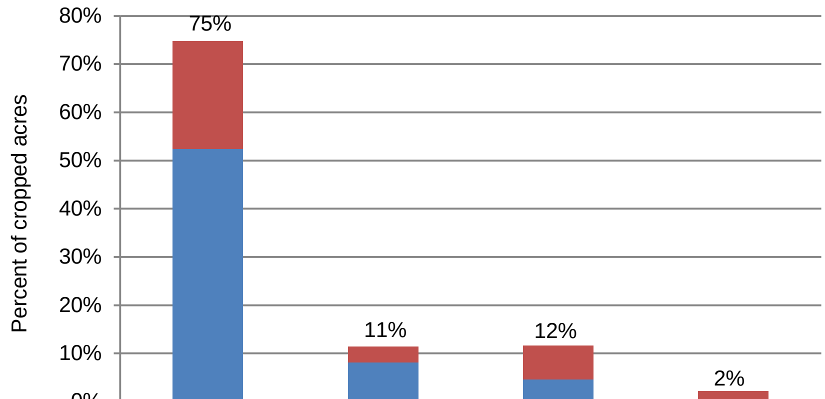
	Low	Moderate	Moderately high	High
HEL	8%	1%	18%	26%
Non-HEL	32%	1%	8%	6%

Figure B3. Soil runoff potential for cropped acres in the Northern Plains (5) region.



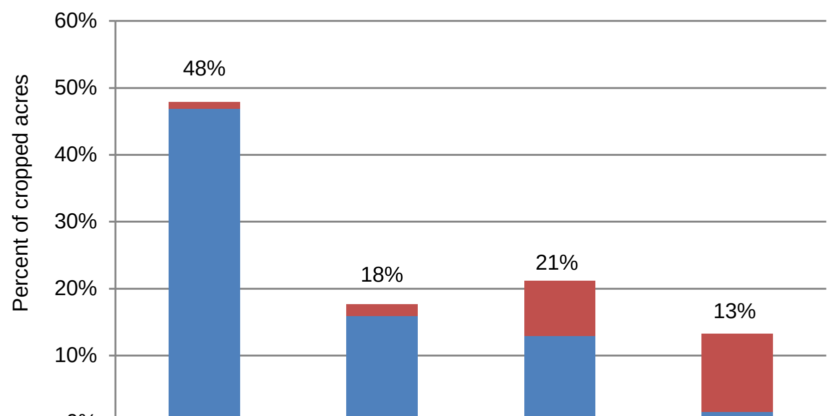
	Low	Moderate	Moderately high	High
HEL	9%	5%	17%	5%
Non-HEL	41%	14%	6%	1%

Figure B4. Soil runoff potential for cropped acres in the Southern Plains (6) region.



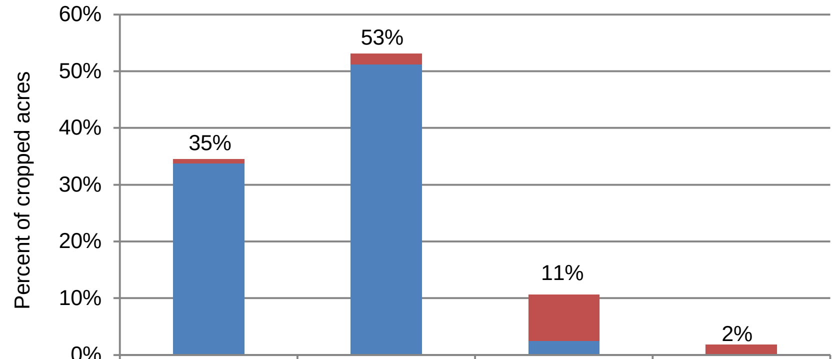
	Low	Moderate	Moderately high	High
HEL	22%	3%	7%	2%
Non-HEL	52%	8%	5%	0.3%

Figure B5. Soil runoff potential for cropped acres in the North Central and Midwest (7) region.



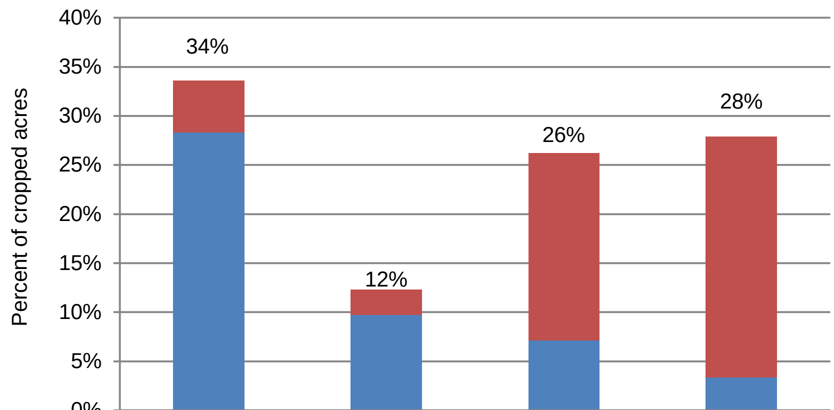
	Low	Moderate	Moderately high	High
HEL	1%	2%	8%	12%
Non-HEL	47%	16%	13%	2%

Figure B6. Soil runoff potential for cropped acres in the Lower Mississippi and Texas Gulf Coast (9) region.



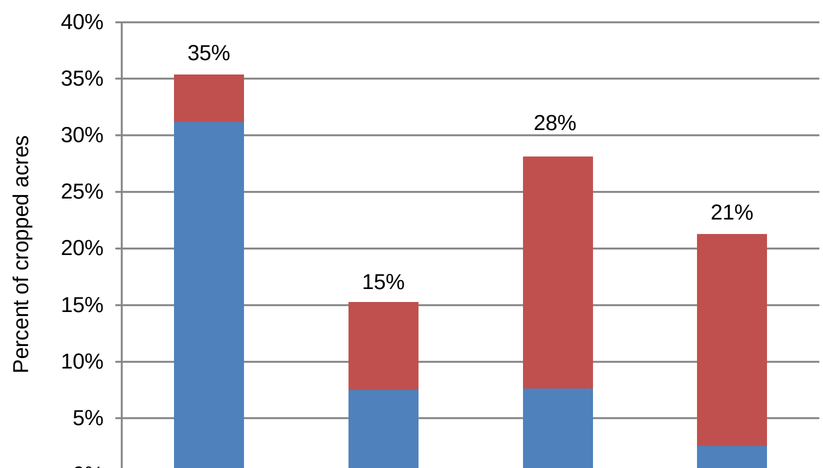
	Low	Moderate	Moderately high	High
HEL	1%	2%	8%	2%
Non-HEL	34%	51%	2%	0.1%

Figure B7. Soil runoff potential for cropped acres in the Northeast (10) region.



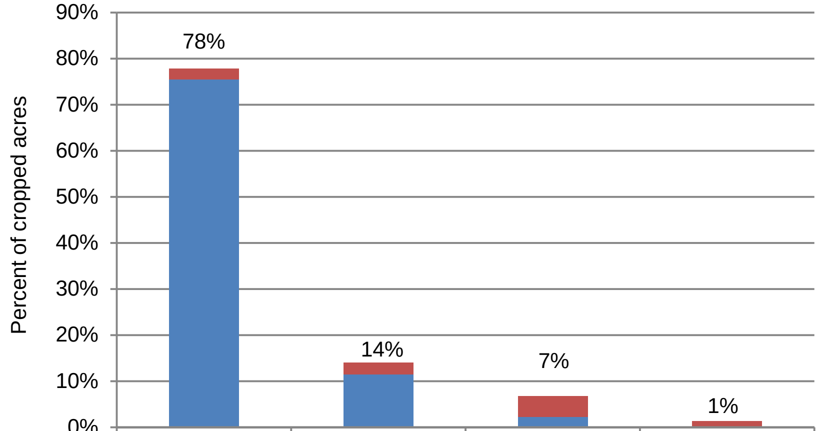
	Low	Moderate	Moderately high	High
HEL	5%	3%	19%	25%
Non-HEL	28%	10%	7%	3%

Figure B8. Soil runoff potential for cropped acres in the East Central (11) region.



	Low	Moderate	Moderately high	High
HEL	4%	8%	20%	19%
Non-HEL	31%	8%	8%	3%

Figure B9. Soil runoff potential for cropped acres in the Southeast Coastal Plain (12) region.



	Low	Moderate	Moderately high	High
HEL	2%	3%	4%	1%
Non-HEL	76%	11%	2%	0.2%