Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

Conservation Practices on Cultivated Cropland

A Comparison of CEAP I and CEAP II Survey Data and Modeling

Summary of Findings

The agricultural landscape is dynamic, shaped by public policy, technology, and natural resource drivers among others, which together affect farmer decisions and conservation trends. Between the CEAP surveys, increased demand and higher prices for commodities encouraged production expansion in nearly all regions of the country. A warming climate, longer growing season, and advances in seed technology and higher yielding crop varieties drove cropping pattern shifts, most notably in the northern and southern plains where corn and soybean production replaced wheat and other close-grown crops that had lower average nutrient needs and fallow periods.

Between CEAP I and CEAP II, farmers' adoption of conservation practices resulted in more cultivated cropland meeting loss thresholds for erosion, sediment, surface nitrogen and sediment-transported phosphorus. While use of advanced nutrient technologies increased, by CEAP II more cultivated cropland exceeded loss thresholds for subsurface nitrogen and soluble phosphorus, reflecting the growth in high-nutrient-demand crop varieties, the increase in conservation tillage systems, and the decline in nutrient incorporation. Nevertheless, most cultivated cropland in the United States is under moderate and high levels of conservation treatment, and opportunities exist to improve conservation performance using currently available tools.

The U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) evaluates conservation trends and effects on cultivated cropland through the multiagency Conservation Effects Assessment Project (CEAP). CEAP uses natural resource and farmer survey data and physical process modeling to estimate the environmental effects of conservation practices on cultivated cropland. USDA's National Agricultural Statistics Service conducted the first set of farmer surveys in 2003–06 (CEAP I) with reports released from 2010 through 2014. Now, comparison data from farmer surveys conducted from 2013–16 (CEAP II) make it possible to estimate shifts in conservation adoption and effects between the CEAP survey periods.

How Did the Use of Conservation Practices Change Between the CEAP Surveys?

Structural practices and conservation tillage, alone or in combination, increased by 42 million acres and were in place on over 81 percent of all cultivated cropland by CEAP II, up from 68 percent in CEAP I.

- Structural practice adoption increased by nearly 31 million acres, largely in combination with conservation tillage and other structural practices on the same field as supporting practices to control erosion and trap sediment. Conservation tillage adoption increased by 53.4 million acres and became the dominant form of tillage on all cultivated cropland (67 percent). More than 41.5 million acres of the total increase was in continuous no-till, which reached 33 percent of all cultivated cropland by CEAP II.
- Adoption patterns were slightly higher on the most vulnerable cultivated cropland, with structural practices, conservation tillage, or both in place on 85 percent of highly erodible land (HEL) and on over 90 percent of cultivated cropland with high or moderately high runoff vulnerability.

Conservation crop rotations were used on nearly 70 percent of cultivated cropland acres, up from 66 percent in CEAP I. Nearly 28 percent of all cultivated cropland had high-biomass conservation crop rotations.

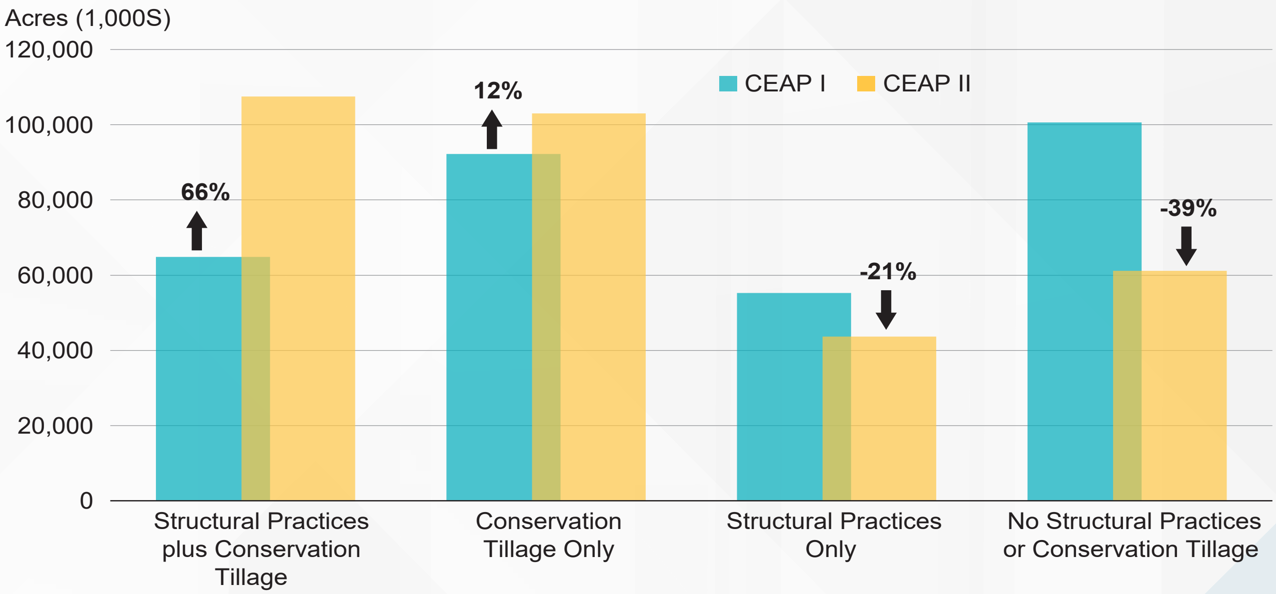
Cover crops were used on nearly 19 million acres by CEAP II, although still only accounting for about 6 percent of total cultivated cropland.

Total irrigation water applications declined by 10 percent (from 71.7 million acre-feet to 64.6 million acre-feet), despite a nearly 5-million-acre increase in irrigated cropland (11 percent), reflecting increased adoption of higher efficiency pressure-based irrigation systems (8.7 million acres).

Nutrient management experienced an overall decline:

- Application rates increased by 7 percent for nitrogen (73 to 78.5 lbs./acre/year) and by 15 percent for phosphorus (16.2 to 18.6 lbs./acre/year), reflecting the increase in new crop varieties with higher nutrient demand and yields. Between the survey periods, average annual corn and soybean yields increased by more than 14 percent and 21 percent, respectively.
- Cultivated cropland acres with all nutrient applications incorporated declined by 29 percent for nitrogen and by 24 percent for phosphorus while acres with no incorporation increased by 41 and 46 percent, respectively. By CEAP II, 50 percent of the nitrogen applied, and 20 percent of the phosphorus applied were not incorporated into the soil as compared to 41 and 14 percent in CEAP I.
- Most nitrogen and phosphorus applications are applied at plant (within 7 days of planting). Nitrogen and phosphorus applied at plant and not incorporated increased by 28 percent and 22 percent, respectively.

Cultivated Cropland by Treatment Group, CEAP I and CEAP II



Note: Number above column is the percent change in treatment group relative to CEAP I.

How did Changes in Sediment and Nutrient Management Affect Resource Concerns?

Manure nutrients were used on more cultivated cropland in CEAP II, up by nearly 3.7 million acres (14-percent increase). There was a significant increase (275 percent) in the purchase of manure nutrients, signaling greater awareness of the value of manure nutrients.

Soil testing on cultivated cropland increased slightly, from 56 percent to 60 percent of acres. Rates were higher on manured acres (77 percent), although testing did not appear to affect application rates, which were considerably higher than for non-manured acres, receiving 71 percent more nitrogen and 90 percent more phosphorus.

Precision technology became more commonplace in field operations. By CEAP II, use of enhanced-efficiency fertilizers increased about six-fold and were used on 26 percent of all cultivated cropland. Variable rate technology more than quadrupled and was used on 16 percent of cultivated cropland.

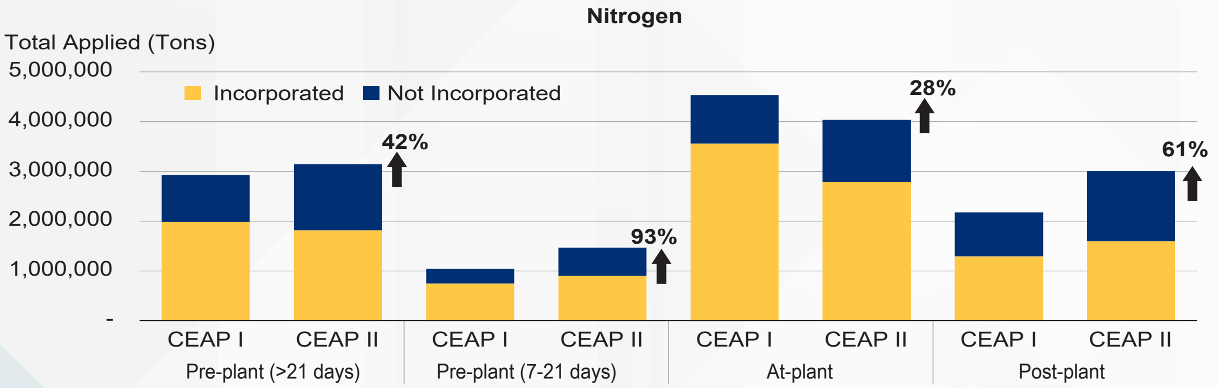
Sediment management on cultivated cropland increased with the adoption of structural practices and conservation tillage. Cultivated cropland with *high sediment management* levels increased by 15 million acres (150 percent) and *moderately high* sediment management levels increased by nearly 30 million acres (42 percent). By CEAP II, high and moderately high sediment management was in place on 40 percent of acres, up from 25 percent in CEAP I.

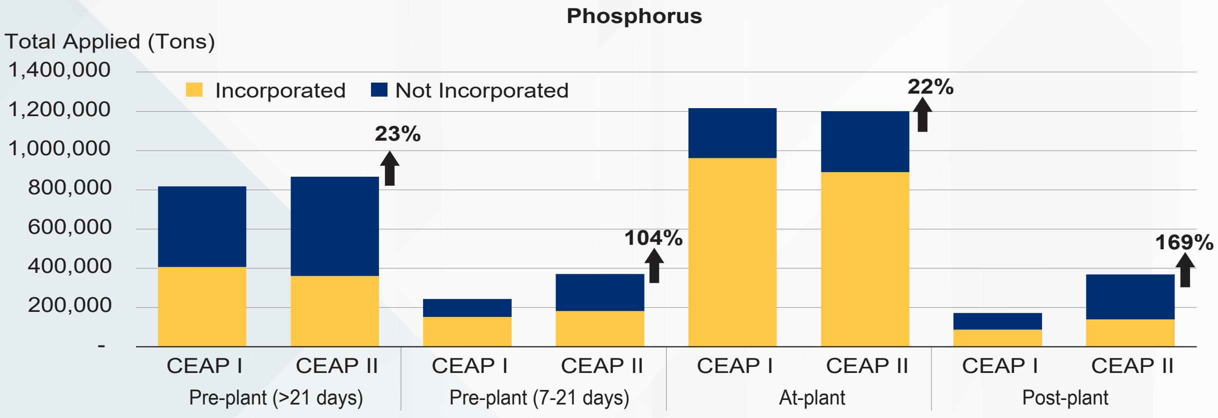
- Average annual sheet and rill erosion and wind erosion dropped by 76 million tons (13 percent) and 94 million tons (16 percent) by CEAP II, respectively. Cultivated cropland eroding above the tolerance level (T) declined by 4.3 million acres (12 percent) for sheet and rill erosion and 7.6 million acres (20 percent) for wind erosion.
- Total sediment load dropped by 74 million tons (22 percent), as cultivated cropland acres moved into higher levels of sediment management.

Nutrient management on cultivated cropland declined, driven by the decrease in incorporated nutrient applications. Cultivated cropland with high nutrient management levels decreased by over 36 million acres (27 percent) for nitrogen and by 31 million acres (15 percent) for phosphorus. Conversely, moderately high nutrient management increased by nearly 17 million acres for nitrogen (16 percent) and by nearly 6.5 million acres for phosphorus (14 percent).

- *Surface losses* of nitrogen decreased by 35,000 tons (3 percent) and sediment-transported phosphorus losses decreased by 14,000 tons (6 percent) reflecting the benefits of conservation tillage and structural practices in reducing runoff.

Total Applied Nutrients by Timing and Incorporation, CEAP I and CEAP II





Note: Number above CEAP II column is the percent increase in the unincorporated load relative to CEAP I.

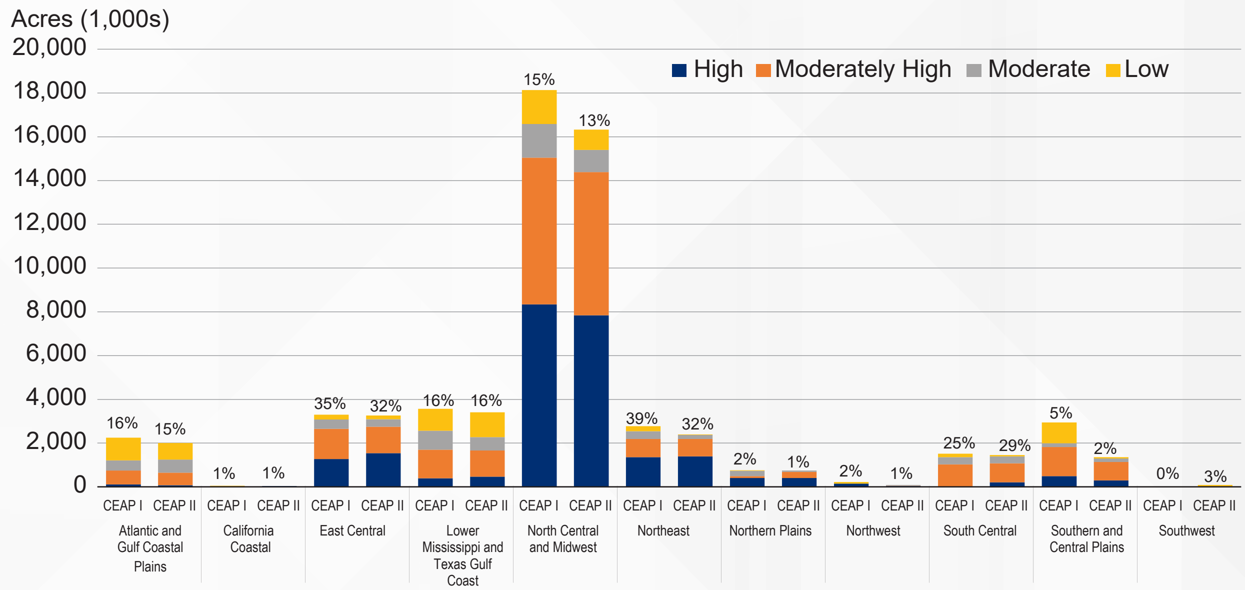
- *Subsurface nitrogen* losses increased by 420,000 tons (13 percent) and soluble phosphorus losses increased by 7,200 tons (11 percent) reflecting the tillage changes that promoted water infiltration and subsurface flow and the decline in incorporation to reduce nutrient mobility.*Carbon* storage in cultivated cropland soils increased by an average of over 8.8 million tons per year, equivalent to reducing annual carbon dioxide emissions by 32.4 million tons. Cultivated cropland gaining soil carbon increased by 25.7 million acres (14 percent increase from CEAP I), reflecting the increase in soil conserving measures applied by farmers.

Fuel used in field operations dropped by an annual average of 110 million gallons of diesel fuel equivalents, in turn avoiding associated greenhouse gas emissions by nearly 1.2 million tons of carbon dioxide equivalents.

*Most cultivated cropland (*90 percent) had moderate (47 percent) or high (43 percent) conservation treatment in both survey periods.

Most soil and nutrient losses come from a small fraction of acres, generally vulnerable areas within fields. For example, in CEAP II, 9 percent of acres accounted for 68 percent of the sediment losses, 28 percent of acres generated 73 percent of the subsurface nitrogen losses, and 27 percent of acres generated 73 percent of the soluble phosphorus losses.

Cultivated Cropland Exceeding Sheet and Rill Erosion Threshold by CEAP Survey



Note: Number above each column indicates the percent of the region's cultivated cropland exceeding the sheet and rill erosion threshold.

Conclusion

Over the survey period, farmers' conservation efforts have improved soil health, decreased erosion and sediment movement, and reduced nutrient losses via surface pathways. Simulations of additional erosion control and nutrient management on cultivated cropland highlighted the difficulty in controlling subsurface nitrogen and soluble phosphorus pathways and point to the need for solutions that include precision technologies, such as variable rate fertilization and enhanced-efficiency fertilizers.

To achieve the full benefits of advanced technology, tillage efficiency, and conservation measures on cultivated cropland requires addressing natural resources as a system. A systems approach to conservation recognizes that treatment needs vary within fields and that conservation measures designed to benefit one resource also may affect another, potentially negatively. For example, in a watershed in which soluble phosphorus is a resource concern, nutrient incorporation may be needed to reduce potential soluble losses, but it also may reduce the maximum soil carbon benefits of strict no till. Conservation planning assesses the agri-environmental system to identify and develop workable solutions that fit the operation, the land, and the resource need in balance with local natural resource priorities.