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Key Findings from the CEAP-Cropland Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Upper Mississippi River Basin

The Upper Mississippi River Basin (UMRB) cropland study was designed to (1) quantify the effects of conservation practices commonly used on cultivated cropland in the region, (2) evaluate the need for additional conservation treatment, and (3) estimate the potential gains that could be attained with additional conservation treatment. The study is part of the Conservation Effects Assessment Project (CEAP), a multi-agency USDA effort to quantify the environmental effects of conservation practices.

Computer modeling simulations indicate that conservation practice use in the UMRB has made good progress toward reducing sediment, nutrient, and pesticide losses from farm fields. However, significant conservation treatment is still needed to reduce nonpoint agricultural sources of pollution to acceptable levels.

- *Use of soil erosion control practices is widespread, but the most vulnerable acres require additional conservation practices.*
- *Complete and consistent use of nutrient management practices is generally lacking; 62 percent of the acres require additional treatment to reduce the loss of nitrogen or phosphorus from farm fields.*
- *The most critical conservation concern is the loss of nitrogen through leaching on half of the cropped acres.*
- *Treatment of erosion alone can exacerbate the nitrogen leaching problem by re-routing surface water to subsurface flow pathways.*
- *Nitrogen leaching loss is controlled by pairing erosion-control practices with nutrient management practices for rate, form, timing, and method of application.*
- *Conservation practices have the greatest effect on the more vulnerable acres.*

The Baseline Conservation Condition

An assessment of the extent of conservation practice use in the UMRB for the period 2003–06, which represents the baseline conservation condition in the region, found that—

- producers use residue and tillage management practices or structural practices, or both, on nearly all acres;
- while most acres have evidence of some nitrogen or phosphorus management, few acres have consistent use of appropriate rate, form, timing, *and* method of application, including nearly all acres receiving manure:
  - appropriate rates of nitrogen application are used on about 34 percent of the acres for all crops in the rotation,
  - good nitrogen management practices (rate, timing, and method) are in use on only about 14 percent of the acres for *all* crops during *every* year of production, and
  - good phosphorus management practices are in use on 29 percent of the acres for *all* crops during *every* year of production.

Effects of Conservation Practices

Model simulation results show that, for cropped acres in the region, on average conservation practices have—

- reduced surface water flow from farm fields by 16 percent, re-routing the water to subsurface flow pathways;
- reduced sediment loss from fields by 69 percent;
- reduced total nitrogen loss (volatilization, denitrification, surface runoff, and subsurface flow losses) from fields by 18 percent:
  - reduced nitrogen lost with surface runoff (attached to sediment and in solution) by 46 percent, and
  - reduced nitrogen loss in subsurface flow by 5 percent;
- reduced total phosphorus loss (including soluble phosphorus) from fields by 49 percent;
- reduced pesticide loss from fields to surface water, resulting in a 51-percent reduction in edge-of-field pesticide risk for aquatic ecosystems and a 48-percent reduction in edge-of-field pesticide risk for humans (all pesticides combined); and
- decreased the percentage of acres that is losing soil organic carbon from 41 percent to 25 percent.

For the 2.8 million acres of land in long-term conserving cover, as represented by enrollment in the Conservation Reserve Program General Signup, soil erosion and sediment loss have been almost completely eliminated; total nitrogen and phosphorus losses have been reduced by 81 and 97 percent, respectively; and soil organic carbon has been increased by an average of more than 400 pounds per acre.

These reductions in field-level losses due to conservation practices, including land in long-term conserving cover, translate into improvements in water quality in streams and rivers in the region. Model simulations show that at the outlet of the UMRB (Grafton, IL), use of conservation practices has reduced (1) instream sediment loads by 37 percent, (2) instream nitrogen loads by 21 percent, (3) instream phosphorus loads by 40 percent, and (4) instream atrazine loads by 51 percent.

Evaluation of Conservation Treatment Needs

This study also determined that the *combination* of practices in use was often inadequate to address excessive losses of sediment *and* nutrients. The evaluation of treatment needs for the UMRB determined that—

- 62 percent of cropped acres (36 million acres) are under-treated for one or more of sediment loss, nitrogen or phosphorus loss with surface runoff, and nitrogen or phosphorus loss in subsurface flow; and
- 15 percent of cropped acres (8.5 million critical under-treated acres) are among the most vulnerable under-treated acres in the region, usually with either a high or moderately high soil runoff or leaching potential.

Model simulations suggest that sediment and nutrient losses with surface runoff could be effectively controlled by treating the 8.5 million most vulnerable under-treated acres with additional erosion control practices. At this level of treatment, model simulations showed that, for the region as a whole—

- sediment loss from farm fields would average 0.6 ton per acre per year, compared to the baseline conservation condition average of 1 ton per acre per year (a 40-percent reduction);
- nitrogen lost from the field with surface runoff (attached to sediment and in solution) would average 6.1 pounds per acre per year, compared to the baseline conservation condition average of 8.6 pounds per acre per year (a 29-percent reduction); and
- total phosphorus loss, most of which occurs with surface runoff, would average 2.4 pounds per acre per year, compared to 3 pounds per acre per year for the baseline conservation condition (a 22-percent reduction).

Model simulations also showed, however, that some of these nutrient savings would be re-routed to subsurface loss pathways. A significant portion of these nutrients are eventually delivered to lakes, streams, and rivers through seepage, artificial drainage systems, and groundwater return flow.

Treatment with nutrient management practices *in addition to* soil erosion control practices is required to effectively control the loss of soluble nitrogen and phosphorus from farm fields in the UMRB. Treatment at this level of all 36 million under-treated acres, compared to the baseline conservation condition, for the region as a whole would reduce nitrogen loss in subsurface flow from an average of 21.8 pounds per acre to an average of 11.4 pounds per acre (a 48-percent reduction). Total nitrogen loss (all loss pathways) would be reduced 43 percent and total phosphorus loss would be reduced 51 percent, compared to the baseline conservation condition.

Reductions of instream loads at the outlet of the UMRB due to additional erosion control and nutrient management

Environmental outcome	Treatment of the 8.5 million most vulnerable under-treated acres	Treatment of all 36 million under-treated acres
Sediment reduction	10%	19%
Nitrogen reduction	12%	39%
Phosphorus reduction	14%	37%
Atrazine reduction	7%	20%

The more vulnerable acres, such as highly erodible land and soils prone to leaching, inherently lose more sediment and/or nutrients. Greater benefit, therefore, can be achieved with conservation treatment. Diminishing returns from additional conservation treatment for nitrogen loss in subsurface flow, however, are not evident until all of the under-treated acres are treated, which reflects the pervasiveness of the nitrogen leaching problems in this region.