Agriculture and Sustainable Practices: Protecting Water Quality

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Conservation practices are used to protect vital resources, such as soil and water, while maintaining productive agriculture. Scientists have conducted hundreds of research projects on conservation practices over decades and the volume of research is evident in the compilation of bibliographies by the Water Quality Information Center at the National Agricultural Library, in conjunction with the USDA, to support the Conservation Effects Assessment Project (CEAP) (Gagnon *et al*., 2004; Maderik *et al*., 2006a, 2006b; Gagnon *et al*., 2008).

The CEAP was created in 2003 to understand and optimize environmental benefits of conservation practices implemented via selected US Department of Agriculture (USDA) conservation programs. Cooperators involved in this USDA project included the Natural Resources Conservation Service (NRCS), Agricultural Research Service, National Institute of Food and Agriculture (NIFA), and the Farm Service Agency. Overall, the goal of CEAP is to improve the efficacy of conservation practices and programs by quantifying conservation effects and providing the science and education base needed to improve future conservation planning, implementation, management decisions, and policy (Duriancik *et al*., 2008).

As part of the overall CEAP initiative, NIFA and NRCS funded 13-watershed scale agricultural projects (2004 to 2006) to focus on relating water-quality change to conservation-practice implementation on crop and pasture land (Figure 1).

These 13 projects, herein called NIFA-CEAP, were retrospective studies. In order to be funded they were required to have smaller-scale watersheds (8–12 HUC[1]), a long-term (>5 years) record of water-quality data, and georeferenced land use and conservation practice information. In addition, each project watershed was expected to use socio-economic analysis to better understand the factors that influenced adoption of practices by farmers. Each project was expected to answer these four questions:

- How do the timing, location, and suite of implemented agricultural conservation practices affect water quality at the watershed scale?
- How do conservation practices implemented in a watershed interact with respect to their effects on water quality?
- What social and economic factors facilitate or impede implementation of conservation practices? and
- What is the optimal set of conservation practices and their optimal placement within the watershed needed to achieve water-quality goals? (Model development and use were expected to address this question.)

The 13 projects selected for funding represent diverse agroecological environments across the United States, and all the projects produced a rich set of scientific results presented in many peer-reviewed articles, including a special issue of the November/December 2010 *Soil and Water Conservation Journal*.

Methods

In 2007, NIFA (then CSREES) and NRCS funded a synthesis of the overall NIFA-CEAP watersheds studies in order to integrate and extend lessons learned from the 13 watersheds. Multiple sources of information (*e.g.*, publications, presentations, factsheets) derived from the projects were integrated into a site description (Osmond *et al.*, 2012). A key informant interview questionnaire was used at each watershed location, with a minimum of six to a maximum of 26 interviewees. Of the 196 key informants, 34 farmers, 33 university/extension affiliates, 23 representatives of federal agencies, 10 representatives of state agencies, 28 representatives of local agencies, 24 representatives of local businesses or newspapers, 11 local residents, and 11 elected officials were interviewed. Lessons were developed from each of the 13 projects and then synthesized by functional areas: key informants, land treatment, water-quality monitoring, modeling, socioeconomics, and outreach. Only lessons for land treatment will be presented in this paper. For more detail, see Osmond *et al.* (2012).

Results and Discussion

The major question for land treatment is, what would make conservation-practice implementation better? First and foremost for effective protection of water, conservation

[1]Hydrologic unit codes.

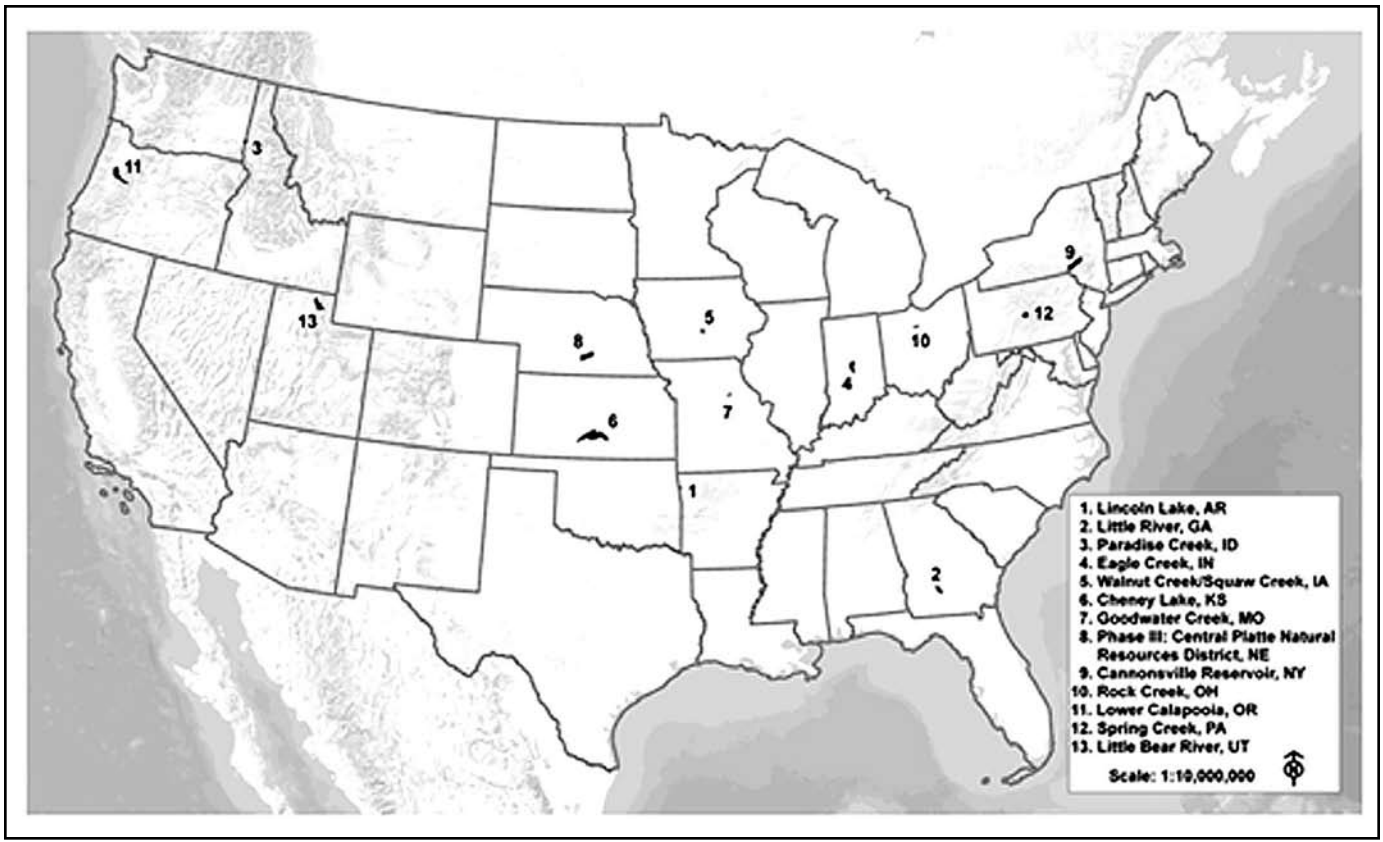

Figure 1. National Institute of Food and Agriculture Conservation Effects Assessment Project locations.

planning must occur at the watershed scale rather than in counties, and there must be sufficient water-quality and potentially modeling information. Before conservation practices are implemented, it is critical to understand the pollutant of concern and pollutant sources and then determine the appropriate conservation practice(s). Several NIFA-CEAP studies found that sediment-reducing conservation practices (*e.g.*, conservation tillage or terraces, grassed waterways and drains) were the predominant practices used when the primary pollutant of concern was nitrate in the groundwater. These sediment-reducing practices can actually increase nitrate leaching. Also, in most watersheds where sediment was of concern, such as Idaho and Iowa, researchers found that the uplands had been well treated for soil loss but that much of the sediment was coming from the streams; under these projects, stream banks were not treated.

Once the appropriate conservation practice is selected, it should be targeted to the critical source area(s). Critical source area(s), that portion of the watershed that delivers the majority of the pollutant, may vary for different pollutants (Meals *et al.*, 2012). In addition, often conservation practices are not directed to these important areas. The Kansas, Missouri, and Utah NIFA-CEAP studies determined critical source areas using different methods and found that, on average, only 25% of the conservation practices were installed in these locations.

Once watershed planning has occurred, the pollutant and source are understood, and the critical source areas identified, it is then critical to work with farmers for adoption of conservation practices. During the key-informant interviews, we found that farmers obtain most of their information from each other (farmer-to-farmer) or from local trusted officials. Conservation work with farmers is very personnel-intensive, as many factors affect farmers' decisions about which practices to use. These factors consist of profit, yield, ease of use, technological development, type of practice, and intangible reasons. Management practices were found to be more difficult for farmers to implement and sustain than structural practices. For instance, terraces were maintained better relative to nutrient-management use. Farmers often told us that conservation-tillage adoption was due to new technologies (planters, herbicides, and genetically modified seed) and reduced labor needs. In addition, it is easier for farmers to understand the impact of soil loss than nutrient loss. As a consequence, there was greater adoption of conservation practices that control sediment than nutrients. Several of the watersheds (Arkansas, Nebraska, New York) were threatened or under regulatory guidelines. Farmers in these watersheds were more aware and often more willing to adopt conservation practices. However, additional money was also spent in these watersheds. Since conservation-practice adoption is a multivariate and individualistic choice, it is critical that conservation planners work closely with farmers to increase adoption.

From the NIFA-CEAP synthesis, it is clear that conservation planning and implementation to protect water quality must be more intentional if we are to protect water quality and use our financial resources more wisely. Protection of water quality through the use of conservation practices must be the responsibility not only of federal and state agency personnel, but also farmers, agricultural businesses, and nonprofit organizations.

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