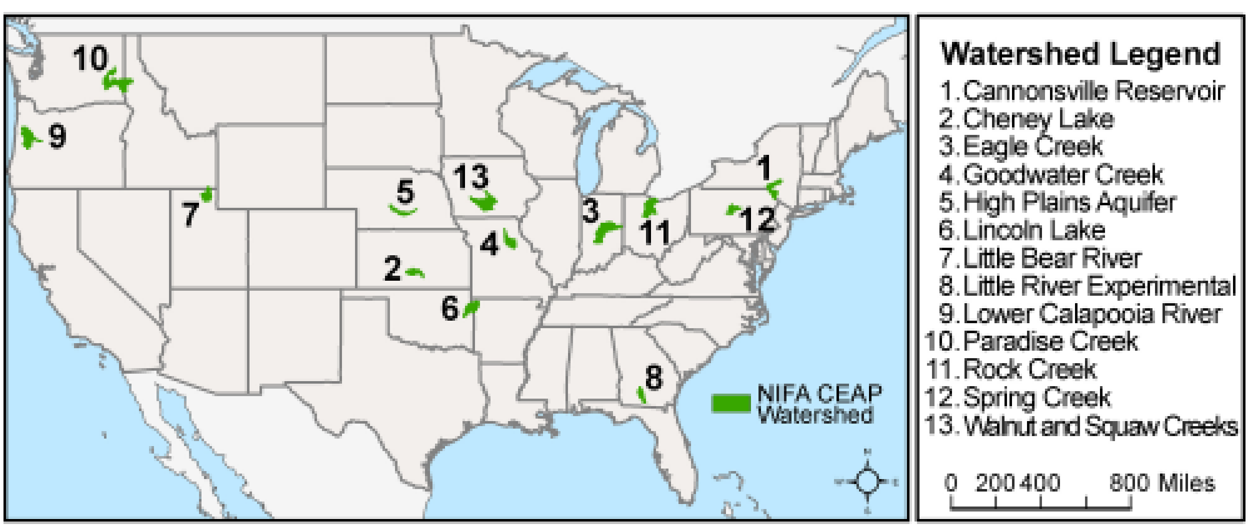
United States Department of Agriculture
National Institute of Food and Agriculture
NRCS

NIFA Conservation Effects Assessment Project (CEAP)
Watershed Assessment Studies

Insights for Developing Successful Agricultural Watershed Projects

Thirteen agricultural watershed projects were funded jointly by the USDA National Institute of Food and Agriculture (NIFA) and Natural Resources Conservation Service (NRCS) to evaluate the effects of cropland and pastureland conservation practices on spatial and temporal trends in water quality at the watershed scale. In some projects, participants also investigated how social and economic factors influence implementation and maintenance of practices. The 13 projects were conducted from 2004 to 2011 as part of the overall Conservation Effects Assessment Project (CEAP). The NIFA-CEAP projects were mainly retrospective; most conservation practices and water quality monitoring efforts were implemented through programs that occurred before the NIFA-CEAP projects began. By synthesizing the results of all these NIFA-CEAP projects, we explore lessons learned about ***developing agricultural watershed projects to investigate conservation practices in relationship to water quality changes***.



NIFA-CEAP watershed locations.

Background

Major government programs to assess the effects of agricultural conservation practices on water quality at the watershed scale go back to the 1970s and include such programs as the 1978—1982 Model Implementation Program (MIP), the 1980—1995 Rural Clean Water Program (RCWP), the 1991—1994 Hydrologic Unit Area Program (HUA), and the ongoing National Nonpoint Source Monitoring Program (NNPSMP). While some of these projects succeeded in showing how water quality responded to land treatment at a watershed scale, many did not. Reasons for this are varied and include failure to implement enough of the right conservation practices in the right places, along with an inability to use available land treatment or water quality monitoring data to detect change or attribute observed water quality to changes in land management. Equally important are the dramatic variability in weather from year to year, differences in human behavior, and the lag time between implementing conservation practices and water quality response. The NIFA-CEAP projects attempted to overcome some of these obstacles (Osmond et al. 2012, in press).

Reductions in federal and state funding for conservation planning and implementation, increasing costs for both, and rising demands for accountability, all combine to require that critical resources be used as efficiently as possible to protect water quality. Agencies and organizations promoting and implementing conservation practices must carefully design programs to correctly prioritize specific problems and watershed locations and to provide convincing evidence of program effectiveness. We cannot afford to continue to disregard lessons learned from past watershed-scale analyses; these lessons must be incorporated into national and local conservation planning.

From the NIFA-CEAP experience and the synthesis project (Osmond et al. 2012, in press), we have developed a series of lessons learned about how to design and conduct a watershed land treatment and water quality project. Heeding these lessons will improve chances of success. These lessons are presented here as a recommended protocol for developing and implementing agricultural watershed projects. Additional resources are cited at the end of this fact sheet.

The most important lesson is that an effective watershed management program requires many participants working in concert, with input from key stakeholders, including farmers and others affected by water quality concerns and the actions proposed to address them.

A Recommended Protocol for Developing Agricultural Watershed Projects

Work at a watershed scale: Although agricultural conservation may occur at a local or county scale, overall assessment of project effectiveness in protecting water quality must be done at a watershed scale. Generally, the smaller the watershed area, the greater the ability to determine the effects of conservation practices on water quality. Tracking land management and conservation practices and controlling for other sources of pollutants are easier in small watersheds, and lag times between treatment and response may be shorter than in larger watersheds.

Develop and assess background information: Background data are essential to define the water quality problem and set project goals. Therefore, it is critical to assemble and assess existing information to support project objectives and design, particularly the suitability of historical data for present purposes. When assessing the availability of critical spatially and temporally specific watershed information, consider the following:

- Watershed physiographic data (e.g., soils, topography, climate)
- Land use and agricultural management data
- Water quality data (e.g., state monitoring programs, special watershed projects)
- Modeling information (availability and quality of data needed to parameterize a model)
- Socioeconomic data (e.g., local economic conditions, demographics, attitudes toward conservation)

Define the problem: The water quality problem must be clearly defined using background water quality information to answer these questions:

- What is the water quality impairment?
- What are the important pollutants and their sources?

Determine land treatment options: Background land use information must be compiled and verified to answer these questions:

- What are the agricultural practices contributing to the water quality problem?
- What conservation practices exist to address the water quality problem?
- Are available conservation practices functional and adaptable to local production systems?

Determine the human factors: Background socioeconomic information must be used to find out the following:

- What individual and community characteristics contribute to the problem?
- What individual and community characteristics contribute to the potential solutions?

Set project objectives: Project objectives must be clearly defined to determine the endpoint toward which the project is striving. This should be done in collaboration with all watershed stakeholders to develop a shared vision for outcomes and procedures:

- Water quality outcomes (e.g., restore a fishery, meet water quality standards, achieve load reduction prioritizations)
- Conservation practice implementation (e.g., numbers of practices installed, prioritized locations, acres treated, change in agrichemical use)
- Water quality monitoring (e.g., annual pollutant load, storm event concentration, detection of change over time)
- Watershed modeling (e.g., role of modeling, hypotheses to be tested)
- Socioeconomic analysis (e.g., approaches promoting conservation adoption, education outreach activities)

Select team members carefully: Problem definition will determine the necessary team expertise. It is critical to select team members who have not only the appropriate skill sets but also a commitment to the project. Unbalanced teams lead to weak projects or, even worse, failure to achieve critical objectives.

Design the project: All planned project activities must be carefully designed to meet the established project objectives:

- Land treatment. Select conservation practices that control the pollutant(s) of concern and their sources. It is important to think through conservation practices not only as individual measures but also considering the system as a whole. The best conservation practices simply will not do the job if they do not treat the right problem.
- Critical pollutant source areas must be identified prior to implementing conservation practices, and all conservation practices need to be prioritized to these critical areas.
- Water quality monitoring. Design a monitoring strategy to detect change in pollutant concentration or load in response to land treatment:
    - o Monitor the water quality variables that best match the water quality problem, the pollutant sources, and the conservation practices being implemented. Look for creative or alternative indicators of response to treatment.
    - o Understand watershed hydrology to guide effective monitoring.
    - o Select monitoring designs such as paired-watershed, above/below, or multiple sub-basins that can control for effects of weather and other sources of variability.
    - o Establish the statistical design for monitoring at the outset. In many cases, it is important to collect background data by monitoring before land treatment begins.
    - o Follow good monitoring practices that provide accurate measurements of desired parameters often enough to be capable of detecting response to treatment.
    - o Coordinate monitoring activities in a comprehensive quality assurance and quality control program that assures the collection of useful data of high and consistent quality.
- Land treatment monitoring. No matter how rigorous the water quality monitoring program, it will be impossible to link observed changes in water quality to land treatment without rigorous monitoring of conservation practice implementation and management activities. Land use and agricultural management tracking—including attention to long-term operation and maintenance of installed conservation prac-

tices—must be coupled with water quality monitoring.

- Modeling. Model application for conservation assessment and planning at the watershed scale must address these concerns:
  - o Select a model based on its ability to represent essential characteristics of the system and land treatment options at desired spatial and temporal scales. Consider also the availability of hydrologic and water quality data along with watershed data, such as chemical usage and conservation practices, that are required to run the model.
  - o Adopt procedures for model parameterization, calibration and validation, and evaluation of uncertainty.
  - o Develop a formal Quality Assurance Project Plan (QAPP) for model application prior to conducting the effort.
  - o Provide adequate technical and personnel support for the modeling effort.
- Socioeconomic analysis. Use knowledge of social and economic conditions in the watershed to identify factors that influence farmers' adoption of conservation practices, to develop cost-share approaches and other incentives, and to leverage institutional influences on conservation. Plan economic modeling to evaluate real trade-offs between conservation and farm finances and to apply the results of economic analysis to support project goals.
- Outreach. Develop a comprehensive outreach education plan with goals, objectives, target audiences, implementation strategies, and responsibilities at the beginning of the project, and adjust the plan as the project proceeds. Provide opportunities for one-on-one education, coordinated by a trusted educator experienced in local farming practices and respected in the community. Farmer-led groups can be very effective. Integrate outreach education into the overall project leadership team.

Allocate and coordinate resources, including funding and personnel: Be certain that adequate funding exists to support planned activities. Conducting an inadequate program simply because it is within budget can be a waste of resources.

- Focus particular attention on assembling personnel with the knowledge and skill to conduct the monitoring, modeling, and other technical project activities.
- Establish the proper sequence for project activities so that all project components have required information at the proper time.
- Integrate water quality monitoring, simulation modeling, and conservation practice implementation into coordinated activities that encourage communication and feedback among participants throughout the project.

Identify and forge partnerships: Partnerships are essential for all aspects of the project to work together. Identify and engage watershed stakeholders and key partners during the planning stage, including local farmers, government agencies, universities, and watershed groups. Pay particular attention to entities that may be beneficiaries of improved water quality (e.g., drinking water customers); such groups are critical partners in the watershed project.

Review progress and adapt: Constant oversight and monitoring are necessary to make sure the project stays on course and to minimize the impact of errors and surprises.

- Review status and collected data regularly to assess progress as project activities continue.
- Make changes to appropriate project activities based on the review.
- Build in frequent communication and feedback opportunities so that problems can be addressed quickly and project work adapted to changing situations.

Analyze results: Careful data analysis and interpretation are required to turn data into information.

- Analyze collected data to address project objectives using appropriate tools.
- Characterize confidence levels and uncertainties as they apply to conclusions drawn from the data.

Report outcomes and highlight accomplishments: Conveying project results in a useful manner is the final step and critically important. The audience is diverse, and a variety of methods and channels are needed to deliver findings.

- Allocate adequate time and resources for effective reporting of project results to the scientific community, watershed farmers, resource managers, and other stakeholders.
- Use a broad spectrum of reporting media; do not rely only on individual journal articles or printed reports to communicate the project's important outcomes.
- Actively extend project findings to local, regional, and national stakeholders.

Related Resources

Arabi, M., D. W. Meals, and D. Hoag. 2012. Lessons Learned from the NIFA-CEAP: Effective Education to Promote Conservation Practice Adoption. NC State University, Raleigh, NC. Online: http://www.soil.ncsu.edu/publications/NIFACEAP/Factsheet_6.pdf

Davenport, T. E. 2003. The Watershed Project Management Guide. New York: Lewis Publishers.

Gale, J.A., D.E. Line, D.L. Osmond, S.W. Coffey, J. Spooner, J.A. Arnold, T.J. Hoban, and R.C. Wimberley. 1993. Evaluation of the Experimental Rural Clean Water Program. National Water Quality Evaluation Project, NCSU Water Quality Group, Biological and Agricultural Engineering Department, NC State University, Raleigh, NC, EPA-841-R-93-005, 559p.

Hoag, D., A. E. Luloff, and D. L. Osmond. 2012. Lessons Learned from the NIFA-CEAP: How Farmers and Ranchers Make Decisions on Conservation Practices. NC State University, Raleigh, NC. Online: http://www.soil.ncsu.edu/publications/NIFACEAP/Factsheet_3.pdf

Jennings, G. D., D. Hoag, M. McFarland, and D. L. Osmond. 2012. Lessons Learned from the NIFA-CEAP: Effective Education to Promote Conservation Practice Adoption. NC State University, Raleigh, NC. Online: http://www.soil.ncsu.edu/publications/NIFACEAP/Factsheet_4.pdf

Knowler, D. and B. Bradshaw. 2007. Farmers' adoption of conservation agriculture: A review and synthesis of recent research. Food Policy 32:25-48.

Meals, D. W., D. L. Osmond, J. Spooner, and D.E. Line. 2012. Lessons Learned from the NIFA-CEAP: Water Quality Monitoring for the Assessment of Watershed Projects. NC State University, Raleigh, NC. Online: http://www.soil.ncsu.edu/publications/NIFACEAP/Factsheet_5.pdf

Meals, D.W., S. A. Dressing, T. E. Davenport. 2010. Lag time in water quality response: A Review. J. Environ. Qual. 39:85-96.

Mesner, N. and G. Paige. 2011. Best Management Practices Monitoring Guide for Stream Systems. Publication B-1213. Laramie, WY: University of Wyoming.

Osmond, D., D. Meals, D. Hoag, and M. Arabi. 2012 (in press). How to Build Better Agricultural Conservation Programs to Protect Water Quality: The NIFA-CEAP Experience. Akeney, IA: Soil and Water Conservation Society. (Available Fall 2012)

Osmond, D. L., D. W. Meals, A. N. Sharpley, M. L. McFarland, and D. E. Line. 2012. Lessons Learned from the NIFA-CEAP: Conservation Practice Implementation and Adoption to Protect Water Quality. NC State University, Raleigh, NC. Online: http://www.soil.ncsu.edu/publications/NIFACEAP/Factsheet_2.pdf

Osmond, D. L., S. W. Coffey, J. A. Gale, and J. Spooner. 1995. Identifying and Documenting a Water Quality Problem: The Rural Clean Water Program Experience. Raleigh: NC State University Water Quality Group. Online: http://www.water.ncsu.edu/watershedss/info/brochures/four.html.

Prokopy, L. S., K. Floress, D. Klotthor-Weinkauf, and A. Baumgart-Getz. 2008. Determinants of agricultural best management practice adoption: Evidence from the literature. J. Soil Water Conserv. 63(5):300-311.

Spooner, J., D. E. Line, S. W. Coffey, D. L. Osmond, and J. A. Gale. 1995. Linking Water Quality Trends with Land Treatment Trends: The Rural Clean Water Program Experience. Raleigh: NC State University Water Quality Group. Online: http://www.water.ncsu.edu/watershedss/info/brochures/ten.html

Tomer, M. D. and M. A. Locke. 2011. The challenge of documenting water quality benefits of conservation practices: A review of USDA-ARS conservation effects assessment project watershed studies. Water Sci. Technol. 64:300-310.

U.S. Dept. of Agriculture (USDA). 1996. National Handbook of Water Quality Monitoring: Part 600. Washington, DC: USDA Natural Resources Conservation Service. Online: http://directives.sc.egov.usda.gov/viewerFS.aspx?hid=21533

U.S. Environmental Protection Agency (EPA). 1997b. Monitoring Guidance for Determining the Effectiveness of Nonpoint Source Control Projects. EPA 841-B-96-004. Washington, DC: Office of Water.

U.S. EPA. 2008. Handbook for Developing Watershed Plans to Restore and Protect Our Waters. EPA 841-B-08-002. Washington, DC: Office of Water, Nonpoint Source Branch. Online: http://www.epa.gov/owow/NPS/watershed_handbook/pdf/handbook.pdf

Information

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Lessons Learned from the NIFA-CEAP (http://www.soil.ncsu.edu/publications/NIFACEAP/)

NIFA-CEAP watershed information (www.eramsinfo.com/ceap/watershedstudies)

CEAP Homepage: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/ceap

CEAP NIFA Watershed webpage: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/?&cid=nrcs143_014164

Acknowledgments

The authors are grateful for the funding supplied by the USDA National Institute of Food and Agriculture (NIFA) and Natural Resources Conservation Service (NRCS) (Agreement No. 2007-51130-18575). We want to thank all NIFA-CEAP project personnel for their help with this publication, our site visits, and our information-gathering efforts. In addition, we greatly appreciate all the time spent by key informants during our interviews with them. We also wish to thank the USDA CEAP Steering Committee and USDA NIFA Committee for Shared Leadership for Water Quality for their comments, questions, and advice during this synthesis project, as well as a special thanks to Lisa Duriancik of NRCS.

This material is based upon work supported in part by the National Institute of Food and Agriculture and the Natural Resources Conservation Service, U.S. Department of Agriculture, under Agreement No. 2007-51130-18575. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture. USDA is an equal opportunity provider and employer.

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Citation

Meals, D. W., D. L. Osmond, D. Hoag, M. Arabi, A. E. Luloff, G. D. Jennings, M. L. McFarland, J. Spooner, A. N. Sharpley, and D. E. Line. 2012. Lessons Learned from the NIFA-CEAP: Developing Agricultural Watershed Projects. NC State University, Raleigh, NC.