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Enhancing conservation on agricultural landscapes:
A new direction for the Conservation Effects Assessment Project

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Now, more than ever, we need solutions to the complex challenges of meeting the nation's food, fiber, feed, and fuel needs while simultaneously enhancing the environment. As agriculture strives to meet future production goals including new demands for bioenergy, both our agricultural ecosystems and our natural resources are likely to face unprecedented pressures and levels of intensity. The challenge of protecting and enhancing environmental quality through effective conservation becomes even more important when this new agricultural production paradigm is viewed in light of the mounting environmental stresses expected for future decades. Increased biomass production for alternative fuel sources (Schnoor et al. 2007), climate change and the associated increased probability of extreme events (SWCS 2007), and looming drought and water security challenges (Dobrowolski et al. 2004) will make the task of reducing risk to natural resources even more difficult.

In 2003, the Conservation Effects Assessment Project (CEAP) was initiated by the USDA Natural Resources Conservation Service (NRCS) in partnership with other USDA agencies (Agricultural Research Service, Cooperative State Research, Education, and Extension Service, Farm Service Agency, and National Agricultural Statistics Service). CEAP was established to develop a scientific understanding and methodology for estimating the environmental benefits and effects of conservation practices on agricultural landscapes at national, regional, and watershed scales. Since its inception, CEAP has grown into a multi-agency, multi-resource effort. In another article in this CEAP special issue of the *Journal of Soil and Water Conservation*, Duriancik et al. (2008) describe the approach and summarize the accomplishments of the first five years of CEAP.

In this article, we describe our vision for new directions for CEAP—a science-based plan designed to help meet the conservation and technology challenges of the future through a coordinated multi-agency assessment, research, and outreach-extension program.

RECOMMENDATIONS INFORM VISION FOR CEAP

Our vision for the future of CEAP is built upon coordinated agency planning that identifies next steps, recommendations toward enhancing the effectivenesss of conservation on the landscape, and insights from experts. Workshops have been sponsored to address the topic, convening the top experts in the nation to offer their thoughts (Schnepf and Cox 2007). Also, in 2005, USDA engaged the Soil and Water Conservation Society (SWCS) to assemble a panel of academics and conservation community leaders (the SWCS CEAP Blue Ribbon Panel). This panel was charged with providing recommendations on how to ensure that CEAP is relevant, responsive, and credible. CEAP products should have utility for program managers, policy makers, and the conservation community. The Blue Ribbon Panel strongly endorsed the goal of CEAP. However, the panel recommended that the CEAP plan be expanded and adjusted: "CEAP must change direction to become the coherent, science-based assessment and evaluation system … needed" (SWCS 2006).

Following release of the Blue Ribbon Panel's recommendations, CEAP expanded research, assessment, education, and outreach efforts to not only address the effects and benefits of conservation practices but also to determine how to best manage agricultural landscapes to more effectively meet environmental goals at local, regional, and national levels.

CEAP—NEW DIRECTIONS

The CEAP vision is enhanced natural resources and healthier ecosystems through improved conservation effectiveness and better management of agricultural landscapes. The goal of CEAP for the future is to improve efficacy of conservation practices and programs by providing the science and education base needed to enrich conservation planning, implementation, management decisions, and policy. We will address this goal by creating and using knowledge gained through CEAP research and outreach to enhance conservation planning and decision making tools and by continuing to assess environmental and ecosystem effects of conservation.

Three principal coordinated activities will guide investments in addressing the goal of CEAP: (1) research, (2) assessment, and (3) applying knowledge (see sidebar on focusing the future of CEAP). The research and assessment activities will continue to address the effects of conservation on croplands, wetlands, wildlife, and grazing lands (Duriancik et al. 2008). In addition, as we move ahead, we will integrate research and assessment across these four component areas and examine cross-resource effects. We can now begin to synthesize lessons learned from our previous research, and then apply this knowledge to "translate science into practice." CEAP will address forward-looking questions, helping us improve decisions about how and where to implement practices on the landscape and how to gain the most from our conservation efforts to improve environmental quality.

A cross-cutting focus throughout CEAP will be to work toward establishing a framework for measuring and reporting the full suite of ecosystem services (see sidebar on ecosystem services) provided by conservation practices. Agricultural lands that produce market commodities also provide ecosystem services such as flood mitigation, pollination, wildlife habitat and biodiversity, carbon sequestration, nutrient cycling, aesthetics, and recreation. These ecosystem services are often under-priced or un-priced by the marketplace. A riparian buffer, for example, not only reduces the transport of soil and agricultural chemicals to streams but also provides habitat for wildlife and reduces greenhouse gases by sequestering carbon, thus reducing greenhouse gas emissions. CEAP research and assessment activities will develop the science basis for measuring ecosystem services enhanced through conservation practices and programs.

Focusing the future of CEAP:
Translating CEAP science into practice

CEAP will accomplish the following objectives:

- Research and assess conservation effects on croplands, wetlands, wildlife, and grazing lands.
- Research and apply how to best manage agricultural landscapes for environmental quality.
- Establish a framework for determining and reporting the ecosystem services provided by conservation.
- Broaden assessment capabilities to address priorities for future program design and implementation.
- Reduce uncertainty in model estimates of conservation benefits.

What are ecosystem services?

Ecosystem services are the processes or products attributable to the natural environment that are valued by human beings. These ecosystem services are often taken for granted (Ecological Society of America 2000).

The Millennium Ecosystem Assessment (Hassan et al. 2005) recognizes four types of ecosystem services:

1. Supporting services (e.g., primary production, nutrient cycling, soil formation)
2. Provisioning services (e.g., food, fresh water, wood and fiber, fuel)
3. Regulating services (e.g., climate regulation, flood regulation, disease regulation, water purification)
4. Cultural services (e.g., aesthetic, spiritual, educational, recreational)

RESEARCH: STRENGTHENING THE SCIENCE BASE

The primary focus of future CEAP investigations will be to determine how to manage agricultural landscapes for environmental quality.

The research agenda will be about determining where to place conservation practices on the landscape to achieve the desired outcomes or the most good. This is a necessary foundation for determining whether and how we need to change the way conservation programs are designed and implemented. There are two aspects to this work.

First, CEAP research will address off-site environmental effects. Most prior research addressed edge-of-field effects, the environmental effects of conservation practices at the field or farm level (Schnepf and Cox 2006). At the field level, soil erosion control and soil quality enhancement are often clearly evident to farmers and ranchers practicing conservation. Off-site environmental effects, however, are determined not only by what happens on an individual field or farm but are also the result of multiple conservation activities within the watershed or landscape. Off-site benefits constitute the ecosystem services provided by agricultural landscapes that commonly go unnoticed by individual farm operators and landowners. The focus of CEAP watershed studies during the first five years was on documenting the off-site effects of conservation at the watershed or landscape scale through retrospective analysis, including analysis of long-term data records (Duriancik et al. 2008). Interactions among suites of practices were also investigated. CEAP research in the next five years will further our understanding of the off-site environment effects of conservation practices at watershed and landscape scales.

Second, watershed or landscape components commonly contribute disproportionately to off-site benefits or, in the absence of conservation, to off-site pollution or environmental degradation (Nowak and Pierce 2007). Both biophysical and socioeconomic factors can contribute to the unequal effects of conservation. In some instances, biophysical attributes can make a certain landscape area particularly vulnerable to environmental degradation (Walter et al. 2007). In other cases, social or economic influences affect conservation adoption or maintenance, leading to disproportionate off-site impacts at the watershed or landscape scale (Nowak et al. 2006). Areas where both biophysical and socioeconomic factors influence conservation behavior present conservation opportunities with great potential impact.

Thus, the future CEAP research agenda will be to identify land units within a watershed or landscape capable of producing the most off-site benefits—or the greatest reduction of risk—and to determine how to treat these units to achieve maximum environmental benefits while minimizing conservation investments.

Meeting this challenge will require developing watershed models that reduce the uncertainty of predicting biophysical factors that impact conservation. A number of unresolved issues related to the conduct of the research remain. The development and refinement of reliable models is a complex task that must take into account the locations and concentration of practices applied on the land. Researchers must determine the appropriate scale and units of measurement to use, and they must choose appropriate remote sensing or other methods to collect meaningful data. Findings related to methodology could have profound positive impacts well beyond the scope of any individual study.

There is also a need to increase our understanding of the human dimensions of conservation behavior (Nowak et al. 2006) beyond what we have already learned through CEAP and other studies. Education has been shown to contribute to conservation behavior and practice adoption (Andrews et al. 2002), but ultimately producers are sensitive to how the cost of adopting a practice affects their economic well-being (i.e., the bottom line). What other incentives influence the adoption of conservation practices by farmers, who adopts certain practices and why, and what socioeconomic factors influence adoption decisions? Because the value of environmental benefits may be influenced by human uses and/or perceptions, additional important socioeconomic questions may include the value of the ecosystem services generated by conservation practices. For example, different units of land may each contribute significantly to an off-site effect, but an impact on human health may increase the value of one unit over the other (Kareiva and Marvier 2007). Understanding these values can improve the delivery of conservation practices. Therefore, another area of investigation will be to develop and enhance ways in which to value the environmental benefits derived from conservation practices.

Some examples of future CEAP research opportunities include the following:

- Continue and expand CEAP projects on the effects and benefits of conservation practices for soil and water quality and wildlife habitat at the watershed and landscape scales.
- Implement a new initiative designed to provide the science base for implementing management practices for grazing lands at the landscape scale.
- Expand the scope to include the effects of conservation practices on water availability, water conservation, and air quality at the watershed or landscape scale.
- Determine what should be measured, and where, to account for environmental benefits.
- Expand the scope of study in all study areas to include measurement of a broader suite of benefits attainable from conservation practices and programs.
- Identify social and economic factors that promote or hinder adoption of appropriate conservation practices.
- Develop and enhance methods for valuing changes in environmental benefits derived from conservation practices.
- Experiment with and evaluate alternative conservation strategies.

ASSESSMENT: ESTIMATING THE EFFECTS OF CONSERVATION

The goal of the CEAP national and regional assessments is to help policy makers and program managers implement existing or design new conservation programs to more effectively and efficiently address resource concerns. Assessment efforts that focus on identifying conservation treatment needs and priorities for future conservation program design, policy, and implementation will be expanded. The primary focus of future CEAP assessment activities will be to develop and apply databases and modeling applications and tools that reduce the uncertainty associated with the estimation of conservation effects.The assessments are the primary tool for estimating benefits from conservation at a regional or national scale. However, assessments at regional and national scales should be more closely linked to watershed- and landscape-scale efforts to produce geographically relevant, reliable estimates of the benefits of conservation. The original design of CEAP recognized this and established watershed- and landscape-scale studies to document detailed, temporally and spatially explicit, measurable effects of conservation (Duriancik et al. 2008). Therefore, the assessments must use this detailed knowledge and, eventually, tested modeling enhancements to reduce the uncertainty currently embedded in regional or national estimates of conservation impacts (O'Neill et al. 2008). Decreasing the difference between model forecasts and measurable impacts will improve both current estimates of conservation benefits and the accuracy of predicted conservation treatment priorities and needs.

Future CEAP assessment activities include the following:

- Continue CEAP initiatives of the first five years to estimate environmental benefits of conservation practices and programs for reporting at the national and regional levels.
- Develop a capacity for integrated biophysical and socioeconomic assessment to understand the full range of effects from conservation efforts.
- Develop a framework for reporting the benefits of conservation practices and programs in terms of ecosystem services at national and regional scales.
- Identify conservation treatment needs at the national/regional level for cropland, wetlands, wildlife, and grazing lands.
- Expand capabilities to assess potential impacts of changes in agricultural land use or agriculture policies, and evaluating options for changing conservation programs to meet new environmental challenges brought about by policy and land use changes.
- Expand capabilities to assess potential producer responses to changes in policies and economic conditions and the resulting environmental impacts.
- Complete data collection, model development, and estimation of ecosystem services for wetland regions, and develop a national wetlands monitoring framework within the National Resources Inventory (NRI) to provide information that will support improved conservation decisions affecting wetlands in agroecosystems and to provide the capability to assess alternative conservation approaches for wetland establishment and management.
- Develop the capability to assess the contributions made by conservation practices in meeting habitat objectives established by technical elements of the fish and wildlife conservation community.
- Update the NRI CEAP survey database in 2011 and associated model estimates to establish baseline data and report long-term trends in monitoring progress toward reducing nutrient loads from agricultural land management activities nationwide.
- Improve remote sensing data collection techniques to inform CEAP rangeland, pastureland, and grazed forest assessments by establishing the relationship between low-resolution, extensive remotely sensed data and high-resolution, intensive ground data.
- Improve and set parameters among models using site-specific data from NRI and other sources to conduct studies of conservation treatment effects.
- Develop the ability to estimate the value of ecosystem service benefits derived from conservation practices.

USING KNOWLEDGE: TRANSLATING SCIENCE INTO PRACTICE

A critical aspect to achieving the vision for CEAP is translating the knowledge gained from the many CEAP research, outreach, and assessment activities during the first five years into conservation practice.These findings are now becoming available. For example, the USDA Agricultural Research Service has prepared a synthesis of findings on watershed-specific effects of conservation practices on environmental quality as well as on ways of improving and validating models used by NRCS in the national/regional assessments (Richardson et al. 2008). Also available are insights drawn from the recently published CEAP bibliographies and literature reviews (Duriancik et al. 2008). Over the next several years, the competitive grant watershed projects will also be systematically analyzed and lessons learned drawn at ecoregional and national scales. The different scales of the various studies (watershed/local or regional/national) lend themselves to being used by different audiences at a variety of levels (local/county/district, regional, national) and in differing ways.

The development of new tools, technologies, and management practices is a major step toward improving the management of agricultural landscapes. The adoption of these tools, technologies, and practices by agricultural producers and land managers is a critical link between building the knowledge base and putting it to work on the landscape. Translating science into practice is fundamentally about linking biophysical knowledge and models with social, economic, and behavioral knowledge and models to achieve

environmental goals. We need to better understand the factors that promote or inhibit the adoption of the best available conservation practices and technologies on the landscape. These factors may be economic, social, cultural, or behavioral; new research is needed to link these factors with existing biophysical models of water quality and other environmental factors to explore how management choices and decisions affect environmental conditions on the landscape.

Some of the specific CEAP activities for translating science into practice will include the following:

- Determine the tools and resources needed by NRCS field offices, county extension educators, and other conservation planners to carry out a landscape management approach to conservation practice implementation, including a process for goal setting at the local level.
- Develop the tools for assessing the costs and benefits of participating in conservation programs as perceived by producers. Through this cooperative effort we should enhance conservation program design by recognizing producer incentives.
- Develop tools that can be used by NRCS field offices, county extension staff, or other conservation planners to determine where and what practices are most needed on the landscape to effectively and efficiently meet environmental goals.
- Engage conservation planners and agricultural producers in the design and implementation of pilot watershed- or landscape-scale studies, with appropriate monitoring strategies, that demonstrate landscape management and adaptive management approaches to conservation implementation.
- Develop innovative, participatory strategies for translating science into practice with farmers, ranchers, county extension educators, and NRCS field office staff, expanding their opportunities to enhance environmental quality by participating in landscape management approaches to conservation practice implementation, including assessments of what kinds of educational and outreach tools and approaches would be the most effective.
- Communicate findings and lessons learned about managing agricultural landscapes to a broad audience and develop an overall communication strategy to ensure that the best available science is used to inform policy and decision making.

STRENGTHENING PARTNERSHIPS

Another effort planned for the future of CEAP is to build and strengthen partnerships within USDA and with other federal, state, and local agencies and nongovernmental organizations to improve the effectiveness of conservation programs both in building the science base and in the planning and delivery of conservation programs. Other agencies with natural resource interests—USDA Farm Service Agency, USDA Economic Research Service, USDA National Agricultural Statistics Service, US Environmental Protection Agency, US Geological Survey, US Fish and Wildlife Service, National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration, and US Forest Service—are currently cooperating in CEAP, either through the interagency CEAP Steering Committee/Executive Steering Committee or through jointly funded projects. Universities, nongovernmental conservation organizations, and state agencies are also making valuable contributions to CEAP and are involved in many of the research and assessment activities.

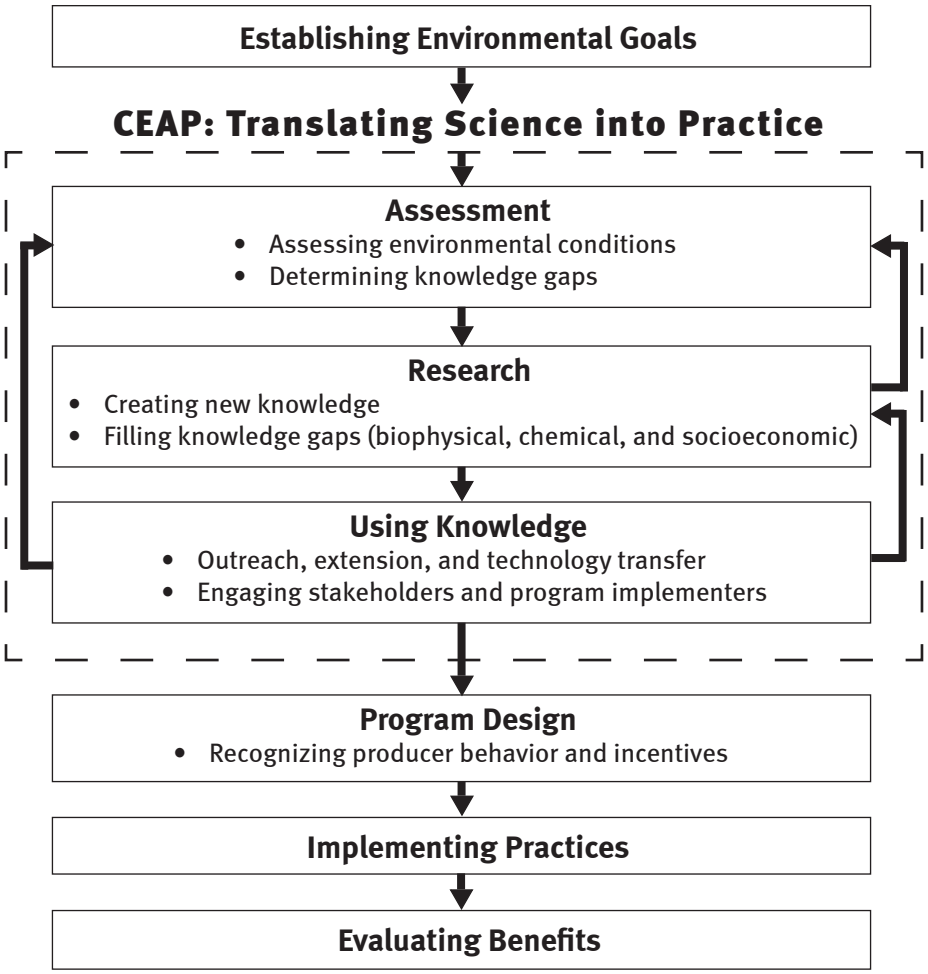
There are opportunities to expand collaboration with these and other agencies and organizations that will not only benefit CEAP but will also help these agencies and organizations accomplish their own mission goals. Some of the collaboration and cooperation opportunities that will be explored are as follows:

- Coordinate more closely with other regional and national initiatives that address agricultural pollution problems, such as the Chesapeake Bay Program, Gulf of Mexico Hypoxia Task Force, National Integrated Water Program, Coral Reef Initiative, and the US Environmental Protection Agency's Wadeable Streams Survey.
- Increase collaboration with agencies and organizations responsible for environmental monitoring and modeling—such as US Geological Survey, US Environmental Protection Agency, National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, and the National Ecological Observatory Network of the National Science Foundation—to better account for the benefits of conservation practices and programs.
- Engage interested agencies and organizations in enhancing and expanding the economic/human dimension in CEAP research and assessment activities, such as establishing methodologies and approaches for economic valuation of conservation benefits.
- Work more closely with professional societies and other organizations to communicate the research and assessment findings to a broad audience of technical specialists, environmental program managers, policy makers, and the general public.
- Coordinate with similar projects addressing the effects and benefits of conservation practices and landscape management in Canada (particularly the Watershed Evaluation of Beneficial Management Practices program), Mexico, and Europe.

We must recognize a complex decision-making arena for managing agricultural landscapes that spans national policy making, allocation of resources at state and local levels, and individual decision making at the farm or field scale. Research, extension, and outreach programs must be designed

Figure 1

Translating science into practice for enhanced delivery of conservation programs.



to engage appropriate decision makers in the research and education process so that solutions are consistent with national, state, or local policy and reflect the local knowledge of technical experts and agricultural producers. The scope of CEAP will be broadened to include conservation practitioners, generating science-based guidance, information, and decision support tools for determining which practices should be implemented on the landscape and where, and to collaborate with conservation program managers to build a "blueprint" for science-based delivery of conservation programs (figure 1).

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