

Conservation Outcomes from Pastureland and Hayland Practices

Assessment, Recommendations, and Knowledge Gaps



The Conservation Effects Assessment Project (CEAP) is a multiagency effort to quantify scientifically the environmental outcomes of conservation practices used by private landowners.

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FOREWORD

Forages and grasslands have long been important for the food supply of humans, mainly through ruminant animals and wildlife. Early on, production of food and farm income was sometimes accomplished at the expense of the environment. Early in the 20th century, while U.S. agriculture felt the brunt of the depression and the dust bowl, strong public interest emerged in conservation and new concepts of grassland agriculture. The Soil Conservation Service was formed, new regulations were enacted, and cost-share programs were established to assist farmers with conservation goals. Now, early in the 21st century, the USA is recognizing that agriculture, and especially grassland agriculture, provides multiple services to humankind.

The pastureland conservation effects assessment project (CEAP) is a multiagency effort by the Natural Resources Conservation Service (NRCS), National Institute of Food and Agriculture (NIFA), Agricultural Research Service (ARS), and National Resources Inventory (NRI) to quantify environmental effects of conservation practices used by landowners participating in selected USDA programs. In 2008, writing teams of university, ARS, and NRCS scientists were assembled to address the science base for conservation practice standards for 1) pasture and hayland planting, 2) prescribed grazing, 3) harvest management, and 4) nutrient management. Integrated syntheses incorporating socioeconomic concerns were also made. The goal was to inform NRCS, scientific and outreach communities, and especially policy advisors of the current status. The literature synthesis itself is a landmark contribution on effects of conservation practices on environmental goods and services derived from U.S. pastures and haylands.

The writing teams are commended for their detailed literature search, thorough review, and salient assessment of the science base for conservation practices. Without their due diligence and persistent efforts the assessment would not be as detailed or effective. It is not easy to compare conservation data from experiments using different species, soils and climates, yet common features were teased out and assessed. In some cases solid themes emerged, while in others there was not enough research data to evaluate, fully, which was duly pointed out. Each team provided conclusions and pointed to new directions. Thanks are due to the ARS (Matt A. Sanderson) and NRCS (Leonard W. Jolley) for agency liaison and to C. Jerry Nelson for professional and editorial leadership on the project.

As an organization that encourages economically and environmentally sound forage agriculture, the American Forage and Grassland Council is pleased to be a part of this major effort. There is a strong need for mechanisms that help producers and agencies work together to apply science in ways that improve both incomes and the environment. It is also critical to discern research needs to fill knowledge gaps and support more effective management decisions. This authoritative book also provides the foundational framework to move toward even more effective practice criteria for conservation and a strong science base to undergird them.

We know this effort will assist in advancing the broader values of pastures and hay fields. It will also better equip landowner clients and agency personnel to develop, implement, and utilize management practices that best provide an adequate income for the producer while enhancing the environment and providing other ecosystem services to improve the quality of life for everyone.

Bob Hendershot, AFGC President (2010–2011)

Miles Kuhn, AFGC President (2009–2010)

Bill Tucker, AFGC President (2008–2009)

Gary Pederson, AFGC President (2007–2008)

PREFACE

Pastureland and hayland are known to reduce soil erosion and play important roles in land stewardship on diversified farms. The Dust Bowl of the 1930s stimulated the concept of grassland agriculture: an on-farm system in which pastures and hay fields play significant roles in crop rotations and soil conservation. In addition, the contributions of nitrogen fixation and organic matter were recognized and utilized. But lower cost fertilizers, especially nitrogen, improved genetics, and increased use of herbicides, pesticides, larger machinery, and other technologies led to higher crop yields, increased farm sizes, and specialization. Gradually livestock enterprises became concentrated in areas or regions where row crops were less competitive.

At the same time there was a new era of public interest in agriculture regarding use of chemical fertilizers and pesticides with the focus on food safety. This was heightened by Rachel Carson's *Silent Spring*, which criticized pesticide use and stimulated formation of the Environmental Protection Agency and movement toward organic agriculture and sustainability. Concern continued to increase about "corporate agriculture," how food supplies were affected by industry, and implications for human health and the environment, well beyond soil conservation. Today food and agricultural products are expected to be produced in a sustainable manner that maintains or improves the physical environment, ensures food safety, provides desired taste and nutrition, and provides adequate food and habitat to support biological diversity. Emotions speak loudly, but science is needed to document the factors involved and to drive efforts toward rational and sound solutions.

The CEAP initiative is a critical step to document the science base for conservation programs that are supported by public funds and to plan for the future. Teams of researchers located and assessed the scientific literature on four key conservation practices supported by USDA-NRCS programs. But the effort was also visionary by evaluating scientific gaps and the needs for science in the future. The document will help guide future programs and policies as well as provide insight for the scientific community to focus research on key ecosystem services to serve humanity. Climate change, food safety, water quality, and preservation of biodiversity are only a few of the many factors addressed in the CEAP effort that will affect future policies and management decisions for pastureland and hayland.

The authors are commended for their exhaustive effort and analyses. This CEAP publication is a stake in the ground that should be revisited and revised on a regular basis. Science and public expectations are both dynamic; research on emerging issues needs to be conducted in a timely manner and evaluated for its application on a regular basis. It is imperative that social science and modeling be incorporated into the research agenda to fully understand the holistic process of pasture and hayland management for multiple purposes.

CEAP has been an extraordinary effort focused on a few key USDA-NRCS programs that clearly illustrates the value of science and power of its use. The implications and needs for new knowledge are also valuable to policy makers and to the research and education communities as they move forward.

C. Jerry Nelson
Editor and Academic Coordinator
Pastureland and Hayland CEAP Synthesis



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Introduction to the Conservation Outcomes from Pastureland and Hayland Practices

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The Conservation Effects Assessment Project (CEAP) is a multiagency effort to quantify scientifically the environmental outcomes of conservation practices used by private landowners. It encompasses a national assessment of conservation practices and studies of conservation practices applied to watersheds that are based on detailed syntheses of scientific literature. First, a bibliography of relevant literature was compiled (Maderick et al., 2006). The CEAP grazing lands assessment, begun

in 2006, was partitioned into rangelands, located primarily in the west, and pasture/hayland, located primarily in the east. That was followed by commissioning a synthesis of the scientific literature regarding four conservation practices on pasture and hayland with funding by the U.S. Department of Agriculture–Natural Resources Conservation Service (USDA-NRCS) through the USDA-Agricultural Research Service (USDA-ARS) and the American Forage and Grassland Council

Hay bales waiting to be taken to storage. Photo courtesy of NRCS.





Large capacity mower. Photo by Jerry Cherney.

(AFGC). A similar synthesis was conducted for rangelands (Briske, 2011).

The current CEAP document is the result of a 4-yr effort by pasture, forage, soil, animal, and watershed scientists from across the USA who thoroughly searched, compiled, interpreted, and synthesized the scientific literature regarding its support of production and environmental outcomes from conservation practices on pasture and hayland. A major purpose of CEAP is to expose scientists to needs of practitioners and expectations of policy makers who must account for intended outcomes from each conservation practice.

The overarching goal of this document is to communicate the depth and comprehensiveness of the science that supports each conservation practice on pastureland and hayland in the USA, and to report the areas where the science base is weak or inadequate. This includes answering scientific questions such as:

- Do published scientific studies support how conservation practices affect the

hydrologic cycle on pastureland or hayland?

- What is known about effects of conservation practices on soil quality, plant communities and their dynamics, and air and water quality in major agroecoregions of the USA?
- How can the conservation practices be modified or improved to be more effective?
- What research is needed to gain insight regarding how to evaluate conservation practices at multiple scales, including trade-offs among ecosystem services?

Two workshops were convened to organize the teams of authors and determine the conservation practices on which to focus the literature synthesis. The first workshop held at Louisville, KY in January 2008 included scientists from land-grant universities and USDA-ARS, technical specialists and staff of USDA-NRCS and representatives from the AFGC. The group discussed the most critical conservation issues or practices that should be addressed, defined the boundaries of the synthesis, and proposed potential writing teams. Several conservation practices

ranging from animal trails and walkways (Practice Standard 575) to watering facilities (Practice Standard 614) were considered. In the end, the consensus was that Prescribed Grazing Management (Practice Standard 528), Nutrient Management (Practice Standard 590), Pasture and Hayland Planting (Practice Standard 512), and Forage Harvest Management (Practice Standard 511) should be assessed (<http://www.nrcs.usda.gov/technical/Standards/nhcp.html>; Appendix I). Several other conservation practice standards have relevance to pasture and hayland practices and, where applicable, should be addressed partially within the chapter framework of the most critical practices.

The second workshop, held in Beltsville, MD in May 2008, brought together university scientists, USDA-ARS scientists, and program leaders from the USDA-NRCS, ARS, and the National Institute of Food and Agriculture (NIFA). This group defined the approach and framework with which to document and synthesize the science behind purported production and environmental outcomes of each conservation practice applied to pasture and hayland. A matrix of purposes and criteria for each conservation practice standard and resource concern was developed as the fundamental framework (Table I.1). The matrix was based on a similar model used by the rangeland literature synthesis teams (Briske, 2011).

An introductory chapter discusses pasture and hayland resources of the USA and resource

concerns, which is followed by assessments of the critical conservation practices in separate chapters. The cross-cutting chapter focuses on integrating the results and recommendations of the individual chapters with a look to the future (Chapter 6, this volume).

For each chapter (practice standard) the purported outcomes based on the published purposes and criteria of the conservation practice are treated as testable research questions. Quantitative evidence was assembled and synthesized to test each question or purported outcome. The responsible mechanisms behind the practice are discussed and critical knowledge gaps identified. In essence, each writing team answered the basic questions of 1) does the literature document that the practice accomplishes its goals, 2) if it does, how effectively does it work, 3) if it does not work, why not, and 4) how can the practice be improved?

The synthesis focuses on peer-reviewed literature from the USA; however, in some cases relevant international literature was consulted. In some instances, high-quality research even though not peer reviewed (i.e., gray literature) is used, but only if the report clearly defined the objectives, gave the experimental design, and presented data with quantitative estimates of precision.

Each chapter was prepared by an independent writing team of university and USDA-ARS scientists who were nominated by their peers. An academic coordinator led the editing



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TABLE I.1. The matrix of conservation practice and resource concerns used to provide structure of the literature synthesis. Outcomes and significance of the assessment were reported in six chapters.

Conservation Practice (chapter, authors)	Resource Concerns					Economic and Social Aspects (Chapter 6, cross cutting, Nelson)
	Soil	Plants	Animals—domestic and wild	Water	Air	
1. Introduction (Sanderson et al.)						
2. Pasture and hay planting (Barker et al.)						
3. Prescribed grazing (Sollenberger et al.)						
4. Forage harvest management (Nelson et al.)						
5. Nutrient management (Wood et al.)						

efforts and kept the teams on task. Each team was supported by USDA-NRCS grazing-land resource specialists from across the USA who provided information, input, and guidance on how USDA-NRCS conservation practice standards are interpreted and applied in the field. Each chapter was peer reviewed by at least two expert scientists external to the writing team. They were also reviewed by two–four NRCS specialists.

Parts of individual chapters were presented at symposia held in conjunction with the annual meetings of the American Forage and Grassland Council (AFGC) in June 2009, the Crop Science Society of America (CSSA) in November 2009, and at the Fourth National Conference on Grazing Lands (GLCI) in December 2009 (Briske et al., 2010). A summary poster of salient findings and recommendations was presented at the annual conference of the AFGC in June 2010. Summations of the findings and implications

were presented at the annual meetings of the AFGC in June 2011, and the Soil and Water Conservation Society in July 2011.

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Round bales of grass hay in Ohio. NRCS photo by Rob Rhyan.

