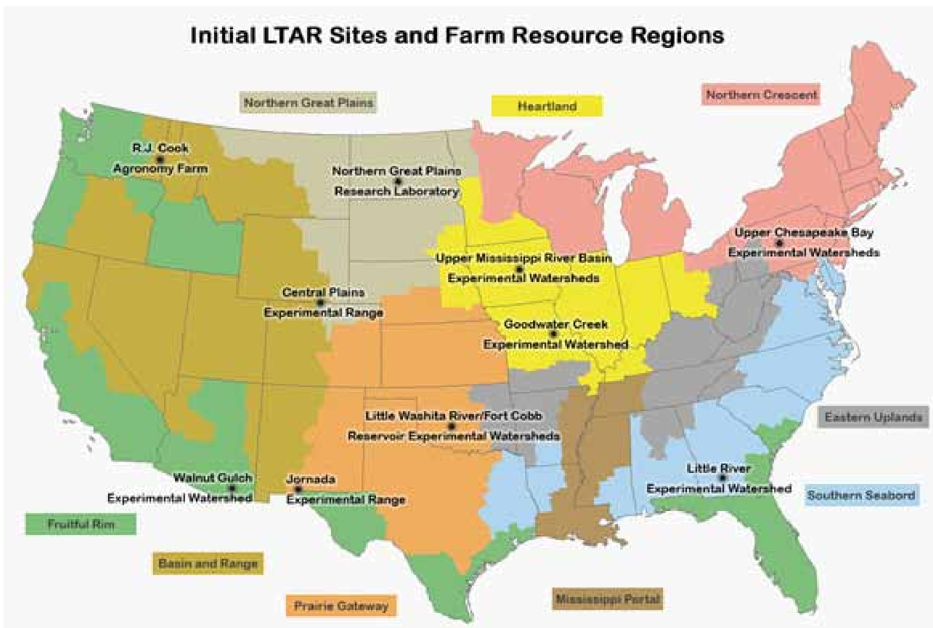

# THE LONG-TERM AGROECOSYSTEM RESEARCH (LTAR) NETWORK




## A New USDA-Wide Coordination

The USDA Agricultural Research Service (ARS) is coordinating ten of its well-established research watersheds and rangelands as a Long-Term Agroecosystem Research Network (LTAR). These locations will engage in synergistic, network-wide research to address questions related to the condition, trends, and sustainability of agricultural systems and resources on large scales of space and time. Sustainable agricultural systems that provide a safe, nutritious, ample, and reliable food supply; produce bioenergy; provide essential ecosystem services; and mitigate climate change are needed for the well-being and welfare of future generations.

One of the sites in the Long-Term Agroecosystem Research Network is coordinated by the Northern Great Plains Research Laboratory (NGPRL). Strategically located in the center of the northern Great Plains, the NGPRL has a 100-year legacy of research for the unique environment of the cold, semiarid northern Great Plains. NGPRL is one of the few ARS laboratories with crop, soils, rangeland, and livestock research capacity at the field and herd scale which is complemented by agricultural economics research expertise.

http://news.sciencemag.org/2012/09/usda-announces-long-term-agro-ecology-network

In this issue:

## BEGINNING OUR SECOND CENTURY OF SUPPORT FOR FAMILY FARMING AND RANCHING


Dr. Matt Sanderson receiving a designation of "Centennial Farm" for the research Lab from N.D. Ag Commissioner Doug Goehring.

Welcome to the February 2013 issue of the Integrator. I am confident that you will find some new and useful research information in this issue. During our centennial year in 2012 we looked back on a century's worth of research accomplishments and celebrated them with the community at our Friends and Neighbors Day. This year marks the beginning of our second century of research here at Mandan and our focus is on the future. This year we look forward to welcoming new staff as we begin to fill several vacant technician positions that have been on hold because of budget restrictions. We also look forward to welcoming a new headquarters-funded post-doctoral research associate in February or March. The new post doc will work with me on a new rangeland research collaboration with the ARS units in Cheyenne, WY; Miles City, MT; and Las Cruces, NM. This collaborative effort is part of the Long-Term Agroecosystem Research (LTAR) network that was established last year with Mandan competitively chosen as one of the ten initial sites. We are also working with the North Dakota NRCS office to establish a shared technician to assist NRCS staff and ARS scientists working on soil health issues. It is exciting to begin to rebuild our staff and we hope to have them on board by the next Friends and Neighbors Day. As always, we appreciate the outstanding support from our customers and stakeholders and we look forward to working with you in the coming year.

*Dr. Matt Sanderson*


## NORTHERN GREAT PLAINS RESEARCH TRIANGLE

Scientists at the Northern Great Plains Research Laboratory have partnered with the USDA Agricultural Research Service units at Cheyenne, WY and Miles City, MT to form the Northern Great Plains Research Triangle to facilitate regional research on rangeland management. The initial focus of the group is organizing, analyzing, and interpreting the long-term grassland and livestock production data from the locations in relation to climate change.

http://www.farmandranchguide.com/news/regional/ngpr-triangle-established-to-facilitate-data-on-rangeland-management/article_de82d5ea-86a5-11e2-9e51-001a4bcf887a.html

## NGPRL News

**Larry Renner**, Electronics Technician, and **Becky Wald**, Lab Technician, were recognized with the 2012 *USDA-ARS Northern Plains Area Safety, Health, and Environmental Award of Excellence* for outstanding sustained effort to foster and protect employee health through implementation of safe and conservation-oriented practices at the Northern Great Plains Research Laboratory. This program recognizes outstanding achievements which have contributed significantly to the mission of the the Agricultural Research Service.

## PRAIRIE DOGS AND SOIL – WHAT'S THE STORY?

Prairie dogs are a controversial burrowing rodent native to the Great Plains. While many people view prairie dogs as an important keystone species of grassland ecosystems, ranchers are concerned about their impact on forage production. While there have been numerous studies on the impact of prairie dogs on vegetation, relatively little is known about the impact of prairie dogs on soils or how prairie dog impacts on vegetation may change with soil type. This is especially puzzling since prairie dogs are considered ecological engineers based on their ability to modify habitat by digging extensive underground burrows and grazing vegetation.

*Prairie dog research site southeast of McLaughlin, SD*

NGPRL along with NDSU and Sitting Bull Tribal College received a grant to evaluate prairie dog impacts on soil and whether the impacts of prairie dogs change with soil type. Vegetation and soils were evaluated for three soil series on a black-tailed prairie dog colony and adjacent non-disturbed mixed-grass prairie in north central South Dakota. The objectives of the study were to 1) determine differences in plant species diversity and richness, and selected soil quality parameters between prairie dog colonies and non-prairie dog disturbed sites, and 2) evaluate impacts of prairie dogs on water infiltration rates.

Three soil series were evaluated and included deep clayey (Opal), shallow loamy (Cabba), and shallow clayey (Wayden) ecological sites. Vegetation was clipped by species to evaluate species richness and diversity in 2010, 2011, and 2012. Soil samples on the prairie dog town were collected at depth increments of 0-4, 4-8, 8-12, 12-24, and 24-40 inches at distances of 1, 2, and 4 feet from the center of prairie dog burrows and compared to soil conditions in adjacent non-disturbed sites in 2010. Water infiltration, soil water content, and penetration resistance were measured on control, near burrow, and off burrow sites in 2011.

Plant species richness (number of plants within a given area) was higher on the control in 2010 on the Opal soil series, while richness was higher on the prairie dog town on the Cabba soil series. Species diversity was higher on the control on the Opal soil series in both 2010 and 2011 and the Wayden soil series in 2010. Prairie dogs impacted productivity more on the Cabba and Wayden soils than the Opal, especially in 2010. In 2010, on-colony sites produced 51, 22 and 34% as much forage as the off-colony controls for the Opal, Cabba, and Wayden soils, respectively. In 2011, which was a wetter year, the on-colony sites produced 55%, 38%, and 49% as much forage as the off-colony controls. Although on-colony productivity was greater as a percentage of off colony production in 2011, the reduction in forage caused by prairie dogs was lower on the least productive soils. Data for productivity for 2012 is still being analyzed.

Soil pH was lower on the prairie dog town in the deep clayey soil near the soil surface (0-4 inches) as well as deeper in the profile (24-40 inches) compared to the control site. Soil pH was also lower in the shallow loamy soil, but in middle depths (4-12 inches) only. Soil nitrate and available phosphorus were higher on the prairie dog town compared to the control sites near the soil surface across all three soil series. On the Cabba and Wayden soil series, water infiltration rates were higher on the near burrow sites compared to off burrow and control sites, while soil water content was higher on the control sites in the same soil series. Penetration resistance, a surrogate measure of soil compaction, was lowest on the near burrow sites on all soil series.

The findings of this study suggest 1) prairie dogs impact soil parameters differently based on soil type, 2) such impacts can affect the diversity and richness of vegetative communities within prairie dog colonies, and 3) rangeland restoration strategies of previously occupied colonies should account for patches of high nutrient, acidic soils near vacated mounds.

*Drs. John Hendrickson and Mark Liebig*

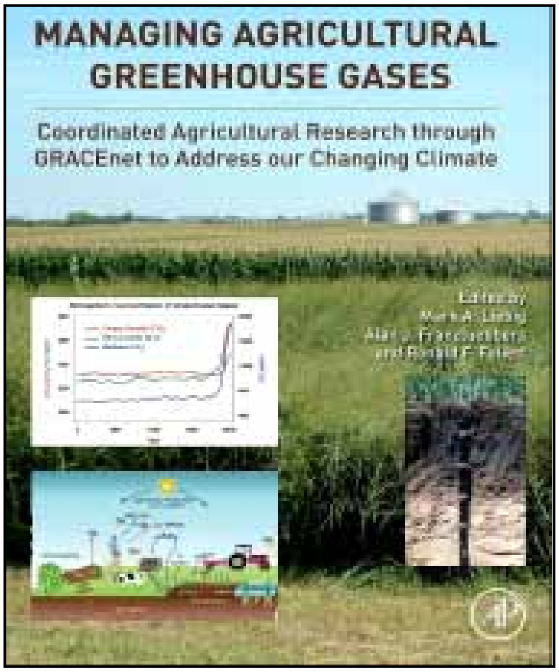
*Barth, C. 2012. Prairie dog (Cynomys ludovicianus) contributions to soil change on grazed mixed-grass prairie. M.S. thesis. North Dakota State Univ. 90 pp.*

http://gradworks.umi.com/15/34/1534942.html

# MANAGING AGRICULTURAL GREENHOUSE GASES

Coordinated Agricultural Research through GRACEnet to Address Our Changing Climate

*1st Edition from Mark Liebig, A.J. Franzluebbers, and Ron Follett*




Dr. Mark Liebig, NGPRL Research Soil Scientist, is the lead author of a new book on greenhouse gases published by Academic Press.

Concurrent efforts to mitigate agricultural contributions to climate change while adapting to its projected consequences will be essential to ensure long-term sustainability and food security throughout the world.

To facilitate successful responses to climate change, USDA-ARS scientists involved in GRACEnet (Greenhouse Gas through Agricultural Carbon Enhancement Network) published a book documenting recent research accomplishments addressing strategies to mitigate and adapt to climate change.

The book, entitled "Managing Agricultural Greenhouse Gases: Coordinated Agricultural Research through GRACEnet to Address our Changing Climate", includes regional syntheses of soil organic carbon and greenhouse gas (GHG) dynamics for a broad portfolio of agricultural land uses, as well as additional chapters central to GRACEnet activities (e.g., modeling, method development, economic outcomes of GHG mitigation options, adaptation research, and international collaboration).

Although GRACEnet is an ARS project, the reported findings have broad natural resource implications on a national level, as well as important international applications given the similarity of environmental conditions to other parts of the world.

*Dr. Mark Liebig*

*Managing Agricultural Greenhouse Gases: Coordinated Agricultural Research through GRACEnet to Address our Changing Climate. Edited by Mark A. Liebig, Alan J. Franzluebbers, and Ron F. Follett. Academic Press, San Diego, CA. 2012. 547 pages. ISBN: 978-0-12-386897-8.*

http://www.amazon.com/Managing-Agricultural-Greenhouse-Gases-Coordinated/dp/0123868971

# CANOPY STRUCTURAL ASSESSMENT AT THE GRAND RIVER NATIONAL GRASSLAND OF SOUTH DAKOTA

Managers of the over 1.2 million acres of public lands rely heavily on physical measurements to ensure conservation of grasslands for livestock forage and wildlife.

More comprehensive assessment of vegetation structure could be achieved for mixed-grass prairies by integrating field survey, topographic position (summit, midslope and toeslope) and spectral reflectance data.

Since 2010, observations were conducted during peak season and after plant dormancy at the Grand River National Grassland in South Dakota. Variation of mixed-grass prairie structural attributes [photosynthetic vegetation, non-photosynthetic vegetation, total standing crop, canopy height or visual obstruction reading] and spectral vegetation indices with variation in topographic position were examined.

Data was collected (including species cover data) on seventy-two permanent sampling points at peak season and post plant senescence each year. Relationships between canopy height and amount of total standing crop varied seasonally and annually. At both high and moderate spatial resolutions, spatial modeling of canopy structural variables shows promise.

*Dr. Rebecca Phillips*

*Mixed-grass prairie canopy structure and spectral reflectance vary with topographic position. Environmental Management. 50:914-928. DOI 10.1007/s00267-012- 9931-5. 2012., Phillips, B.L., Ngugi, M., Hendrickson, J.R., Smith, A., West, M.S.*



http://www.ncbi.nlm.nih.gov/pubmed/22961614

USDA ARS

Northern Great Plains Research Lab
Area 4 SCD Cooperative Research Farm

# Research Results Conference

AREA 4 SCD Cooperative Research Farm

**Noon - 4 PM**
**Tuesday, February 19, 2013**
**Seven Seas Conference Center**
**2611 Old Red Trail, Mandan, ND**

**What happened on the Research Farm this year...and why?**
*Drs. Mark Liebig & Dave Archer*

**Advanced Techniques for Tracking Nitrogen in Agriculture**
*Dr. Rebecca Phillips*

**Removing crop residue**
*Dr. Dave Archer*

**Soil health on the research farm: why diversity matters**
*Dr. Mark Liebig*

**Long-Term Agro-Ecosystem Research (LTAR) Network**
*Dr. Matt Sanderson*

**ND bioethanol industries development using energy beets**
*Dr. Igathi Cannayen, NDSU*

**Transitioning grasslands to cropland**
*Dr. John Hendrickson*

**Integrating cattle and crop enterprises**
*Dr. Scott Kronberg*

www.mandan.ars.usda.gov Lunch Provided CCA CEUs 701.667.3001

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# ECONOMICS OF GRASSLAND CONVERSION

*"Trouble is on the horizon for grasslands, wetlands, and ducks. There is a rapidly growing world demand for food and commodities, production of corn ethanol has rapidly expanded, and the 2008 Federal Farm Bill provided incentives to convert grassland to cropland. Grassland destruction is accelerating." –Warhurst, R. Grasslands for Tomorrow- A model for protecting the prairie and wetland ecosystem.*

From 1997 to 2007, there were net increases in all categories of grasslands in the U.S., including the Conservation Reserve Program (CRP), rangeland, pasture, and hay lands. However, there have been regional differences in grassland conversion trends. In the Northern Great Plains (NGP), CRP and pasture increased, while rangeland and hay land acres decreased over this period. There have likely been further changes since 2007. In North Dakota, CRP area declined from 2007 to 2010 to the lowest levels since 1989.

This paper provides an overview of economic factors that contribute to these changes, including the relative profitability of crop and livestock production, effects of land productivity, and effects of conversion costs. We identify other potential socio-economic influences on grassland conversion, and describe a case farm where the use of multiple enterprises is being investigated as a method to improve economic returns from grasslands and reverse the trend toward conversion of grasslands to cropland.

From an economic perspective, land use decisions are influenced primarily by the relative profitability of alternative land uses. In the NGP, profitability of wheat production has generally increased since 1997 and especially since 2002. This increase reflects rapid rises in wheat prices, but increases in profitability have been moderated by increased production costs over this same period. These trends have also occurred for other crops in the region. Along with increases in crop profitability have been increases in land rent.


It is not clear if this is truly due to differences in productivity, or if productivity classes are often related to other factors that limit the feasibility of cropping (e.g. high slope, rocky, wet), and grazing is just physically more practical. Based on the conceptual model, increasing crop prices with all else held constant shifts the break even point between cropland and grassland, with more marginal lands becoming profitable for crop production.

However, converting between crop and grass uses is costly. In an ongoing study at Mandan, ND the direct cost of transitioning from grass to crop was relatively low, as little as the cost of a single herbicide application. There is some evidence that there could be additional costs associated with crop yield reduction following conversion. Also, cost of conversion from grass to crop can be greater if there is a need to remove excess vegetation, use tillage to smooth the land, or use labor and equipment for removing rocks.

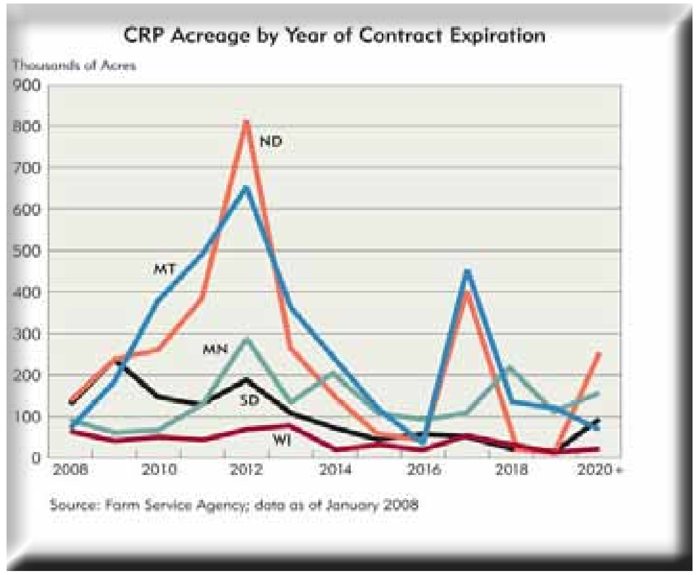
Costs for conversion from crop to grass can be substantial, including seed and seeding costs, forgone income while waiting for grass to establish, and the risk of reseeding if establishment fails.

In the Mandan study, cumulative costs were estimated at $207 per acre for conversion of cropland to switchgrass relative to continuous crop production. Presence of conversion costs can serve as a barrier to conversion in either direction, so producers want to be sure that they will stay with the new land use for a long enough period of time to recoup the conversion costs.

Reducing conversion costs (e.g. cost-sharing establishment of grass) reduces this barrier to conversion in either direction, which could have the counter intuitive impact of accelerating the conversion from grass to crop since it will be less costly to convert back to grass in the future.

Other socio-economic factors can also influence land use decisions. Some of these factors include off-farm employment, lifestyle goals, and demographics.

Greater off-farm work, preferences to live in a rural area and older producers have been associated with a greater percentage of farm production value from beef and lower percentage from crops, and thus are likely to lead to more grassland and less cropland. College graduates, however, likely realize greater percentages of farm production value from crops and lower percentages from beef.




A typical CRP contract is for ten years, with annual payments fixed for the entire life of the contract and based on cropland rents at the time enrollment occurred. When cropland cash rent is relatively stable producers are willing to enroll and remain in the program since cash rent at the end of the contract is not substantially higher than when the contract began. For example in Burleigh County, North Dakota, from 1989 to 1998, cash rent at the end of the 10 year contract was only 22% greater than at the beginning of the contract with most of the increase occurring only in the final 3 years. However, for a producer with a contract beginning in 1999, cash rent in the county had increased 32% by the end of the contract, and for a contract beginning in 2001, cash rent had increased 44% by 2010. Since CRP had become much less profitable than renting the land out as cropland, many producers chose not to reenroll.

For range and pasture lands in the NGP, income from cattle production is the primary alternative to crop production. In the NGP, cow-calf net returns have shown cyclical increases and decreases. Gross returns have shown an upward trend, but declined from 2005-2009, likely related to reduced beef demand as a result of recession and increased feeding costs at feedlot.

At the same time, cow-calf production costs have shown an upward trend, closely tied to feed costs. As a result, profitability also declined over that period. Beef cattle numbers have declined with the lower profitability, which has tended to reduce both grazing/forage needs and the value of grasslands. This has been somewhat mitigated since the price of feed grains has increased, tending to increase demand for grass/forage.

Many factors have contributed to rising crop prices over the period, including increasing energy prices, rising food and feed demand, use of corn for biofuels, and a long period of declining stocks relative to use. A common conceptual model is that grasslands tend to be more profitable on soils that have lower productivity and crops tend to be more profitable on soils that have higher productivity. This is supported by the observation in the NGP that most high productivity land is in cropland, while most low productivity land is in rangeland. However, proportions in CRP, hay, or pasture show no strong relationship to land productivity.

*Dr. Dave Archer*

*Archer, D.W. 2012. Economics of grassland conversion. In: A. Glaser (ed.) America's Grasslands, Status, Threats, and Opportunities: Proceedings of the 1st Biennial Conference on the Conservation of America's Grasslands. August 15-17, 2011, Sioux Falls, SD. National Wildlife Federation, Washington, DC and South Dakota State University, Brookings, SD.*

https://www.nwf.org/pdf/Policy-Solutions/Americas%20Grasslands%20Conference%20Proceedings061312.pdf

# SOIL ACIDIFICATION

A lesson from the Northern Great Plains Research Laboratory historical pastures

Increasing reliance on synthetic nitrogen fertilizer (N) has prompted questions about its long-term effects on soil health. While nitrogen fertilizer is often required to enhance soil fertility, there are some notable agronomic and environmental outcomes associated with its use. One outcome, increased soil acidity, has become a concern throughout the northern Great Plains.

Soil acidity is generated through the loss of available nitrogen from the soil profile (see sidebar). Direct effects of increased acidity on soil properties are many, and include decreased macro- and micro-nutrient availability, accelerated weathering of clay minerals, and changes in the amount and type of microorganisms present in soil. Such changes can significantly compromise the capacity of soil to function efficiently.

Organic matter can buffer nitrogen-induced acidity due to its high surface area and prevalence of exchange sites for positively charged ions. However, the effectiveness of organic matter to provide this buffering influence can decrease following decades of applied nitrogen. Changes in soil properties under the historical pastures at Northern Great Plains Research Laboratory exhibited this very outcome (see Table).

Though soil organic carbon was not different between native vegetation and crested wheatgrass pastures, applied nitrogen to the latter resulted in much lower pH, which contributed to decreased cation exchange capacity and soil microbial biomass. Said differently, the crested wheatgrass pasture with applied nitrogen exhibited greater weathering of clay minerals (lower cation exchange capacity) and a limited capacity to efficiently cycle nutrients (lower soil microbial biomass), despite having roughly same amount of soil organic carbon as a native vegetation pasture. Such findings underscore the important role of soil acidity to affect soil function.

### How does nitrogen fertilizer increase soil acidity?

Urea and anhydrous ammonia are commonly used nitrogen fertilizers. Acidification ($H^+$) from these two sources of synthetic nitrogen is generated via nitrification through the following simplified reactions:

*Urea:* $(NH_2)_2CO + 4O_2 \rightarrow 2NO_3^- + 2H^+ + CO_2 + H_2O$

*Anhydrous Ammonia:* $NH_3 + 2O_2 \rightarrow NO_3^- + H^+ + H_2O$

Based on these reactions, each mole of N oxidized to $NO_3^-$ produces one mole of $H^+$.

Plant uptake of $NO_3^-$ results in the release of an equivalent amount of OH- into the soil solution, effectively neutralizing the acidity (creating $H_2O$). However, loss of $NO_3$- by leaching and/or its conversion to $N^-$ containing gases ($N_2O$, $N_2$) results in permanent acidification.

This permanent acidification can be intensified with the export of basic cations ($Ca^{+2}$, $Mg^{+2}$) from the soil in harvested material.

| Grazing treatment | Soil organic carbon (Mg C ha$^{-1}$) | Soil pH (-log[H$^+$]) | Cation exchange capacity (cmol kg$^{-1}$) | Microbial biomass carbon (kg C ha$^{-1}$) |
|---|---|---|---|---|
| Native vegetation; High stocking rate | 28.4[a] | 6.6 | 18.2 | 640 |
| Crested wheatgrass; High stocking rate, N applied annually | 28.6 | 4.8 | 10.4 | 169 |

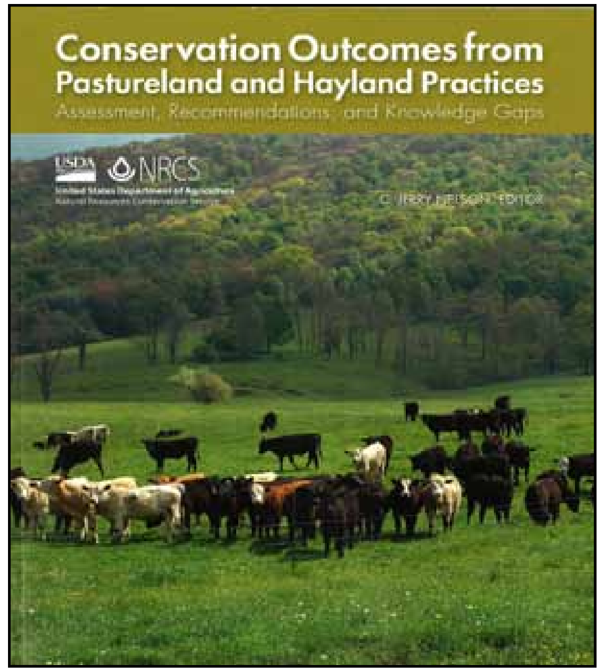
[a] Values refer to 0-5 cm (0-2 inch) depth.

While many soils throughout the northern Great Plains possess calcareous (alkaline) parent material, long-term application of synthetic nitrogen to surface soil depths may negatively affect plant productivity through increased acidity (e.g., poor germination, reduced seedling vigor, reduced herbicide efficacy, etc.). Consequently, once near-neutral soils may need to be limed to sustain production. Additionally, management practices that more efficiently use nitrogen will contribute to slowing rates of soil acidification.

*Dr. Mark Liebig*

http://naldc.nal.usda.gov/download/7982/PDF

## PASTURELAND LITERATURE SYNTHESIS AVAILABLE ON-LINE




As part of the USDA multi-agency Conservation Effects Assessment Project (CEAP), a new publication, Conservation Outcomes from Pastureland and Hayland Practices: Assessment, Recommendations, and Knowledge Gaps, edited by C. Jerry Nelson, is available on-line from NRCS at http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/?cid=stelprdb1080581.

Matt Sanderson was the USDA-ARS liaison to the project and facilitated the organization of research and writing teams to evaluate the scientific basis for support of NRCS Practice Standards including Planting for Hay, Silage, and Biomass (Practice Code 512), Prescribed Grazing (Code 528), Forage Harvest Management (Code 511) and Nutrient Management (Code 590).

The pastureland literature synthesis provides an unprecedented source of evidence-based information to guide the development and assessment of management practices and conservation programs on the nation's pasturelands.

The American Forage and Grassland Council (AFGC) played a significant role in supporting the effort and provided financial administration for the publication. Printed copies of the Executive Summary and the full report are available at no cost from the NRCS Distribution Center, Urbandale, IA: http://nrcspad.sc.egov.usda.gov/DistributionCenter. The parallel Rangeland Literature Synthesis covering seven NRCS Practice Standards is also available on-line at http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/ceap/?cid=stelprdb1045811. Print copies are also available at no cost from the NRCS Distribution Center.

*Dr. Matt Sanderson*

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/?cid=stelprdb1080581

Feel free to pass on this issue of Northern Great Plains Integrator to others interested in agricultural research in the northern Great Plains. Northern Great Plains Integrator is published and distributed by the USDA-ARS, Northern Great Plains Research Laboratory, PO Box 459, 1701 10th Avenue S.W., Mandan, ND 58554. Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD). The United States Department of Agriculture prohibits discrimination in all its programs and activities on the basis of race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital and family status. To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, Room 326-W, Whitten Building, 14th and Independence, SW, Washington, DC 20250-9410 or call 202-720-5964 (voice or TDD). USDA is an equal opportunity provider and employer. Mention of trade or manufacturer names is provided for information only and does not constitute endorsement by USDA-ARS. To be added to our mailing list, request a copy through our website or contact editor: Cal Thorson, Technical Information Specialist, USDA-ARS Northern Great Plains Research Laboratory, 1701 10th Ave., S.W., Mandan, ND 58554. Office:701 667-3018 FAX:701 667-3077 Email: cal.thorson@ars.usda.gov