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Influence of Topography on Sediment Trapping in Grass Buffers

by Dean Eisenhauer, Michael Dosskey, Matthew Helmers, Jason Brothers, and Thomas Franti
Department of Biological Systems Engineering, UNL

In 1997 the U.S. Department of Agriculture, in cooperation with nearly 100 federal agencies, national agricultural and conservation organizations, and agribusiness firms, established the National Conservation Buffer Initiative. The goal of the initiative was to establish, by the year 2002, two million miles of conservation buffers in the United States. Cost sharing is provided to landowners to encourage them to install buffers on their property. Since the initiative began, nearly 1.2 million miles have been planted in the U.S., with about 4,000 miles having been established in Nebraska

Grass buffers in uplands and riparian zones are tracts of land with permanent grass cover. The purposes of buffers are to (1) remove contaminants in water that is flowing to the stream, (2) improve the stream environment and stabilize the banks, (3) enhance wildlife habitat, and (4) provide for biological diversity in the landscape. Sediment removal from water flowing on the land surface is one of the key water quality benefits of conservation buffers.



Grass Buffer in Riparian Zone

Just how effective are these buffers at filtering sediment? Are they performing as expected? Do they perform as well in the real world as they have in research plot studies? Do land topography, micro-topography (small depressions), and farming practices influence the performance of buffers? What are the desired dimensions and shapes of buffers? These are some of the questions that we have set out to answer in our research. In this article we summarize the results of three studies that we have

conducted on riparian buffers.

In the first study we evaluated the performance of grass buffers on a field scale in four watersheds in eastern Nebraska. One of the objectives of the study was to assess the extent of concentrated flow and its impact on sediment trapping. Runoff can concentrate on the land surface and become channelized. Once runoff is concentrated, it no longer is spread uniformly throughout the buffer, but enters and leaves the buffer in a relatively small area. Thus, the buffer area is effectively

(continued on page 3)

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The Center for Grassland Studies is a unit within the University of Nebraska-Lincoln Institute of Agriculture and Natural Resources. It receives guidance from a Policy Advisory Committee and a 50-member Citizens Advisory Council. This newsletter is published quarterly.

Note: Opinions expressed in this newsletter are those of the authors and do not necessarily represent the policy of the Center for Grassland Studies, the Institute of Agriculture and Natural Resources or the University of Nebraska.

Martin A. Massengale CGS Director
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FROM THE DIRECTOR

When we speak of grass or grasslands, we often think only of the vegetative plant—namely, its leaves and stems. As a general rule, grass plants do not have showy flowers like legumes, forbes and shrubs. Thus, we tend to overlook a highly important component of the grass plant—its seed. Most, but not all, of our cultivated grasses are propagated by seed.

Grass plants produce flowers which are either self or cross pollinated to produce a seed. A grass seed is actually a dry fruit which consists of the embryo, a mass of stored food called the endosperm, and the seed coat (covering). The seed provides the continuity from generation to generation.

After maturity, the seed is harvested, cleaned, processed and used for planting at some future date. The ability of a plant to produce seed is influenced by both its genetic composition and the environment under which it is grown. Management practices applied to the plant also influence seed yields.

The production of high quality grass seed can be an expensive, but rewarding enterprise. High quality seed is a prerequisite to a high quality stand of grass whether it is used for turf, forage, recreation or leisure purposes. When we speak of high quality seed, we are referring to seeds that are free of weed or other crop seeds, are true to cultivar or type, and have a high germination percentage. Seeds should be well developed in size, plump and able to produce a healthy seedling. Seed quality can be influenced by many factors in the production process and therefore requires good stewardship. These seeds sell for a premium price but they are a good investment when compared to the potential problems associated with using seed of a lesser quality.

The primary factor in producing quality seed is planting pure seed on clean land initially. Contaminants in either the seed or land can cause real problems in producing high quality seed. If the seed is produced from cross-fertilization, then sufficient isolation from other closely related plants must be provided to prevent contamination from foreign pollen. Grass seed production is a specialized enterprise requiring skilled manipulation of various operations. This is a high value crop requiring intensive management and a high level of knowledge of the crop's needs. When a grower is producing seed as their main enterprise, they usually purchase specialized equipment. In order to produce seed efficiently and economically, sizeable acreages are desired. All of the seed produced by one grower need not be of the same cultivar, but when different cultivars are produced, one must be careful to provide adequate isolation and to thoroughly clean the machines when shifting from one cultivar to another.

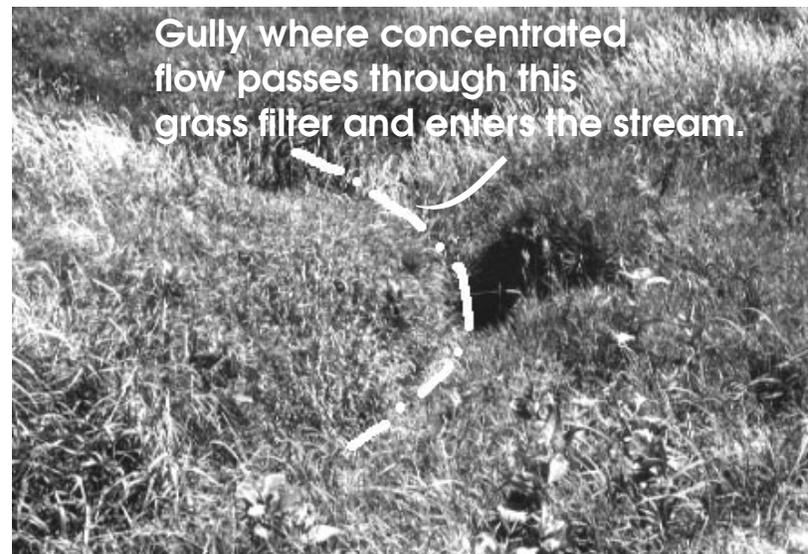
The grass seed industry has been largely confined to the Pacific Northwest region of the United States. However, that part of the country is now very densely populated, and air pollution from burning crop residue left on the field following harvest is of major concern. Reduced air movement and inversion layers exacerbate this problem. The seed industry is interested in locating alternate sites with less population density and more air circulation to relieve some of these concerns. We are hopeful that western Nebraska will become one of the alternate sites for grass seed production. A stable and profitable seed industry in western Nebraska will provide diversification, more economic stability, and better control of soil erosion.

M. A. Massengale

Influence of Topography on Sediment Trapping in Grass Buffers (continued from page 1)

reduced along with its sediment trapping ability. Using observed flow paths and mathematical modeling, we found that when runoff flowed uniformly into the entire buffer, the percent of sediment trapped was 99, 67, 59, and 41 for the sites in Lancaster, Otoe, Saunders, and Hamilton Counties, respectively. These percentages were reduced to 43, 15, 23, and 34, respectively, when the effect of flow concentration was considered. Thus, the research demonstrated the impact of flow concentration on reducing buffer effectiveness. Most flow concentration occurred within the cropped fields where runoff tended to flow into topographic swales. Some earth movement prior to establishing the buffers would probably have helped distribute the runoff more uniformly to the buffers.

At the UNL Rogers Memorial Farm east of Lincoln, we evaluated the importance of the accuracy of the topographic map information and crop row (micro-topography) effects on flow paths and flow entry locations into grass buffers and their sediment trapping capability. What we found was that if a buffer is going to be designed based on a topographic map or digital elevation model, the map must be of very high accuracy. This is because grass buffers are commonly located in riparian zones in stream valleys, which usually have relatively low slopes. The predicted sediment delivery to the stream was greatly influenced by the map accuracy. In a field with five tons of erosion in three years, nearly 70% was trapped in the existing buffer when predictions using computer simulations were based on a topographic map that had a contour interval of six inches. When a conventional topographic map with 10-foot contours was used, it was predicted that only 19% of the eroded sediment would be trapped in the existing buffer. The existing buffer is a typical "strip" of land parallel with the stream on one edge of the field. Another finding was that a rectangular shaped buffer positioned at the point where concentrated flow enters the stream would be more effective than the existing "buffer strip" for trapping sediment. A final aspect of this study revealed the importance of accounting for how water is guided by crop rows, not just by the land topography. For example, when using the traditional 10-foot contour map, the predicted sediment trapping in the existing buffer was 19% when the "crop row effect" was not considered, but was 67% when the water-guiding effect of the crop rows was included in the analysis. Keep in mind that when field slopes are large, pointing crop rows toward the buffer is not recommended because of the increased erosion potential.



Dye tracers studies were conducted in a grass buffer adjacent to Clear Creek near Osceola, Nebraska during the summer of 2000. The path of the tracers revealed how localized topography influences the water flow through a buffer and controls the amount of flow concentration that occurs within a buffer. In low-sloping terrain, the predicted water path was accurate as long as the topographic map accuracy had contour intervals of about one inch. Flow concentration within a buffer reduces its ability to remove sediment because the more the flow concentrates, the faster the water moves, and the less chance there is for sediment to settle within the buffer.

Buffers that are properly designed and strategically located could easily remove more than one-half of the sediment lost from cropland in Nebraska. The intent of our research is to develop strategies that will help achieve this potential water quality benefit. The results of all three studies reveal the importance of land topography and micro-topography on buffer performance and the need for highly accurate mapping when planning buffers. The potential need for considering buffer shapes that differ from narrow strips and/or land shaping prior to seeding to reduce the impacts of flow concentration was apparent at all buffer sites that were studied.

Editor's Note: Eisenhower and Franti are faculty members, Helmers is Ph.D. Fellow, and Brothers is a former graduate research assistant in the Department of Biological Systems Engineering. Dosskey is a research ecologist with the USDA Forest Service.

CGS Tour Showcased Golfing, Hunting, Ranching, Biology Education and Research

This year's tour by CGS Citizens Advisory Council members and CGS Associates took us to western Nebraska. On June 25 we started out at the new Bayside Golf Course near Ogallala where superintendent Elton Nolde described some of the unique challenges he deals with in developing and maintaining this natural setting course in a high-wind, low-moisture area.

The harsh environmental conditions along with steep slopes, heavy compaction from course construction, and poor irrigation coverage due to wind and sand-clogged heads, make it tough to promote healthy, deep-rooted turf on this course. Wind is a serious problem that Nolde faces because of the lack of trees around the course. Besides the impact wind has on water-use and watering uniformity, it makes scheduling routine maintenance practices, such as topdressing, fertilizing and pest control very difficult because of uneven product coverage. The high winds have also blown much of the sand out of the sand traps, leaving hard pans for golfers to hit out of and raised bunker lips for the maintenance crew to deal with. At the end of this stop, the group visited one of Nolde's tougher greens to maintain because of the heavy compaction that resulted during construction. He indicated that it is very hard for a golfer's shot to hold this green because of the increased surface hardness and the slope of the green. Nolde tossed a golf ball from the front of the green and the group watched it roll to the back of the green, turn and roll down a mound, roll past the hole, and finally roll off the green, stopping on the collar. Nolde has started using deep-tine aerification to help alleviate the compaction/hardness problem and to encourage deeper root growth. Another challenge on this particular green is the aggressive growth of Yucca (*Yucca glauca*) plants. Yucca, a plant that is very common in the rough areas of this golf course, is emerging on the green, even with low-mowing practices. In order to maintain a smooth surface, Nolde uses a cup cutter to cut the plants out. See www.baysidegolf.com for more information.

Our next stop was the Cedar Point Biological Station (CPBS) where Dr. Richard Alward provided an overview of the facilities and the research and teaching activities at the station. Dr. Tamera Minnick from Nebraska Wesleyan University, who is teaching a prairie ecology course at CPBS this summer, also spoke to our group. From them we learned that up to nine classes in field biology are taught each summer. Each class meets for two long (8:00 am to 10:00 pm) days per week for five weeks. Most students take two classes or one class and an independent study project such as a senior thesis; we heard about some of those projects from students during lunch. The ecosystem diversity (upland grasslands, woodlands, sandhills, lakes) draws researchers from around the country to CPBS from early spring through late fall. Nine books, more than 250 scientific papers and 50 graduate degrees have resulted from research conducted at CPBS. Alward and Minnick pointed out the synergism between education and research. For example, UNL biologist Dr. Svata Louda, who conducts research at CPBS and nearby Arapahoe Prairie, was to give a seminar the following night. The facilities lend themselves to excellent student-faculty interaction because they dine and socialize in the main building, so education is accomplished in informal



Bayside Golf Course superintendent Elton Nolde shows tour participants a core from one of the greens of this natural-setting course nestled next to Lake McConaughy.

settings as well including, Alward quipped, that “faculty are real people.” More information is available at www.unl.edu/cedarpt.

In the afternoon we visited Buckboard Ranch near Sutherland where ranch owner Mike Kelly, along with a few of his conservation partners — Doug Whisenhunt and Vince Shay with The Nature Conservancy and Jeff Nichols with the Natural Resources Conservation Service — described how they worked together to design and fund improvements to the 16,000-acre ranch that also benefit the environment. Those improvements included wells and pipeline for alternative stock-water sites and fencing to complement rotational grazing; these measures relieved pressure on Birdwood Creek, which Kelly said is one of the most steadily flowing streams in the world, five miles of which are on the ranch. Additional help came in the form of a purchased easement on approximately 10,000 acres that encompass the riparian corridor along the creek; this was in answer to the encroaching development that has begun in the last few years. Other partners in these conservation efforts include the Nebraska Grazing Lands Coalition, Sandhills Task Force, U.S. Fish and Wildlife Service, and Twin Platte Natural Resource District. At the 2001 Nebraska Grazing Conference, Kelly talked about the objectives of the partnerships, including to: protect and restore riparian areas; protect ground water quantity and quality; improve species composition on the rangeland; enhance wildlife habitat; preserve open space; and help the profitability of the ranch. Kelly encourages other ranchers to explore whether such partnerships might be right for them.

While at Buckboard Ranch, Jay Longacre and Scott Skrdla discussed opportunities for combining a hunting enterprise with a ranching operation. They manage Prairie Sands Hunting on the nearby Applegate Ranch. In its first year of operation last year, people from five different states paid to hunt on the ranch, so the demand is definitely there. They pointed out that beginning such a business takes a significant investment of time and money (a single trained dog can cost thousands of dollars), but bartering labor for hunting privileges is an option that can help. At Prairie Sands, bird hunters pay \$175/half day or \$300/day, which includes a guide, trained dog, guaranteed birds, and dressing the bird. Other game are also available; deer and turkey are quite popular. In answer to a question, Longacre said use of rotational grazing can make a big difference in game habitat. For more, see www.prairiesands.com.

New Grassland Reserve Program in Farm Bill

The Farm Security and Rural Investment Act of 2002 (Farm Bill) represents the single most significant commitment of resources toward conservation on private lands in the Nation's history." The legislation responds to a broad range of emerging natural resource challenges faced by farmers and ranchers, including soil erosion, wetlands, wildlife habitat, and farmland protection. Private landowners will benefit from a portfolio of voluntary assistance, including cost-share, land rental, incentive payments, and technical assistance. The 2002 Farm Bill places a strong emphasis on the conservation of working lands, ensuring that land remain both healthy and productive.

Natural Resources Conservation Service, USDA

One of the new Farm Bill conservation programs is the Grasslands Reserve Program (GRP) under which the Secretary of Agriculture may enroll up to two million acres of restored, improved, or natural grassland, rangeland and pastureland, including prairie. Section 2401 specifies that the Secretary shall enroll not less than 40 contiguous acres of land using 10-, 15-, 20- or 30-year rental agreements or 30-year permanent easements. Sixty percent of the funding is reserved for 30-year rental agreements or easements. The legislation provides criteria for ranking of applications for the benefits of this program, which implies that some bidding procedure may be followed for acceptance of land. Funding is limited to a total of \$254 million over the years 2003 through 2007. Normal grazing may continue as long as it is consistent with “maintaining the viability of grassland, forb, and shrub species common to that locality.” Haying, mowing or seed harvesting operations may continue on enrolled land with some restrictions that pertain during nesting season for birds that are in significant decline. Payments will be made to the owner for the agreement or easement and for the federal share (cost share) of the cost of restoration. Lands that have never been cultivated can receive 90 percent cost-share versus 75 percent cost share for restored grasslands.

In addition to the Web sites listed in Sources below, check out the following Farm Bill sites for more information and analyses:

www.usda.gov/farmbill (USDA)
www.swcs.org/t_seeking_intro.htm
 (Soil and Water Conservation Society)
www.extension.iastate.edu/feci/FSRIA/homepage.html (Iowa State U.)
www.agecon.ksu.edu/kfma/new%20web/farmbill.htm (Kansas State U.)
agecoext.tamu.edu (Texas A&M University)

Sources: “Farm Bill 2002: Conservation Provisions Overview,” Natural Resources Conservation Service, USDA (see www.nrcs.usda.gov/programs/farmbill/2002/index.html). “Conservation in the ‘New Farm Program,’” by Richard T. Clark (see farmbill.unl.edu/policyupdate.htm).

Landscape Connections September 14

Landscape Connections will be held on the University of Nebraska's East Campus on Saturday, September 14, 9:00-3:30. This event is free to the public.

There is much to celebrate in the first year of this new public event at the University of Nebraska—the beauty of Nebraska and the UNL campus, the innovation and energy in its academic programs, and the home and community quality-of-life for all Nebraskans that is enhanced through properly designed, installed and maintained landscapes.

The event also celebrates the synergy of integrating two successful educational horticulture programs into one fall season East Campus event. The former programs include Festival of Color, held each September at the ARDC near Mead, NE, and Gardener's Gala, a popular program scheduled each fall on East Campus. The combined event will allow a more effective sharing of resources among University programs while allowing the University to showcase its academic programs, award-winning campus landscapes, and program expertise in the cost-effective design and maintenance of beautiful, functional landscapes.

The theme and focus of the program is a stronger, more personal connection of Nebraska's people to its landscapes. This enhanced connection includes a:

- ❖ deeper appreciation of our universal connectedness to nature and plants;
- ❖ better understanding of the connection between good design and beautiful, functional outdoor living environments;
- ❖ broader sensitivity to the sustainability and environmental friendliness of built landscapes; and perhaps most important,
- ❖ greater awareness of Nebraska's urban and rural landscape richness.

This year's program includes talks on selecting and maintaining plants, designing landscapes, and attracting and managing wildlife and birds. Tours will also be given in several of the gardens on UNL's East Campus.

The program is sponsored by Landscape Services (Division of University Services, UNL) and the UNL Institute of Agricultural and Natural Resources (including the Nebraska Statewide Arboretum, the Department of Agronomy/Horticulture, and Cooperative Extension).

Gudmundsen Ranch Open House August 28

The 3rd annual Gudmundsen Sandhills Lab (GSL) Open House will be August 28, 2002, 9:30-4:00. GSL is UNL's working research ranch near Whitman. Demonstrations will be held throughout the day on various aspects of cattle and natural resource management. Businesses, services and associations that support the beef cattle industry will be participating with exhibits and presentations. Topics to be covered that day by ranchers and UNL specialists include: issues facing the cattle industry, assisting the cow during calving, sandhills hydroecology, water use efficiency on rangeland, biostimulation of 3-year-old cows, beef cattle marketing, new technologies in estrous synchronization, genetic differences in beef cow efficiency, and detection of BVD infection. A complimentary lunch will be provided. Registrations are requested by August 20. For more information or to register, call (308) 532-3611 ext. 124, or e-mail ehel1@unl.edu.

GSL contains about 1,200 acres of subirrigated and wetland meadows and 11,600 acres of upland Sandhills range. The cowherd includes more than 550 commercial cows. The ranch was a gift from Elmer "Pete" and Abbie Gudmundsen to the University of Nebraska Foundation for the purpose of strengthening agricultural viability through research regarding the management of agricultural commodities and natural resources of the Nebraska Sandhills. The research goal at GSL is to discover and develop new practices, techniques, and concepts that will allow Sandhills ranchers to maximize financial gain consistent with the improvement and sustainability of the natural resources of the region.

Info Tufts



On June 15, 2002 the Nebraska National Forest centennial was celebrated at Bessey National Forest in Halsey.



In just one year, 2001, USDA's Plant Materials Program in NRCS released 24 new plant species in support of conservation issues related to buffers, wetland creation/restoration, wildlife habitat, forage improvement, bioengineering, soil stabilization, windbreaks/shelterbelts, roadside revegetation, urban conservation and native plant landscaping.

CGS Associates

Stephen Baenziger received the prestigious Distinguished Agricultural Alumni Award from Purdue University's School of Agriculture.

2002 inductees into the Nebraska Hall of Agricultural Achievement included **Robert Klein**.

Kim Stine, formerly State Range Management Specialist for NRCS in Nebraska, is now the Northern Plains Regional Grazing Lands Coordinator.

Walter Schacht was recently presented with the Outstanding Achievement Award by the Society for Range Management for being "tireless in his efforts to meld ecology and agronomy in academic programs in the College of Agricultural Sciences and Natural Resources." The society says Schacht has argued persuasively that "sound natural resources management and livestock management are compatible when ecological principles are followed."

Arbor Links Golf Course Opens



What would bring famed golfer Arnold Palmer and Environmental Protection Agency director Christie Whitman together in southeastern Nebraska? Dedication of the new environmentally-friendly Arbor Links Golf Course, of course! Palmer and Whitman were in Nebraska City on June 25 to dedicate Arbor Links, created by the partnership of Palmer

Course Design, Landscapes Unlimited of Lincoln, and the National Arbor Day Foundation.

The course was built with minimal disruption to the natural setting; most of the original trees and streams remain. The course is designed to capture storm water in ponds that will be supplemented with well water. All water will empty into wetlands to filter sediment and pesticides before it reaches the main irrigation lake. Many aspects of the course, including different types of greens and use of various native grasses and drought-tolerant plants as well as management practices will be monitored to learn more about environmental impacts.

Congratulations to CGS Associate and President of Landscapes Unlimited, Bill Kubly, and all the leaders in the effort to see this project to fruition. For more information, see www.arborlinks.com.

Vivien Allen to be Leu Distinguished Lecturer

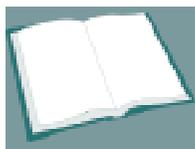
Dr. Vivien Allen, Thornton Distinguished Professor of Forages at Texas Tech University, will be the 2002 Leu Distinguished Lecturer. While in Lincoln, she will give a lecture in the Center for Grassland Studies Seminar Series, meet with faculty and graduate students, and visit with Grazing Livestock Systems undergraduate majors. The lecture, which is free and open to the public, will be October 14, 3:00-4:00 in the East Campus Union. The title of the lecture is "Grassland Ecosystems: Pieces of the Puzzle."

At Texas Tech Dr. Allen has responsibilities in teaching and research. Her areas of expertise are: design and development of forage/livestock systems with emphasis on maximizing use of forages and grazing to protect natural resources, improve nutrient management, profitability, energy efficiency, and animal performance, for long-term productivity; production, management, physiology, forage quality and anti-quality factor of forages; and mineral nutrition in the soil/plant/animal system. Recent awards and honors include American Forage and Grassland Council Medallion Award, Barnie E. Rushing Jr. Distinguished Research Award, College of Agriculture and Natural Resource's Research Award, Gamma Sigma Delta Outstanding Contributions to Agriculture Award, named a Faculty Associate in the TTU Economic Development Resource Center, Crop Science Society of America Fellow, and American Association for the Advancement of Science Fellow.

Other topics to be covered in this fall's seminar series include using prescribed burning for ecosystem management, carbon sequestration, wildlife and grasslands, conservation aspects of the new Farm Bill, using ecological site descriptions, biofuels, using grasslands in conservation measures in urban areas, and environmental aspects of the new Arbor Links Golf Course. Seminars will be videotaped and available for onsite viewing or checkout from the CGS office.

For more information, see www.grassland.unl.edu/seminars.htm.

Resources



2001 Turfgrass Research Report, an annual report published by the UNL Turfgrass Science Team, is available online at agronomy.unl.edu/turf.science/turf.htm. The publication reports research results in the following categories: cultivar trials, disease and insect control trials, fertilizer evaluations, management and physiological studies, weed control and herbicide evaluation trials, and ornamental field trials.

And Biological Trends Assessment. This report, dated June 2001, provides an detailed look at the grasslands of the United States and the importance of this shrinking resource. Authors are from Texas A&M University, Colorado State University, and the University of Idaho. It is available online at landinfo.tamu.edu/presentations/grasslands.html.

ATTRA (Appropriate Technology Transfer for Rural Areas) has many excellent publications related to pasture and grazing management. There are six publications in the Grass Farming category alone. And in the Beef-Dairy category you'll find reports such as "Economics of Grass Based Dairying (new). Available free from ATTRA, PO Box 3657, Fayetteville, AR 72702, 1-800-346-9140, and online at www.attra.org/attra-pub/index.html.

Drought-related publications from the UNL Institute of Agriculture and Natural Resources. Online publications are at www.ianr.unl.edu/pubs/drought.htm. *Drought Management on Range and Pastureland: A Handbook for Nebraska and South Dakota* (EC123) is available for \$4 + s&h; to order see www.ianr.unl.edu/pubs/orders/ordpub.htm or call 402-472-3023.

Reminder of August 12-13 Grazing Conference

The 2002 Nebraska Grazing Conference will be held at the Holiday Inn in Kearney, Nebraska on August 12 and 13. It will provide new ideas and options for all ranchers, farmers, wildlife managers, and advisers who want to make grazing a profitable enterprise while benefitting the environment. If you missed the August 1 pre-registration deadline, you can still register, although late fees will apply. For more information, see the Center for Grassland Studies Web site, www.grassland.unl.edu, or contact the Buffalo County Extension, 1400 E. 34th, Kearney, NE 68847-3998, phone 308-236-1235, e-mail Buffalo-County@unl.edu.

Calendar

Contact CGS for more information on these upcoming events:

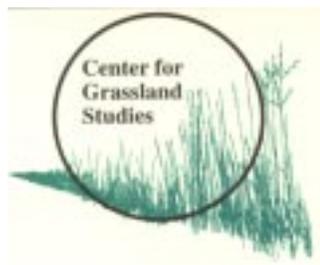
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- Aug. 12-13:** 2nd annual Nebraska Grazing Conference, Kearney, NE, www.grassland.unl.edu/grazeconf.htm
- Aug. 28:** Gudmundsen Sandhills Laboratory (UNL research ranch) Open House, Whitman, NE
- Sep. 14:** Landscape Connections, Lincoln, NE
- Nov. 10-14:** 2002 ASA-CSSA-SSSA Annual Meetings, Indianapolis, IN, www.asa-cssa-sssa.org/anmeet/

2003

- Jan. 6-8:** Nebraska Turfgrass Conference, Omaha, NE

If you have articles, events, resources, CGS Associate News, or other items you would like to submit for inclusion in future issues of this newsletter, please contact the editor, Pam Murray, at the CGS office.



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