

## Center for Grassland Studies

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UNIVERSITY OF  
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# Insects as Agents of Improved Rangeland Quality and Cattle Production

by Sean Whipple, Panhandle Research and Extension Center, UNL

## Dung Beetle Background

Dung beetles are a relatively small group of Scarab beetles with approximately 7,000 species worldwide. They occur on every continent but Antarctica, and are most diverse in Africa, where more than 2,000 species occur. Dung beetles are extremely important ecologically and are a major component of the biological removal of dung and control of pests and parasites which use dung for breeding. In the state of Nebraska, beef production is the most economically valuable industry. Dung beetles are estimated to save farmers and ranchers \$380 million annually in the U.S. based on yield loss, pesticide applications and fertilizer use. Not included in this estimation are health costs and environmental problems from pests and pesticides. This is especially important considering approximately \$800 million are spent annually to control livestock pests in the U.S. alone. Other than their role as decomposers, dung beetles are a likely candidate for use in the measure of biodiversity, and are also involved in the pollination and seed dispersal of some plants.

Individual cattle produce approximately 10-20 dung pats every day. While dung may be broken down by weathering and by other organisms such as earthworms, ants and termites, some areas in the southern U.S. rely more heavily on dung beetles. Dung beetles significantly increase the rate of dung decomposition, with larvae being able to consume up to 100% of their body weight per day until pupation. Additionally, cattle will not graze in close proximity to their own feces, and it has also been concluded that the nutritional quality of the dung of grazing mammals is directly related to range health. Undegraded dung can prevent the growth of vegetation, resulting in an area that will remain ungrazed by cattle for up to two years.

Manure is a breeding ground for pests and parasites. The horn fly causes an estimated \$730 million annual loss to the cattle industry. Dung beetles reduce horn flies by 95% and bush flies by 80-100%, and result in nine times fewer parasites produced.

This is staggering when it is considered that over 100 adult bush flies can emerge from a 1000 cc. dung pat in Australia. Dung beetle activity has been shown to reduce numbers, resurgence and migration of parasitic larvae within feces.

Up to 56% of cattle in the U.S. are treated with insecticides to control dipterans and internal parasites. Some veterinary pharmaceuticals can reduce survival and be fatal to dung beetle populations. If treatment is necessary, it is recommended to be done when dung beetles are inactive or by using dusts and sprays.



The dung beetle *Canthon pilularius* in the process of forming a dung ball to roll away and bury elsewhere.

With overstocking and drought, as much as 85% of a pasture's biomass can be consumed by herbivores. Dung beetles efficiently cycle nutrients into the soil and create healthier rangelands and reduce greenhouse gas emissions. If dung is not removed by the beetles, 80% of the nitrogen is lost to the atmosphere. In addition, burial of animal dung by the beetles increases soil aeration and the eventual leaching of water and nutrients into the soil. Soil aeration resulting

from dung burial enhances the role dung beetles play in nutrient cycling. Soil aeration lowers runoff of surface wastes and aids in reduction of water contamination and algal blooms.

When stocking rates are high, dung beetles may become ineffective. Exceeding recommended stocking rates for livestock results in reduced forage, increased dung, and a decrease in livestock yield. Overgrazing can result in reduced surface cover, increased surface temperature, increased runoff, reduced soil moisture, and an eventual change in plant community composition. Intensive and rough grazing has been observed to reduce dung beetle abundance.

Dung beetles have adapted to fill numerous niches in a wide variety of ecosystems and many are highly specialized. Depending upon species, dung beetles may have specific preference toward dung and dung condition, as well as dung odor. Dung beetles have also been shown to segregate based upon habitat and soil type. Species differ in their nocturnal or diurnal activity, as well

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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 Citizens Advisory Council.

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.



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## FROM THE DIRECTOR

Nebraska is a leading state in beef cattle production. When considering the entire beef industry of production, harvesting, processing and packaging, it comprises a significant component of Nebraska's economy. With the increasing world population and more individuals from developing countries moving into the middle income wage earners, there will be a greater demand for animal protein in the future.

Nebraska has more than half of its land surface area in grasslands, a large number of cow-calf producers and feedlots, and large acreages of irrigated cropland for producing corn and soybeans – making the state ideally suited to be a major player in red meat production. However, with the number of acres of grasslands being converted to cropland, there is concern about the availability of adequate forage for beef cattle as we go forward.

One of the major cost components in the beef production system is feed. Approximately 85% of the feed that a beef animal consumes from birth to slaughter comes from forages. How can we increase the amount of forages available for our beef cattle in a cost effective way? There are multiple ways this could happen such as increased use and more efficient use of crop residues and the use of cover crops including annual forages. Cattle can digest materials that humans cannot and then turn those materials into high quality protein.

The increase in acres of irrigated corn has provided a significant increase in the amount of corn stover that could be utilized for fall and winter grazing. In the past there has been some concern about the potential negative impacts from the removal of corn stover. Recent research by scientists of the USDA Agricultural Research Service has shown that a large percentage of the corn stover can be grazed from the field without harm from wind and water erosion or by cattle trampling the soil.

As mentioned above, another way of increasing the availability of forages is through the use of cover crops, which are crops that are grown on idle land usually between the time of harvesting one crop and planting another. Cover crops can serve multiple uses including animal feed, protection of the land from wind and water erosion, and adding organic matter to the soil. Cover crops can be used in either warm or cool weather conditions, and they are usually annual plants. Plants that are frequently used for cover crops include wheat, rye, triticale, barley, oats, corn, millet, Sudangrass, sorghum, ryegrass, hairy vetch, peas, turnips and radishes. Cover crops may be either grazed or cut for hay.

Because of the enormous importance of beef cattle production in Nebraska, the administration of the University's Institute of Agriculture and Natural Resources has approved the hiring of four additional faculty to increase the University's effort in enhancing beef cattle production systems for this state. The University has had a significant effort underway in this area for many years; these new positions are expected to work as a team that will provide additional strength to the holistic approach to beef production systems. Through the effort of all the scientists and educators working in beef cattle and related areas, we hope to grow the industry and find ways to make it more efficient and profitable.

*M. A. Massengale*

## Insects as Agents *(continued from page 1)*

as exhibit variances in seasonal activity. Dung beetle numbers and species also vary depending upon light and light intensity. Additionally, beetles respond differently to elevation, with higher temperatures at low altitudes being optimal.

### Ongoing Research

We are currently conducting research on dung beetles as agents of biocontrol in rangeland systems through the manipulation of cattle diet. Although there have been several studies of feeding preference and niche partitioning of various dung beetle species, our understanding of the interaction among livestock diet, bacterial communities, dung beetles, pest flies, and other parasites is limited. We seek to answer the questions: 1) How does attractiveness of dung to dung beetles, pest flies, and parasites vary based on quality of livestock diet? 2) How does grazing strategy impact dung beetle abundance and species diversity?

It is known that cattle diet can impact fecal bacterial community composition and that forage quality can impact dung beetle behavior. Preliminary studies indicate strong dung beetle preference for dung from cattle fed by highly digestible diets (Fig. 1). These results show differences in beetle attraction based on livestock forage. If beetles cannot adequately degrade dung of low quality, there are implications that ranchers and range managers in Nebraska may not be receiving adequate decomposition of dung on their rangelands. This inhibits the control of flies (since dung piles remain intact) and allows for the survival of other manure-borne animal pests. This also reduces forage availability and nutrient cycling because cattle avoid grazing in areas with intact manure pats.

Further preliminary work (from Whipple and Hoback 2012) shows that even when diet is standardized, dung beetle attraction across mammalian species differs markedly, indicating that diet alone is not the only deciding factor in beetle attraction, and suggesting a role for bacterial communities and their associated volatiles. Understanding the interactions among cattle diets, bacterial flora of manure, and their volatiles has the potential to improve agricultural production through the discovery of novel strategies for enhancing biologically-based pest management of cattle.

Preliminary data from two years of dung beetle pitfall sampling in western Nebraska at two bordering 4,000 ha ranches with similar stocking rates (~900 cattle) but different management strategies yielded twice the number of dung beetle species and more

than six times the total number of dung beetles under organically managed rotational grazing compared to conventionally managed continuous grazing. A total of 3,287 dung beetles from 15 species were captured on the organic ranch utilizing rotational grazing, while only 480 beetles from eight species were collected from continuously grazed rangeland that utilized pesticides (Whipple 2011). This research stresses that range and livestock management practices impact dung beetles, and their potential benefits to agriculture.

#### Preliminary data from two years of dung beetle pitfall sampling in western Nebraska.

Species	Rotational Grazing	Continuous Grazing
<i>Aphodius coloradensis</i>	156	2
<i>Aphodius distinctus</i>	365	4
<i>Aphodius erraticus</i>	28	0
<i>Aphodius fimetarius</i>	2	6
<i>Aphodius granarius</i>	32	0
<i>Aphodius prodromus</i>	8	0
<i>Aphodius testadeiventris</i>	3	0
<i>Aphodius walshii</i>	63	0
<i>Canthon pilularius</i>	53	1
<i>Copris fricator</i>	266	29
<i>Melanocanthon nigricomis</i>	13	0
<i>Onthophagus hecate</i>	716	191
<i>Onthophagus orpheus pseudorpheus</i>	48	158
<i>Onthophagus pennsylvanicus</i>	1,175	89
<i>Phanaeus vindex</i>	359	0
<b>Totals</b>	<b>3,287</b>	<b>480</b>

### Future Research

In 2014, research will take place on the UNL Barta Brothers Ranch, which is a 2,350 ha research ranch in the eastern Nebraska Sandhills. As it concerns dung beetles, our objectives are to: 1) measure the macro-scale spatial and temporal distribution of the nutrient pulses in relation to grazing strategies, and 2) determine the micro-scale vertical and lateral transport/movement of nutrients from dung into soil by physical and biological (e.g., dung beetle) processes under varied moisture conditions. We will be assessing dung decomposition with and without dung beetle colonization.

Following the methods of Whipple and Hoback (2012), dung beetle abundance and diversity will be monitored by examining dung pats and pitfall traps on ultra-high stocking density, low stocking density, and hayed pastures at Barta Brothers and cooperating ranches. Subsequently, vertical and lateral transport/movement of nutrients in the dung by dung beetles will be monitored. This will allow determination of optimal grazing strategies for dung beetle conservation, as well as the role of dung beetles in nutrient cycling depending upon grazing strategy.

### Literature Cited

- Whipple, S. D. 2011. Dung beetle ecology: Habitat and food preference, hypoxia tolerance, and genetic variability. Dissertation, University of Nebraska–Lincoln. Online at <http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1012&context=entomologydiss>.
- Whipple, S.D. and W.W. Hoback. 2012. A comparison of dung beetle (Coleoptera: Scarabaeidae) attraction to native and exotic mammal dung. *Environmental Entomology* 41:238-244.

Editor's Note: Sean Whipple has just taken a new position with a biosciences company in another state. If you have questions regarding this article, contact the Center for Grassland Studies and we will get in touch with Sean.

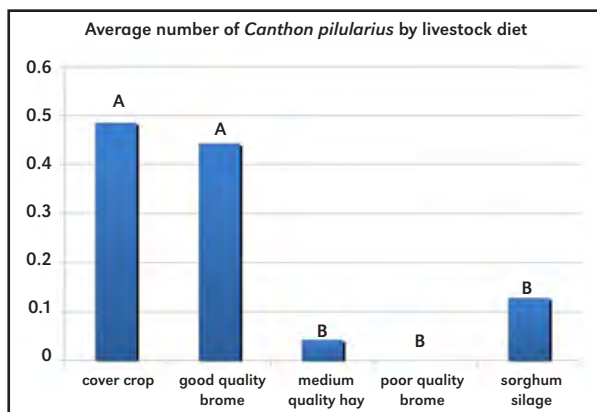


Fig 1. Preliminary field data from summer 2012 showing differences in attraction of the dung beetle *Canthon pilularius* to dung of cattle fed variable diet quality.

## Another Successful Nebraska Grazing Conference

Nearly 200 people and 20 exhibitors participated in the 13th annual Nebraska Grazing Conference held August 13-14, 2013 in Kearney. The event continues to “hit the mark,” as evidenced by the below comments from this year’s evaluations.

Comments on speakers:

[Burke Teichert’s talks were] *very interesting and simple ways of describing the economics of ranching; lots of excellent wisdom!*

[Bob Price, Lindsey Smith and Terry DeGroff with Gracie Creek Ranch provided] *a nice blend of philosophies; excellent example of a great operation.*

[Sean Whipple gave] *a knockout presentation. Not enough said about the benefits of the dung beetle.*

[Jim Faulstich was a] *good speaker and general enough to be applicable to many different kinds of operations.*

[Lyle Perman discussed a] *critical area that I need to think about – I manage sunshine and water!*

[Douglas Olsen, Jeff Pribbeno and Dan Stelling were] *best part of the program; love the comparisons of what works for each operation.*

[Grady Grissom provided] *a different look at grazing planning; very good speaker who used good combination of science and personal examples; good hands-on perspective.*

*I appreciate their [Chad and Homer Buell] generational stewardship ethic. It was great to see the two generations do the presentation. Great ranching family!*

[Sarah Sortum is a] *great speaker; interesting to hear the supplemental side of what operations have – great utilization of resources (and implementing them too!).*

[Talks by UNL’s Karla Jenkins and Jerry Volesky were] *interesting and timely. I like to see the research UNL is doing.*

Overall comments on the conference:

*Very interesting and useful information that a person can take home and use.*

*Continues to be excellent and stimulating.*

*Excellent program for continuing education. More producers should attend!*

*All excellent; producers program exceptional; best one I’ve been to.*

*Wonderful conference! A lot of excellent speakers with great information. Thank you!*

Files from the 2012 and 2013 conference proceedings are online at the conference website, [nebraskagrazingconference.unl.edu](http://nebraskagrazingconference.unl.edu). Hard copy of those and past conferences can be ordered from that site, which lists the speakers and topics for each year.



Visiting with exhibitors is always a popular activity with conference goers.



From the evaluations, we know that participants highly value hearing from grazing practitioners. This year’s producer panel of (from left) Douglas Olsen from Harrisburg, Jeff Pribbeno from Imperial, and Dan Stelling from Pierce, discussed how they fit grazing strategies to their environments.



Grady Grissom from Fowler, CO told the audience how he adapted management practices over 16 years, changing the focus from decisions based on economics to decisions based on ecology. He told the audience that initial application of a calendar-driven “grazing system” failed ecologically and economically. He said as he observed plant-animal interactions during the early years of rotation, he came to understand that maximum economic returns on rangelands require maximum ecological health, and thus, began to adapt the grazing system in a variety of ways to fit his environment, infrastructure, and management abilities.



Wednesday moderator Daryl Cisney kept things moving and provided wrap-up comments.



Two UNL Extension Specialists, Karla Jenkins and Jerry Volesky, teamed up for a joint presentation on cover crop and fall annual forage grazing. (Photos by Troy E. Smith)



Long-time member of the grazing conference planning committee, Roger Chesley, asks a question from the audience.



Having received multiple awards for stewardship of his Highmore, SD ranch, Jim Faulstich had a lot of good information to share about managing grassland for multiple uses, including details of incorporating a hunting enterprise. Jim also emphasized the importance of family, cooperating with agencies, educating the public, and giving back to the community.



Tuesday moderator Scott Cotton directs a comment to Bob Price and daughter Lindsey Smith, who, with their consultant Terry DeGross, shared the historical and current grazing plans of the Gracie Creek Ranch in Burwell, NE.

(Photo by Troy E. Smith)



Father and son, Homer (right) and Chad Buell, shared the management practices and philosophies that led to the Buell Family winning the 2012 Leopold Conservation Award for Nebraska.



Sarah Sortum described how enterprise diversification allowed her and her brother to return to the home ranch, which now supports their two families in addition to their parents. Today the operation includes Calamus Outfitters/Gracie Creek Landowners, and the land in the Burwell, NE area is now managed for tourism and wildlife as well as beef production. In 2010, the Greater Gracie Creek area was the first privately-owned land in the state to be designated an Important Bird Area by Audubon Nebraska. (Photo by Troy E. Smith)



Experienced ranch manager and consultant Burke Teichert "bookended" the conference with his opening talk on the key indicators of ranch efficiencies and closing presentation on resource management and monitoring.



Questioning the wisdom of putting him on the program shortly after lunch, Sean Whipple gave an entertaining but important talk on how dung beetles improve rangeland and therefore cattle production.

(Photo by Troy E. Smith)

With the intriguing title, "Managing two billion gallons of water," Lyle Perman of Lowry, SD gave the audience lots to think about with respect to increasing water infiltration rates as well as the impacts water management decisions have on not only the managed land, but on the entire watershed.



If you have not attended previous conferences but would like to be on the mailing list to receive notice of the next conference, to be held in at the Kearney Ramada on August 12-13, 2014, simply send your name and address to the CGS office. Details of the 2014 program will be posted on the conference website as they become available early next year.

The Nebraska Grazing Conference has several sponsors including this year's conference underwriters: Center for Grassland Studies, Nebraska Game and Parks Commission, Nebraska Grazing Lands Coalition, and Farm Credit Services of America.

## Sand County Foundation Conservation Partners Hold National Symposium

In partnership with Nebraska Cattlemen, Nebraska Land Trust and the University of Nebraska–Lincoln Center for Grassland Studies, the Leopold Conservation Award (LCA) program national symposium “Innovations on the Land” was held July 24-26, 2013 in Lincoln, Neb. attracting nearly 130 LCA recipients, partners and sponsors.

A kick-off dinner at the Spring Creek Prairie Audubon Center followed a mini-ranch tour at the Eggerling Family’s Bluestem Valley Farm. Then, we were off to our day-long symposium featuring Nebraska Lt. Gov. Lavon Heidemann, Sand County Foundation Chairman Reed Coleman, and two excellent sessions comprised of speaker presentations and panel discussions.

Dr. Stan Temple, a Sand County Foundation Director who recently presented a nationally-viewed TED talk on the concept of de-extinction, taught us all more about Aldo Leopold during lunch. And we concluded the day with dinner featuring conservation photographer Michael Forsberg as speaker.

Our group also toured the Rainwater Basin Wetland complex and met with landowners there, thanks to our partners at Rainwater Basin Joint Venture.

Beyond the personal connections made at the symposium, there is a wonderful opportunity to share “Innovations on the Land” with many others among our fellow citizens. What can you do to tell the story of the importance of conservation on private lands?

Be sure to watch and share videos of each symposium presentation to be posted in the coming weeks on our Sand County Foundation YouTube channel. Stay tuned for a special conservation publication we’ll publish later this year, and join us in our social spaces.

Thanks to our symposium sponsors: Cargill, DuPont Pioneer, Farm Credit, Nebraska Environmental Trust, World Wildlife Fund and The Lynde and Harry Bradley Foundation.

Editor’s Note: The above information was supplied by the Sand County Foundation.



**Todd Eggerling addresses participants in the “Innovations on the Land” symposium as they toured the operation owned by his family, which won the 2009 Leopold Conservation Award.**

## Nominate Someone for Leopold Conservation Award

Know exceptionally good stewards of the land? Then nominate them for the Leopold Conservation Award, which honors landowner achievement in voluntary stewardship and management of natural resources. The Sand County Foundation administers the award in several states; partnering with SCF for the Nebraska award are Nebraska Cattlemen and Cargill.

People can nominate themselves or others. The nomination process, which is fairly simple, and criteria can be found at [leopoldconservationaward.org](http://leopoldconservationaward.org). Evaluations are based on responsible and sustainable land management, economics, innovation, overall land health, and community outreach and leadership. Nomination deadline is March 1 of each year, and the award is announced in late April. Past recipients of the Nebraska award are:

2006 - The Wilson Ranch, northeast of Lakeside

2007 - Rod and Amy Christen, near Steinauer

2008 - A.B. Cox, Cherry County

2009 - Bluestem Valley Farms, near Martell

2010 - Kalkowski Family Ranches, Boyd County

2011 - Mathewson Family, RGM Corporation, near Potter

2012 - Buell Family, Shovel Dot Ranch, near Bassett

2013 - The Beel Ranch on Brown and Cherry County line



## Terry Klopfenstein Recognized as BEEF Top 50

On the occasion of the start of BEEF magazine's 50th year of publication, the BEEF 50 project was initiated in early 2013 to formally recognize 50 industry leaders who had been instrumental in the direction and development of the U.S. beef industry. BEEF asked readers to submit profiles of their industry heroes and mentors, and then submitted those nominations to an independent panel of judges who were long-time contributors to the U.S. beef industry and representative of all production sectors. As the magazine states: "The final 50 make for an interesting glimpse into the history, drive and resourcefulness of those who built, and are engaged in, this vital industry."



**Terry Klopfenstein speaks during the Fall 2012 CGS Citizens Advisory Council tour of the Agricultural Research and Development Center.**

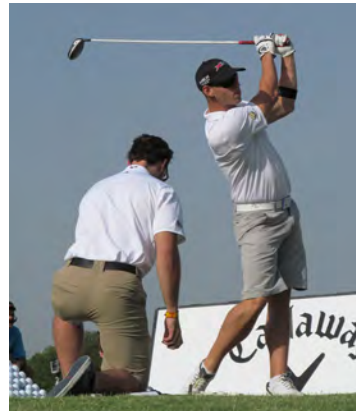
Our very own Terry Klopfenstein was among those distinguished top 50. He is an internationally recognized authority in beef cattle nutrition and the first to develop beef cattle diets using distillers grains as both a protein and energy source. Discovering the synergy that occurs when wet distillers grains replace corn in cattle finishing diets, his research served as the foundation for the "golden triangle" of corn, ethanol and cattle feeding industries in Nebraska.

Klopfenstein joined the UNL Animal Science Department faculty in 1965. He has helped guide the education of more than 150 graduate students, many of whom have gone on to become leaders in education and research in academia, industry and government realms. His 26 college, university, national and international awards include the Morrison Award, the most prestigious award given by the American Society of Animal Science.

As an Associate of the Center for Grassland Studies, Klopfenstein has made invaluable contributions to research, extension and education projects that include: leading multi-state, multi-disciplinary research projects; giving presentations in the Grassland Studies fall seminar series, field tours and the annual Nebraska Grazing Conference; authoring many CGS newsletter articles; serving on the CGS Policy Advisory Committee; and so much more. We congratulate Dr. Klopfenstein on this most recent special recognition!

## Golf Student Breaks Guinness World Record!

In the last issue of this newsletter we told you about our PGA Golf Management student, Andrew Frakes, who had been training to compete in the 2013 RE/MAX World Long Drive Championship and also to break the Guinness Book of World Records for the number of 300-yard or better golf drives in an hour. While he didn't reach the goal of winning the long drive competition, on August 7



**With his brother, Brandon, teeing up the balls and monitoring his heart rate, PGA Golf Management student Andrew Frakes hits one of the more than 600 balls in his attempt to break the world record for most balls hit 300 yards or longer in an hour. Old record: 272. New record: 448. Money raised for charities: \$20,000. Experience: Priceless!**

in McKinney, TX he not only broke the world record, he smashed it to smithereens! In fact, he broke the record of 272 only 31 minutes into the attempt. Andrew's record of 448 will likely stand for a long time... or at least until he attempts to break his own record, which he plans to try in the near future. But Andrew didn't do all of that hard work just to break a record; he did it as a fundraiser for two charities that are near and dear to his heart. The event raised more than \$20,000 for Families for Effective Autism Treatment and Spay It Forward Texas. That makes Andrew a winner in our eyes! To see video of Andrew breaking the world record, go to [www.frakesmethod.com](http://www.frakesmethod.com).

## CGS Associates

**Dennis Brink** received the American Society of Animal Science's Fellow Award, which is presented to animal scientists who have made excellent contributions to the animal industry and have had continuous membership in the ASAS for a minimum of 25 years.

**Roch Gaussoin** received the 2013 Crop Science Extension Education Award at the annual ASA, CSSA, SSSA Annual Meetings in early November.

Earlier this year **Scott Hygnstrom** received a Career Award from the Nebraska Chapter of the Wildlife Society for his long-term accomplishment in natural resources and commitment to the society.



## UNL Launches Online Grassland Management Graduate Certificate Program

The University of Nebraska–Lincoln is now offering a fully online graduate certificate in grassland management. The program leverages partnerships with faculty in six cooperating Great Plains universities to provide students with access to the best resources, research and instruction in the region. Students in the multi-institutional grassland management certificate program will learn about the conservation, utilization and sustainability of managed grassland systems.

UNL's College of Agricultural Sciences and Natural Resources developed the program in order to help preserve the delicate ecology of our nation's rapidly disappearing grasslands. Grasslands are the principal land resource type in the Great Plains and comprise more than half of all the land surface area in the region. Grasslands also represent a fundamental resource that determines the environmental and economic future of the Great Plains states. Without proper management, grasslands are subject to over-grazing, undesirable shifts in the composition of plant life and ultimately, decreased long-term productivity.

The grassland management certificate is offered jointly through AG\*IDEA, a consortium of universities focused on developing and offering distance education programs in agriculture and natural resources. Thanks to that partnership, students who enroll at UNL will receive instruction from the best faculty in the discipline from several universities.

“Students have the opportunity to learn from a broad base of faculty with expertise in their field,” said Walter Schacht, professor in the UNL Department of Agronomy and Horticulture, citing also the strong history of partnership the new program is built on. “The faculty members at the collaborating institutions have been sharing courses since 2005. Students from the participating institutions have been taking the courses online for the past 7 years.”

The job outlook for grassland managers is positive according to the U.S. Bureau of Labor Statistics. In the 2010-11 edition of the Occupational Outlook Handbook, the BLS predicts that job growth among agricultural and food scientists should be faster than the average for all occupations, stemming primarily from efforts to increase the quantity and quality of food produced for a growing population.

For more information visit [online.unl.edu/gm](http://online.unl.edu/gm).



**UNL's meadow-clipping crew takes a break from field work.**