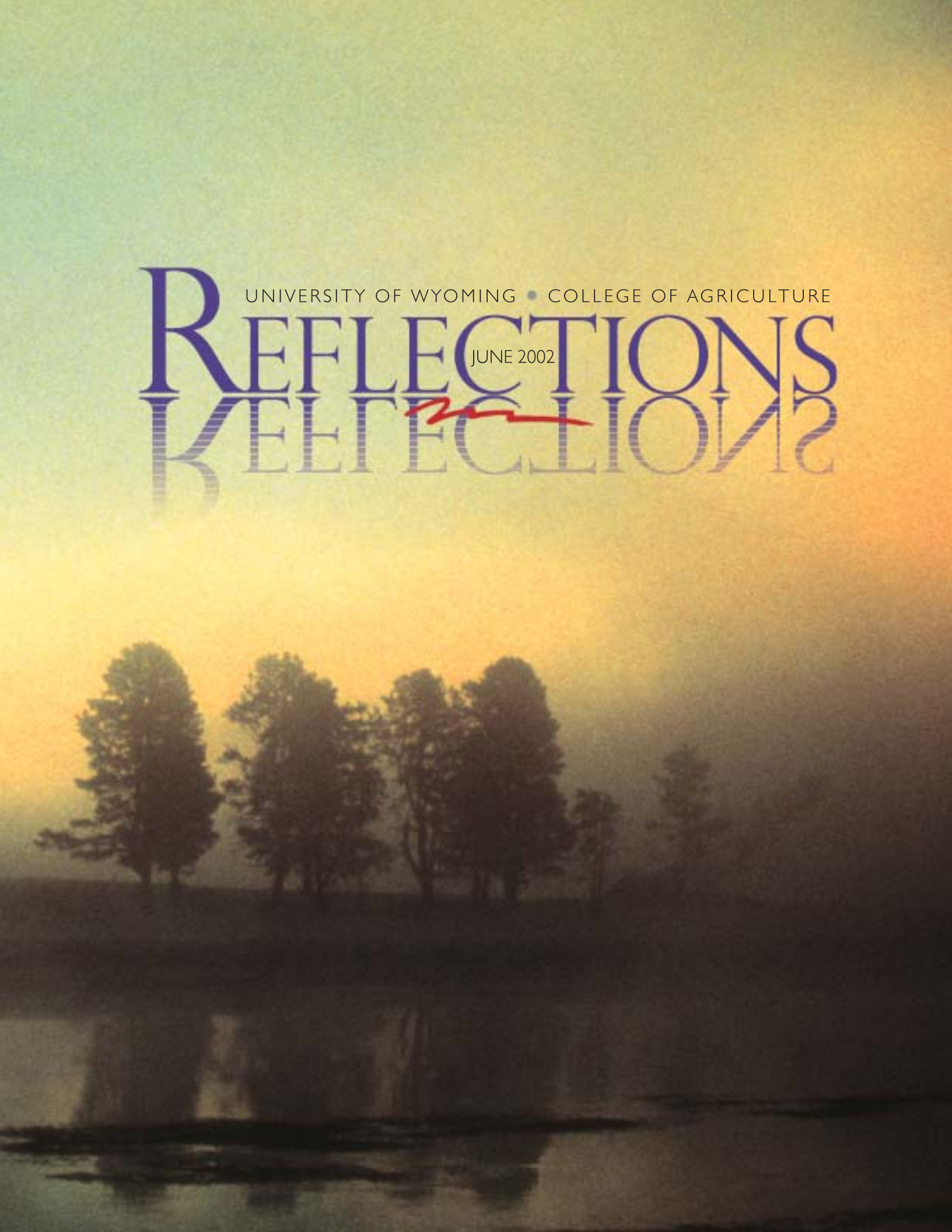

UNIVERSITY OF WYOMING • COLLEGE OF AGRICULTURE
REFLECTIONS
JUNE 2002

Jim Jacobs with twin grandsons, Toby and Wade

The Seeds of change

If asked about change, a person's first response would likely include certain major events and the dramatic changes associated with them. On a personal note, ask my daughter-in-law and son if life has changed since the arrival of twin boys this past September. In northeastern Wyoming, ask residents what changes have occurred with the rapid development of coal bed methane. Such dramatic change tends to be associated with major activities that immediately influence our lives.

However, much of the change we experience in our daily lives is the result of research that is pursued for months, years, and even decades. As Larry Tidemann, director of South Dakota's Cooperative Extension Service, so succinctly put it, we are "planting questions, harvesting answers."

In the College of Agriculture at the University of Wyoming, these seeds of change are sought from a broad spectrum of people, ranging from researchers to individual producers and consumers. The current visioning process is an effort to seek statewide input on what Wyoming citizens want the state to look like in the year 2012. The college will use this input to align the seeds it plants and to provide the information necessary to move toward the Wyoming we envision.

Personnel in the College of Agriculture are one of the best investments the state of Wyoming makes. State money invested in the Wyoming Agricultural Experiment Station (WAES) is matched by federal base funds and, increasingly, from grants and contracts. During FY01, for every state dollar invested in the WAES, personnel brought in over two dollars in additional funding.

Researchers in the college work cooperatively with agencies, communities, and individuals in planning and implementing projects to provide information to the public. The articles and briefs in "Reflections" represent only a fraction of the college's research and education projects. As you read the articles and briefs, you'll discover carefully planted and nourished seeds and perhaps think about what future results might be harvested. For example, the article "4-H Animal Care Program benefits the Wyoming Girls School" demonstrates that carefully planted and nourished seeds can foster changed views and behavior.

For more information about the College of Agriculture, visit the college's Web site at www.uwyo.edu/agcollege or contact any of the departments listed on the inside back cover of the magazine. Better yet, stop by with your ideas and questions. Working together, we will reap the most abundant harvest.

I hope you enjoy this year's *Reflections*.

Jim Jacobs
Director and Associate Dean, Wyoming Agricultural Experiment Station

Table of Contents

Photo by Orlando Hiller

Isolating the cause of a fatal viral disease in ranched bison

Malignant catarrhal fever (MCF) is the most significant fatal disease in the bison industry. Although MCF outbreaks usually occur following exposure of susceptible cattle and bison to sheep, the virus responsible for MCF in the United States has never been isolated. Most adult sheep are infected with MCF; however, they show no clinical signs of the disease.

A report published in the *Journal of Veterinary Diagnostic Investigation* details how veterinary researchers at the University of Wyoming, Washington State University, and the USDA's Agricultural Research Service in Pullman, Washington, demonstrated that MCF was responsible for more than 75 percent of fatal losses in adult bison at a large feedlot. The same researchers were recently awarded a USDA grant to isolate the virus responsible for MCF in bison, cattle, and many species of deer.

The current work is being done in two phases. In phase one, Tim Crawford and Hong Li, from Washington State University, are identifying "high shedder" sheep—animals that excrete large amounts of the virus from their nasal passages—to establish the circumstances under which sheep shed the virus and to obtain a clearer understanding of transmission patterns between sheep. Crawford and Li are working with a postdoctoral fellow who will isolate the virus. In the past, veterinary researchers have concentrated virus isolation efforts on animals dying of MCF, and they were uniformly unsuccessful. Attempting to isolate the virus from its natural host—sheep—represents a new approach and one that, surprisingly, has not been used before.

Once the virus is isolated, phase two will begin. Veterinary pathologist Dónal O'Toole, UW Department of Veterinary Sciences, will use the viral isolate to inoculate a small number of bison and establish whether MCF is reproduced. Reproduction of the disease is necessary to establish that the isolate is, indeed, the cause of MCF. A large bison holding and working facility has been built at the Wyoming State Veterinary Laboratory (WSVL), in part with funds from the Wyoming Agricultural Experiment Station.

New MCF cases represent a valuable source of research material, and O'Toole would like to hear from producers. For more information or to report MCF in an operation, call O'Toole at (307) 742-6638 or e-mail him at DOT@uwyo.edu.

Dónal O'Toole, Professor, Department of Veterinary Sciences

Exploring the possibilities of pea-grazed fallow

In an effort to maintain long-term profitability, wheat growers are exploring alternatives to conventional fallow management techniques and variations in crop selection and rotation. The traditional two-year rotation—a year of growing wheat followed

by a year of summer fallow intended to replenish the soil—has fallen short of producers' expectations, saving as little as 20 percent of the soil moisture for the following year's wheat crop. The lack of improvement in soil quality associated with the traditional two-year rotation is exacerbated by increased rates of evaporation, erosion, deep soil losses, and degraded organic matter. The outcome is costly; two acres of land are needed to grow one acre of wheat.

As part of an effort to improve dryland crop profitability, alternative fallow practices are being considered, including the possibility of growing annual legumes such as Austrian winter peas during the fallow period. In addition to enhancing soil quality and moisture usage, alternating annual legume crops with wheat may supply supplemental forage, providing extra income for producers.

Wheat-fallow budgets based upon multi-year dryland rotation trials at the University of Wyoming Archer Research and Extension Center were prepared to test the differences between traditional fallow and fallow seeded to Austrian winter peas that were subsequently grazed by lambs. Researchers found that wheat grown after lamb-grazed Austrian winter pea fallow could increase net returns by $8 per acre, representing a corresponding increase in the rate of return to farmland from 2 to 5 percent.

In addition to exploring alternatives to traditional fallow, producers have expressed a growing interest in extending the standard two-year rotation by adding other crops in an effort to quell the weed, disease, and pest problems associated with wheat as a single crop. Researchers also prepared budgets for growing wheat in a three-year wheat/corn/fallow rotation, and a four-year wheat/corn/millet/fallow rotation, both of which included comparisons between traditional summer fallow and lamb-grazed Austrian winter pea fallow. Extended crop rotations, especially those including pea-grazed fallow, increased the cost per acre by as much as $20 when compared to the conventional two-year rotation with summer fallow. However, the addition of dryland corn and millet to crop rotations improved the profit margin significantly. Pea-grazed fallow was shown to be more successful with these longer crop rotations than with the two-year cycle.

Previous analysis has shown that similar results can be obtained by substituting sunflowers for corn in either a three- or four-year rotation. College of Agriculture researchers emphasize that, while the potential to gain added profitability from pea-grazed fallow looks promising, the reality of extra time, management, and risk associated with growing more crops and managing livestock is no small matter.

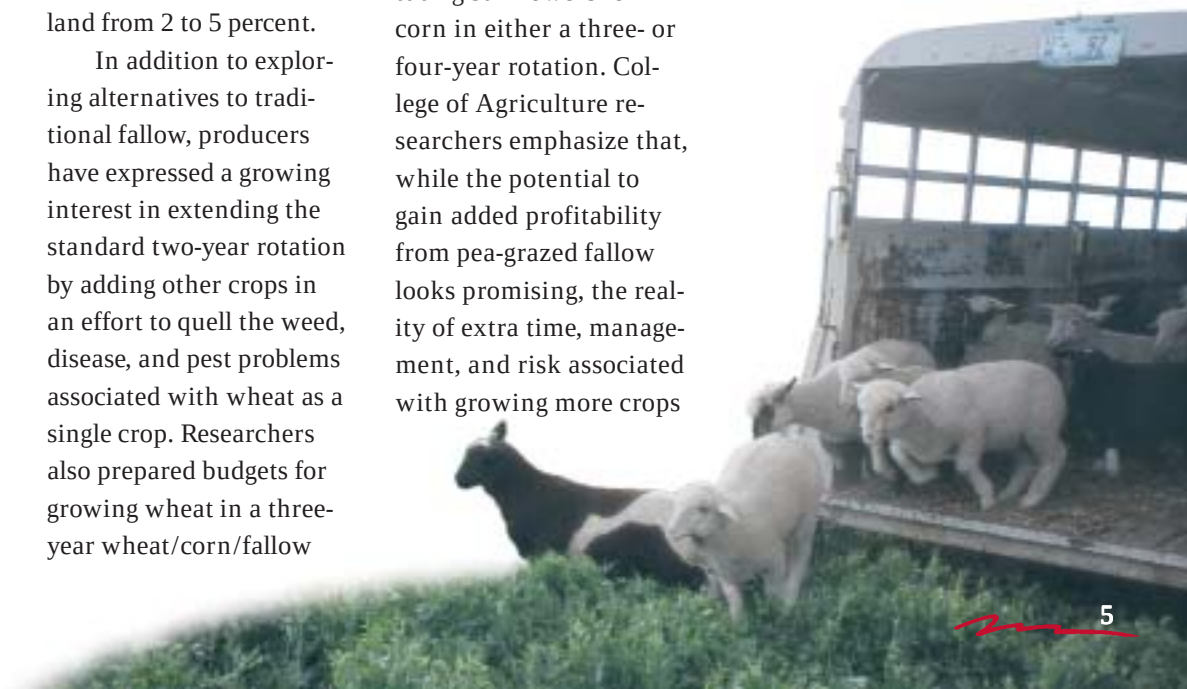
This study has confirmed that the conventional two-year wheat/fallow rotation is the poorest with respect to profitability. A viable alternative to conventional rotation is a pea-grazed fallow system, which has been shown to increase profitability, especially when combined with an extended crop rotation.

Andrew A. Haag, M.S. Candidate, Department of Agricultural and Applied Economics

Larry J. Held, Professor, Department of Agricultural and Applied Economics

James M. Krall, Professor, Department of Plant Sciences

Ronald H. Delaney, Professor, Department of Plant Sciences



A field in a wheat-fallow rotation duplicates the most common management system used by farmers in southeastern Wyoming. In order for all plots to be treated equally, a uniform soil is necessary. Researchers consult the soils map to note any areas that must be avoided. Next, the field history is consulted to identify the previous crop rotations. The project requires a 230- by 140- foot planting area. Will everything fit? Using GIS, the area can be drawn to scale.

Technologies to better manage univer

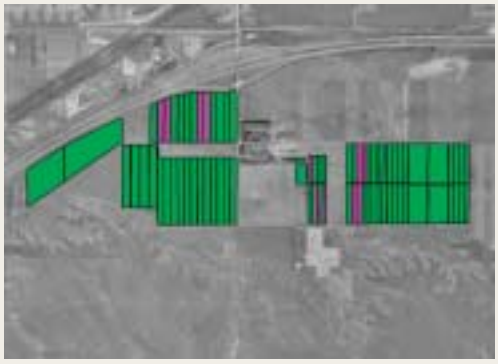


Figure 1: An aerial photo of the Archer R&E Center with the cropland locations superimposed. A query of the field records has identified several available areas that were in summer fallow. These areas are highlighted in purple.

Figure 2: Digitized soil maps, which can be copied and added to GIS databases, can be found on the Internet. In this figure, the outlines of the Archer fields are layered over the soils. Some fields have more than one soil series.

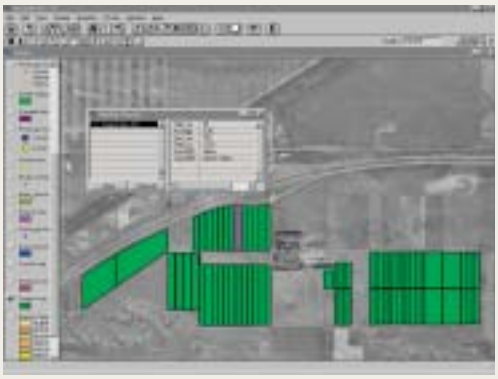


Figure 3: Individual fields can be selected and a table of information displayed. The scientist can specify the type of information she needs. In this example, note the width of the field and the cropping history for the past two years. Field F8 has the required wheat-fallow rotation.

Figure 4: The size of the required area can be typed into the program, and a rectangle representing the variety trial is drawn. If several research studies are located in one field, individual placement can be planned in advance to make sure each project has enough room.

The Wyoming Agricultural Experiment Station (AES) operates four Research and Extension Centers (R&E Centers) to serve the diverse agricultural industry of Wyoming. The centers, located at Archer, Powell, Sheridan, and Torrington, are field laboratories for the study of weed science, plant pathology, crop physiology, plant breeding, soil fertility, and animal science. In addition to research, R&E Center personnel adopt new technologies to improve operation and management of the centers.

The most recently adopted technologies are global positioning system (GPS) and geographic information systems (GIS). Both are being used to develop a map-based record-keeping and management system that consolidates and integrates all field records in a consistent and accessible format.

GPS has greatly simplified map making at the R&E Centers. The AES uses a model capable of sub-meter accuracy carried in a small backpack. With this unit, an area (such as a field, research study, or patch of weeds) can be mapped by walking around it. The exact longitude and latitude, area, and perimeter are recorded and transferred to a computer for further processing in a GIS program. Previously recorded locations can be relocated in the field.

sity lands

A GIS computer program, such as ArcView®, integrates map and database functions. Data such as crop species, herbicides, and soil fertility are associated with specific locations on a computerized map. The user points to a location on the map to retrieve the available information. For example, a researcher is looking for a site suitable for a winter wheat variety trial at the Archer R&E Center. The field must have been in a wheat-fallow rotation, have a uniform soil type, and be large enough for the trial. Because different types of field information are stored as layers in the computer program, the scientist can search the center's records to find a field that meets his or her requirements.

Once a suitable area has been located and the variety trial has been planted, the actual location will be recorded with GPS. All pertinent information, including location, crop, and the type of research project will be added to the center's permanent record.

Dave Claypool, Research Associate II, Department of Plant Sciences

Cent$ible Nutrition catapults into the Nielsen ratings

The University of Wyoming Cooperative Extension Service (UW CES) recently launched a new TV series designed to show homemakers how to make healthful, tasty meals without busting their budgets. Funded by a grant from the U.S. Department of Agriculture Food Stamp Program, UW TV, and UW CES, this 13-part series is targeted primarily at limited-resource audiences, but a wide range of viewers has tuned in to learn valuable lessons related to meal planning, grocery shopping, and preparing affordable, healthful, tasty food. The series has been so successful that it already has shown up in the Nielsen ratings!

The series employs a TV-magazine format, interspersing interviews, tips, and testimonials. Experts in the areas of food, nutrition, and consumer sciences provide information related to each program theme. Homemakers who have participated in the Cent$ible Nutrition Program (offered through UW CES in Wyoming counties) demonstrate techniques that have helped them overcome specific challenges and barriers in the kitchen. Topics include eating well on a limited budget; making quick, healthful meals; creating delightful, low-cost, and nutritious food gifts; preventing foodborne illness; cooking successfully at high altitudes; involving kids in selecting, preparing, and enjoying healthy family meals; and removing physical barriers to food preparation for seniors.

For program information in your area and a schedule of the Cent$ible Nutrition TV series, visit www.uwyo.edu/centsible/.

Linda Melcher, Cent$ible Nutrition Program Director and Senior Extension Educator, Department of Family and Consumer Sciences

Nets were dropped down over each tagged animal to measure the effectiveness of Python™ ear tags in reducing mosquito feeding on calves.

Ear tags spare cattle from blood-feeding mosquitoes

Aedes dorsalis and *Aedes melanimon* are the dominant mosquito species in areas of Wyoming where spring flooding may be problematic. Up to thousands of mosquitoes per day can attack cattle during the summer months.

College of Agriculture and USDA researchers recently combined forces to study the effect of a pyrethroid fly tag (worn by cattle) on blood-feeding mosquitoes. Research results from Jack Lloyd, Rabinder Kumar, Jim Waggoner, David Legg, and Dale Hill, of the Department of Renewable Resources, and Ed Schmidtmann, from the USDA-ARS Arthropod-Borne Animal Diseases Research Lab, will appear in the next issue of the *Journal of the American Mosquito Control Association*.

Two Python™ ear tags, products of Y-Tex Corporation in Cody, Wyoming, were applied to each beef animal. (These tags are already approved for use on beef cattle for control of the horn fly, another blood-feeding pest.) Using insect drop traps, which were lowered over treated and untreated calves to compare blood-feeding rates, the scientists determined the tags reduced mosquito feeding by approximately 78 percent at two weeks after application of the tags and 83 percent at four weeks.

In the past, these researchers found that topical spray and pour-on treatments with related insecticide formulations provided effective protection for a maximum of 7 to 11 days. The ear tags, which gradually release the synthetic pyrethroid zeta cypermethrin and piperonyl butoxide, technical, appear to offer protection over an extended period of time. Future studies will evaluate the effectiveness of ear tags beyond the four-week period.

These collection tubes display the number of mosquitoes collected from one untagged animal.

Based on this research, Y-Tex Corporation plans to submit a label claim to the Environmental Protection Agency so the existing label will include the statement, "Aids in the control of mosquitoes."

Jack Lloyd, Professor, Department of Renewable Resources

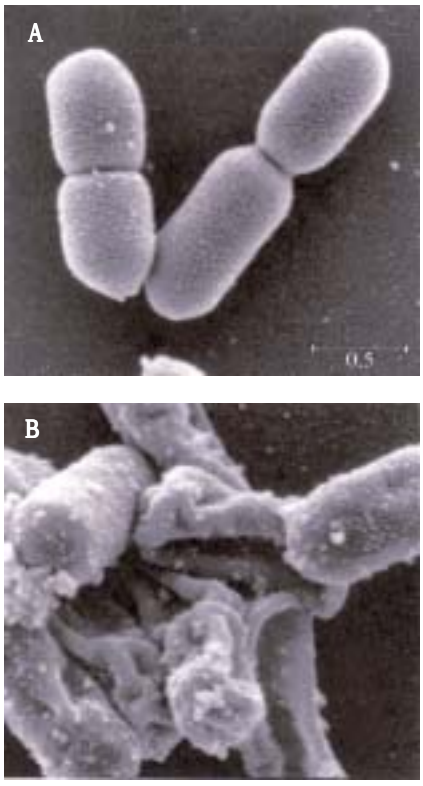
(Note: The information given herein is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the University of Wyoming or the U.S. Department of Agriculture is implied.)

Antimicrobial peptide research attacks antibiotic-resistant bacteria

Because of their growing resistance to standard antibiotics, infectious disease-causing bacteria pose a serious health threat to modern society. Previously effective antibiotics, such as tetracycline, are now useful against only a limited number of pathogenic bacterial strains. Unfortunately, as the number of resistant bacteria has increased, the rate of discovery of conventional antibiotics that can be used to combat them has declined.

Two University of Wyoming researchers, Associate Professor Kurt Miller, Department of Molecular Biology, and Professor Bibek Ray, Department of Animal Science, are studying an alternative type of antimicrobial agent that could be used to fight many types of human and animal pathogenic bacteria, particularly those causing topical skin infections. Their research focuses on the antimicrobial peptide known as pediocin AcH, which is produced by lactic acid bacteria, a member of the food-grade bacterial family used in meat, vegetable, and cheese products. Pediocin AcH reacts against the deadly food-borne pathogen *Listeria monocytogenes* and is a promising agent for food preservation. This bacterium also has modest activity against some *Staphylococcus* and *Streptococcus* strains, which often cause topical infections.

Miller and Ray are taking a multi-pronged approach in investigating pediocin AcH and optimizing its activity against pathogenic bacteria. They will determine the structure and action mechanism of the peptide. (The shape of the peptide is important for pore formation in the membrane and cell killing when essential cellular nutrients leak.) Because they already have determined the structure of pediocin AcH when bound to *Listeria* membranes, next they will explore the peptide in *Staphylococcus* membranes and make genetically engineered variants that can form better pores in this bacterium.



Listeria monocytogenes before (A) and after (B) antimicrobial peptide treatment. (Sample prepared by Norasak Kalchayanand in the Ray Laboratory.)

Miller and Ray also have analyzed components of the *Listeria* cell surface that are important for pediocin AcH binding and passage through the cell wall. Defining cellular components that interact with the peptide is important, as this will facilitate genetic engineering of pediocin AcH variants that have superior cell-penetration properties. Providing definition will aid in the design of variants that still can attack cells if components of the uptake pathway become mutated and are no longer recognizable by pediocin AcH.

It is widely anticipated that antimicrobial peptides of bacterial and other origins will be used in the future to control many disease-causing microbes because they do not give rise to resistant strains as frequently as conventional antibiotics do. Researchers in the Miller Laboratory look forward to continuing their basic research focus for the good of individuals everywhere.

Kurt W. Miller, Associate Professor, Department of Molecular Biology

Bibek Ray, Professor, Department of Animal Science

New hope for threatened species

The College of Agriculture's Renewable Resources Department has formed a partnership with F.E. Warren Air Force Base in Cheyenne to study management options for Colorado butterfly plant (*Gaura neomexicana* ssp. *Coloradensis*) populations. Listed as a threatened species, the Colorado butterfly plant is a short-lived perennial that spends up to three years as a basal rosette before sending up a flowering stalk and producing seed. When in bloom, the large flowers are a striking white and pink against reddish stems, and the unique seed capsules are green oblongs with red ribs running end to end along hard, thick sides.

A few populations of the Colorado butterfly plant are clinging to survival in the far southeastern corner of Wyoming and the adjacent corners of Colorado and Nebraska. The Colorado butterfly plant thrives in riparian areas and wet meadows in short-grass and mixed-grass prairie habitats and prefers open areas with little competition from surrounding plants. Urban expansion, inhospitable agricultural practices, and changes in natural fire and flooding patterns have altered or eliminated many of the habitats necessary for this species to survive.

Because significant populations of Colorado butterfly plants have evolved in landscapes shaped by fire, flooding, haying, or grazing, UW researchers are mowing and burning study plots to determine the best way to remove accumulated grass and litter from the areas of the Air Force base inhabited by this species in an effort to enhance the seedling establishment. The first mowing treatment, conducted in August 2001, was followed by a second mowing in June 2002, timed to coincide with the local haygrowers' first cutting. Healthy populations of the Colorado butterfly plant have been found on private lands that are hayed, and researchers have speculated that mowing prior to flowering may clear overstory vegetation in the spring, enhancing growing conditions for this species. The initial controlled burn experiment (October 2001) was followed by a second fire treatment in early spring. The study plots will be monitored for new Colorado butterfly plant seedlings to determine the benefits of mowing or burning to seedling recruitment.

Concurrently, researchers are experimenting with Colorado butterfly seeds, using propagation techniques to learn more about the conditions required for germination in the wild.

The experiments conducted on the Colorado butterfly plant will result in information about the life characteristics and habitat preferences that will enable the stabilization or expansion of populations beyond the scope of the area studied. With continued advancement of scientific knowledge and informed management applications, this could be one native species' success story of survival amidst a changing landscape.

Leah Burgess,
Research Assistant,
Department of Renewable Resources

Ann Hild, Associate Professor
Department of Renewable Resources

Equine

In June 2001, more than 40 horses on a dude ranch in Wyoming began displaying signs of neurological disease, including fever, hind limb weakness, unsteady gait, and urinary incontinence. Most of the horses remained standing and alert, but the most severely affected animals suffered paralysis of the hind limbs, weakness of the front limbs, and inability to rise (Figure 1). By the end of July, one horse had died and eight more had been euthanized.

Bacterial infection and many viral diseases were ruled out by testing tissue samples from affected horses at the Wyoming State Veterinary Laboratory (WSVL). Polymerase chain reaction (PCR) tests performed at the WSVL and at Colorado State University led to the discovery of equine herpesvirus type 1 (EHV-1) nucleic acid in a whole blood sample from one horse.

Further testing at the WSVL revealed serological evidence of acute EHV-1 infection in many horses on the premises, prompting diagnosticians from the WSVL to perform a

herpesvirus strikes Wyoming horses

necropsy on one of the most severely affected animals. Microscopic lesions consistent with EHV-1 infection were identified in the brain and spinal cord of this horse, as well as in another horse that had been euthanized due to severe neurological impairment. Lesions observed included characteristic inflammation of blood vessels and neural tissue, with hemorrhage throughout much of the brain and spinal cord (Figure 2).

Equine herpesvirus type 1 infection can cause outbreaks of respiratory disease, abortion, and/or neurological disease in horses. Clinical signs of the neurological form of EHV-1 disease include unsteadiness and gait abnormalities, limb weakness, urinary incontinence, and in a few cases, paralysis or death. The prognosis for recovery is fair to good if recumbent horses regain the ability to rise. Horses that remain down for more than a few days may not recover and may require euthanasia. Permanent neurological deficits are possible outcomes of infection.

Like most herpesviruses, EHV-1 causes latent infections in horses, with viral shedding precipitated by stress or a change in environment. EHV-1 infection is very contagious and can be transmitted from horse to horse in fresh secretions or aerosols. The virus is not hardy in the environment, however, and can be killed by most common disinfectants.

Approved vaccines for EHV-1 help to prevent respiratory disease and abortions in horses, but current vaccines are not effective in preventing the neurological form of the disease. Despite controversial evidence that vaccinated horses may be at an increased risk for developing neurological disease compared to unvaccinated animals, most veterinarians agree that the benefits of vaccinating horses against the EHV-1 virus far outweigh the risks, especially with young horses, performance horses, and pregnant mares.

Given the contagious nature of this disease, affected herds should be quarantined for at least three weeks after the last affected animal has recovered. Contaminated instruments, clothing, boots, and tack should be cleaned and disinfected to avoid transmitting the virus to susceptible animals. Feed and water that have been in contact with affected horses should not be shared with unexposed animals. For more information about EHV-1 infection or other neurological diseases affecting horses, contact your local veterinarian or the WSVL at (307) 742-6638.

Figure 1: The neurological form of EHV-1 infection led to the paralysis of this horse's hind legs.

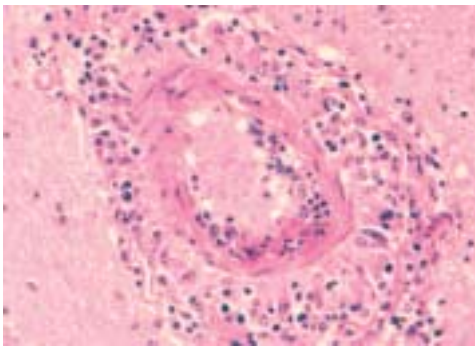


Figure 2: Inflammatory cells have infiltrated the wall of this blood vessel as well as the surrounding tissue in the brain of a horse infected with EHV-1.

Todd Cornish, Assistant Professor, Department of Veterinary Sciences

R&E Center explores cull-cow marketing opportunities

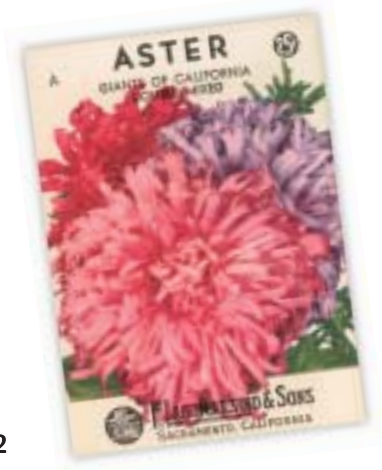
Wyoming Agricultural Experiment Station Director Jim Jacobs, second from right, discusses the cull-cow marketing project with local producers.

Cattle ranchers in southeastern Wyoming are working with researchers from the University of Wyoming to determine how they might increase income through the sale of cull cows. The dictionary defines a cull as "something picked out from others, especially something rejected because of inferior quality." For the typical Wyoming cow-calf operation, sales of cull cows account for up to 25 percent of gross income.

Currently, UW Torrington Research and Extension Center personnel are working with seven ranchers from five southeastern Wyoming counties to evaluate four different marketing alternatives, involving 170 head of cattle. The possible alternatives include:

- Sell in November at the sale barn
- Sell in November on grade and yield basis
- Feed for three to four months; sell on grade and yield basis

The costs of feeding and yardage will mandate higher sales revenue for the cows marketed in late winter if ranchers are to increase net income. The cows will be heavier after feeding, and on the average, prices are higher toward spring. Cull-cow prices traditionally bottom out in November when most cows from Wyoming are marketed, and data shows that prices for cull cows will then increase through the winter and into the spring months. But will the increased weights and prices be sufficient to pay for the cost of feed and ownership during the feeding period?



Cattle owners have expressed a variety of thoughts on the research project. Rancher and cooperator Larry Cundall said that he "enjoyed the opportunity to see the individual variation of the cows on feed." Cundall is also looking at age, genetics, and physical condition to try and determine if there are any valuable and informational trends in his cow herd. Shawn Daly, a rancher in Douglas, said, "Learning about the various rations and feed sources has been an educational experience."

An additional aspect of the cull-cow feeding project is an evaluation of radish hay as a component of the cows' ration. Bret Hess, a ruminant nutritionist with the Department of Animal Science, is investigating the feasibility of using radish hay to replace alfalfa in the ration because radish hay can be grown following wheat or barley on irrigated cropland in Wyoming, with planting dates as late as August 10. Since prices for radish hay are generally lower than prices for alfalfa, it may be a cost-effective substitute in the ration.

Both projects will conclude in late winter, and details of the project results will be released to the general public.

Jim Freeburn, Director, Torrington and Archer Research and Extension Centers

UW establishes the Center for the Study of Fetal Programming

The University of Wyoming and New York University are working together to establish the Center for Fetal Programming in Laramie. By providing a venue for the investigation of the specific affects of nutritional, environmental, and hormonal stress on the health of offspring, this joint venture will improve the profitability of livestock production with further implications in the area of human health.

Fetal programming means that a maternal stimulus or insult at a sensitive period of fetal development could have long-term effects on the resulting individual. In evolutionary terms, this phenomenon is likely to reflect the benefits of developmental flexibility of the fetus during the early gestational period, but it may have negative affects on post-partum health.

At Southampton University in England, David Barker championed the concept of fetal programming. Barker and his colleagues studied birth records of babies born in the United Kingdom and related different maternal stresses to the weight and physical characteristics of babies at birth and to the subsequent health status of these children in later life. He found that if a woman was undernourished during the first half of gestation and then received adequate nutrition to term, the baby would be a normal birth weight, but proportionally longer and thinner than normal. Early fetal malnourishment resulted in an increased incidence of health problems when these children became adults, including obesity, diabetes, hypertension, and cardiovascular disease.

While the concept of fetal programming is well accepted by the medical community, very little is known about the specific mechanisms involved. No research has been conducted to evaluate the impacts of maternal stress in livestock species on the subsequent growth efficiency, reproductive performance, and carcass quality of their progeny.

The idea for the Center for the Study of Fetal Programming was hatched last summer at the Society for the Study of Reproduction Meetings in Ottawa, Canada. Stephen Ford, professor and Rochelle chair in the UW Department of Animal Science, and Peter Nathanielsz, director for women's health research and professor of obstetrics at New York University School of Medicine, both have a keen interest in gaining a better understanding of uterine and placental factors controlling the growth, development, and birth of a healthy fetus. Nathanielsz is relocating the bulk of his research equipment and animals, as well as several of his research personnel, to UW to help establish the center.

The Center for Fetal Programming is committed to the production of healthy, high-quality livestock, while at the same time, applying this understanding to improve the health and longevity of human babies. Center personnel will apply for federal agricultural funding through USDA, in addition to biomedical funding through NIH.

From right, Stephen Ford, professor and Rochelle chair in the Department of Animal Science, Amanda Mullins, undergraduate animal science major, and Carole Hertz, research scientist, collect samples from lambs whose mothers had been nutrient restricted during gestation.

Stephen Ford, Professor and Rochelle Chair, Department of Animal Science

Big Horn/Wind River Basins Applied Research Fund

The University of Wyoming Research and Extension Center (R&E) in Powell has been partnered with the agricultural producers and communities of northwestern Wyoming for more than 50 years. Whether helping ranchers increase acreages of specialty hays or barleys, introducing producers to alternative crops, or exploring new uses for traditional crops, the R&E Center brings applied research directly to the local agricultural community—one producer at a time.

In 2001, members of the Powell R&E Center Advisory Board, together with the Center's director and representatives from the UW College of Agriculture, established the Big Horn/Wind River Basins Applied Research Fund to finance projects with direct impacts upon the agricultural communities of northwestern Wyoming. The fund will expand the scope of existing applied research projects, including field trials with plant metabolic regulators, seed-coating treatments, and other programs that focus upon irrigated crops grown in Fremont, Hot Springs, Washakie, Big Horn, and Park Counties.

For more information or to make a contribution to the Applied Research Fund, call the College of Agriculture Development Office at (307) 766-3372 or e-mail aleonard@uwyo.edu.

Expanding
Family and

"I think you may be the answer to my prayers! Does your program really offer all the classes I need to complete my bachelor's in family and consumer sciences/professional child development option without my having to come to Wyoming or go to a specified site somewhere for testing or viewing a class? I work full time and find it very difficult to do evening classes since we do foster care, and the children don't do well with sitters on a predictable basis."
(Wilmore, Kentucky)

boundaries:
Consumer Sciences students span the nation

The word is out, and students from across the country are excited about fulfilling their career goals through the University of Wyoming. The Department of Family and Consumer Sciences now offers a bachelor's degree with a professional child development option and a new Early Childhood Program Director's Certificate through distance education.

The distance degree program is a joint venture between Casper College and the University of Wyoming. In Wyoming, a student can earn an associate's degree in early childhood development from Casper College, and then seamlessly transfer to the UW distance education program to complete a bachelor's degree in the Department of Family and Consumer Sciences. Long-distance learners from outside Wyoming can transfer credits and associate's degrees from other accredited institutions, as well.

"Quality" and "student access" have been the watchwords of the distance degree program. Graduates will become teachers or directors of developmental centers, preschools, daycares, and Head Start programs, working directly with young children, families, and staff members. Because of the importance of early life experiences to later learning, off-campus students must possess the same skills and competencies at graduation as on-campus students. The following guidelines have been implemented to ensure consistency between both programs:

- The distance degree program and the early childhood director's certificate programs have the same requirements as the on-campus programs.
- All courses are offered through distance methods accessible nationwide. Most are available online.
- Criminal background checks are required of all students and must be on file before practicum or internship placement.
- Only programs accredited by the National Association for the Education of Young Children may be used for a practicum or an internship. Students work with an identified on-site mentor teacher and a distance faculty supervisor.
- Students work with an assigned advisor throughout the program to ensure consistent information and personal contact.

Departmental faculty members want all students who graduate from the distance education degree options to be successful and proud of their degrees. Because of this, the Department of Family and Consumer Sciences will focus upcoming research on the program's impact on early childhood educators nationwide.

Karen C. Williams, Associate Professor, Family and Consumer Sciences

"I am interested in earning my BA in professional child development. I'm 34 years old, and I have hours accumulated from three prior institutions. Since I live in the San Luis Valley, online degree completion is ideal for me. There is a vast and varied need for social welfare in the area of child development here. I'm ready to enter the work force doing something meaningful and rewarding." (Crestone, Colorado)

Ag Ambassador Mike Henn, right, meets with FFA members at the Nebraska State FFA Convention.

Ambassadors personalize

Moriah Pohlman, Office of Academic and Student Programs

Willow Rossmiller, Agricultural Communications Student

The University of Wyoming Agriculture Ambassadors is a unique, student-run organization whose influence goes far beyond the bounds of the traditional college club.

College of Agriculture Ambassadors are the official student recruiters for the college. The 23-member organization is made up of students with majors representing all seven of the college's departments. The ambassadors strive to recruit high school and community college students to the College of Agriculture, inform them about the University of Wyoming, and encourage them to pursue higher education through the college's eight undergraduate degree programs.

"Agriculture Ambassadors are highly effective in our student recruiting program because they can connect and relate with other students," said Associate Dean James Wangberg. "Their dedication to the college and the passion they exhibit for their educational pursuits are two of the greatest contributions the group makes to the college."

Throughout the year, the ambassadors participate in many college and university functions. These students ensure the college is represented at UW Discovery Days, the UW Campus Resource Fair, the UW Family Weekend Resource Fair, UW Summer Orientation, state 4-H and FFA events, high school visits, community college visits, the Wyoming State Fair, and county fairs throughout the state. For out-of-state exposure, ambassadors represent the UW College of Agriculture at the Nebraska FFA Convention and at Colorado and Nebraska high schools and community colleges.

Recruiting activities give ambassadors an opportunity to meet new people, network with future employers, and promote the college to outside entities. "For me, the most rewarding opportunity has been speaking with students one-on-one and having the satisfaction of enlightening them about the exciting opportunities at the University of Wyoming and in the College of Agriculture," said Ambassador Amber Jackson. She has been an active group participant for two years.

Members gain many valuable skills while serving in the organization, including people and public-speaking skills, and gain an extensive knowledge about the college and university. To keep up on college and university activities and accomplishments, the club holds monthly training meetings to learn all about the programs and services offered.

"These students are true ambassadors for both the college and the agriculture industry," said Anne Leonard, director of Development and College Relations. "Whether meeting with alumni, helping explain ruminants to fourth and fifth graders at the Albany County Ag Expo, or meeting with people at the Wyoming State Fair, this group represents our pro-

"Agriculture Ambassadors' dedication to the college and the passion they exhibit for their educational pursuits are two of the greatest contributions the group makes to the college."

James Wangberg, Associate Dean

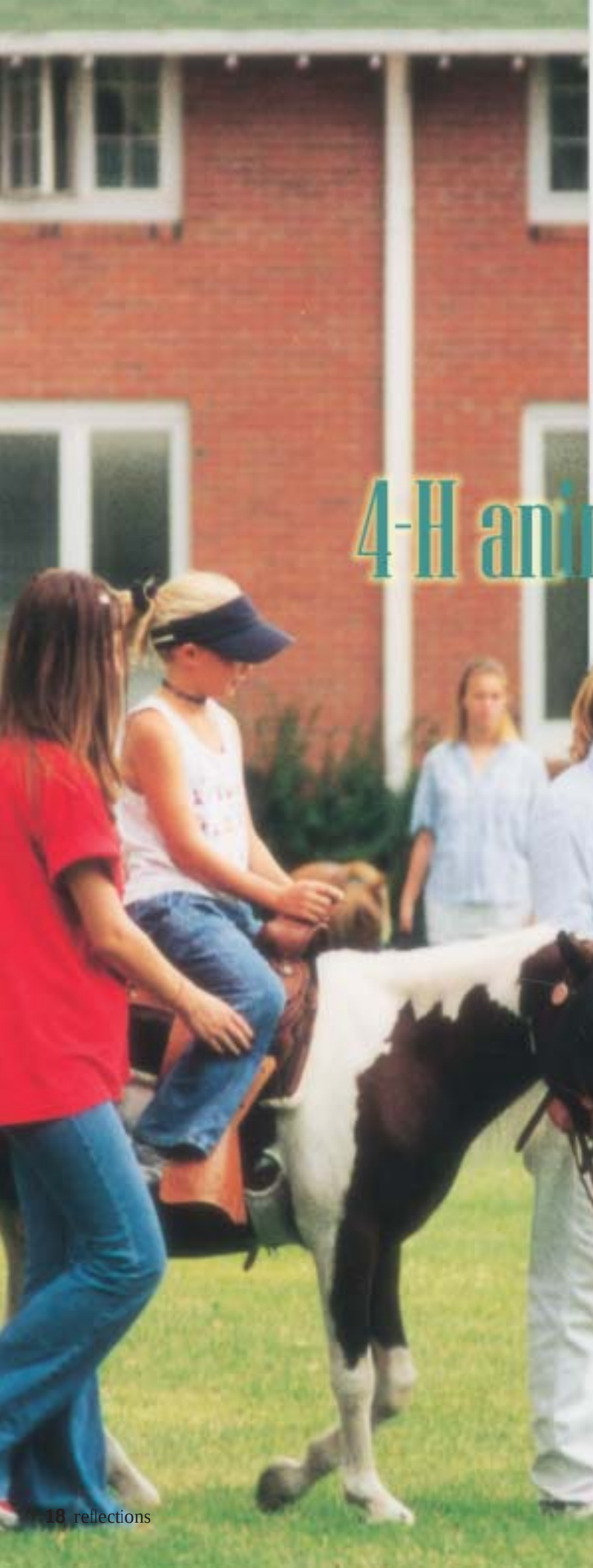
the College of Agriculture

grams and the next generation of agricultural leaders with grace and poise."

To become an ambassador, College of Agriculture students must go through an interview process. After the top students are selected, they gain active member status and begin training. The undergraduate ambassadors must be enrolled as full-time students, maintain a minimum 2.75 grade point average (graduate students must maintain a 3.0 GPA), be knowledgeable about the college and university, perfect their public-speaking skills, and get to know the faculty, staff, and students in the College of Agriculture.

For more information or to become an ambassador, contact the Office of Academic and Student Programs by phone at (307) 766-4034; e-mail wangberg@uwyo.edu; or stop by Room 139 in the Ag C Building.

Kristy Moores Lindsay Pahl Becky Torpy Evee George Shane Thompson



"Many of the girls had abandonment and attachment issues prior to joining the Animal-Care Program. My expectations were to create a bonding experience for each girl and to teach the girls how to nurture another living creature."

(Staff counselor, The Wyoming Girls School)

4-H animal care program

Randy R. Weigel, Associate Professor and Extension Specialist, Department of Family and Consumer Sciences

Brenda Caiola, Educational Staff, The Wyoming Girls School

Lise Pittman-Foy, 4-H Program Associate, University of Wyoming Cooperative Extension Service, Sheridan County

The University of Wyoming Cooperative Extension Service (UW CES) Sheridan County Office has teamed up with area ranchers to develop an animal-care program at the Wyoming Girls School. The combination of companionship and responsibility of caring for animals can play an important role in adolescent development, especially for children and youth who are at risk emotionally, socially, or behaviorally. Many of these young people have suffered abuse

Photo by Robert Kemp

benefits the Wyoming Girls School

and neglect from parents or caregivers and tend to identify with their aggressors, either believing themselves to be at fault for the abuse or abusing others. Carefully introducing at-risk children to companion animals can reduce antisocial behavior while encouraging nurturing traits. As a source of love, companionship, and responsibility, animals can help smooth the transition from childhood through adolescence and into young adulthood.

The Wyoming Girls School (WSG) is a state residential facility located in Sheridan, Wyoming. The students are 12- to18-year-old girls who have been sentenced to this residential facility for rehabilitation as a result of inappropriate, delinquent behavior or offenses.

Funded by UW CES's Children, Youth, and Families at Risk (CYFAR) Initiative and local foundations, the Animal-Care Program includes miniature horses, llamas, goats, cattle, and rabbits. Project variety is designed to match residents' interest and comfort levels and to increase the number of residents who can benefit from 4-H participation.

The students are responsible for the daily care of their animals, including feeding, cleaning, gentling, grooming, and training, as well as the completion of daily responsibility charts. In some instances, the animals come to the program in a wild, or nearly wild, condition. For example, in the miniature horse project last year, some of the horses had to first be gentled by the staff and students before grooming and training began.

For many of the students, this is the first experience with this level of responsibility. Though not all participants are able to rise to the program's expectations, many experience positive benefits from their involvement. If the students choose, they can compete at the county fair or participate in private, local shows.

While the students learn positive social behaviors from their interactions with the animals, the animals also have a therapeutic effect on the youth. In self-assessments of their 4-H experience, WGS residents reported that their animals served many roles including teacher, listener, comforter, distracter, and friend.

Animals as teachers

Working with animals teaches the residents valuable life skills. As the students observed, even though the animals are "corrected" as they are trained, the animals continue to work with the students. The students are able to see and learn from a situation in which an animal is disciplined, but the animal is still loved.

My bunny Licorice has helped me to know that I am going to be able to make it as a parent some day. I have a pretty big issue with abuse and my biggest fear is someday treating my kids the way I was treated. Licorice taught me ways I can handle myself when I get upset at what he does (WGS resident, age 16).

Animals as listeners

Many WGS residents are reluctant to talk to others because communication involves the risks of ridicule, sarcasm, criticism, and vindictiveness. However, there were reports by many of the young women that their animals seemed to listen, provided unconditional and empathetic nonverbal

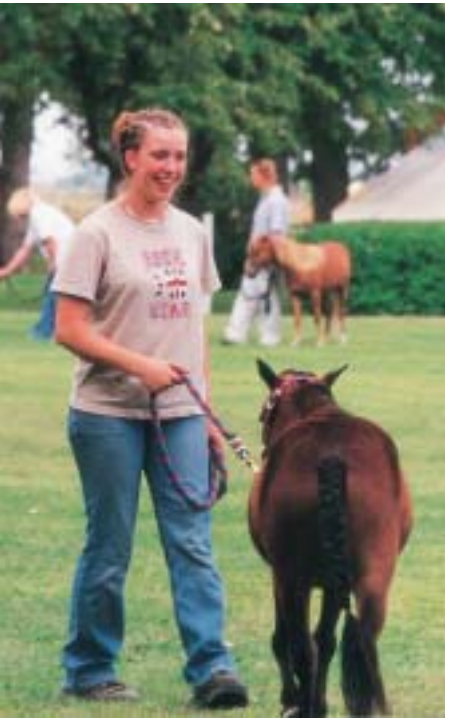


Photo by Robert Kemp

feedback, and were good sounding boards as the students worked through their personal issues.

Whenever I am sad or angry my rabbit is something I can go to and hold, and my rabbit doesn't criticize me like people I know. He is just silent and calm (WGS resident, age 15).

Animals as comforters

Grooming animals has a therapeutic effect for many people. Several of the residents come from families where positive emotions are not expressed, and hugs and comfort are not experienced. Grooming the animals allows the students to feel and touch in a peaceful and loving way. Grooming the rabbits' soft fur or the horses' shiny coats is comforting to many of the students.

I get a sense of comfort when I have a soft rabbit to hold. Instead of going to guys to comfort and hold me, I can cuddle with my bunny when I'm down (WGS resident, age 14).

Animals as distraction

The WGS treatment plan for the residents includes dealing with personal issues. Focusing on animal training provides a temporary distraction from the stress, pain, and anxiety they are experiencing.

I wanted to learn patience and work with my horse, but having love in my heart for him got me to this point today. I am so proud of him—and myself as well. Everyday I go down there and he's waiting at the gate looking right at me just waiting to get out and try new things. Even though fair never happened, he would have won and I know that because he's my champion (WGS resident, age 17).

Animals as friends

In their assessments, WGS students frequently referred to their animals as friends. In an environment where these young women are dealing with problems of trust and broken relationships, the animals provide unconditional, uncompromising friendship. The residents often attribute human qualities to their animal friends, describing them as "someone I could talk to," "someone I could hold," or "someone who would listen."

The bunny program has benefited me in many ways. Most of all, it gave me a friend. When I was struggling, I was able to go out there and hold her and even sing to her. It was really comforting to know that she was there to help make me feel good. It was also a good feeling because she relied on me. I have really never been needed, and she needed me. She counted on me to give her food, water, and attention (WGS resident, age 16).

For those who have worked in 4-H, the value of animals in the physical, emotional, and psychosocial development of children and youth is well known. The long-term benefit of these 4-H animal-care projects in the lives of at-risk youth is unclear, but for many of these kids, interacting with animals is a new experience that appears to have special therapeutic value.

By the time many at-risk youth reach adolescence, their ability to connect with others is weakened or absent. The challenge for adults, teachers, and mental health professionals is to find a way to help them build confidence, self-esteem, and trust. Supervised interaction with animals can serve as a powerful way for adults, educators, and therapists to open many closed doors and pave the way for dramatic breakthroughs.

Photo by Robert Kemp

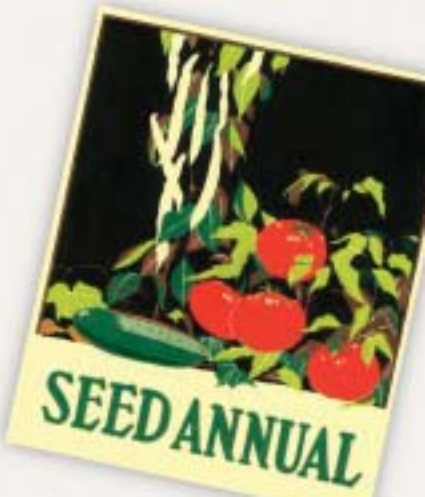
Impacts of grazing removal from Wyoming sagebrush communities

Jennifer Boyle, Master's Candidate, Department of Renewable Resources ◆ Ann Hild, Associate Professor, Department of Renewable Resources ◆ Pete Stahl, Assistant Professor, Department of Renewable Resources ◆ Larry Munn, Professor, Department of Renewable Resources ◆ Martha Christensen, Professor Emerita, Department of Botany

Removal of livestock grazing from public rangelands has been suggested in Wyoming and other western states. Some people feel strongly that the removal of livestock grazing in semi-arid regions will increase the diversity of rangelands or return them to "pristine" or pre-grazed conditions. The long-term effects of grazing removal have not been thoroughly researched in shrubland systems that evolved with large herds of grazing animals such as bison, antelope, elk, and deer. In some areas of the West, increased shrub density and cover after removal of grazing from shrubland ecosystems has been well documented, but in other areas, shrubland communities have remained nearly unchanged after many years.

While a University of Wyoming professor, Herbert Fisser established a network of fenced exclosures throughout Wyoming in the 1950s and 1960s, providing the opportunity to examine the effects of grazing removal from shrubland communities. Many were erected on lands managed by the U.S. Forest Service, Bureau of Land Management (BLM), Bureau of Indian Affairs, and the National Park Service. Rangeland exclosures are commonly used to determine how livestock grazing and other land uses affect vegetation change and productivity by comparing outside and inside areas of the exclosure. By 1963, over 200 range exclosures had been established in Wyoming. Not all of these still exist, but initial surveys in the summer of 2001 led researchers to believe that as many as 150 of these range exclosures are still intact.

Department of Renewable Resources researchers are using these exclosures to examine changes in vegetation and soil 40 years after the removal of domestic grazing.



In the past, ecologists believed that removal of grazing would allow grasses to increase at the expense of shrubs. The Poison Spider site demonstrates the opposite can occur.

Previous research

From 1959 to 1962, a number of range exclosures were constructed on BLM-owned lands in Wyoming. The late Fisser, initiated a number of studies and collected data on many of these exclosures. These projects included looking at different grazing treatments, shrub improvement and control using herbicides, moisture relationships, and vegetation change. Some of these exclosures have permanent plots that can still be identified today. Fisser and his colleagues did intensive data collecting for the first 20 years, but since the early 1980s, little research has been conducted within these exclosures. On BLM-managed lands, most of the exclosures have been maintained, and precipitation records are available from the original rain gauges installed during initial construction. Approximately 70 of Fisser's original BLM exclosures are intact and can be monitored. Because these exclosures were fenced on areas already grazed, they cannot be considered "relict" areas; however, these sites are ideal for addressing questions concerning changes that follow grazing removal.

During the summer of 2001, UW researchers began the search for these exclosures. With the help of the Casper and Lander BLM districts and Fisser's original documents, researchers began a re-inventory of intact exclosures, recording major vegetative species and noting any sign of animal presence within the exclosure. They visited 21 Wyoming exclosures in Fremont, Natrona, Carbon, and Sweetwater Counties, and found that only two of these exclosures were not intact.

This finding suggests that many exclosures in Wyoming are available for future studies. Five exclosures were selected for more intensive monitoring, and researchers documented basal and aerial cover of all plant species and density and cover of the shrubs. Soil samples were collected to determine the variety of organisms present and to estimate soil health. Biological soil crusts, which are good indicators of soil integrity, also were collected.

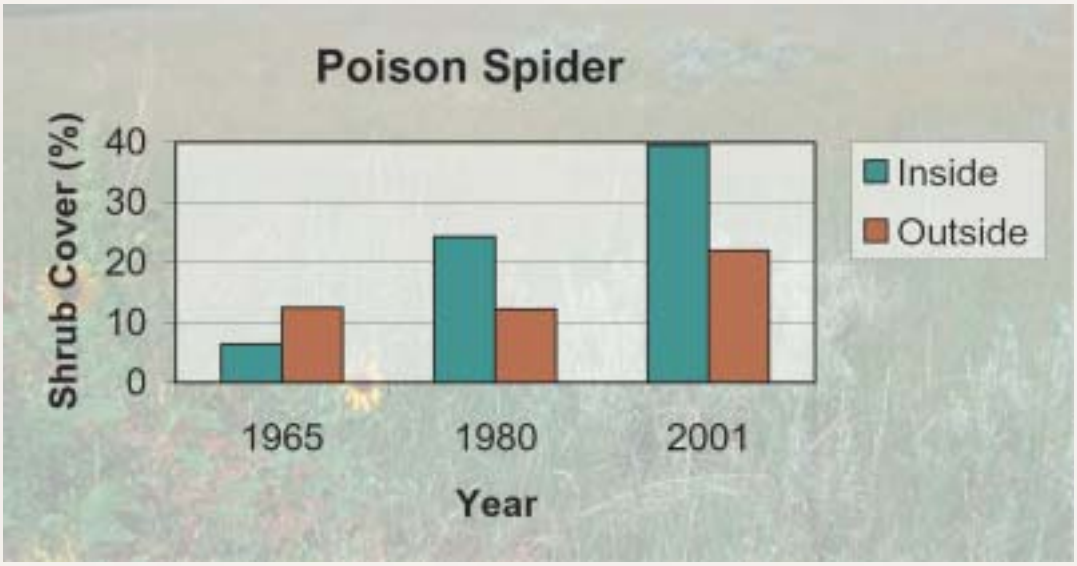


Figure 2. Changes in total shrub cover from 1965 to 2001 at the Poison Spider exclosure site.

Poison Spider exclosure

The Poison Spider site, approximately 30 miles west of Casper, Wyoming, is a five-acre exclosure established in 1965 and maintained by the Casper BLM district. From a distance, this site is a dramatically obvious square area on the landscape, visibly dominated by abundance of Wyoming big sagebrush inside the fenceline (Figure 1). Samples of the vegetation revealed there is much more bare ground and winterfat (another shrub species) inside the exclosure, while native grass cover is greater outside the fenced area. Cheatgrass had invaded the exclosure after 1980 when records were last collected in this site. The shrub cover at the time of construction in 1965 was 75 percent less than the cover found inside the exclosure in 2001, 35 years later (Figure 2). These records are exciting to researchers because they show that shrubs can dominate a site when grazing pressure is removed. In the past, ecologists believed that removal of grazing would allow grasses to increase at the expense of shrubs. The Poison Spider site demonstrates the opposite can occur in less than 40 years, although not all exclosures show such dramatic changes. Other exclosures sampled did not have such a significant increase in shrub cover, and interior and exterior comparisons are not as dramatically different visually. UW Department of Renewable Resources researchers believe whether or not shrubs take over when grazing is removed is determined by both soil quality and the quantity of shrubs present when the exclosures were built.

Management implications

New models of Wyoming sagebrush steppe indicate that shrub species often gain an upper hand in the competition with grass species following the removal of domestic stock. In dense shrub cover, livestock removal from shrublands actually may be detrimental to the maintenance of native grasses and may make the exclusion of weedy invaders, such as cheatgrass, more difficult.

The UW research team will continue to use these valuable exclosure sites to gain a better understanding of the impacts of abruptly ending animal use and domestic grazing on Wyoming shrublands. Such knowledge is critical for the evolution of wise land-use policy in the arid west.

scrapie:
Searching for a new solution

Bob Stobart, Associate Professor, Department of Animal Science

Gary Moss, Professor, Department of Animal Science

Bill Russell, Professor, Department of Animal Science

Katherine O'Rourke, Research Microbiologist, USDA Agricultural Research Service, Animal Disease Research Unit

Scrapie is a disease that has affected sheep for centuries. It was first described in England in 1732, but was not detected in the United States until 1947 when it arrived with a flock of sheep imported from Canada. Since that time, approximately 1,600 cases in sheep and 7 in goats have been reported in more than 1,000 flocks nationwide.

This insidious disease requires two to five years for outward symptoms to manifest. Clinical symptoms include chronic weight loss, anxiety, aggression, tremors, and loss of coordination, resulting in a staggering gait or "rabbit hop." The name "scrapie" was coined because of the characteristic rubbing behavior of infected animals.

Scrapie is now classified with diseases known as transmissible spongiform encephalopathies (TSEs), which are of international importance. Other diseases in this class include bovine spongiform encephalopathy (BSE) or "mad cow disease," chronic wasting disease in deer and elk, transmissible mink encephalopathy, and a variant of Creutzfeldt-Jakob disease (vCJK) detected in humans in Europe. These diseases are caused by abnormal prions. Although research has demonstrated that scrapie is not a human health risk, public concern about all types of TSEs has increased because of apparent links between BSE and vCJK. Beef consumption in Japan fell more than 50 percent when two cases of BSE were discovered in that country, costing Japan's farm-

The name "scrapie" was coined because of the characteristic rubbing behavior of infected animals.

A ewe exhibits symptoms of scrapie.

to an old disease

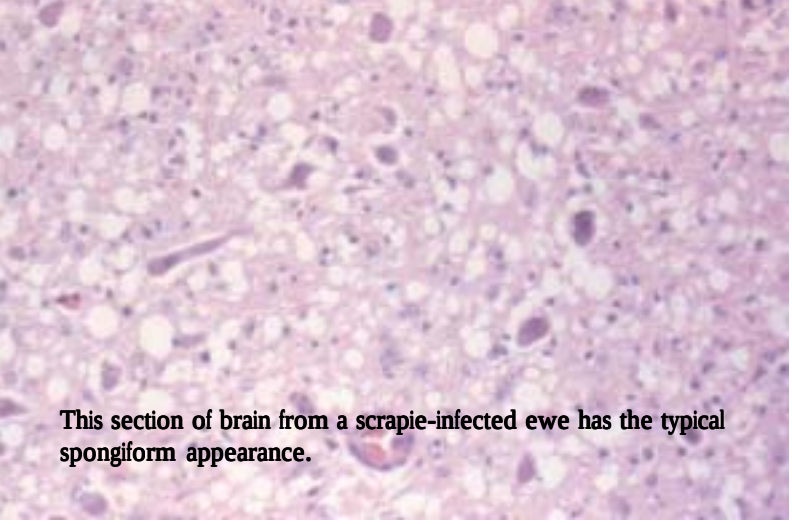
ers and food industry $1.5 billion since the first outbreak in September 2001. A similar occurrence in the United States could potentially devastate the livestock industry.

The American Sheep Industry (ASI) estimated that scrapie losses average $20 to $25 million each year. In addition to its impact on infected flocks, the presence of scrapie in the U.S. sheep population prohibits the export of breeding stock, semen, and embryos to many countries. The United States Department of Agriculture's Animal and Plant Health Inspection Service (USDA APHIS), in conjunction with state veterinarians, has embarked on an accelerated National Scrapie Eradication Program.

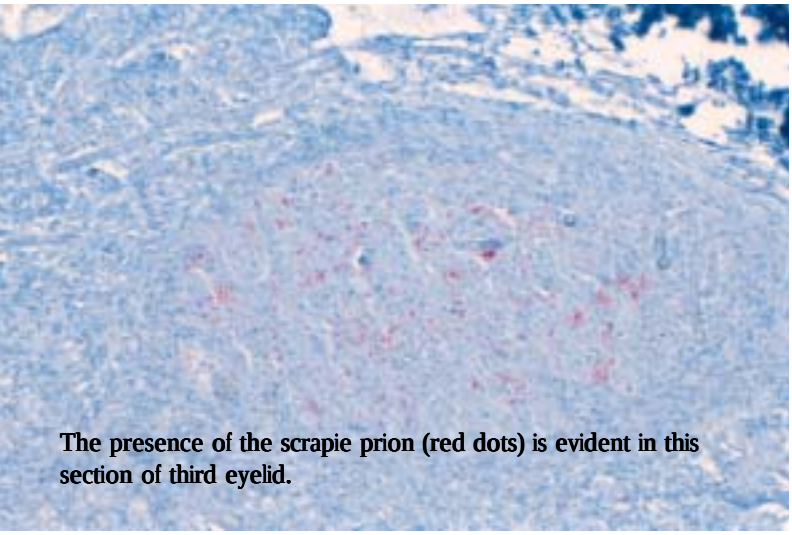
Currently, there is no cure or treatment for scrapie. The disease is caused by a protease-resistant prion that has undergone a change in shape that renders it resistant to normal enzymatic breakdown. It is hypothesized that 90 percent of the transmission of abnormal scrapie protein takes place between infected ewes and their offspring or other lambs through contact with the placenta and placental fluids. The other 10 percent of disease transmission occurs between infected ewes and other mature sheep. This abnormal prion protein (PrP^{sc}) accumulates in neurons, ultimately causing neuronal death. Since neurons are one of the few tissues that are not regenerated, the brains of infected sheep have a characteristic sponge-like appearance, warranting spongiform encephalopathy classification.

Recently, great strides have been made in the scientific understanding of scrapie and its causes. The production of PrP^{sc} has been associated with a particular genotype at position (codon) 171 on the gene that regulates the synthesis of this protein. The letters R, Q, and H represent alleles or sites on the gene that dictate the placement of specific amino acids into newly synthesized prions. Resistance to scrapie appears to be conferred to animals that inherit the dominant R allele. Sheep with QQ, QH, or HH alleles remain susceptible to scrapie. Because only the R allele infers resistance, the H allele is generally reported as Q for simplicity.

In the past, a positive scrapie diagnosis was dependent upon the identification of spongiform lesions in sheep brains at autopsy. Within the last few months, however, the USDA has approved an alternative test that can detect the presence of the



This section of brain from a scrapie-infected ewe has the typical spongiform appearance.



The presence of the scrapie prion (red dots) is evident in this section of third eyelid.

scrapie prion in live animals. Tissue from the third eyelid of suspect animals 14 months of age and older can be biopsied to determine the presence of the scrapie prion, but this test is only 85 percent accurate.

In the spring of 2001, personnel from the University of Wyoming, Wyoming State Veterinarian's Office, Agricultural Research Service Animal Disease Research Unit, and the APHIS Veterinary Medical Officer for Wyoming established a plan to genotype all of the sheep from the University of Wyoming flock that were 14 months of age and older. In addition, all sheep susceptible to scrapie (QQ) were tested for the presence of scrapie prions utilizing the third-eyelid test. The goals of this collaborative effort were to quantify the distribution of genotypes present on codon 171 in Rambouillet, Columbia, Hampshire, and Suffolk sheep from the university's purebred flock and test for the presence of scrapie in susceptible animals (QQ).

The presence of scrapie-resistant alleles (RR or QR) on codon 171 varied with breed in the UW purebred flocks. In the Rambouillet ewes, 65 percent were RR, 32 percent QR, and 3 percent lacked QQ the scrapie-resistant gene. In Columbia ewes, 1.7 percent were RR, 39.7 percent QR, and 58.6 percent QQ. Similar distributions for Suffolk and Hampshire ewes, respectively, were 2 percent RR, 25 percent QR, 73 percent QQ and 16.1 percent RR, 62.9 percent QR, and 21 percent QQ. Researchers are now attempting to determine if these data reflect the distribution of the scrapie-resistant gene in typical Wyoming sheep flocks, or whether they are unique to the genetics in the UW purebred flock.

A concern of many producers is that scrapie-susceptible sheep (QQ) may possess superior production traits. Bob Stobart, Gary Moss, and Bill Russell (UW Animal Science Department) are collaborating with Jim Logan (Wyoming State Veterinarian's Office), Katherine O'Rourke (ARS), and John Duncan (APHIS Wyoming Veterinary Medical Office) to determine whether selecting for scrapie-resistant sheep will adversely affect sheep productivity. Over the course of the next three years, these researchers will:

- Evaluate production and performance characteristics of sheep proven to be homozygous (positive and negative) and heterozygous for the scrapie-resistant gene
- Predict the distribution of scrapie-resistant genes in sheep typical to Wyoming
- Provide producers with the education and knowledge necessary to make informed decisions regarding concomitant selection for scrapie resistance and economically important production traits

The results of this research should yield information that will help producers identify animals with the traits most important to the viability of their operations. Additional information concerning scrapie or the progress of this project may be obtained by contacting the collaborators at (307) 766-2224.

Tracking seeds from space

David W. Wilson, Associate Lecturer, Department of Plant Sciences

Stephen D. Miller, Professor, Department of Plant Sciences

College of Agriculture researchers are now using Global Positioning System (GPS), a network of 24 satellites orbiting earth, to track microchip implanted seed lots in agricultural fields. This research will allow weed seeds to be tracked in various tillage systems and the information to be compared with previous no-till studies.

The microchip

Microchips have an estimated life span of more than 100 years. The ferrous copper core is programmed with a sequential letter and number integrated code. Passive microchips have no battery or power source and can be read only with a powered transceiver. The transceiver emits a signal that is reflected back by the chip and descrambled from the computer language to form a 12- to 18-digit tracking code. The metal core is encased in a protective covering of glass or plastic to prevent oxidative or corrosive damage.

Current microchip uses

One of the most common biological uses of passive microchips includes implantation into animals. Veterinarians implant microchips for pet identification. Every microchip's unique code can conclusively identify a lost pet. The chip allows for a positive identification years after disappearance. All mustangs and many wildlife species are microchip tagged for research and tracking purposes, and the Wyoming Game and Fish Department currently uses microchips to track the underground movements of pocket gophers. The U.S. Department of Defense is researching the use of bees wearing microchip collars to locate land mines, while salmon tagging on the Columbia River has been a means of tracking migrations for years.

In the future, everyone carrying American currency may be walking around with microchips in their pockets. A newly developed, paper-thin microchip can be sandwiched into currency and important documents. Microchip currency would allow the government to track the transfer of money, determine the average life span of paper money, discourage forgery, and monitor illegal

The microchip, center, as compared in size to wild oat, left, and feral rye, right.

Table 1. Detection of microchips in various soils (depth in inches).

	Sandy loam topsoil (5% iron content)	Granite sand (washed masonry)	Artificial soil (#2 Growth Mix)
Average depth*	8.3	7.1	9.8
Maximum recovery depth	11.2	9.2	14.2
Lowest recovery depth	5.6	5.2	8.0

**Data was derived from five replicates of four microchips per soil type.*

activities involving large sums of money. Current vehicle location systems use an active, or self-powered, microchip for tracking by satellite. And because of their durability, microchips even have been imbedded in cruise missiles to allow the military to trace the dispersal of missile parts after impact and detonation.

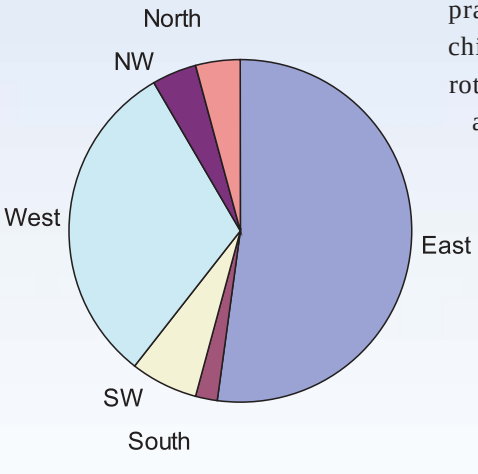
To prove the detrimental effects on weed seeds in no-till systems, researchers must perform a comparison to tilled seed viability. Initial studies conducted during the summer of 2001 tested the durability and practicality of using microchip tagged seed packets in rotational cropping systems, and the results were encouraging. Fiberglass mesh packets and seed-sized microchips showed high resilience when exposed to intense tillage. Packets remained intact and microchips remained functional after repeated tillage with a tractor mounted rototiller at 500 rpm. In fact, after 50 passes with the rototiller, none of the packets or microchips showed any visible damage.

After microchip durability was established, UW researchers conducted several experiments to test functionality. They looked at the maximum depth the microchip could be read in a sandy, high-iron-content soil, pure granitic sand, and artificial soil mix. There was little difference in the depth the microchips could be detected in each of the soils (Table 1). Microchips were easily recovered from the 5- to 6-inch depth range. Chips recovered at the maximum depths of 8 to 14 inches were easier to locate if they were on end, rather than laying flat.

Researchers also studied the movement of seed packets and individual microchips after tillage. There was no consistency to the direction samples moved with tillage; samples moved in the opposite direction of tillage 40 percent of the time and in the direction of tillage 60 percent of the time (Figure 1). There was also movement perpendicular to the direction of tillage. Microchips and packets moved a maximum distance of 70 inches horizontally and 10 inches deeper in the soil profile. The average movement of microchips and packets was 4 inches deeper and 10 inches horizontally from the initial implant location (Figure 2).

Expensive, scientific-grade GPS units, costing

Figure 1. Direction of microchip movement after tillage.

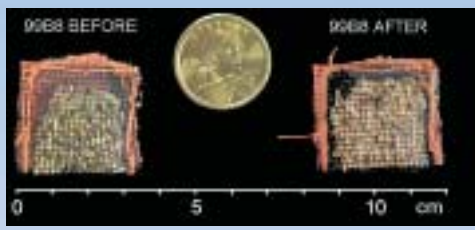


At the Archer Research and Extension Center, a disc harrow is used to till microchip-tagged packets of wild oat and feral rye seed for comparison to four other levels of tillage treatments in a wheat rotation study.

approximately $10,000, have a maximum inaccuracy of 1 yard; however, in practical application, most samples were located within a 6-inch area. Although this equipment allows for the relocation of samples, it is not accurate enough to evaluate horizontal movement in the field. Nonetheless, the more critical factor of changes in seed depth after tillage can be monitored precisely when the microchip transceiver and GPS unit are used together.

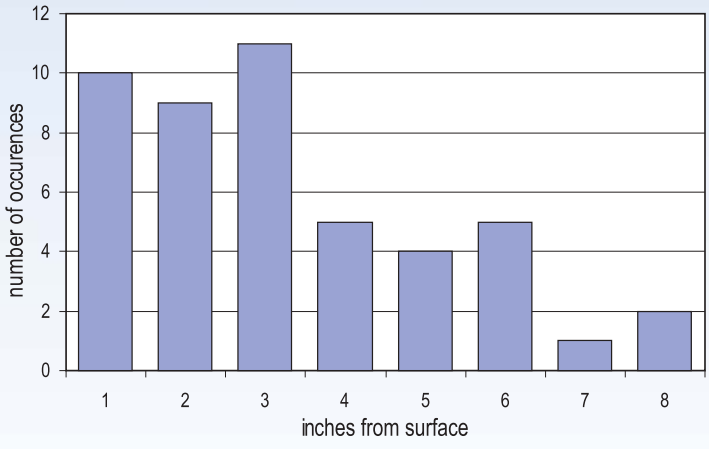
Studies using the new microchip implantation technique began in the fall of 2001. Researchers are tracking weed-seed drift and assessing the effects of tillage on seed viability. One hundred sixty microchip-tagged feral rye and wild oat seed packets were implanted into five fields. Each of the fields underwent a different tillage treatment and winter wheat was planted. The tillage treatments included a no-till field, tillage with an Australian prickle chain, a rod weeder, a spring harrow, and a disk harrow (see photo above). Dryland sunflower will be grown on the fields next year, followed by proso millet, and finally a season of bare fallow. Viability tests will be run on recovered seed packets annually with the final analysis of the effects of tillage on feral rye and wild oat survival completed in 2004.

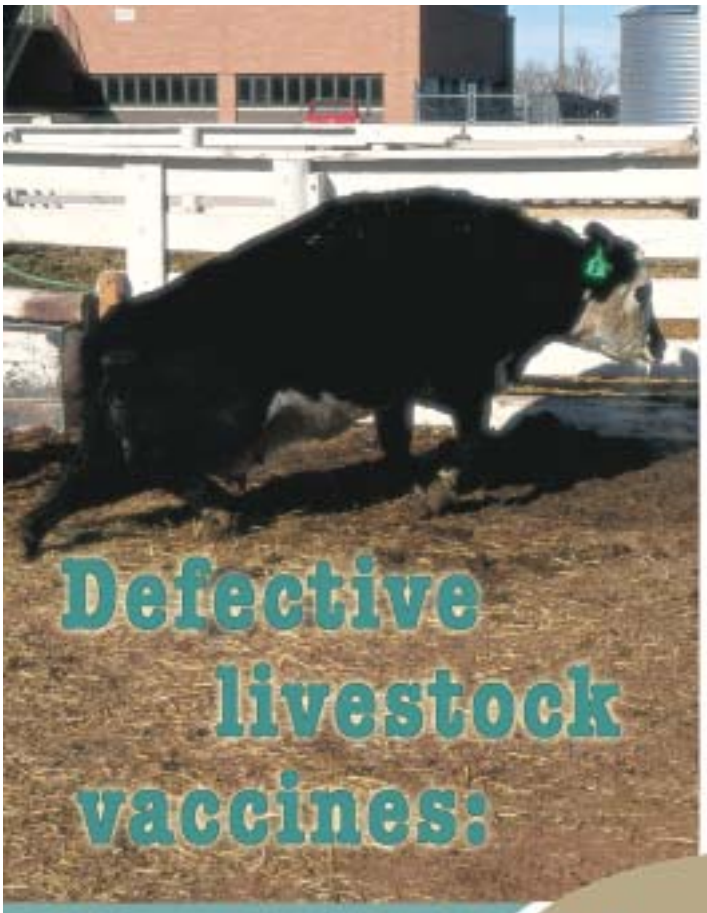
Note: We would like to thank and acknowledge the work and efforts of QiQi Wang, a Laramie High School student funded through the University of Wyoming EPSCoR-SRAPE program. Wang, shown here tracking microchips, assisted researchers through the summer of 2001 and wrote a report and poster presentation on the preliminary studies for the 2001 SRAPE Student Research Seminar.



After recovery, seed packets containing microchips show very little damage.

Figure 2.





This cow was paralyzed after a veterinary vaccine was injected too close to the spinal column. The product was highly irritating to tissues and caused damage to spinal nerves and muscles that resulted in paresis.

Defective livestock vaccines: the legal loophole

Dónal O'Toole, Professor, Department of Veterinary Sciences

Lynn Woodard, Professor, Department of Veterinary Sciences

In 1993, a veterinarian reported to the Wyoming State Veterinary Laboratory (WSVL) that he had a herd of 610 pregnant beef cows with 56 animals "walking like frogs" after they were vaccinated to help prevent calf scours. Upon investigation, College of Agriculture Department of Veterinary Sciences faculty members determined the vaccine was given too close to the spinal column and that the irritating vaccine caused paralysis and lameness.

Vaccine company officials were contacted and eventually compensated the owner when presented with scientific proof that their product was responsible. But without sufficient evidence, the company could have simply ignored the complaint from the owner and his veterinarian.

Most producers use veterinary vaccines to protect livestock from bacterial and viral diseases. Often vaccines are the only effective way to control disease, but sometimes problems occur after injection. Quite commonly, a producer may vaccinate for a disease, such as bovine viral diarrhea (BVD), and a short time later an outbreak of that disease will occur in the herd. Manifestation of the disease does not mean the product was defective or at fault for the outbreak, since gathering and processing animals for vaccination causes stress and the resulting decrease in immunity may cause the disease despite vaccination. Swellings that occur following vaccination are also relatively common in cattle.

According to USDA's Center for Veterinary Biologics, the agency that monitors adverse reactions to veterinary vaccines, more

Vaccines can be an

formal complaints are received each year about ferret vaccines than cattle vaccines. The low complaint rate is not proportional to vaccine problems; instead, it simply reflects tolerance in the beef industry for vaccine reactions and limited investigation of the problem.

In the case of a vaccine "wreck," the best way to establish what went wrong is to involve a nationally accredited laboratory, such as the WSVL, where diagnosticians deal with up to four such episodes annually. In situations like this, a specialist can clarify for the producer, the company, the local veterinary practitioner, and, if necessary, the courts whether the product was at fault. Most produc-

effective way to control disease, but sometimes problems occur after injection.

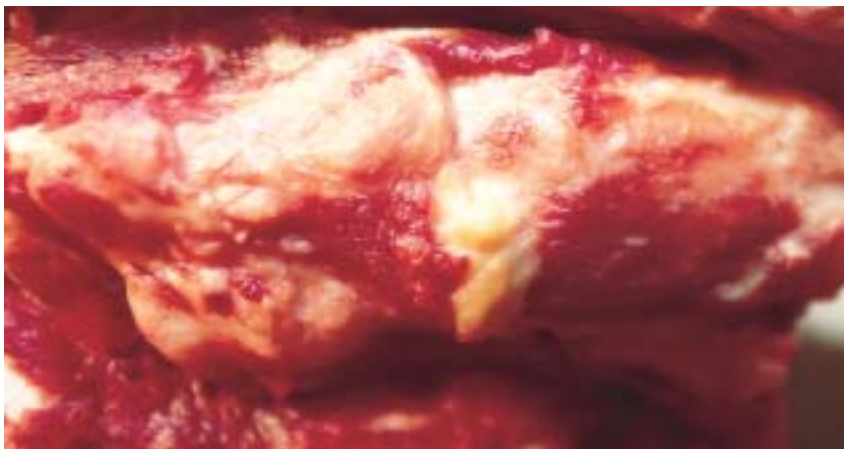
ers and veterinarians are unaware of the peculiar legal protection enjoyed by veterinary vaccine producers and the need to collect adequate data.

Recently, a producer in western Nebraska used two vaccines from one company. He vaccinated 469 near-term pregnant cows, injecting each product as directed into the left and right hip muscles. The following day, seven vaccinated cattle either were unable to rise or were profoundly lame. Over the next several days, 50 percent of the cows developed large swellings where each product was injected. In addition to lameness, the producer was concerned about meat quality and the effects on his imminent calf crop.

The local veterinarian and WSVL personnel provided advice and collected samples, anticipating a dispute with the vaccine company. Biopsies taken of large swellings in multiple cattle confirmed that muscles at injection sites in the hip had extensive damage. As biopsies were taken, an oil-like substance leaked from swellings and was consistent with the recent use of oil-based vaccines. Oil from the vaccine was visible when tissues were examined microscopically (Figure 4). Bacteriological testing confirmed that the vaccines were uncontaminated with microorganisms and that the inflammation was not due to poor injection techniques. Additional testing was done to determine whether high concentrations of endotoxin, a toxic bacterial cell-wall component, might have been present in this serial of vaccines.

This producer followed the correct protocol. He involved his veterinarian, kept excellent records, lodged a complaint with the USDA's Center for Veterinary Biologics in Iowa, had a company representative examine affected animals shortly after the event, and requested sufficient laboratory work done to establish the basis of the problem. In spite of all this, the company disputed it was responsible for a problem intrinsic to its vaccine, and as of spring 2002, it is still unclear whether the producer will be reimbursed for his losses. Why is this?

Manufacturers and sellers of some federally licensed products, including veterinary vaccines, enjoy a type of legal protection known as *preemption*, which means that, provided a product is made according to federal guidelines, the consumer has little or no recourse against the company. Preemption was an



Damaged muscle at vaccination site, collected at a necropsy from a paralyzed cow. The yellow material was sterile pus that formed due to irritating oil in the vaccine.

For more information on the Wyoming Beef Quality Assurance Program and to become BQA certified, please see http://wyovet.uwyo.edu/

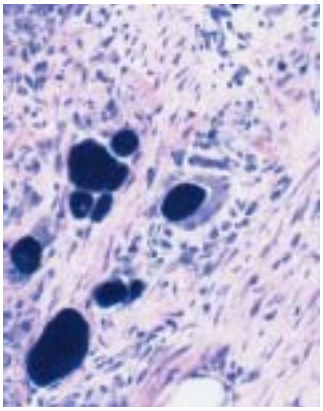
What should you do if you have a problem with an animal vaccine

- Have your local veterinary laboratory test sick or dead animals, by necropsy when necessary, so that the basis for the problem can be established to the satisfaction of all. Reputable veterinary vaccine companies will pay for laboratory testing.
- Keep a detailed, separately dated, hand-written diary of what happened to the animals, costs for treatment and deaths, and notes of all conversations with concerned parties.
- Involve your veterinarian in documenting the problem.
- Record how the product was given, when, by whom, and the exact sites of administration.
- Log an adverse reaction report with the USDA's Center for Veterinary Biologics at www.aphis.usda.gov/vs/cvb/. Write down the main points of the conversation, including the name of the person to whom you spoke.
- Notify the company and product retailer of the problem immediately. Write down the main points of the conversation(s) and any verbal agreements.
- If the product is still available (particularly if you have unused vials), label it appropriately and have it tested by a reputable laboratory.
- Take photographs or videos of sick and dead animals.
- Ensure necropsies are done at a laboratory. Veterinary practitioners are not equipped to do forensic-type examinations and to follow chain-of-custody rules. A detailed, properly recorded necropsy is essential when losses are substantial and legal action is contemplated.
- If the company offers to settle out-of-court, do not inflate the estimates of your losses. Companies know what wrecks cost. Settlements are driven in large part by a company's wish to maintain its reputation and goodwill in the area and to stay out of the papers. They are willing to cover most reasonable costs–but not to be taken to the cleaners!

unexpected consequence of an attempt by the USDA to prevent states from imposing additional requirements—over and above national USDA requirements—on veterinary vaccine manufacturers.

The manufacture and sale of veterinary biological products are controlled under the 1913 Virus-Serum-Toxin Act (amended in 1985). Under this act, it is illegal to manufacture a virus-, bacteria-, or serum-containing product intended for use in animals if that product is worthless, contaminated, dangerous, or harmful. In theory, this confers some protection for producers when vaccines are contaminated by a virulent agent during manufacturing. In practice, however, preemption trumps most consumers' rights, including the ability to successfully pursue common law torts against vaccine manufacturers and individuals who sell defective vaccines. Vaccine companies have successfully argued in the courts that preemption also protects them from civil litigation. The USDA defends this loss of legal remedy. In effect, provided a company can show it produced a vaccine in accordance with the statutes, the producer has no legal recourse for losses, even when animals are directly harmed.

Regulations governing the manufacture of veterinary vaccines are outdated, particularly for those vaccines that contain killed microorganisms and are used in food animals. Companies are required to meet a relatively low standard to demonstrate that products are effective, and regulations regarding the presence of irritants in vaccines are loose. Unlike human vaccines, which are regulated by the Food and Drug Administration, veterinary vaccine manufacturers have a wide legal latitude when incorporating irritating compounds into their products as a way of inducing a protective immune response. The weak regulatory atmosphere in which the USDA operates compounds this situation. The USDA's Center for Veteri-



Microscopic appearance of vaccine-induced inflammation in the muscle from a cow. The black droplets are oil in the vaccine. Inflammatory cells in the tissue are attempting to ingest and degrade this material.

nary Biologics currently cannot compel manufacturers to keep a log of customer complaints about their products, even though producers most commonly go to vaccine companies when they encounter a problem. As a result, there are no reliable national statistics on problems associated with veterinary vaccines.

In Europe and Canada, consumer complaints are automatically transmitted from vaccine companies to the regulatory agency, which then establishes whether there is a widespread problem. In the United States, however, vaccine problems rarely surface in the veterinary literature or in the public press. There is nothing to prevent a vaccine manufacturer from settling with an American producer who has a valid complaint and, in the process, inserting a stipulation that the USDA is not informed of the problem. Although under the Freedom of Information of Act it is possible to request information from companies about their products' safety, companies can remove all meaningful information under the guise of protecting market-sensitive, proprietary information.

State-funded diagnostic laboratories are a major potential source of independent data on vaccine-associated problems. Laboratories like the WSVL have reported several such episodes in the past few years as part of the land-grant mission,

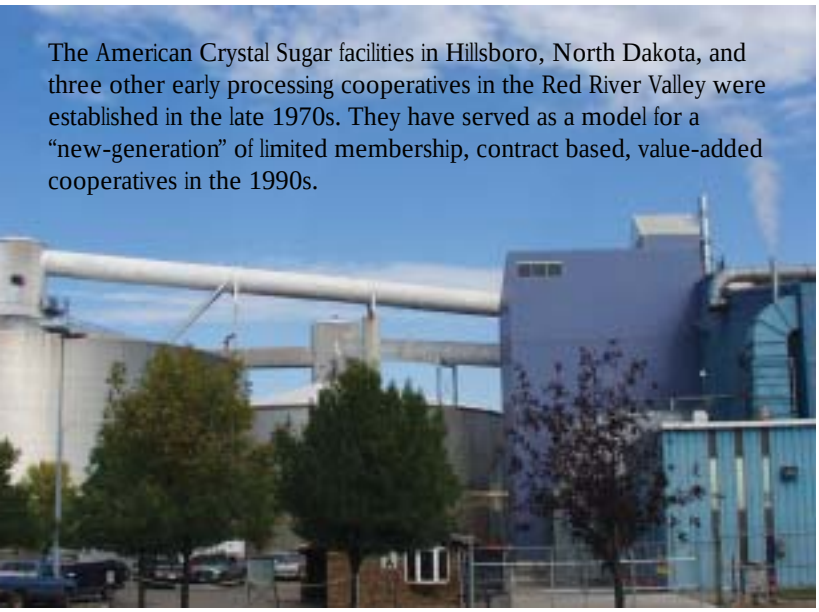
Marked injection site reaction in the skin of a cow after vaccination.

but case-by-case reporting via the scientific literature is a slow, ineffective way of drawing attention to defective vaccines. The situation can only be improved by recurring documentation of problems in the field and by tighter legislation. It is unwise to endure bad vaccines simply because manufacturers are legally protected.

For more information or to report a possible vaccine wreck, contact the WSVL at (307) 742-6638.

The "new generation" of value-added cooperatives are structured to facilitate closer ties between consumers and producers—matching demand for tailored foods with new biological and information technology.

Dusting off Wyoming's cooperative



The American Crystal Sugar facilities in Hillsboro, North Dakota, and three other early processing cooperatives in the Red River Valley were established in the late 1970s. They have served as a model for a "new-generation" of limited membership, contract based, value-added cooperatives in the 1990s.

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Dale Menkhaus, Professor, Department of Agricultural and Applied Economics

With accelerating changes in today's agricultural markets threatening to put the few remaining family ranches and farms out of business, this may be an opportune time for Wyoming producers to reconsider cooperative businesses. According to Fred Kirschenmann, director of the Leopold Center for Sustainable Agriculture, "The future looks increasingly bleak for midsize farmers who produce undifferentiated commodities for global markets."

The economic advantages of cooperative business structures include tax breaks and anti-trust exemptions, but for producers to reap the benefits of owning a processing facility, they need the same freedom investor-owned firms have. Current cooperative law allows farmers and ranchers to process only what they grow or raise. To capture retail markets, a cooperative may need to use many ingredients not produced by its member producers in an integrated processing and marketing strategy. Cooperatives also need the ability to raise sufficient amounts of capital, and to be compensated for this higher investment with full profits. This must be done without giving up the benefits of cooperative ownership—democratic control and a structure built to pass added value directly back to the farm or ranch.

A Hatch project for multi-disciplinary study involving the Departments of Agricultural and Applied Economics, American Studies, and Statistics was funded through the College of Agriculture's Wyoming Agricultural Experiment Station Competitive Grants Program to explore the potential for new forms of agricultural cooperatives in Wyoming. The study began by asking two questions: "What accounts for differences in cooperative innovation, development, and success in particular areas within the Northern Plains region?" and "What potential is there in Wyoming for

National organizations such as Farmers Union and Farm Bureau served as incubators in the 1920s and 1930s for new cooperative businesses. Their offspring are predecessors to large federated cooperatives familiar to every agriculturalist today, including this Farmers Union-affiliated CENEX supply cooperative in South Dakota.

new cooperative enterprises and what business forms are best suited to specific producer and production needs in this state?"

Cooperatives in most states still operate under variants of the 80-year-old Standard Marketing Act. In response to new opportunities and incentives for agricultural producers to collectively capture value from vertical integration, as opposed to horizontal market power, several states have tried to overhaul these dusty rules.

Minnesota, Colorado, and Ohio have rewritten cooperative laws into more modern corporate forms. Iowa's Chapter 501 allows cooperative ownership of more levels of food production (specifically, ownership of livestock processing facilities). More radical changes have been trumped by federal tax definitions or blocked by resistance from numerous cooperative enterprises already established under the existing law.

In the past, Wyoming cooperative statutes were similar to those of surrounding states, but were often more favorable to development as they mirrored Wyoming's liberal corporate laws. Wyoming now has one of the most progressive cooperative laws in the nation, the Wyoming Processing Cooperative Law, which was enacted July 1, 2001.

Wyoming's new law is the first to bypass federal Subsection T tax exemption requirements, allowing the new rules to address some basic structural impediments to cooperative development in the contemporary food industry. Under this new law, a Wyoming processing cooperative will be organized as an unincorporated association, similar to a limited liability company. Eligibility under IRS rules has been established, and members are not responsible for cooperative debt. In addition to producer-members, non-patron investors are allowed to join

law to capture new markets

Description of a New Wyoming Processing Cooperative under Wyo. Stat. 17-10-201 to 253

Structure

Organized as unincorporated associations—similar to limited liability companies.

Purpose

"To market, process, or otherwise change the form or marketability of crops, livestock, and other agricultural products, including other purposes necessary or convenient to facilitate production." (Wyo. Stat. §17-10-205).

Membership

Two owner-member classes: 1) Producer patrons with delivery rights and obligations are allocated profits based on use; 2) Investor non-patron members are allocated profits proportional to their investment. (Neither has personal liability for cooperative debt.)

Control

Patrons get one vote each, which count collectively as a majority ensuring producer control. Investors are allocated votes proportionally to investment. The cooperative is governed by a board of at least three directors—at least one of whom is elected by patrons.

Tax treatment

Eligible under check the box rules (IRS Code §301.77.01-3(a)).

The Dakota Pasta Growers Cooperative produces one-third of the United States' pasta at this state-of-the-art Italian flour mill and processing facility in Carrington, North Dakota.

with both voting rights and profits based on their investment. Producer-members are allotted one vote each, which collectively count as a majority to ensure producer control.

Ironically, Wyoming's progressive new law probably passed through the legislature without much fanfare precisely *because* of the lack of new cooperative development in the state. The lobby behind this new law is the only new processing cooperative venture currently active in the state—the Mountain States Lamb and Wool Cooperative (MSL&W). With a prominent leadership, two state lobbyists, and a growing membership that spans nine western states, this cooperative was the driving force behind Wyoming's new law. MSL&W member and co-chair Pat O'Toole expressed the motivation behind this venture at a recent natural meats conference: "If we don't make some significant changes, there is not going to be a future for agricultural producers."

Whether this new law will provide Wyoming producers with an opportunity to capture new food markets or will be forgotten as the pet project of a few failing lamb growers depends upon Wyoming producers themselves. A survey of Wyoming producers' attitudes toward cooperative development was encouraging. Sixty-two percent agreed that "cooperatives will become increasingly important" while only 7 percent said that "cooperatives were important in the past but not today."

The "new generation" of value-added cooperatives are structured more like investor-owned firms with closed membership, stock tied to delivery contracts, and high levels of equity investment. They are structured to facilitate closer ties between consumers and producers—matching demand for tailored foods with new biological and information technology.

In the past, cooperative businesses have not figured largely in Wyoming agriculture. This tradition may prove to be a stumbling block to cooperative success in the future, but the progressive nature of the Wyoming Processing Cooperative Law allows for more innovative cooperative ventures that may appeal to a wider range of producers.

Water Impact Issues:

Coal bed methane development in the Powder River Basin

Larry Munn, Professor,
Department of Renewable Resources

According to the Bureau of Land Management, 51,000 new coal bed methane (CBM) wells may be drilled in the Wyoming portion of the Powder River Basin (PRB) over the next 15 years, while 30,000 wells may be actively producing at one time. CBM extraction requires pumping water from the coal bed aquifers to de-pressurize the system and to allow the methane to de-adsorb from the coal surfaces. After the area is de-pressurized, the CBM is collected for processing.

Since a single well initially produces approximately 15,000 gallons of product water per day at a rate of approximately 10 gallons per minute (and this production occurs steadily 365 days per year), each well may be expected to produce 17 acre-feet of water annually. At this rate, approximately 450,000 acre-feet of water will be disposed of annually because of CBM production.

Given Wyoming's semi-arid climate and the current prolonged drought, this influx of water might seem like a blessing, but the quality of CBM product water is highly

A single coal bed methane well produces 15,000 gallons of product water per day at a rate of approximately 10 gallons per minute.

The quality of CBM product suitable

variable and not all of it will prove suitable for livestock watering and application to the land. However, some CBM water is high quality. The coal bed aquifers have long been known to hold large reserves of water that have been used extensively for livestock watering and, to a lesser extent, human consumption in the PRB. In general, water quality is best south of Gillette and quality declines across the Powder River Basin heading to the northwest toward Sheridan and up into Montana. In areas with the best water quality, the water is suitable for both human and livestock use and for irrigation; in the areas with poorer quality water, the water is unsuitable for growing plants, and some of it may even be unsuitable for watering beef cattle.

CBM product water issues revolve around quality—specifically the water's salinity, sodicity, and potential toxicity. When the soil water is high in salinity, most plants have a hard time extracting water. It takes far more energy for plants to remove water from salt-affected soils, so these plants wilt earlier in the day, thereby decreasing photosynthesis and plant production. At very high levels, salinity is toxic to plants.

While salinity refers to the mineral content of water, it is much simpler to use the electrical conductivity of the water as a measure of its salt load. The more salt a water sample contains, the more readily it conducts electricity and the higher the electrical conductivity (EC) value. Typically, the conductivity is reported in units of micro-mhos per cm. Sometimes the unit used is the mill-mho/cm (1,000 micro-mhos/cm equals 1 milli-mhos/cm).

There is a good, but not perfect, correspondence between EC and total dissolved solids (TDS) in the water. Sodicity of water is usually specified with a parameter called the sodium adsorption ratio (SAR), which is calculated as the ratio of sodium (Na) to calcium (Ca) and magnesium (Mg).

Sodicity is a different, and often separate, problem from salinity. High sodium in irrigation water, relative to levels of calcium and magnesium, results in the breakdown of soil aggregates and the loss of water's ability to readily infiltrate into the soil. Infiltration slows markedly through the destruction of aggregation and plugging the pores with dispersed clay. Ultimately, this process reduces the water available for plant growth. Vegetation on sodium-affected soils is typically sparse, and the soil's surface becomes very hard when it dries. Sodium problems are most pronounced on soils with high clay contents—particularly if the clay is the high shrink-swell type common in the semi-arid basins and plains of Wyoming.

If the water's salinity is low, sodicity problems interrelated with salinity can be problematic, even with low SAR levels. For example, water with an EC of 500 micro-mhos/cm may cause dispersion problems and slow infiltration on clayey soils if the SAR is as low as 2. On the other hand, water with a salinity of 2,000 micro-mhos/cm will not exhibit infiltration problems until the SAR reaches levels above 10, which is the upper limit usually recommended for application to crop fields.

Because the CBM water has accumulated over long periods of time under a low-oxygen environment in the coal seams, there is a concern that toxic concentrations of particular elements may exist in some of the water. So far, barium is the only element that has been documented at levels above established standards in CBM product water, but there may be problems with additional elements such as selenium, arsenic, and others.

Natural precipitation in the PRB is concentrated in the spring, and many of the streams are ephemeral, carrying water only for short periods in response to snow melt and thunderstorms. CBM product water is produced evenly throughout the year, and large quantities of water are produced during periods when plants are dormant and when the opportunity to dilute the water with stream flow is limited. Some of the ephemeral streams in the PRB al-

water is highly variable and not all of it will prove for livestock watering and application to the land.

ready have been converted to year-round flow, and there have been reports of ice damming that has caused flooding along the stream with undiluted product water.

Crops have different salt tolerances before yield reductions occur. Alfalfa is relatively sensitive to salinity and yield loss begins at an EC of 1,300 micro-mhos/cm; the threshold for corn is 1,200. Wheat is much more salt tolerant, and its yield-loss threshold EC reaches 4,000 micro-mhos/cm. CBM water from Wyoming wells in the PRB has been measured with an EC as low as 500 micro-mhos/cm and as high as 3,000. SARs have been observed to range from less than 2 to 50 or higher.

Research with PRB alfalfa irrigation has shown that, typically, alfalfa can effectively utilize approximately 22 inches of water in addition to natural precipitation. Additional water is required to achieve adequate leaching and prevent salt build-up over time. Other crops and most of the native vegetation in the basin will utilize less water, however, and this limits the effectiveness of using plants to dispose of the product water through consumptive use. Where large quantities of water are applied to the soil with the intent of allowing plant transpiration and evaporation to dispose of the water, the salt will quickly limit plant growth. Water with 1,300 micro-mhos/cm conductance contains approximately 830 parts per million (ppm) TDS. Each acre-foot of this water will add 1.2 tons of salt; 2,000 micro-mhos/cm water contains 1.7 tons of salt. This fact explains why farmers must leach the soil even when irrigating with high-quality water. Except for very limited areas of naturally saline soils that are tied to particular bedrock conditions or landscape position, the soils of the PRB have only received rainfall and snowmelt waters with very low salt contents. The salt load of even the best CBM product water will damage the area's native vegetation and common crops unless good water management—including annual leaching of the salt from the root zone—is achieved. Because many of the soils in the PRB are clayey, and many are shallow or only moderately deep, adding large amounts of product water is not practical.

Many of the streams in the Powder River Basin only carry water for short periods in response to weather conditions such as snowmelt and thunderstorms.

Some CBM product water may not meet livestock watering requirements. Yield reductions can be expected in beef cattle when sodium levels in water reach a threshold of 2,500 ppm, depending upon the mineral content of the feed. Some water from coal seams in the northern part of the PRB shows high levels of magnesium (in some cases, greater than 250 ppm). Magnesium levels greater than 250 ppm in the water may make sodium toxic to livestock at a lower threshold. High magnesium levels relative to calcium also may also cause slow infiltration problems similar to those induced by high sodium levels.

CBM development is spreading to other basins in Wyoming underlain by coal, and test wells are now being drilled. Product water management will be a statewide concern in the years ahead. Some agricultural water users will receive water they can put to good use, but for others, the water will be one more problem as they try to carry on in an already demanding environment.

Open spaces

Introduction

The rural places of the intermountain west are changing. State and county officials, agriculturists, and various citizens from around the state have voiced concern about the loss of agricultural lands and open spaces. Such concerns have not gone unnoticed at the University of Wyoming.

The Open Space Project started as a response to changing rural landscapes and became a research project funded in 1995 by the Wyoming Agricultural Experiment Station, the University of Wyoming Research Office, and the Institute of Environment and Natural Resources at the University of Wyoming. Funding from the U.S. Department of Agriculture National Research Initiative for Rural Development and, again, from the Institute of Environment and Natural Resources has permitted the work not only to continue but also to expand. May 2002 marks the fourth master's thesis completed on this topic, with another ongoing. A host of faculty, research scientists, academic professionals, students, and staff have contributed enormously to this project.

If one looks over the summaries to follow, it becomes clear that the landscape, rural economies, and communities of the West and Wyoming are changing. The outcomes of the preliminary Open Space research efforts, offered here, are the result of employing scientific methods to a large set of issues in order to provide reliable and useful information about the future of Wyoming's rural landscapes.

Population change in Wyoming, 1990-2000

During the last decade, states in the Rocky Mountain West have seen strong increases in their populations. Portions of Wyoming, especially the western part of the state, have seen population growth as rapid as any area in the region, but Wyoming's census numbers also indicate differences in growth between the urban and rural areas of the state.

Population growth is caused by two factors: a natural increase as a result of births exceeding deaths among current residents and a net in-migration of individuals from outside the region. At the state level, three-fourths of the 8.9 percent population growth between 1990 and 2000 was due to a natural increase, and one-fourth of the growth was due to in-migration. In some counties (Teton, Sublette, Johnson, Sheridan, Park, Crook, Big Horn, and Platte), most of the growth was due to in-migration. In other counties (Campbell, Laramie, Natrona, Converse, and Fremont), most of the growth was due to natural increases. Eight counties (Uinta, Albany, Weston, Goshen, Washakie, Sweetwater, Niobrara, and Carbon) had a net out-migration between 1990 and 2000. In most cases, these population losses were at least partially offset by natural increases, although Niobrara had both decreased natural growth and out-migration.

From 1990 to 2000, the majority of Wyoming's population growth occurred in rural areas on the periphery of incorporated cities and towns. Even three of the four counties that lost overall population had increases in their rural populations. In some counties (Sublette, Lincoln, Crook, and Fremont) almost all of the growth was in rural areas. In Natrona County, most of the growth was in urban (incorporated) areas. Clearly, understanding the changing population patterns is a key step in understanding land-use changes and in planning for Wyoming's future.

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Scott Lieske, Research Scientist, Department of Agricultural and Applied Economics

and working landscapes

Results from four Rocky Mountain land use and planning surveys

Rural population growth is becoming part of the landscape in the Rocky Mountain region as agricultural lands have been—and are being—sub-divided for residential development.

The UW Department of Agricultural and Applied Economics worked in conjunction with the Colorado and Wyoming Cooperative Extension Services to assess the changes in land-use planning issues caused by increasing rural residential development. Three counties in Wyoming (Sublette, Sheridan, and Uinta) and Colorado's Moffat County participated in this study. Focus groups of local citizens from each county, representing an array of interests, assembled to discuss land use and planning issues. Survey questions were created based upon the issues raised during these meetings, and surveys were mailed to 2,000–4,000 households in these four counties. Overall, survey respondents preferred rural lands that had open space, wildlife habitat, ranching, and recreation (Table 1). Water and wildlife conflicts, reduced public land access, and potential increased cost of services were perceived to accompany rural residential development. Residents supported purchasing agricultural conservation easements in lieu of subdividing. These survey results provide the initial relevant information collection for updating Wyoming County Land Use Plans.

Table 1. Selected results from three Wyoming and one Colorado land use surveys.

	Sublette, WY	Sheridan, WY	Uinta, WY	Moffat, CO
Year performed	1997	1999	1999	2001
Percent response rate	52	46	43	55
Preferred rural land uses/outcomes *(percent of survey respondents agreeing)*				
Scenery/open space	62	93	97	93
Wildlife habitat	YES*	84	97	95
Ag. lands/western livestock culture	YES*	63	84	89
Recreation	59	80	94	96
Issues with rural residential development *(percent of survey respondents agreeing)*				
Water conflicts	NA	98	96	77
Wildlife conflicts	NA	93	93	73
Reduced access to public lands	NA	90	93	71
Potential increased cost of county services	NA	95	95	53
Preferred land use management strategies *(percent of survey respondents supporting)*				
Land use districts	43	78	67	MAYBE**
Purchase of agricultural conservation easements	55	77	78	MAYBE**

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Kate Inman, Former Research Faculty, Department of Agricultural and Applied Economics

Roger Coupal, Assistant Professor, Department of Agricultural and Applied Economics

Jody Woirhaye, Agricultural Liaison, Staff member with Wyoming Senator Craig Thomas

Jonathan Gates, former Master's Candidate, Department of Agricultural and Applied Economics

Amy Bittner, former Master's Candidate, Department of Agricultural and Applied Economics

Andy Seidl, Natural Resource Extension Economist, Colorado State University

Second home growth in Wyoming, 1990-2000

Between 1990 and 2000, second homes accounted for almost 3,000 new housing units in Wyoming, more than 14 percent of the total increase in housing units during that decade. Part-time home dwellers, however, are not counted as part of the community's population, and second homes affect local government finances because residential developments tend to cost more in public services than they generate in tax revenue.

The percentage of second homes varies substantially among counties in Wyoming, ranging from more than 26 percent in Sublette County and more than 20 percent in Teton County to less than 2 percent in Sweetwater and Campbell Counties. About 60 percent of the second homes in Wyoming are located in six counties: Teton (2,121), Albany (1,097), Carbon (1,050), Sublette (930), Natrona (923), and Lincoln (912). Park (809), Sheridan (790), and Fremont Counties (657) also had significant numbers of second homes.

The number of second homes in Wyoming increased by over 30 percent between 1990 and 2000. This growth rate was almost twice the national average (16.1 percent), ranking Wyoming among the top 20 states in the nation for second home growth. Among neighboring states, Wyoming ranked second only to Utah (41.2 percent).

Residential development in Wyoming is becoming more than just a matter of population growth. The increasing number of second homes is changing both the landscape and the culture of Wyoming communities.

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The fiscal impacts of

Land fragmentation has become an increasingly important issue in many counties around the country as farm and ranch lands are sold and developed into rural residences. As the rural landscape population grows, existing residents, neighboring farms and ranches, and taxpayers in general find themselves confronted with the loss of many of the environmental and social values they find important, an increased cost of doing business, and higher local taxes. In this study, researchers focused on measuring the net impacts of land fragmentation on the fiscal structure of county governments. The modeling framework used an econometric model of county revenues, county expenditures, school

Understanding rural land values using geographic information systems data

Whether private rural land is to be used for agricultural production or rural residential development, the demand for land parcels is determined by such factors as soil quality, the availability and quality of water, the type and condition of buildings, and geographic location. However, the demand for rural residential development lands also is affected by recreational and scenic amenities, which have not been formally measured or valued to date.

The UW Department of Agricultural and Applied Economics and the UW Department of Botany undertook a joint research project to investigate agricultural land values. Parcel-specific production attributes obtained from appraisal sheets for agricultural land sales were combined with Geographic Information Systems (GIS) data measuring on-parcel recreational and scenic amenities for 138 agricultural land sales in Wyoming. GIS data were obtained first by mapping parcel boundaries (known as digitizing), and then by overlaying the parcel with measured attributes (known as coverages).

The on-parcel production attributes measured and analyzed include: total deeded acres, percent range acres, percent irrigated cropland acres, percent irrigated meadow acres, a measure of improvements (such as buildings and fencing per acre), and percent of acres of leased public range. The on-parcel amenity attributes measured and analyzed include: an index of scenic view measured from the parcel's center, meters of stream per acre, an index of fishing productivity on the parcel, acres of elk habitat, and the distance by road to the nearest town with at

rural residential development

revenues, and school expenditures for each county. This framework allowed specific scenarios to be analyzed, as well as an analysis of the general policy frameworks that would be of interest to local decision makers.

Results show that, on average, replacing 35 acres of agricultural land with one family is a net loss to the county. The ratio of expenditures to revenues ranged from a low of $1.04 in Weston County to a high of $1.46 in Hot Springs County. On average across Wyoming, converting 35 acres of agricultural land to a residence creates a burden of $1.14 in county and school expenditures for every dollar of tax revenue.

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Population mix, revenue change, and ratios of public expenditures to revenues for Wyoming counties.

	Urban pop.	Rural pop.	Percent rural	Revenue change	Expense change	Net revenue change	Ratio exp. to revenue
Albany	26,526	3,849	13%	809	992.57	-183.57	1.23
Big Horn	7,049	4,007	36%	2,429	2,779.28	-350.28	1.14
Campbell	20,249	11,293	36%	2,344	2779.51	-435.51	1.19
Carbon	13,755	2,174	14%	1,620	1,717.58	-97.58	1.06
Converse	8,151	3,844	32%	1,989	2,257.89	-268.89	1.14
Crook	2,653	3,030	53%	3,426	3,730.99	-304.99	1.09
Fremont	19,273	16,269	46%	2,774	3,116.85	-342.85	1.12
Goshen	7,014	5,685	45%	2,039	2,301.55	-262.55	1.13
Hot Springs	3,406	1,253	27%	1,807	2,644.04	-837.04	1.46
Johnson	3,828	2,797	42%	2,153	2,409.84	-256.84	1.12
Laramie	54,922	23,271	30%	1,439	1,626.99	-187.99	1.13
Lincoln	7,233	6,500	47%	3,359	3,919.04	-560.04	1.17
Natrona	53,432	10,082	16%	1,245	1,429.65	-184.65	1.15
Niobrara	1,684	923	35%	2,217	2440.17	-223.17	1.10
Park	14,751	10,459	41%	1,667	1908.41	-241.41	1.14
Platte	5,074	3,320	40%	2,255	2,551.97	-296.97	1.13
Sheridan	16,098	8,838	35%	1,670	1,872.53	-202.53	1.12
Sublette	2,461	3,041	55%	3,965	4,252.66	-287.66	1.07
Sweetwater	33,929	6,313	16%	1,534	1,874.67	-340.67	1.22
Teton							
Uinta	15,020	5,148	26%	2,062	2,313.49	-251.49	1.12
Washakie	6,222	2,349	27%	1,647	1,831.11	-184.11	1.11
Weston	4,139	2,395	37%	2,188	2,268.24	-80.24	1.04

The unique characteristics of Teton County—unusually high levels of wealth and very little private land—excluded it from this research.

least 2,000 residents. The land values, as dollar-per-acre amounts, are nearly all statistically related with the amenity measurements, as well as with production attributes. On-parcel improvements, increased agricultural productivity, fishing opportunities, diverse views from the parcel, and being distant from a town were positive contributions to parcel value.

This exploratory research suggests that GIS technology has the potential to measure attributes in a way that allows economic values associated with recreational and scenic amenity attributes to be estimated from market transactions. Objectively measuring these attributes could improve rural appraisal procedures, valuation of conservation easements, and policies related to agricultural lands.

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Private lands and public economics: The role of private lands in big game habitat

Private lands play an important role in big-game habitat and hunting in Wyoming. Land boundaries generally go unnoticed by wild animals whose annual, seasonal, or daily travels take them from private to public land, from state to federal land, and back again. The public's responses to the presence of these animals on both public and private lands range from delight to concern.

Researchers have estimated the total winter habitat for six big-game species: pronghorn, elk, Bighorn sheep, moose, whitetail deer, and mule deer. After accounting for overlapping ranges, the total winter range for these six species covers more than 52 million acres, and of this total, 26.1 million acres (50 percent) are privately owned.

Some species are more dependent upon private winter range than others. Whitetail deer and mule deer utilize the most private winter range of these six species, and Bighorn sheep have the least amount of winter habitat on private land. Elk winter on 11.8 million acres of land around the state, of which approximately 39 percent is private. Moose winter on 5.6 million acres of land, of which 25 percent is private.

The significance of private land in the maintenance of big game populations extends beyond the number of acres. Hunting generates considerable revenue in Wyoming, and the ecological services provided by the owners of private winter range contribute to this aspect of the state's economy. The six species reviewed generated over $142.3 million in hunter expenditures in 1999, with private land contributing more than $64 million out of a $120 million total in revenue from hunter license fees and hunter expenditures.

Current work involves quantifying the relationship between big game migration routes and private lands. Future work will examine the relationship between private land and riparian areas, as well as the relationship between private land and threatened and endangered species habitat. These baseline analyses will be used to motivate the development of tools that can aid policy makers in prioritizing areas in the state where wildlife habitat is potentially threatened. The work will aid in the formulation of equitable, informed resolutions to issues ranging from conservation easements to cooperative agreements, for the protection of Wyoming's wildlife habitat and working spaces.

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Statewide

Statewide	Winter habitat (acres)		Hunter-days (1999)		Annual hunter expenditures (1999)		
Big game species	Total winter habitat	Private winter habitat	Resident	Non-resident	Resident	Non-resident	Total expenditures
Antelope	36,788,889	20,774,779	57,823	52,573	$11,484,510	$7,000,331	$18,484,841
Bighorn sheep	2,840,833	155,035	1,559	453	$339,155	$268,724	$607,879
Elk	11,785,859	4,545,556	331,825	66,071	$26,749,158	$15,410,071	$42,159,825
Moose	5,556,940	1,407,513	6,815	1,000	$1,097,469	$362,356	$1,459,825
Mule deer	38,493,635	22,220,860	201,381	121,624	$20,714,293	$26,122,630	$46,836,923
White tail deer	9,034,676	7,411,620	57,160	20,330	$5,879,547	$4,855,482	$10,735,029
Statewide total	52,008,215	26,128,466	656,563	262,051	$66,264,133	$54,019,594	$120,283,727

Private lands dependency

		Hunter days			Expenditures		
	Percent of total winter habitat on private land	Total hunter-days	Resident dependency	Non-resident dependency	Resident	Non-resident	Total expenditures
Antelope	56%	62,341	32,653	29,688	$3,953,105	$6,485,332	$10,438,437
Bighorn sheep	5%	110	85	25	$18,509	$14,665	$33,174
Elk	39%	153,460	127,978	25,482	$10,316,585	$5,943,338	$16,259,923
Moose	25%	1,979	1,726	253	$277,977	$91,781	$369,758
Mule deer	58%	186,458	116,249	70,209	$11,957,546	$16,768,190	$28,725,736
White tail deer	82%	63,569	46,891	16,678	$4,823,302	$3,983,207	$8,806,509
Total	50.2%	467,917	325,583	142,335	$32,347,023	$33,286,514	$64,633,537

College of Agriculture collaborative efforts enhanced by COBRE research

The University of Wyoming recently received a major grant from the National Institutes of Health (NIH) to promote the development of biomedical research. The granting program, which falls under the auspices of the Institutional Development Awards Initiative, is the Center of Biomedical Research Excellence (COBRE). This COBRE grant explores cellular responses to stressors of cardiovascular health.

The cardiovascular COBRE has resulted in interdisciplinary associations and collaborative efforts involving different departments, colleges, and universities. The cardiovascular project involves six researchers from the College of Agriculture: Assistant Professor Mark Gomelsky, Associate Professor Mark Stayton, Professor Don Jarvis, Senior Research Scientist Mark Harpster, and Graduate Student Vijay Amarendran, all from the Department of Molecular Biology, and Professor Richard McCormick of the Department of Animal Science. Professor Bill Flynn, the COBRE director, is from the Department of Zoology and Physiology. Professor and Associate Dean D. Paul Thomas represents the College of Health Sciences Division of Kinesiology and Health in the COBRE effort.

The unifying research theme of the cardiovascular COBRE is the impact of myocardial infarction (heart attack) on gene expression. The recent development of high-density DNA microarrays (called gene chips) makes possible genome-wide exploration of the heart's response to infarction. A mouse's gene chips contain the genetic code (in the form of DNA sequences) for virtually all the genes in the genome. By extracting genetic material from the hearts of animals that have had surgically induced heart attacks and matching it to the gene chips, researchers can measure the response of all genes in the heart.

These genome-wide approaches to understanding heart physiology require teamwork and collaborative effort. Because gene-chip studies simultaneously measure gene expression for 36,000 genes in response to an insult such as infarction, different and varied research expertise is needed to analyze and interpret results.

Mark Harpster, senior research scientist, and Vijay Amarendran, graduate student, prepare RNA from a mouse's heart tissue.

Thomas, a cardiovascular physiologist, will surgically produce a heart attack and assess heart function responses to it. Gomelsky plans to study the mechanisms in the tissue that sense hypoxia or lack of oxygen. Stayton's focus is the repair of DNA damage and the pathways in tissues by which this may be accomplished, and McCormick, a muscle biologist, will study the extracellular matrix responses to stress in cardiac muscle.

To enhance these interrelated research efforts, COBRE also supports a Protein Expression Core Lab directed by Jarvis and a microscopy facility directed by Research Scientist Zhaojie Zhang. Application of the gene chips technology is facilitated by a collaborative arrangement established with the University of Colorado Health Sciences Center in Denver.

Results of the group's first studies using DNA mircoassays to measure the gene response to heart attacks in mice were reported in February at the American Physiological Society Conference on Cardiovascular Genomics held in San Francisco, California. Preliminary data have formed the basis of a second grant submission to NIH for additional funds, which will expand this area of research.

Richard J. McCormick, Professor, Department of Animal Science

Team-based research benefits span the

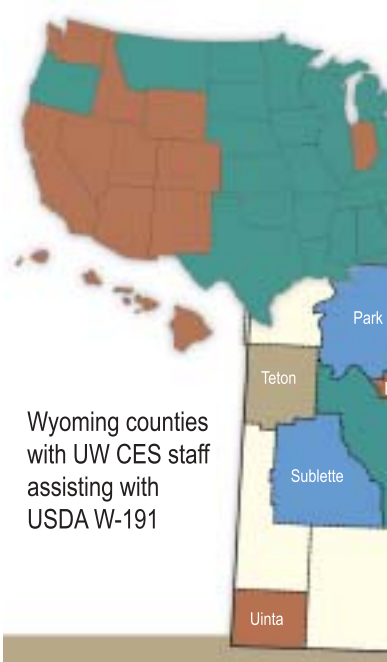
The University of Wyoming's participation in the United States Department of Agriculture (USDA) Hatch Multi-State Research Project W-191 exemplifies the meaning of collaboration. "Factors Influencing the Intake of Calcium-Rich Foods by Adolescents" involves research teams in 11 states: Arizona, California, Colorado, Hawaii, Idaho, Indiana, Nevada, New Mexico, Utah, Washington, and Wyoming. In Wyoming, the project has been a productive five-year partnership between UW Cooperative Extension Service educators in the areas of family and consumer sciences and 4-H and youth development. Educators and program associates in the following counties have been an integral part of the project: Natrona, Johnson, Fremont, Weston, Teton, Sublette, Laramie, Uinta, Park, Campbell, Hot Springs, and Washakie.

"Factors Influencing the Intake of Calcium-Rich Foods by Adolescents" is designed to assess calcium intake within two groups of adolescents—the younger group, ages 11 to 12 years, and the older group, ages 15 to 16 years—and to identify the factors that influence calcium-rich food intake. Researchers targeted these two age groups because considerable research indicates that calcium intake drops precipitously between the ages of 12 and 16. And since the rates of osteoporosis are highest among Caucasian, Asian, and Hispanic individuals in the United States, the project also focuses on these three groups.

During Phase I of the project, researchers collected and analyzed qualitative data gathered through adolescent focus groups. From this information, the team identified factors associated with the promotion of calcium intake (motivators) and obstacles to calcium intake (barriers). Phase II involved the development and administration of a two-part survey based on Phase I data: a food-frequency questionnaire and a motivator-barrier assessment tool. The two-part survey tool was distributed to both the younger and older adolescents in all 11 project states during the spring and fall of 2001. Currently, the research team is analyzing the results and will make those available to educators and the public to

Conclusions drawn from focus group data gathered during Phase I:

- Many youth expressed a strong opinion about milk needing to be cold to be appealing, and keeping milk cold appears to be a problem with much of the milk served in school lunch programs.
- Caucasian youth appear to have the most positive reactions to milk and Hispanic youth have the most negative reactions.
- Generally limited expectations within families for drinking milk appear to be a substantial barrier to intake, a finding more common among older girls and Asian youth but not unusual among younger girls, as well.
- Ethnic differences emerged in some of the forms of milk consumed. Hispanic youth were more likely to mention milkshakes, puddings, and flan, while many Asian teens expressed preferences for sweetened milks, milk teas, and warm milk.
- Nutrition education efforts to increase calcium intake among teens should include a family component that targets mothers in particular. Outreach efforts should also stress the benefits of drinking milk for both females and males and should focus on breakfast as the meal to provide a good start in meeting calcium needs.



Wyoming counties with UW CES staff assisting with USDA W-191

County and state-based

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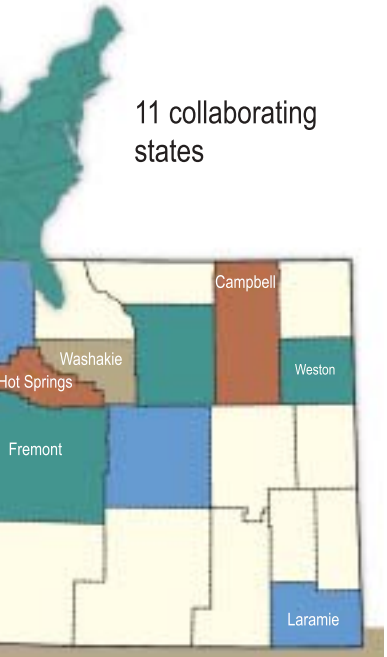

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help guide and strengthen calcium education programs for youth.

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