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Farm & Home RESEARCH

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South Dakota State University • College of

Agricultural Experiment Station



**NORTHERN PLAINS BIOSTRESS LABORATORY
10TH ANNIVERSARY**

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On the cover:

The first-ever annual Griffith Faculty Research Award, open to all faculty members at South Dakota State University, was awarded in May 2003 to Jon Jenks, professor in the Wildlife and Fisheries Sciences Department in the Northern Plains Biostress Laboratory. Jenks has earned an international reputation for excellence in wildlife ecology and management research. He is a national leader for the U.S. Geological Survey Gap Analysis Program, conducts research that includes chronic wasting disease in Black Hills deer and mountain lions in South Dakota, and directs the studies of graduate students. His work advances both scientific and public understandings of environmental/ human interactions.

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Director's comments

BY KEVIN KEPHART

Director, South Dakota Agricultural Experiment Station

South Dakota: 'land of infinite complexity'

This entire issue of Farm & Home Research is devoted to “biostress.” This is a term developed by the late Experiment Station Director Ray Moore for the stresses that all living things must adapt to and manage if they are to survive.

Specifically, this issue marks the 10th anniversary of our Northern Plains Biostress Laboratory, dedicated in September 1993. The name of that facility, where many of our scientists work, is a reminder of what our land-grant mission is all about here in South Dakota.

As Fred Cholick, dean of SDSU's College of Agriculture and Biological Sciences, notes in his remarks in this issue, South Dakota is a place where crop zones overlap from south to north. The same is true in terms of east and west. South Dakota is a transition zone between the tallgrass prairie to the east and the shortgrass prairie to the west. The change is from a humid grassland to an arid one.

In one way an old term for South Dakota and other area states still applies: “the Middle Border.” Yes, South Dakota lies at the geographical center of North America. But it's also at the edge of things.

Prairies give way to the Great Plains at about the 99th or 100th meridian. Corn and soybeans give way to small grains, sunflowers, and expansive range and pasture lands. In geographic terms, there's a distinct difference in soils and terrain as you cross the Missouri River. Glaciers once scraped across eastern South Dakota, but left the West River country untouched.

Even in purely human terms there are transitions. With the exceptions of Pierre and Rapid City, South Dakota's largest cities are all east of the 99th meridian. Our central time zone gives way to mountain time at about the Missouri River or slightly west of there in southwest South Dakota.

South Dakota is part of three major watersheds. Though most rain falling on South Dakota will find its way into the



Kevin Kephart, AES director

Missouri River drainage leading south toward the Gulf of Mexico, the far northeast corner of the state feeds into the Red River of the North, flowing into Canada toward Hudson's Bay. And a small portion of runoff from eastern South Dakota drains directly into the Mississippi River system by feeding into the Minnesota River.

Southwestern South Dakota is home to an anomaly—the Black Hills form an “island” in the plains where plant and animal species from different ecosystems overlap.

All of these various transition zones make for divergence. As Dr. Cholick suggested, plants and animals—and people—must adapt to “biostress” or they won't endure very long in a place such as South Dakota. “Land of Infinite Variety,” a slogan calls our state. We could as easily say, “Land of Infinite Complexity.”

In fact, South Dakota may fit the definition of what scientists call an “ecotone”—the interface where two ecosystems meet and interact. Is South Dakota one massive ecotone? I think today it is.

Soils, rainfall, habitat, wildlife species, temperatures, and agricultural systems vary widely from one part of the state to the next. For scientists at South Dakota State University, carrying out the land-grant mission we were given more than a century ago means finding out what works in this land of infinite complexity.

The biostress effort is uniquely South Dakotan. As we'll show in this issue, the Northern Plains Biostress Laboratory was constructed to facilitate collaboration among scientists and sharing of equipment.

Their efforts in dealing with the various challenges of biostress—in the Northern Plains Biostress Laboratory and wherever else SDSU scientists carry out their work—are clearly linked to our mission of serving the citizens of the state. ♦



Fred Cholick, Dean of ABS College, and the NPBL

'the backbone' of programs helping you deal with stress

FRED CHOLICK
Dean, College of Agriculture and Biological Sciences

One of the reasons I came to South Dakota
22 years ago was that this was a great place for a wheat breeder. It still is.

Southern edges of northern crops overlap the upper boundaries of crops from south of here. Edges are where things are likely to change in the genetic makeup of plants; the less-than-perfect plant environment calls for new coping mechanisms, or the plant dies. From the survivors of environmental stress, we can produce cultivars and varieties with high yield and high value to South Dakota farmers.

Twelve years later when the Northern Plains Biostress Laboratory opened, I was still more interested in stress on plants than in any that might affect humans or animals.

I talked about field work and how South Dakota is an unmatched outdoor lab but that we needed the indoor

facilities and equipment that would let us burrow into plants to the molecular level so we could find and define those mechanisms by which plants cope with stress.

And now, 10 years later, I'm dean of the College of Agriculture and Biological Sciences. No one calls me anymore for a spring wheat recommendation. And my idea of biostress has expanded exponentially.

BIOSTRESS IS WHAT keeps us from reaching our fullest potential and, in many cases, from even knowing what that potential is. It affects crops, livestock, humans, and communities all across South Dakota.

We live in a state of too much rain, too little rain, too hot, too dry, too cold, too snowy. Since the NPBL has opened, we have gone through one of the most severe droughts in our history, one of the greatest snowstorms oldtimers can remember, a flood that washed out crops and roads and homes, a West Nile Virus pandemic, one of the lowest wheat crops in memory, and a tremendous livestock buyoff.

WITH ALL THAT SAID, the NPBL was never intended to eliminate drought or kill every mosquito in South Dakota. It does permit us to conduct solid research that is the backbone of educational programs that help you deal with stress. Some examples are appropriate.

During the drought, Extension surveys of farmers and ranchers in the hardest-hit northwest counties showed their primary needs were for hay and for money to ship cattle out of the area to feed.

Extension's Feed Finder program led to requests for donated hay from eastern South Dakota, and that expanded into "Hands Across South Dakota," a coalition of church, commodity, and governmental agencies that worked on feed donation, trucking, family assistance, food banks, and counseling.

In the meantime, Extension educators also tested water, crops, and even weeds for nitrate load. They offered programs and counseling on family and financial stress.

OUR RESPONSE to the drought was no knee-jerk reaction. We are rarely caught off guard when a natural crisis hits. We saw the drought coming; we knew West Nile Virus wouldn't miss us as it swept across the country; history and climatologists told us it was only a matter of years before another rugged winter would cycle down on us.

Often, however, biostress does not announce itself with a lot of fanfare. Diseases can rob our crops of yield or remain subclinical in our feedlots, disagreements can fester in the family. That's why our scientists and specialists work on scab, feed and water quality, conflict resolution, and other projects continuously. Their work is solidly science based.

Some of the money that built the NPBL was dedicated to remodeling the Veterinary Science Department and its Animal Disease Research and Diagnostic Laboratory (ADRDL); the goal was to increase their capacity to handle infectious diseases. From the ADRDL in recent years has come major breakthrough research into the Porcine Reproductive and Respiratory Syndrome, shipping fever, and *E. coli* in young pigs. The ADRDL became a major regional diagnostic center for West Nile Virus.

Our projects are team based. That is one of the advantages of the NPBL approach: ideas come from individuals, but progress comes from individuals working together.

Much of what we do is in partnership with the South Dakota Department of Agriculture and the industry. Major commodity groups and farm organizations have bought in to the biostress concept; an example is the support from the Wheat Commission. Scab would devastate the crop in South

Dakota if we let it, but with partial industry funding, we have developed at least some genetic resistance to wheat scab.

You are another one of our partners. You have asked questions, listened to our Extension educators, and applied the results of our research.

NOW WE ARE ENTERING into an era where, in concert with communities across South Dakota and a grant from the Northwest Area Foundation, we are putting even more emphasis on local leadership. We will be the catalyst, we will provide resources, but the community leaders will determine their own problems and, ultimately, their own fate.

But first, they need to become leaders. That we can teach them.

In academic programs on campus, we have developed the Biostress Center of Excellence. This is a "virtual" center, not a

"...one of the advantages of the NPBL approach: ideas come from individuals, but progress comes from individuals working together."

—FRED CHOLICK

DEAN, COLLEGE OF AGRICULTURE AND BIOLOGICAL SCIENCES

physical building. The program brings together students from various disciplines and majors to work on problems in an integrated, team-centered fashion.

Employers have told us that team and leadership skills are what they look for when they hire our graduates. The Biostress Center of Excellence is all about sharpening those skills, particularly when the students are assigned a rural development or community project that has been identified by people out in the state. The students do on-site investigations and write reports, and they must present possible real-life solutions to the community leaders.

It's harder work than the students ever expected, but they also find it invigorating to consolidate bits and pieces from sometimes unrelated classwork into a coherent whole education that will carry them into their own leadership roles after graduation.

YOU HAVE CERTAINLY gathered that biostress and our progress in combating them are the central theme of this issue of *Farm & Home Research* and of this article. Let me finish this way:

I have found in my 22 years in South Dakota that it is a great place to live and to raise my family. I have been befriended and challenged by the people who call this state home; I work with a fantastic group of people, both within the University family and across South Dakota.

You have helped us to "make a difference." Thank you. ♦



'making life easier for livestock and operator'

DON BOGGS

Head, Animal and Range Sciences Department

The Animal and Range Sciences Department mission focuses on three broad areas of biostress concern; drought, heat stress, and cold stress.

Recent dry years have kept drought at the front of our research and Extension programs. But that's nothing new: We've been evaluating the short- and long-term impacts of drought at the Cottonwood station since the early 1940s.

These older data sets provide the basis for long-term strategies to help rangelands recover from drought. And they help us to see if early-season precipitation can be used to assess summer forage availability.

We have also been evaluating how soon cattle can come back on to drought-stricken pastures. Just because green grass has reappeared does not mean that it is a good idea to put cattle back on to the pasture.

We initiated a new project this year investigating whether early weaning of calves reduces grazing pressure on the range. Weaning should reduce grass consumption, but if we early wean calves, what is the effect on calf growth, on cow condition recovery, on recovery of the range, and most importantly, on the economics of the cow-calf operation?

Our faculty, both on campus and in the county Extension offices, has been instrumental in assisting producers to develop drought management strategies. These have ranged from the development of grazing management plans to identifying alternative feeds that could carry cattle through the drought period.

South Dakota has several co-products from the processing of soybeans and corn, such as soybean hulls and distillers grain, that make excellent livestock feeds. The question


becomes: How can we best use these somewhat novel feed-stuffs to maintain livestock productivity while sparing pastures and avoiding overgrazing? A least-cost ration using alternative feeds developed by a county educator for a producer saved \$3,600 on a 300-cow herd.

THE DROUGHT ALSO INTENSIFIED water quality problems in western South Dakota. County Extension educators tested numerous water samples for West River ranchers and found nearly 90% of the samples high enough in Total Dissolved Solids (TDS) to be harmful to livestock.

Research at the Cottonwood and Antelope research stations quantified the losses in livestock performance caused by the poor water. Armed with this information, Extension educators and producers were able to make informed decisions on the economic comparisons of selling the cattle, moving them to other pastures, or providing an improved water source.

Developing winter management programs that allow livestock to remain productive even during severe winters is a second important area of biostress. The practice of using cow condition score as a management tool to reduce costs yet retain reproductive efficiency is used across the country and is based on research generated at the Cottonwood Station.

More recently, our faculty has conducted management studies evaluating time of calving and time of weaning in relation to the requirements of the cow herd during those stressful times. By calving later, in the spring or early summer, produc-



ers can reduce winter feed costs, alleviate winter stress on baby calves, and better balance their herds' requirements with the forages available.

A RELATIVELY NEW AREA of biostress research for our department is developing management strategies to alleviate heat stress. As we begin to see more confined animal feeding operations in South Dakota, a direction the state would like to head from an economic development standpoint, it becomes an even more important issue.

Our current research focuses on some really interesting work looking at equations that predict when an animal would be heat-stressed and at sprinkling systems that alleviate the heat load on the animal during those really hot days with high humidity.

In the future, drought, cold, and heat are likely to continue as the dominant environmental stresses that our producers will have to deal with. Continuing to find new and different ways to address those topics is an ongoing emphasis of the department.

But while we usually think of biostress as the impact of the environment on the animal, we also have to address the impact of the animal on the environment.

Our swine and beef feedlot groups are looking at methodologies to minimize impacts livestock have on the environment. They are formulating advanced strategies for nutrient management, manure handling, and odor reduction from large animal confinement units.

Predators, such as coyotes, provide another dimension to biostress. They are a significant source of stress on livestock and humans during lambing and calving seasons. A new project is being initiated to evaluate new methods for predator control and for lambing on range rather than in confinement.

WE ARE ALSO COGNIZANT of the role livestock management plays on stress in humans. So we are looking at strategies to make livestock production and management less labor-

“...we are looking at strategies to make livestock production and management less labor-intensive and, from that standpoint, reduce some of the stress on the human.”

—DON BOGGS
HEAD, ANIMAL AND RANGE SCIENCES DEPARTMENT

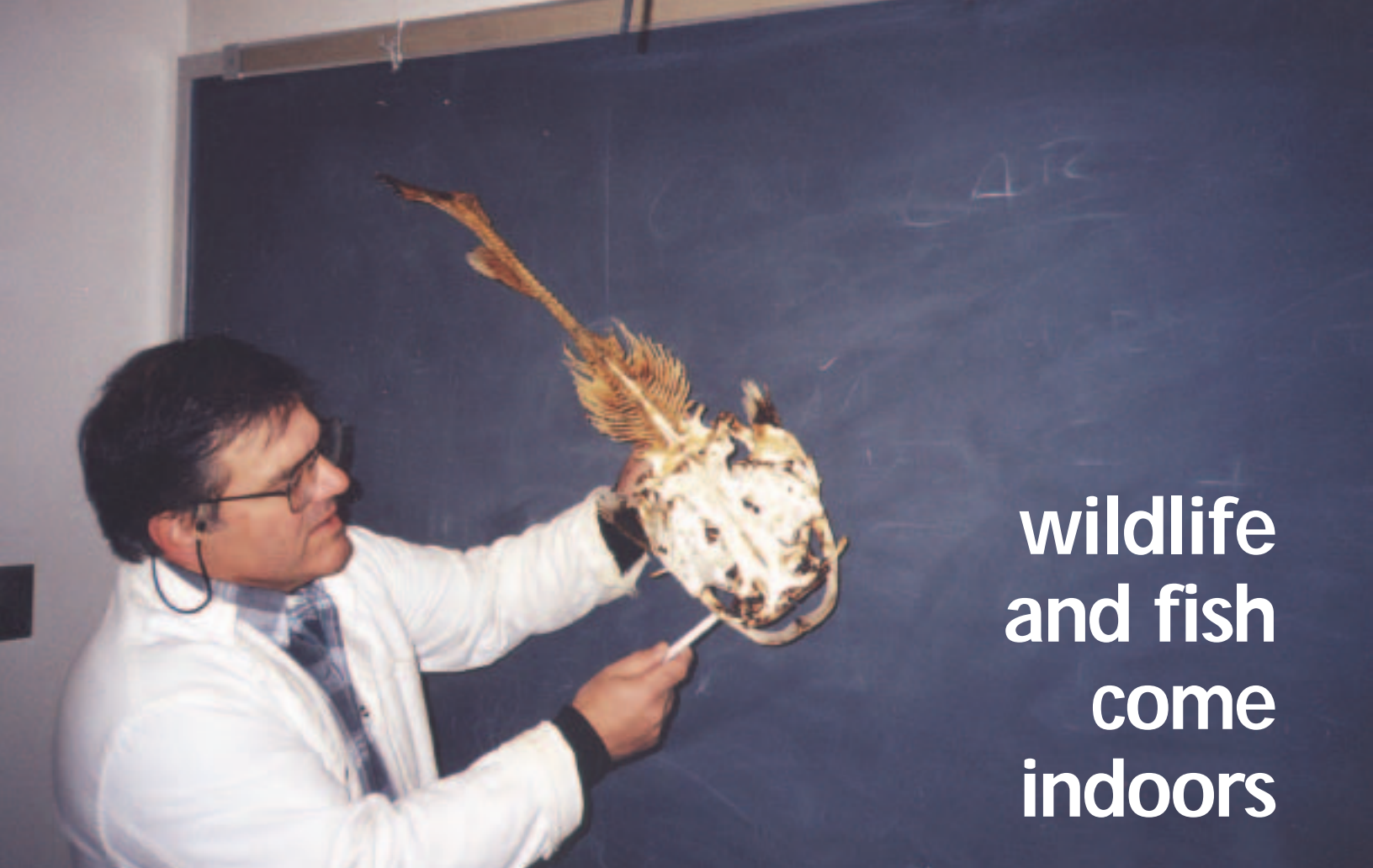
intensive and, from that standpoint, reduce some of the stress on the human.

Producers are all too well aware that the calving season and weaning time have a human component. Calving in late spring and summer on pasture is much less labor-intensive than calving in winter. And checking cows at midnight in May is a lot more fun and much less stressful than checking cows at midnight in February.

Our faculty has also been evaluating a new weaning strategy whereby calves are actually fence-line weaned, on pasture, alongside their dams. The calves can see the cows, they can smell the cows, and they can hear the cows. They simply can't get to them to nurse. This is a lot easier on people and a lot easier, apparently, on the cattle.

We are also developing systems for extending the grazing season with alternative forages and improved grazing systems. These strategies have the dual advantage of reducing winter feed costs and reducing labor requirements for harvesting and delivering winter feed.

BIOSTRESS WILL NEVER be eliminated from our livestock systems in the Northern Great Plains. However, Animal and Range Sciences Department research at SDSU and across the state is designed with the goal of making life easier for both livestock and operator. ♦



wildlife and fish come indoors

CHUCK BERRY

Unit leader, South Dakota Cooperative Fish and Wildlife Research Unit,
U.S. Fish & Wildlife Service, U.S. Geological Survey

I remember the night that the microscope case fell off the wall of the old fish and wildlife building.

The walls in the one laboratory that was also a classroom just gave up. We didn't lose much. The microscopes were as old as the building.

In those pre-NPBL days, fish and wildlife research at SDSU was limited to field studies. But a solid research and education program in fish and wildlife means bringing samples into laboratories for more detailed analysis.

We have those laboratories in the Northern Plains Biostress Laboratory.

THE NECROPSY LAB is a special place. Here in an atmosphere resembling a hospital operating room our students can dissect animals, process organs and tissues, and maintain high standards of cleanliness.

Christopher Jacques, grad student, used this room to study the heads of hunter-harvested deer collected throughout South Dakota. He was looking for a worm that dwells in the brain. About 20% of the deer were infected, which has implications for deer health but not human health. Humans cannot be a host for the worm.

My class in fish anatomy uses the room to boil the flesh off fish to prepare the skeletons for observation. Everyone in the building is thankful that we have a special necropsy

lab for this procedure and that the lab has an up-to-date ventilation system.

POOR DIET IS A STRESS that can be compounded by other environmental stresses for wildlife and fish. Poor nutrition leads to immune deficiencies, weight loss, slow growth, and other secondary and tertiary effects. But you can't always tell what's wrong by looking at the outside of the animal.

Fishery students usually count and identify items in a fish stomach, whereas wildlife students usually search through feces (scat). Jacquie Gerads, grad student, used the new lab facilities and equipment to examine the food habits of coyotes, one of the most important and abundant predators in the prairie region and a concern for ranchers. She found that small wild mammals (mice, rabbits) were coyotes' most frequent meals but they also ate vegetation, bugs, and birds.

Like cows, elk are ruminants, so Bob Osborn, grad student, compared rumen and fecal samples from elk. The study is an example of how our wildlife students learn the importance of verifying the precision and accuracy of their analyses. In this case, Osborn was learning whether, in plain words, what came out of the elk represented everything that went in.

The complicated process of preparing rumen samples is greatly facilitated by the open, safe, clean working environment of the new laboratory with its array of equipment suitable for the analysis.

INSECTS ARE AN IMPORTANT LINK in the food web of many wildlife species, but especially waterfowl and fish.

In the field, students studying bugs collect samples by sweeping the grasses of the uplands or the emergent aquatic vegetation, or collect a sample of upland soil, wetland mud, or stream gravel. Graduate Student Carmen Kennedy used a special vacuum cleaner to snatch insects from pasture grasses to learn how various livestock grazing practices can be managed to enhance pasture habitat for wildlife.

However, once samples are collected, the difficult part that students call "bug picking" begins in several NPBL laboratories. This process does not require lots of equipment, but bug pickers spend a lot of time in the laboratory, and it is nice to have clean, appealing labs that are well lighted and have plenty of electrical outlets, good ventilation, and lots of storage for the samples.

The largest and most impressive lab is the "fish tank" room. Here are aquariums of all sizes: large round tanks 4 feet deep and long rectangular tanks that hold hundreds of gallons of water and many pounds of live fish. Each tank can be aerated, and hot and cold water can represent water temperatures from all seasons of the year.

It was here that Graduate Student Craig Paukert held bluegill to study the effects of implanted radio transmitters on fish fitness. His study involved tracking bluegill movements around a lake, but first, he had to learn whether the tiny transmitters inserted in the body cavity would bias results of his experiment.

The facilities in the tank room allowed him to hold the fish for post-operative observation and health measurements without concern for other factors. His work was published in a prestigious journal and, in the "methods" section of his manuscript, he described the facilities in the fish tank room. When our students publish their work, other scientists realize that it is being done under the best of lab conditions when they read about the NBPL facilities.

Another specialized lab is the limnology lab. Limnology is the study of lakes, and a big part of the work includes water quality analysis, but we pick some bugs there also. Resembling a chemistry lab with its glassware and meters and microscopes, the limnology lab supports the work of many students. The hoods that control air flow, the safety cabinets for storing chemicals, and the emergency showers and eye wash stations make this lab a safe place to work.

It is in this lab where current Graduate Student Trevor Selch is analyzing water quality (nitrogen, phosphorus, iron, pH) of Angustora Reservoir. Because of our facilities, the Bureau of Reclamation now funds an ongoing research project concerning the water quality and biological communities (plankton, bugs, fish) of their water supply reservoirs in western South Dakota.

While laboratory research is usually the domain of the faculty and graduate students, we now have enough space to allow undergraduates to get involved.

Jason Kral became interested in chemicals in the environment and the effect they might be having on the sex ratios of fish. He studied the sex ratio of flathead chubs, a minnow that is disappearing in other parts of the Missouri River basin but is still common in South Dakota's West River streams and rivers. Using microscopic analysis of the dissected ovaries and testes of the chubs, he learned that the normal sex ratio of the White River population is 57% female:43% male.

BACK IN 1989 I whined in an article in this magazine about having no laboratories, and I mentioned that genetic analysis of fish and wildlife was a growing field, just as it was in agriculture. Yes, we have now done genetic studies.

Most of the work has been to identify walleye and sauger from their hybrids, called saugeye. The outward appearance of these fish could lead to misidentification, but analysis of a piece of tissue reveals the species-specific proteins that give away the true identity of the specimens. Graduate students Neil Ward and Mark Flamming both published articles in scientific journals detailing the results of these studies.

One research tool not around in the late 1990s has had the most spectacular growth of all, and fortunately we've had the space to accommodate it.

The tool is GIS or Geographic Information System, which is the computerized method of analyzing maps of natural resources and determining how fish and wildlife are distributed in South Dakota. The largest project has been funded by the U.S. Geological Survey and is called GAP analysis, meaning geographic approach to planning. The idea is to avoid listing any more endangered species by planning for their conservation now, but the map products from this study are finding many, many more uses in research and planning. Computer users can view the vegetation coverage of the South Dakota or see the distribution of most wildlife species on our web page <http://wfs.sdstate.edu/sdgap/sdgap.htm>

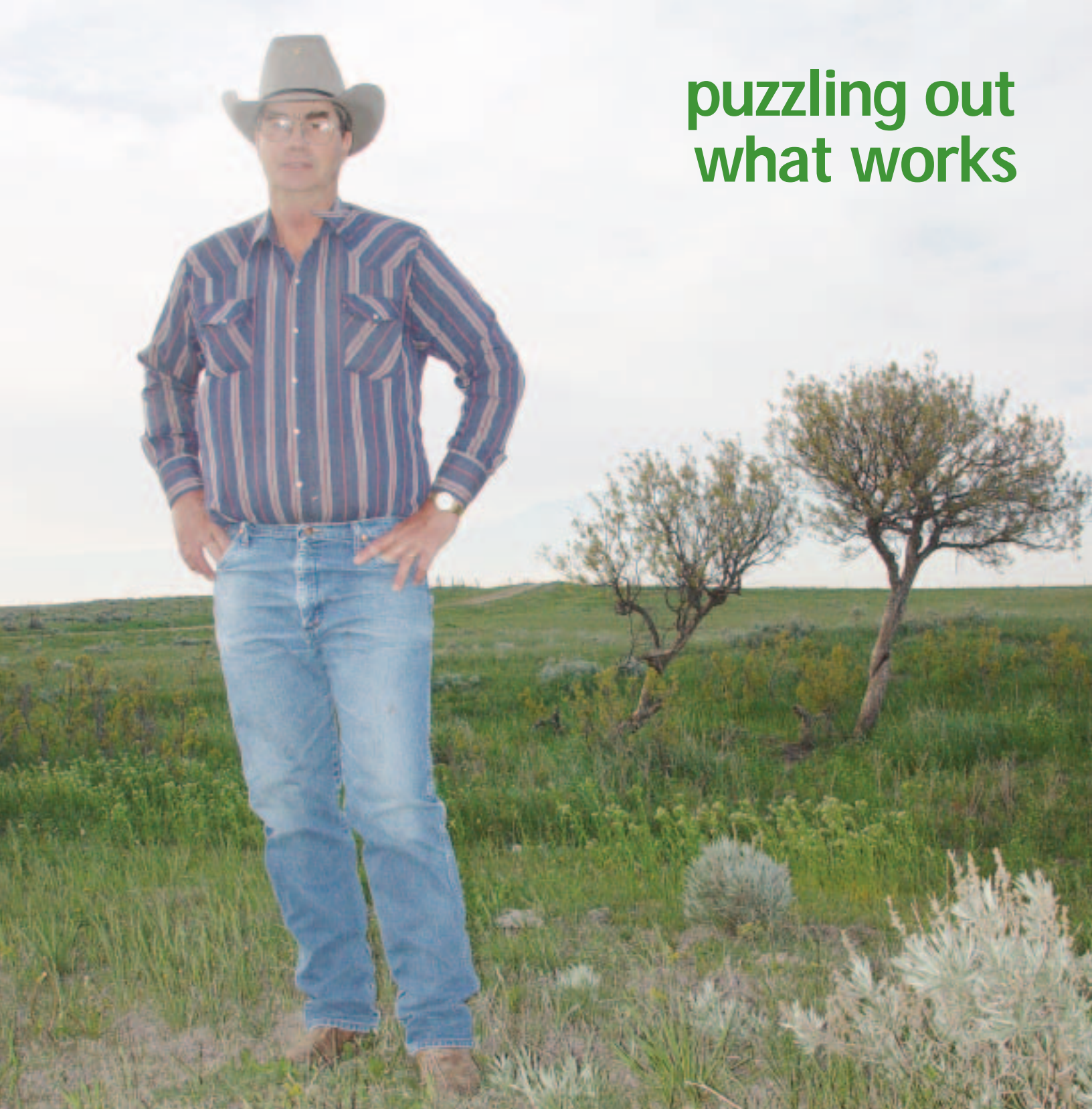
"...the SDSU wildlife and fisheries program has been ranked by our peers as one of the top 12 in the country."

—CHUCK BERRY
UNIT LEADER, SOUTH DAKOTA COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

The new labs and the whole building have been a benefit in recruiting the better students in the country. We are proud to show a prospective student the facilities, and the SDSU wildlife and fisheries program has been ranked by our peers as one of the top 12 in the country.

Before the NPBL was built, our programs, faculty, and students were spread around campus. Now we are together. This greatly increases the educational and research atmosphere in the department. ♦

puzzling out what works



Red Scaffold Creek where it passes south of Dave Fischbach's ranch had more water flowing in the spring of 2003 than in the previous 2 years.

It was a welcome sign that the drought that began in late 2001 and seared South Dakota in 2002 was breaking.

And a reminder that drought is part of a cycle that all living things in western South Dakota have to adapt to—a lesson Fischbach kin and their neighbors have been learning for nearly a century now.

"My granddad homesteaded out here in 1910, so my family's been here on this ranch since then," said Fischbach, a past president of the International Society for Range Management.

"I can't imagine what those folks must have gone through. When they came out here, there were no power lines, there were no fences, nothing but wagon trails every here and there.

Living in sod shanties, burning wood, hauling water from the creeks—when you could find water.”

YET LAND WAS FREE, and it must have looked pretty good to Fischbach’s grandfather, an immigrant from Alsace-Lorraine who had spent 11 years working his way west across the country before coming to what was still a frontier for homesteaders in western South Dakota.

Mike Fischbach’s saga is like those of hundreds of other South Dakotans. He raised cattle and registered his initials, MF, as his brand. He met an immigrant woman from Hungary and brought her home to the ranch as his wife.

A generation later, Mike’s son, Andrew, was 3 months away from earning his degree in civil engineering from South Dakota State College when his National Guard unit was mobilized in February 1941. He never made it back to Brookings to finish the degree.

Instead he found himself going back to the ranch after World War II to help his father, bringing with him his own idea for the brand he would register—a propeller shape such as he’d seen on military ships sitting in dry dock.

He also brought along the New Orleans girl he’d met and married back when they both thought Andrew would go back and finish his degree.

“Now there’s someone who made some adaptations. Mom had no intention of marrying a rancher. She thought she was getting a civil engineer,” Dave Fischbach said.

“When they moved out here after World War II, there was no electricity, no indoor plumbing, not much for graded roads, the only heat in the house was a coal-and-wood stove in the middle of a three-room shack that was lean-to pushed together.

“She has always said this is a very harsh land and you can’t deny that. This can be a terribly, terribly harsh land. You get hot, dry summers and cold, deep, long winters. You can wake up some mornings and you really kind of wonder, ‘Why in the heck am I here? Do I really want to do this?’

“If you meet a person from around here who tells you they haven’t ever thought that, I guess I’d have to say that would be a rare person.”

Yet the ranch has been extraordinarily good to the Fischbachs. They calculate that since the start of the 1960s, it has paid for about 50 to 55 years of university study for the young people in the family—mostly at South Dakota State University.

The ranch was paying for Dave Fischbach’s education in range management when a telephone call that first week of March 1966 let him know that his parents had lost between 125 and 150 cattle in a devastating blizzard.

The family recovered. The ranch still paid the final few months of Fischbach’s education.

ANOTHER GENERATION LATER, the Fischbach ranch is starting to recover from another natural disaster—with the help of careful management. Dave Fischbach can name without a moment’s hesitation the day he sold his last head of livestock: Sept. 23, 2002.

That eased the stress on his pastures to help his range recover.

In 2003, with welcome rains, he took the first cautious steps toward using his grazing land once more, summering some cattle for other ranchers and some yearlings that he bought.

“I think people are becoming more aware all the time that all we have to market out here is the grass. And if we don’t take care of the grass, it won’t grow sheep or cattle or anything else,” Fischbach said.

That’s why scientific research is so crucial to ranch families, said Fischbach, who sits on the advisory board of SDSU’s Antelope Range Experiment Station near Buffalo.

“Regardless of whether we have a direct connection with the university, I think all ranchers over the years have undoubtedly benefited a whole lot from range research, as well as livestock genetics and feeding research that’s been done by the university system,” Fischbach said. “The research stations do the research, the Extension Service gets the information out to producers.

“I think people are becoming more aware all the time that all we have to market out here is the grass. And if we don’t take care of the grass, it won’t grow sheep or cattle or anything else.”

—DAVE FISCHBACH,
WESTERN SOUTH DAKOTA RANCHER

“We might be doing the same thing without the university system, but without the research that’s been done, we might be doing it more like the way it was done in 1935 than the way we do it now.”

Fischbach noted that the land-grant model fits well with the way ranchers operate on the Great Plains.

“Every ranch out here, to one extent or another, is an experiment station. We change our operations or we stay with the same thing, we’re doing what we’re doing for whatever reasons. A lot of times it’s easy to think that all ranchers do things the same, but we don’t. The product that we sell is the same, it’s beef or it’s lamb, but we go about producing it in a lot of different ways.

“We do what we do based on the resource that we have. There are no two ranches that have the same resource. There are some basics that are the same, but different ranches have different water capabilities, different production capabilities, different landscapes, different topography, different vegetation. All those things have a play in how you run your operation day to day throughout the year.”

Informally, he said, ranchers are doing the very thing SDSU is doing more methodically in places such as the Northern Plains Biostress Laboratory—puzzling out what works and what doesn’t in a lean, thirsty place like Faith, South Dakota. ♦



'new insights'

PETE SCHAEFER

Head, Horticulture, Forestry, Landscape & Parks

Prior to moving into the Northern Plains Biostress Laboratory, research in the Horticulture, Forestry, Landscape & Parks Department was heavily field based.

We had very limited resources for laboratory studies to back up that field work or for research that might more effectively address pressing issues. Facilities in the NPBL have enabled research into a number of critical areas related to plant growth in the Northern Plains.

Dormancy and acclimation in woody plants. Anne Fennell has relied heavily on her laboratory, growth chamber, and greenhouse in developing a grape genetic model system with a wide range of freezing tolerance and acclimation capa-

bilities. This has enabled her to identify a bud dormancy-related gene that is responsive to day length and expressed in buds during the early stages of dormancy.

She has also found that tissues just below the buds freeze at lower temperatures than other stem tissue, which suggests that tissues adjacent to the buds provide a barrier to ice spreading from the stem to the bud.

Grape production and wineries are small but rapidly growing industries in the state and region. Dr. Fennell's research on cold acclimation and dormancy will provide critical knowledge

in developing varieties that can withstand northern climates. Her research has been supported by the South Dakota Agricultural Experiment Station (SDAES), USDA National Research Initiative Competitive Grants Program, South Dakota Experimental Program to Stimulate Competitive Research, Binational Agriculture and Research Development Fund, and the SDSU Research Support Fund.

Winter hardiness in turf-type perennial ryegrass. The extreme subfreezing temperatures in the Northern Plains limit the number of turfgrass species acceptable for golf course fairway use. Although perennial ryegrass is a widely used fairway turfgrass, golf course superintendents in northern regions are discouraged by frequent perennial ryegrass winterkill.

Leo Schleicher and Fennell combined laboratory freeze testing and viability assays with field evaluation to enhance screening ryegrass cultivars for suitability for northern winter conditions. This research is supported by SDAES and the turfgrass seed industry.

Lethal temperature does not appear as important as loss of recuperative ability from crown injury at pre-lethal temperatures. Fennell and Schleicher have found that unacceptable injury occurs at considerably higher temperatures than LT50 values. This information will aid golf course superintendents in selecting appropriate cultivars for their locations.

Putting green improvement. A collaborative project between Schleicher and James Doolittle, professor of plant science and adjunct horticulture professor, was funded by SDAES, the South Dakota Golf Association, the South Dakota Turf Foundation, and the South Dakota Golf Course Superintendents Association.

Results will be used to provide specific recommendations for improving putting green quality at 36 South Dakota golf courses. Undergraduate turfgrass science students assisted with the project on site and in the laboratory.

Mycorrhizal interactions with crops. Rhoda Burrows is working with both Fennell and Schleicher to examine the effects of mycorrhizal fungi on buffalograss and grape vine establishment and acclimation (chilling resistance and dormancy induction).

Greenhouse tests have shown that buffalograss responds with increased growth and tillering to mycorrhizal inoculation. Field tests are currently underway. Greenhouse tests have also shown that grapes can be successfully colonized by the fungi during rooting of vine cuttings; growth chamber tests are underway to assess the effect of mycorrhizal inoculation on fall acclimation processes.

The goal is to develop systems to inoculate buffalograss and grapevines during propagation, to increase field establishment

success under the low-input conditions in which these crops are normally grown.

Forest and wetland ecology. The availability of expanded lab space and new equipment allowed Carter Johnson to expand his research documenting and predicting changes in riparian landscapes in the northern and western plains. His work has been supported by the SDAES, Federal Emergency Management Agency, USDA Sustainable Agriculture Research and Education Program, U.S. Fish & Wildlife Service, and the Environmental Protection Agency. This research resulted in the development of a mathematical model (WETSCAPE) to evaluate the effects of climate change on the hydrology and biodiversity of prairie wetlands in the northern Great Plains.

It is the first tool to quantitatively assist scientists in predicting the consequences of climate change and land use interactions on landscapes of prairie wetlands.

Published work on riparian vegetation is currently being used to better manage the nation's large rivers. For example, Johnson's forestry research on the Snake River (Idaho) has

“New facilities in the NPBL have enabled research into a number of critical areas related to plant growth in the Northern Great Plains.”

—PETE SCHAEFER
HEAD, HORTICULTURE, FORESTRY, LANDSCAPE & PARKS

been used to determine instream flow requirements to maintain and enhance the integrity of the islands of Deer Flat National Wildlife Refuge.

The National Research Council incorporated Dr. Johnson's research in its recent book “Missouri River ecosystem: exploring the prospects for recovery.” From his work on the riparian vegetation of the Platte River, industry and government can work out science-based flow prescriptions to maintain the open character of the Platte River.

Our 10 years in the NPBL have seen substantial increases in both quantity and quality of laboratory-based research produced by our faculty and support personnel. Because of the NPBL we can better address fundamental questions of plant growth and landscape function, expanding the possibilities for producers of horticultural crops and offering new insights into ecologically sound land management practices. ♦

It's a family issue

LIZ GORHAM

Extension family resource management specialist, and

ANN MICHELLE DANIELS

Extension family life, parenting, and child care specialist



Patricia Edler, senior secretary, SDSU

Most people carry around a load of stress without even realizing it, handling the stress with grace and assurance, the thought “I’m frazzled” never crossing their minds. Other people fall apart in an instant.

Reactions to stress depend on a complex interplay between situation and individual.

Sometimes, through no one’s fault, things get out of control. A blizzard, consecutive years of drought, the West Nile Virus, fears about BSE can overwhelm the stoutest character. When South Dakota families need help, they turn to the South Dakota Cooperative Extension Service (CES).

Extension Service specialists and county educators recognize that stress affects people in a variety of ways and that stressors pile up. Drought may start with pasture stress and feed prices too high, escalate to livestock stress and cattle prices too low, and end with marital stress in the ranch or farm house.

Married-couple ranchers respond to the stress of a drought in different ways. At an Extension presentation, a husband, confronted with a burned up pasture, said, “When you are in ranching you just expect a few bad years and take them in your stride.” The wife, on the other hand, wanted to downsize their land and herd holdings immediately. “Since it is getting more difficult for one ranch to support both us and our sons and their families, maybe we should get out of the business altogether.”

Other examples of family stress caused by the drought included a couple bickering over spending priorities—money for meeting the current needs of their growing family versus

capital to expand the farming operation. Every South Dakota farm family has had its own, sometimes tragic, reaction to the drought. Extension has been there to serve and to help families through.

THEN THERE IS WINTER WEATHER. Within the past 10 years, South Dakota farmers and ranchers were hit with a devastating blizzard leading to the loss of 60,000 cows, 60,000 calves, 15,000 sheep, and 30,000 lambs. Snowbound families sometimes faced medical emergencies. Extension educators in many counties had already collaborated with first responders in the communities to establish rural emergency response teams. Local networks of volunteers, often recruited in advance by Extension, were those who answered the call.

On “Tornado Tuesday” and for weeks afterward, Extension was there, along with other agencies and many volunteers. West Nile Virus threatened lives and ruined outdoor evenings all summer; over 1,000 human cases of West Nile were reported across South Dakota in 2003; by late November, 13 people had died.

Extension, with the financial backing from the South Dakota Department of Health, led an educational effort, distributing thousands of activity books to schools throughout the state; putting up posters in schools, assisted-living resi-

dences, and community centers; and handing out “wallet cards,” all carrying the same message: Get rid of standing water. Use DEET, which is found in most mosquito repellants.

Who knows how many parents first heard about these preventive measures against “Nita the mosquito” from their grade-school children or how many people stayed healthy or even alive because of other Extension efforts?

It is difficult, usually impossible, to assign a numerical value to prevention or amelioration. We know, however, from listening to individuals and families of South Dakota, that Extension made a difference this summer.

WE LIVE IN UNCERTAIN TIMES when stressful situations can catch us off guard. One or more poor years of farming or ranching, devastating storms, disease, high medical bills with no or insufficient health insurance, loss of employment, a divorce, deployment in the military, or higher than expected college costs can upset our lives both financially and emotionally. Too often, the stress is nagging, constant debt.

Dependence upon dual-income earners has become the norm for most U.S. families; the loss of a second income can be traumatic. Farm households are no different than other households in pursuing two careers and diversifying earnings. Half of U.S. farm operators have extra jobs—about 80% of those operators have full-time jobs—and about half of farm wives work off farm.

The farm as a source of income plays an increasingly smaller role in determining the well-being of farm households; nationally, nearly 90% of farm income is from off-farm sources.

South Dakota per-capita income is among the lowest in the nation (\$25,993 in 2000) and yet South Dakotans had the nation’s third highest household debt in 2002 at \$9,667 (behind only Alaska and Vermont residents).

When in debt, the greatest deterrent to getting out of debt is worrying about it and failing to take action. Debt often paralyzes the consumer, who may be clueless about even the total amount of debt owed.

“People are afraid to communicate with bankers and even with their own families,” a county Extension educator reported.

When the family is deep in debt, Extension is ready to help there, too. The family members learn financial survival strategies to use when times get tough: They learn where to cut corners, shop wisely, conserve resources, and more. They learn where help—financial, emotional, and educational—can be found in their communities.

PowerPay[®] is a confidential money management service provided by SDSU Extension designed to help families take control of their debt. A county Extension educator used a PowerPay[®] repayment printout to show a local business owner how long it would take for a sample family to repay \$1,000 at

\$20 a month, assuming credit was no longer extended. The business owner came to understand the difficulties some of his customers were in and assisted some of them with their credit decisions.

And Extension county educators, both personally and in educational programs, have helped families recognize the symptoms of stress, thus helping them respond appropriately to stress when it comes. Symptoms include physical ailments such as stomachaches, headaches, and increased use of alcohol or drugs; mental aberrations such as irritability, depression, and mood swings; and finally, such deeper emotional issues as bitterness, poor relationship management, and loneliness.

“Positive perceptions can help people create a less stressful environment for themselves. There are always options.”

—LIZ GORHAM

EXTENSION FAMILY RESOURCE MANAGEMENT SPECIALIST, AND


—ANN MICHELLE DANIELS

EXTENSION FAMILY LIFE, PARENTING, AND CHILD CARE SPECIALIST

During the height—or depths—of the drought, for example, Extension prepared and used a series of 17 publications to empower youth and families with strategies and techniques to help them recognize, address, and prevent stress. By recognizing the symptoms of stress, families are better able to come through their difficulties.

RESILIENCY (the ability to work through stressful period) is an important factor in counteracting stress. Attitude and knowledge are proven effective resiliency factors. Families who are resilient solve problems together, communicate openly, are flexible, and have planned family time or family meetings. CES has shown families how to become more resilient; 50% of the families attending Extension drought meetings reported they would spend more time focusing on family meetings and activities.

Positive perceptions can help people create a less stressful environment for themselves. There are always options. In cooperation with state and federal agencies and various church and community service organizations, Extension specialists and educators bring the latest stress research to South Dakota families through programs, counseling, the media, and educational programs. We listen to the challenges and we provide the science-based knowledge that will help confront and overcome human stressors and make living in South Dakota more attractive and rewarding. ♦



the NPBL: 'It takes a lot of stress off me'

The seed drill behind Laird Larson's tractor was packed with a biotech soybean variety called 'SD1081RR'—developed specifically for South Dakota's soil and growing conditions by SDSU plant breeder Roy Scott.

It's one example of why Larson, a certified seed grower from Clark and a past president of the South Dakota Crop Improvement Association, thinks it's fitting that SDSU has a facility called the Northern Plains Biostress Laboratory on campus.

The Biostress Lab happens to be where Roy Scott and many other SDSU plant breeders have their laboratories, sharing space with scientists from other agricultural and biological science disciplines.

"A building's a building, but the concept of that building was ahead of its time," Larson said.

"I remember [former South Dakota Experiment Station Director] Ray Moore and the involvement he had in getting the Northern Plains Biostress Lab building built. From the start, it was meant to be a facility for the breeders and the research scientist people to work together in an environment where they could meet over a cup of coffee, a lunch, or in the hallway.

"They could discuss problems that Roy Scott is seeing out in the field and give the Catherine Carters, the Tom Cheesbroughs, the Fedora Suttons, the basic-research people, the chance to sit and brainstorm how they can alleviate that problem. They've been put into an environment where that can happen.

"If they were in separate buildings, where they might not see each other but once a month and maybe that's during a staff meeting, you might not accomplish as much."

IT MIGHT BE A STRETCH to say that Roy Scott's success with SD1081RR is due to insights from colleagues at the coffee machine.

Larson's point, however, is that such cross-fertilization of ideas does take place, and the facility makes it easier for it to happen.

He goes on to say that the range of problems Scott was addressing as he developed the new soybean variety for South Dakota is exactly what SDSU officials had in mind when they used the term "biostress" as part of the name for the new laboratory.

SD1081RR carries a gene for resistance to Phytophthora root rot, for instance. It also tolerates iron chlorosis well, a problem in some South Dakota soils. It has higher protein and oil concentration than soybean varieties from other states typically deliver when grown in South Dakota.

"We're colder, we're hotter, we're drier, we're wetter, we don't drain very well. We've got all those kinds of problems," says Larson. "You go another 60 or 80 miles west of here and it gets that much worse.

"Because of these stresses, the quality of the crop coming from the plants we grow here can be hurt. We've been known in this area to produce soybeans with lower oil and protein content than those grown farther south and east from here.

"Those are things Roy has to keep in mind in working with a variety to get it to produce a higher protein concentration and a higher oil concentration in this environment."

THE SEED IN LARSON'S DRILL also carried the glyphosate-tolerance trait that gives farmers an added weed control tool on a variety specific to South Dakota.

"You take a private industry company, they're going to do testing on varieties that do well over a large area. The one that does well in northeastern South Dakota might not do very well at all in central Minnesota or Wisconsin or any of those places, so they're going to drop it from their lineup.

"Our program at SDSU can stay very local, though it does spill over to our neighbors in North Dakota and Minnesota who use some of our varieties. Our wheat program is very popular in both of those states."

Larson sees local applications of research as one of the key tasks of a land-grant university—to deal with whatever stresses plants, animals, and humans must face within certain geographic boundaries.

"When you think about it, the biostress lab down there in Brookings really does involve plants, animals, and people," Larson said.

"It takes a lot of stress off me if I can raise a healthier, higher-producing, higher protein, higher oil, more profitable crop." ♦



a vision come true

T. CHEESBROUGH
Head, Biology/Microbiology

Charles McMullen, the former head of Biology/Microbiology, wrote of the department's vision for the Northern Plains Biostress Laboratory in a special edition of this magazine focusing on the lab:

"The NPBL will allow our scientists to design and carry out experiments not currently feasible or practical and will strengthen our established research programs related to the effects of environmentally-induced and pest/parasite-induced stresses on commercially important biological systems."

This vision has come true—in ways both expected and unexpected.

As predicted, the Biostress Laboratory provides facilities that allowed new breakthroughs such as C.H. Chen's selection of tan spot-resistant wheat from tissue cultures. Biologists analyzed soybean responses to cold stress and used this information to target genes for genetic modification to improve agronomic characteristics of soybean. Mike Hildreth used the new facilities to develop tests to detect tapeworm infections. The laboratory has also served as a recruiting tool to attract top-notch new faculty.

THE CLUSTERING OF SCIENTISTS from across campus in the new building provided another important benefit to South Dakota producers and consumers; the NPBL became a catalyst for the change from individual scientists working on unique projects to interdisciplinary teams taking on larger problems facing agriculture in South Dakota. In the 10 years since the dedication of the NPBL, scientists from Biology/Microbiology have teamed with scientists from other departments on campus, the USDA Agricultural Research Service, the South Dakota Department of Environment and Natural Resources, and with private industry to form teams of scientists addressing major problems facing agricultural producers and the people of South Dakota.

Yang Yen has worked with wheat breeders and plant pathologists from the Plant Science Department to control wheat scab. Yen and his students have identified two genes involved in resistance to the disease. When combined with the findings of other scientists in the group, this could lead to better varieties and practices for controlling wheat scab.

Bob Rowland worked with David Benfield, Eric Nelson, and Jane Christopher-Hennings in Veterinary Science to determine the mechanism of PRRS virus infection in pigs. Rowland focused on changes in the viral genome during infection and localization of the viral RNA during infection. These results, and those of other team members, form the basis for new generations of vaccines and diagnostic tests for PRRS.

Nels Granholm teamed with faculty from the Animal Science department to identify genes in cattle and pigs that are homologous to those he studied in mice. The team was able to identify the agouti-related protein and its receptor in both cattle and pigs. These genes play a key role in controlling traits such as coat color, fertility, and feed use efficiency. This information will help in future breeding programs to produce improved cattle and pig breeds.

Bill Gibbons has been a leader on teams developing new value-added products from crops. Bill worked with a team that helped develop methods for using co-products from ethanol production to make high value chemicals. His work with Bruce Bleakley and TJ Enterprises led to the development of new microbial-based treatments to help farmers combat crop diseases.

Nels Troelstrup has worked with Bruce Bleakley and the Department of Environment and Natural Resources to identify indicator strains of *E. coli* for rapid assessment of water quality.

This team has also conducted water quality assessment for lakes and streams in South Dakota. These tests and assessments will help the state address potential water quality problems and more efficiently manage this valuable resource for the benefit of all South Dakotans.

TEAMS OF EXPERTS developed during the last 10 years have set the stage for future research on biological stress at South Dakota State University. Newly hired faculty will augment our faculty studying infectious diseases in domestic food animals; these new scientists will bring additional expertise for understanding and treating disease stress. New faculty in plant molecular biology and genetics will help existing teams develop improved crop varieties to resist disease and environmental stress.

Teams of environmental scientists, including Biology/Microbiology faculty, will continue to increase our knowledge of environmental stress effects. New faculty in microbiology will bring genomic expertise to teams studying value-added processes and food safety.

We are confident that research at the NPBL will be even more productive in addressing stress-related problems in commercially important biological systems during the next 10 years. ♦

space, flexibility, new ideas, new opportunities

DALE GALLENBERG
Head, Plant Science Department

The Plant Science Department has long been engaged in biostress research.

For years, we have helped crop producers combat the constant and, it seems, increasing challenges of weather extremes and pest problems. We have developed production systems that maximize the potential of our natural resources in an economically and environmentally safe manner.

So the biostress concept was, in many ways, nothing new for us. What the Northern Plains Biostress Laboratory did, however, was give us a new way to focus and coordinate our activities.

The NPBL gave us an opportunity to intensify our research and teaching through the addition of laboratory, classroom, and office space and also gave us the opportunity to use shared equipment with other departments, equipment no single department could afford by itself.

The NPBL not only created new space. It also gave increased flexibility to the space that we have.

Most importantly, the NPBL created new ideas and opportunities by combining scientists from several departments in one location.

Variations and extremes in the weather—temperature, moisture, and wind—continue to be factors in crop production. Using our natural resources—water, soil, and plant life—in an economical and environmentally sustainable manner remains critical. Shifting pest populations and problems—of both developing new pests and resurging more familiar ones—demand our attention. The challenges of biostress remain much the same as they were many years ago. We have had successes in the last decade; we face new challenges.

Spring wheat breeding. Our emphasis in all our breeding programs has always been on developing high-yielding, superior quality varieties adapted to South Dakota and the region, and our spring wheat breeding program has a history of regional and even national importance.

Ten years ago, an “old” problem, wheat scab (*Fusarium* head blight), emerged to cause several years of significant problems in South Dakota and surrounding states. South

Dakota’s program to breed varieties more resistant to scab was jump-started by joint funding from the South Dakota Wheat Commission, the South Dakota Agricultural Experiment Station, and the Minnesota Wheat Research and Promotion Council. The program continues today under Karl Glover, our new breeder.

Several years ago a major funding initiative, the National Wheat and Barley Scab Initiative, was approved in the U.S. Congress. South Dakota scientists, commodity group representatives, and producers were instrumental in developing the program and securing its funding. SDSU’s spring wheat breeding program continues to release excellent varieties that are widely accepted in the state and region.

Soybean breeding. SDSU did not have a soybean breeding program prior to the arrival of Roy Scott on campus in 1991. Since then, he has developed a program widely recognized by producers, commodity groups, and private industry. Emphasis has always been on developing South Dakota-adapted varieties

“The challenges of biostress remain much the same as they were many years ago. We have had successes in the last decade; we face new challenges.”

—DALE GALLENBERG
HEAD, PLANT SCIENCE DEPARTMENT

with high yield and high quality. The South Dakota Soybean Research and Promotion Council has been an active supporter since the program began.

Technology for rapid and nondestructive measurement of protein and oil concentration in soybeans has been developed.

The variety ‘Surge’ is well known for its protein and oil characteristics. ‘Turner’ was the first soybean cyst nematode-resistant variety released by SDSU.



Marty Draper, Extension plant pathologist

Several years ago, SDSU entered into agreements with Monsanto that allowed the development and subsequent release of glyphosate-tolerant soybean varieties at SDSU. To date, the varieties 'SD1091RR' and 'SD1081RR' have been released as a result of this collaboration with private industry.

Precision agriculture. Under the direction of Dave Clay, Gregg Carlson, Sharon Clay, and other scientists, the precision agriculture group has developed a program nationally recognized for its work.

The program involves a combination of research, teaching, and Extension/outreach activities; its goal is to collect, manage, and utilize information for making crop production and management decisions. Collaborations exist with other universities across the country, USDA-ARS labs, state and federal government agencies, private industries, commodity groups, and producers.

Research areas have included ground water quality, agricultural and fertilizer interaction and movement in soil, carbon and nitrogen cycling, pest density variation, remote sensing, GIS/GPS and site/variable mapping, input efficiency maximization, and several other topics.

This group has been very active in securing outside grant funding, including commodity group support from the South Dakota Corn Utilization Council, South Dakota Soybean Research and Promotion Council, and South Dakota Wheat Commission..

Forages. South Dakota's history of research and development in forages dates back to N.E. Hansen and other early scientists at the turn of the 20th century. Numerous varieties of grasses and legumes have been released over the years that have made significant contributions to the state's livestock and dairy industries, as well as enhanced wildlife habitat.

More recently, an emphasis on biomass production and the development of biofuel feedstocks has come to the forefront.

Arvid Boe and Vance Owens, forage scientists, and scientists in other disciplines are involved in state and regional efforts looking at the potential of switchgrass in biomass production systems. The Sun Grant Initiative further represents a major opportunity for South Dakota and the nation to provide alternatives to farmers and rural communities in terms of production options and economic development strategies. ♦



a gift that keeps giving

CHARLES SCALET
Head, Wildlife and Fisheries Sciences

Construction of the Northern Plains Biostress Laboratory (NPBL) has had a greater effect on the Department of Wildlife and Fisheries Sciences than on any other department on campus.

When most folks think of the NPBL, they think of research. But for us, the NPBL means teaching, service, and research space.

Our faculty and students had been scattered across campus at three different locations. You might remember our previous central quarters, the old Wildlife and Fisheries Sciences building. That structure, built in 1899 as the “Agricultural Building,” lives on in our memories, with its roughly 4-foot-square entry way, stairs steep as a ladder, and sagging floors. If somebody told a joke at one end of the building, you’d hear laughter all along the hall. We were that packed in.

Just having all the faculty and students in one place in the NPBL has resulted in increased faculty-student interactions and improved mentoring. Now we have wet labs, a walk-in freezer, labs for GIS interpretation, limnology studies, and for bioassay work, a library and computer room, and study space for our graduate students. The move into these quarters has tied us together as a more cohesive unit. It has also been a major benefit in student recruitment. We have now room for both undergraduate and graduate students.

We went from one obsolete teaching laboratory with no preparation space in the old building to two excellent teaching laboratories and adequate preparation space in the NPBL. We

have been able to implement new laboratory exercises in all of our courses, using modern equipment students will encounter in their professional careers. These new teaching laboratories were especially important because our academic program is strongly based on providing courses that have major laboratory components.

The results have been significantly increased educational benefits and opportunities for our 200-plus undergraduate and 45-plus graduate students.

THE ONE LARGE AND TWO SMALL lecture classrooms in the NPBL receive heavy usage by all teaching programs in the building and by other departments across campus.

Fortunately, the relationship between teaching and research in our department is seamless; many research projects spill over into the teaching labs, especially during summer.

Naturally, much of our research is conducted in the field; the land and water of the state are where we obtain samples and information. However, we needed laboratories totally dedicated to research to be more effective in developing and analyzing data. The new facilities have also allowed us to conduct research that we were unable to even contemplate before.

Until NPBL construction we had two primary research thrusts, wildlife-fisheries-agriculture interactions and wetlands research. With the NPBL we have added a third: biostress research. Many of our projects address more than one of our primary research thrusts; they tend to interact with each other just as drought, CRP vegetation, and pheasants do.

FOLLOWING ARE JUST A FEW of our recent research projects that were greatly enhanced by the availability of research laboratories in the new building.

Les Flake conducted research on the introduction of eastern wild turkeys in northeastern South Dakota. The research was funded by the South Dakota Agricultural Experiment Station, South Dakota Game, Fish & Parks, and the National Wild Turkey Federation. That work went far in determining the suitability of the eastern turkey subspecies compared to existing populations of the Rio Grande subspecies.

Dan Hubbard, with funding from the USDA and the U.S. Environmental Protection Agency, studied the impacts of agricultural management systems on the wildlife values of altered and unaltered wetland areas. Bird abundance and richness were greater on organic and transitional-no-till farming areas than in conventionally-farmed areas.

Jon Jenks conducted research on minimizing winter hay depredation by white-tailed deer. Funding came from the

South Dakota Agricultural Experiment Station and South Dakota Game, Fish & Parks. For reducing depredation, shelled corn was the preferred feed, followed by pelleted soy hulls and alfalfa.

Mike Brown, working with funding provided by South Dakota Game, Fish & Parks, evaluated chemical immersion as a marking technique on yellow perch. Oxytetracycline hydrochloride at concentrations of 600 to 700 ppm for 6 to 8 hours produced identifiable markings for at least 3 months.

Dave Willis completed a study on human, habitat, and biotic influences on panfish populations. This was a large study involving funding from the South Dakota Agricultural Experiment Station, South Dakota Game, Fish & Parks, the Minnesota Department of Natural Resources, and the Nebraska Game and Parks Commission. This study involved

“If the next 10 years are anything like the first 10, faculty, students, and the state citizenry will continue to receive multiple benefits from the NPBL and the concept it embodies.”

—CHARLES SCALET
HEAD, WILDLIFE AND FISHERIES SCIENCES

numerous fish species from a variety of locations and resulted in a greatly improved understanding of panfish population dynamics.

Service activities were also enhanced by the presence of the NPBL. It would be difficult to list all of the individuals and groups who have used the building for meetings, forums, and informational sessions. For example, the South Dakota Game, Fish & Parks Commission has had Commission meetings in the building.

We continue to expect the NPBL to enhance the teaching, research, and service activities of our department and other campus programs. If the next 10 years are anything like the first 10, faculty, students, and the state citizenry will continue to receive multiple benefits from the NPBL and the concept it embodies. Many challenges still await us, but the NPBL is a gift that keeps giving. ♦

A variable environment



NELS H. TROELSTRUP, JR.
Department of Biology/Microbiology

The Northern Plains Biostress Laboratory became a reality just as I began my career at South Dakota State University.

As a new assistant professor and director of the Oak Lake Field Station (in northeast Brookings County), I could see that the mission of the NPBL extended beyond the brick boundaries of a building.

Knowing what we have. We live in a variable environment. SDSU biostress research has documented the effects of drought and flood, extreme cold and extreme heat, pest outbreaks, and pollution episodes.

Studies conducted since the inauguration of the NPBL have helped us to better define our prairie environment and have provided the means to define what is “normal” vs. what is “not normal.” Resource managers use these measures of normality to evaluate change in our resources over time. Knowing where we are now and where we are headed allows us to plan and manage for the future.

We have made additional progress in cataloging our prairie species, thus far poorly described within our state. Several species considered rare, threatened, or endangered in states around us have been found in relatively healthy populations within South Dakota. This inventory of natural resources and our improved understanding of resource dynamics have allowed development and testing of monitoring and assessment programs to evaluate changes in our prairie environment.

Diagnosing the health of our systems. In any given summer, crops, livestock, and wildlife may contend with drought, high temperatures, poor water quality, and pest

populations, all at the same time. We must understand the individual and cumulative effects of multiple stressors before we can assess advantages of certain management alternatives.

Biological research has helped us trace aquatic biotic signatures back to specific stressors at the whole organism and community levels. These signatures provide “fingerprints” which might be used to evaluate other water bodies.

“Successful natural resource management requires active participation by people from many different walks of life... These partnerships display the true spirit of land-grant university ideals”

—NELS H. TROELSTRUP, JR.
DEPARTMENT OF BIOLOGY/MICROBIOLOGY

The sophistication of our natural resource monitoring continues to improve. Fecal coliform bacteria in surface waters indicate the presence of fecal contamination and raise the probability of animals and humans contracting a water-borne infectious disease.

DNA sequencing and antibiotic resistance procedures are now being developed to identify, with high probability, the



animals that contribute these bacteria to surface waters. Management practices then can be targeted to reduce these sources of contamination and in turn reduce health risks for livestock, wildlife, and people.

Associations of plants and animals living together can tell us much about the health of our environment. Healthy environments normally harbor many species of plants and animals. Their abundance is balanced and relatively stable. Biostress scientists are defining characteristics of these associations. The information then will assist the diagnosis of stressed biological systems.

Remote sensing and geographic information system technologies allow us to examine the spatial patterns and relationships of plants and animals. These tools have been combined with efforts to define landscape areas likely to experience severe erosion or soil nutrient loss.

These models, combined with field sampling, have helped us identify critically disturbed watershed areas. In turn, they become the focus for voluntary best management practices designed to keep farm nutrients and soil in place, improve water quality, and reduce stress to aquatic communities.

Moving toward the future. Successful natural resource management requires participation by people from many different walks of life who are united in a common goal. Biostress research cultures these partnerships and facilitates collaborative efforts to resolve natural resource problems throughout the state.

Within the area of water resources alone, successful partnerships have been established between private landowners, federal and state agencies, local conservation districts, and South Dakota State University to define critical land management areas and best management practices to improve and sustain watersheds and their inhabitants.

These partnerships display the true spirit of land-grant university ideals: Private landowners benefit from these relationships through cost-sharing and implementation of projects which improve the value of their own property. Scientists benefit through collection of data, greater understanding of South Dakota natural resources, and personal advances within their respective scientific disciplines. Resource managers and the South Dakota public benefit from conservation of natural resources.

Additional efforts might enhance these partnerships by dissolving old disciplinary barriers. For example, a new partnership between the departments of Civil Engineering, Ag Systems Engineering, and Biology at SDSU has led to an academic emphasis in environmental engineering, in which biologists team up with engineers to study and resolve natural resource problems.

Many of our research efforts are designed to define the current state and trends in natural resource condition. Our ability to monitor crops, livestock, and natural resources and to detect problems before they become unmanageable is key to better resource management.

It is sometimes difficult to place a value on such work because it is preventative. We must weigh costs of conducting these efforts and the information they provide against the potential cost of lost income, cleanup, or damage control that might be borne by society in the absence of such information. As many of our research efforts are funded by public dollars and conducted within public institutions that interact with other public agencies, we have a responsibility to communicate the value of and the results from our work. We recognize we contribute to society, no matter how indirectly.

The NPBL has already added greatly to our understanding of northern prairie environments and sustainable resource management. ♦

'We've changed our whole farming picture'

Thunder rumbles above Scalp Mountain, on the west side of the Missouri River where Tom Varilek runs cattle.

But on the east side of the river, 8 miles away as the crow flies, there's bright sunshine in the level field where Varilek is inspecting the alfalfa he's cut for hay. It's ready to be baled and moved off the land so that he can start irrigating for the next cutting.

Some 10,000 feet of pipe bring water up from the Missouri River for three irrigation pivots to water corn, soybeans, alfalfa, and sometimes wheat on Varilek land in Charles Mix County. It's one of the ways the family has made the geography of central South Dakota work for them in this place a few miles upstream from the Ft. Randall Dam. Just about every neighboring farm is also a diverse operation that includes livestock and a range of crops.

"Dad got the very first irrigation permit to irrigate with water from behind that dam. That was in about 1955," Varilek said.

But livestock is Varilek's main enterprise. The family raises registered Angus cattle and holds a bull sale every spring.

VARILEK BELIEVES ONE PRACTICE the family has always followed has helped make farming and ranching a success.

"My dad was always a great experimenter. We'd try anything and everything," Varilek recalled. "We even tried spraying cows with airplanes. We tried using very low rates of malathion, something like 6 ounces to the acre, spraying flies. We even had some people down from Canada looking the project over.

"It was wild. We'd have to go get the horses and get the cows in a bunch and get them moving the same direction as the airplane was going."

There have been crop and insect control test plots through the years on the Varilek farm. Tom can remember crawling through the corn patch on his knees with children from the area looking for fallen ears of corn in a rootworm test plot for Ben Kantack, former SDSU entomologist.

BEHIND MANY OF THOSE EXPERIMENTS stands South Dakota State University, which carries out original and applied research to help farmers know what works and what doesn't in their differing soils and conditions.

Varilek is enough of a believer in the power of science that he currently serves as the Colleges of Agriculture, Research, Extension and Teaching (CARET) representative for South Dakota State University.

"Science," he explained, "adds some stability to a world where weather and markets are inconstant.

"Our average is about 20 inches of precipitation here, but we're always about 2 weeks from a drought or being too wet. Our soils in most cases are somewhat light here so we don't hold all the water we should," Varilek said.

"Since we've gone to minimum-till and no-till techniques, we're raising crops that we used to not be able to grow here because we didn't think we had enough moisture. With technology we've changed our whole farming picture.

"You could hardly find a soybean around here 15 or 20 years ago, now there's lots of soybeans grown here. We're also growing corn hybrids that are more drought-tolerant than they used to be."

**"Science adds some stability
to a world where weather
and market are inconstant."**

—TOM VARILEK,
CENTRAL SOUTH DAKOTA FARMER/RANCHER

ADAPTING TO NEW MARKETS by growing new, improved crops is the unspoken message in Varilek's line-up of crops. Conspicuously absent from his fields are grain sorghum and oats, two very common crops in Charles Mix County in past decades.

SDSU scientists have helped farmers make the transition to more profitable corn and soybeans by doing the experiments to show what tools and techniques work in South Dakota's varying soils and conditions. That's implicitly the principle behind the Northern Plains Biostress Laboratory, Varilek noted.

"We've also become quite a cash hay-producing area. We ship a lot of hay out of here. We sent hay to Illinois and Indiana out of this area in May. It used to be we didn't cut any hay until after Memorial Day," Varilek said.

"I talked to a guy from Wisconsin who says he can get by with less hay from here than if he raises it at home. They raise a lot of hay out there, but it's never the quality that we can get."



Tom Varilke, Geddes

YET THE CHANGES IN AGRICULTURE bring trade-offs.

Growing alfalfa as a cash crop has made the alfalfa weevil a more important pest to some growers. Information from SDSU entomologists and Extension educators alerts growers when the pests are showing up in their area and reminds them of the economic threshold at which they ought to take action. Ongoing research demonstrates what kinds of herbicides and pesticides are most effective in South Dakota and what rates give the best results.

Similarly, Varilek noted that the switch away from grain sorghum may have reduced some habitat for pheasants, which thrived in sorghum fields—especially when herbicides were less sophisticated, not controlling weeds as well as they do now.

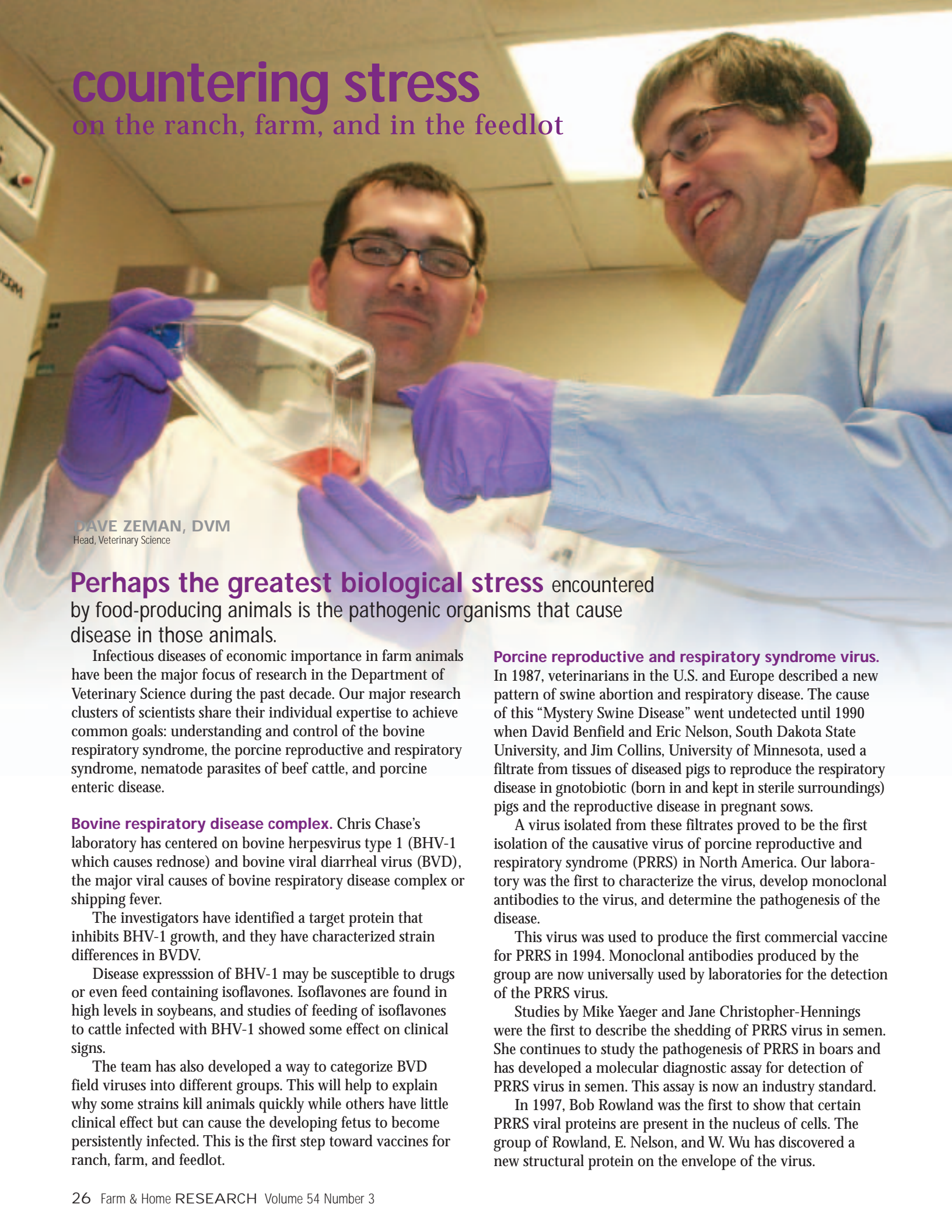
A healthy pheasant population attracts hunters, which are an important contributor to the state's tourism economy.

Towns such as nearby Geddes have been affected by the changes in agriculture. Once a major shipping point for oats destined to other markets when it was a town of about 1,200 people, Geddes now has fewer than 300. There's no longer a railroad servicing it.

Varilek believes SDSU needs to continue to play a role in the future by helping farmers adapt to new technologies and markets and by assessing the impacts of those changes on wildlife and the environment. And ultimately, he believes, SDSU can help South Dakotans manage change by providing unbiased, science-based information. ♦

countering stress

on the ranch, farm, and in the feedlot



DAVE ZEMAN, DVM
Head, Veterinary Science

Perhaps the greatest biological stress encountered by food-producing animals is the pathogenic organisms that cause disease in those animals.

Infectious diseases of economic importance in farm animals have been the major focus of research in the Department of Veterinary Science during the past decade. Our major research clusters of scientists share their individual expertise to achieve common goals: understanding and control of the bovine respiratory syndrome, the porcine reproductive and respiratory syndrome, nematode parasites of beef cattle, and porcine enteric disease.

Bovine respiratory disease complex. Chris Chase's laboratory has centered on bovine herpesvirus type 1 (BHV-1 which causes rednose) and bovine viral diarrheal virus (BVD), the major viral causes of bovine respiratory disease complex or shipping fever.

The investigators have identified a target protein that inhibits BHV-1 growth, and they have characterized strain differences in BVDV.

Disease expression of BHV-1 may be susceptible to drugs or even feed containing isoflavones. Isoflavones are found in high levels in soybeans, and studies of feeding of isoflavones to cattle infected with BHV-1 showed some effect on clinical signs.

The team has also developed a way to categorize BVD field viruses into different groups. This will help to explain why some strains kill animals quickly while others have little clinical effect but can cause the developing fetus to become persistently infected. This is the first step toward vaccines for ranch, farm, and feedlot.

Porcine reproductive and respiratory syndrome virus.

In 1987, veterinarians in the U.S. and Europe described a new pattern of swine abortion and respiratory disease. The cause of this "Mystery Swine Disease" went undetected until 1990 when David Benfield and Eric Nelson, South Dakota State University, and Jim Collins, University of Minnesota, used a filtrate from tissues of diseased pigs to reproduce the respiratory disease in gnotobiotic (born in and kept in sterile surroundings) pigs and the reproductive disease in pregnant sows.

A virus isolated from these filtrates proved to be the first isolation of the causative virus of porcine reproductive and respiratory syndrome (PRRS) in North America. Our laboratory was the first to characterize the virus, develop monoclonal antibodies to the virus, and determine the pathogenesis of the disease.

This virus was used to produce the first commercial vaccine for PRRS in 1994. Monoclonal antibodies produced by the group are now universally used by laboratories for the detection of the PRRS virus.

Studies by Mike Yaeger and Jane Christopher-Hennings were the first to describe the shedding of PRRS virus in semen. She continues to study the pathogenesis of PRRS in boars and has developed a molecular diagnostic assay for detection of PRRS virus in semen. This assay is now an industry standard.

In 1997, Bob Rowland was the first to show that certain PRRS viral proteins are present in the nucleus of cells. The group of Rowland, E. Nelson, and W. Wu has discovered a new structural protein on the envelope of the virus.

From 1990 to 2002, the South Dakota team was one of the most recognized and competitive research teams studying the PRRS virus, garnering more than \$700,000 in extramural funding and publishing over 20 papers in refereed journals. Reagents, assays, and mechanisms produced and published by this group are still widely used by scientists and diagnostic laboratories throughout the world.

Recently, the National Pork Board and USDA have targeted PRRS for elimination. Thus, the next several years of PRRS research will focus on new diagnostic technologies and new vaccines, mechanisms of transmission, and herd biosecurity protocols. Our laboratory will continue to be a leader in this field.

Parasite issues in South Dakota beef production. The central objective of Bill Epperson and Mike Hildreth has been to provide South Dakota beef producers information about cost and control of cattle nematodes (worms).

In a 1992 survey, they found 92% of South Dakota calves shedding nematode eggs at the end of the summer grazing season. Yet the impact of nematodes on production was unknown.

These investigators designed a novel method to measure losses from nematodes. Unlike other scientists, the investigators used a single pasture system—more relevant to commercial ranching situations.

Between 1997 and 2001, and using yearlings as the target animal under typical South Dakota grazing conditions at 16 sites in eastern and central South Dakota, they determined that naturally occurring nematodes decreased weight gain by a mean of 0.11 lb/head/grazing day over control animals. Diminished gain varied from 0 to 0.18 lb/head/grazing day.

This suggests that nematodes may decrease production of grazing yearlings by 6 million pounds per year in the study region. Preliminary work further suggests that the impact of nematodes is similar in nursing calves, an additional potential loss of around 14 million pounds.

Application of long-acting deworming products at the start of the grazing season (spring or strategic deworming) has been shown to reduce parasite loads in grazing cattle. However, their utility in the South Dakota environment has been questioned. Under commercial conditions in the Northern Plains the key in determining the effectiveness of strategic deworming is the length of time the overwintered nematode juveniles are able to survive on pasture in the spring and subsequently infect grazing cattle.

Hildreth and Epperson worked out a way to measure the rate at which nematode juveniles die during a typical South Dakota spring. They installed young cattle to act as “sentinels” in a pasture “seeded” with a uniform level of nematode eggs the previous summer. The level of infection in the susceptible cattle was decreased by 67% every 2 weeks, indicating a rapid die-off of overwintered nematode larva.

This indicates that the application of modern dewormers to cattle at June 1 spring turnout would be expected to

decrease initial nematode infections by 88% and would likely capture the majority of the calculated nematode losses.

They are now identifying environmental variables that may be associated with cattle nematode survival in South Dakota, relating nematode infections to climatic variables, land use, land cover, and observations made by satellite. Prediction of nematode infection might be possible.

Their eventual goal is to develop a mathematical model that will aid producers in estimating losses based upon local climate, animal management, and vegetation cover of their own pastures.

Enterotoxigenic *E. coli* diarrhea in young pigs. *E. coli* bacteria are a major cause of diarrheal disease in neonatal and recently weaned pigs. These organisms produce hair-like structures called fimbriae or pili on their surfaces, by which they adhere to and colonize the intestinal epithelium and cause disease. The most common strains produce a fimbriae called K88 (also known as F4). Preventing that disease has been a long-term goal of David Francis and Alan Erickson.

In the early 1990s they showed that up to about half of domestic swine produced intestinal epithelial cells to which K88 fimbriae avidly adhered. The animals passed the characteristic on to their offspring. The scientists traced down the molecules responsible for this adherence and showed that only pigs able to synthesize the molecules were susceptible to infection by K88-producing *E. coli*.

The molecules to which K88 fimbriae adhered contained both protein and carbohydrate structures and were similar in design to mucus. Unlike mucus, however, they were firmly

“Our major research clusters of scientists share their individual expertise for common goals.”

—DAVE ZEMAN, DVM
HEAD, VETERINARY SCIENCE

attached to the surface of the epithelial cells in which they were synthesized.

Subsequent investigations have revealed that pigs produce a variety of molecules to which different variants of the K88 fimbriae attach. These molecules may contain either protein or lipid, but always contain carbohydrate. It is to certain sugars that are a part of the molecule’s carbohydrate structure that the K88 fimbriae attach.

The scientists now are seeking the pig genes responsible for attachment of K88 fimbriae and thus disease susceptibility.

The large body of knowledge created in recent years regarding the molecules utilized by K88 fimbriae to attach to pig intestines has been the subject of several recent reviews in international journals, each of which focused largely on knowledge brought to light by research conducted in the Department of Veterinary Science at South Dakota State University.◆



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