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Farm and Home Research: 53-1

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WATER QUALITY
affects cattle and ranchers' profits

SAFE TO EAT
transgenic corn and soybeans

RAISING
dairy replacement heifers

114th Annual Report

In this issue

Farm & Home RESEARCH
South Dakota State University · College of Agriculture & Biological Sciences · Agricultural Experiment Station
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On the cover:

Don Evenson, distinguished professor of biochemistry, and Denise Brake, graduate student and Evenson's research assistant, report that they found no dangers to heath from eating food products made from Bt corn and glyphosate-tolerant soybeans.

Photo by University photographer Eric Landwehr.

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Director's comments

BY KEVIN KEPHART
Director, South Dakota Agricultural Experiment Station

Kevin Kephart

This annual report highlights the

variety & vitality

of our scientists and their work

Anytime you bring together about 125 scientists as diverse in their specialties and interests as South Dakota itself you will have a full plate of research efforts.

That's true as well for the numerous locations of the South Dakota Agricultural Experiment Station (SDAES). Much of our research is conducted across the state at field stations that reflect local conditions. Other research pulls in local cooperators who share the work and its benefits. And, of course, some research is accomplished in our laboratories and livestock units at SDSU. This annual report was written to specifically highlight the diversity of agricultural research at SDSU.

All our projects fit the mission of the SDAES to enhance quality of life for all South Dakotans through the beneficial use and development of economic, human, and natural resources. Our projects also meet the five goals set collaboratively by the USDA and state experiment station and Extension directors. Our contributions to these five goals and a safe and productive agriculture are varied and vital.

Greater harmony between agriculture and the environment
I visited Harding and Perkins counties in April. It became pretty clear to me that a significant drought is in the making for the 2002 growing season. As in years past, water quality will undoubtedly be a concern for ranchers throughout West River. While there is plenty of information relating water quality to livestock mortality, this project takes that work a step farther by determining the consequences of poor quality water on animal performance.

A safe and secure food and fiber system
Although transgenic crops (so called GMOs) currently planted in South Dakota have been approved for human consumption by the FDA, many people are concerned with the safety of food products from these crops. Because South Dakota soybean and corn producers lead the nation in adoption of transgenic crops and because consumer reactions across the globe could negatively affect exports and farmer profits, the state Legislature requested that AES conduct independent research on food safety, trait movement, and other aspects of these crops. One of these projects is now completed and reported here.

Enhanced economic opportunity and quality of life for Americans
AES scientists and specialists in the South Dakota Cooperative Extension Service are working to expand the dairy industry in South Dakota. Availability of high quality replacement heifers will be an essential part of this expansion, and raising these animals until they're ready to enter production herds is an opportunity for producers.

A healthy well-nourished population
I'm very pleased with the collaboration of some AES scientists and American Indian peoples in a "partnership project." Students from SDSU and the Sisseton Wahpeton Community College will work side by side with scientists and elders to discover how traditional foods are still used by rural American Indians and to determine the nutritive and medicinal value of native plants used in these foods.

An agricultural system highly competitive in the global market
A research program that applies the tools of modern biotechnology to improve the genetic potential of our beef herds is starting up. This effort to develop genetic markers will lead to identification of superior individuals in beef breeding programs.

The benefits of our research become available to you at speeds as varied as the projects themselves. Some results of the projects I've listed here are immediately available to you; others, such as the gene marker project, will probably require outside marketing assistance before coming to your beef operation. We are supported in our research by our state and federal governments and by many different outside grants. Thank you to all our partners for helping us to meet our mission and goals in these challenging times. ◆

Cattle are wh

BY LANCE NIXON

at they drink

an SDSU team is preparing 'hard numbers' for ranchers to use in assessing water quality

When cattle on a West River ranch died for no apparent reason a few years ago, South Dakota Cooperative Extension Service workers tested for disease and searched for toxic plants before zeroing in on a more likely cause: water.

As Pat Johnson, SDSU range science professor, tells it, that first puzzle led the Extension Service and the South Dakota Agricultural Experiment Station to team up on a study of how water quality affects cattle—and ranchers' profits. Johnson is project director for the study.

"We know we can kill cattle if we give them really poor quality water to drink. But we don't know enough about how sub-lethal water affects them," Johnson said. "What we're trying to do is find out if there is any impact on animal weight gain or animal health, and most importantly, any overall economic impact when you add it up."

Data collected so far indicate that cattle may drink less if water is high in total dissolved solids, though scientists don't know if that's because of the taste, the smell, or perhaps because the water affects them physically in some way. And it's not always clear which poses the greater problems for livestock—total dissolved solids or specific compounds such as sulfates.

Current guidelines show levels of total dissolved solids and other compounds in livestock drinking water that can cause production and/or health problems in livestock. The SDSU study, however, indicates that problems may arise at lower levels than the guidelines suggest.

"When we're done at the end of this year, we'll be able to give producers a range of situations where we saw problems," Johnson said. "My guess is that this study is going to lead to additional studies to pinpoint what that level or threshold is."

Merrill Karlen Jr. of Reliance, president of the South Dakota Cattlemen's Association, is one rancher who understands the value of the project. Poor water quality is a leading concern of cattle producers, he said.

"It's a big issue. Water is the number-one nutrient in an animal's diet, and we have a lot of variation in water quality in the western part of the state—really, across all of South Dakota," Karlen said. "Having useful information about water quality would give producers hard numbers to help decide what water source to use."

Johnson said the goal of the study is to obtain the data so that ranchers can judge for themselves whether it is cost-effective to provide alternative water supplies. Every ranch will have a different set of circumstances, and those with poor water may find it necessary to connect to rural water systems, drill new wells, or perhaps use management techniques such as grazing some pastures early in the year when water quality is better, for example.

In addition, Johnson said, the study may be one factor in helping ranchers

a study of how water quality affects cattle—and ranchers' profits.

and landowners determine fair pasture rent. Pastures with good quality water supplies should be able to command a better price.

A segment of the water quality study looks at the flip side of the coin—how cattle in calving pastures affect water quality. This knowledge will prove vitally important, Johnson said, if federal or state water quality rules on concentrated animal feeding operations are ever expanded to include calving pastures—and some people in the cattle industry believe this could happen.

From pastures with a live stream running through or bordering them, the scientists measure fecal coliform bacteria where the stream enters the pasture and where it leaves to determine how much bacteria the livestock in that pasture contribute to the water. Samples are taken every 2 weeks from about February until mid-May, with additional samples taken whenever there is a major runoff event such as a rain or snowmelt.

The pastures contribute a large range of fecal coliform bacteria to streams, Johnson said. At one site the measurement was actually lower where the stream exited the pasture than where it came in.

Butte County Extension Educator Bart Krautschun, who is helping gather data about stream quality, said part of the value of the study may be information that could help producers prove they're not polluting streams. Or the study may point producers to management techniques to protect stream quality. In either case, it may make it easier to get along with stringent water quality regulations that some livestock producers believe the future may hold.

"Producers are interested in this," Krautschun said. "This is going to be information they need to keep from being put out of business."

The scientists are using the Cottonwood and Antelope Range livestock research stations in western South Dakota to track how cattle in a pasture setting compare when given good and poor quality water.

Some are given water from a rural water system that has about 1,000 parts per million total dissolved solids, while others are given water drawn from a nearby stockdam that has about 7,500 parts per million total dissolved solids.

The data so far suggest pastured steers on good quality water gain about two-tenths pound per day more than those on the poorer water, Johnson said. That works out to about 1.85 pounds per head average daily gain on rural water compared to 1.66 pounds for those on the poorer quality water.

None of the animals in the pastures sickened, no matter the quality of the water. But Johnson added that it's impossible to control all variables in a pasture setting, and the cattle may have had access to better water when occasional rains replenished pasture potholes.

Meanwhile, calves raised in a feedlot setting to weights of about 800 pounds performed noticeably better if they had access to rural water, the best quality water in the study.

Trey Patterson, Extension beef specialist at SDSU's West River Ag Center in Rapid City, said data show that calves on rural water drank more, ate more, and gained more than calves on three other treatments. The best quality water in his study had about 1,000 parts per million total dissolved solids. The worst had near 7,000 parts per million total dissolved solids. The calves were being backgrounded to develop their frames before being shipped to the Southeast Experiment Farm near Beresford for finishing.

Patterson said calves on rural water drank 13.25 gallons of water a day compared to about 11.5 gallons for calves on other treatments where water quality was not as good. The calves on rural water ate 17.5 pounds of dry matter a day, compared to about 16.5 pounds dry matter for calves on other treatments.

Though the calves weighed the same at the start of backgrounding, off-weights were considerably better for the calves on rural water—815 pounds compared to 785 pounds.

So, said Patterson, calves on rural water gained 1.38 pounds a day, compared to about 1.02 and 1.03 pounds for the calves on other treatments.

What risks do ranchers run when they provide poor quality water? Will giving up two- or three-tenths of a pound daily gain eventually catch up with the producer? Patterson asked ranchers these questions at last fall's range station field days.

There can be obvious health issues. No animals got sick or died on the rural water treatments in the feedlot settings, he said. Some animals on poorer quality water did get sick or die of polioencephalomalacia.

Bart Krautschun, Extension educator, takes water samples from a pasture stream. His Butte County Extension office can perform tests for total dissolved solids for ranchers concerned about water quality.

Polioencephalomalacia, simply known as cattle polio to the feedlot industry, is a disease created by sulfur toxicity. It is characterized by symptoms such as blindness, disorientation and wandering, and retraction of the head. Scientists also know that sulfur interferes with thiamin use, perhaps by destroying thiamin in the rumen. Veterinarians can treat polioencephalomalacia with thiamin, and most cattle will recover in a few days if treatment begins soon after clinical signs are expressed.

In addition, Patterson said, high sulfur intake can tie up copper, causing a copper deficiency in livestock. If molybdenum is in the diet, the problem becomes worse. Molybdenum, sulfur, and copper combine to form an insoluble complex that livestock can't utilize. Some molybdenum was present in the hay fed to calves in the feedlot study.

Patterson said livestock diseases or deficiencies linked to sulfur are worrisome because sulfates make up as much as 70% of the total dissolved solids in some water supplies in western South Dakota where total dissolved solids are high.

Calves from the feedlot at the Cottonwood station were shipped to the Southeast Research Farm near Beresford at about 800 pounds for finishing to a weight of about 1,300 pounds. At Beresford, all animals were provided with good quality water until they were marketed in early February.

The scientists are still analyzing the Beresford data before drawing firm conclusions about whether poor quality water at early growth stages will affect finishing performance and carcass quality.

Patterson stressed there is no way to tell simply by looking at water whether it is high in sulfates or total dissolved solids. The only sure way, he said, is for producers to have a sample analyzed.

"You've got to have it tested. You're playing Russian roulette otherwise," Patterson said.

Beef specialists recommend ranchers concerned about water quality bring a sample in a clean jar or bottle to the local Extension office. Most Extension offices are equipped with meters to do the electroconductivity tests that provide an indication of total dissolved solids. Labs at SDSU can perform more extensive tests if ranchers and Extension personnel believe they are warranted.

The pasture and feedlot studies will be repeated in 2002.◆

Members of the SDSU water quality team who have participated in different phases of the project are (Agricultural Experiment Station) Pat Johnson, range scientist, West River Ag Center, Rapid City; Ron Haigh, livestock superintendent, Cottonwood Range and Livestock Field Station; Doug Young, research technician, Antelope Livestock and Range Field Station; Lan Xu, research associate, Animal and Range Sciences Department, SDSU; (Cooperative Extension Service) Trey Patterson, beef specialist, and Dan Oedekoven, area management specialist in economics, West River Ag Center, Rapid City; Bill Epperson, DVM, Veterinary Science Department, SDSU; Julie Walker, area beef specialist, Fort Pierre; John Kangas, Extension educator, Haakon County; Bart Krautschun, Extension educator, Butte County; and Robin Salverson, Extension educator, Harding County. Also on the team are Marty Beutler, director, West River Ag Center, Rapid City, and Dave German, research associate, SDSU Water Resources Institute, Brookings.

Study finds foods from Bt corn and glyphosate-tolerant soybeans pose

no dangers to health

BY MARY BRASHIER

Don Evenson, Distinguished Professor of Biochemistry

How to get a handle on biotechnology these days? When it comes to food, which claims about its safety are believable?

Take heart.

Consumers can turn to reliable, trustworthy sources of information—scientists in land-grant universities. Part of the SDSU land-grant system is the South Dakota Agricultural Experiment Station, SDAES, funded in large part with public funds and therefore directly answerable to citizens themselves.

Working on this issue in the SDAES, for example, are one particular scientist and his assistants in a roomful of mice and with sophisticated and proven equipment and methodology. A report is in preparation that citizens, through their representatives, asked for.

Don Evenson, Distinguished Professor of Biochemistry, and Denise Brake, graduate student, have collected the data at the request of the 2000 South Dakota Legislature. The question: Are there any dangers to human health from eating genetically modified foods? The answer: They looked really hard for possible damage from transgenic corn and soybeans but found none.

"Year 2000 was the peak of the hype about Monarch butterflies," Evenson said. "A lot of publicity was given to the finding that if they ate the pollen from *Bt* corn, they died."

Bt corn is a type of transgenic corn with an additional gene from the bacterium *Bacillus thuringiensis* that kills the European corn borer, a serious economic pest of corn in the U.S.

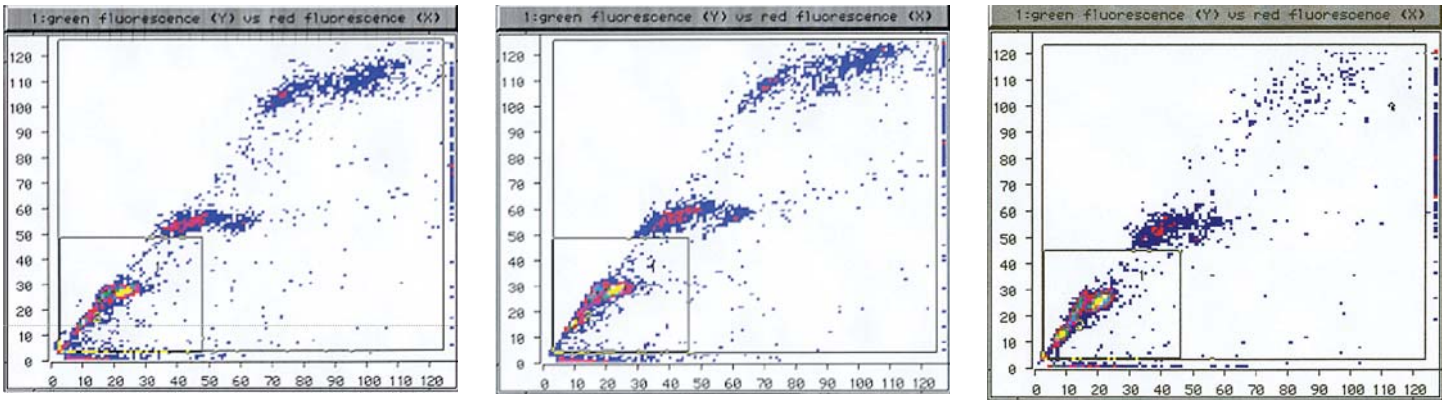
"It's been shown pretty reliably that the first science about the Monarchs was flawed," Evenson said. "But this is America's favorite butterfly, and if indeed it was affected by the biotechnology, as reports seemed to indicate at the time, what would the same biotechnology be doing to us?"

At the same time as the Monarch publicity surfaced, a reaction to foods from genetically modified crops was spreading across Europe and Japan and a U.S. food manufacturer announced it would drop baby foods prepared from transgenic crops. (A transgenic plant contains a gene transferred in by molecular biological techniques from an outside source. The new genetic material is introduced early in the plant's development, appears in all cells, and is heritable.)

In the midst of this furor, the South Dakota Legislature turned to SDSU, funding research in hopes it would settle the dust about human health and transgenics. At least 15 years of study and hundreds of experiments have established the Evenson team as an international authority in the effects of certain pollutants, environmental hazards, and other chemicals on the fertility of mice and other mammalian males.

The Legislature's concern was twofold: potential human health impacts on consumers and economic impacts on farmers. If the reports proved true, international markets for South Dakota-produced commodities—a heavy percentage of them transgenic—would surely dry up. About 47% of South Dakota corn acres were planted to transgenic corn and 80% of the state's

Denise Brake, graduate student, assistedin the collection of data showing that transgenic corn and soybeans in food products posed no health threats to consumers.



Cytograms of red and green fluorescence from testicular cells on mice of (left) a transgenic and (center) a non-transgenic soybean diet and (right) a group injected with hydroxyurea as a positive control, which shows, by disrupting cell growth, that the procedure works. There are no differences in the percentages of normal and damaged cell populations between mice fed the transgenic and non-transgenic diets.

soybean acres to transgenic soybean varieties in 2001.

Evenson's upbeat conclusions about the safety of current foods marketed from Bt corn and glyphosate-tolerant soybeans are based on studies of two of the most toxin-sensitive systems of the body. If any ill effects of eating foods from these transgenic crops were to show up, they would be found in those systems.

Glyphosate-tolerant soybeans contain an extra gene from a soil bacterium. The gene blocks the impact of glyphosate-containing herbicides, permitting normal cell growth to continue in the soybeans while weeds, unprotected by the gene, succumb to the herbicide.

Evenson and Brake fed groups of pregnant mice specially formulated diets containing the transgenic soybeans, Bt corn, and feed from conventional soybeans and corn. The idea was that fetal development, a time of rapid cell division and differentiation of organs and tissues, is a highly susceptible period in the lives of baby and mother.

"Pregnant women, you recall, have been urged for years not to use harmful products—alcohol, cigarettes, certain drugs—because of possible effects on the child," Evenson said. "That's the case with mammals in general."

When the mice born in the project, still on the same diets, were entering the puberty stage of development, the research team examined another mammalian organ system, one characterized by a high rate of cell division and a high level of differentiation in young animals: the mammalian testis.

"The bottom line is that we found no ill effects when our mice ate Bt corn and glyphosate-tolerant soybeans,"

–Don Evenson, Distinguished Professor of Biochemistry

So what happened to the mother mice and their pups in the experiment?

Nothing at all.

"The bottom line is that we found no ill effects when our mice ate Bt corn and glyphosate-tolerant soybeans," Evenson said. "Yes, we used mice. We would hardly run such tests on human subjects."

The scientists are continuing the experiments into the third generation of the mice. So far they are finding no long-term ill effects of the novel diets.

For roughly 400 pups born in the experiment and continuing to eat the same transgenic soybean diet that was fed their mothers, only the labels on the front of the cages distinguish the test and control groups from each other. Pups were delivered on time and were normal in behavior and weight. There were no differences in litter sizes, an important measurement because "had there been a change in litter size, that would have indicated an effect on the mother and spontaneous abortion or resorption of fetuses," Evenson said.

The performance of the mice impressed SDAES Director Kevin Kephart. "The charts look like they

fed the same diet to all the animals. This comes from good, solid research and should lay to rest any lingering concerns about the safety of eating products made from Bt corn and glyphosate-tolerant soybeans."

The graphics that picture flow cytometry measurements of testis development in the pubertal mice show this same overlapping of results. With the exception of the "positive control," the computer-generated figures could have been layered on top of each other.

The positive control simply shows that the assay works, by involving an agent known to disrupt cell growth. The significant difference lies in the upper right quadrant of the cytograms. If the transgenic foods had affected cell growth and division, those areas on the figures from the transgenic soybeans and the one from the positive control would have been more similar.

"We use the testis model system because it is one of the complex organs where development occurs on an exact timetable. This is an organ that is characterized by a very high rate of cell division, producing millions of cells per day in a complex and predictable pattern of differentiation. If there are aberrations, they're bound to show up."

Testes are surgically removed from mice of various ages, and the cells are separated from each other and exposed to an acid that has no effect on normal DNA. A fluorescent dye, added in the next step of the procedure, stains developing sperm. Then all cells are passed through a glass channel in a flow cytometer. A laser beam shining through the tube causes the dye bonded to the cellular DNA to fluoresce red and be detected and measured by the machine and its attached computer.

This is a modification of the sperm chromatin structure assay (SCSA) Evenson developed at SDSU and which is used around the world for molecular probing to reveal the genetic integrity of mammalian sperm. The SDSU group has conducted tests that show the extreme vulnerability of the mammalian testis to heat stress, fever, and toxicants. This work has brought the South Dakota scientists acclaim as the world's primary experts on the interactions of toxicology and fertility.

"We're quite comfortable that these kinds of transgenic soybeans and Bt corn cause no ill health in mice, and by extrapolation, humans."

–Don Evenson, Distinguished Professor of Biochemistry

Evenson repeats, "We're quite comfortable that these kinds of transgenic soybeans and Bt corn cause no ill health in mice, and by extrapolation, humans."

Yes, but there's that nagging question. Can mice be trusted to stand in for humans in so important an issue?

The first scientific paper on yellow mice appeared in 1886. Mice have substituted for humans in cancer research projects since 1894 and have served in diabetes and organ transplant breakthroughs since then. They are a majority of experimental mammals, and are valued especially in biomedical research where they serve as models of human beings. A very rough estimate of their numbers in labs around the country is at least 6 million a year.

Under Brake's care, the mice meet every standard of the SDSU committee on animal care. Their food is fresh, their water is clean. Mice like to burrow; their shavings litter lets them dig and hide. They are social; they are housed with up to four companions in a cage.

Outside of the fact that they fit more easily into cages, mice are remarkably similar in physiology and genetic makeup to humans. But then, said Evenson, so are most other living things.

"One thing that has come out of the plant and human genome projects is our greater than 90% similarity in genetic makeup to plants. And scientists say that 99% of human genes are similar to the genes of other animals. So it's just about 300 genes that make us humans instead of mice.

"So I'd say, based on that and much previous research, that yes, we can trust mice to stand in for us. In this particular study, they were unaffected by transgenic crops. This doesn't mean the end of all testing. We can't let our guard down. We must continue to monitor new products. However, this project accomplished what we set out to do: provide basic, hard science to answer the questions of the Legislature, farmers, and consumers of South Dakota."◆

Scientists say South Dakota is prime place for raising

dairy replacement heifers

by Marianne Stein

South Dakota may be the best place in the nation to raise dairy replacement heifers, according to a team of SDSU dairy specialists.

"Starting a dairy heifer business is an excellent opportunity for South Dakota farmers," says Arnold Hippen, dairy scientist at SDSU. South Dakota is an ideal place to raise heifers, primarily because of the excellent forage grown in the state.

"Forage is abundant, the quality is very high, and the price is low compared with other regions of the U.S.," Hippen says. In addition, at an average daily temperature of 40-60 degrees F., the climate is comfortable for the heifers.

"It costs about $1100 to $1200 over 2 years to raise a heifer, which currently sells for around $1800 to $2500, making the business very profitable," says David Schingoethe, professor and interim department head of dairy science at SDSU.

Most dairy farmers—around 80% of them, Hippen estimates—still raise their own heifers. But large dairy farms with more than 500 cows are specialized operations that concentrate only on milk production and leave the rearing of heifers to contractors. The general trend in the dairy industry, as everywhere else in agriculture, is toward larger, specialized units, so the need for heifer operations will be larger in the future, says Alvaro Garcia, Extension dairy specialist.

The number of dairy operations in South Dakota has declined dramatically over the past 15 years, while milk production has remained constant at around 1,600 million pounds per year. In 1988, South Dakota had 2,960 commercial dairy operations; in 1998, that number was down to 1,233. As of January 2002, there were 889 dairy farms in South Dakota.

During the same time period, the number of milk cows decreased from 146,000 head in 1987 to 98,000 in 2002. Milk production per cow has increased considerably, and production has been concentrated onto fewer, larger farms. For dairy farmers going out of the milking business, the opportunity to move into dairy heifer raising is appealing, especially since South Dakota is ideally suited for this segment of dairy production.

South Dakota dairy producers specializing in heifers are also raising animals from other states, even from as far away as the southwestern U.S.

It works this way, Schingoethe says: The price of alfalfa hay in, for example, Texas or California is twice as high as it is in South Dakota. Instead of transporting hay from South Dakota to the southwest, it is a lot more cost-effective to bring heifers here and then sell them back to southwest dairy operations after 2 years. Contract heifer raising for out-of-state producers is a flourishing business in South Dakota.

Hippen believes that anyone can start a heifer operation without large investments, but it is a particularly great opportunity for former dairy producers

Gordon Bleeker, Castlewood, tells Alvaro Garcia, (left) Extension dairy specialist, that he quit milking 4 years ago to raise only replacement heifers.

who already have the facilities to keep the heifers. "You don't need to have and maintain the milking equipment. And for one cow you can feed two to three heifers," Hippen points out.

Gordon Bleeker of Castlewood used to be a dairy farmer, but 4 years ago he switched to raising replacement heifers. He raises 800-1000 head at a time, and he grows most of the feed on his own land. He sends virtually all his heifers out of state.

"I sell 90% of my heifers to a dairy farmer in California, and the rest go to a farmer in Idaho. I have also sold heifers to New Mexico and to Mexico," Bleeker says. He has found that South Dakota heifers are hardy, partly due to the cold winter weather in the state. "If they can survive a South Dakota winter, they can handle anything," he says.

Comparing milk production to raising heifers, Bleeker finds that heifers allow a more flexible lifestyle.

"For a dairy farmer, the workday ends after the last milking at 11 p.m. I may work the same number of hours, but I can work when it suits me, and I have more time to be with my family," he says. He believes that freedom and flexibility are some of the greatest benefits of switching from regular dairy production to heifer raising.

Getting into the dairy heifer business is also an good opportunity for farmers who have raised beef cattle or dairy bull calves.

However, beef producers switching to dairy need to be aware that the feeding strategy is quite different, explains Ken Kalscheur, assistant professor of dairy science at SDSU. For dairy cattle, the goal is to build frame, and too much energy in the diet will negatively affect the development of the mammary glands. Beef cattle need a high-concentrate diet to ensure rapid weight gain; however, dairy cattle should not gain weight rapidly and need a diet that is high in forage and low in concentrate.

Dairy heifer growing is ideal for small producers, Hippen says.

And there are alternative ways to approach the business: initial purchase and buy back, contract feeding, or an individual method adapted to the farmer's operation, labor pool, and financial situation.

It is quite common that each heifer goes through two to three different managers, says Hippen. "Specialization actually can improve the product, save money, and help the farmer recapture his investment costs quicker."

Industry outlooks predict that heifer prices will stay high for some time. It is a simple matter of supply and demand, and the supply of dairy heifers can barely meet the demand at this time. "In South Dakota, we have a herd of 98,000 milking cows. Approximately 40,000 cows leave the herd every year, and we raise between 30,000 and 40,000 heifers per year, so we need them all in order to replace the cows and maintain the dairy herds.

"Basically, it is a matter of needing all the heifers we have born in South Dakota to provide replacements for our dairy herds," Hippen points out.

In fact, the need for dairy heifers is so great that some operations are trying out a new technique: implanting dairy embryos in beef cattle, in essence making the beef cow a surrogate mother for dairy calves. This may offer a short-term niche market for some beef producers. However, the technique is still very costly, and it is not likely to be widespread in commercial operations any time soon, Garcia explains.

SDSU will host a one-day tour and seminar for the regional chapter of the Professional Dairy Heifer Growers Association, tentatively scheduled for June 19, 2002. The focus of the tour will be dairy heifer operations in South Dakota, facilities, and management practices.◆

For more information about the tour or about starting and operating a heifer business, contact Dairy Extension Specialist Alvaro Garcia at 605-688-5488 or email Alvaro_Garcia@sdstate.edu

Collaborative SDSU-SWCC nutrition project enhances

community health

by Lance Nixon

Padu Krishnan, left, SDSU foods scientist, and Helen Chipman, coordinator for the South Dakota Cooperative Extension Service family nutrition program and the expanded food and nutrition education program, share principal-investigator responsibilites in the project.

A partnership between SDSU and Sisseton Wahpeton Community College (SWCC) could pave the way to a healthier diet for Sisseton-Wahpeton Dakota people—and improve cultural understanding between whites and American Indians in the process.

Helen Chipman, co-coordinator for the South Dakota Cooperative Extension Service family nutrition program and the expanded food and nutrition education program, said the project involves close cooperation between SDSU and the community college. Chipman and Padu Krishnan, SDSU foods scientist and co-coordinator, are working with Dedria Keeble, who oversees the project at SWCC.

The 2-year project, supported by a grant from USDA, contains three segments. The first is now being conducted:

- SWCC personnel are gathering diet records from residents of the Lake Traverse Reservation. The sample consists of 300 surveys.
- Lab studies at SDSU will determine the nutritional value of these foods. Krishnan also plans to include some 20 traditional foods still being used.
- Students from SWCC will take part in some activities at SDSU, while SDSU students will visit the community college. Chipman explains that those visits back and forth can give students from the community college more experience in using laboratory techniques and other research methods, while SDSU students will gain a better understanding of the tribal culture—the context necessary to understand information about diet.

At SDSU, graduate assistant Shelly Brandenburger is helping Chipman assemble and analyze the data.

Chipman explained, "There have been assumptions that people's food choices have changed in recent years—that people are not taking the time to choose a healthy diet, they feel they are too busy, or they lack the skills or knowledge to eat healthily. Also, there is the assumption that most readily available foods are not healthy."

Changes in the diet of the Sisseton-Wahpeton Dakota over recent decades could be a factor in the incidence of various diseases. The survey could help address that issue, she said.

"We know there are problems with diabetes, we know there are problems with other diseases. Diet is implicated, a lack of exercise is implicated." However, until the data is assembled, she added, the assumptions remain just guesses that may or may not be correct.

"We need to know what people are actually eating," Chipman said.

The surveys could show patterns of change. For example, Chipman said, there are strong indications that some traditional foods still eaten today are no longer prepared as they were originally. Young people in the tribe, for example,

often prefer a sweeter version of pemmican than the traditional recipe.

But the surveys also point to the persistence of some of those traditional foods.

"I found that a majority of people still eat deer and fish," said Karen Brown, a tribal member gathering the information. "A lot of young people don't know how to hunt and fish, but they want to. A few people are gathering wild and native plants for foods."

The survey also is revealing cultural differences in how people acquire food. Sharing of food, especially among family members, is an important part of the American Indian culture.

Keeble adds that while traditional American Indian foods are not necessarily staples, they still have a place in the diet of most families. "Most people eat these foods now as special-occasion foods," she said.

Traditional foods include things such as wild turnips, wild parsnips, various kinds of corn, and pemmican.

Dorothy Gill and Clara Eagle, two Sisseton-Wahpeton Dakota elders, are helping Chipman and her colleagues understand the role of some of those traditional foods by demonstrating how they were grown, harvested, preserved, and prepared.

If the techniques of food preparation have been lost in many tribal families, so has the knowledge of how to gather foods and even how to garden. Gill blames that partly on boarding schools, which took American Indian children out of their family circles. That made it harder to pass knowledge from generation to generation, she said.

Gill and Eagle have also worked with SDSU botanist Neil Reese to teach a course at SWCC about the uses of native plants.

Gill points out that a great deal already is known about some items that show up in the Dakota diet. For example, rose hips, known to be rich in ascorbic acid or vitamin C, were used in puddings and in tea by Sisseton-Wahpeton Dakotas. Such foods were dried for use in winter.

"The drying of foods was very important," Gill said. "That was how our families survived. We did not have the luxury of freezers or dehydrators."

Similarly, pemmican, made from dried meat and chokecherries or other fruits pounded together, seeds and all, was vitally important.

> "We are trying to get a happy marriage between information of historical significance and information of practical significance for nutrition..."
>
> PADU KRISHNAN, SDSU FOODS SCIENTIST

Krishnan said the Sisseton-Wahpeton version of pemmican could be one of the foods he will analyze in the SDSU Food Science Lab to determine its nutritional content. Pemmican was widely used but varied widely by tribe and region, with differing fruits, meats, and animal fat content.

Among the other foods that Krishnan thinks could be candidates for analysis are dried corn soup, flint corn soup, Juneberry pudding, mushroom barley soup, and Indian pudding made with

Dorothy Gill and Clara Eagle, two Sisseton-Wahpeton Dakota elders, are helping Chipman and her colleagues understand the role of some of those traditional foods by demonstrating how they were grown, harvested, preserved, and prepared.

Wild turnips are a traditional food for American Indians, eaten on special occasions. Krishnan will analyze them for nutritional content.

"The SDSU and Sisseton Wahpeton Community College collaboration is a really good thing. SWCC is working to benefit its community health through nutrition, and SDSU is helping them. SDSU benefits, too, by gaining a better understanding of another culture right within our own state."

HELEN CHIPMAN, EFNEP COORDINATOR

nannyberries. One Sisseton-Wahpeton version of wild rice soup may be worth looking at because it uses goose meat, not a common ingredient in other wild rice soups.

Krishnan said his work will depend partly on what foods Sisseton-Wahpeton people are using. He added that the nutritional content in a food can vary depending on what time of the year the plant or animal products in it were harvested—all factors that must be taken into consideration.

"We are trying to get a happy marriage between information of historical significance and information of practical significance for nutrition," Krishnan said.

Krishnan will determine the amount of protein, carbohydrates, minerals, fats, and selected vitamins in a serving of food.

"Some of these foods I know have not been analyzed," Krishnan said. "The whole idea of research is to get new information. That's where the fun is, in the hunt. It's almost like detective work, Sherlock Holmes work, tracking down unknowns."

Krishnan added that although food is viewed traditionally as the vehicle for nutrition, scientists can't dismiss the fact that some Dakota foods have therapeutic or medicinal properties.

Chipman said one of the benefits of the project may be simply in making young tribal members aware of the need for someone in their community to study food science and nutrition. A scholarship has been set aside for a tribal member who would pursue an education in dietary skills and nutrition, Gill added.

Krishnan finds that one of the most exciting parts of the project for him. It could be the gateway leading young American Indian students into a career in food science and nutrition.

"It's one thing to farm this work out to me and say, 'Here, do this.' It's another to use this as a teaching and learning experience," Krishnan said. "As the opportunity presents, we'll bring some students here, they'll spend the better part of a day here, they'll do what I do."

That will give students from SWCC a greater sense of ownership in the project, he explained. "This whole project is not about 'Let's measure and cook.' It's about people."

He added that the Lake Traverse area people—equipped with their own survey information and the scientific research that SDSU can help provide—will actually put the information to work. They will make their own decisions, Krishnan said, about taking any steps to improve their own diets.

Ultimately, Chipman agreed, the project is about community health.

"The SDSU and Sisseton Wahpeton Community College collaboration is a really good thing. SWCC is working to benefit its community health through nutrition, and SDSU is helping them. SDSU benefits, too, by gaining a better understanding of another culture within our own state."◆

Emilie Campbell, SDSU geneticist

Searching for gene markers, animal scientists are

'looking at efficiency'

by Lance Nixon

A beef producer buying calves to put on feed has no sure way of knowing one of the key factors that will affect his bottom line: How efficiently will those calves convert feed to meat?

Now, scientists at SDSU and the Antelope Range Livestock Station near Buffalo are beginning a study that could help producers answer that question.

Don Boggs, head of the Animal and Range Sciences Department at SDSU, says the long-term project will use calves from the Antelope station and the techniques of biotechnology to search for genetic markers tied to feed efficiency.

A genetic marker, in scientists' terms, is a physical location that can be identified on a chromosome. Markers can be specific genes, the functional units of heredity passed from parent to offspring, or more likely they can be segments of DNA that are not technically genes but simply DNA sequences. Since DNA segments that lie near each other on a chromosome tend to be inherited together, a marker can be used as an indirect way of tracking the inheritance pattern of a gene that has not yet been identified, but whose general location is known.

"A lot of universities are chasing markers for meat tenderness and marbling," Boggs says. "We are, as far as I know, one of the few that are looking at efficiency. It's an exciting project, one that we think will have a lot of impact for the industry down the road."

Emilie Campbell, SDSU geneticist who heads the project, agrees.

"What we really want to do is find a way to pick an animal that can convert feed to meat, feed to gain, growth, the most efficiently." Campbell says. "My goal is to have something that can be used as a selection tool. If it can't help a producer, there's no point in our doing it."

> ***"It's an exciting project, one that we think will have a lot of impact for the industry down the road."***
>
> DON BOGGS, HEAD OF THE ANIMAL AND RANGE SCIENCES DEPARTMENT AT SDSU

"Developing a test to determine what allele an animal has at that gene location would enable producers to select animals that are superior for feed efficiency."

EMILIE CAMPBELL,
SDSU GENETICIST

Most costs of raising cattle are associated with feed, and the efficiency with which cattle consume feed is expensive to measure because every animal's intake must be measured individually. SDSU has those monitoring facilities, a step in finding gene markers that indicate the presence of other genes that control feed efficiency.

Campbell says one reason universities are not doing more on gene markers for efficiency, even though such work holds obvious benefits for producers, is that feed efficiency is expensive to measure. It requires feeding every animal individually.

"There's been a lot of work on carcass traits and average daily gain, but I think feed efficiency is more important because your cost is associated with your feed. That's the major component of feedlot costs," Campbell says.

SDSU will be able to do the project by feeding the calves at its beef breeding unit north of Brookings, which has stalls where animals can be fed separately, Campbell says.

The calves born at the Antelope research station in the northwest corner of South Dakota will likely be kept at the station until they're about 7 months old—from the time they're born in about March until they're weaned in October. Then they'll be trucked to Brookings for monitoring of their individual feed efficiencies.

Four crossbred bulls have been picked for the project, and researchers plan to add a fifth as it matures. The bulls are Angus, Simmental, and Hereford crosses. About 100 calves from each bull will be monitored over a period of years, Campbell says.

"The idea of the cross-bred bulls is that they are heterozygous, they're different from each other. So each individual bull's offspring will segregate for the genes controlling feed efficiency," Campbell says.

Some genetic terms: An allele is one of the variant forms of a gene at a particular locus, or location, on a chromosome. Different alleles produce different inherited characteristics such as hair color or blood type. A heterozygote is an organism that carries two different alleles instead of two copies of the same allele.

"There will be offspring that are better than others. We want to identify superior offspring and the inferior offspring and find the genetic differences between them," Campbell says.

Livestock producers have always known that cattle vary for most economically important traits, but until scientists study the entire genome of an organism—its set of chromosomes, containing all its genes and associated DNA—it is impossible to pinpoint the location of specific genes and define what traits they carry.

That element of uncertainty has always made cattle breeding—and buying—an inexact business. But Campbell's research could remove some of the uncertainty about whether a given animal has the genetic make-up to convert feed to meat most efficiently.

Campbell explains that finding the markers is not the end of the project, because the markers in most cases are not the genes that carry the biological instructions to produce a hereditary result. Very often the markers are simply DNA segments that lie near a particular gene on a chromosome and so tend to be inherited along with that gene. Identifying the genes comes later.

"We'll use the next 5 years to collect data," Campbell says. "We'll be doing what's called 'genotyping,' determining which allele each animal has of each marker as we go. Then we have all the analysis and on top of that we have gene identification."

There is also a process of "fine mapping." This narrows the region where a trait is found and homes in on the DNA sequence that marks it.

"The genetic markers are kind of like markers along the road to your house, which is the gene. Without fine mapping, it is like saying your house is between Omaha and Fargo. Fine mapping narrows down the region containing the gene of interest," Campbell says.

"We want to find a way to pick an animal that can efficiently convert feed into meat. Once we have fine mapped the region, we are going to try to identify the actual gene which causes the effect on feed efficiency. Developing a test to determine what allele an animal has at that gene location would enable producers to select animals that are superior for feed efficiency."

As the genetic marker project gets under way, Campbell says there are some practical questions that need to be answered. One is simply how to fund the project, since some major cattle organizations by policy are limited to funding carcass-related research, not production-related studies.

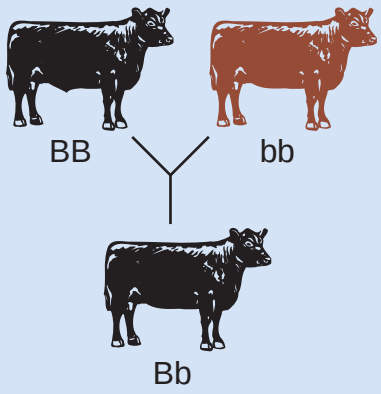
Perhaps an even more troublesome question, Campbell says, is the next step: delivering useful information about efficiency genes to the private sector in a way that allows producers to benefit. "Once you have the gene, you have to develop a test for that gene."

That may mean working with a private company to help develop and perhaps patent the testing procedures. The company would need to see a profit at the end of that process in order to make those investments, Campbell says, but she adds that cattle producers, too, stand to profit in the long run by being able to test for certain desirable and undesirable traits in animals they're buying or selling.◆

Hair Color

Allele B= Black hair (dominant trait)
Allele b= Red hair (recessive trait)

Two homozygous (two copies of the same allele) parents, one with black hair and the other with red hair...



will produce heterozygote (two copies of different allele) offspring. Although the offspring carry the trait for red hair, they will have black hair because it is the dominant trait.

Don Boggs, far right, head of the Animal and Range Sciences Department, explains the feed efficiency project at an Antelope Livestock and Range Field Station near Buffalo.

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AES Research Project Portfolio

Agricultural & Biosystems Engineering
H-018 Effects of process parameters on melt/flow/structure characteristics of cheeses at high temperatures; Muthukumarappan, Mistry, Julson
H-020 Synergistic effects of bacteriocins combined with ozone or irradiation; Julson, Muthukumarappan, Henning, Dave, Pitts, Wulf
G-041 Effect of calcium on functional and structural properties of mozzarella cheese; Muthukumarappan
H-091 Enhancing the value of South Dakota agriculturally based materials; Julson, Muthukumarappan, Henning, West
H-119 Swine and dairy facility design for odor reduction; Hellickson, Pohl, Thaler
R-130 Improvement of thermal and alternative processes for foods; Muthukumarappan, Julson, Krishnan, Wang
H-141 Enhancing post-frame building design for reduced environmental impact, increased structural integrity, and energy efficiency; Anderson, Schippull
H-229 Impact of climate and soils on crop selection and management; Bender
H-307 Management of irrigation technology and water to minimize negative environmental impacts; Trooien
H-317 Adaptation of emerging technologies to upper Great Plains agriculture; Humburg

Animal & Range Sciences
H-027 Hormonal influences on swine growth, reproduction, and carcass characteristics; Clapper
H-037 Increased efficiency of sheep production; Daniels
H-047 Improving reproductive efficiency of beef cattle; Miller
H-050 Water quality and beef production; P. Johnson, J. Johnson, Walker, Beutler, Oedekoven, Epperson
H-087 Production systems to reduce cost of production and improve reproductive performance of beef cows; Pruitt
H-131 Factors affecting nutrient utilization and excretion by growing swine; Stein
H-149 Genetic and environmental factors affecting meat quality; Wulf
R-170 Molecular mechanisms regulating skeletal muscle growth and differentiation; McFarland

H-277 Optimizing feed resource use in beef cattle production: alternative feeds as energy sources; Tjardes

H-281 Nutritonal management of health and growth in beef cattle backgrounding programs; Pritchard

H-287 Improving the sustainable use by livestock of leafy spurge-infested and other pastures in the NGP; Smart

R-347 Genetic improvement of cattle using molecular genetic information; Marshall

H-351 Grazing patterns and plant responses to grazing on mixed-grass prairie vegetation; P. Johnson, Patterson, Xu, Walker

Biology/Microbiology

SD9702751 Virological, immunological, and molecular components of reproductive PRRS; Benefield, Cafruny

H-059 Genes important in livestock health; Westby

H-060 Analysis of factors that regulate energy balance in humans, livestock, and mice; Granholm, Marshall, Specker, Westby, Kattlemann, Pitts

H-076 Pullulan, a commercially valuable polymer: gene identification and creating fungal overproducers; Westby

H-088 Mechanisms of viral persistence and pathogenesis; Rowland

H-089 Use of native plants and a permacultural approach for development of niche market crops for the Northern Great Plains; Reese

H-110 Genetic modification to enhance crop quality and insect resistance; Cheesbrough

H-151 Production of organic chemicals from biomass; Gibbons, West, Julson

H-168 Ecological analysis of land-water interactions in prairie environments; Troelstrup

H-191 Analyses of mammalian genes that regulate pigmentation, obesity, fertility, and systemic physiology; Granholm, Westby, Marshall, Campbell, Diggins

H-237 Utilizing biotechniques to enhance wheat germplasms; Yen

Chemistry/Biochemistry

H-049 Analysis of pesticides and related substances; Matthees

G-051 Calcium signaling during embryonic development in cattle; Sergeev

H-067 Production of value-added, corn based microbial gums; West

H-090 Characterization of livestock sperm that demonstrate susceptibility to DNA denaturation in situ; Evenson

G-129 Corn-based production of commercially-available gellan gum; West

G-140 A rationally designed vaccine for rotoviruses using hyperbranched and dendrimeric materials; Majerle, Hurley

H-179 Calcium and vitamin D regulation of cellular processes in domestic livestock and poultry species; Sergeev

G-210 Molecular probes of bull sperm nuclei producing abnormal embryos; Evenson

G-240 Acquisition of a scintillation counter with solids capability; Rice (equipment grant)

S-891 Potential effects of genetically modified corn and soybeans on mammalian fetal, breast-fed postnatal, pubertal, and adult development; Evenson

S-996 Analytical services; Thiex

Dairy Science

H-031 Improving quality and consumer acceptance of milk and dairy products; Baer

H-100 Expanding use of whey in food products; Dave

H-101 Improvement of the nutritional value of process cheese and management and utilization of dairy byproducts; Mistry, Specker, Vukovich

H-121 Strategies for improved health and productivity of early lactation dairy cows; Hippen, Schingoethe, Kalscheur

R-167 Management systems for improved decision making and profitability of dairy herds; Hippen

R-207 Metabolic relationships in supply of nutrients for lactating cows; Schingoethe

R-209 Modifying milk fat composition for enhanced manufacturing qualities and consumer acceptability; Schingoethe, Baer, Hippen

Economics

H-021 Case profile of profitability determinants in the South Dakota beef cow-calf enterprise; Cumber, Dunn, Hamilton

H-069 Changes in global patterns of food products trade: implication for the U.S. and South Dakota; Qasmi

H-081 Agri-environmental policy options and implementation based on multifunctionality; Dobbs

H-107 Changes in agricultural food systems: the increasing importance of value-added activities; Van der Sluis

G-109 Health and management factors affecting beef value; Fausti, Epperson

H-127 Economic analysis of agricultural and land markets and land management practices in South Dakota; Janssen, Beutler

H-148 Rural labor markets and factors influencing rural/urban and metro/nonmetro migration; Adamson

H-160 Value added agriculture in South Dakota: its impact on structure, efficiency, prices, and agricultural policy; Taylor, Klein

H-200 Perception of biotechnology and biotech produced agricultural products and implications for risk management; Franklin

R-337 Enhancing global competitiveness of U.S. red meat; Fausti

S-983 Agricultural biotechnology: economic implications for Midwest agriculture; Van der Sluis, Qasmi

Family & Consumer Sciences

SD0001 Liquid chromatograph mass spectroscopic measurement of folic acid and natural folates in food; Krishnan

H-098 Promoting healthy families and communities through high school relationship education; Gardner

H-147 Phytochemicals in soybeans; Wang, Krishnan, Julson, Scott, Matthees, Woodard

H-211 Value addition of cereal, grains, and oilseeds – an investigation of bioactive compounds of economic, health, and food value; Krishnan, Wang, Scott, Grady, Muthukumarappan, Doehlert

R-238 Impact of technology on rural consumer access to food and fiber products; Lyons

R-311 Using stage based interventions to increase fruit and vegetable intake in young adults; Kattelmann

Horticulture, Forestry, Landscape & Parks

MS-028 Trends impacting forest production and forest recreation: 2010; Stubbles

MS-048 Restoring riparian woodland in agroecosystems of the Northern Great Plains; Johnson

H-137 Dormancy and stress response of deciduous fruit crops; Fennell

G-139 Molecular and genetic mechanisms involved in bud dormancy in woody plants; Fennell

R-177 Rootstock and interstem effects on pome and stone fruit trees; Fennell

H-198 Evaluation, selection, and management of turfgrass species/cultivars by geographical region in South Dakota; Schleicher

MS-239 Evaluation of native and introduced trees and shrubs for South Dakota in relation to their growth on soils in urban landscapes; Evers

R-258 Freeze damage and protection of horticultural species; Fennell

H-261 Cultural practices optimizing growth of herbaceous horticultural plants in the Northern Great Plains; Burrows, Fennell, Schleicher, Reese

R-270 Integrating biophysical functions of riparian systems with management practices and policies; Schaefer, Johnson, Boettcher

Plant Science

H-011 Winter wheat breeding and genetics; Ibrahim, Jin, Langham

H-038 Nutrient recycling in crop rotations; Woodard

R-057 Forage crop genetics and breeding to improve yield and quality; Boe

H-058 Ecological and alternative management considerations for corn rootworms in the Northern Great Plains; Fuller, McManus

H-068 Spring wheat breeding and genetics; Rudd, Jin

H-077 Development and utilization of oats and rye adapted in South Dakota; Reeves

H-078 Genetics of fungal pathogens of row crops; Chase

H-079 Sunflower breeding and testing alternative oilseed crops; Grady

H-099 Soybean breeding, genetics, and production; Scott

H-108 Breeding perennial grasses and legumes for forage, wildlife habitat, and tolerance to stresses; Boe

H-111 Pedology information transfer for South Dakota; Malo, Doolittle, Schumacher, K. Clay, S. Clay, Carlson, Gelderman, Ellsbury, Lee, Lindstrom

H-117 Forage production, quality, and persistence; Owens

H-118 Weed management in conventional and alternative cropping systems; S. Clay

R-128 Supplemental information support for pesticide use in minor crops; S. Clay

H-138 Wireworms of the Northern Great Plains; Johnson

H-150 Influence of potassium (K) rate, placement, in-season treatment and hybrid, and tillage on K deficiency in corn; Gelderman

H-159 Soil mnagement for improved soil quality and reduced biostress; T. Schumacher

H-161 Studies of host-parasite interactions between small grains and its fungal pathogens; Jin

H-169 Etiology and epidemiology of plant viruses in South Dakota; Langham

H-178	Corn genetics, physiology and breeding; Wicks
H-180	Plant biotechnology methods and applications in agriculture; Carter
H-181	Water and soil management for maximizing returns to agriculture; Kohl, Jin, Bleakley, Johnson, Schumacher, Carlson
H-188	Fate and transport of waste components when land-treated; Doolittle
H-197	Biological control of foliar and head diseases of wheat; Bleakley
R-199	Persistence of Heterodera glycines and other regionally important nematodes; Smolik
R-218	Management of eroded soils for enhancement of productivity and environmental quality; T. Schumacher, Lindstrom
H-220	Tillage and crop rotations for eastern South Dakota; Berg
H-221	Linking soil characteristics, remote sensing, simulations models, and enterprise analysis through GIS to improve site specific management; D. Clay
H-227	Nondestructive freeze test using thermoelectric cooling; Sutton
R-230	Characterizing weed population variability for improved management decision support systems to reduce herbicide use; S. Clay
R-231	Assessing nitrogen mineralization and other diagnostic criteria to refine nitrogen rates for crops and minimize losses; D. Clay
R-236	Plant germplasm, information management, and utilization; Boe
H-248	Diversifying crop rotations; Beck
G-250	Atomic absorption spectrophotometer; Doolittle (equipment grant)
H-257	Agricultural wetland management; Rickerl, Janssen, R. Johnson
R-260	Reducing the potential for environmental contamination by pesticides and other organic chemicals; S. Clay
H-276	Alternative methods of meeting conservation compliance; Stymiest
H-291	Using emerging technology to increase agronomic productivity and producer profitability; Carlson
G-301	Linking ecological and soil property information to improve site specific management; D. Clay, S. Clay, Batchelor, Ellsbury, Carlson, Dierson, Malo, Dalsted
S-892	Transgene dispersal and transgenic soybeans as feed and as food; Carter, Cheesbrough, Scott, Wrage, Turnipseed, Thaler
S-957	Plant Science Farm; Kohl
S-958	Greenhouse and seedhouse maintenance; Gallenberg
S-991	Seed certification; Pollmann
S-992	Seed testing; Turnipseed
S-993	Variety testing; Hall
S-994	Survey entomologist; Fuller
S-995	Foundation Seed Stock; Ingemansen

Rural Sociology

H-097	Census Data Center; Hess
G-190	Consortium on social, economic, and ethical aspects of biotechnology; Hess

Veterinary Science

SD-9602270	Envelope proteins of PRRSV and their role in antigenic variation; Nelson, Hennings
SD-9902298	Receptor binding specificity of the K88 fimbriae of E. coli; Francis, Rowland
H-010	Johne's Disease in cattle and buffalo; Christopher-Hennings, Nelson, Epperson, C. Chase, Henning
G-070	Biochemical basis for genetic resistance to K88 E. coli infections; Erickson
G-120	Genomic quasispecies associated with the persistence and pathogenesis or porcine reproductive and respiratory syndrome virus (PRRSV); Benfield
R-171	Evolving pathogens, targeted sequences, and strategies for control of bovine respiratory disease; Chase, Epperson
H-208	Understanding the role of transferred maternal immunity in development of the neonatal immune system; Young
R-219	Porcine reproductive and respiratory syndrome: mechanisms of disease and methods for the detection, protection, and elimination of the PRRS virus; Benfield, Christopher-Hennings
H-228	Control of cattle parasites in South Dakota: profitability assessment; Hildreth, Epperson
AH-241	Antimicrobial sensitivity and characterization of Campylobacter spp. isolates from ovine abortions and comparison to other Campylobacter; Epperson, Holler
H-251	Description, impact, and risk factors associated with lung lesions in lambs; Epperson, Holler, Held
AH-271	Evaluation of anti-diarrhea substances in pigs; Francis
G-331	Veterinary virology symposium: emerging and zoonotic animal viral diseases; Benfield
AH-341	Controlling bovine viral diarrhea virus: improving methods for diagnosis and understanding mechanisms of pathogenesis; Chase, Lemire
R-357	Enteric diseases of swine and cattle: prevention, control and food safety, Francis, Benfield, Hildreth

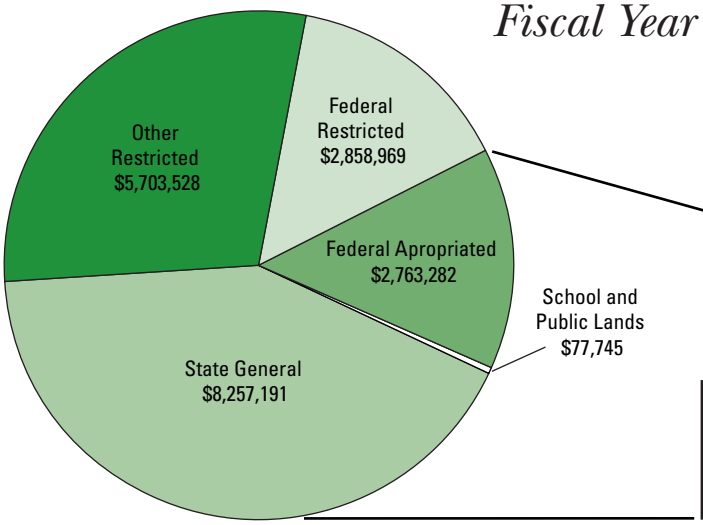
Wildlife & Fisheries Sciences

H-061	Yellow perch fingerling production and harvest methods for ponds and small glacial lakes in eastern South Dakota; Brown, Scalet
MS-071	Merriam's wild turkey in the southern Black Hills of South Dakota, survival, recruitment, movements, habitat use, and farmstead dependence; Flake
H-157	Strategies for minimizing winter depredation by white-tailed deer I. developing lure forages; Jenks
H-158	Human, habitat, and biotic influences on panfish populations; Willis
S-963	South Dakota Cooperative Fish and Wildlife Research Unit; Berry, Higgins

Operating Budget

South Dakota Agricultural Experiment Station

Fiscal Year 2002



Salary & benefits	$9,832,108	88.59%
Operating	$1,266,110	11.41%
Total	**$11,098,218**	

SOUTH DAKOTA STATE UNIVERSITY
College of Agriculture and Biological Sciences
Agricultural Experiment Station
Brookings, SD 57007
Kevin Kephart, Director

Publication

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