9-1-2004

Farm and Home Research: 55-3

Lance Nixon

Marianne Stein

Utilizing and developing our resources to enhance quality of life

Farm & Home RESEARCH

Volume 55 • Number 3

South Dakota State University · College of Agriculture & Biological Sciences · Agricultural Experiment Station

WON'T DRINK MILK? EAT CHEESE

TAKING THE CALF AWAY FROM MOM EARLY: CAN IT PAY?

ROTATE AWAY FROM SCN

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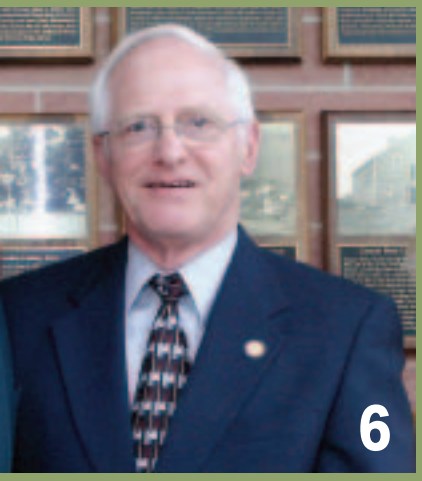

On the cover:

Jim Smolik, SDSU nematologist, has advice for South Dakota soybean growers worried that soybean cyst nematodes (SCN) will reduce their yields: Rotate resistant varieties with non-host crops. That still won't eliminate the pest, he says, but it will keep population densities below economic thresholds. SCN is the most damaging soybean pest in the U.S., causing nationwide losses of about $1 billion annually. The nematode is in 18 of South Dakota counties.

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Volume 55 • Number 3 • 2004

Published quarterly by the Agricultural Experiment Station, College of Agriculture and Biological Sciences, South Dakota State University, Brookings, South Dakota. Sent free to any resident of South Dakota in response to a written request.

The mission of SDAES is to conduct research to enhance quality of life in South Dakota through the beneficial use and development of human, economic, and natural resources. This mission centers on responsiveness to the changing needs of South Dakotans and is based on six themes: biostress, agricultural production, natural resources and their conservation, people, biotechnology, and bio-based energy and industry. Research programs in SDAES directly support the teaching programs offered in the College of Agriculture & Biological Sciences and FCS and the educational programs delivered by the South Dakota Cooperative Extension Service.

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Farm & Home Research may be accessed on the web at
http://agbiopubs.sdstate.edu/articles/FHR55-3.pdf

Published in accordance with an act passed in 1881 by the 14th Legislative Assembly, Dakota Territory, establishing the Dakota Agricultural College and with the act of re-organization passed in 1887 by the 17th Legislative Assembly, which established the Agricultural Experiment Station at South Dakota State University. South Dakota State University is an Affirmative Action/Equal Opportunity Employer (Male/Female) and offers all benefits, services, education and employment opportunities without regard for ancestry, age, race, citizenship, color, creed, religion, gender, disability, national origin, sexual preference, or Vietnam Era veteran status.

7000 printed by the AES at a cost of $.48 each. AX036 August 2004

Director's comments

BY KEVIN KEPHART
Director, South Dakota Agricultural Experiment Station

Kevin Kephart

Only science can answer some "headline issues"

Research in agriculture and the biological sciences is rooted in the here-and-now but looks to the future.

That explains why this *Farm & Home Research* could look like a recap of current events. Some of these issues—West Nile virus, endangered species—raise the questions of today that only science can answer.

We don't know all we need to know about the reproductive cycles of the mosquitoes that carry West Nile virus. There's immediacy to our research; we need to help local governments and state health officials make the right moves to protect human health.

Incidentally, our WNV work is one of the most visible examples of the land-grant university system functioning as it was designed. The SDSU Extension Service, our outreach partner, has issued recommended thresholds at which local governments should consider spraying for adult mosquitoes. The thresholds are based partly on the work of SDSU researchers; Extension delivers that information to the public in a form it can use.

The Topeka shiner is also a headline issue in South Dakota. Farmers are the primary caretakers of the Topeka shiner. They're the primary caretakers of a lot of the environment, and it's our job to help them by putting science to work to define how we can safely co-exist with species that are part of our prairie ecosystems.

The South Dakota Agricultural Experiment Station has been tracking the soybean cyst nematode since it first appeared in the state in the 1990s. As soybean acreage expands in South Dakota, it's a good bet that SCN will be a growing concern with farmers who have never dealt with it before. Our research will help them manage it.

Elderly nutrition is a particular concern in South Dakota with its large segment of older citizens. That's one of the reasons our dairy scientists are looking at ways to pack more Vitamin D into cheese.

Another headline issue is economic development. That's part of what drives our study on early weaning of calves, one of the projects in the Four-State Ruminant Consortium, a group of land-grant university scientists in South Dakota, North Dakota, Montana, and Wyoming working together on common problems in the vast range-and-livestock region where those states meet.

Similarly, our two studies of dried distillers grain as a possible ingredient in pet foods—one a study of how DDG works in the actual processing, another looking at the economics —acquired even more immediacy after December 2003. That's when the first—and let's hope, the only—case of mad cow disease was found in the U.S.

As a consequence of that case, we have seen regulatory changes for additional protections for human health; but we could also see tighter restrictions for the rendering industry, one of the suppliers for pet food manufacturers. To my mind, our studies of DDG as a possible protein source in pet food are even more relevant today than when we began them.

Finally, our reflection on the distinguished career of our Griffith research award winner, Dr. David Schingoethe, isn't really about the past at all. It's about how a good scientist must stay current, or even slightly ahead of the times.

I think this recognition is long overdue. Dr. Schingoethe has had a stellar career and his publication record is phenomenal. His work has an impact and it will continue to have an impact as dairy continues as a means of economic development in this state.◆

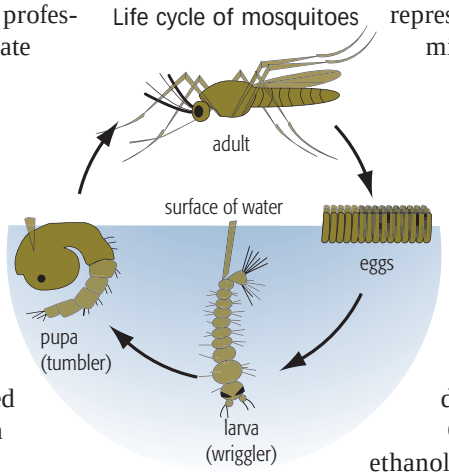
Where were the WRIGGLERS?

Several *C. restuans* larvae (wrigglers) and pupae (tumblers) suspended from the water surface.

Matt Hart, a senior wildlife and fisheries major at South Dakota State University from Winfred, spent Summer 2003 collecting mosquito larvae.

Under the guidance of Mike Hildreth, professor of biology, and Nels Troelstrup, associate professor, Hart was studying the breeding behavior of the mosquito species *Culex tarsalis*.

Culex tarsalis is the main vector in South Dakota for West Nile virus (WNV), an infectious disease that primarily affects humans, horses, and birds. In humans, the disease can cause flu-like symptoms and can in some cases lead to encephalitis, or inflammation of the brain. In 2003, there were 1,041 reported human cases and 14 deaths from WNV in South Dakota.



WNV is transmitted by mosquitoes that feed on infected hosts. There are several hundred mosquito species in the U.S., but only a few of them are known carriers of the WNV. Of the 44 known mosquito species in the state, eight are potential WNV vectors. The western encephalitis mosquito *C. tarsalis* is present in all South Dakota counties.

Protection against the disease includes the use of personal mosquito repellents, as well as control of adult mosquitoes and larvae (wrigglers). Many cities and towns have implemented mosquito control programs, but little is known about the actual breeding behavior of *C. tarsalis* through the Northern Great Plains.

THE MOSQUITO COLLECTOR was in for a surprise. The larvae weren't where he expected.

Hart received a Joseph F. Nelson undergraduate mentorship to collect mosquito larvae in 2003 from a number of natural and artificial collection sites in eastern South Dakota.

Hart, Hildreth, and Troelstrup had identified 35 potential mosquito breeding sites from both natural and urban settings, representing a variety of habitats that mosquitoes might find attractive for larvae development. Sites included flowing streams, ponded streams, lake edges, swamps and marshes, shallow permanent pools, shallow temporary pools, intermittent ephemeral pools, natural containers, and artificial containers.

"We monitored the sites weekly during the summer for the condition of the water and sampled for the presence of mosquito larvae," Hart says. "We used a standard collection of 10 'dips' using a 13-cm mosquito dipper from each location."

Collected larvae were preserved in a 70% ethanol solution, dehydrated, mounted on glass slides, identified, and counted.

Hart found plenty of mosquito larvae in his collection sites, but very few of the *C. tarsalis* species. In fact, it wasn't until August that *C. tarsalis* larvae started showing up in the collection sites at all.

"We found no *C. tarsalis* larvae in any of the natural sites, and only in five artificial sites after August 5," Hart says. *C. tarsalis* larvae were also found earlier in the summer in two places that were not part of the original sites: an artificial barrel mesocosm (a culture system for larvae) in Oak Lake and a water-filled shallow tire imprint in a hayfield in Minnehaha County.

The scientists still aren't sure why it was so difficult to find the larvae in the expected places, in spite of adult *C. tarsalis* mosquitoes being present in large numbers.

PERHAPS THE AVAILABILITY OF SUNLIGHT plays a role when a *C. tarsalis* female selects a breeding site, says Hart.

"A barrel exposed to full sunlight contained higher numbers of *C. tarsalis* than another one located in a heavily shaded

No *C. tarsalis* wrigglers showed up in any natural sites Matt Hart monitored in 2003.

"You may think that he didn't succeed, because he didn't find what he was looking for. But [he has eliminated some sites] ... and that is very useful knowledge."

—MIKE HILDRETH, SDSU PROFESSOR OF BIOLOGY

area. A third barrel that received sunlight half of the day contained numbers of larvae in between the full sun and full shade barrels."

Hildreth explains that while most mosquitoes like stale water in shaded areas, it is possible that *C. tarsalis* prefers to breed in fresh water and sunlight. "Based on our data, as well as research from California, it looks like *C. tarsalis* prefers freshly formed water habitats."

That's different from other species, such as *C. pipiens*, which is the main vector for West Nile virus in the eastern part of the U.S.

C. pipiens likes urban areas and cannot tolerate a dry climate, so it's not found in the Midwest, whereas *C. tarsalis* appears to thrive in dry, rural areas.

C. pipiens is known to breed in stale water, and most cities base their mosquito control programs on this information, but Hildreth suggests this may not be the best approach in South Dakota.

"When controlling for *C. tarsalis*, you should look for water that meets two criteria: It has just recently been replenished or at least has a fresh component to it, and it has sat around for a week—long enough for the mosquitoes to lay their eggs, the eggs to develop to larvae, and the larvae to develop to adults."

Hildreth adds that larval control programs shouldn't just focus on location, but also on timing.

"In August, we started to find *C. tarsalis* in some of the artificial sites they had shunned earlier in the summer. We suspect that with winter approaching, it becomes more critical for the mosquitoes to breed in order for the larvae to have time to develop before winter comes, since it is the adult mosquito that overwinters. So maybe they start using sites that aren't their preferred choice."

SO NOW SCIENTISTS have a pretty good idea where *C. tarsalis* larvae are not found, thanks to Hart's project. But it still remains to be determined exactly where the larvae breed, and Hildreth is continuing mosquito larvae research in the summer of 2004.

"The 2004 research is based on Matt's negative data. You may think that he didn't succeed, because he didn't find what he was looking for. But in reality he eliminated some of those sites on which people have focused a lot of attention, and that is very useful knowledge."

Hildreth's 2004 research concentrates on sites with relatively fresh water. "We're looking at creeks that run sporadically, such as those running into the Big Sioux River.

"We know that mosquitoes can't survive in flowing water, so the river itself cannot be a source, but there are creeks that run temporarily, and there are places where water accumulates within these creeks, such as potholes. We're going to look at such places. We wait until it rains, and then we sample those areas, because they meet the two criteria: it is new water, and it stays around for a period of time."

Hildreth suggests that cities might focus on such areas in their mosquito control programs, but he adds that it still makes sense to control mosquitoes in stale water as well. A profusion of *C. restuans* mosquito larvae were found in Hart's collection sites. This mosquito is also a vector for WNV; and although it doesn't feed on humans, it can contribute to spreading the disease through birds.

HART FINDS THAT IT WAS a very useful experience to be a Joseph F. Nelson scholar and work on a research project.

"This was my first time doing research, so I was pretty green when I started. But Dr. Hildreth and Dr. Troelstrup were very good about answering my questions and they taught me a lot. This project gave me a chance to learn about some of the research instruments they use, such as global positioning systems (GPS). I hope to be a biologist, possibly working for the Department of Game, Fish, and Parks in South Dakota."

Hildreth says that the undergraduate research opportunity offered by the Nelson mentorship program is valuable for a student.

"Job experience is probably as important as the academics. If our students have some good practical experiences in the area that they want to be in, and if they get good recommendations, it speaks volumes for their job prospects. And any student who wants to go to graduate school really has to get some undergraduate research experience. The Nelson program is one of several different tools we have to fund those opportunities."

In addition, Hildreth points out that the Nelson program helps faculty members fund new research projects. "To get a grant funded, you need to have some pilot data. Undergraduate research funds such as the Nelson mentorship provide a good source for research that can generate pilot data."

Hildreth is taking his own advice. He is planning to use the data obtained in Hart's study to apply for a grant that will allow him to conduct a larger-scale study of *C. tarsalis* larvae. ◆ —*Marianne Stein*

Fred Cholick, college dean, Schingoethe, and Peggy Miller, university president.

GRIFFITH WINNER
is leader in boosting dairy production

On David Schingoethe's desk is an Ayrshire cow trophy he won in the summer of 1954 for raising the champion Ayrshire heifer in an Illinois 4-H competition—the first of several 4-H trophies the teenager collected.

It was also the first step toward an academic career, though he didn't know it then.

"It was what originally sparked my interest," says Schingoethe, who grew up on an Illinois dairy farm. "I went on to the University of Illinois and majored in dairy science."

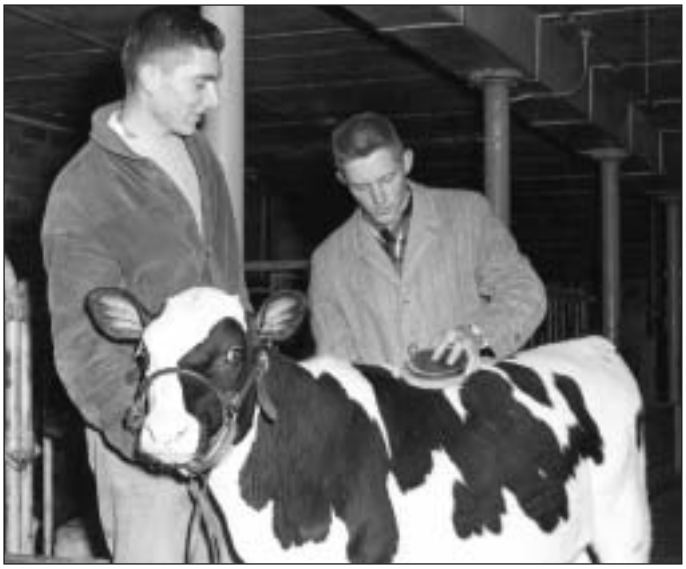
Half a century later, David Schingoethe keeps adding to his list of accomplishments in his chosen profession. He was already formally recognized as a Distinguished Professor in the South Dakota State University Department of Dairy Science when, in April 2004, he won the Griffith Research Award, a one-time cash stipend of $2,500 and $12,000 in research funds for 2 years, given annually to an SDSU faculty member making outstanding contributions in agricultural research.

In addition to being named as Distinguished Professor in the SDSU Department of Dairy Science and winning the Griffith Research Award, Schingoethe has won the F.O. Butler Research Award and the Gamma Sigma Delta Research Award from SDSU. In 1989 he received the American Feed Industry Association Award from the American Dairy Science Association, its top award in dairy cattle nutrition. In 1996 he received ADSA's Nutrition Professionals Inc. Award in Applied Dairy Nutrition. In 2003 he received the Land O' Lakes Inc. Award from ADSA, the organization's top research award for both dairy production and dairy manufacturing.

PRODUCTS IMPORTANT TO SOUTH DAKOTA and area states—such as distillers grains, sunflower products, soybeans, and whey—have played prominent roles in Schingoethe's research since he came to SDSU in 1969 after earning his doctorate in dairy science and nutrition from Michigan State University. His master's and bachelor's degrees are from the University of Illinois.

At SDSU, he has focused specifically on protein and energy needs of dairy cattle, mainly in three areas:

- improving protein utilization so producers can formulate more nutritionally correct diets,
- using added fat in rations that allows cattle to meet energy needs and increase milk production, and



1962: David Schingoethe (right) and Don Beitz, now professor at Iowa State University.

• helping gather research data on injections of bovine somatotropin to increase the efficiency of milk production.

Schingoethe says research in each of those three areas of emphasis, pursued by scientists at SDSU and other universities, has boosted dairy production by about 10%—or 30% collectively—over past decades. Milk production per cow has roughly doubled since 1970, driven in part by such research, he adds.

• Improving protein utilization. Schingoethe continues his work in determining amino acid requirements for milk protein synthesis that he began in graduate school.

"Through the years here at SDSU, we've evaluated a number of different protein supplements, ultimately intending to increase protein utilization by dairy cows," he says.

Some of his work has involved rumen degradable protein, which is ultimately converted to microbial cells that are later digested in the lower tract of the cow. He's also studied how rumen undegradable proteins can provide amino acids that the cow needs by escaping degradation in the rumen to be digested in the intestinal tract.

Schingoethe also worked to estimate the amino acid composition of the starting dietary protein that is ultimately available to the animal. SDSU was one of the first institutions to use new processing methods—heat treatments, extrusion, chemical treatments—that would improve protein utilization by dairy cows if adopted by feed processors.

SCHINGOETHE CONTINUES TO TRACK the uptake of the amino acids by the mammary gland. That involves sampling the blood as it comes to the mammary gland and then as it travels its course through the cow's body away from the mammary gland.

"Through the years we probably have amassed the most extensive data set anywhere on amino acid uptake across the mammary gland," he notes.

That gives researchers a good idea of how much of the amino acids in the diet are actually reaching the mammary gland and being used there in the process of making milk.

"In most diets typically methionine and lysine are most apt to show up as limiting amino acids. Methionine is most limiting in soybean protein, and lysine is most limiting in corn-based products. So the question is, how can we incorporate other protein supplements to supply those amino acids, or in some cases, ruminally protected amino acids?

"For instance, we feed distillers grains with or without ruminally protected lysine and methionine. So those two amino acids will escape degradation in the rumen but will be digested and used in the intestinal tract. When we do that, in many cases we get an increase in production, sometimes with less total protein in the diet."

• Adding fats to dairy cow diets. Most forages and grains contain from to 2 to 4% fat, Schingoethe says. A cow can't use as much fat as a human, but he and other researchers have shown that producers can formulate dairy cow diets with a maximum of 8 to 10% fat.

"Realistically we aim for about 6 to 7% fat. That increases the energy intake of the animal because fat is a more concentrated source of energy than carbohydrates," Schingoethe explains. "We probably can get roughly a 10% increase in production because of that."

Because SDSU's Department of Dairy Science is one of the few in the nation that includes dairy production and dairy manufacturing in the same department, Schingoethe could find out how production changes affected flavor and processing properties in milk products.

Griffith Research Award

Griffith awards are made possible by funds from the William and Byrne Griffth Endowment in Agriculture and the Arts. The endowment has supported agricultural research at SDSU for over 20 years. Since 2003, one faculty member and outstanding undergraduate students have been chosen as honorees each year.

SDSU also presented 2004 Griffith Student Research Awards to four undergraduates in the SDSU College of Agriculture and Biological Sciences. They are Nicholas Harms, Dell Rapids, Department of Veterinary Science; Shannon Sellner, Sleepy Eye, Minn., Department of Dairy Science; Jared Oswald, Volga, Department of Agricultural and Biosystems Engineering; and Laura Geraets, Dell Rapids, Department of Animal and Range Sciences.

"It is gratifying to have a role in meeting the challenges that push back the frontiers of science to help farmers —especially dairy producers—meet the world's need for high quality food."

—David Schingoethe,
SDSU dairy scientist and Griffith Award honoree

1971: Schingoethe talks to dairy farmers at the South Dakota State Dairy Herd Improvement Association meeting in Huron.

For example, feeding high-grain, limited-roughage diets results in a drastic drop in the milk fat test. Schingoethe and John Parsons, who retired as head of the Dairy Science Department in 2001, evaluated what that meant for processors.

"Nobody had ever tasted the milk before. We found the drop in milk fat increased the incidence of oxidized flavor. This is a 'cardboardy' or almost rancid flavor that discourages people from drinking milk."

Later, working with Professor Bob Baer, Schingoethe added fat to dairy cow diets using feedstuffs such as extruded soybeans or sunflower seeds.

"It did not affect the milk flavor, but it allowed the processors to make a softer, more spreadable butter at refrigerated temperatures because of the modest changes in the fatty acid composition of the milk fat."

That approach is being used today in some areas of Europe for making a softer butter, and processors in the U.S. have at least explored the idea, Schingoethe notes.

Schingoethe also worked with SDSU colleagues from dairy manufacturing in feeding fish oils to increase conjugated linoleic acid and its precursor, vaccenic acid, in milk fat. Milk producers can get some of the same benefits by grazing cows on pasture in summer, but that's only a seasonal benefit, he says. A diet such as he used can increase conjugated linoleic acid and vaccenic acid even when cows are not on pasture, "actually getting a triple or maybe a fivefold increase.

"The reason for trying to increase conjugated linoleic acid and vaccenic acid is that they have been shown to prevent cancer."

With Baer's help, Schingoethe used panelists to taste the milk to find whether it gave a fishy taste. It didn't.

Some dairy processors, particularly cheese plants, are using this method to add nutritional value to their products, Schingoethe says.

• **Bovine somatotropin.** In the late 1980s and early 1990s, Schingoethe was among the scientists around the nation evaluating bovine somatotropin, or bST.

"All it does is redirect blood flow to the mammary gland," Schingoethe says. "If you send more nutrients past the mammary gland, more can be taken up and synthesized into milk.

"There's a safety feature in the cow's body. If she's thin and really needs the nutrients for maintaining her body or muscle replenishment, bST will not send additional nutrients to the mammary gland. Or if the animal is still growing, such as a 2-year-old, first-lactation cow that is quite small, you're going to get little or no response in increased milk production from bST."

CHANGES IN DAIRY SCIENCE ARE RESHAPING the rural landscape, says Schingoethe.

In 2002, there were roughly 96,000 milk cows in South Dakota, or about half the 183,000 of 1970. But total milk production hasn't dropped off much because each cow is producing 16,000 pounds per year, compared to 8,377 pounds in 1970.

"One interesting thing I often hear is that this high production is going to burn out these cows," Schingoethe says.

"But the average cow in today's dairy herd has had about two-and-a-half lactations. In 1960, when I was an entering freshman at the University of Illinois, the average cow had two-and-a-half lactations. So we're not burning out cows."

Cows are eating more on a per-animal basis, but that added feed is going almost entirely into added production—maintenance requirements per animal are about the same as they were decades ago.

"For many years in our introductory course I used to tell students, assume a cow in the milking herd is eating about 3 pounds of dry matter per hundred pounds of body weight. In other words, a 1,400-pound cow is consuming about 42 pounds of dry matter daily," Schingoethe says.

"Today, that 1,400-pound cow through most of her lactation is consuming 3.5 to 4.5 pounds of dry matter per hundred

SDSU Dairy Science Department's impact on the dairy industry

The SDSU Dairy Science Department has been deeply involved in all that has happened in the state and national dairy industry since founding of Dakota Agricultural College in 1881. Many changes, in fact, were initiated by the department.

1891. When farmers began selling off milk, the first bulletin from the department explains the new Babcock test, which establishes an equitable way of making payment based on fat.

1900. The first short course for creamery operators starts a tradition that continues for over 50 years.

1906. Department faculty author a text book, "Butter."

1910. The department leads the nation in research with milking machines. South Dakota dairy scientists are pioneers in pasteurization and homogenization.

1912. College Belle Wayne from the department herd challenges the world milking record, coming in second by producing 3,338 pounds of milk in a 30-day period.

1916. The first dairy team participates in the first national college dairy cattle and foods judging contest. Since then, 14 SDSU teams have been national champions in the dairy foods division.

1920s. Two classic studies by department scientists are cited in textbooks for decades. That research leads to mastitis studies.

1922. The department awards its first M.S. degree.

1934. Scientists pin down vitamins A and D requirements of dairy cows, one of the most important contributions to the dairy industry nationwide. Rickets as a major dairy cattle disease is eliminated. Along with the production testing program, the research is credited with doubling milk production per cow in less than 30 years.

1941. The first milking parlor in South Dakota is installed in the SDSU dairy barn, paving the way for better and more sanitary milk handling on South Dakota farms.

1952. A formula for low-fat dairy spread is released, an early step in developing "light" foods.

1950s. Scientists build individual outdoor hutches for dairy calves. Calf losses to pneumonia in the college herd drop from 40% to virtually nothing.

1959. In the face of pressure from other states shutting down their university dairy plants, the South Dakota Legislature expresses its confidence in the department by appropriating funds to construct the present dairy science building which houses the manufacturing plant. Today only three universities offer both dairy production and manufacturing coursework, and SDSU is the largest.

1959. The department awards its first Ph.D. degree.

1963. South Dakota is among the very first states to achieve 100% bulk-milk handling. Combined research and education programs from the department help double dairy income, improve butter quality, and expand the state's cheesemaking plants to ninth place in the U.S. by 1971.

1966. A new low-calorie spread-type dairy product is developed. It contains 40% butterfat, compared to 80% in butter.

1970. Dairy scientists begin to carve out a position as world leaders in whey utilization. Whey had been a waste byproduct of the industry; over the next 30 years SDSU scientists develop it as an ingredient in feed and dairy products.

1976. The first South Dakota Dairymen's Conference starts up at SDSU. This later evolves into the Dairy and Forage Conference.

1988. The department opens the Dairy Foods Research Center, one of six in the nation, in partnership with the University of Minnesota. Department scientists become leaders in dairy products research.

1989. The first sanitation shortcourse is conducted in collaboration with the Henkel (later Klenzade) company.

1991. Research and educational outreach begins on distillers grains. Ultimately, farmers will learn how to turn these leftovers from ethanol production into nutritious, economical livestock feeds.

1994. Cows move into the state-of-the-art dairy barn. Now the department can intensify its leadership in dairy cattle nutrition.

1997. A department faculty member co-authors the book "Cheese and Fermented Milk Foods."

2000. The first Central Plains Dairy Expo is held in Sioux Falls.

2004. A capital campaign begins to renovate the dairy plant where 10,000 pounds of milk a week from the SDSU herd is processed into 24 cheese varieties, butter, beverage milk, and 90–plus flavors of ice cream by SDSU students also responsible for marketing and retailing the finished products. The renovated plant will help keep SDSU a leader in dairy education and research.

pounds of body weight, or 50 to 60 pounds of dry matter daily. If some cows consume 70 pounds, that isn't unusual."

AS SOUTH DAKOTA PUSHES for more value-added agriculture, Schingoethe points out that dairy farmers have always been value-added processors.

Especially when feed grains and forages have been low in price, they've used dairy cows to add value to what they grow. That will continue in South Dakota's future, he says. And some of the changes in milk composition that result from SDSU's research with feeding certain unsaturated fat sources can further increase the value of dairy products.

"Our SDSU herd average is 25,000 pounds of milk per cow per year. That means they're averaging, for the typical 10– or 11–month lactation, more than 80 pounds per day. Their maximum production is more than 100 pounds per day.

"When you figure milk is roughly 12% solids, you realize that cow is putting out 12 pounds of dry matter a day. A steer gaining 4 pounds of body weight per day is doing very well in a feedlot, but that's only 40% dry matter, so it's really about 1.6 pounds per day dry matter that they are gaining.

"Dairy cows are some tremendously efficient food-producing animals."

SCHINGOETHE SEES NO CEILING to milk production in the future. He points out that the first time on record that any cow produced more than 50,000 pounds of milk a year was in the 1970s.

"Since then, many cows have done quite a bit better than that. There are individual cows that have produced more than 70,000 pounds of milk in a year."

Dairy scientists at SDSU and other land-grant universities will play a key role in helping farmers use technology to get the most out of their herds.

"It is gratifying to have a role in meeting the challenges that push back the frontiers of science to help farmers—especially dairy producers—meet the world's need for high quality food," Schingoethe says.◆ *—Lance Nixon*

Rotate AWAY FROM SCN

Jim Smolik, SDSU nematologist.

One good way to deal with a new pest is an old tool well known to producers: crop rotations.

That's one of the findings from South Dakota State University Agricultural Experiment Station's ongoing work on soybean cyst nematodes. The research is supported in part by the South Dakota Soybean Research and Promotion Council.

The soybean cyst nematode (SCN) is the most damaging pest of soybeans in the U.S., says Jim Smolik, SDSU plant science professor. Losses nationwide are about $1 billion annually.

The SCN is a small, plant-parasitic roundworm (*Heterodera glycines*) that feeds on the roots of soybeans. Most nematodes are too small to be seen with the naked eye, though the adult females and cysts of SCN, at about 1/32 inch long, are big enough to be visible. SCN was first found in South Dakota in 1995 in Union County, though it has been present in Iowa and Minnesota since the late 1970s. It is now in 18 South Dakota counties.

Farmers may not even know their fields are infested with SCN. Up to 30% undetected yield loss can occur with no obvious above-ground symptoms.

So it pays to be alert to the potential for SCN damage, Smolik says. "It hasn't been found in all counties that grow soybeans, but the nematode is hardy and likely to survive wherever soybeans are grown."

THE SUCCESS OF ROTATIONS IN DEALING with SCN is underscored by Smolik and cooperating producers in southeastern South Dakota.

A soybean field in Turner County heavily infested with SCN was planted to alfalfa in 1998. Smolik measured the population density of SCN each fall. Numbers of soybean cyst nematodes dropped by a third over the first growing season and over the next two seasons remained at about 90% less than the original population.

Though still detectable at 5 years, populations of SCN had dropped below the detection level 6 years after the field was seeded to alfalfa.

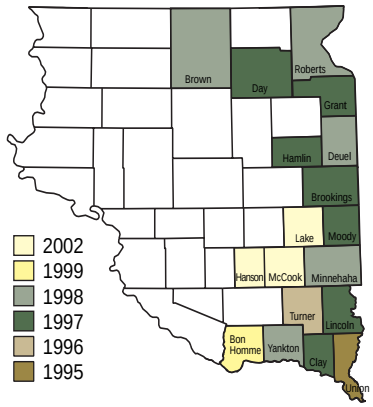
The best way to detect SCN is by soil sampling.

SOIL SAMPLING IS ONE OF THE FIRST THINGS in combating SCN, says Smolik.

Detection of the nematode can be complicated by its uneven distribution in a field, as shown by the results of a cooperative sampling program with Union County Fertilizer in 2003.

Two fields were sampled in a grid pattern, and then SDSU analyzed the samples to determine SCN populations.

South Dakota counties infested with SCN and year in which infestation was detected.



"It hasn't been found in all counties that grow soybeans, but the nematode is hardy and likely to survive wherever soybeans are grown."

—JIM SMOLIK, SDSU PLANT SCIENTIST

"In Field 1, only the northeast corner was heavily infested," reports Smolik. "SCN was not detected in much of the remaining portion of the field. In Field 2, SCN was distributed throughout the field, but populations were highly variable.

"The erratic distribution of soybean cyst nematodes in these fields highlights the importance of obtaining a representative soil sample for SCN analysis."

Smolik continues to survey for SCN in South Dakota. The nematode was not detected in any new counties in 2003, which leaves the total at 18 counties known to have SCN.

Some 32% of the 750 samples analyzed at SDSU in 2003 tested positive for SCN, Smolik notes. Even though the pest didn't expand its range to new counties, Smolik has found several new locations within counties already known to harbor the pest.

"In several instances the populations of SCN were very high and crop damage was noted," Smolik says.

SCN-RESISTANT VARIETIES WERE PLANTED beside susceptible varieties in a Turner County producer's field in 2003.

"Yields of the resistant varieties were significantly higher than the susceptible in this field-scale irrigated strip test," Smolik says. "Yield increases ranged from 25 to 48%. Population densities of SCN were greatly reduced on all of the resistant entries."

A second strip trial on non-irrigated land in Clay Country produced similar results.

"Yields of the resistant varieties were two to three times higher than the yield of the susceptible variety," Smolik says. "All the resistant varieties suppressed population development of SCN."

At a third strip trial in Union County, "performance of the resistant varieties was variable." Several of the resistant entries yielded significantly higher than the susceptible, where others did not. The effects of the resistant varieties on population densities of SCN were also variable. Populations of SCN on the resistant varieties were lower than the susceptible at harvest, but in many instances were still at high levels.

"This underscores the importance of a double-pronged response to SCN," Smolik advises. "Use rotations in combination with resistant varieties."

Non-host crops in the rotation can be corn, small grains, sunflowers, flax, canola, or alfalfa. "Don't use dry beans. They are an excellent host for SCN."

About 75 experimental lines were evaluated by Smolik and Roy Scott, SDSU soybean breeder, for possible sources of resistance to SCN in the greenhouse last winter.

"We identified several promising lines, and we evaluated those plus additional experimental material in a field study at the Southeast Farm near Beresford," Smolik says. "Several of the South Dakota entries appear to have a useful degree of SCN resistance."

These and other experimental lines are being further evaluated in 2004, Smolik says.

BREEDING FOR SCN RESISTANCE WILL CONTINUE to be a priority in the SDSU soybean program.

Scott says SDSU professor Catherine Carter can make that search for SCN resistance faster by using molecular markers to assess whether breeding lines have the genes that confer SCN resistance.

Scott was already familiar with SCN when it showed up in South Dakota. "I had already been crossing with SCN-resistant parents," he says. "That's where the SDSU variety Turner came from."

One drawback to Turner: Released in the 1990s, it is a conventional variety. Since producers are planting more and more transgenic soybeans that will tolerate herbicides, Scott is currently developing SCN-resistant varieties to fill that demand.

In addition, an emphasis of the SDSU soybean breeding program is to develop high-yielding, early maturing varieties with SCN resistance for soybean maturity groups 0 and 1. Those are the maturity groups grown in the area north of Brookings, Scott says. Although Minnesota has done some work on developing SCN resistance for group 1, those lines don't yield very well in South Dakota.

Work has already been done to find SCN resistance for maturity groups 2 and 3, grown in southeastern South Dakota.

THE NEMATODE STAYS AROUND, once it has infested a field, says Smolik.

"Once SCN has become established, there just is no practical way to completely eliminate it from a field. So we can only reduce the nematode below detectable levels. Very probably it is still there, but we can keep population densities below economic thresholds by rotating resistant varieties with non-host crops.◆

—Lance Nixon

Vikram Mistry and Bonny Specker

Won't drink milk? Eat cheese

Sunlight and milk are the primary sources of vitamin D, which is essential for bone density and muscle strength. But, during winter months in northern states such as South Dakota, most people have limited exposure to the sun.

Elderly people are especially prone to suffer from vitamin D deficiency, because the skin's ability to produce the vitamin from sunlight decreases with age. They are also less likely than younger people to consume fluid milk, which has been fortified with vitamin D since the 1930s.

But while older people consume less milk, they consume more cheese. That's why scientists at South Dakota State University are suggesting that cheese be fortified with vitamin D.

"Because of an aging population in the U.S., fluid milk consumption is decreasing. It becomes important to expand available food sources of vitamin D, and cheese was a logical choice," says Vikram Mistry, head of SDSU's Dairy Science Department.

Mistry and Joe Warthesen of the University of Minnesota were principal investigators in a research project to develop a method for adding vitamin D to process cheese. Praveen Upreti, an SDSU graduate student in dairy science, also worked on the project, which was funded by the Minnesota-South Dakota Dairy Foods Research Center.

"We selected process cheese, because it is consumed in large amounts. It is also easier to control the distribution of vitamin D than it would be in hard cheese, because of the vigorous mixing that occurs during process cheese manufacture," Mistry says.

Process cheese is primarily used as an ingredient in cooking and also is used in sandwiches, cheese melts, and cheese sauces.

CHEDDAR CHEESE BLOCKS WERE shredded, blended, and heated with direct steam injection in a process cheese cooker, and the scientists stirred in butter oil and emulsifier. Vitamin D_3 was added at a level of 100 International Units (IU) per 28 grams of cheese (equivalent to one serving) to the experimental cheese. Testing showed no vitamin D_3 loss during the manufacture of the cheese.

Storage stability tests showed no loss of vitamin D_3 up to 9 months at either room or refrigerated temperatures.

Vitamin D in high doses can be toxic, so it is important to know if the vitamin is uniformly distributed in the cheese or if some portions contain a higher level than others, Mistry says. Again, no differences were found among containers, indicating that the vitamin was uniformly distributed.

"Since process cheese is often used in ready-to-eat foods such as pizza, which is baked at high temperatures to melt the cheese, we also needed to determine if vitamin D remained stable under such heat conditions," Mistry says.

After heating at 232° C for 5 minutes, approximately 25–30% of both fat and water-dispersible vitamin D_3 was lost.

"Cheese should not be the only source of vitamin D. But it can be a supplement to other sources, and it can perhaps help boost vitamin D levels in the diets of elderly people."

—Vikram Mistry,
SDSU Dairy Science Department head

"We learned from this study that fortifying process cheese with vitamin D_3 is feasible," Mistry says. "The vitamin was uniformly distributed, it could survive manufacturing and storage, and while there was some heat loss, most of the vitamin was retained during cooking."

THE NEXT QUESTION WAS whether humans are able to utilize vitamin D in cheese, Mistry says. "We can fortify cheese with vitamin D, but can humans pick it up and benefit from it when eating the cheese? We needed to take the project to the next level."

In addition to Mistry, this project included Bonny Specker, director of the Ethel Austin Martin Program in Human Nutrition, and Matthew Vukovich of the Applied Physiology Laboratory at SDSU. Jana Johnson, a graduate student in dairy science, also contributed to the project, which was funded by the National Dairy Council. A hundred people aged 60 and older agreed to participate.

Vitamin D deficiency in older people might result in lower bone density and a greater risk of osteoporosis.

"Vitamin D is important for the absorption of calcium in the diet," Specker says. "If you're vitamin D deficient and unable to absorb enough calcium, your body takes it out of the bones. Bone mass decreases with age, and if calcium is leaching because of vitamin D deficiency, the bones are further weakened and you're at greater risk for fractures."

The study was conducted during the winter where there would be little or no interference with vitamin D absorption from sunlight. Subjects were randomly assigned to one of three treatment groups: process cheese fortified with vitamin D_3, process cheese with no vitamin D, and no cheese at all. The fortified cheese was made with 200 IU of vitamin D_3 per serving, and the subjects were asked to consume three servings per day, for a total of 600 IU. The current recommendation for that age group is 800 IU of vitamin D per day.

The study was conducted over a 2-month period, and vitamin D status was measured in blood samples at the beginning and end of the study.

CONTRARY TO EXPECTATIONS, the scientists found no differences in vitamin D level between any of the three groups.

"We asked ourselves why this happened," says Mistry. "Is it possible that older people don't have the capacity to absorb vitamin D from cheese? Does something happen in cheese that prevents vitamin D from being absorbed by the body? Or is the vitamin D bound by the cheese and not bioavailable?"

To test these questions, Mistry and Specker decided to conduct an additional study. This time, they recruited both young and old subjects and used either cheese or water fortified with vitamin D_2, testing for vitamin D status by blood samples.

Vitamin D_2 and D_3 have equal biological properties, but vitamin D_3 is the kind produced by sunlight and normally used for fortification of food. The scientists used vitamin D_2 for this study, which was conducted during the summer, to avoid interference from sun exposure or milk consumption, and they hiked the IU of D_2 up to 5,800, still a safe level for human consumption but surely detectable in blood samples. Including both younger and older people would answer the question about age.

Results of this study showed that vitamin D_2 was in fact absorbed from cheese, actually more efficiently than from water. The researchers also found that there were no differences between younger and older subjects; that is, age is not a factor in absorption efficiency.

So why did the researchers observe no effect in the first study?

"We came to the conclusion that 600 IU per day may not be enough to make a measurable difference," Mistry says.

SHOULD WE LOAD UP CHEESE with high quantities of vitamin D?

No, says Specker. "Vitamin D can be toxic in large quantities and there are susceptible groups within the population, such as children who may be consuming a lot of cheese and milk. People won't get vitamin D only from cheese, they'll also get it from fluid milk, sunlight, and perhaps from taking a multi-vitamin."

Mistry agrees. "We believe that we shouldn't go much beyond 200 IU per serving. Cheese should not be the only source of vitamin D. But it can be a supplement to other sources, and it can perhaps help boost vitamin D levels in the diets of elderly people. Cheese is not meant to be a medicinal product. Cheese is a food product."

"The most important conclusion from this research is that cheese can be a source of vitamin D," Mistry says. "I don't know if vitamin D fortified cheese will be on the market soon, but it's an option, and there has already been some interest from companies that manufacture process cheese." ◆

—Marianne Stein

Sheila Thomson, Steve Wall, and Tracey Mastel look for Topekas after seining Six Mile Creek.

'WAKE-UP CALL' from the Topeka shiner

He's just a little minnow, an average 2 inches long, a Topeka shiner.

His species had vanished from 90% of its historic range by the time it made the federal endangered species list in 1999. Now, however, things are looking up. In addition to federal recovery programs in other states, he also has his own specific South Dakota"management plan."

If he lives in Six Mile Creek, a tributary of the Big Sioux River, he might have a little adventure; he could be swept up in the seine of a fisheries team from South Dakota State University. Not to worry; he'll be released back into the stream again.

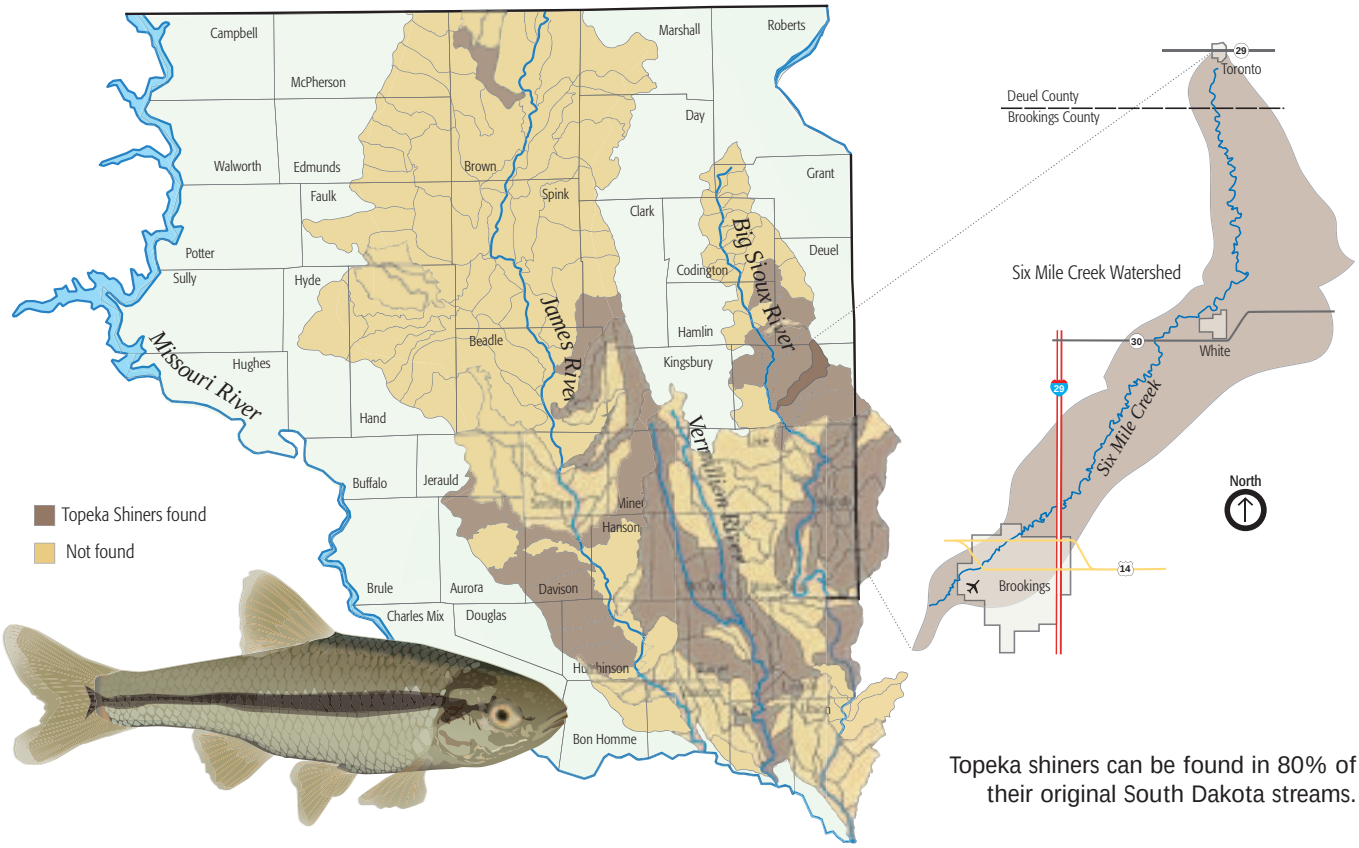
Why all this attention to a little fish?

The 1999 endangered species listing "was a wake-up call," says Chuck Berry, unit leader of the South Dakota Cooperative Fish and Wildlife Research Unit at SDSU. "Five years ago we didn't know much about the Topeka shiner.

"Now we know more about how it fits into stream and floodplain habitats. We have new information on its populations, new plans for its recovery, and new programs at agencies like the NRCS [Natural Resources Conservation Service], and SDDOT [South Dakota Department of Transportation] that can have big impacts on the species.

"And not just on him. There are all the benefits that extend to all the other fish, wildlife, livestock, and landowners who depend on a healthy stream ecosystem."

IT MAY COME AS A SURPRISE that the small tributaries of the Big Sioux, Vermillion, and James rivers have 20 to 30 species of fish in them. This high species richness, or biodiversity, is an indicator of a healthy stream ecosystem. So is the Topeka shiner, Berry says.



Topeka shiners can be found in 80% of their original South Dakota streams.

Its presence tells biologists that the stream will have little sediment, abundant invertebrate prey species, normally a gravelly stream bed, groundwater flow, and stable, and grassy banks. Besides being beneficial for other fish, that's also "a good deal for livestock," says Berry.

"In fact, we can usually count on good shiner populations in streams running through pastures where grazing is managed for sustainable grass production."

Topeka shiners can be found in 80% of their historically occupied South Dakota streams, and they're in places they've never been seen before. That tells fisheries scientists that "farmers have been doing things right on the land, with their conservation of soil and water," Berry says.

"On a good day in the James River drainage, we can get up to a hundred Topeka shiners in one seine haul."

It's more like what farmers don't do on their land that makes life easier for the Topeka shiner in South Dakota. National Wetlands Inventory data show that only 3% of South Dakota streams have been altered or channelized in East River.

In former Topeka shiner range, changes in land use probably lead the list of reasons the Topeka shiner is endangered, according to Jeff Shearer, SDSU graduate and senior author of the South Dakota management plan for the Game, Fish and Parks Department. Urbanization and residential development on farm land and intensive agriculture in more populous states to the south have most likely increased sediment load and degraded streams below the point the minnow can survive.

WHILE FARMERS ARE THE PRIMARY CARETAKERS of the Topeka shiner, scientists and state officials also have contributions to make.

From stream size, amount and timing of flow, groundwater potential, stream position within a watershed, and other geographical data, Steve Wall, research assistant in the SDSU Wildlife and Fisheries Sciences Department, has designed a GIS (Geographic Information System, a way to visualize and analyze spatial data) model that correctly predicts, 89% of the time, whether Topeka shiners will be present or absent in a stream.

And the Department of Transportation now has its first field biologist, a move prompted by the shiner.

"BMPs, best management practices, for road and bridge construction are already known. The problem is putting a good plan on paper into the dirt. Contractors have other things on their minds than protecting a little fish, but there are some things they can do to protect stream life," says Berry.

"The big thing is usually just putting some inflatable floating barriers in the water to keep the stream flowing and the work going. It's stuff we already know how to do."

THERE'S MORE BEING DONE. Sheila Thomson, graduate student; Wall; and Tracey Mastel, a senior biology student from the University of Minnesota-Moorhead regularly wade Six Mile Creek, a tributary of the Big Sioux River in eastern South Dakota. Their research will help farmers dig dugouts that meet NRCS [Natural Resources Conservation Service] criteria for technical assistance and partial funding in situations where an endangered species is found. The team hopes for rain and a flooding stream sometime this summer.

"We tend to think of a stream ecosystem as the water between the banks, but every other year or so, the stream jumps its banks onto the flood plain. This is a natural process,

FWS: South Dakota needs no critical habitat designation

The U.S. Fish and Wildlife Service (FWS) has announced that it is exempting South Dakota from critical habitat designation for the Topeka shiner, federally designated as endangered.

The state has "management plans that provide comprehensive conservation measures and programs to achieve recovery of the Topeka shiner," the FWS says.

The state management plan for the species, prepared by the South Dakota Department of Game, Fish and Parks (GFP), was based largely on a 5-year investigation of the distribution, abundance, and habitat needs of the fish by the South Dakota Cooperative Fish and Wildlife Research Unit based at South Dakota State University.

"This is one of the best examples of how research pays off with good information leading to decisions that help both the species and the landowners," says Chuck Berry, Unit leader and head of the Topeka shiner research team.

The federal decision says three things, Berry adds.

"First, it acknowledges the proactive conservation activities that the state has undertaken. Second, there is an economic benefit because the costs of designating critical habitat might have exceeded the costs of existing conservation activities. Third, fewer regulations are in effect for South Dakota agencies, landowners, and researchers.

"South Dakotans can be proud that their landowners, state agencies, and SDSU have been proactive about this little fish. We've been ahead of the game and need no federal oversight on management of the Topeka shiner."

the "flood pulse," and we are becoming more and more aware of the importance of the flood pulse to stream health and the health of the plants, fish, and wildlife that depend on the stream," says Berry.

When the stream rises out of its banks, it connects with secondary channels, backwaters, and wetlands, ponds, and dugouts. These places can be nursery areas for some animals, watering holes for others, and sources of nutrients for the stream.

"Just think of all the studies that one little minnow has started for all the other life in this creek," says Berry as he watches two of his team work a seine down the creek.

Nearby are two dugouts, marvels for the cooperation that went into their creation, says Berry.

"They were designed by NRCS, constructed on SDSU property, paid for by FWS [Fish & Wildlife Service], and monitored by USGS [U.S. Geological Survey]." In addition, NRCS is funding the entire 3-year study.

Even though one dugout is 2 feet lower than the other and in a swale that could receive creek overflow, neither has Topeka shiners.

"Give them time," says Sheila Thomson, graduate student in fisheries sciences and leading this study. "They're new last fall. Theoretically, based on GIS, that lower dugout should flood in one out of every 2 years."

Six Mile Creek in eastern South Dakota is site of Topeka shiner study.

THE TEAM IS HAVING BETTER LUCK upstream.

With the cooperation of private landowners, the crew is monitoring 20 dugouts that represent different degrees of flooding along Six Mile Creek. Eleven of the 20 have fish, and five have Topeka shiners.

They may be sources or sinks.

"Do flooded dugouts become places Topeka shiners like? Do they breed there and flush out again at the next high water and repopulate the stream again?" asks Berry. "Those are sources.

"Or do these dugouts become death traps for the Topeka shiners? Are the fish trapped in there with a big predator pike, or is the water quality bad, or is it too hot in the summer, and they die? Those dugouts will be sinks."

This year the water level has been low, but the finds are encouraging. Some unflooded dugouts have fish in them, including Topeka shiners.

"This means that the minnows survived the winter and predation in a confined environment," Thomson says. "We're seeing successful spawning, no winter kill, and in fact, actually higher numbers of Topeka shiners than last summer."

Decisions on funding new dugouts and dugout cleanouts in the floodplain are being held up until information is gathered from this study.

"Then we hope to tell people which types of dugouts are sources or sinks; where and how they can build dugouts to be good sources, be easy to flush; or how to build dugouts far enough away to never get any fish in them to start with," Berry says.

When the study is concluded, in somewhat less than 2 years from now, the NRCS will have new criteria for dugout construction that will meld the use of this type of livestock watering system with better fish and wildlife conservation.

Berry also has other hopeful plans for the dugouts on SDSU property.

"This pasture could become a great SDSU outdoor classroom or demonstration site for the public, where people can walk out and see how farming, ranching, and fish and wildlife conservation can coexist in the floodplain of a prairie stream."◆ *—Mary Brashier*

Distillers Dried Grains

Pet foods are big business. Could South Dakota corn growers one day cash in on the pet food market?

Another outlet for both corn grain and for distillers dried grains from ethanol production would add welcome value to the products, but two studies at South Dakota State University illustrate the value of "doing your homework first." They show that the science is far from settled and the economic returns are far from assured.

The science: Would DDG appeal to Rover?

Ethanol plants in South Dakota currently produce more than 1 million tons of distillers dried grains (DDG) in the process of making more than 400 million gallons of ethanol, according to estimates by the South Dakota Corn Utilization Council (SDCUC).

Each bushel of corn produces about 2.7 gallons of ethanol and 17 pounds of DDG.

The logical use for DDG is to feed it to animals as a high-protein feed, and that's exactly what corn and livestock groups have been advocating. Industry groups want to use the state's corn to grow the state's cattle feedlot and dairy industries, in particular.

South Dakota State University scientists and producers also are looking at DDG as part of the feed ration for hogs during some stages of production.

ARE THERE MORE USES FOR DDG than livestock feeding, asks Kasiviswanathan Muthukumarappan, associate professor of food and biological materials engineering at SDSU.

"We can feed cattle and other livestock DDG but there's only so much you can feed. So we need to diversify and use our DDG in other ways," Muthukumarappan says.

With partial funding from the SDCUC, Muthukumarappan and his graduate research assistant, Chirag Shukla, considered pet food. Muthukumarappan says DDG could supply the protein component that dogs need.

Using a small single-screw extruder in SDSU's Agricultural and Biosystems Engineering Department, the two scientists tried different ratios of ingredients to produce a puffed nutritious product that would appeal to Rover.

"We tried a lot of combinations," Chirag Shukla says. "All the way from 5% to 50%. But our main focus was around 20 to 25% DDG. We found that if you went beyond 30%, you

"We can feed cattle and other farm animals DDG but there's only so much you can feed. So we need to diversify and use our DDG in other ways," says Kasiviswanathan Muthukumarappan.

"Are there more uses for DDG than livestock feeding?"

—Kasiviswanathan Muthukumarappan, SDSU associate professor of food and biological materials engineering

don't get a well-formed product."

Corn flour provides the carbohydrate, also necessary to make the product bind, says Shukla. He and Muthukumarappan experimented with ranges of 25 to 55% corn flour, settling on the range of 30 to 40%.

Pork, at 5 to 15%, adds fat and flavor. Bone meal, at 5%, adds calcium.

Corn meal is another option. "DDG needs a vehicle to travel with," Shukla explains. "One of these is cornmeal. Cornmeal has a lot of starch, so it can puff, swell, and gelatinize much better than DDG."

Muthukumarappan and Shukla also are looking at technology to "puff" the pet food. Since protein does not readily expand, and since DDG is rich in protein, a way to expand a DDG-based pet food would likely make the product softer and more palatable to pets.

Muthukumarappan and Shukla have done some preliminary work at the Northern Crops Institute in Fargo, N.D., which has a twin-screw, industrial extruder that can produce a more intricately shaped product.

They are using DDG from the Dakota Ethanol plant in Wentworth, which is interested in possible new markets.

But putting all these pieces together is only part of the puzzle, Muthukumarappan says.

"How it looks, tastes, whether it is crunchy or soft—those are all important qualities." So far the product has not been tested on animals, but that's a step in the future.

THE PET FOOD INDUSTRY, with established sources for ingredients in its product, is likely to take a wait-and-see attitude about the SDSU research.

For example, the Iams Co. says DDG probably won't be in its immediate future. The company's corporate communications office added that the company wouldn't rule out looking at new ideas. But the company says that poultry and lamb, not DDG, typically supplies the protein in the Iams Co. dry product.

But what if scientists had turned their backs on the possibility, and what if bags of DDG pet food tumbled off the shelves and into the shopping carts—and somebody else benefited from this new use of an ethanol byproduct? "You can't let an opportunity slip by without exploring it," Muthu says. ◆ —*Lance Nixon*

The economics: no room for newcomers

South Dakota State University economists don't foresee a farmer-owned processing facility in South Dakota for making pet food.

The push toward value-added processing might intrigue producers, but the South Dakota State University economists say that a few established firms already control a large share of the pet food industry.

But that wouldn't rule out a role for South Dakota producers in selling inputs to the pet food industry.

Tonya Hansen, research associate, and Evert Van der Sluis, agricultural economist, used a grant from the South Dakota Corn Utilization Council (SDCUC) to study the feasibility of producing corn-based pet food in South Dakota.

PET FOOD COMPANIES use a substantial amount of corn in producing their products, but Hansen notes that's not always apparent from a quick glance at product information on the package.

"The first ingredient listed on the product label is considered the primary ingredient. Because consumers prefer to see a meat product as the first ingredient on the label, pet food companies traditionally get around that by listing corn as separate components.

"For example, you might see 'corn,' 'corn gluten meal,' 'ground corn,' 'corn grits,' 'corn bran,' 'cornmeal run,' and 'corn

Tonya Hansen replies that the pet food industry is full up with well-established sources for ingredients and that a newcomer would have to fight "tooth and claw" for a share of the market.

oil.' As a result, corn will not appear as the primary ingredient.

"Meanwhile, the label will likely list a protein source as the primary ingredient."

Hansen says there's no doubt that there's money to be made in the pet food industry, especially in the domestic market. The U.S. ranks first in the world in pet ownership, with 76.8 million cats—roughly one-third of all cats in the world—and 60.7 million dogs, according to 2002 figures.

That has made competition intense among established pet food firms. A newcomer trying to seize a share of the market would have to fight for it tooth and claw.

"For a new entrant, such as a group of farmers from South Dakota, there's a very slim chance for success because there's such a high degree of concentration in this market," Hansen says. "The industry competition is intense. A large amount of advertising dollars is spent by the established companies to maintain their individual market shares. This would pose a difficult challenge for a small new entrant to compete with."

Double-digit growth rates in the pet food market were common in the 1990s but are rarer today.

"The growth rates have slimmed down to about 5% a year," Hansen says. "That's still a steady growth rate, but not near the levels this market was achieving in the 1990s."

One change that has occurred in the petfood market between the late 1990s and the present is a decrease in the number of firms in this market and an increase in market share among remaining firms.

Eight firms accounted for 64% of the U.S. market for pet food in 1998, Hansen says. By 2002, however, the top seven firms held more than 87% of the market.

ON THE OTHER HAND, SOUTH DAKOTA sits in the middle of an expanding pet food market. Supermarket and drug store scanner data suggest that regionally, the largest rate of growth in pet products—dog food, cat food, cat litter, and pet supplies—was in the Plains states of North Dakota, South Dakota, Nebraska, Kansas, Missouri, Iowa, and Minnesota. For the year that ended Sept. 9, 2001, sales grew 11% for the region. In comparison, sales didn't grow at all in the Northeast and a mere 3.9% in the West.

The downside of that, Hansen cautions, is that, although the sales growth rate in the region is exceptional, total numbers of people and pets are smaller than in more urban areas of the country.

NATIONALLY, CHANGES IN THE DEMOGRAPHICS of pet ownership suggest the pet food industry will remain strong.

"U.S. households have moved toward owning multiple pets," Hansen says. "We are the country with the most dogs and the largest number of cats in the entire world, and we seem to have a desire to own multiple pets in each household."

And having multiple pets will likely only strengthen consumers' loyalty to the brands of pet food they already use, Hansen says.

So where might South Dakota producers fit in?

"There are probably some opportunities to contract directly with these companies so that they would have a constant supply of corn and ethanol byproducts.

"This may not be the venture that helps [farmers] keep more of the consumer's dollar in return for their quality product."

—TONYA HANSEN,
SDSU ECONOMICS RESEARCH ASSOCIATE

"However, then you wonder, have you moved any farther up the value-added chain? Pet food companies are going to buy their protein and carbohydrate sources as inexpensively as they possibly can. And selling inputs to them does not have the economic development effects that starting your own business would have in your local community.

"Farmers and ranchers desire to capture some of the profits that are made beyond the farm gate by moving away from commodities only. This may not be the venture that helps them keep more of the consumer's dollar in return for their quality product."◆ —*Lance Nixon*

Taking the calf away from Mom early: Can it pay?

Early weaning of beef calves may sometimes benefit producers because the mother cows consume less forage and show improved weights and body condition scores going into winter.

That is suggested by early data in a study involving South Dakota State University scientists working with colleagues at the University of Wyoming and North Dakota State University.

The study was funded by the USDA Cooperative State Research, Education, and Extension Service through the Four-States Ruminant Consortium. The consortium funds ruminant research in the abutting corners of the Dakotas, Wyoming, and Montana and is designed to enhance the economic strength of this semi-arid region, where ranchers are typically some 400 miles from their state's land-grant university campus.

Because producers in the area face the same problems, no matter their mailing addresses, scientists and Extension specialists from all four states work together without regard for state jurisdictions to provide the information and technology that assist the ranchers to build more profitable production and marketing systems, says Kevin Kephart, director of the South Dakota Agricultural Experiment Station (AES), who is lead coordinator for the consortium.

"They have now the opportunity to receive objective information that directly relates to their operations, no matter which is the lead institution on a project," Kephart adds.

Trey Patterson

"We want to enhance awareness ... of how early weaning/retained ownership programs can fit into production systems."

—Trey Patterson, SDSU beef specialist

THE EFFECTS OF WEANING DATE and retained ownership in adding value to cow/calf production systems is a consortium project headed by Trey Patterson, who has both Extension and AES appointments at SDSU.

"The study was designed to evaluate beef cattle production systems that have the potential to return more to regional ranchers, local feeding operations, and those producing and marketing local feed resources," Patterson says. "We want to enhance awareness and knowledge by Extension educators and producers of how early weaning/retained ownership programs can fit into production systems found in the four-state region."

The project compares early versus normal weaning/retained ownership systems for

- economic return to capital across weaning dates and retained ownership programs,
- forage utilization in late summer and fall,
- cow weight and body condition score change in late summer and fall, and
- calf performance and health.

An additional goal is to develop a predictive tool to determine the requirement for harvested/purchased feed inputs in early and normal weaning systems in the four-state region.

COW HERDS FROM THE SDSU Antelope Range and Livestock Research Station (140 cows), the NDSU Dickinson Research and Extension Center (88 cows), and the UW Beef Unit (90 cows) were used in the study. At each location, spring-born calves were weaned from cows at approximately 140 days (mid August) or 215 days (early November)of age.

Scientists monitored cow body weight and body condition score change between the August and November weaning dates to determine the impacts of weaning on cow performance. They also recorded calf weaning weights at each location.

Steer calves from Antelope and Dickinson were transported immediately after weaning to the NDSU Hettinger Research and Extension Center for an approximate 50-day backgrounding on a diet of locally grown forage and a commercial pellet made up of regionally available co-product feedstuffs.

Blood samples were taken from steers approximately 3 weeks prior to weaning, at weaning, and 7 days after arrival in the backgrounding phase.

"The blood samples will determine immune function and stress levels in the calves from each weaning date," Patterson says. The blood samples will also be used to measure the level of antibody titers, an indication of how well the animal's immune system is working.

Although admitting it is difficult to arrive at a precise measurement for stress, the scientists have chosen two markers. One is the glucose level in the blood, which increases with stress. The other is the level of non-esterified fatty acids in the blood. A high level of non-esterified fatty acids indicates that body fat is being broken down, which suggests the animal needs more energy than it is consuming as feed.

Following the backgrounding phase, Antelope and Dickinson calves were transported to a commercial feedlot for finishing. Carcass data were collected after slaughter at a commercial packing plant.

Steers and heifers from the UW Beef Unit were managed in a similar manner except that the cattle stayed in Wyoming for the backgrounding and finishing phases of the trial. Blood samples were not collected on the Wyoming cattle.

SDSU Range Scientists Roger Gates and Pat Johnson collected vegetation samples at the Dickinson location to determine if the utilization of range forage differed for cows suckling calves from August to November (normal weaning) versus dry cows (early weaned).

At the first weaning date (August), cows were moved into six pastures that had not been grazed previously that year (three pastures per treatment). The vegetation had been previously sampled to determine the amount of standing forage in each. All cows were removed after the second weaning date (November) and the pastures were again sampled to determine the amount of standing forage. The amount of forage remaining after grazing compared to that measured prior to grazing was used to estimate forage utilization for each treatment group.

COWS AT THE ANTELOPE STATION that had early-weaned calves gained 36 pounds from August to November and gained body condition, while cows suckling calves during that time lost 47 pounds (Table 1).

At NDSU's Dickinson Research and Extension Center, cows suckling calves from August to November lost 197 pounds and 1.2 in body condition score, while cows that had their calves weaned only lost 12 pounds and gained in body condition during that period of time (Table 2).

At the UW Beef Unit, cows suckling calves from August to November lost 64 pounds and .8 body condition score, while cows that had their calves weaned in August gained 21 pounds and maintained body condition from August to November.

The conclusions that can be drawn depend on the severity of loss, the starting body condition score of the cows, and the cost and availability of feed resources, Patterson says. For example, if cows were in good condition to begin with (i.e. a body condition score of 6.0), the implications of cows losing 0.8 of body condition score during the fall on reproduction would not likely be great if the cows did not continue to lose body condition for the rest of winter. Reproduction in young cows would be expected to be more sensitive to body condition score than in older cows.

"Early weaning is a management tool that can allow cows to maintain, if not gain, body condition during the fall, and it can be a potential benefit for thin cows," Patterson says. "Cows that are thin at normal weaning dates may require more feed inputs to achieve adequate body condition at calving."

NORMAL WEANING MIGHT BE ESPECIALLY HARD on young cows that are 2 to 3 years old, since they haven't achieved full growth and have higher energy requirements, says UW Extension Beef Cattle Specialist Steven Paisley, looking at the Wyoming data.

"I see early weaning as a distinct possibility for managing younger cows," Paisley says. "For producers who want to test the waters and give early weaning a try, those younger cows might be the ones to try it with."

Wyoming producers have been forced by drought to experiment with early weaning, especially in the past 2 years, Paisley says. Some producers have been forced to wean as early as June in some of the most severe drought areas. More typically, early weaning takes place in August or September. So far, Paisley says, producers have been pleased that it's worked so well.

THE PERFORMANCE OF ANTELOPE and Dickinson calves during the backgrounding phase is shown in Table 3. Normal weaning resulted in heavier calves at the initiation of backgrounding.

Early-weaned Dickinson calves had a higher average daily gain during backgrounding than normal weaned calves; calves from Antelope had similar backgrounding gains across weaning dates. Early weaned calves from both research stations converted feed to gain more efficiently during the backgrounding phase than normal weaned calves.

NDSU Animal Scientist Doug Landblom also notes that there was no death loss among the calves weaned early among steers from either the Dickinson or Antelope groups.

"We did experience some death loss among both Antelope and Dickinson steers weaned in November, one from the Antelope group and two from the Dickinson group."

Landblom offers some thoughts as to why he thinks the early weaned calves fared better. "Immunity from maternal influence, manifested from colostrum at birth, is likely greater in mid August than in November. Calves weaned early in August experience less weaning stress because seasons are not changing dramatically and the social bond between cows and their calves is less intense. Compared to early weaned calves, calves weaned in November have developed a stronger bond with their mothers, resulting in more intense weaning stress.

Table 1. Summary of early versus normal weaning for cows and calves in western South Dakota in 2003 (Antelope Research Station).

	Weaning Date		
Item	Aug. 12	Nov. 4	P Value
Cow Wt in Aug, lb	1341	1329	0.6795
Cow Wt in Nov, lb	1375	1281	0.0003
Cow Weight Change, lb	36	-47	0.0001
Cow Body Condition Score in Aug	5.63	5.65	0.8830
Cow Body Condition Score in Nov	5.97	5.63	0.0002
Cow Body Condition Score Change	0.34	-0.02	0.0001
Calf Weight in Aug, lb	407	403	0.7291
Calf Weight in Nov, lb	—	582	

Table 2. Summary of early versus normal weaning for cows and calves in western North Dakota in 2003 (Dickinson Research and Extension Center).

	Weaning Date		
Item	Aug. 11	Nov. 6	P Value
Cow Wt in Aug, lb	1285	1332	0.0724
Cow Wt in Nov, lb	1273	1135	0.0001
Cow Weight Change, lb	12	-197	0.0001
Cow Body Condition Score in Aug	5.52	5.52	0.8830
Cow Body Condition Score in Nov	5.91	4.32	0.0001
Cow Body Condition Score Change	0.39	-1.20	0.0001
Calf Weight in Aug, lb	386	405	0.0783
Calf Weight in Nov, lb	—	543	

Early data from a four-state beef consortium project led by Trey Patterson suggests that weaning the calf early could benefit northwestern South Dakota ranchers.

Additionally, calves weaned in November are subjected to widely fluctuating temperatures and challenging early winter storms, all of which compromise immune defenses."

Landblom is interested to see whether the pattern holds during the second year of the study.

COWS WHOSE CALVES WERE WEANED EARLY utilized 73% the amount of forage from August to November as did the cows suckling calves during that period of time. The early weaned treatment used 715 pounds/acre and the normal weaned treatment used 978 pounds/acre.

"That was a 27% reduction in forage utilization for the early weaned group. The difference in forage utilization was likely a combination of the early weaned treatment having lower total intake (cow + calf intake) and less trampling," Patterson says. "This forage-sparing effect of early weaning can be important in periods of drought, and may allow for a higher stocking rate when forage is available."

Table 3. Summary of backgrounding performance for North Dakota (Dickinson Research and Extension Center) and South Dakota (Antelope Station) steer calves weaned in mid-August or early November.

	Dickinson Calves		Antelope Calves		
Item	Aug Wean	Nov Wean	Aug Wean	Nov Wean	P Value
No. Steers	40	38	36	35	
Days on Feed	49	54	49	54	
Start Wt, lb	407[a]	553[b]	414[a]	600[c]	0.0001
End Wt, lb	578[a]	715[b]	568[a]	765[c]	0.0001
ADG lb/day	3.50[b]	2.99[a]	3.12[a]	3.05[a]	0.0060
Dry Matter Intake, lb	12.0[a]	12.5[a,b]	11.7[a]	13.2[b]	0.0270
Feed:Gain	3.44[a]	4.16[c]	3.76[b]	4.35[c]	0.0008

[a, b, c] within an row means without a common superscript letter differ.

ONCE ALL THE DATA HAVE BEEN COLLECTED, economists will begin looking at the potential economic return on investment if a producer retains ownership through various stages.

SDSU Economist Scott Fausti explains that once animals go to slaughter, he and Marty Beutler, Extension ranch management specialist, will begin assembling data to compare economic return from three scenarios: the producer sells calves at weaning, as producers traditionally have done; the producer sells calves after backgrounding, or when the animals enter a feedlot; or the producer retains ownership of the animals until they are slaughtered.

Fausti emphasizes that retaining ownership is actually a form of investment. Producers give up the traditional infusion of cash from selling their calves at weaning time to try to make more money from selling their animals after backgrounding, or at slaughter. Each year that will pencil out differently because of varying costs for feedstuffs, Fausti says.

Landblom adds, "Economics—whether a producer makes more money by weaning early as compared to traditional weaning—will be the single largest factor in whether producers adopt the practice."

Economists will also evaluate the monetary importance of differing forage utilization from early and late weaning systems.

BASED ON VEGETATION SAMPLING at the Antelope Station, range scientists will begin developing a forage production prediction tool.

"The objective is to develop a tool that can be used early in the grazing season to determine total forage production so that weaning and other management decisions can be made in an appropriate time frame," SDSU Extension Range Specialist Roger Gates says.

As the project progresses, scientists also will summarize immune response data, finishing performance, and calf carcass characteristics.

The project also includes a 2-year study evaluating the production and economics of developing early-weaned heifers on native range with dried distillers grain supplement compared to normal weaned heifers developed on hay and commercial cake.

Robin Salverson, SDSU Extension livestock educator for Harding County, says that, in Fall 2003, 65 heifers were randomly allotted to one of the two heifer development systems. Weights have been taken every 28 days to monitor change and develop appropriate supplementation. Both systems have been supplemented to reach the same target weight (65% mature weight).

Heifer weights, body condition scores, conception rates, pregnancy rates, and economic return will be recorded both years to determine if either system has had an affect on these parameters. Data from that portion of the study will be coming later.◆ *—Lance Nixon*

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