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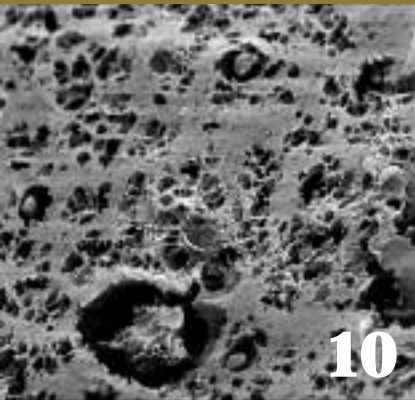
South Dakota State University • College of Agriculture & Biological Sciences • Experiment Station



**NO CRIME SCENE
OR VICTIMS, BUT THE
THIEF (SOYBEAN RUST)
WAS HERE**

**MEASURING THE CARBON CYCLE,
MOLECULE BY MOLECULE**

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On the cover:

There's a strong possibility that the "yield thief," Asian soybean rust, was prowling South Dakota last season. Spores were trapped on SDSU farms, but the state's soybeans were already mature enough that the fungus would have been unable to affect yield, even if it had managed to gain a foothold in the fields. Nor were last summer's dry conditions favorable for disease development. South Dakota freezing temperatures mean spores will again have to lift into the wind and blow north from their overwintering grounds in the South. Brad Ruden, SDSU Extension coordinator of the state's soybean rust sentinel plots, is again preparing the state's defenses.

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DIRECTOR'S COMMENTS

BY JOHN D. KIRBY

Director, South Dakota Agricultural Experiment Station

THERE IS A LOT GOING ON THESE DAYS...

I want to tell you about some of the exciting things happening in the SDSU Agricultural Experiment Station these days.

I have had the opportunity to interact with a good number of folks over the past 6 months as I have traveled around the state visiting each of the stations, the field days, and meeting with a broad array of producer and industry groups. However, I know I am visiting with only a relatively small number of all the people who have interests in agriculture and our research. To better get the word out, we use our publications like this one to keep folks up to speed on some of the interesting and important work our faculty, students, staff, and partners are doing for the benefit of South Dakotans.

As a brief introduction, I came to SDSU in May of this year. Previously, I was on faculty in the Division of Agriculture at the University of Arkansas in Fayetteville. As a scientist I studied male reproductive biology (in chickens) and worked on industry related problems in fertility and performance, primarily using research tools developed through the chicken genome project. I also directed a campus program in cell and molecular biology and the campus genomics lab—lots of high technology to solve real world problems in agricultural production and animal genetics.

Here at SDSU, our faculty, commodity groups, producers, and other members of the agricultural community are working hard to enhance our overall research portfolio to provide “focused excellence” in key areas. These areas of excellence will allow us to develop even stronger research programs that have real, measurable impact.



John Kirby

One of those areas involves enhancing our capacity in human nutrition research to help better understand nutrition, human health, and obesity. These efforts are led by faculty in the College of Family and Consumer Sciences. One essential ingredient in these efforts is the integration of our AES scientists and our Cooperative Extension partners; this integration will provide better access to information and a fresh perspective to our mission-oriented and problem-solving research objectives. Over the coming year and beyond you will see how this integration and collaboration contributes to South Dakota well-being.

Another area of excitement is the development of the seed technology program at SDSU. This involves the building of a new Seed Technology Building at the Innovation Research Park adjacent to the SDSU campus and the development of the Drought Tolerance Biotechnology 2010 Center proposed by Governor Rounds. South Dakota farmers and producers through the various commodity and promotion boards have provided \$4.25 million to kick the project off. That contribution, coupled with the proposed investment by the state via the 2010 initiative, puts us well on our way to breaking ground next summer and opening the doors in 2008.

Thank you for the opportunity to present some of the exciting things going on. We consider each of the research stations to be a vital and essential piece of the total package. If you have any questions or concerns please stop by and speak with me or send an email (john.kirby@sdstate.edu).

I look forward to the opportunity to work with all. ^u



Brad Ruden

No crime scene or victims, BUT THE THIEF WAS HERE

It's a little like a crime stopper program that targets a burglar with a known MO.

It's South Dakota State University's ongoing monitoring for the soybean rust that robs producers of yield.

And there were signs in 2006 of the plant pathology equivalent of fingerprints left around the neighborhood, though the disease never quite forced an entry into South Dakota fields.

"We have fairly good evidence that at least the spores of the soybean rust pathogen likely made it to South Dakota during this growing season, albeit late in the growing season," says

Brad Ruden, SDSU Extension's coordinator of the state's soybean rust sentinel plots.

"Having the spores here means that the precursor to disease development was here. But the disease itself did not develop in South Dakota this year."

A STAKEOUT HAS BEEN ACTIVELY maintained by SDSU and other land-grant universities in all soybean producing

states since the pathogen was first introduced into the U.S. several years ago.

“All soybean samples submitted to the Plant Diagnostic Lab at SDSU throughout the summer of 2006 were scanned carefully for any sign of soybean rust, along with other pathogens. No suspect samples were found,” states Ruden.

“In addition to lab samples, our primary method to monitor for soybean rust in South Dakota for the past 2 years has been sentinel plots,” Ruden commented. Sentinel plots, small plots of soybean that have either been planted especially for this purpose or small areas that have been selected from within existing producers’ fields, have served as the early alarm system protecting South Dakota’s soybean producers.

This year 33 separate plots were established at 26 sites throughout the soybean production areas of South Dakota. Marty Draper, SDSU Extension plant pathologist, was overall project leader, with Brad Ruden coordinating the sentinel plot network and Kim Maxson-Stein, SDSU plant diagnostician, leading the laboratory analyses.

The sentinel plots were a part of a larger sentinel plot network, officially called the “PIPE” Program, a USDA cooperative effort with land-grant universities. “PIPE stands for the Pest Information Platform for Extension and Education,” explains Ruden.

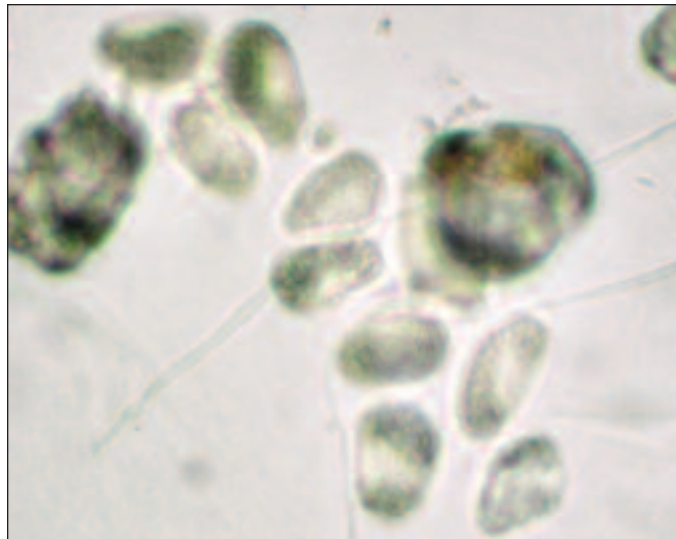
Each of the sentinel plots was monitored in detail on a weekly basis by a county Extension agronomy educator who had received training in identifying soybean rust and other soybean pathogens. “Monitoring a sentinel plot takes a tremendous amount of effort. I cannot tell you the dedication that the county Extension agronomy educators put into this project,” Ruden says.

Sentinel plot data is collected, analyzed, and fed into a national database, which is then made available to producers through a website, www.sbrusa.net.

NO FOLIAR DISEASE OF SIGNIFICANT economic concern was found in the sentinel plots during 2006. The sentinel plots were, however, supplemented by the addition of two dry-deposition spore traps located at sentinel sites in eastern South Dakota. It is these spore traps that tripped the alarm this past summer.

During the last week in June of 2006, two “soybean rust-like spores” were detected at the trap at the Southeast Research Farm near Beresford. However, weather data from the site suggests that dry conditions were not favorable for development of the disease. In addition, the identification of those spores as soybean rust spores was “very tenuous,” Ruden notes. They were the right color for soybean rust, but because of rapid desiccation associated with the dry weather, the spores were not the right size and shape.

Far more worrisome was a find on August 28 in a spore trap at the Brookings Agronomy farm—10 spores in one cluster and another four spores elsewhere on the same trap. The trap, part of a network sponsored by Syngenta Crop Protection, was simply an ordinary microscope slide smeared with a thin 1-inch square layer of Vaseline and placed inside a piece of 4-inch PVC pipe mounted on a wind vane. Whatever blows through that wind vane and across the slide for a week’s time is captured in the gel so that experts can look at it under the microscope later.



Soybean rust spores found on August 28 in a spore trap at the Brookings Agronomy farm.

University of Arkansas plant pathologist John Rupe, one of the nation’s experts in identifying soybean rust spores, found that size, shape, and hyaline color (clear to very light tan) fit the description.

“From the best expert opinion we have, these appear to be soybean rust spores,” Ruden says. “They certainly are the right color, the right shape, the right size, for soybean rust. We cannot prove it genetically, there were not enough spores on this slide to do PCR (polymerase chain reaction) analysis to look at the DNA of these organisms. But from a basic morphology point of view—visual observation—they appear to be soybean rust spores.”

Wind charts for the week immediately before August 28 show that, starting on about August 24, wind patterns were right to bring packets of air from northern Louisiana and eastern Texas into South Dakota, says SDSU Extension State Climatologist Dennis Todey. But this occurred over a 2- to 3-day period, likely exposing the rust to sunlight and reducing chances of the spores being viable. During that same period of time, Louisiana was just moving into a period of favorable weather for soybean rust development and the disease was beginning to increase.

About a month later a similar pattern led to a huge outbreak of soybean rust in the Mississippi and Ohio valleys of Arkansas, southern Illinois, the Missouri bootheel, Tennessee, Kentucky, and southern Indiana.

“What we don’t know about these spores is whether they were alive or dead when they arrived in South Dakota. The viability of these spores over long-distance transport is still somewhat of an unknown,” Ruden says. “We do know that the spores do not survive particularly well with long-term exposure to ultraviolet light, but exactly what conditions it takes to help those spores survive is still being investigated.”

Survivability could be higher if spores are riding wind currents at night or during storms with heavy cloud cover—the sort of conditions that can also help generate the uplift and wind patterns needed to move the spores long distances.

“What we don’t want is for producers to forget about this disease. ... Because we’ve gone 3 years now without the disease, does that mean that it will never make it here? I don’t think we can say that.”

—BRAD RUDEN,
SDSU PLANT SCIENTIST

SOYBEAN RUST SPORES APPARENTLY MADE it to South Dakota in 2005 as well but were apparently dead when detected, says Marty Draper, longtime SDSU Extension plant pathologist and now the national program leader for plant pathology for the Cooperative State Research, Education, and Extension Service (CSREES). They were found in a system called the National Atmospheric Deposition System that monitors rainfall nationwide and has been modified to collect soybean rust DNA in rainwater, including at the Range & Livestock Research Station at Cottonwood between Philip and Wall and at Huron. The 2005 collection occurred at Cottonwood.

It’s also unknown how many spores are needed to generate an outbreak of disease, but Ruden said the August 28 event might have been enough to do the job. Unlike the June find at Beresford, the August arrival also came at a time when weather conditions would have supported growth of the disease.

“Certainly 14 potential spores per square inch is a high enough inoculum load to cause an infection if we have the right environmental conditions, but what is the minimum number? That is a little bit less understood,” Ruden says.

“There is also an association with time. While 14 spores per square inch might start an epidemic, we don’t know how many cycles of the pathogen would be needed to allow detection of the disease. The outbreak in the Mississippi and Ohio River valleys was very late in the year, but the sites where the disease was detected varied considerably in the amount of disease present at each site, from one infected leaf in 100 sampled to 40% infection. In some cases the first disease at a site was detected 2 to 3 weeks later than the initially detected sites. This is likely due to the non-uniform deposition of spores across a wide area and that smaller numbers of spores require more infection cycles to reach a detectable level. From infection to spore production takes 7 to 14 days and varies with temperature and moisture.”

The August 28 find prompted intense scouting and sampling in the next weeks by SDSU personnel. They collected leaf samples, incubated them to induce sporulation in the diagnostic lab, and examined them individually with transmitted light and by microscopic examination of suspect samples. They found no soybean rust infections.

EVEN IF SOYBEAN RUST HAD DEVELOPED from that event, it would have taken several disease cycles to get well established, and by then soybeans were beginning drydown, past the stage at which soybean rust can do damage, Ruden says.

“In South Dakota our risk period is approximately from July 15 to August 15, from the reproductive stages to the R5 and R6 stage. If soybean rust spores can make it here before that and if they have good conditions right at the beginning of those reproductive stages, we may have a time when we need to be spraying.

“Are we going to spray three times, like they have in some areas of the southern United States? The answer is no. I would estimate that at most we would be applying one fungicide application, and in many years we’re not going to be applying it at all.”

He adds that producers should keep in mind that drought conditions in the southeastern U.S. hindered development and spread of soybean rust in the early part of the 2006 growing season. With normal conditions, the disease might have been better poised to leapfrog to other parts of the country.

“What we don’t want is for producers to forget about this disease. Is soybean rust likely to be here 3 out of 5 years? The answer is probably not. Because we’ve gone 3 years now without the disease, does that mean that it will never make it here? I don’t think we can say that.

“The message for growers is this. Keep your eyes open, keep your ears open to what’s happening with soybean rust. There is a monitoring network in place across the United States, the sentinel plot network. That network will exist in some form next year. It will give us the best warning of where soybean rust is developing.

“I would guess that the soybean rust spore-trapping network will also exist in some form in another year. The spore trappers may give us some additional early warning.”

Ruden also recommends that producers monitor a USDA Web site, www.sbrusa.net to learn where soybean rust is currently developing on kudzu or on soybeans. The side benefit is that it also records where soybean aphids are showing up. That network may be expanding in the future also, Ruden adds. ♦

—Lance Nixon



MCCRORY GARDENS: TURNING 40 AND STILL GROWING

As South Dakota State University marks its 125th year in 2006, one of its associated showpieces is marking a different anniversary.

It was the early 1960s when SDSU's Department of Horticulture, Forestry, Landscape, and Parks began development of what is now known as McCrory Gardens, envisioned as a showcase for some of the ornamental plant material used for research and teaching at SDSU.

It was 1966 when a highly maintained 2-acre formal area along Sixth Street in Brookings was started. It would soon display a dazzling array of annual, perennial, and ground cover plants. An additional 10 acres was used for woody ornamental research and instructional purposes by the Department.

From the start the area has been open to the public at no charge, and it quickly became a regional attraction for garden enthusiasts. The formal garden site was named "McCrory Gardens" to honor Professor S.A. McCrory who headed the department from 1947 until his death in 1964.

"Professor McCrory had envisioned a research garden that would display trees, shrubs, grasses, and flowers that were or could be a part of South Dakota's landscape. That vision—the selection, evaluation, and display of ornamental plants for South Dakota's climate—is still the prime directive for all the



work done at the Gardens,” David Graper, professor and Extension specialist for home and commercial horticulture and McCrory Gardens director, says. “McCrory Gardens is unique in the nation because of the variety of ornamental plants, all placed in harmonious settings to display them to their best advantage.”

The area north of the formal garden was dedicated in 1982 to the planting and testing of ornamental trees and shrubs. The 45-acre site was designated the South Dakota State Arboretum in 1988.

A MAJOR FUND CUT LOOMED in 1985, and supporters launched a fundraising drive. The local community, state and local businesses, and horticultural enterprises and associations throughout South Dakota raised funds to keep the Gardens open and growing.

That effort continues to this day. An endowment, managed by the SDSU Foundation, was established in 1986 and, since that time, all maintenance and development at McCrory

Gardens has been supported by public donations of money, equipment, labor, seed, plants, and other supplies.

“The ‘Friends of McCrory Gardens’ are a continuing source of enthusiastic support,” says Graper.

As it marks its 40th year in its Sixth Street location, McCrory Gardens now comprises about 20 acres of floral botanical gardens, as well as 45 acres of arboretum.

Graper says that what the public gets from McCrory Gardens, in addition to the chance to enjoy the garden for free, is a firsthand look at how different species of flowers, trees, and shrubs fare on the Northern Plains; plus a professional evaluation of plant material.

From the beginning, the Gardens have been an All-America Selections (AAS) display site. All-America Selections, or AAS, is an organization that relies on McCrory Gardens as one of only 36 AAS “trial ground” sites around the U.S. that evaluate different varieties of plants to learn how well they do in different settings. All-America Selections also has seven sites in Canada.

“That vision—the selection, evaluation, and display of ornamental plants for South Dakota’s climate—is still the prime directive for all the work done at the Gardens.”

—DAVID GRAPER,
McCRORY GARDENS DIRECTOR

All-America Selections promotes new garden seed varieties that show superior garden performance when evaluated in impartial trials across North America.

“Each year they send out probably six to 10 varieties that we have to evaluate. There are all these other sites around the country that are evaluating those same materials,” Graper says. “Each one of us judges rates those materials. If something is given high enough marks by enough judges, it’s then given this All-America designation. That’s a good indication to consumers that this plant did well in most of the trial sites around the country, so it’s probably going to do well in their yards or gardens.”

PAST WINNERS IN THE ALL-AMERICA TRIALS also are grown for visitors to see.

“That’s certainly something we want to continue and expand on,” Graper says. “It’s kind of a concentrated area where people can come out and see lots of these All-America Selections winners to get an idea of how they look and how they perform here in Brookings. We’ll be making sure that we get as many All-America trial winners in that area as possible.”

Past All-America Selections winners typically are readily available to consumers because greenhouse producers try to carry such proven varieties.

McCrary Gardens currently takes part in the AAS flower trials. But the AAS also has bedding plant trials and vegetable trials. It’s possible that McCrary Gardens will be involved in the bedding plant trials at some point, Graper notes.

All-America Selections is not the only trials program McCrary Gardens participates in. It also takes part in the NC7 trials.

“Those are trials for woody plant materials. Each year we probably get about five different trees or shrubs through that program.”

The NC7 program has sites scattered throughout the

northern Great Plains and Upper Midwest. Trials generally last 10 years.

“Again, it’s another way for breeders to get new materials out into the botanic gardens and arboreta and get them evaluated and expose people to these new varieties.”

Graper says it’s quite prestigious for McCrary Gardens to be one of the evaluation sites for such programs as AAS and NC7. One side benefit is that it also makes some free plant material available to the garden. That is always an issue for an operation as large as McCrary Gardens.

“We probably spent \$500 to \$1,000 just on seed last year. For living plant materials that we added to the garden we probably spent \$2,000 to \$3,000, and that’s without even putting in any new gardens. We really need help to purchase those plant materials and for the general labor to get those plant materials propagated, put in the ground, and maintained for the summer. Just general garden maintenance is our biggest source of expense each year.”

YET ANOTHER BENEFIT of the trials programs is that McCrary Gardens becomes more valuable as an educational resource for homeowners and horticulture-related business owners. SDSU classes also meet there.

“We’re really trying to work at providing that in-the-field demonstration of these new materials so people can come out there and compare one variety with another and see which ones are up-and-coming plant materials. It’s a resource not only for the homeowner but also for the area nurseryman or greenhouse grower,” Graper says.

“I think one of the biggest things we’re trying to do with that outreach component is to have more information available for people on the spot. We’re concentrating on updating our labeling of plant materials so that when folks come out they can identify the plant materials that they like.”

Gardeners can learn more about All America Selections at its Web site, <http://www.all-americaelections.org> ♦

—Lance Nixon



David Graper



Hard science and soft cheese

Ashraf Hassan

Ashraf Hassan, assistant professor of dairy science at South Dakota State University, is putting hard science to work improving cheese quality—and the dairy industry is taking notice.

Hassan won this year's prestigious American Dairy Science Association Foundation's Scholar Award for outstanding research and teaching in dairy foods. The ADSA Foundation gives two such awards each year to young researchers, one in dairy foods and one in dairy production.

Hassan won the Scholar Award based on 10 years of dairy foods research, starting when he graduated from the University of Georgia and including his 3 years of work at SDSU.

He received the award during the ADSA's annual meeting in Minneapolis at the same time that another SDSU colleague, Distinguished Professor David Schingoethe, won the ADSA Award of Honor for his outstanding lifetime contributions to dairy science.

HASSAN'S WORK FOCUSES ON exopolysaccharide-producing cultures. Specifically, he's working on ways to use exopolysaccharides in low fat cheese to perform the same role that fat serves in full fat cheese: to interrupt the hard protein network or matrix so that cheese is softer and smoother.

"People are aware now of the health problems associated with a high-fat diet. So the low fat dairy products are gaining popularity," Hassan says. "The problem is that when you reduce fat, the texture and mouth feel become very poor."

Reduced fat cheese typically becomes very rigid and rubbery. As a result, Hassan says, consumers don't like the texture, although they want to eat more reduced fat cheeses because of

the health benefits associated with lowering fat intake.

Cheese makers try to deal with the problem by increasing the moisture. That makes low fat cheese softer and less rigid. But the added moisture also makes the product pasty and almost impossible to shred, so cheese becomes soft and weak, yet rubbery.

Hassan went to work on this problem after years spent studying different polymers, or complex sugars, called exopolysaccharides that are produced by some bacteria.

"Since we use bacteria in making cheese, we selected some strains that are able to produce polymers. A polymer is a complex sugar. It does not affect the taste of cheese but it has a high ability to bind water. This reduces the rigidity of cheese and makes it smoother."

Hassan's work was easier because he'd already developed his own techniques to observe dairy product microstructure by confocal laser scanning microscopy. This technology provided, for the first time, observation of microstructure of dairy products in their natural state.

Vikram Mistry, head of SDSU's Department of Dairy Science, says Hassan started from an observation that lactic cultures produce exopolysaccharides (EPS) in two different forms, unattached to the cells and attached in the form of a capsule.

Hassan saw that the capsular EPS modified the microstructure of yogurt and cheese curd by interrupting the protein matrix, in the same manner milk fat globules do.

“What we see in cheese is a 3-D network of proteins. Fat is trapped in this network, and this fat decreases the rigidity of the network. When we remove fat, the protein network becomes too compact, too tight, too dense. You need weak spots in the network.”

—ASHRAF HASSAN,
SDSU DAIRY SCIENTIST

IN OTHER WORDS?

“What we see in cheese is a 3-D network of proteins,” Hassan says. “Fat is trapped in this network, and this fat decreases the rigidity of the network. When we remove fat, the protein network becomes too compact, too tight, too dense. You need weak spots in the network.”

SDSU, in successfully creating a low fat Cheddar with very similar qualities to full fat cheese, used exopolysaccharides to interfere with that protein network in the same way as fat. Other universities had tried it before, but not successfully.

“We produced all-natural, reduced fat cheeses with texture and mouth feel similar to the full fat counterpart,” Hassan says. “Sensory specialists—people who know how to evaluate cheese—did not find any difference between the reduced fat and full fat cheeses.”

That’s because the exopolysaccharide Hassan used in SDSU’s low fat Cheddar has a high ability to bind water, which then makes the cheese smoother and softer. And because the water is bound to the exopolysaccharide, not free, it doesn’t make the cheese pasty.

Hassan has published some of his findings in dairy science journals, but he still can’t discuss all the details because some of his work may deserve protection as intellectual property.

“We think the technology that will develop is patentable, and we are talking to some companies to commercialize it. Our ultimate goal is to see this product on the market. This definitely would increase the sale of reduced fat cheeses,” Hassan says.

And that, he adds, would reduce fat intake, which translates into better health for consumers.

Cheese lovers may receive another health benefit: Studies at other universities have shown that polysaccharides may decrease the risk of cancer and improve the immune system. More research is needed to say which polysaccharides might be best at conveying those health benefits. Hassan and researchers elsewhere will be pursuing that area of research in the future.

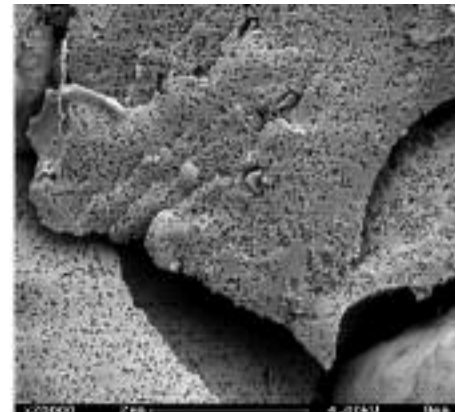
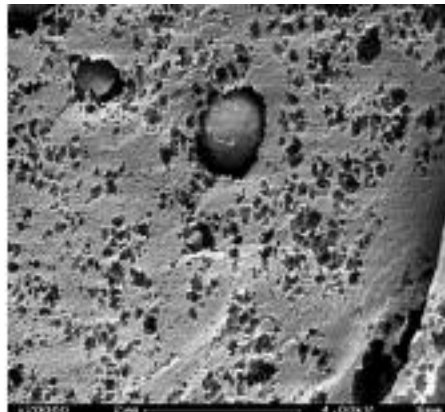
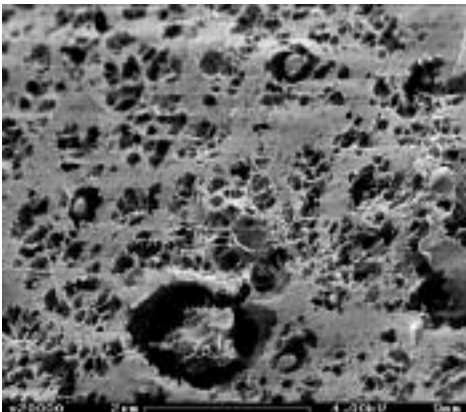
“I am trying to collaborate with other scientists at SDSU to study the relationship between the structure of exopolysaccharide and its anti-cancer effect,” Hassan says.

His exopolysaccharide research is supported by the Agricultural Experiment Station and Midwest Dairy Foods Research Center.

IN A COMPLETELY DIFFERENT research project, Hassan is also exploring whether exopolysaccharides can make it easier and cheaper to make processed cheese.

“When we make processed cheese, we mix young cheese with aged cheese. We cannot use 100% young cheese because young cheese is very rigid. Even full fat cheese is stiff. During cheese ripening (maturation), the structure becomes softer and softer. But cheese ripening is a very expensive process. If we use exopolysaccharides in making cheese base (cheese used as an ingredient in making processed cheese), it becomes softer, easier to melt. This would allow us to use more young cheeses in making processed cheese. This would save the industry a lot of money because aged cheese is very expensive.”

That research will continue at SDSU. ♦ —Lance Nixon



In photomicrograph at far left, large dark area is an “exopoly” pore. Large pores are “weak spots” in a protein network that make a reduced fat cheese softer and more consumer-friendly. In center, a fat globule rests in a large pore in a full fat cheese, adding softness, taste, and calories. At right, a reduced fat cheese with no exopolysaccharides is very dense, rubbery, and unattractive in “mouth feel.”



Don Auger and
Nick Gau

When is a weed not a weed?

“What is a weed? A plant whose virtues have not yet been discovered,” said Ralph Waldo Emerson back in the late 1800s.

Cuphea (KOO-fee-uh) is a plant that grows bountifully in South Dakota and Minnesota. You can call it a weed. You can call it an ornamental. You can't call it a crop plant. Yet.

But its virtues are in the process of being discovered.

Don Auger, South Dakota State University assistant professor of biology and microbiology, and Nick Gau, an undergraduate student from Marshall, Minn., in biology and clinical laboratory science, are helping producers come closer to cultivating the plant.

Why would they deliberately plant a weed?

The oil in cuphea's seeds has special properties that resemble coconut and palm oil. If the plant can be cropped, the oil can be extracted and used for detergents in products like soap and shampoo, replacing imported palm and coconut oil. Although commercialization may be years off, at least one brand-name company has cuphea on its agenda as a source of lauric acid for detergents and possibly nutraceuticals.

“Identifying molecular markers should assist in breeding efforts to make cuphea more agronomically acceptable.”

—DON AUGER,
SDSU BIOLOGIST

Another potential application is as an additive to biodiesel. The University of North Dakota’s Energy & Environmental Research Center (EERC) is studying the use of cuphea oils to improve the cold-flow properties of biodiesel. At cold temperatures biodiesel fuel thickens, but adding cuphea oils reduces the fuel’s freezing point. This work is supported by the U.S. Department of Energy, the Agricultural Utilization Research Institute, and Technology Crops International.

“It has also been suggested that cuphea could be rotated with corn and soybeans,” Auger says. “That could help disrupt the life cycle of corn rootworms, because it was recently demonstrated that cuphea does not support corn rootworms.”

CUPHEA ISN’T TAKING KINDLY to domestication.

Because cuphea has only recently been subjected to artificial selection, it has persistent attributes that serve it well in the wild state but may be detrimental to its agronomic value. For example, most cuphea species are covered from head to toe—stems, leaves, and flowers—with sticky or glandular hairs. The hairs may help defend it from insect pests; aphids, for example, can mire down among the hairs of several cuphea species. This stickiness may or may not interfere with efficient machine harvesting.

The very traits that make it most difficult to tame are the ones that have assisted its survival in the wild, and the genus was left alone in the wild until the late 1980s. Seed dormancy, susceptibility to frost, and indeterminate growth can most likely be overcome by breeding. Perhaps the most important problem is seed shattering, which maximizes seed dispersal for wild cuphea. Unless curbed, it will seriously affect yield. According to researchers at the U. S. Agricultural Research Station in Morris, Minn., over half of the seeds are lost when cuphea is harvested mechanically.

Auger aims to develop genetic tools that will aid plant breeders in domesticating this plant.

“Identifying molecular markers should assist in breeding efforts to make cuphea more agronomically acceptable,” Auger says. “The breeder will identify traits that are useful for domesticating cuphea, and then use DNA sequences that are associated with those traits as markers to assist with selection of those traits.”

This marker-assisted selection speeds up the breeding process. Instead of waiting to identify mature plants with the desired traits every generation, researchers analyze the DNA and identify plants with the molecular markers that are associ-

ated with those traits.

In cuphea, breeders would, for example, be looking for plants that are able to hold their seeds, Auger says. “As a wild plant, cuphea shatters its seed capsules continuously. If it is to be cultivated it needs to hold on to the seeds until harvest. Breeders are looking for a tighter seed capsule that will keep the seeds until autumn.”

His first step is to look for DNA polymorphisms that can be associated with certain traits. DNA polymorphisms are differences in DNA sequences among individuals and are the basis of DNA fingerprinting that is used in forensics. Among the most common source of polymorphisms are simple sequence repeats (SSR)—strings of DNA that repeat the same combination of a few nucleotides again and again, for example adenine-thymine, adenine-thymine, etc.

“These repeated sequences tend to be variable in the number of repeats from one individual to another. For example, there may be 12 repeats of adenine-thymine at a certain location of a chromosome from parent A, while parent B has 16 repeats on that same location on its chromosome. The difference in the number of repeats can be easily distinguished in the laboratory.

“If a particular desirable trait is associated with an SSR with a repeat of a particular size, then it indicates that this trait has a genetic component that is located on that chromosome near that SSR marker.”

To find SSRs in cuphea, Auger and Gau extract cuphea DNA and cut it into pieces using enzymes. They then attempt to enrich the DNA sample for those pieces that have simple sequence repeats and amplify those fragments using Polymerase Chain Reaction (PCR). They clone the PCR products and have the clones analyzed to determine the presence of SSRs.

Gau says his career goal is to work with medical technology in a hospital laboratory and that his research gives him valuable experience and also makes him “more marketable” for jobs or graduate schools.

The project received funding from the Governor’s 2010 Research Initiative and from the South Dakota Agricultural Experiment Station. Auger’s work is conducted in cooperation with Jose Gonzalez, plant science assistant professor at the recently established SDSU Seed Technology Laboratory, and with Abdullah Jaradat at USDA-ARS in Morris, Minn. ♦

—Marianne Stein

An interview with Extension's beef feedlot specialist



Erik Loe

Erik Loe (pronounced: Low) is the new beef feedlot specialist for the South Dakota State University Cooperative Extension Service. A native of McVille, N.D., Loe holds bachelor's and master's degrees in animal sciences from North Dakota State University, and a doctoral degree in animal sciences and industry from Kansas State University. He was manager of the KSU Beef Cattle Research Center for 3 years while working on his doctorate. What follows is a question-and-answer interview with Loe.

Q: What will your role be at SDSU, and how can producers contact you?

A: I am the Extension beef feedlot specialist. In that position I'm involved with Extension educators across South Dakota, working with them and with cattle feeders. And I work with cattle feeders directly in situations where I can be of assistance with nutrition or management concerns.

I also have a research appointment and will conduct research at the Southeast Research Farm west of Beresford. We will do nutrition research to look at different diet components, as well as maybe some management techniques that we can use to increase production for cattle feeders in South Dakota. I also teach one class, feedlot operations and management. It meets in the fall and will give students a more involved look at the day-to-day operation of a feedlot and what can impact cattle performance and improve the return on investment.

Producers can reach me by phone at (605) 688-5460, by fax at (605) 688-6170, or by e-mail at Erik.Loe@sdstate.edu. The mailing address is SAS 213, Box 2170, SDSU, Brookings, SD 57007-0392.

Q: What's happening at South Dakota State University in research in the beef feedlot area?

A: Right now, we're continuing to work with co-products from the ethanol industry. There are different streams of product flow through the ethanol plants, and one of the end uses of those product streams is livestock feed. There's a tremendous amount of ethanol being produced in South Dakota, and that makes a lot of byproducts available for cattle feeders to use. We are continually doing work with the new co-products that are coming from ethanol production, trying to see how best they can be used in diets fed to feedlot cattle.

Also we'd like to continue doing research in the area of grain processing. We want to address when grain should be processed and what is the impact not only on cattle performance, but also the impact on the economics of feeding cattle. We want to evaluate whether or not it is important to process grain when considering the cost of rolling and transporting the grain to and from the processing area.

Other research that is going on in the feedlot area includes experiments conducted by Dr. Robbi Pritchard. He's continuing to work with implant strategies and growth-promoting strategies for feedlot cattle, so that we can better manage how and when to implant cattle during the growing and finishing periods.

An area of research that I would like to pursue is in lipid supplementation to feedlot cattle—adding sources of dietary fat that can increase the energy density of the diet, which improves feed conversion and alters the fatty acid composition of beef. There are many sources of oilseeds in South Dakota, such as soybeans, sunflowers, flaxseed, and canola, that can be incorporated into feedlot diets.

Q: What are a few key points you try to stress to producers feeding livestock?

A: The things I always talk about are consistent management practices—consistency when making feed calls, which is the amount of feed that you offer to the cattle on a daily basis. You do not want to offer greatly different amounts of feed on consecutive days, you need to keep that very even so that feed intake stays consistent. Consistency in the amount of feed offered is a good management technique to decrease digestive disturbances.

Over the years, SDSU, led by Dr. [Robbi] Pritchard, has done an excellent job in developing a standardized bunk scoring system. That system is an excellent model to use when developing your own bunk management system.

Another key management practice is to be very concerned with your costs of production. What is the cost of gain at your feedyard? What areas can you work on in improving your returns or decreasing your cost of gain? Those things are vital to the success of your business. Also, if you are in a situation where you farm, you are raising corn and other grains and also feeding cattle, it is important to know what amount of corn should go into silage, to earlage, or to be harvested as high-moisture corn or dry corn. Knowing the costs and benefits of each of those options when you are raising crops to feed to cattle can give you a management edge.

Q: What advice can you offer to producers facing drought conditions?

A: One strategy would be to early wean calves. One important aspect of that is to know what type of feed to give those calves once they've been weaned.

It's important to give them a dry diet just after weaning. Primarily avoid very wet feedstuffs such as silage, wet distillers grains, or wet corn gluten feed early on after they have been weaned. Corn, grain, dry supplement, pelleted supplement, and good quality forage such as alfalfa hay or high quality grass hay would be appropriate to use. The aromas and tex-

tures of certain wet co-products and fermented feedstuffs are foreign to newly weaned calves and can put them off.

After a couple of weeks when calves are consuming an appropriate amount of feed (greater than 2% of their body weight), then you can begin incorporating wet feedstuffs, especially silage.

If using silage in receiving diets, it is very important to have good bunk management and to make sure that the feed in the bunk is fresh.

In the feedlot scenario, when you're talking about drought problems, it is important for cattle feeders who have open pens in their feedlots to advertise and let cattlemen know that they can place animals in their feedlots.

Also, cattle feeders should know what their cost of gain will be. Then, producers who are looking for a place for their cattle can project what it will cost them. That is important information for ranchers and farmers who may want to early wean their calves due to lack of forage in their pastures. It helps them decide whether to background or finish their calves.

Q: South Dakotans used to send a great many feeder cattle out of state to be finished rather than finishing them in South Dakota. Do you see that changing, and why?

A: Typically, in the last few years there have been 400,000 cattle finished in South Dakota, and we have 1.6 to 1.7 million cows that calve in the state. So we're feeding about a quarter of the calves that are raised in South Dakota.

The indicators right now are quite positive for growth in the number of cattle backgrounded and finished in South Dakota. The high-quality calves raised in South Dakota and the cost of feedstuffs are two important factors that allow cattle feeders in South Dakota to be competitive with cattle feeders in other regions of the United States.

The more traditional cattle-feeding regions, especially the High Plains, have higher corn prices than we do in South Dakota. That is an advantage for cattle feeders here.

Q: If you had to recommend one ration that works for most producers most of the time, what would it be?

A: The simple answer: It depends on your location.

In a case where you have ample supply of every feedstuff available, corn-based diets are the gold standard of feedlot diets. Corn is a digestible, high-energy feedstuff because of the starch and oil content. When feeding grain-based diets, a source of supplemental protein is needed. A very brief overview of a feedlot diet is (all values on a dry matter basis): 8 to 10% roughage, 12.5 to 13.5% crude protein (primarily a ruminally degradable source of protein), 0.6% calcium, 0.3% salt, other macrominerals, trace minerals, and vitamins. There is no need to add supplemental phosphorus in grain-based diets. When incorporating distiller's grains into feedlot diets, it is recommended to include 10 to 30% on a dry basis. Inclusion level of distiller's grains is dependent on the distance your feedlot is away from the ethanol plant.

In South Dakota, we are fortunate to have so many feedstuffs available to feed to cattle. Do not hesitate to contact me or other SDSU Extension personnel if you have any questions about feeds or feeding. ♦
—Lance Nixon



Rick Miller, vice president,
CorTrust Bank, Sioux Falls

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GOING, GOING, SOLD!

As a South Dakota banker with long experience in rural lending, Vice President Rick Miller of CorTrust Bank has a pretty good idea how well a field of soybeans at the east edge of Sioux Falls will yield in Fall 2006.

He also has a pretty good idea what the return will be once a developer starts planting streets, sewers, and houses in the ground after the 2006 soybean crop is off the field.

“Some land right now is bringing \$2,000, \$3,000, \$4,000, \$5,000 an acre. If you do a cash flow analysis on it from the standpoint of what it will produce in the form of either corn or beans, \$1,300 an acre would be the max.

“It’s not being sold to be farmed. It’s being sold to be developed for urban sprawl,” says Miller, whose bank is helping to finance the developer.

In the 21st century, Miller said, the growth of cities is becoming an important factor swaying the farm real estate market even in South Dakota—and not just in Minnehaha and Lincoln counties.

“You go to any major community in South Dakota and drive around and it becomes very, very apparent.”



Expectations of capital appreciation are bounding ahead of expected agricultural cash returns in many areas of the state, making it especially hard for young farmers to expand when competing with land developers, say Burton Pflueger and Larry Janssen, SDSU economists.

URBAN BIDDERS' COMPETITION for farmland is only one factor of many causing the continued climb of land values, according to the latest report in an ongoing South Dakota State University survey.

SDSU's 2006 South Dakota farm real estate market survey showed agricultural land values in the state rose an average of 14.4% in one year, from 2005 to 2006. Values have doubled since 2000.

That's good news for landowners, but it's potentially troubling to young farmers or ranchers trying to buy land for their operations.

The study also detects signals that South Dakota's land boom may be poised to level off.

Compiled by SDSU economists Larry Janssen and Burton Pflueger, the 2006 survey is based on reports from 222 respondents: agricultural lenders, Farm Service Agency officials, rural appraisers, assessors, realtors, professional farm managers, and Extension agricultural educators. All are familiar with farmland market trends in their local areas.

Pflueger suspects tough times for the new generation of producers may be lurking behind the statistics.

"One of the things that leaps to mind is the impact on beginning farmers," Pflueger says. "As land values increase, and as quickly as they have, it becomes much more difficult for holders of small farm acreages to expand. The cost of expansion is so much greater as the land values have increased."

THE TREND POSES A FAMILIAR PROBLEM for rural lenders in trying to work with producers, says Miller.

"When you're looking at approving a loan for a young farmer, what he's going to have to pay to buy land or to rent land becomes part of his operating costs."

The survey backs up Miller's observation that ag producers are not the only ones competing for ag land, says Janssen. Respondents also pointed to investment potential and hunting/recreation as other major reasons to buy agricultural land.

"Buying to expand the farming operation remains still the number one motivation," Janssen said. "However, there is also a substantial proportion of successful buyers who are outside investors to the region, or who are local investors but not farmers. If they're in there competing, that means that if the farmer-buyers are going to be successful, they have to be able to outbid them."

In a market like suburban Minnehaha and Lincoln counties, farmers are at a disadvantage in that bidding war. Other investors often don't need to borrow as much, if at all, in order to buy ag land.

"Today you've got people coming in and buying, and they're writing a check," says Miller. "They don't really care one way or another whether that land produces 70, 80, or 120 bushels an acre. Their motivation for owning that land is entirely different."

Taking parcels of ag land out of use as cities expand makes

“Some land right now is bringing \$2,000, \$3,000, \$4,000, \$5,000 an acre. If you do a cash flow analysis on it from the standpoint of what it will produce in the form of either corn or beans, \$1,300 an acre would be the max.”

—RICK MILLER, VICE PRESIDENT,
CORTRUST BANK, SIOUX FALLS

the competition more fierce for the ag land that remains in those counties.

Miller adds that in comparing notes with bankers from the western part of the state, he's heard of a similar thing happening there. Instead of evaluating rangeland's potential for feeding livestock, some of the new buyers value it based on one thing: its view of the Black Hills.

He and other bankers still see opportunities for entrepreneurs in rural South Dakota to invest in ag land for livestock operations or for other enterprises that have been flourishing in recent decades in South Dakota, such as commercial pheasant farms.

On the other side of the equation, the survey showed that retirement from farming, favorable market conditions (a seller's market), and settling estates are the three major reasons for selling farmland.

ANNUAL RATES OF INCREASE for cropland from 2005 to 2006 were above 12% in all regions east of the Missouri River compared to less than 9% in the northwest and south-central regions.

Rangeland values increased in all regions with increases exceeding 18% in the northwest, east-central, north-central, and southeast region, Janssen says.

Cash rental rates also increased, with a statewide average increase of \$2.35 per acre for hay land, \$2.05 per acre for cropland, and \$1.00 per acre for rangeland and pasture.

In fact, the survey shows that the average value of nonirrigated South Dakota cropland in 2006 exceeds \$2,250 per acre, and average cash rental rates exceed \$100 per acre in two clusters of counties (Minnehaha-Moody and Clay-Lincoln-Turner-Union). Those are the highest average land values and cash rental rates reported during the past 16 years in which the annual SDSU survey has tracked the market.

Janssen and Pflueger say key factors influencing ag land markets include sharp declines in farm mortgage interest rates from early 2001 to late 2004; federal farm program provisions of the 1996 and 2002 farm bills, especially the level of crop subsidies and removal of planting restrictions; and general economic conditions of low inflation rates.

Miller can add another one that's not reflected in the survey but which has a great deal to do with institutions such as SDSU: increased productivity.

“When I grew up in Aberdeen, it was not uncommon for a farmer in northern Brown County to harvest a 70-bushel corn crop per acre and think he had a good crop,” Miller says. “Today, if you get 70-bushel corn, you're embarrassed.”

FARMLAND VALUES INCREASED more rapidly than the rate of general price inflation in all regions of South Dakota from 1991 to 2006. Cash rental rate increases provided underlying support for increases in land values.

“These two basic economic factors, along with declining mortgage interest rates, attract interest in farmland purchases by investors and by farmers expanding their operations,” Janssen says.

“However, gross and net cash rates of return are approaching the lower end of historical rates of return to agricultural land in South Dakota. Farmland investors are currently in market conditions where most of the total returns are from expectations of capital appreciation instead of current cash returns. This pattern of declining rates of cash return to land also occurs during the latter stages of land market price booms.”

Miller agrees that capital appreciation is a major motivation for investing in land, especially in recent years when some other investment options have been lackluster. But he's not sure the land boom is slowing, and he doesn't see farmers doing very well in the tug-of-war over land use with other investors.

“They're not buying this stuff so that they can go out and plant beans or corn,” Miller says. “They're buying 160 acres so they can subdivide it, put in the amenities like streets and water and sewer, and then turn around and sell it in the form of lots. There's your capital appreciation.”

Even in South Dakota, Miller says, housing developments are eclipsing tall corn and soybeans, and yielding better.

JANSSEN AND PFLUEGER BEGAN reporting the results of their 2006 South Dakota Farm Real Estate Market Survey in the May 22 issue of the SDSU Economics Commentator. Find that issue online at

<http://econ.sdstate.edu/Research/Commentator/No475.pdf>

Or the complete report at:

<http://agbiopubs.sdstate.edu/articles/C271.pdf> ◆

—Lance Nixon



Roy Scott

High performance package

In plant breeder Roy Scott's world, the soybean is like a sporty little machine that performs well just as it is but does even better once you start tooling around under the hood—adding genetic traits that juice up the plant's performance in areas such as yield, oil content, and fatty acid profile.

While plant breeding is a little more complex than auto mechanics, Scott says the metaphor of the plant as a vehicle does tell what's going on. Through traditional plant breeding techniques as well as new high-tech tools, the plant can be outfitted with the right package of genetic material to do certain things.

Right now, for instance, the soybean breeding program at South Dakota State University continues its push of the past 4

years to better adapt South Dakota soybeans to food industry requirements. Developing high-yielding varieties with high protein and high oil content remains the top priority.

"We're still focusing on developing Group 0 through Group II varieties," says Scott, who has headed the program since it began in 1991. "The yield emphasis is still the big thing. We're trying not to sacrifice yield for anything else."

“The yield emphasis is still the big thing. We’re trying not to sacrifice yield for anything else.”

—ROY SCOTT,
SDSU SOYBEAN BREEDER

SOYBEANS “MAKE MONEY” on their protein and oil content, says Scott. “So we’re still breeding to develop high-protein varieties. Right now we have a lot of materials in the program that are high protein. We’re trying not to lower the oil below about 19%. That’s a big challenge. The goal is to get varieties, on a 13% moisture basis, with at least 35% protein and 19% oil.”

Scott says modifying the oil quality could make SDSU varieties more valuable to the food industry.

“We’ve been trying to modify the fatty acid composition by using existing germplasm out of Iowa State University to modify the linolenic acid content, or the saturates.”

He explains that the saturates he’s concerned about—palmitic and stearic fatty acids—make up about 15% of oil content in soybeans. Ideally, Scott would like to lower that to 7% or less.

Lowering those two constituents of soybean oil would make the oil more desirable to the food industry because of health benefits. Health studies show that high levels of saturated fat consumption can contribute to increased blood serum cholesterol, and high blood serum cholesterol increases the risk of coronary heart disease.

Linolenic acid typically makes up from 6 to 7% of the content of soybean oil. Scott wants to lower that to 3% or less, and ideally to about 1%, something he believes can be done with the plant material he is working with.

The low linolenic acid trait is what contributes to the flavor and stability of soybean oil, Scott says. The added benefit of lowering the linolenic acid content to 1% is that the soybean oil then has no trans fats. Numerous studies show that trans fats increase the risk of heart disease. The federal Food and Drug Administration began requiring that food manufacturers list trans fat on nutrition labels in 2006.

“The other fatty acid that we’re trying to modify is oleic acid. In normal soybeans it’s about 23 to 24%, and we’re trying to raise that to at least 50%.”

Oleic acid is a heart-healthy fat that can help lower blood levels of cholesterol.

Scott adds that he is trying to combine the fatty acid traits with protein traits.

“I’m trying to get a high-protein, low-linolenic acid variety, for example. That way, if for some reason we don’t have a market for the fatty acid, we can still have a useful variety that can be grown with high protein.”

FOR THE FIRST TIME THIS YEAR SDSU will be yield-testing a few of its low-phytate soybean lines. When released,

they will have a market niche in the animal feeding industry.

Scott explains that monogastric animals such as hogs and poultry don’t have an intestinal enzyme, phytase, needed to digest and assimilate phosphorus. As a result, those animals excrete a great deal of undigested phosphorus after consuming feedstuffs such as soybeans. Over time, this phosphorus can make its way into streams and waterways.

Low-phytate soybean varieties can help address that problem by reducing phosphorus levels in manure perhaps by as much as 50%.

Producers would need to add inorganic (mined) phosphorus (phytase) as an animal feed supplement to liberate some of the phosphorus that is in the feed. But that will further reduce the amount of phosphorus that is excreted in animal wastes.

Meanwhile, Scott says, the SDSU program continues to address problems such as iron chlorosis, a condition that shows up annually in some South Dakota soils.

“We’re continuing to work on that. Every year we make new crosses for iron chlorosis tolerance.”

The SDSU releases ‘Spink’ and ‘Hamlin’ of past years are among the varieties farmers can use if they have fields with where iron chlorosis can be a problem.

In all his breeding work, Scott adds, he works on both Roundup Ready and conventional varieties. He notes that far fewer conventional lines are entering the marketplace. That means SDSU’s conventional varieties may be all the more important for area growers who want a conventional variety but have fewer options available.

The very newest release from the SDSU soybean-breeding program is SD1111RR, an early Group I Roundup Ready variety with excellent yield potential.

Scott adds that there are four varieties currently approved for increase with intent to release. They’re likely to be considered for final release in 2007.

The soybean breeding program is funded in part by the South Dakota Soybean Research and Promotion Council. Additional funding comes from South Dakota Foundation Seed Stocks, the South Dakota Crop Improvement Agency, the United Soybean Board (which includes funding from South Dakota producers), and the South Dakota Agricultural Experiment Station.

In addition, the South Dakota Soybean Research and Promotion Council has awarded \$18,000 to Professor Catherine Carter, Plant Science Department, and Tom Cheesbrough, professor and head of the Biology/Microbiology Department, to identify molecular markers for genes that control fatty acid composition in soybean seeds. ♦ *Lance Nixon*

Pulling together



Peter Jeranyama

The shared vision of five South Dakota commodity groups is giving a boost to the research of some scientists of the South Dakota Agricultural Experiment Station.

Experiment Station Director John Kirby says the groups will cooperate in what is called the Farming System Research Initiative to fund research that all the groups recognize as important.

The South Dakota Wheat Commission, the South Dakota Corn Utilization Council, the South Dakota Soybean Research and Promotion Council, the South Dakota Crop Improvement Association, and the South Dakota Oilseeds Council are initially contributing a combined total of \$65,000. The South Dakota Agricultural Experiment Station is adding \$15,000, for a total of \$80,000 to fund research on common areas of interest during the first year of the initiative.

Kirby says South Dakota ag producers grow a variety of crops, so it's logical that commodity groups see shared areas of interest that can benefit their growers.

Laird Larson, a commissioner for the South Dakota Wheat Commission, agrees.

"I sit on the Wheat Commission, but I also grow corn and soybeans. Why shouldn't I be interested in that research work?" Larson said.

Larson adds that for commodity groups, the new organization is in part a way to hold SDSU scientists accountable for getting the most mileage out of agricultural research intended to benefit South Dakotans. He points out that all growers are interested in nitrogen studies, for example, since it's so crucial to soil fertility. Producers would like researchers to do more talking to each other, Larson says, so they don't duplicate studies.

Clark Moeckly of Britton, a member of the South Dakota Crop Improvement Association, adds that while one-shot research projects have value, producers also want to know what's happening in the long term, the advantages or synergies when growers follow one crop with another in a particular rotation, for example. The Farming System Research Initiative

“There’s not one farmer out there who grows just corn, or just soybeans, or just wheat or oilseeds. Farmers grow a combination of crops.”

—LAIRD LARSON, CLARK,
SOUTH DAKOTA WHEAT COMMISSION

can help foster that long-term view, he says.

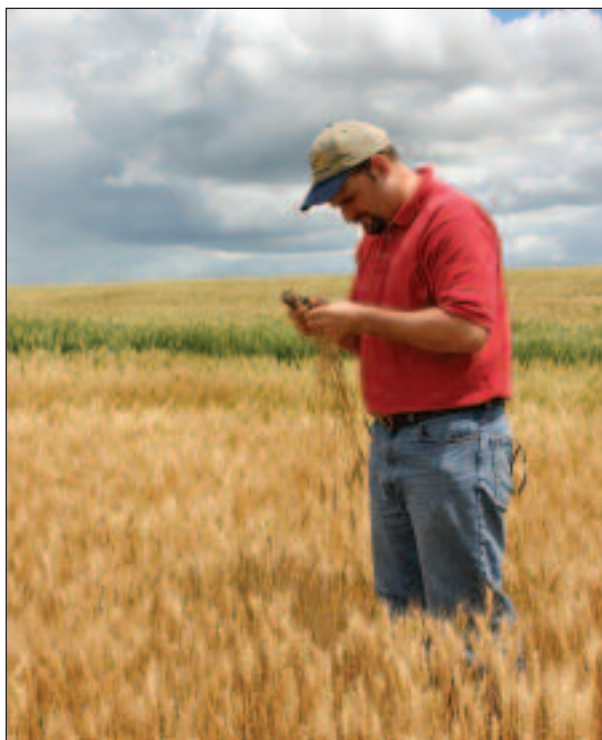
Besides benefits to producers, the initiative also provides advantages to researchers, says Jeff Stein, plant science assistant professor and small grains pathologist, who is coordinating one of the first projects funded under the initiative.

“The Farming Systems Research Initiative gives scientists at SDSU the unique opportunity to study broader topics related to crop production in South Dakota than the researchers might normally be able to do by using multiple single-funding sources,” Stein says. “This is important because different agricultural practices, for example, rotation choices, can substantially influence a variety of factors such as diseases and fertility that impact crop productivity in the future.”

Three projects will be funded in the first year. Here’s a closer look:

• Cropping systems evaluation to enhance crop production in

South Dakota, \$45,000; first year of a 2-year project. The project uses four long-term rotation studies that are already under way to conduct data mining and targeted experiments to assess crop rotation effects on carbon storage, soil quality, profitability, weeds, and pest spatial and temporal trends. The project also targets experiments to maximize corn, soybean, wheat, pulse crops, safflower, and sunflower yields in South Dakota. Peter Jeranyama, assistant professor of plant science and Extension forage specialist, is coordinating the study, which involves 13 SDSU scientists and one scientist from the USDA Agricultural Research Service.



Alter just one farming practice, and unplanned changes may occur in the field, and the future, says Jeff Stein, SDSU small grains pathologist. Intent of the farming systems initiative is to take the surprises out of such changes.

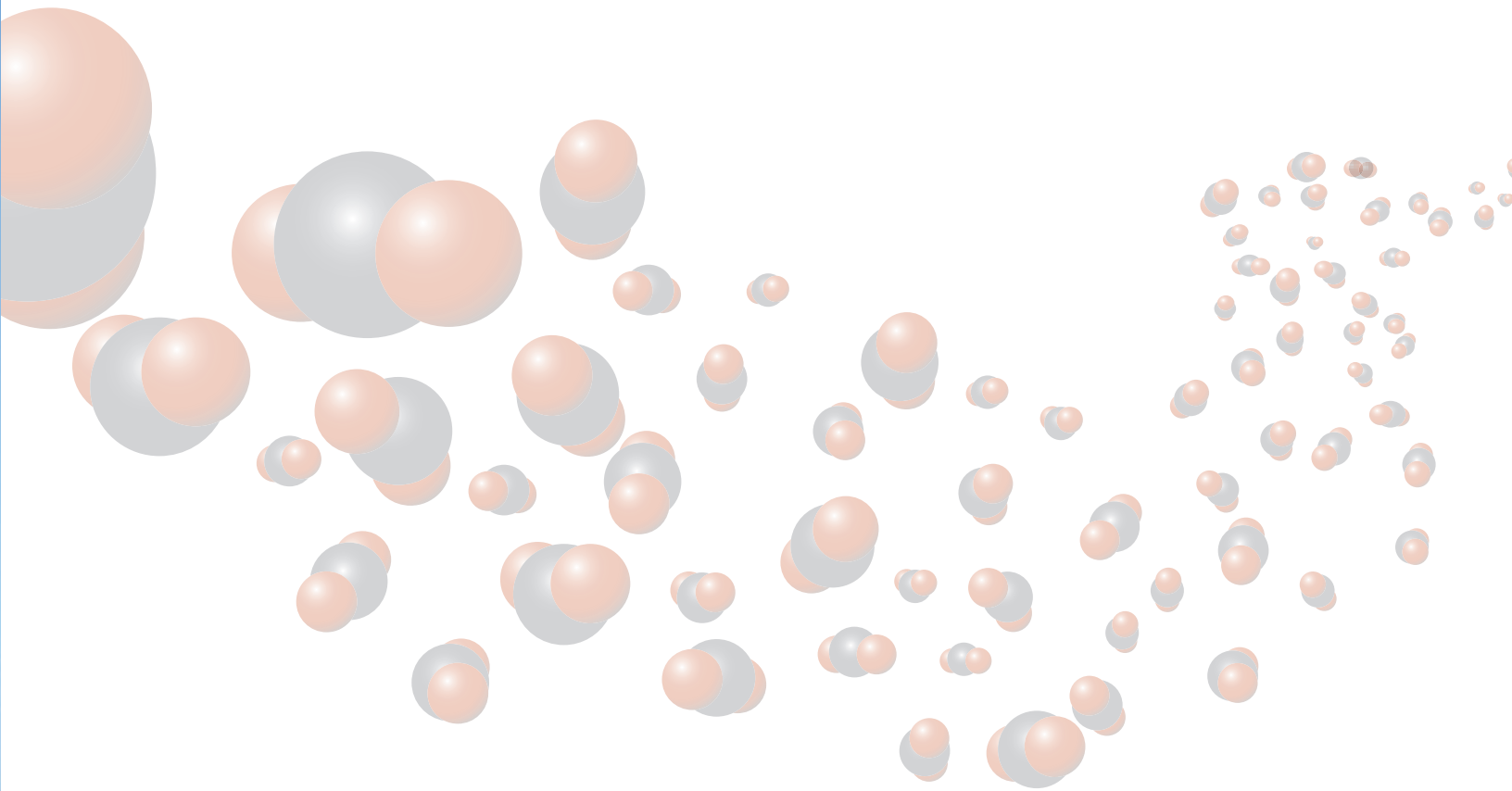
• Soil microbial/pathogen communities in dynamic agricultural systems, \$20,000; first year of a 2-year study. The project will investigate the effects of diverse crops, rotation schemes, and tillage on soilborne plant pathogens (nematodes and fungi) and on groups of soil microbes (bacteria, fungi, and nematodes) that are competitors to pathogens in the Northern Great Plains. It also will refine research tools for assessing pathogen dynamics and for detecting seedling pathogens in soils. Data gathered can help assess the impact of management systems on pathogen presence in the soil, seedling disease incidence, and severity. Stein is coordinating that project, which includes seven SDSU scientists and one scientist from the USDA Agricultural Research Service.

• Influence of tillage, crop rotations, and residue management on soil quality, grain yield, nutrient cycling, and residue

production for potential biofuels industry, \$15,000; first year of a 2-year project. The study will determine how no-till vs. conventional tillage influences soil quality as measured by soil organic carbon (SOC) level changes over time. It will also look at how residue management (removed residue vs. maintained residue levels) influences soil quality, nutrient cycling, and grain yield. It will determine how crop residue production (post-harvest stover and straw levels) and grain yields are influenced by tillage and by various crop rotation systems. Howard Woodard, plant science professor, coordinates that project, which involves three SDSU scientists. ♦—Lance Nixon



Tagir Gilmanov



Measuring the carbon cycle, molecule by molecule

In a pasture...

The state-of-the-art hardware is positioned on what is called a “flux tower,” one of dozens across North America that are beginning to assemble the data that will help scientists understand the carbon cycle and how it affects climate and ecology. The tower has been installed by the National Oceanic and Atmospheric Administration (NOAA) Atmospheric Turbulence and Diffusion Division (<http://www.atdd.noaa.gov/>) since April 2004 and will be a research tool for years to come.

“We are going to understand how this pasture functions,” says Tagir Gilmanov, SDSU associate professor and soil scientist.

“What it is doing, of course, is using the energy of the sun and the resources of water and nutrients to maintain what is called the carbon cycle. What we are going to do here is to measure how many molecules of CO₂ go from the atmosphere to this system and return back. The tower is measuring just that.”

In fact, the tower’s equipment makes that measurement 20 times a second. Half-hour values are calculated and sent to a NOAA/ATDD computer in Oak Ridge, Tenn. Gilmanov and his colleagues can download that information to study it.

The tower also has instruments to measure the flux of water and flux of energy. It has sensors to record soil moisture, soil temperature, and three-dimensional wind speed. It’s equipped with an infrared gas analyzer that is measuring the CO₂ concentration in the air above the ecosystem with high accuracy. And it has a camera that takes a photo every day so that researchers can assemble a “movie,” if they wish, showing outward visual changes in the landscape as the carbon cycle progresses through the seasons.

WHY STUDY THE CARBON CYCLE? There are other important biogeochemical cycles, such as the water, nitrogen, and phosphorus cycles. But Gilmanov says the carbon cycle is one of the most important because of the fossil fuels issue—



If Sandy Smart, SDSU range scientist, finds differences in how grazed and ungrazed pastures capture and sequester carbon in the soil, the findings may one day play a part in determining carbon credits for ag producers.

the fact that burning fossil fuels releases carbon dioxide (CO₂) into the atmosphere, adding to what is called the “greenhouse effect.”

The greenhouse effect refers to the fact that atmospheric gases such as carbon dioxide, water vapor, methane, ozone, nitrous oxide, and others allow sunlight to reach the earth, but then trap a portion of the backward radiation from earth to atmosphere. The greenhouse effect is what makes earth suitable for life as we know it. But it can also lead to global warming and climate change as more greenhouse gases accumulate in the atmosphere.

Scientists say that since the Industrial Revolution, the CO₂ concentration in the atmosphere has gone from 270 parts per million to near 385 parts per million.

THE NORTHERN PLAINS IS A GRASSLAND SINK.

Sandy Smart, SDSU associate professor and range scientist, says one focus of carbon cycle research is learning more about which ecosystems are better at storing carbon and which ecosystems aren't as effective.

“We use terms like ‘sources’ and ‘sinks.’ A ‘sink’ is just like the visual picture: If you're pouring water into a sink, it's taking it in. A source is giving it off. Most of the time we think of grasslands as being a sink.”

But not always, Smart adds.

“A colleague at EROS Data Center, Bruce Wylie, has done some looking at the Northern Great Plains and found that in the dry years, there's actually more carbon dioxide given off

from the soil, so the net is actually greater to the atmosphere than would be going down into the soil.

“That's because precipitation drives the system, it drives production. In dry years you don't have the photosynthesis that you normally would have had,” Smart says.

Smart is cooperating with Gilmanov in the carbon study by measuring vegetative growth of the pasture at regular intervals, both within enclosed areas and outside the enclosures where cattle can graze. His data on forage production helps to verify Gilmanov's data. The entire project is giving a far more exact picture than researchers have had previously of how the carbon cycle works in pastures and grasslands of eastern South Dakota.

“The flow of CO₂ that's going down into the ground is happening because photosynthesis during daytime considerably overshoots respiration of plants, microbes, and animals. And then at night, when photosynthesis isn't working anymore, respiration continues to give off CO₂ back to the atmosphere. The net effect, of course, is that during the active growing season, there's actually more CO₂ that is getting stored in the plants and the soil through photosynthesis than is given off at night. There's a net sequestration [storage] of carbon in the plant biomass and the soil organic matter of the ecosystem,” says Smart.

SIMPLY TAKING READINGS from the instruments in a pasture won't give a complete picture of the carbon situation in eastern South Dakota, says Gilmanov. Pasture is only one of

“We are going to understand how this pasture functions.”

—TAGIR GILMANOV,
SDSU SOIL SCIENTIST

the three main types of land use in the eastern part of the state. The others are the corn-soybean rotation, and alfalfa. Small grains are yet another land-use type.

“Our goal for the future is to have this kind of equipment installed in all these other land-use types, as well as in the natural systems such as prairie pothole wetlands, so that we can combine all these data sets and eventually get an estimate of what is the contribution of eastern South Dakota to the balance of the Northern Great Plains, for example. Currently there are no measurement-based estimates of this. There are some experts’ estimates, but not estimates based on actual measurement data.”

One problem, Gilmanov says, is that “gathering and analyzing carbon cycle data doesn’t produce immediate results that affect people directly. That can make it difficult to find funding for such research. Nevertheless, we were able to find support from the South Dakota EPSCOR Center for Biocomplexity, and just recently, from the South Dakota Governor’s 2010 Individual Research Seed Grant Program.”

One practical result of the research is that it could help assemble the data to help landowners get paid for storing carbon in their soil, says Smart.

“The bottom line would be that if we know that the process of carbon sequestration is greater or lesser under some certain management scenario, then we can calculate how much carbon would be sequestered that year under that management,” Smart says. “So if there was a payment for carbon, then we could say, OK, you have to switch management to be able to effectively increase the carbon sequestration that you’re wanting to get paid for.”

A LOT OF WORK NEEDS TO BE DONE before researchers can tell landowners what amount of carbon is being stored in eastern South Dakota soils.

“The first thing we’re doing is looking at mechanisms: How does this work?” Smart says. “The next thing would be to impose management scenarios. You ask the question, Under heavy grazing or moderate grazing or light grazing, how do you affect the process? We first have to show that our methodology works and show that we understand the mechanism. Then we look at it under different management options.”

Wayne Smith, director of field services for the South Dakota Farm Bureau, says he’s pleased with the direction of SDSU research. South Dakota Farm Bureau already is encouraging its members to investigate the possibility of being paid to sequester carbon through a pilot program launched in 2003 by the Iowa Farm Bureau that allows trading of carbon on the Chicago Climate Exchange.

In essence, the program allows companies to buy carbon storage in farmers’ fields to “offset” the carbon dioxide they

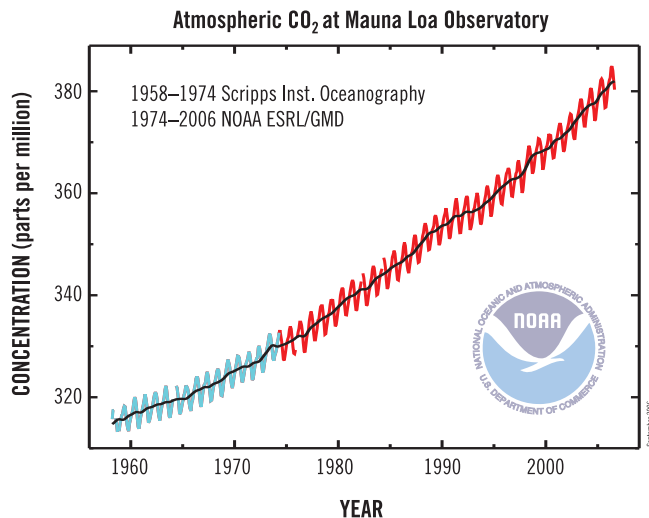


Fig. 1. Monthly mean atmospheric carbon dioxide at Mauna Loa Observatory, Hawaii, the longest-running record of direct measurements of CO₂ in the atmosphere, http://www.cmdl.noaa.gov/ccgg/trends/co2_data_mlo.php

emit into the atmosphere. Smith said that program is based on research that suggested a no-till corn or soybean field stores one-half ton per acre per year of carbon.

But more precise information of the kind SDSU is trying to obtain would be even better, Smith adds.

“If we can start quantifying exactly what each farm sequesters, that could be related to the return back to the producer,” Smith says. “I think it’s an opportunity for farmers to capitalize on some of the good things they’ve been doing for the environment.”

The South Dakota Farmers Union is also examining how farmers and ranchers can collect carbon credits and get paid for them.

There’s more about trading carbon credits at the Chicago Climate Exchange Web site, <http://www.chicagoclimatex.com/>

Learn more about the concerted effort to study carbon cycling across North America by visiting the Web site for the combined AmeriFlux network, <http://public.ornl.gov/ameriflux/> AmeriFlux is a network of federal and university researchers who have been working together since 1996 to study ecosystem exchanges of CO₂, water, energy, and momentum.

Carbon cycle studies in South Dakota conducted at the USGS Earth Resources Observation and Science Center are described at http://edc.usgs.gov/carbon_cycle ♦

—Lance Nixon



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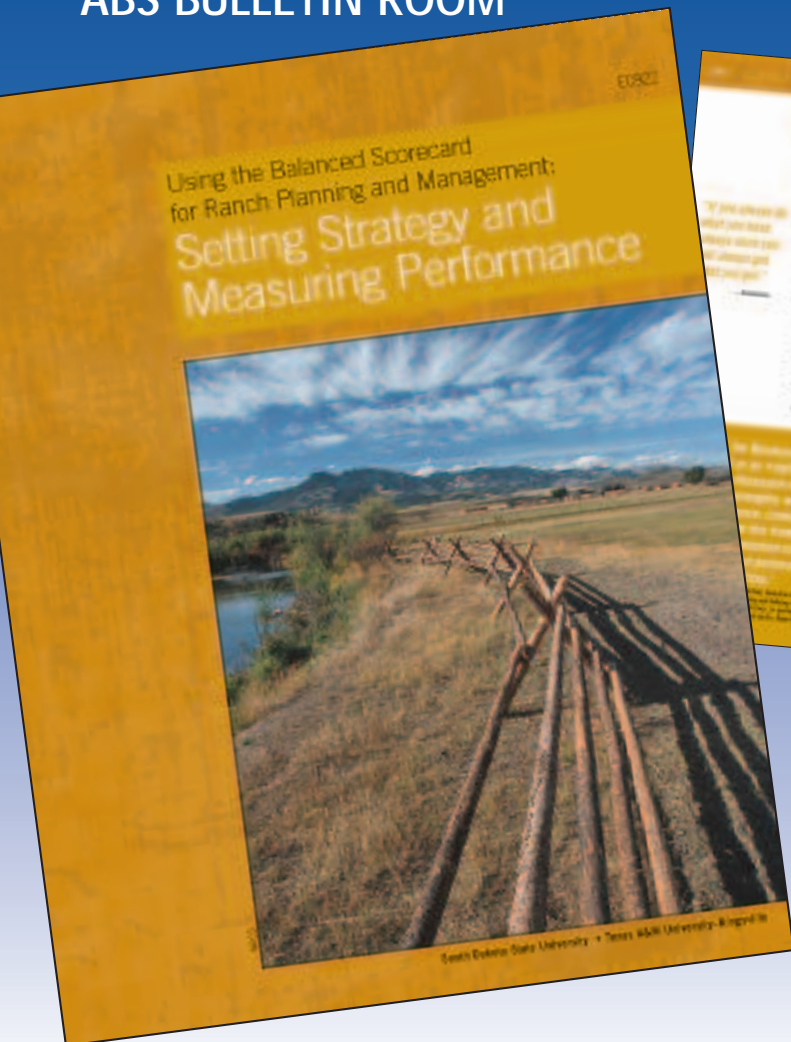
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