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Lance Nixon

Marianne Stein

Utilizing and developing our resources to enhance quality of life

Farm & Home RESEARCH

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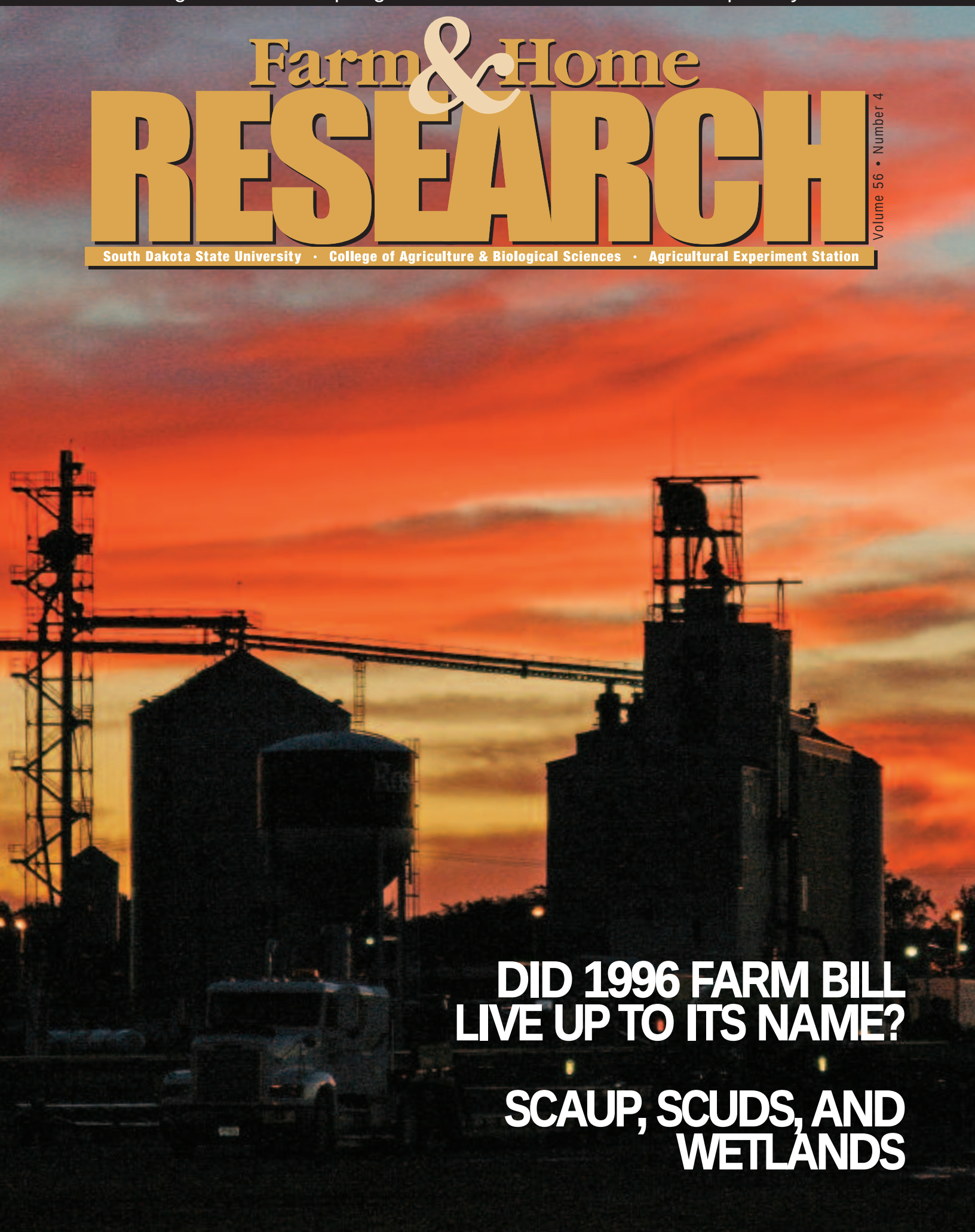

DID 1996 FARM BILL LIVE UP TO ITS NAME?

SCAUP, SCUDS, AND WETLANDS

CONTENTS

On the cover:

The combined northeast and north-central areas of South Dakota (outlined as crop reporting districts) collected a higher percentage of federal payments in relation to income than most other areas of the state, according to a report from the SDSU Economics Department (page12). The absence of a metropolitan area and the presence of only two major trade centers may be contributing factors. Pictured is Roscoe in Edmunds County.

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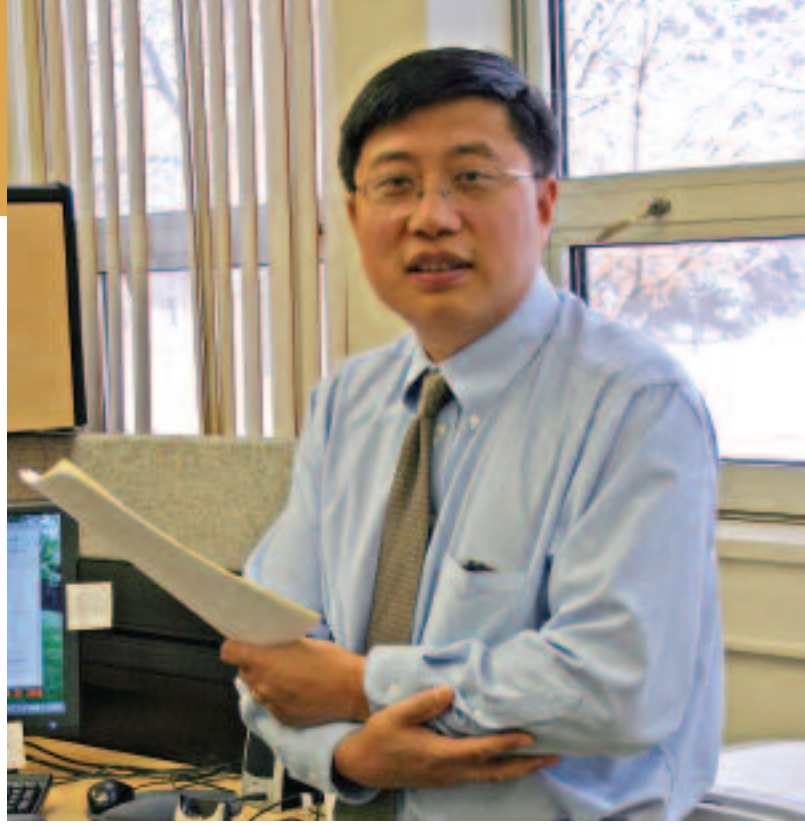
Dean's comments

BY C.Y. WANG
Interim Associate Director, South Dakota Agricultural Experiment Station

'World-class research addressing South Dakota's needs'



C.Y. Wang

It has been a blessing for me to have this opportunity to serve as interim associate director for the South Dakota Agricultural Experiment Station. Though I've been familiar with some of SDAES's research as scientist and head of the Department of Nutrition, Food Science and Hospitality, this job has given me a much broader view of the work that SDSU scientists do in their respective fields within agriculture and the biological sciences. I'm extremely impressed with what our people are doing. I am happy to report to our citizens that SDAES produces world-class research addressing South Dakota's needs.

This issue of Farm & Home Research samples the quality and the balance of our research portfolio:

Production agriculture is our continuing focus as we carry on research to help producers refine and improve methods for raising crops and livestock. This issue of Farm & Home Research reflects that with its look at SDSU's work about fenceline weaning, and fungicide spray coverage studies to help producers be prepared for Asian soybean rust.

We also have research projects that look beyond production to value-added processing. The magazine gives a glimpse of that in our story about homegrown chemicals from agriculture. That is research that is good for producers and good for South Dakota because it can help us, the people of the state, capture more value from the raw commodities we produce.

Some of our research looks at conservation of natural resources—as in the question of what is reducing the population of the lesser scaup and its food supply. Protecting natural resources such as wildlife is something everyone in South Dakota, ag producers and urban residents alike, agree is crucial for the health of our state.

Finally, our research looks at families and communities. We want to give South Dakotans not only the tools to raise healthy crops and livestock but to grow healthy families and communities, too. An SDSU economics study on farm program payments in recent years examines the degree to which farm families in different regions of the state—and by implication, their communities—depend on farm programs.

During this interim period, I truly enjoyed my interactions with our stakeholders throughout the state. South Dakota is a special place because of our people who are willing to work together for a better future. I very much appreciated the partnerships between our citizens and SDSU.

People of the state rely on South Dakota State University to do scientific research that, in the long run, can help create a better future for them. But we scientists at SDSU also rely on stakeholder input to help us choose and refine our topics so that the university continues to address the needs of the people.

So, to my colleagues in the South Dakota Agricultural Experiment Station, I'd like to say: Keep doing the fine work that you do on the various research questions that contribute to our knowledge of agriculture and the biological sciences. And to the people of South Dakota, I'd like to say: Stay in touch. We need to hear from you about the issues that are important to you, and the ways science can make a difference in your lives.u

THE COLOR PURPLE

If purple turns out to be an "in" color in the months ahead, some South Dakota State University research will be right in fashion—and also right on time.

A purple dye in spray mixes on soybeans at the Southeast Research Farm near Beresford in 2005 gave researchers information about spray pattern, droplet size, and the effectiveness of getting fungicide spray low inside the canopy. It's research that will be crucial in helping producers protect their fields from the latest major threat to hit soybean country—Asian soybean rust.

Soybean rust spores hitchhiked their way to the U.S. on Hurricane Ivan in 2004, then overwintered in Florida. The disease began spreading into southeastern states in 2005. But freezing weather will limit where the disease survives, which in turn determines how quickly it can reach heartland states such as South Dakota.

"Soybean rust does not produce an overwintering spore. Wherever it freezes hard, it is not going to survive. It must overwinter on green, living tissue. That's the most fortunate thing for our producers in South Dakota," says Brad Ruden, whose work on his doctorate at SDSU includes the fungicide application studies.

Marty Draper, SDSU Extension plant pathologist, says that

since soybean rust is new to North America, scientists are still waiting to see how serious the threat is to growers in different parts of the country. Right now, Draper says, it appears that the disease may survive along the Gulf Coast in some years; in other years, cold weather could limit its survival to Florida.

Dennis Todey, SDSU Extension climatologist, says if spores survive in a more western Gulf Coast location—southern Texas, for example—South Dakota is more at risk because of a spring and early summer phenomenon called the Great Plains low level jet, which occurs once or twice a week, depending on the season.

"This jet is a rapid current of wind originating in the Southern Plains that moves warmer air and moisture northward on wind 400 to 2,000 meters above the surface. The jet could quickly move spores northward," Todey says.

If those disease spores hit South Dakota at the right time of crop development, the disease could be serious.

"The period from July 15 to August 15 is really our risk period," Draper says. "If we get beyond August 15, our beans are close enough to harvest that rust will never build to a high enough level to cause serious damage."

AS LONG THE AMOUNT OF DAMAGE that soybean rust can cause in northern soybean regions remains an open question, SDSU scientists will be part of the team monitoring fields to see whether or when rust arrives and figuring out how to deal with it when it does.

"... a medium-sized droplet is really our best compromise between a large-enough droplet to limit drift and a small-enough droplet to maximize coverage."

—Brad Ruden,
SDSU Extension associate, plant science

Watching for soybean rust was coordinated in 2005 partly through a nationwide network of sentinel plots. South Dakota, too, kept sentinel plots in its soybean-producing region.

"There were 40 sentinel plot locations in South Dakota, all East River except for one in Gregory County," Draper says. SDSU Extension county educators who had trained to scout for Asian soybean rust kept a close watch on those sentinel plots throughout the growing season.

The plots were closely associated with another weapon in the war against soybean rust and other plant diseases: SDSU's Plant Diagnostic Lab.

"Any time there's a new disease, the lab is of critical importance," Draper says. "This year we had probably twice as many samples sent in for diagnosis as usual. Probably 50 samples came directly out of sentinel plots, along with numerous samples of soybeans from producers where soybean rust was a question. They didn't know what the problem was but they were concerned about rust and wanted to be proactive and stay on top of things, so they sent samples in."

Soybean rust never made it to South Dakota fields this year—but producers may have slept a little sounder, knowing that the SDSU plant surveillance and diagnosis network was on the alert.

Meanwhile, Draper adds, the intensified scouting due to the threat of rust turned up some surprises. Draper diagnosed only the second case ever of sudden death syndrome in soybeans this past year. Bacterial pustule, an uncommon disease in South Dakota that produces leaf symptoms that can be confused with soybean rust, was also identified in or near three sentinel plots late in the 2005 season.

SOYBEAN RUST WILL CHANGE THE WAY many growers spray their soybeans.

SDSU researchers are looking at various spray nozzles, spray pressures, application speeds, application angles, and gallonage per acre to determine what works best in applying fungicides.

"Most of our herbicide applications do not require us to have the kind of coverage we need with a fungicide application.

PLANT DIAGNOSTIC LAB PROVES ITS WORTH IN YEAR OF SEVERE CROP DISEASES

The 9-11 terrorist attack , as South Dakota State University Extension Plant Pathologist Marty Draper sees it, brought at least one positive result: a national Plant Diagnostic Network that can offer a coordinated response to plant disease outbreaks.

It was in place by the time the United States' latest plant disease threat, Asian soybean rust, blew ashore with Hurricane Ivan in late 2004.

The biosecurity grant that funds the network made it possible for SDSU to hire Kim Maxson-Stein as the first full-time manager ever for the Plant Diagnostic Laboratory, just in time for 2005, an especially severe year for crop disease across the board.

According to Maxon-Stein, the lab processed over 600 samples this year, including small grains, row crops, oilseeds, forages, tree fruit, vines, commercial and homeowner trees, shrubs, turf, perennials, and annuals.

Of the 183 small grain samples that were tested, Maxson-Stein says 30% showed scab. Twenty percent showed wheat streak mosaic virus.

"This season's weather was unusual in many ways, which caused some diseases to be more severe," Maxson-Stein explains. "Although unfortunate for many growers, it enabled us to test the new lab and optimize our services for producers and home owners.

In addition to this direct assistance, lab results give Extension specialists a scientific basis for crop-wide control recommendations.

Also among the samples seen in the lab was Fusarium head blight, or scab. South Dakota wheat producers took a hit of $36.1 million in lost production in 2005 due to scab, according to calculations by Jeff Stein, SDSU small grains pathologist, and Draper.

Stein says two-thirds of the losses, or $24.7 million, were in winter wheat. Winter wheat is usually less vulnerable to scab in South Dakota, but conditions this year happened to be ideal when winter wheat was in flower, he says. Spring wheat losses totaled $11.4 million statewide.

This is only lost yield, he adds. The figures don't include losses producers might suffer because of reduced quality of their grain due to scab.

Sudden death syndrome in soybeans was documented for only the second time in South Dakota. Charcoal rot, first documented in the state 2 years ago, also reappeared in soybeans. There was an increase in brown stem rot. And in late summer a disease called bacterial pustule appeared.

SDSU will likely begin charging a small fee for some tests to help offset costs of operating the lab.

"What we're really trying to do is just make sure that it is a service we can maintain," Draper says. "If we reach that point, it might be $3 to $5. In most cases, that's going to be one of the cheapest services you could buy to determine what the problem is with your crop or home garden plant."

Brad Ruden, SDSU Extension associate, sets up a card on which purple-dyed fungicide droplets will collect. From those droplet patterns he will be able to determine if the fungicidal spray penetrated the soybean canopy far enough to be effective.

"Rather than spraying mostly at the top of the canopy, we have to get down to the lower leaves," explains Ruden. "We're looking at a disease that initially develops low in the crop canopy.

"We probably have to use more water than we have used before. Our water gallonage or carrier volume has to be 10 to 15 or even 20 gallons per acre, versus herbicide applications that are sometimes at 5 to 10 gallons an acre. We also have to look at getting a little finer droplet than we've used before. We need thorough coverage because our fungicide products don't move within the plant very much."

THAT'S WHERE THE PURPLE DYE HELPS tell what's going on.

In nine locations within each research plot, Ruden and his colleagues set up a fiberglass post with a little aluminum tray on it and a blank white-coated card in each tray. After spraying the plot with a mixture of water, Quadris fungicide, and purple/pink dye, they collected the cards and used a computer program to analyze the spray patterns and determine which pattern was most effective in reaching different places in the soybean canopy.

Agricultural scientists classify spray droplets by size categories, Ruden explains.

"We can get them fine and get excellent coverage, but if we have any kind of wind, they're going to drift off target. However, if we go too coarse, we get excellent drift reduction, but we don't get enough coverage."

The SDSU studies to date make it clear that nozzles used for applying products such as Roundup aren't ideal for applying fungicide, because they produce too large a droplet.

"Droplets that are in the coarse, very coarse, and extra coarse categories are simply too large to get us adequate coverage for control of soybean rust, even if we put on a lot of gallons of water," Ruden says.

"On the other hand we can go with certain smaller nozzles and higher pressures that can get us tremendous coverage if conditions are perfect. We can crank out droplets that are in the fine or very fine category."

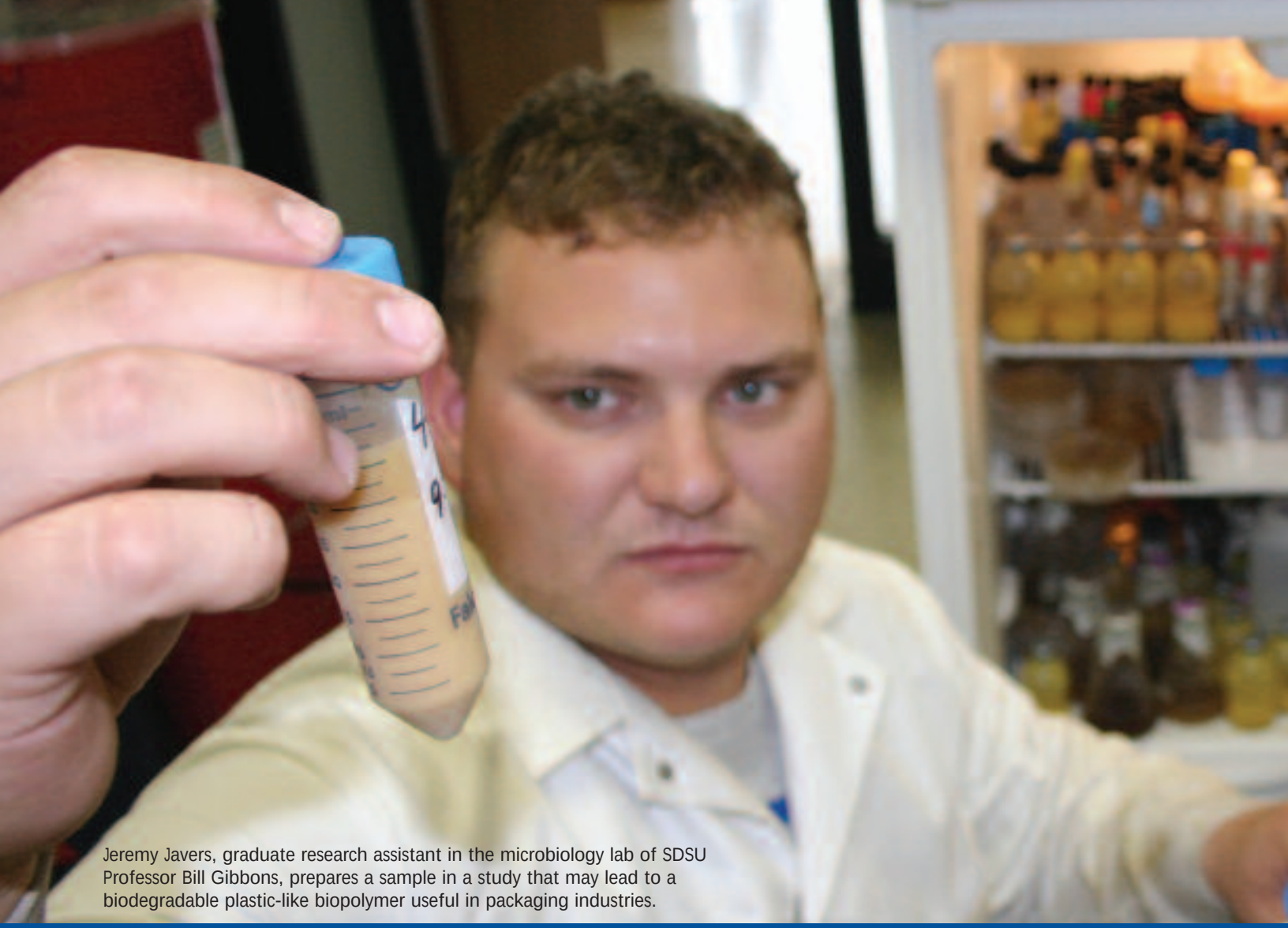
The problem, Ruden said, is that a breeze of even 3 to 4 mph will prevent the droplets from reaching their target. They might not even penetrate to the bottom of the soybean canopy even under the best conditions.

"We've come to the conclusion that a medium-sized droplet is really our best compromise between a large-enough droplet to limit drift and a small-enough droplet to maximize coverage."

Ruden adds that to get a medium droplet and keep the gallonage up, producers may possibly need to look at a sprayer nozzle or nozzle combination that has two spray orifices rather than one. "It is very hard to get a medium droplet from a single nozzle orifice and still apply 15 or more gallons of spray mixture per acre at legitimate field sprayer speeds."

SDSU's look at the different variables involved in getting the most effective control with fungicides will continue, Ruden says. This is the third year of studying fungicide applications to soybeans. These preliminary studies were funded by USDA. Beginning in 2005, the North Central Soybean Research Program (NCSRP), a producer checkoff, funded the program.u

—Lance Nixon



Jeremy Javers, graduate research assistant in the microbiology lab of SDSU Professor Bill Gibbons, prepares a sample in a study that may lead to a biodegradable plastic-like biopolymer useful in packaging industries.

HOMEGROWN CHEMICALS

Co-products from ethanol production, such as distillers grains (DDGS), are currently used as feedstuffs for livestock animals. Scientists at South Dakota State University are looking for other uses for the co-products, uses that may add value to both corn and ethanol production.

Extracting valuable chemicals from ethanol co-products is the focus of several research projects at SDSU. Kasiviswanathan "Muthu" Muthukumarappan, associate professor of agricultural and biosystems engineering, and Bill Gibbons, professor of microbiology, are two of the lead scientists.

"We see much more opportunity than only with feedstuffs. We're not trying to prevent DDGS from going to feedstuffs; we're trying to find additional value for ethanol co-products.

In ethanol production, corn goes through fermentation and distillation that convert the starch to ethanol and CO_2.

"We're looking at a biomass refinery as an alternative to a petrol refinery."

—Bill Gibbons, SDSU microbiologist

The remaining co-product, wet stillage, contains about 92% water. It passes through a centrifugation process that yields a liquid called corn solubles and a solid mass called wet distillers grain (WDG). WDG is then dried, the solubles are added back, and the final product is called dried distillers grains with solubles, or DDGS, containing 12-15% water, Gibbons explains.

Gibbons adds, "It takes a lot of energy to evaporate all the liquid from the wet stillage. The end product is sold as livestock feed, which is fairly low-value. As more ethanol plants are established, there will be additional pressure on DDGS prices.

"So one of the goals of our research is to treat the whole stillage and convert it into higher-value products without having to go through all these evaporation steps."

THE MAIN CHALLENGE FOR THE RESEARCHERS is that wet stillage and distillers grains are very high in fiber. Like all plant materials, distillers grains contain long chains of cellulose, hemicellulose, and lignin, which must be broken up to access the glucose molecules and convert them to other materials.

"There are several steps to this," Muthu says. "First we need to pretreat the distillers grains to break down the fibers. Then comes fermentation, and finally, recovery of the chemicals or other materials."

One of Muthu's research projects focuses on pretreating wet distillers grains through a method called supercritical CO_2 extrusion.

Lindsey Bernau, an undergraduate student from Emmons, Minn., is assisting with this part of the study. She received a Nelson Undergraduate Research Scholarship and a Griffith Undergraduate Research Award from SDSU to work on the project.

"Lindsey is looking at how extrusion processing can enhance the enzymatic digestibility of the distillers grains," Muthu says.

The researchers evaluated extrusion at different temperatures and screw speeds. They found that lower screw speed (80 RPM) and higher temperature (180ºC) enhanced the digestibility of wet distillers grains (WDG) compared to untreated WDG. The treated WDG samples had more cellulose open to enzyme action and more glucose produced than non-treated control samples.

The next step will be to inject supercritical CO_2 into the distillers grains before extrusion. Supercritical CO_2 is carbon dioxide that is above its critical temperature and pressure, at which point it becomes an intermediate substance between gas and liquid. This pretreatment is expected to further enhance the digestibility of whole stillage and WDG.

GIBBONS' RESEARCH PROJECTS FOCUS ON both the pretreatment and fermentation processes.

To pretreat whole stillage, he uses an artificial rumen culture that mimics the fermentation process in a cow's ruminal chambers. The purpose of this process is to convert the fiber to sugars and obtain volatile fatty acids such as acetic, lactic, and propionic acids, which are commonly used in many commercial applications including food, detergents, pharmaceuticals, and other industries.

These acids can also be converted, by another microbe, to a biopolymer called polyhydroxyalkanoate (PHA). PHA is a plastic-like substance that is completely biodegradable. It has many potential applications such as packaging material, bottles, garbage bags, and biomedical equipment.

"We're looking at a biomass refinery as an alternative to a petrol refinery," Gibbons says. "You can produce 10 to 15 valuable, industrial chemicals from crude oil. You can produce the same chemicals from biomass, but the processing costs have traditionally been much higher. If we can bring down the cost of processing, biomass products will be competitive."

Biomass is "homegrown," so it promotes economic development in the U.S., Gibbons points out. It also helps bypass national security issues related to energy production.

While the SDSU researchers are currently working with corn co-products, their research is potentially applicable to other plant materials. Distillers grains serve as a "model fiber source," but eventually the methods can be applied to grasses such as switchgrass, Indiangrass, and big bluestem or to wood wastes from locations like the Black Hills.

"There is a huge potential for the state of South Dakota, in terms of taking bio-processing to the next level," Muthu says.

Other researchers involved in the projects are Jim Julson, associate professor of food and biosystems engineering; Padu Krishnan, C. Y. Wang and Basil Dalaly, professors of nutrition, food science, and hospitality; Doug Raynie, assistant professor of chemistry and biochemistry; and Tom West, professor of biology and microbiology.

The research is funded by the South Dakota Corn Utilization Council and the SDSU Agricultural Experiment Station.u

—Marianne Stein

Mom's just over THE FENCE

South Dakota State University research isn't always a noisy affair, but when the topic is weaning of calves, some bawling and bellering is inevitable.

So what was noteworthy about Dick Pruitt's 3-year study was the silence. Half of the participating subjects—heifers separated from their dams in early October—had no complaints at all.

Pruitt, professor in the Animal and Range Sciences Department at SDSU, examined fenceline weaning on pasture combined with grazing of small grains grown for forage as an alternative to traditional drylot weaning systems.

His conclusion: It's a feasible option for producers in some cases and seems to put less stress on the animals.

CALVES ARE TURNED INTO A PASTURE next to their dams in fenceline weaning, instead of being transported to a drylot some distance away, the traditional method. They can still see, hear, and smell their mothers. They just can't nurse.

Pruitt separated heifer calves averaging 198 days of age into two groups in early October in each of 3 years. The drylot-weaned group was fed a traditional weaning diet of grass hay, corn, and protein supplement from weaning until early December.

Meanwhile, heifers in the pasture-weaned group were separated from their dams and grazed a grass pasture across the fence from their dams for 2 weeks. Then, until early December, they grazed a field of August-planted forage barley ('Robust') that had been no-tilled into oat stubble.

Then both groups of heifers received the same diet and were managed as one group from December until April.

"Pasture weaning appeared to cause less stress for both cows and calves. No differences in incidence of disease were observed," Pruitt says.

The drylot-weaned group showed typical weaning behavior by walking the fence and bawling for about a week following weaning. In contrast there was no bawling or walking the fence in the pasture-weaned group.

SAYS A SOUTH DAKOTA PRODUCER, "I'm a 100-percent believer."

SDSU's research is only confirming what Roger Deiter of Deiter Brothers in Faulkton had already found out. In fact, Pruitt says, the SDSU experiment was driven partly by what he heard anecdotally from producers who find fenceline weaning works well for them.

"Those that were weaned on pasture gained about a pound and a half a day more than the drylot-weaned group over the first 30 days. 'We did that for a couple of years and got similar results."

—Roger Deiter, Deiter Brothers, Faulkton

Deiter estimates that Deiter Brothers has used fenceline weaning for the past 5 or 6 years, weaning calves at about 150 days of age in its Angus operation. Conversion to fenceline weaning was executed with caution; first-off, animals that were drylot-weaned were compared to those that had been fence-line-weaned.

"The first couple years we were very skeptical, so we kept records and weighed the calves. Those that were weaned on pasture gained about a pound and a half a day more than the drylot-weaned group over the first 30 days," Deiter says. "We did that for a couple of years and got similar results."

The pasture-weaned group, in addition to grazing, had access to a commercially available supplement.

The drylot-weaned group was fed a mixed diet of hay, grain, and protein, depending on available feedstocks.

Deiter says he has no doubts that fenceline weaning works, and he has a pretty good idea why.

"The calves are weaned in their natural environment. They haven't been hauled anywhere, so they know where the feed is at, they know where the water is. The stress and shock to their systems is much less. I'm a 100-percent believer in it."

THE COMBINATION OF PASTURE WEANING and grazing until early December resulted in similar average daily gains in the first 2 years of the SDSU study. In the third year the drylot group outgained the heifers that were pasture-weaned and then grazed until early December.

Pruitt says it's clear that yearly differences affecting forage quality and quantity will influence gain. Calf weight at weaning and forage conditions may be important when determining the need for supplementation.

The SDSU study also found that the less stressed, fenceline-weaned calves didn't have a greater response to vaccination at weaning, as might have been expected.

"Intuitively we thought that there might be a difference in acquisition of immunity. It made sense that this could happen earlier in the animals that were less stressed," Pruitt says. "But our experiment was not able to show that it did."

That may be a subject of further research, Pruitt says.

He adds that yearling ultrasound measurements in the SDSU experiment found small differences in the two groups—differences that raise more questions than they answer. The heifers that grazed until early December had slightly less rib fat, a slightly smaller ribeye area, and a slightly smaller percentage of intramuscular fat. But further research is needed before drawing any sort of conclusions from the data, Pruitt says.

As the experiment wraps up, Pruitt is confident that "Fenceline weaning on pasture followed by grazing small grain pasture is an alternative to drylot weaning for developing replacement heifers."

Pruitt says the research suggests South Dakota producers can adopt strategies similar to what ranchers do in the southern United States, where it is common to graze calves on small grain pasture in fall and winter.

"In South Dakota, combining pasture weaning and an extended grazing season has the potential to reduce cost and labor associated with feeding, maintaining drylot facilities, and manure management," Pruitt says. "Small grains such as wheat, oats, rye, barley, and triticale are potential sources of high quality forage for calves."

The project was made possible by funds from the USDA Multi-State Feed Barley Grant; Bill and Rita Larson of Fowler, Colo.; and the South Dakota Agricultural Experiment Station.u

—Lance Nixon

FORAGE OPTIONS FOR FENCELINE WEANING

Producers looking at a fenceline weaning system that uses forage crops to extend the grazing season have several options, SDSU scientists say. Sandy Smart, range scientist, and Vance Owens, forage researcher, worked with Pruitt to evaluate how well three crops—barley, rye, and turnips—would work in such a system.

Three planting dates, July 20, August 1, and August 15, and three harvest dates, October 1, November 1, and December 1, were used.

In a nutshell?

Turnips do better if planted at the earliest date. Rye and barley show no significant difference if planted by August 1. All three crops saw significant decreases in yield if not seeded until August 15.

"Planting date is of big importance for determining yield," Smart says. "August 1 is kind of a magical date to be shooting for. Generally you're double-cropping if you're planting fall forages. You'd want to plant them as soon as you've taken off the other crop."

Barley reached its maximum yield by October 1 and maintained that level until November. Rye didn't mature as quickly but continued to grow through October. Turnips continued growing through October.

All three fall forages—barley, rye, and turnips—started to decline in yield after November 1 as a result of freezing weather.

DID 1996 FARM BILL LIVE UP TO ITS NAME?

From its nickname you'd guess that the 1996 U.S. farm bill, "Freedom to Farm," would allow producers greater freedom from involvement by the federal government.

But a South Dakota State University agricultural economist's study of farm payments shows a surprising paradox in South Dakota: Freedom to Farm actually had the federal government more deeply involved than the previous farm bill in supporting agriculture.

"The dependency of the farm sector, and for that matter, of the state as a whole on farm program payments increased from 1996 to 2001, as opposed to the earlier time period from 1990 to 1995," SDSU economics professor Larry Janssen says.

"In other words, during the recent farm bill, which supposedly was market transition, we actually ended up with a lot more dependence on farm payments than in the earlier period, which was mostly a continuation of the 1985 farm bill."

THE PARADOX IS NOT SO HARD TO EXPLAIN, Janssen says.

"What really caused it was that we no longer had the acreage restrictions. The Conservation Reserve Program was maintained, but at a little bit lower level, and so on a nationwide basis we simply had more acres devoted to crop production during that period of time. As we know in the Northern Plains, we also had some truly incredible gains in yields.

"If you create a lot more production and you don't have a similar increase in demand, prices go down. When prices go down, then the LDPs, or loan deficiency payments, the market loan payments, start kicking in. That was a significant part of the story."

Janssen and an SDSU graduate student in economics, Yonas Hamda, studied farm payments in South Dakota as part of Hamda's work to earn his Master's degree in economics.

The study looked at farm program payment information from 1991 through 2001, not only at the state level, but also at regional, county, and payment recipient levels.

From the passage of the 1996 farm bill to 2001, Janssen notes that commodity program payments made up almost 80% of farm program payments in South Dakota; conservation payments for CRP as well as many other conservation programs accounted for about 13% of farm payments; and disaster payments made up between 7 and 8%.

Hamda and Janssen found that on a regional basis, farm payments were especially significant in north-central and northeastern South Dakota.

"It's a quite rural region. It really has two major trade centers, Watertown and Aberdeen, but beyond that it's a fairly rural region," Janssen says. "Farm program payments as a percent of everybody's personal income is higher in that region than anywhere else in the state."

Hamda and Janssen not only looked at farm program payments, but also considered what are known as federal transfer payments such as Social Security, Medicare, and certain kinds of veterans benefits. Once again, the north-central/northeastern region of South Dakota stood out.

"That region is basically more dependent on federal payments or at least receives a higher percentage of federal payments in relation to income than most other regions of the state," Janssen says, adding that the central region of the state ranks next to it.

"I think that, to a large extent, has to do with neither region having a metropolitan area—no Sioux Falls, no Rapid City—and South Dakota has a rather high percentage of elderly people."

WHAT SURPRISED JANSSEN AND HAMDA to some extent was that in east-central and southeastern South Dakota, which have a lot of crop farmers, farm program payments make up a smaller portion of net farm income than in the central or western parts of the state.

"What can that be due to? That's a little more difficult to answer. Of course there's more wheat base the farther west you go, and those areas historically have received higher payments, but there were a lot of changes in the '96 farm bill that kind of counteracted that."

One contributing factor, Janssen believes, is that producers in central and western South Dakota lean heavily on cattle.

"When we look at farm net income, we're obviously not just looking at crops. We're looking at everything, crops and livestock. At least the data showed that in some of those years, income from cow-calf production wasn't very good," Janssen says.

"I think what happened is that the farm income increase from all sources were stronger in the eastern region of the state, and so the government portion of it didn't kick in as much. In the western region, farm program payments really didn't increase very much from the early and mid-1990s to the later '90s, but net farm income went down considerably. If you look at payments against income, that, I think, is what's happening."

"If you create a lot more production and you don't have a similar increase in demand, prices go down. When prices go down, then the LDPs ... start kicking in. That was a significant part of the story."

—Larry Janssen,
SDSU economist

Larry Janssen, SDSU agricultural economist, explains why South Dakota farmers ended up with less freedom from involvement by the federal government under the "Freedom to Farm" act.

ON AN INDIVIDUAL RECIPIENT LEVEL, the SDSU study showed the average recipient in South Dakota between 1996 and 2001 received about $11,300 a year. However, when economists ranked payments from top to bottom, the median or midpoint was just under $4,000.

"In other words, there's a lot of payments that are not very large," Janssen says.

The SDSU study also showed where payments are going.

"What we found was this pattern, almost regardless of which year we were looking at from 1996 to 2001: If you rank recipients from top to bottom, the top 20 percent received 68 to 71 percent of total payments," Janssen says, noting that the top 20% in one year are not always the top 20% in the next year because of some year-to-year fluctuation.

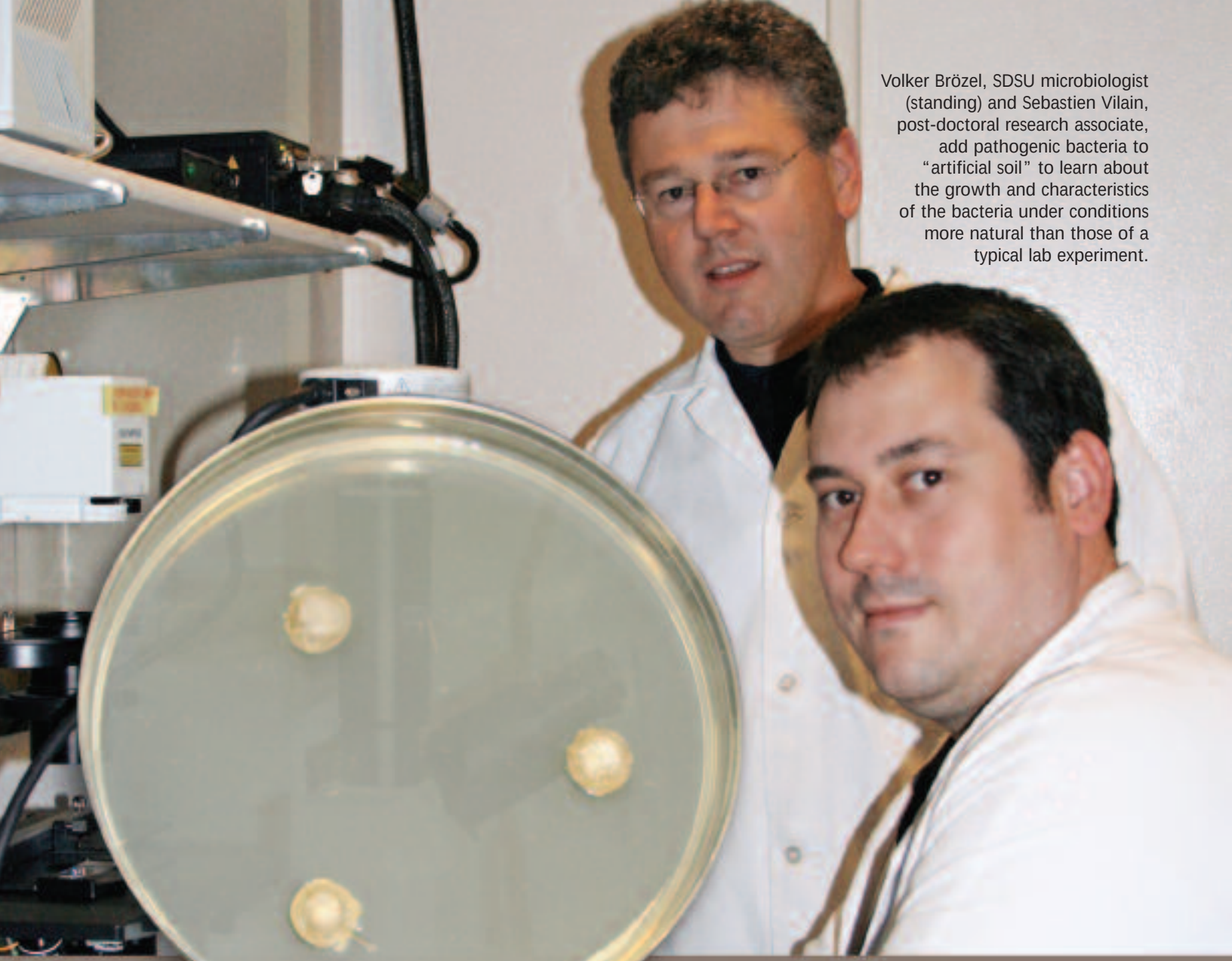
"The next 20 percent received about 18 to 20 percent. The bottom 60 percent received about 11 to 12 percent of farm program payments."

The distribution of farm payments mirrors the distribution of cropland acres operated, Janssen says.

Janssen says there are some 25,000 farms in the state that produce crops that generate farm program payments. About 5,000 farms in the state are ranches that produce no grains to speak of, and so they don't show up in the farm program payment data.

Janssen notes there are about 47,000 to 49,000 farm program payment recipients in South Dakota, or nearly twice the number of crop farms in the state. That is because some farms have multiple recipients, possibly family members or other parties involved in landlord/operator agreements.u

—Lance Nixon



Volker Brözel, SDSU microbiologist (standing) and Sebastien Vilain, post-doctoral research associate, add pathogenic bacteria to "artificial soil" to learn about the growth and characteristics of the bacteria under conditions more natural than those of a typical lab experiment.

WE CAN CHANGE OUR MINDS ABOUT BACTERIAL BEHAVIOR

Most people associate foodborne pathogens such as *Escherichia coli* O157:H7 or *Listeria monocytogenes* with contamination from animal or human waste. But that's just one side of the issue, says Volker Brözel, microbiologist at South Dakota State University.

Brözel's research shows that pathogenic bacteria can actually thrive in soil, without help from animal hosts. That might influence management practices and food safety measures, he says.

"The current mindset is that pathogenic bacteria proliferate in warm-blooded mammals, and when they occur in soil it's because of contamination from these animals. The bacteria are thought to then slowly decline," Brözel says. "But our hypothesis is that many of these bacteria can actually proliferate under soil conditions."

Brözel conducted the research with Sebastien Vilain, post-doctoral research associate. Also contributing were Yun Luo

"We're using these three samples of bacterial pathogens, but there are many others where the soil—our natural environment—could be revealed as a source of pathogens rather than just a transient survival zone."

—Volker Brözel,
SDSU microbiologist

and Amy Christie, graduate students, as well as Carmen Leonard, a visiting scholar from Tshwane University of Technology in Pretoria, South Africa.

The research team first focused on *Bacillus cereus*, a common cause of mild cases of food poisoning. "It's a fairly benign organism, but it has a number of relatives that are less benign, including *Bacillus anthracis*, which is the causative agent of anthrax. They are very similar in genetic makeup," Brözel says.

The study was later expanded to also include the common foodborne pathogens *E. coli* O157:H7 and *Listeria*.

THE FIRST GOAL OF THE RESEARCH WAS TO SHOW if these bacteria can indeed grow in soil, Brözel says. The researchers acquired soil samples from two different locations: a cornfield outside of Brookings and a forest bottom from SDSU's Oak Lake Field Station.

They conducted the study in a laboratory under controlled conditions. "In the real world you always have a mixture of organisms in soil, but if you want to study the behavior of a specific one, you have to work under pure culture conditions where you have no other growth but the species you want," Brözel says.

Normally, researchers sterilize soil by using heat, but that process completely changes the soil's makeup, Brözel says. Instead, his team developed a method to extract the organic matter from soil and then sterilize it by filtration, using membranes with very small pore sizes.

"We used the dissolved organic matter as a nutrient source, and we re-made an artificial soil that way. By avoiding heat damage, we had a nutritional makeup that was as close as possible to the original soil," Brözel says.

The researchers added the bacteria to liquid extract from soil, as well as to artificial soil microcosms inserted into wells in agar media.

"Basically, we had little soil systems where we introduced the bacteria in the middle to see if they could actually grow there," Brözel says.

And *B. cereus*, *E. coli* O157, and *Listeria* were indeed able to germinate, grow, and disseminate in both the liquid extract and the soil medium.

"They didn't just survive, they actually grew and spread and developed filaments," Brözel says. "We're using these three samples of bacterial pathogens, but there are many others where the soil—our natural environment—could be revealed as a source of pathogens rather than just a transient survival zone."

THE NEXT STEP FOR THE RESEARCHERS is to more closely study the behavior of the bacteria in soil. "Our medium-term objective is to understand how the bacteria grow and what phenotype they display; in other words, what their properties are," Brözel says.

Longer-term objectives are to find what the bacteria use for nourishment in the soil, and how they influence soil fertility.

"All three of these bacterial species have been studied intensively under laboratory conditions, where they are fed very high protein nutrients. But the question is what do they grow on in soil," Brözel says.

Brözel's studies of *B. cereus* under the microscope indicate that there is a big difference between bacteria grown in a soil environment and those grown in typical lab conditions. "In the lab, they look and behave differently; they make long filaments that look like fungi and are encased in a matrix we've been trying to characterize," Brözel says.

Brözel says his team's results eventually may have implications for management practices. For example, it may be useful to study the types of soils used to grow vegetables, as some soils may be more conducive to harboring bacteria. Knowledge of soil types may also influence management practices in stocking feedlot cattle.

David Francis, SDSU veterinary science professor who assisted Brözel's team, points to research from Nebraska and Texas showing that certain pens in large feedlots seem more prone to harboring bacteria than others.

Brözel also points out that naturally occurring anthrax seems to localize around certain areas, which can be linked to soil chemistry. It may be that some natural soil conditions favor bacterial growth.

"If we know that the soil is a source of pathogens, we can focus on management strategies that would reduce exposure to harmful bacteria," Brözel says. Such knowledge might, for example, influence how cattle are moved between pens and how manure is used to fertilize produce.

Brözel adds that it might also be possible to classify soils based on whether or not they would support the natural growth of certain pathogens. "Perhaps one would have to certify soils for some produce; say if you grow seed potatoes, the soil should be certified free of pathogens," he says.

The project is funded by an EPSCoR grant from the National Science Foundation and by the South Dakota Agricultural Experiment Station. u

—Marianne Stein

SCAUP, SCUDS, AND WETLANDS

If you hunted ducks this year, did it seem there were fewer bluebills coming south?

In the short haul, a 3% decline in lesser scaup numbers every year might not grab your attention, but this has been going on for 25 years. Even though lesser scaup are still the third most common duck in North America, behind only mallards and blue-winged teal, the scaup population has dropped to 3.4 million this year, an all-time low and nearly 50% off counts in the early 1980s.

Most biologists don't think hunting mortality is causing this long-term decline, says Spencer Vaa, South Dakota Game, Fish and Parks waterfowl biologist. "More likely, it's something happening in the environment, and nobody's been able to put a finger on it yet."

There are three suggestions as to the cause, and South Dakota State University researchers are contributing to the body of knowledge that seems to be zeroing in on one. That lead, however, is also uncovering more questions. And doesn't eliminate the other two possibilities. Or their combination.

MOST LESSER SCAUP NEST in the western boreal forest of the Northwest Territories. Numbers trickle off to the south; rare pairs bring off broods in northeastern South Dakota.

"When scaup leave wintering grounds in Louisiana in the spring, they're in excellent body condition," Vaa says. "But by the time they leave the northern staging areas in Iowa, Minnesota, Manitoba, and South Dakota, their body condition has deteriorated."

Scientists know this, Vaa says, from 20 years of weighing migrating scaup from Louisiana to Minnesota and Manitoba. Now biologists are looking for the source of this weight loss.

In the prairie pothole region of which South Dakota is a part, water is back since the dry years of the late 1980s to early 1990s. Other waterfowl like mallards and blue-winged teal have responded.

But not scaup. Where there should be plenty of food to recharge scaup for their final push north, pothole wetlands don't seem to be able to supply the kinds or amounts of food that the birds need to finish their migration and enter the breeding grounds in prime breeding condition.

Arriving on the breeding grounds in poor condition, without the fat and mineral reserves needed to lay a normal-sized

In the search for attractive scud habitat, Andrew Martian, undergraduate student from Watertown, calls out numbers for dissolved oxygen, pH, and other water variables to Sharon Kahara, graduate student in Wildlife and Fisheries Sciences.

"... the most dramatic weight losses in scaup occur in the Upper Midwest, one of their last major stopovers. So the answer may be in our prairie pothole wetlands, or it may be just one link in the chain of answers ..."

—Sharon Kahara,
SDSU Wildlife and Fisheries Sciences graduate student

clutch, scaup hens are forced to forage for several weeks before they can build up the energy to lay eggs. Clutch size may be reduced. And summer time in the boreal forest is short. Ducklings of late-nesting hens may not be old enough or strong enough to make a successful flight south.

Graduate research students in the SDSU Wildlife and Fisheries Sciences Department are filling in the blanks in South Dakota wetlands. While research in this state doesn't go back as far as in other states, data from the last several years in South Dakota fit the pattern of poor food selection and thin birds.

This scenario—not enough food in the northern staging areas— is known as the "spring condition hypothesis."

THE ZEBRA MUSSEL AND GLOBAL WARMING in the far Canadian north figure in the other two scenarios.

The mussel, an invader species and problem for boaters and environmentalists, is an unwitting actor in the "contaminants" scenario.

"The scaup that migrate through the Great Lakes and upper Mississippi River areas have discovered that the zebra mussel is tasty—they eat them in large quantities," Vaa says. "The zebra mussel is a very efficient storehouse of selenium, mercury, other heavy metals picked up in foraging. In fact, zebras concentrate contaminants in their bodies better than almost any other aquatic invertebrate. Along comes a scaup who's acquired a taste for the mussel, and the contaminants pass into the bird.

"Does this affect the bird's reproduction? It wouldn't be the first time and the first species where contaminants were responsible for a population decline."

There is scientific evidence to support this scenario. Selenium and mercury concentrations in collected scaup are higher now than in past years, say waterfowl biologists.

There's a third possible explanation for the dip in scaup numbers.

"We know the breeding grounds of lesser scaup is the area most affected by global warming," Vaa says. "We've got underweight polar bears in northern Canada. They can't hunt; the ice is too thin for them to get out to the seals. What we don't know is how global warming is affecting the organisms that scaup eat. Does a couple of degrees average rise in temperature have negative effects on them?"

Added to that, Vaa says, are the effects of economic development in the traditional scaup breeding grounds. "There's been a rapid expansion in mining, energy exploration and extraction, and in logging. This is no pristine area anymore.

"As to which scenario will finally be responsible for the decline in scaup numbers—there's no smoking gun yet," Vaa says. "And it's possible they're all linked together in some way. After all, that's the way nature works—it's a complex state of affairs out there."

WHY DO SCAUP GO AWAY HUNGRY when they leave South Dakota?

The prairie pothole region of South Dakota ought to be providing safe resting places and a diet rich in aquatic macroinvertebrates, especially amphipods, otherwise known as scuds and resembling a miniature shrimp. They are a favorite scaup food.

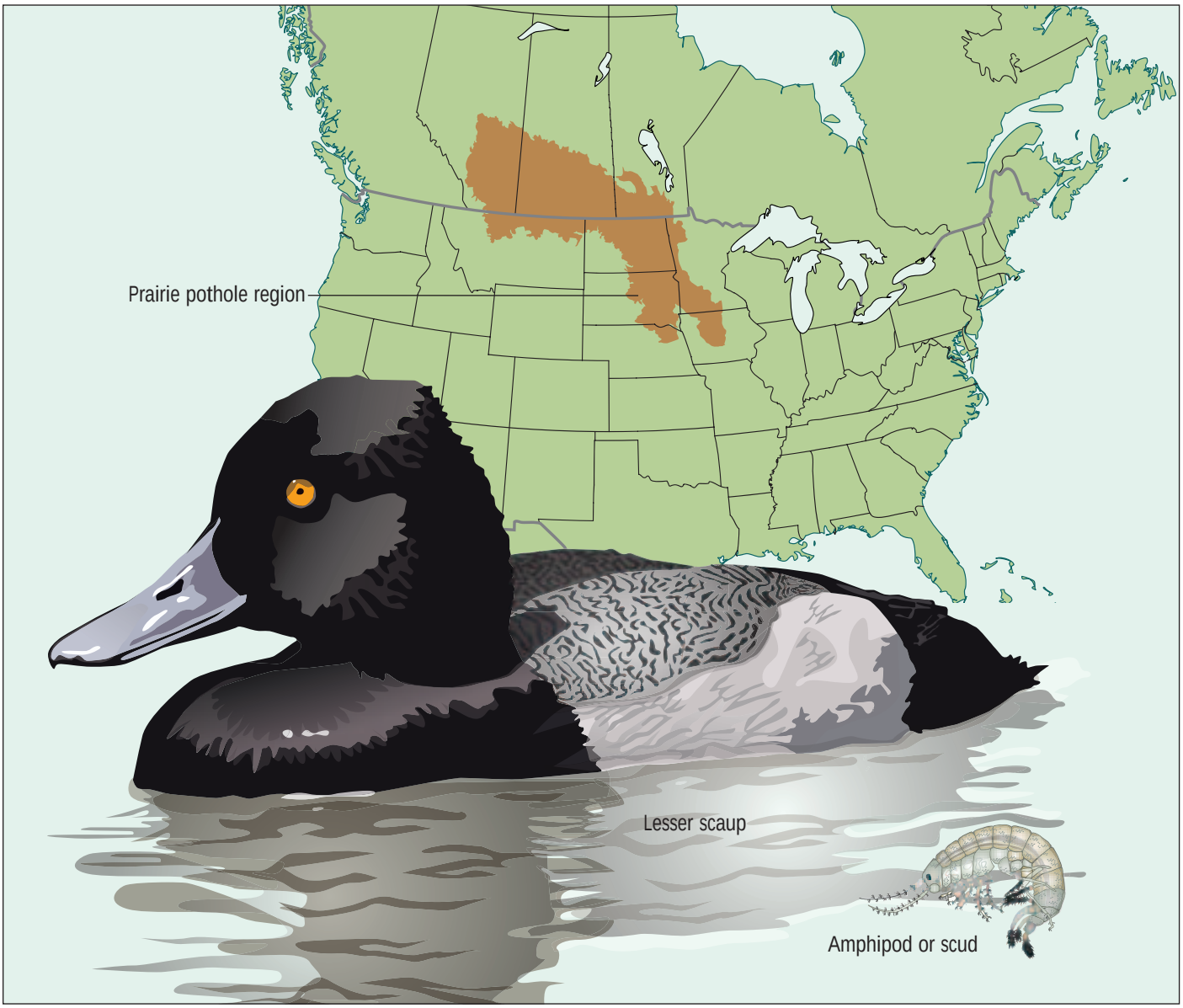
Some wetlands indeed are these havens. "And there are some wetlands with no amphipods," says Sharon Kahara, graduate assistant in the SDSU Wildlife and Fisheries Sciences Department working on a project funded by the South Dakota Game, Fish and Parks Department.

"One thing we know," Kahara continues, "is that scaup love scuds."

Something else has a taste for scuds.

"Fish, such as yellow perch, walleyes, and bullheads, also love scuds. Since fish are there year round, they could be consuming enough scuds to make them unavailable to scaup. At the end of the day, there just may not be enough prey to go around."

Black bullheads are among the most abundant fish species in eastern South Dakota wetlands, and they got an enormous boost in numbers when water levels rose once more. According to Kimberly Strand in her Wildlife and Fisheries Sciences Department Master's thesis, diet analysis revealed that scuds (21%), snails (18%), and fish (14%) were the dominant prey of scaup during spring migration, while for black bullheads the main items were fish (29%), scuds (24%), and crayfish (21%).



In earlier studies, the frequency of occurrence of amphipods in scaup diets was 51%. In Strand's study it was 33%. Of 29 semipermanent wetlands from which scaup were collected during the 2003 and 2004 spring migrations, those most used by the birds were "strongly associated with amphipod abundance."

A MODEL MAY SHED SOME LIGHT on these findings.

Kahara's model is sophisticated and predictive. Using data going back 15 years and from her own wetland visits, she is seeking the relationships between scaup, scuds, and wetlands.

"A model can tell you what went on in the past and what's going on now. It's like a recipe.

"I put in the behaviors of an organism, measure what happens, and then associate them with variables of the environment—weather conditions on a particular day, precipitation a week before, water quality, invertebrate abundance. I'm focusing on the scuds, and I'm looking for a link."

Amphipods are a popular organism for scientists studying population dynamics and toxicology, Kahara says, "about as popular as white lab mice."

They're sought by aquatic biologists because they're scavengers. A scud's main food is microscopic plants, animals, and debris from the surface of plants and on the bottom of the wetland. This diet marks the tiny animal (1/4 to 1/2 inch long) as an indicator. Scientists measure healthy water by its scud content.

What is the link?

"We already know that the most dramatic weight losses in scaup occur in the Upper Midwest, one of their last major stopovers. So the answer may be in our prairie pothole wetlands, or it may be just one link in the chain of answers that also contain aspects of environmental contamination and global warming.

"At the end of the day, I hope those of us in South Dakota have contributed our part in answering why scaup arrive at their breeding grounds in northern Canada in poorer body condition than they did 20 years ago."u —*Mary Brashier*

A BIOFILTER THAT STANDS ON END

Dick Nicolai, SDSU Extension engineer, and Ryan Lefers, engineering graduate student, built a working composite vertical biofilter. This one is larger than a farm model because it is actually six different versions of a vertical biofilter; the best version will be selected for continued testing.

Biofilters are practical solutions to reduce odor from hog barns. However, traditional flat biofilters take up considerable space outside the barn, making it difficult for some producers to accommodate them.

But what if you tip the filter up, so that it stands vertically rather than horizontally? That would require much less room.

Designing a vertical biofilter was the focus of a research project conducted by Dick Nicolai, South Dakota State University Extension farm machinery and safety specialist, and Ryan Lefers, a graduate student in SDSU's Agricultural and Biosystems Engineering Department.

"We know that biofilters work. So we set out to find the best design for a vertical filter," Nicolai says of their project, which served as the topic for Lefers' Master's thesis. Lefers, a

"If you have neighbors and you have a problem with odor, a biofilter may be the tool that allows you to stay in the hog business."

DICK NICOLAI,
SDSU AGRICULTURAL ENGINEER

Corsica native, won first prize in a student contest held by the Air & Waste Management Association for a paper on the biofilter research.

A BIOFILTER IS BUILT ON THE SIDE of a confinement barn with a vent leading from one or more ventilation fans into the filter. The biofilter works primarily with mechanically ventilated buildings, and the exhaust fan must be powerful enough to push the air through the biofilter. An air duct leads the air into a plenum under the biofilter material. As the air goes through the filter, odorous gases are neutralized.

The filter itself is a mixture of woodchips and compost. "The woodchips provide porosity, and the compost is the source of the microorganisms that break down the odorous compounds and convert them to carbon dioxide and water," Nicolai explains.

The concept used in biofilters is not new, Nicolai says. "Since the world was created, we've had biofilters. When a living thing dies and you bury it, you have a natural biofilter, because as the gases come up through the soil, microorganisms break down the odor. All we've done is learn how to adapt that to an agricultural building."

Agricultural biofilters were developed in Europe during the latter half of the 20th century, but their use was limited by high costs. The first U.S. biofilter was constructed by Nicolai in 1996 while he worked at the University of Minnesota. "We were having odor problems in Minnesota from livestock facilities, and I came across all this European research on biofilters," he says. Nicolai worked on ways to cut production costs and developed a more affordable prototype.

"Biofilters are up to 90% effective in reducing odorous gases," Nicolai says. "They are easy to design and build, and they are relatively inexpensive."

Construction costs range between $100 and $150 per 1000 cfm of air to be treated. Operating costs are about $3.00/1000 cfm per year.

THE MEDIUM (COMPOST) THAT IS REQUIRED for the biofilter to work can be quite bulky, and traditional biofilters take up considerable space. That's why Nicolai and Lefers set out to construct a vertical biofilter—with some variations off the vertical.

"If you have a filter with a straight wall, the media will settle after a period of time and become denser at the bottom than the top of the filter. That means the air will go through quicker at the top than at the bottom, making the filter less efficient. To compensate for that, you put a taper on one wall, so the air going through the top has the same resistance as the air going through the bottom. Ryan's research addressed what the taper should be to achieve uniform airflow," Nicolai says.

Lefers and Nicolai constructed six different vertical filter designs, varying in thickness of the media (12 or 24 inches) and in the slope of the wall (0%, 4.8%, and 9.6% taper) in a circular unit that contained all six configurations side-by-side. The filters were tested at a swine finishing barn a few miles south of Brookings. The unit was connected to a pit exhaust fan from the barn that forced the air into the center of the construction. "We had six little individual fans that blew the air through each of the cells, so that each cell got the same amount of air," Nicolai says.

The biofilters were tested over the course of a year, in order to let the media settle and to compare performance during winter and summer months.

Lefers measured airflow from 15 different sampling locations on the biofilter outlet wall, using an air collection apparatus to concentrate the treated air from each grid and an anemometer to measure the airflow. Odor samples were collected every nine weeks and sent to the University of Minnesota Olfactometry Laboratory for analysis.

The research showed that the largest degree of tapering was the most effective in obtaining uniform airflow, while thickness did not matter. "The 9.6% taper provides the most uniform airflow for either 12- or 24-inch media thickness," Nicolai says.

"A vertical biofilter may be a good option for reducing odor and gas emission when not enough space is available to install a horizontal biofilter," he concludes. "The vertical filter should be cylindrical, and the inner wall should be tapered."

The next research step would be to build a complete unit according to these specifications. "This research only looked at the best design for a vertical filter and did not compare it to regular filters. That's next," Nicolai says.

Producers can construct their own biofilters according to specifications provided by Nicolai and other specialists. "If you have neighbors and you have a problem with odor, a biofilter may be the tool that allows you to stay in the hog business," Nicolai says. Even without neighbors who are bothered by odors, some producers may want to install biofilters for their own benefit. "There are some producers who want to look into it for their own quality of life." u —*Marianne Stein*

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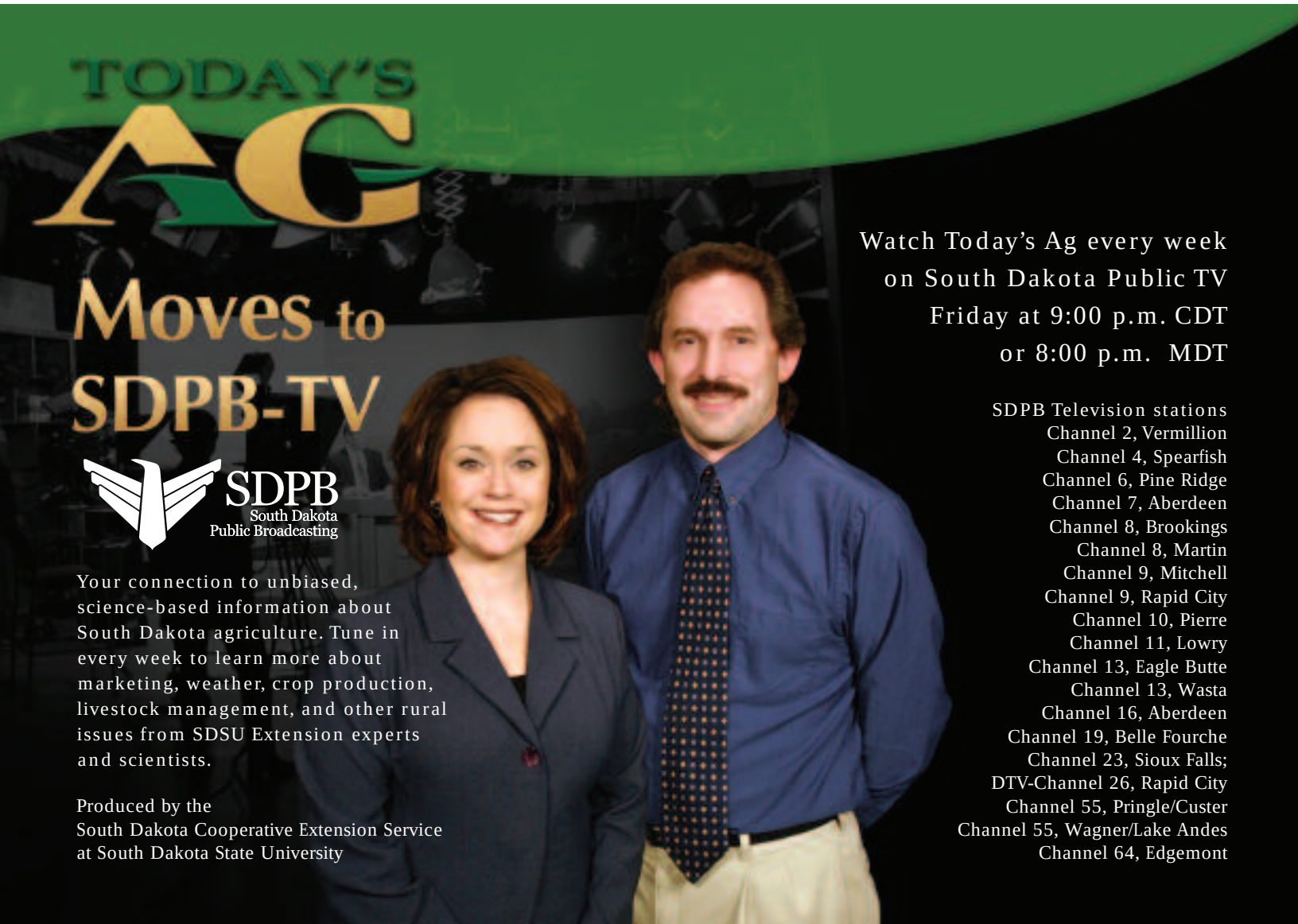

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