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Farm and Home Research: 55-4

Lance Nixon

Marianne Stein

Utilizing and developing our resources to enhance quality of life

Farm & Home RESEARCH

South Dakota State University · College of Agriculture & Biol ation

Volume 55 • Number 4

MR. WEEDS, MR. EXTENSION,
MR. WRAGE

PULSE CROPS:
ROTATIONS
THE ECONOMICS
THE AGRONOMIC ANGLE
FEEDING PEAS TO SWINE

TAKE ANOTHER LOOK AT YOUR SOYBEANS. THAT MAY BE IRON DEFICIENCY CHLOROSIS

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On the cover:

Leon Wrage, Mr. Weeds, is supposed to be "retired" after 35 years of employment by the South Dakota Cooperative Extension Service. True, he may not be heading up county crops meetings or leading weeds tours, but look for his popular 525 fact sheets and other evidence of his continued influence on the SDSU weeds program. Even on this, perhaps his last photo shoot, he couldn't resist showing the photographers how to identify a bull thistle. Story on page 6.

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Director's comments

BY KEVIN KEPHART
Director, South Dakota Agricultural Experiment Station

Kevin Kephart

What is new under the sun?

A lot of what's "new" in agriculture is really very old. Everything we do, in one sense, simply refines the ideas of the first farmer who dared to raise animals rather than hunt them or planted seeds rather than gathering them from wild plants.

Take the current three-state consortium on alternative crops, with researchers from South Dakota State University teaming up with colleagues from North Dakota State University and the University of Nebraska. They report that pulse crops—legumes such as beans, peas, and lentils—can fit comfortably into the agricultural systems in our three states.

Pulse crops raise some "new" research questions. But the truth is, pulse crops were among the earliest domesticated crops, and farmers and ranchers have puzzled over these same questions in other parts of the world for millennia.

A good example is Thomas Jefferson. Jefferson—politician, president, patriot—also had a scientist's interest in agriculture. In 1798, he wrote to a farmer acknowledging that he'd received a box of seed, including peas and vetch—both legumes.

Jefferson then discusses how such crops fit into his own farming system: "My rotation is triennial: to wit, one year of wheat and two of clover in the stronger fields, or two of peas in the weaker, with a crop of Indian corn and potatoes between every other rotation, that is to say once in seven years. Under this easy course of culture, aided with some manure, I hope my fields will recover their pristine fertility, which had in some of them been completely exhausted by perpetual crops of Indian corn and wheat alternately."

Some things never change: Here at SDSU, and at our research farms, our scientists are still deeply interested in what rotations work best to build the soil and confound weed and insect pressure. Expanding the biological diversity of our crop production is good for agronomic and economic reasons.

Something Jefferson and his neighbors never had was a land-grant university, a grand combination of academic pursuits in the arts and sciences, research, and Extension. The land-grant university opens new doors and enables us to understand what a Virginia grower in 1798 could know only intuitively.

Frankly, it's because growers such as Thomas Jefferson and his correspondent needed answers from science that the land-grant system came to be. The fact that we have that system is why SDSU animal scientists can look at winter feeding of beef cattle. It's why SDSU rural sociologists can survey the quality-of-life factors that people value about living in South Dakota; this research will help shape public policy as communities chart their futures.

The land-grant system is why we have a Leon Wrage to celebrate in this issue. Known throughout the state as "Mr. Weeds," Leon has made a difference for many farm families in South Dakota. Leon is one of the best living examples SDSU can offer of how the land-grant system ought to do its job—providing science-based information to make life better for the people of our region.

Weeds also are nothing new. The first grower to poke a seed into the earth had to deal with them, and we're still dealing with them. But thanks to Leon Wrage—brought to you by the land-grant university system—knowing how to fight them is a little bit easier.◆

Antibiotics in runoff

Todd Trooien

Ongoing research at South Dakota State University could lead to ways to help concentrated animal livestock operations manage antibiotics in animal manure.

SDSU scientists are studying how antibiotics fed to livestock have the potential to move in runoff when they're excreted in livestock wastes.

Todd Trooien, a natural resources engineer in SDSU's Agricultural and Biosystems Engineering Department, is the lead investigator in a study funded by the South Dakota Agricultural Experiment Station to examine the potential transport of two antibiotics. Trooien's undergraduate researchers—Jared Oswald in 2003 and Ryan Lefers and Seth Swanson in 2004—helped him carry out the research.

The 2003 work looked at the antibiotic tylosin, sold under the trade name Tylan. The 2004 work looked at the antibiotic chlortetracycline.

Trooien is only beginning to analyze the data from 2004, but already it's clear that chlortetracycline, like tylosin, is excreted in animal manure.

"There's really a key question here: Is it a problem?"

—TODD TROOIEN,
SDSU NATURAL RESOURCES ENGINEER

From the 2003 study, it's apparent that tylosin, an antibacterial chemical fed to swine, is capable of being transported in runoff.

"There's really a key question here: Is it a problem?

"We don't know that," Trooien says.

ANTIBIOTICS ARE ROUTINELY FED to livestock at subtherapeutic levels to maintain health and promote growth. Approximately 17.2 to 24.2 million pounds of antibiotics are used annually across the U.S. in animal production compared to 2.8 million pounds in humans.

For the study, Trooien chose land that had never had the antibiotics tylosin (in the 2003 field work) or chlortetracycline (in the 2004 work) applied to it.

Then he and the students measured the runoff potential for each antibiotic when applied alone or in manure excreted from treated animals; how manure affected the water infiltration rate, or the speed at which water moved into the soil; and what effect landscape position had on infiltration rate.

They set up a "worst-case scenario. The manure was surface applied with no incorporation, the manure was "fresh," and rainfall occurred one day after manure application.

Using a small sprinkler infiltrometer, Trooien and his students measured the infiltration rate at three positions on the landscape—at the foot of a slope, midway up, and at the top of the slope.

Manure was applied to the plots at the equivalent rate of 8 tons per acre. At that rate, each plot received .000012 ounce of tylosin in the manure. Of that tylosin, up to 23% was recovered in runoff. The results show that tylosin can be transported in runoff, Trooien says.

"This is equivalent to a transport rate of 0.02 pound per acre," Trooien says. "Total mass transport could be greater if precipitation continued longer, because tylosin was still being transported at the end of our tests."

"In areas where manure that contains tylosin is applied to fields, runoff reduction or prevention measures may be required to prevent tylosin from reaching surface water resources," he adds.

It is not known if holding or composting the manure would result in tylosin decomposition, reducing runoff potential.

Trooien's study found that the presence of tylosin had no effect on infiltration rates. Adding manure to soil decreased infiltration rates by as much as 86% when tested 24 hours after application. Infiltration rates also varied by landscape position, but the variation was not as much as the reduction caused by field traffic or application of manure.

"In the longer term, we would expect the infiltration rate to increase as a result of manure addition," Trooien says.

YES, AT LEAST ONE COMMON ANTIBIOTIC is capable of moving in the environment when excreted in animal manure, Trooien says. But the research raises several more questions for which there currently are no answers.

One potential issue for future researchers is antibiotic-resistant bacteria.

Antibiotic-resistant bacteria could be developing within the livestock that are being fed antibiotics. It's possible that those bacteria are then being excreted in animal waste so that they enter the environment.

It's also possible, Trooien says, that the antibiotics that are being excreted in animal waste and going into the soil could be killing non-resistant bacteria and leaving the resistant ones. The result could be that a relatively greater proportion of that bacterial population would be resistant to that particular antibiotic.

Professor Sharon Clay, SDSU weed scientist, says another issue is the impact of the antibiotics on the microbes that break down some of the pesticides in the soil. Clay has previously studied the issue of herbicide degradation in soil with USDA National Research Initiative and U.S. Geological Survey funding and says the possibility that antibiotics could affect that process is another research question.

Susan Gibson, SDSU microbiologist, adds that it's also possible that antibiotics in the environment could adversely affect important microbial processes in the degradation and cycling of natural components of the ecosystem, not just introduced chemicals such as pesticides or wastes.

The presence of tylosin slowed the degradation of the herbicide 2,4-D by a pure culture of a herbicide-degrading bacterium in preliminary studies under laboratory conditions, Gibson says. Biodegradation of this herbicide continued but at an impaired rate.

"Tylosin seems to delay 2,4-D degradation, but it did not completely stop it under the conditions tested," Gibson says.

In ongoing SDSU work, Gibson says, tests will evaluate how the herbicide atrazine breaks down when tylosin is present. Further tests will look at how 2,4-D and atrazine break down when the antibiotic chlortetracycline is present.

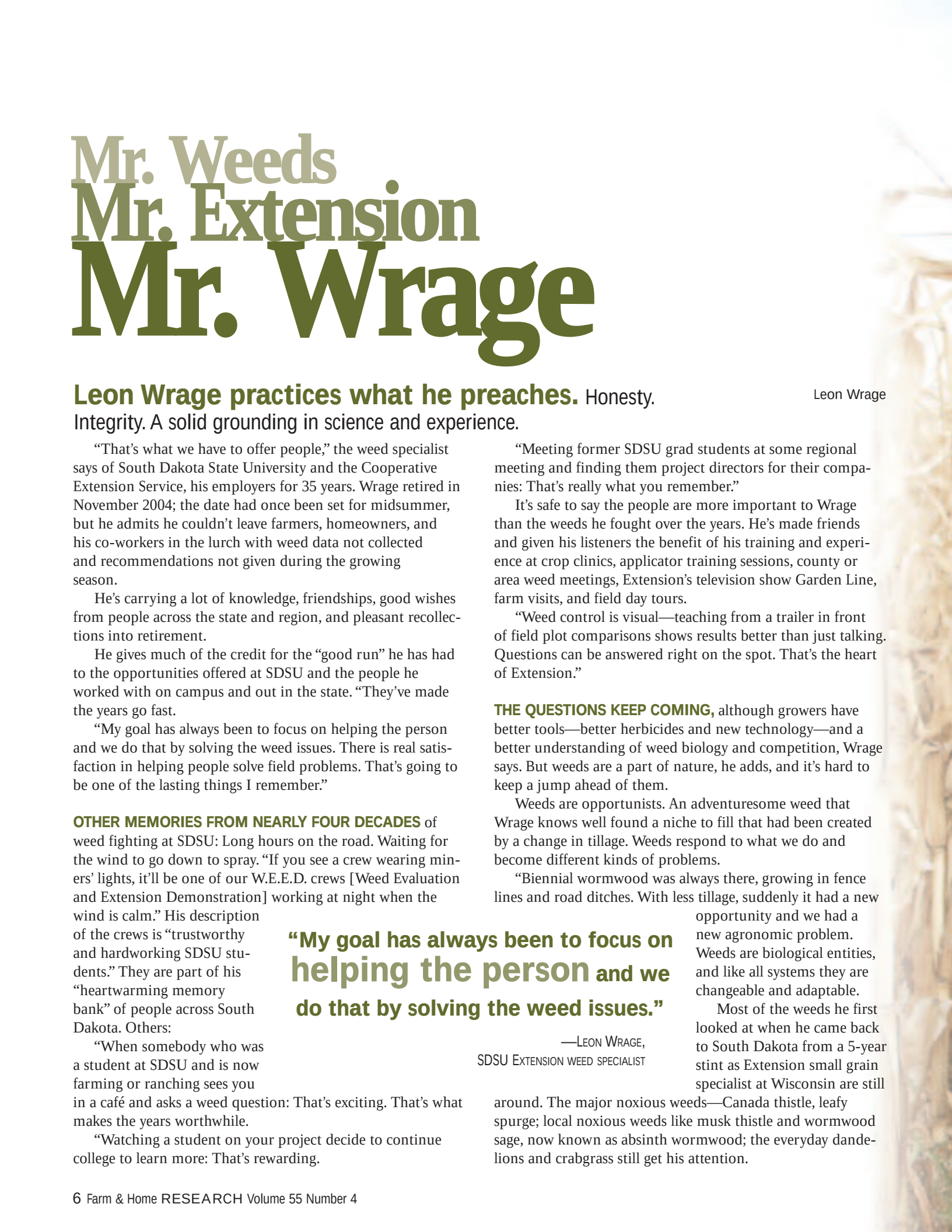
Clay and Gibson add that field environmental conditions are quite different from lab experiments, with occasional concentrations of antibiotics possible in "hot spots" and lower levels of antibiotics more common across larger areas.

A graduate student will do further testing in soils under laboratory conditions to determine what, if any, influence these antibiotics have on natural microbial populations. ◆

—Lance Nixon

Mr. Weeds
Mr. Extension
Mr. Wrage

Leon Wrage practices what he preaches. Honesty. Integrity. A solid grounding in science and experience.



Leon Wrage

"That's what we have to offer people," the weed specialist says of South Dakota State University and the Cooperative Extension Service, his employers for 35 years. Wrage retired in November 2004; the date had once been set for midsummer, but he admits he couldn't leave farmers, homeowners, and his co-workers in the lurch with weed data not collected and recommendations not given during the growing season.

He's carrying a lot of knowledge, friendships, good wishes from people across the state and region, and pleasant recollections into retirement.

He gives much of the credit for the "good run" he has had to the opportunities offered at SDSU and the people he worked with on campus and out in the state. "They've made the years go fast.

"My goal has always been to focus on helping the person and we do that by solving the weed issues. There is real satisfaction in helping people solve field problems. That's going to be one of the lasting things I remember."

OTHER MEMORIES FROM NEARLY FOUR DECADES of weed fighting at SDSU: Long hours on the road. Waiting for the wind to go down to spray. "If you see a crew wearing miners' lights, it'll be one of our W.E.E.D. crews [Weed Evaluation and Extension Demonstration] working at night when the wind is calm." His description of the crews is "trustworthy and hardworking SDSU students." They are part of his "heartwarming memory bank" of people across South Dakota. Others:

"When somebody who was a student at SDSU and is now farming or ranching sees you in a café and asks a weed question: That's exciting. That's what makes the years worthwhile.

"Watching a student on your project decide to continue college to learn more: That's rewarding.

"Meeting former SDSU grad students at some regional meeting and finding them project directors for their companies: That's really what you remember."

It's safe to say the people are more important to Wrage than the weeds he fought over the years. He's made friends and given his listeners the benefit of his training and experience at crop clinics, applicator training sessions, county or area weed meetings, Extension's television show Garden Line, farm visits, and field day tours.

"Weed control is visual—teaching from a trailer in front of field plot comparisons shows results better than just talking. Questions can be answered right on the spot. That's the heart of Extension."

THE QUESTIONS KEEP COMING, although growers have better tools—better herbicides and new technology—and a better understanding of weed biology and competition, Wrage says. But weeds are a part of nature, he adds, and it's hard to keep a jump ahead of them.

Weeds are opportunists. An adventuresome weed that Wrage knows well found a niche to fill that had been created by a change in tillage. Weeds respond to what we do and become different kinds of problems.

"Biennial wormwood was always there, growing in fence lines and road ditches. With less tillage, suddenly it had a new opportunity and we had a new agronomic problem. Weeds are biological entities, and like all systems they are changeable and adaptable.

"My goal has always been to focus on helping the person and we do that by solving the weed issues."

—Leon Wrage, SDSU Extension weed specialist

Most of the weeds he first looked at when he came back to South Dakota from a 5-year stint as Extension small grain specialist at Wisconsin are still around. The major noxious weeds—Canada thistle, leafy spurge; local noxious weeds like musk thistle and wormwood sage, now known as absinth wormwood; the everyday dandelions and crabgrass still get his attention.


North Dakota
Extension
Service

Leon Wrage, right, is presented parting gifts on the last Garden Line show of the 2004 season. Other panelists are Rhoda Burrows, Extension horticulturist, and Marty Draper, Extension plant pathologist. On the table is the apple gourd that stumped visitors to State Fair and callers to the show.

Velvetleaf became an issue shortly after Wrage became weed specialist.

"In the mid 70s, we had our first velvetleaf test plot to compare herbicides in Union County, set up with the county agent and cooperators. Soon after that, the Southeast Experiment Farm [near Beresford] allowed us to actually purchase a quart of velvetleaf seed and establish a research site on the farm.

"This was an excellent example of the role the SDSU experiment farms have had with us through the years. There has to be a check plot [no herbicide applied], and because it's not on a cooperator's land we don't need to get too worried if some treatments don't work as well as others and some don't work at all. That's science.

"The seed was sowed about dusk when we hoped no one was watching. Fred Shubeck [long-time manager of the farm] still cringes over this 'crop'."

ALL OF THESE WEEDS have been familiar enemies. Saltcedar wasn't. It could have caught Wrage, other SDSU scientists, and county weed boards just slightly off balance if they hadn't already learned how weeds sometimes behave.

Saltcedar never even made it into the 2002 edition of the book, "South Dakota Weeds," published by the Department of Agriculture, the state Weed and Pest Control Commission, and the Extension Service. But 2 years later in Extension's "Noxious Weeds," it is listed as noxious statewide, and Wrage and coworkers have prepared a fact sheet, FS 924, on the plant.

It's not a native; no "state noxious weed" is, by definition. It had been introduced from Eurasia in the early 1800s to use as an ornamental and to stabilize stream banks. In 2003, the South Dakota Weed and Pest Control report listed 1,381 acres of saltcedar, most along streams in West River.

"A mature saltcedar tree can withstand cutting, grazing, burning, cold, drought, flooding, you name it," Wrage says. "In fact, it's been shown that burning and cutting actually stimulate its growth."

Among its other nasty attributes, saltcedar is a water hog.

"A large saltcedar tree can take up 200 gallons of water a day," Wrage says. "That can dry up creeks and kill the rest of the vegetation.

"Herbicides, perhaps in combination with a defoliating insect, seem to be the best bet, but you have to be very careful and follow the label because if you're in a riparian area some herbicides could pollute the water."

WEED FIGHTERS HAVE CHANGED THEIR TACTICS over the years, Wrage says.

"My career started right at the beginning of the modern chemical years in agriculture. Times were changing from cultivation to herbicides. Pounds or quarts of herbicides."

But by the '90s the chemical weed control industry was maturing.

"Thanks to research and new products, we can use much lower rates, ounces per acre instead of pints or pounds. And these new chemicals are safer for us and the environment. They're more selective in that they target specific weeds. That accounts for the multiple programs and treatments available today."

In a table he shows what has happened to SDSU recommendations over time. The 1960 Extension fact sheet on weed control was a single sheet of paper, front and back. Three products, each with its own treatment guide, were the only herbicides for corn. Soybeans weren't even mentioned. In contrast, the 2004 weed control fact sheet for only corn is 36 pages.

SDSU weed recommendations

	Products/Treatment*			
	1960	**1970**	**1985**	**2004**
Corn	3/3	8/10	16/45	63/154
Wheat	2/2	6/16	15/29	40/62
Soybeans	0/0	5/6	21/81	55/137

*Products are the actual chemicals; treatments are combinations with other chemicals, various timings of applications, etc.

"I hope [upcoming] years are as rewarding for the next Extension weed specialist as my years have been for me."

—LEON WRAGE,
SDSU EXTENSION WEED SPECIALIST

"Now we know that chemicals alone may not be the most efficient treatment. Now we know about how to combine our efforts with biocontrol—flea beetles, goats, and sheep on leafy spurge or a couple of weevils and beetles on purple loosestrife," another state-noxious weed.

So Wrage has dropped the word "chemical" from the titles of his "525 series" of fact sheets. They are now "weed control" fact sheets, updated every year.

"I'm a believer in using whatever is safe and works if it will keep pressure on weeds," he says.

"We are learning interactions between crop plant and weed. In corn fields, for example, when the crops are stressed for moisture, just a 10-day delay in taking out foxtail can mean as much as a 20 bushel difference in corn yield. That's common sense, but now there are data to show just how big the drop in yield is and how costly the problem can become."

"When cultivation was the primary control, we watched each row at a time and stopped and got out the corn knife and chopped off that cocklebur. Now fields are larger, and producers may see what's happening only at planting and harvest. That makes scouting very important.

"The risk of a change in the weed is actually greater today. Consider the 1.7 million seeds a single waterhemp can produce and you can see this could happen incredibly fast."

That possibility underlines the need for objective, fact-driven information that can get to the producer when it's needed, Wrage says. "That's what Extension does best."

The SDSU recommendations are "based on results from our plot work and from adjacent states," Wrage says. "That's a real payoff in the South Dakota investment in the weed program. Unbiased information is what producers get in return."

THE WEEDS PROGRAM "has never been about me," Wrage emphasizes at the close of his SDSU career.

"It's we. Our system is incredibly unique. I couldn't begin to name all the weed scientists, biologists, agronomists, communicators, and office staff at SDSU who have contributed to the success of our weed program."

He has made supporters and friends in commodity groups and the South Dakota Department of Agriculture and among county Extension educators, cooperators, and others who have played major roles in collecting and disseminating SDSU weed control information. They have all been vital parts of the weed program, he says.

There is plenty of work for them to carry on, he adds.

"Our immediate challenges are areas sometimes overlooked—fence lines, corners, weed patches by the trees.

Briefly:

"We're South Dakotans, and I guess I thought an opportunity to work at SDSU would be just as good as it gets. The whole family has taken courses here, children and their spouses, a sister, nephews, and now a grandchild. It's going to be tough to leave SDSU behind." —Leon Wrage

Born in Canistota, he graduated from Monroe High School and attended SDSU where he earned a bachelor's in agricultural education and a master's in agronomy.

"Opportunities for students are one of the unique things about SDSU. They aren't as available at other institutions where they have much more expanded programs than we do. I found mentors and opportunities. We were always encouraged to try things and give people all the help we could."

After 5 years in Wisconsin as Extension small grains specialist, Wrage returned to SDSU in 1969 to develop the South Dakota Extension weeds program.

His 184 different annual editions of the "Fact Sheet 525s" on weed control in various crops have been "best sellers" for over three decades. He has written and contributed to 235 Extension publications. The total number of all copies of all publications combined is 1,179,109.

If just the Fact Sheet 525s printed in 2004 alone were taken apart and the pages laid end to end, they would reach from Fort Lauderdale, Fla., to Portland, Ore.

Among his many awards is his induction as Fellow of the North-Central Weed Science Society, the highest honor the Society bestows. Only .5% of the more than 900 weed-scientist members from universities, governments, and private industry in 16 states and four provinces are eligible to receive the award each year.

He is both a Distinguished Alumnus and Distinguished Professsor at SDSU.

"These are all seed sources, and that's why we continue to have weeds even though they are being managed from an economic standpoint fairly well in most—not all—crop situations.

"I would anticipate that in the future weeds will continue to expand in the niches we've provided them, and this is going to happen more rapidly.

"We're learning the incredible implications that growing conditions—sunlight, humidity, dew, precipitation, temperature— have on both crops and weeds. Another challenge down the road will be to further define how each of those factors are related so we can develop models that will help the grower more accurately predict what rate, product, additive, carrier volume, or even time of day to apply a herbicide.

"Undoubtedly, we will see further applications of biological control. Perhaps changing the whole physiology of a weed will in some way trigger the mechanism of bud release over the entire underground system on perennials. That would exhaust the weed's stored food in short order.

"There may be success in modifying crop plants so they produce their own herbicides.

"From just looking at the recent past, we shouldn't be surprised at how weeds will be controlled 15 years from now.

"I hope those years are as rewarding for the next Extension weed specialist as my years have been for me." ◆

—Mary Brashier

Feed for efficiency

Raising feedlot cattle can be a challenge during the cold winters of South Dakota, but appropriate feeding strategies can help reduce costs and improve performance.

The results from a South Dakota State University study can be implemented immediately and will help make South Dakota producers more competitive, says Robbi Pritchard, professor of Animal and Range Sciences.

"South Dakota cattle producers deal with heat stress half of the year, and cold stress the other half. In our research, we always try to deal with weather-induced stress issues. Our work aims to help the local feed industry compete with the feeding industries in the southern plains," he says.

SIMPLY CHANGING THE TIME OF THE DAY when cattle are fed can save feeding costs. Limit-feeding growing steers in the afternoon instead of in the morning is more cost-efficient, the study shows.

"A few years ago we discovered that if cattle are fed in the afternoon, they are more efficient than if they are fed in the morning," Pritchard says. "We wanted to find out why that happens."

"And we did. The energy that's generated by the heat of fermentation and heat of nutrient metabolism from afternoon feeding helps maintain core body temperature through the night. The animals don't have to dissipate the heat, but can use it to stay warm. That prevents them from having to crank up the metabolism to cope with the long, cold night."

In the study, Pritchard, Jeff Clapper, associate professor, and Simone Holt, research associate in the Animal and Range Sciences Department, determined the effect of feeding time on efficiency and performance of growing steers during the winter months in South Dakota.

Simone Holt, research associate in the Animal and Range Sciences Department

"... we always try to deal with weather-induced stress issues."

—Robbi Pritchard, SDSU animal scientist

The research took place in December 2002 and January 2003 at the SDSU feedlot in Brookings. During a 56-day trial period, 96 growing steers were limit-fed a diet of high-moisture ear corn plus a supplement. Half of the animals were fed at 9 a.m., the other half at 3 p.m.

Each animal was equipped with a tympanic temperature data logger, which is a thermometer attached inside the ear of the steer. It continuously monitors the animal's body temperature and stores the data. Later, the researcher plugs the device into a computer and obtains temperature data at desired intervals.

"We found that animals fed in the afternoon had a lower body temperature than the cattle that were fed in the morning," Holt says. Average daily body temperature of morning-fed cattle was 102.9 F; for afternoon-fed cattle it was 102.0 F. Maximum daily body temperature was 104.0 F for the morning-fed and 102.9 F for the afternoon-fed animals.

The researchers also collected blood samples to determine serum concentrations of T3 and T4, two thyroid hormones that are known to change with metabolic activity. No differences were detected in serum concentrations of either hormone between the two groups.

Holt, Pritchard, and Clapper measured dry matter intake and average daily gain to calculate feed efficiency, and they found that PM-fed animals performed much better than their AM-fed counterparts.

"Both groups started out at 656 lb in bodyweight, and the afternoon group ended up heavier than the morning group. The average bodyweight for the afternoon-fed group after the 56-day growing period was 847, while the morning-fed group averaged 829 lb. Animals in both groups were fed the same amount, but the afternoon group gained more, which means that they were converting the feed better," says Holt.

Average daily gain was 3.12 lb for the morning-fed group and 3.42 lb for the afternoon-fed group. These performance data indicate a 25% increase in maintenance energy expenditure for the morning-fed steers.

IT LOOKS LIKE AFTERNOON FEEDING takes advantage of the heat of fermentation, says Holt. "If you feed in the morning, heat production from fermentation occurs during the day. But the coldest period during the winter is early evening into the early morning hours.

"If the animals are fed in the evening, the heat production that occurs as a result of fermentation may do 'double duty' by heating the animal at the coldest time of the day, reducing the amount of energy needed for maintenance."

The afternoon-fed cattle can utilize the heat generated by fermentation to help maintain their body temperature without expending excess energy, so they can put that energy into growing.

Holt, Pritchard, and Clapper are planning another study to better understand the connection between time of feeding and performance. This time they will include more animals, as well as a third treatment group that is fed twice daily. The current project was funded by the SDSU Beef Nutrition Program and the South Dakota Agricultural Experiment Station. ◆

—Marianne Stein

Dwayne Beck, manager, Dakota Lakes Research Farm

Pulse crops: rotations

If pulse crops seem like something new to American farmers, Dwayne Beck recommends a trip to the local library to borrow a copy of Laura Ingalls Wilder's "Farmer Boy."

That childhood classic—an authentic story about the growing-up years of Laura Ingalls Wilder's husband, Almanzo Wilder, on a farm in New York state—offers a glimpse back at American agriculture in the mid-1800s.

"They talk in that book about Almanzo feeding peas to his calves. Those would be field peas, dried field peas," the manager of Dakota Lakes Research Farm says.

Beck believes field peas can have an important place on farms once more, particularly in the Northern Plains. So can lentils and chickpeas.

All three of those legumes can be grown in South Dakota. Field peas probably are suited for most areas of the state, lentils should fit best from Pierre to the north and west, and chickpeas would be a choice from Pierre to the south and west.

PULSE CROPS IN ROTATIONS help break the cycle of plant diseases and insect infestations, Beck says, just as soybeans in the 1990s in the James River Valley helped farmers break up the diseases and insects associated with wheat and barley rotations. Brown and Spink counties now lead South Dakota in soybean production.

Growing legumes can also help spread out farm labor.

For example, field peas can be planted as early as possible in the spring—before spring wheat in some cases—and can be

"The initial reason for looking at the cool-season broadleaf crops was to find a substitute for summer fallow in central South Dakota. Pulse crops fill that need."

—Dwayne Beck, manager,
Dakota Lakes Research Farm

harvested after the winter wheat and before spring wheat combining begins. Beck adds that some of SDSU's ongoing work with pulse crops is looking at the possibility of winter peas and winter lentils. That would add even greater flexibility by allowing farmers to seed them in the fall.

SDSU has been doing research on field peas since the 1980s. Beck has been carrying out research on pulse crops since 1990.

With the recent addition of field peas, lentils, and small chickpeas to the federal farm program, there's additional incentive to grow them.

"The reality of it was, we weren't going to have a pulse industry until we put them on the same footing as other crops," Beck says.

What kind of yields can farmers expect? In 2004, a good year for growing field peas in central South Dakota, Beck calculates the Dakota Lakes Research Farm harvested an average of 60 bushels an acre.

Ruth Beck, longtime liaison for the South Dakota Pulse Growers Inc. and now SDSU Extension educator for Hughes and Stanley counties, says field peas closely mirror what happens with wheat in any given year.

"When you have a good wheat year, it's generally going to be a good year for field peas, too," she says.

GROWING PULSE CROPS REAPS BENEFITS beyond the current year. Those benefits are more than breaking up insect and weed pressure.

Some of SDSU's past work in Lyman County showed that wheat, when grown on land that had field peas on it the previous year, outyielded wheat following fallow by 2 bushels an acre. In 2004, Beck says, wheat following field peas outyielded wheat following flax by 20 bushels an acre.

"There are some things going on there that we don't fully understand," Beck says. "There may be some microbial factors, there may be some carbon cycling factors."

So where and how do these crops fit into a rotation?

"The initial reason for looking at the cool-season broadleaf crops was to find a substitute for summer fallow in central South Dakota. Pulse crops fill that need. The next obvious place is to use them as a transition crop that makes it easier to switch from a full-season (late fall harvested) crop to winter wheat."

For instance, Beck says, the sequence could be corn-pea-winter wheat instead of corn-soybean-winter wheat. Seeding winter wheat following soybeans or sunflowers is difficult, and those crops are often not ready to harvest when it is optimum time to seed wheat. In addition, it is commonly too dry to get good stand establishment.

"Since peas are harvested in the summer, there is time for some moisture recharge before optimum wheat-seeding time," Beck says. "The biggest benefit is that you don't have two things (wheat seeding and soybean harvest) going on at the same time. The other place these crops seem to fit is as a means to transition from high-residue crops to corn under no-till in northern areas."

In the cooler but drier areas of the state, Beck adds, producers often want to plant corn into small grain stubble because of the additional moisture it contains. Commonly they find it is difficult to do a good job because the weather is too cool.

Crops such as peas and lentils have moisture use patterns similar to small grains but have dark-colored residue. This results in conditions the next spring that have deep moisture similar to small-grain residue and surface conditions more like soybean or sunflower.

ALL OF THE PULSE CROPS do very well when seeded into high-residue conditions. This is especially true for peas. These crops break some but not all of the weed, disease, and insect cycles that impact crops like soybeans.

"Planting them early in the spring brings a whole new dimension to controlling weeds through competition," Beck says. "By the time most soybean weeds get started the peas will be nearly full canopy. Some insects will not initially recognize peas or do not emerge or arrive until the peas are well along."

Much of Beck's original work on pulse crop rotations was conducted with Agricultural Experiment Station funding and activity funds from farm sales. In addition, the South Dakota Wheat Commission has funded rotational studies for nearly 20 years.

Beck adds that no one knows what impact pulse crops could have on cyst nematodes—a question for SDSU's research farms to address in the future. In the meantime, he says, adding pulse crops to rotations adds one more weapon to the fight against crop diseases, weeds, and insect pests.

"One of the things we talk to farmers about is not having rotations that are consistent in either sequence or by interval," Beck says. "Having pulse crops in the arsenal will help with that goal." ◆

—Lance Nixon

Pulse crops: the agronomic angle

The search for alternative cropping systems that are agronomically feasible and sustainable is leading South Dakota State University scientists and growers in parts of South Dakota to investigate pulse crops.

Thandiwe Nleya, SDSU Extension agronomy specialist

Thandiwe Nleya, SDSU Extension agronomy specialist, says that because pulse crops are legumes they fix nitrogen in symbiotic association with Rhizobium bacteria. That means they can reduce fertilizer costs for producers.

With funding from the three-state Consortium for Alternative Crops, USDA Cooperative State Research, Education, and Extension Service, that includes scientists from South Dakota, North Dakota, and Nebraska, Nleya and colleagues from SDSU's West River Ag Center in Rapid City are currently determining the potential of three pulse crops—field peas, chickpeas and lentils—for central and western South Dakota. Aided by John Rickertsen, research associate, and Bruce Swan, senior ag research technician, Nleya is picking varieties of these three crops that are well adapted to the South Dakota environment, the best management practices for South Dakota's conditions, and the fit of pulse crops into current cropping systems.

THE TEAM'S EXPERIMENTS include both spring and winter varieties of field peas.

Forage and grain types of spring pea varieties were evaluated at Bison, Hayes, Selby, and Wall.

"Results show that spring pea varieties are well adapted to South Dakota conditions. Average yields from our experimental plots have ranged from 20 bushels per acre in drier environments to 50 bushels per acre in more moist environments," Nleya says.

"In 2003 the cool summer favored pea production, and average pea yield at Selby, a relatively wetter environment, was 64 bushels per acre. At Wall, a drier environment, the average yield was 23 bushels per acre."

Chickpea variety trials were conducted at Hayes, Wall, and Oelrichs. Yields have been variable depending on variety and growing season precipitation and have ranged from as low as 600 pounds per acre in dry years to as high as 1,800 pounds per acre in wetter years.

Winter pea and winter lentil varieties were evaluated at Wall and at Dakota Lakes Research Farm. Planting is at the same time as winter wheat.

"The winter pea varieties seem to be susceptible to winter injury and have yielded lower than the spring varieties at both locations," Nleya says. "However, winter pea is more physiologically advanced in early spring. Potentially, early biomass production can be exploited for forage."

Winter lentils have been more promising than winter peas, showing less winter injury and yields averaging over 1,000 pounds an acre. Chickpeas and lentils seem best adapted to the West River area while field peas are adapted to central and east central South Dakota, Nleya says.

BEST PLANTING DATES and best seeding rates (plant populations) for pulse crops will have to be worked out for South Dakota conditions, Nleya says.

"We get calls every spring from producers wanting to know the best time to plant field pea or chickpea. They also want to know the seeding rates to use and how deep to place the seed in the soil."

Nleya notes that, at least until now, many of the answers have been based on research conducted in North Dakota or in Canada. She finds that worrisome.

"It is likely that best management practices in western South Dakota may be considerably different from those in

North Dakota, given that we are much drier out here. We are currently conducting research to answer these questions under our conditions."

In 2004 the trio of scientists established plots at two locations (Sturgis and Hayes) and planted four varieties each of field peas and chickpeas at five planting dates of April 1, April 15, May 1, May 15, and May 30 for both crops.

"Unfortunately, deer trampled our plots and picked all the pods at Sturgis, so we had to abandon that location," Nleya says.

At Hayes, field peas planted on April 1 yielded lower than field peas planted April 15, April 30, and May 15 but yielded higher than peas planted on May 30. Field pea yields were similar when peas was planted on April 15, April 30, or May 15.

"It is important to note that the spring in 2004 was very dry and that the April 1 planting was at a disadvantage due to the dry conditions," Nleya says.

"Our earlier research has shown that planting as early as April 1 can result in higher yields than we observed in 2004. It is also important to note that field pea is very sensitive to high temperatures during flowering. When seeding is delayed beyond mid-May the crop will begin flowering in mid-July, increasing the risk of heat stress."

Results of the chickpea planting date study showed that chickpeas should be planted when soils have warmed up to about 45 degrees F and the temperature is on the rise.

"Planting early in April under our conditions often results in delayed emergence and exposes the seed to infection by soilborne pathogens. In our experiments chickpea planted on April 1 emerged late, had poor plant stands, and flowered at the same time as chickpea planted mid to late April. We recommend that producers plant chickpea between mid-April and early May," Nleya says.

IN ANOTHER STUDY CONDUCTED at Wall and Hayes, funded by the Research Support Fund of the Office of Research and Sponsored Programs, scientists planted four different field pea varieties at six seeding rates of 100,000, 150,000, 200,000, 250,000, 300,000, and 350,000 seeds per acre to determine the best plant density for optimum yield.

"At Wall, the land had been fallowed the previous year, while at Hayes we planted peas into winter wheat stubble. Thus, although both locations experienced drought in 2003, there was relatively more moisture at Wall than at Hayes. At Wall, where soil moisture was least limiting, seeding rate had no significant effect on the yield of peas, meaning that the low seeding rates yielded as good as the higher seeding rates."

The results also showed that where seeding rates were low, pea plants produced more pods and more seeds per pod (Table 1). In a drier environment at Hayes, grain yield increased as seeding rate increased, with the 300,000 seeding rate yielding 285 pounds more than the 100,000 seeding rate.

"Although plants in lower seeding rates did produce more pods and more seeds, soil moisture limited the extent of this plasticity and thus, did not help the yield as much as we observed at Wall," Nleya says.

"While lower seeding rates look promising under high moisture situations, it is important to note that weed control may be a problem in an open canopy. We observed higher weed pressure where plant populations were lower than 200,000 plants per acre at Hayes, and this should be taken into consideration when deciding on seeding rates."

DESPITE THE PROMISE SHOWN by pulse crops, Nleya says it is no secret that wheat is still king. "Winter wheat is and will remain the main crop in western South Dakota, but pulse crops can serve as important rotational crops."

With funding from the South Dakota Wheat Commission and the Consortium of Alternative Crops, scientists are currently studying the impact of pulse crops on the following winter wheat crop. That work involves Nleya, Rickertsen, and Swan, Jim Gerwing, SDSU Extension soil fertility specialist, Ron Gelderman, SDSU soils lab manager, and Sharon Osborne, research agronomist in the USDA Agricultural Research Service laboratory in Brookings.

They are comparing the pulse crop-winter wheat sequence with the spring wheat-winter wheat sequence. It's not just winter wheat yield that catches their interest, but also nutrient use efficiency, water use efficiency, and disease pressure in the different sequences.

Nleya says a lot of research is still to be done on pulse crops in South Dakota. SDSU scientists will need to determine optimum seeding rates in chickpeas, winter peas, and winter lentils. They will also need to investigate questions such as the effectiveness of inoculants in western South Dakota's dry environment. ◆ *—Lance Nixon*

Table 1. Effect of seeding rate on yield, number of pods per plant, and number of seeds per pod of field peas, Wall, 2004.

Seeds/acre	*Yield, lb/A*	*Pods /plant, number*	*Seeds/pod, number*
100,000	954	7	6
150,000	976	6	5
200,000	941	6	5
250,000	989	5	5
300,000	1,087	5	5
350,000	1,017	5	4
S.E.	37.4	0.6	0.4
Significance (0.05)	n.s.	*	*

Table 2. Effect of seeding rate on yield, number of pods per plant, and number of seeds per pod of field peas, Hayes, 2004.

Seeds/acre	*Yield, lb/A*	*Pods /plant, number*	*Seeds/pod, number*
100,000	694	6	6
150,000	771	6	5
200,000	822	5	5
250,000	831	5	5
300,000	978	4	5
350,000	953	4	5
S.E.	45.6	0.3	0.2
Significance (0.05)	*	*	*

Pulse crops: the economics

Pulse crops such as field peas, lentils, and chickpeas are well adapted to the soils and climate of the Northern Plains, but American producers will have to contend with large established producers such as Canada in marketing their crops to the world.

That hasn't stopped U.S. acreages from growing rapidly, and trade groups have their eye on developing markets in the U.S. and elsewhere that could boost the demand for pulse crops.

Those are among the issues North Dakota State University has highlighted in a study of the economics and market development of pulse crops. Jay Fisher, director of NDSU's North Central Research Extension Center, was the project leader for that study, part of a three-state effort with South Dakota State University and the University of Nebraska, studying pulse crops as alternative crops in the Northern Plains with USDA Cooperative State Research, Education, and Extension Service funding.

The result is NDSU's "Pulse Crop Marketing Guide," written by Edward L. Janzen, J.J. Fisher, Eric Bartsch, and George Flaskerud.

PULSE CROP TRADE GROUPS say marketing is becoming easier thanks to the growth in acreage, which is bringing more processors and buyers into the field. In North Dakota, for instance, there are now about 35 buyers and about eight processors—up from only one processor a decade ago.

"The U.S. in general is always known for top quality," says Bartsch, executive director of the North Dakota Dry Pea and Lentil Association. "I think we're getting to the point where we're being known as a reliable supplier. North Dakota has moved into a stage where we're going to be a large supplier to major buyers. The potential is there for the whole Midwest."

Nevertheless, competition is strong in the world market. Pulse Canada estimates that by 2005 Canada will account for 45% of world chickpea trade, 48% of the world pea trade, and 63% of the world lentil trade.

"In North Dakota we are starting to see several country elevators that normally handle wheat now handling peas for the feed market. ... As our acres increase I predict we will start seeing more unit trains of feed peas."

—Eric Bartsch,
North Dakota Dry Pea and Lentil Association executive director

Australia, meanwhile, has a geographic advantage in reaching Asian markets.

Local logistics can be a problem for U.S. producers, since not all grain elevators in the Northern Plains are willing to accept pulse crops or perhaps don't have the capabilities to accept them. Quantities are often small, and special handling, especially of food-grade pulse crops, is often required to minimize splitting of seeds. Facilities that clean and bag pulse crops for human consumption, though on the increase, are still few in number.

However, pulse crop acreage is on the rise in the U.S. North Dakota's acreage of dry peas has jumped from 160,000 acres in 2003 to 280,000 acres in 2004, which suggests pulse crops are becoming easier for producers to move to market.

"Feed peas for most markets do not need any special handling," Bartsch says. "In North Dakota we are starting to see several country elevators that normally handle wheat now handling peas for the feed market. Some of the elevators in the fall are putting together bulk quantities to be shipped to port or to a domestic feed buyer. As our acres increase I predict we will start seeing more unit trains of feed peas."

Fisher says import tariffs on feed ingredients are another issue, since they put U.S. producers at a disadvantage in trying to sell to some countries—especially countries that allocate quotas to their historic suppliers. That practice can be a hurdle for growing exporters such as the U.S.

THERE ARE STILL OPPORTUNITIES, Fisher says.

The market for pulses for human consumption centers primarily on countries where, for religious dietary preferences or economic reasons, pulses are a staple and primary source of protein in the local diets, Fisher says.

"India is the major importer of dry peas for human consumption. Bangladesh and Pakistan are also significant importers of dry peas for food use. Other importers of dry peas primarily for food include Colombia and Peru in Latin America and Cuba, which is one of the largest importing countries of dry peas in the western hemisphere."

Meanwhile, Europe is the largest feed market for field peas. Feed markets are slowly being established in Asia and Latin America.

Trade groups also are looking at a number of trends that may spur greater demand for pulse crops.

Pulse crops are not familiar items in the diet of most Americans. But immigrant and ethnic populations in urban areas make up a niche market of people who already consume pulse crops and in many cases prefer pulses to some other food staples. There's a chance to grow the pulse market, perhaps by making some ethnic foods that use pulse more familiar to Americans.

Pulses could be key components of the nutraceutical and functional food industries because of health benefits.

The rapidly growing organic market in the U.S. and Europe is another potential market. Vegetarians—who rely on sources such as pulse crops to meet their protein needs—may make up a small niche market.

The market for foods that use no transgenic ingredients presents another opportunity, Fisher says.

"There may be unique marketing opportunities for pulses because there are no transgenic pulse varieties currently registered in the U.S. or Canada, and there are none identified as being developed in the immediate future," Fisher says. "As the European Union and others struggle with concerns over genetic modification issues, some of their food requirements may be met with increased use of non-transgenic pulses. In the feed market, field peas may be in a unique position to provide the non-transgenic energy and protein sources that are desired or required in livestock rations in several European countries."

AS WITH ALL SPECIALTY CROPS, Fisher says, growers should locate markets and delivery points for their specific variety of pulse crops before they decide to grow the crop. They should also, if possible, negotiate a price.

"Markets come and go," Fisher says. "A market available this year might not be available next year."

Among the sources Fisher suggests for information about pulse marketing are several industry or trade associations, including the South Dakota Pulse Growers, www.sdpulsegrowers.com; the North Dakota Dry Pea and Lentil Association, www.ndpealentil.org; and the U.S.A. Dry Pea & Lentil Council, www.pea-lentil.com. ◆ *—Lance Nixon*

Pulse crops: feeding peas to swine

Laura Geraets and Hans Stein

Not long ago, a South Dakota farmer using field peas in his crop rotation might have had trouble selling his field peas as feed to a neighbor who raises pigs. The problem? No one had done the research quantifying what nutrients the animals might get from field peas.

"When I first came to SDSU, the field pea producers in South Dakota asked me if I could start doing some research on this," Hans Stein, South Dakota State University swine nutritionist, says. "Every time they tried to sell to a swine producer, the swine producer would turn around and ask, 'But what is the digestibility, how much can we include in the diet?'

"No one knew that."

Some of Stein's research at SDSU is now answering those questions, generating knowledge that will benefit both field pea growers and swine producers in area states.

FIELD PEAS CAN MAKE UP at least 18% of diets for nursery pigs and 36% for growing and finishing pigs, Stein found in previous work. Now, as a project funded by the tri-state (South Dakota, North Dakota, and Nebraska) Consortium for Alternative Crops, USDA Cooperative State Research, Education, and Extension Service, Stein is wrapping up a study of how much phosphorus swine can digest from field peas, monitoring consumption and excretion of the element.

The study will make it easy for producers to formulate field pea diets to supply enough phosphorus for pigs. It will also make it easier to manage the amount of undigested phosphorus that passes through pigs and is excreted in hog manure—a concern because phosphorus, if it gets into streams and waterways, can cause algal blooms that deplete oxygen supplies for aquatic life.

The findings about phosphorus suggest field peas may be an ideal option for swine producers.

"The pig can use more of the phosphorus that is present in field peas compared to corn and soybean meal," Stein says. That's about 55% of the phosphorus in field peas, compared to about 20 to 30% for corn and soybean meal.

In corn and soybean meal, about 70 to 80% of the phosphorus is what nutritionists call "phytate-bound." That is, because each phytate molecule can link to six phosphorus molecules in a tight bond, it is impossible for non-ruminant animals such as hogs to digest it (ruminants can digest the phosphorus because microbes in the rumen manufacture their own phytase). Stein's study indicates that less of the phosphorus in field peas is phytate-bound.

CAN SWINE DIGEST MORE of the phosphorus in field peas when the enzyme phytase is added to the diet?

Phytase breaks some of those bonds that hold the phosphorus molecules in the phytate complex, making it possible for swine to digest more of the phosphorus. In corn and soybean meal diets, about 50 to 60% of the phosphorus becomes available to swine when phytase is added to the diet.

Phytase in the field pea diet made it possible for pigs to digest 70% of the phosphorus present in field peas.

Stein adds that those numbers show what is called "apparent digestibility." But nutritionists also look at what is called "true digestibility." He explains that a portion of the phosphorus that is excreted has actually been absorbed by the pig, but the pig loses phosphorus from the cells through "endogenous secretions."

Though apparent digestibility is what is important to producers because it shows what percentage of the phosphorus in field peas can actually be utilized, Stein's study also quantifies true digestibility. The experiment showed that pigs actually absorb 61% of the phosphorus in field peas without phytase. When the enzyme is added to the diet, pigs can absorb 76% of the phosphorus in field peas.

The study clearly shows that a field pea diet is an excellent option for swine producers, Stein says.

"It basically does two things: One, it reduces diet costs for producers," he says. "Second, it reduces the amount of phosphorus that is excreted from the pig. There is less phosphorus entering into the waste and less environmental concern." ◆

—Lance Nixon

First-ever statewide quality-of-life survey:

Most South Dakotans are satisfied

South Dakotans feel that their quality of life is high.
They appreciate the state's open spaces, clean air, and friendly communities, and they are very satisfied with public services and amenities.

On the other hand, they are concerned about financial security and lack of job opportunities for young people.

Those are some of the results of a statewide survey conducted by faculty in South Dakota State University's College of Agriculture and Biological Sciences.

Almost 3,000 questionnaires were sent out to randomly selected South Dakota households in May 2004, and 471 completed questionnaires were returned. That's a response rate of 15.7%, somewhat low for a mail-out survey of this type but still giving a reasonable margin of error of about 4.5%, says Donna Hess, professor and head of SDSU's Rural Sociology Department and lead investigator for the project.

The survey contained questions about community issues, individual and family well-being, work, economic development, and regionalism. It's the first statewide survey of its kind in South Dakota, but similar surveys have been conducted for years in other states, including Nebraska and Iowa, making regional comparisons possible. The intention is to repeat the South Dakota survey on an annual basis, so developments within the state can be traced over time, Hess says.

"Our main purpose is to get input from citizens about their perceptions of their quality of life, as well as about the concerns and issues that are important to them," Hess says. "The results can provide input for future directions and policy development in communities and at the state level."

IN GENERAL, RESPONDENTS ARE VERY POSITIVE about their communities, Hess says.

Most people feel their local community has either changed for the better (44.9%) or stayed the same (40.9%) over the

past year. Only 13.9% feel it has changed for the worse. Similarly, most respondents feel that their community is friendly (77.2%), trusting (69.4%), and supportive (68.8%).

A large majority of respondents say they are either satisfied or very satisfied with community services and amenities such as parks and recreation, library services, basic medical services, highways and bridges, law enforcement, waste disposal, and K-12 education. Respondents are less satisfied with retail shopping, entertainment/arts, restaurants, and some aspects of local government (Table 1).

Table 1. Satisfaction with public services & community amenities

Greatest satisfaction (somewhat + very satisfied)		*Least satisfaction (somewhat + very dissatisfied)*	
Parks & recreation –	81.1%	Retail shopping –	30.6%
Library services –	76.2%	Entertainment/arts –	23.1%
Basic medical services –	74.8%	Restaurants –	22.9%
Highways & bridges –	72.2%	City/village government –	22.7%
Law enforcement –	72.0%	Airline service –	21.1%
Sewage disposal –	70.5%	County government –	21.1%
Solid waste disposal –	69.2%	Bus service –	20.2%
Education (K-12) –	68.6%		

Respondents are reasonably satisfied with available community resources but do not always feel that these resources are distributed appropriately. One third (30.6%) indicate that community resources are adequate and properly distributed, while another third (34.8%) feel that resources are adequate, but not appropriately distributed. A fourth of respondents (27.2%) feel that their community has limited resources, and 7.4% say that their community is in a financial crisis.

Most respondents indicate that they feel good about their personal life situation, Hess says. A majority (43.8%) feel they are better off than 5 years ago, while 39.5% feel they are about the same, and 16.6% feel they are worse off. Most people (62.1%) feel they are better off than their parents when they were the same age, 23.7% feel they are about the same, and 14.2% feel they are worse off than their parents at their age.

Greenery and open space, family, clean air, clean water, friends, and housing are the aspects of life giving the most satisfaction to respondents.

On the other end of the scale are the aspects of life that cause most dissatisfaction or concern. Those are all related to economic issues: financial security during retirement, current income level, and job opportunities (Table 2).

Table 2: Satisfaction/dissatisfaction with aspects of life

Most satisfied with (satisfied + very satisfied)		*Least satisfied with (dissatisfied + very dissatisfied)*	
Greenery & open space –	88.8%	Financial security during retirement –	41.3%
Family –	88%	Current income level –	32.7%
Clean air –	85.9%	Job opportunities –	31.9%
Clean water –	83.1%		
Friends –	82.2%		
Housing –	81.5%		

RAISING WAGES TO ATTRACT AND RETAIN PEOPLE is the most favored approach to economic development, supported by half of the respondents. Other popular approaches are retention and expansion of existing industries, emphasizing local processing of grain and livestock, improving and maintaining rural infrastructure, emphasizing tourism in the state, and focusing on main street business development.

The least favored approach to economic development is promoting gambling opportunities for tourism, opposed by 28% of respondents. Other unpopular approaches are increasing sales tax to provide property tax relief and increasing the state's population to match growth of neighboring states (Table 3).

Table 3: Economic development

Most supported approaches (strongly support)		*Least supported approaches (strongly oppose)*	
Raise wages to attract & retain people –	49.3%	Retail shopping –	30.6%
Focus on retention & expansion of existing industries –	47.4%	Entertainment/arts –	23.1%
Emphasize more local processing of grains & livestock –	44.8%	Restaurants –	22.9%
Focus on improving & maintaining rural infrastructure –	44.2%	City/village government –	22.7%
Emphasize tourism in state –	40.5%	Airline service –	21.1%
Focus on main street business development –	39.7%	County government –	21.1%
		Bus service –	20.2%

The survey also included questions about regionalism—combining resources with neighboring communities to reduce costs and increase efficiency. Respondents were quite favorable toward this concept, Hess says.

"People appear to be optimistic and positive in their views on collaboration and its outcomes. Most believe that it will improve goods and services, and most respondents do not believe that combining services will result in higher prices or lower quality of service."

Eighty percent of respondents agree/strongly agree that communities in a region working together to generate new businesses are better able to create quality jobs for residents, and slightly more than half (53.6%) agree that combining community or county services in a region will improve access to services. Three-fourths of respondents (72.3%) agree/strongly agree that retail business collaboration is likely to provide better goods and services.

Respondents were also presented with a situation involving a shortage of funding and asked how they viewed different approaches in regard to various community services.

"The findings indicated that there are some services that respondents clearly favor keeping in the local community, even if it means raising revenue to do so. These include K-12 schools, fire protection, law enforcement, and emergency medical services," Hess says.

"On the other hand, there are some services that respondents would favor combining or sharing with other communities, if necessary. These include telecommunication services, some county services such as road maintenance and weed control, licenses and permits, and regional economic development activities.

"The results can provide input for future directions and policy development in communities and at the state level."

—Donna Hess, head,
SDSU Rural Sociology Department

"There are still other services that respondents would be willing to see reduced in order to keep them. These include fairs, property assessments, recreational facilities, and promotion of tourism.

"Two of these (fairs and promotion of tourism) are also among those that some respondents would be most willing to eliminate in their area if faced with resource shortages."

At the end of the survey, respondents were asked to write down what they think is the most pressing issue for their community. The question was open-ended and respondents could write anything they wished, but many similar responses were identified.

The most common issue, listed by 37 respondents, was "need for employment opportunities." Almost as many respondents (32) listed "need for living wages/benefits." Other frequently mentioned issues were greater retention of high school and college graduates, concern over water quality and supply, declining population, too many alcohol-serving establishments, need for more affordable housing, affordable health care, high property taxes, other taxes, and poor economic development.

THE RESULTS OF THIS SURVEY provide a good indication of how South Dakotans feel about their quality of life and what some of their concerns are, Hess says. She believes that state and community leaders will use the findings to identify directions for future development. Hess and the team intend to develop a series of policy briefs following further analysis of the data.

Survey respondents differed slightly from the average population profile in South Dakota, Hess points out. There was an over-representation of white, middle-aged males with middle income and at least some college education.

"That's typical for most surveys. It's very difficult to get an adequate number of responses from people with lower income and lower level of education," Hess says. "However, the people who answered this survey are probably the community opinion leaders and those who are likely to take on leadership roles and work on the issues identified in the survey, so they do provide a good indication of pressing issues for the communities."

The Brookings city council is already using survey results to engage in a dialogue with citizens about future planning and development.

A separate survey was conducted just for Brookings County, using the same questionnaire but sampling a relatively greater number of people. This survey was sent out to a sample of 2,719 randomly selected Brookings residents with 548 usable surveys returned, giving a response rate of 20%. Brookings data were not included in the statewide results to avoid heavy over-representation of one county.

The Brookings results were very similar to those of the statewide survey, with a few exceptions, Hess says.

Most differences were found in approaches to economic development. Brookings respondents strongly support funding of biotechnology research and attracting biotechnology industries. They also agree that South Dakota universities and colleges should focus on economic development.

Some differences from statewide results also occurred in the most pressing community issues, identified through open-ended responses.

For Brookings residents, the most pressing issue is too few retail stores, mentioned by 72 respondents. This was followed by a need for living wages/benefits (34), poor community planning and budget management (32), inadequate public school funding (30), impact of Walmart/Super Walmart on the community (27), and need for employment opportunities (23).

The Brookings city council used results from this survey as a basis for a town hall meeting in September 2004. Citizens were invited to participate in group discussions of community issues identified through the survey. Hess and students from SDSU's Rural Sociology Department assisted with the meeting.

"This project integrates all three aspects of a land-grant university; research, teaching, and outreach," Hess says. "We're engaged with the community by conducting the survey, presenting the results, and assisting with the town hall meeting. Graduate and undergraduate students have been involved in the research process by entering and analyzing survey data. Students also acted as discussion leaders and recorders at the town hall meeting."

Other contributing faculty to the project were Meredith Redlin, assistant professor of rural sociology, Diane Kayongo-Male, professor of rural sociology, and Carol Cumber, professor of economics. Also collaborating on the project were Karla Trautman, Extension program leader for family and consumer sciences and youth development, 4-H; Barb Hartinger, director, and Mary Brashier, publications editor, of the AgBio Communications Unit. The survey was funded by the Agricultural Experiment Station.

For complete reports of the South Dakota and Brookings surveys, contact SDSU's Rural Sociology Department or look online at http://sdrurallife.sdstate.edu/ ◆ —*Marianne Stein*

Howard Woodard

Take another look at your soybeans. That may be

Iron Deficiency Chlorosis

A farmer who brought a soybean sample to South Dakota State University's soil scientists thought he might have already diagnosed the yellow leaves. Was the discoloration caused by a sulfur deficiency? he wanted to know.

After looking at the leaves and asking a few questions, SDSU scientists had their own explanation: iron deficiency chlorosis (IDC). With IDC, the leaf veins are dark green and the interveinal areas are light green to yellow in color. Symptoms typically appear on the upper leaves of the plant.

South Dakota almost never sees IDC in crops such as corn or wheat, but it is a major problem in soybeans. Probably every county in eastern South Dakota has some soils that could induce IDC.

"The soil conditions that we know of that contribute to this problem are high pH levels—7.5 and above, high carbonate content, and maybe high salt content," says Howard Woodard, SDSU plant science professor. "But also it seems to occur more in soils that are poorly drained or in lower positions on the landscape where water collects."

Woodard adds that although it's been a problem for some growers for as long as soybeans have been grown in the state, IDC may have become worse during the wet years of the 1990s, when free water in the soil profile washed or leached carbonate minerals and concentrated them in low field locations and drainage areas.

IDC IS WELL KNOWN TO GROWERS in parts of Minnesota and North Dakota, particularly in the Red River Valley. Roy

Soybeans leaves with typical iron deficiency chlorosis symptoms.

"Variety selection is the first line of defense against iron deficiency chlorosis. It's very, very important."

—HOWARD WOODARD, SDSU PLANT SCIENCE PROFESSOR

Scott, SDSU soybean breeder, adds that growers and plant breeders in Iowa and Illinois are also concerned. Southern soybean growers don't have much of a problem with IDC; it seems to be an issue more or less confined to many northern states where soybeans are grown.

"There are some tolerant varieties available for producers to choose from, but not a lot of them," Scott says.

Scott says breeding for IDC tolerance has been a priority since the SDSU soybean breeding program began in 1991. It's taken on additional importance in the past 5 years, he adds, as soybeans have expanded their range in the state.

"It's a big problem, especially as we try to push soybeans north and west in South Dakota," Scott said.

One of SDSU's conventional soybean varieties, 'Spink,' was released partly because it had some tolerance to IDC. But Scott adds that a line being increased now is a possible candidate for release because it has both good yields and excellent IDC tolerance in ongoing trials in South Dakota and other states. If it holds up well when data from this year is tabulated, that variety could be released in 2005, Scott says.

Scott adds that he began infusing IDC tolerance into SDSU's glyphosate-tolerant soybean breeding program about 3 years ago.

Woodard and Anthony Bly, research associate, completed the third year of a study in 2004 that complements Scott's work. Funded by the South Dakota Soybean Research and Promotion Council, the North Central Soybean Research Program, and the South Dakota Agricultural Experiment Station, the study examines agronomic practices as possible tactics farmers could use to reduce IDC in soybeans.

Woodard and Bly had five goals in mind: evaluate the influence of iron fertilizer applications on IDC severity, determine the influence of residual nitrogen on IDC severity, evaluate how the timing of plant thinning influences IDC severity, evaluate how plant population and row spacing influences IDC severity, and measure variety response to IDC severity.

WHAT DIDN'T WORK WAS SEED-APPLIED iron fertilizer. It didn't alleviate IDC symptoms. Increasing the application rate of nitrogen as ammonium nitrate actually increased the severity of IDC significantly, consequently reducing grain yield. Spraying an iron chelate solution on the foliage showed some response but was too expensive.

Timing of plant thinning did not significantly reduce IDC or increase grain yield when compared to a very high seeding rate. But thinning the plant stand at the second week after IDC onset resulted in grain yield comparable to the very high seeding rate.

The strategies that worked were higher seeding rate and wider row spacing. The result: significantly reduced IDC symptoms and increased grain yield.

"If you have a higher plant density, you've got the plants working together to acidify the root zone. The literature seems to indicate that's an important issue," Woodard says.

Woodard and Bly explain that if a producer keeps the seed population per acre the same but chooses to plant soybeans in 30-inch rows rather than drilling the seed into 7-inch rows, there will be four times as many seeds in each row. That enables the roots to do a more efficient job of changing the local chemistry of the soil immediately next to the root.

"All plant roots leak out or pump out organic acids. Iron availability is related to the pH. The lower—or more acidic—the pH, the more iron is available to the plant," Woodard explains. "So, if right around the root zone you get a more acidic environment, that would render the iron a little bit more available. It solubilizes more of the iron compounds."

That explains why farmers will sometimes notice patches of green, healthy soybeans in the midst of areas where IDC is clearly a problem, Bly says. Typically, those patches of healthy beans might be on the end rows where seeding overlaps. Or they may be where a drill or seeder malfunctions and seed is spilled in one place.

"Imagine all the roots from the different plants intersecting each other. Where they intersect, maybe the exudation of acid is greater so it has greater effect," Bly says.

IT WASN'T HARD TO SEE, say Woodard and Bly, that some varieties in their study were more vulnerable to IDC than others. Yields ranged from a mere 7 bushels an acre for a very susceptible variety up to 36 bushels an acre for a variety more tolerant of IDC.

"Variety selection is the first line of defense against iron deficiency chlorosis. It's very, very important," Woodard says.

While agronomic practices such as choosing 30-inch rows and keeping a good seed density can help a farmer compensate for a variety that's somewhat tolerant of IDC, it can't compensate for a variety that is susceptible.

"If you've got a site that is typically iron chlorotic and you just have to plant soybeans, choose a good variety that is tolerant of IDC, and plant it thicker than you think you should," Bly says. ◆ *—Lance Nixon*

Seed science center planned for campus

Brent Turnipseed, SDSU plant science professor and manager of the SDSU Seed Testing Laboratory.

On the dusty heels of 1936, one of the worst years in the history of agriculture in America, South Dakota State University was already looking to the future, optimistically laying plans for a seed lab to serve coming generations of South Dakota farmers.

"The lab was set up back in about 1937 so that there would be a place in the state to test seed samples for farmers and for seed companies. It was mainly for the farmers back at the time," says Brent Turnipseed, SDSU plant science professor and manager of the SDSU Seed Testing Laboratory.

TO THIS DAY, THE LAB has filled that niche. It also does regulatory testing for the state and all testing for the South Dakota Crop Improvement Association. Three key tests are required by state seed law before seed can be advertised and sold in South Dakota: a purity analysis, a noxious weed-seed exam, and a germination test. The lab also performs numerous other tests needed by producers and seed companies.

But the lab does its work in four rooms in Ag Hall that were never designed to house a seed testing laboratory and with none of the facilities to do more complex genetic research and testing that require a "clean room."

That's part of why plans for an SDSU Seed Science Center are in the works at a cost of approximately $4 million. Turnipseed says the center will probably be based in the planned SDSU research park. The new facilities would enable SDSU to develop and conduct more seed research projects, offer an undergraduate seed specialization, and train students in the more complex PCR (a polymerase-chain-reaction test to detect DNA) and Enzyme Linked Immunosorbent Assay (ELISA), necessary if SDSU is to have an advanced seed science program.

The new center would house the SDSU Seed Testing Lab, research and teaching labs, and the state's Seed Certification office. The South Dakota Crop Improvement Association

"We see an opportunity to offer an undergraduate and a graduate program in the area of seeds."

—Brent Turnipseed,
SDSU Seed Testing Lab manager

already has committed $1 million to the project.

In addition, the new facility will have classrooms. That's because long-term plans for the SDSU Seed Science Center include a new academic emphasis in the Plant Science Department.

"We see an opportunity to offer an undergraduate and a graduate program in the area of seeds. We would have a new specialization within agronomy, a seed technology specialization," Turnipseed says.

SDSU has an advantage over many other places simply because it has a seed testing lab with a long history of hiring and training students.

"We want to expand that training program. We also see the chance to do internships with private labs and the seed industry," Turnipseed says. "Our goal is to provide trained students or graduates for the seed industry. We want to produce students who are well-grounded in the basics as well as those who might work in the biotech end of the industry."

Also housed within the department are the Foundation Seed Stocks, the Seed Certification Offices, plant breeders, and many other faculty members with seed research experience. "A lot of the components for a seed science center are already here," Turnipseed says. Collaborative research within the department and college already exists but he would like to see it expand.

The Seed Science Center will require additional staff. SDSU has just received a federal grant that will enable it to hire two new Ph.D. faculty members to carry out research and teaching in association with the center, Turnipseed says. One of those appointments will probably be in seed physiology and biotechnology, while the other will possibly be in seed conditioning, drying and storage, or in seed pathology.

Counting Turnipseed, whose position focuses on seed technology and the management of the laboratory, that will make three faculty members whose main duties will be in seed science.

In addition, other SDSU faculty with special expertise important to seed science may teach courses or help present workshops as the program progresses.

PEOPLE IN THE SEED INDUSTRY who got their start working in the seed lab at SDSU say they're excited about the plan.

Among them is Quentin Schultz, founder and president of BioDiagnostics, Inc., of River Falls, Wis., a business that provides genetic purity testing services to the seed industry. Schultz earned his bachelor's degree from SDSU in 1972 and his master's in 1976, both in agronomy.

Ray Kinch, Schultz's advisor, was director of the seed lab at the time. "He told me he had jobs available for students and I started working there the second semester of my freshman year, in 1969. That work really enriched my college experience. It actually caused me to change my career plans. My initial goal was to finish my degree in agronomy and go back home to farm."

Instead, Schultz found himself growing more and more fascinated with seed science. He eventually became part of the SDSU Plant Science Department faculty from 1982-84 and ran the seed lab.

He thinks the planned center, with its expanded role for students, is a good idea. If SDSU adds an undergraduate and graduate specialization in seed science or seed technology, so much the better, Schultz says.

"In my business, we have to hire people with biochemistry and biology degrees. They've been exposed to genetic testing procedures, but they don't understand agriculture or seed at all. So we have to train them on the job. That can be problematic for us," Schultz says. "SDSU would have a ready market for its graduates from this program."

YET ANOTHER SDSU GRADUATE who got his start in seed science by working in the seed lab is Loren Wiesner, a research leader at the National Center for Genetic Resources Preservation in Colorado.

Wiesner started working in the seed lab in about the fall of 1957, en route to earning his bachelor's degree in agricultural education in 1960 and his master's in agronomy in 1963, both from SDSU.

"There is a long history of students getting interested in the seed industry by working in that lab. It's hard to explain why you get excited about something like this," Wiesner says. "But if you have any interest in plants, you begin to see each seed as being something different.

"It becomes a challenge. When you do a germination test, you want to find out why this seed germinated and that one didn't. There are always new questions to explore."

Wiesner adds that university programs that teach seed technology or seed science are becoming fewer, in part because of faculty retirements, but also because there aren't a great number of students who choose to study it. But he adds that as the biotechnology sector continues packaging new traits in seeds, more students might begin seeing seed science as a career choice.

"I don't see how the Monsantos and Pioneers of the world can get along with marketing their products without having seed scientists involved in the development of those products," Wiesner says.

SDSU, he adds, could become a major center in training seed technologists and seed scientists. ◆ *—Lance Nixon*

Dave Francis, SDSU veterinary science professor

'2010' research initiative comes to SDSU

A new center at South Dakota State University with spin-off applications for human health will focus on technologies to protect animal health.

It's one of the projects approved under South Dakota Gov. Mike Rounds' 2010 Research Initiative Centers Program. The state has awarded $780,000 for the first year of a 5-year program entitled the "The Center for Infectious Disease Research and Vaccinology" at SDSU with University of South Dakota scientists cooperating.

"We are' anxious to expand our research program in the area of infectious disease research and novel methods of disease prevention."

—DAVID ZEMAN, HEAD,
SDSU VETERINARY SCIENCE DEPARTMENT

Contingent on approval from the South Dakota Legislature, the grant could funnel the same amount of money into the project for each of the 4 additional years for a total of $3.9 million. But at the end of 5 years, the initiative would have to stand on its own by generating federal grants, grants from non-profits and foundations, and the marketing of its own intellectual property and inventions.

The Veterinary Science Department is the lead department in the grant, which also includes SDSU's Biology/Microbiology Department and the Division of Basic Biomedical Science at the University of South Dakota.

"The Veterinary Science Department is anxious to expand our research program in the area of infectious disease research and novel methods of disease prevention," says David Zeman, department head.

"Over the past decade there has been growing concern over the accidental or malicious introduction of foreign animal diseases. This has been prompted by increased global travel and bioterrorism concerns. Our scientists have great expertise in this area, and this grant will bring more scientists to the task."

David Francis, SDSU veterinary science professor and lead investigator for the project, says the center will focus on developing a number of technologies or products.

"We are going to be funding brand-new ideas before they are ready for federal funding. What we do will enhance the capability of scientists to get federal funding. And then after the federal funding, after an idea has become mature, we will fund that transition phase between basic science research and marketability of a product."

Francis says the center will be an economic asset to South Dakota, initially by generating jobs for additional scientists.

"But beyond that, we have partnered with several businesses in South Dakota and just across the border in Iowa. Through these partnerships we hope to be developing new products that will expand business opportunities in this region, particularly in South Dakota. We have some ideas for new products that would generate economic activity in the state."

PARTICULAR INTEREST is centered on "needle-less vaccine strategies," or vaccines that don't require an injection.

"These are attractive both to the livestock industry and in human medicine. In human medicine the distaste for injectable vaccines is fairly obvious, people don't like to be poked with needles," Francis says.

"In the livestock industry there are several issues. One is that there are risks of abscesses in tissues where needles have been injected. That can cause problems, particularly in the meat industry. Also there are some issues of transmission of disease. Diseases are transmitted by needles in animals just as in humans."

Francis adds that needle-less vaccine strategies could reduce the labor costs of administering vaccines—potentially a huge savings to livestock producers.

"If you can put the vaccine in the water trough, or in the feed trough, you don't have to run all the cattle through the chute," Francis says.

THE PROJECT ALSO WILL LOOK at other possible products and technologies. Francis adds that the USD scientists will be looking at applications for human health, while SDSU will concentrate much of its work on animal health.

"We're looking as much at general strategies as we are at specific products. A strategy that might work for animals might also work for humans and vice versa," Francis says.

During the past year, senior investigators from SDSU who were the founding members of the new center were awarded, as principal investigators or co-investigators, more that $2 million in federal grants, nearly three-fourths of which will come to South Dakota. A portion of the new grant will go to expand research capacity in South Dakota and to develop investigators who will be a part of the new center, Francis says.

"We have three new faculty positions. We have three new technical expertise positions in addition to post-doctoral research associates, graduate students, and lab technicians that will be hired." ◆

—Lance Nixon

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