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Trends in South Dakota Agriculture

In this issue

On the cover: SDSU economists, in a study of who controls South Dakota agriculture, found few surprises: bigger and fewer farms, increasing importance of leasing land and taking off-farm jobs, and growth of "hobby" or "after work hours" acreages.

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Director's comments

BY KEVIN KEPHART
Director, South Dakota Agricultural Experiment Station

On a recent visit to Krasnodar, Russia, Kephart stands by the czar's cannon inside The Kremlin in Moscow.

We think and work globally, and never more so than since 9-11

Two world wars, a cold war, and 70 years of Communism side-tracked but has not ended a special relationship between South Dakota and Russia. That connection began in 1897, when our own Professor N.E. Hansen explored Russia on the first of seven trips to that country and obtained a wealth of new horticultural and agricultural plants that continue to benefit us today. Now that connection is being renewed.

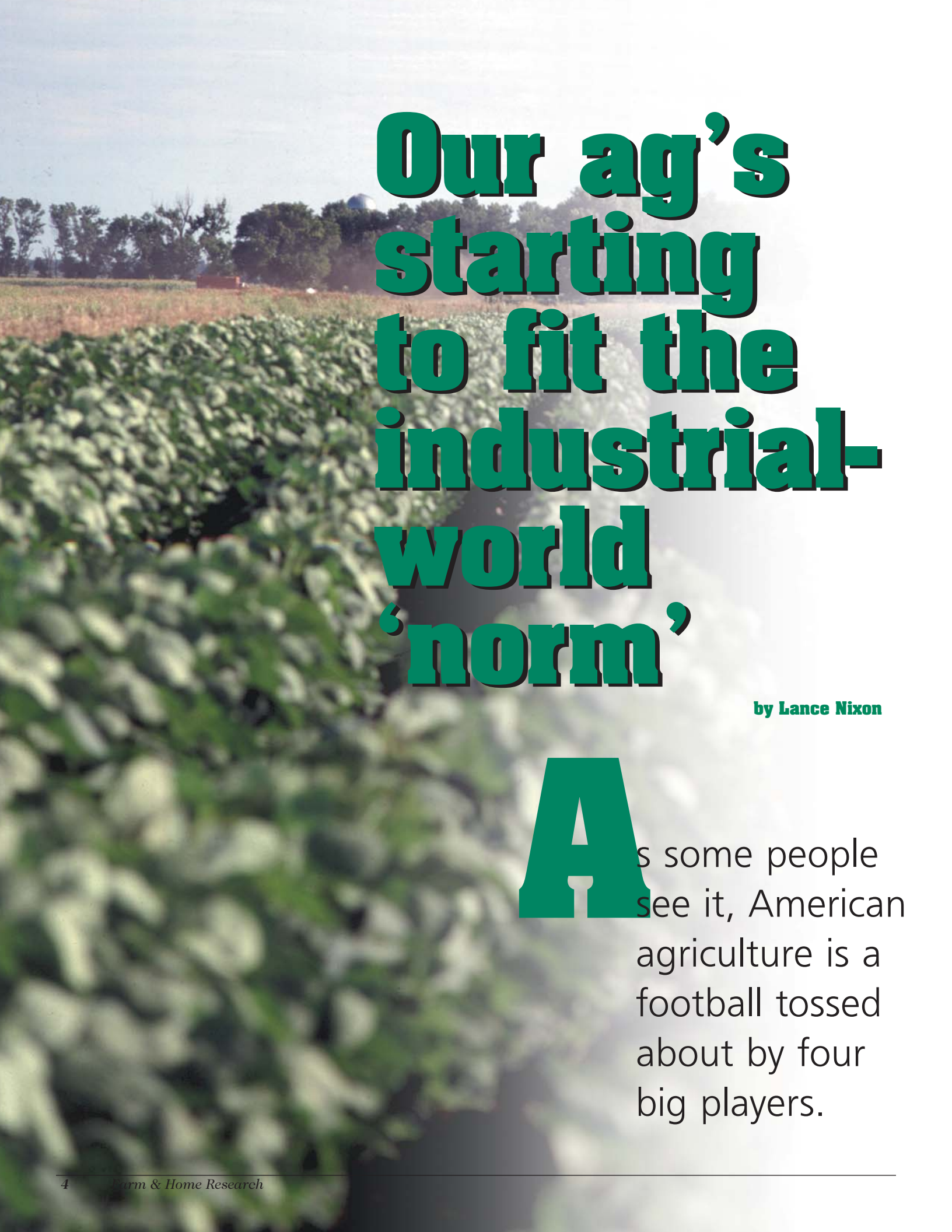
In July 2000, a delegation from Krasnodar Russia visited the SDSU campus. This visit rekindled our century-long relationship, and hopefully we're on the verge of moving forward with Hansen's legacy of collaborative science. Our most recent contacts with Russia are described on page 20 of this issue of *Farm & Home Research*.

Global affairs affect other research projects. Our nation has become more conscious of food safety and security since September 11, 2001. Our Agricultural Experiment Station scientists and engineers were already working to improve irradiation, ozonation, and herbal approaches in preventing microbial threats to meat and dairy foods. Ways to use irradiation in concert with ozonation to kill dangerous pathogens without negative effects on food quality or appearance appear promising.

On a lighter note, like many other South Dakotans, I'm looking forward to this spring's wild turkey season. I'm headed to West River this year, but northeastern South Dakota may become particularly inviting in future years because of cooperative work between South Dakota Game, Fish & Parks and the SDSU Wildlife and Fisheries Department. Their work has determined that the Eastern wild turkey subspecies is surprisingly well adapted to sections along the prairie couteau. Whether you like or dislike wild turkeys, the article on page 12 provides some interesting information on Benjamin Franklin's favorite bird.

Our cover story for this issue summarizes information from the 1997 census of agriculture and puts numbers on trends that we're already aware of: our decreasing number of farms and increasing average farm size. Our experiences seem to coincide with what has already happened in other states.

It's on this note that I'll conclude by inviting your help. Ideas and commitment are needed now to empower family farms and farm families, to bring new enterprises to rural communities, and to capture value from agriculture. These are important parts of our work, and your insights on these issues are valuable to us.◆



Our ag's starting to fit the industrial-world 'norm'

by Lance Nixon

As some people see it, American agriculture is a football tossed about by four big players.

Economic prosperity is one catalyst for changes in farming; government policies on trade, environment, and farming are another; the industries that supply inputs such as feed and fertilizer or that process or market farm products are still another; and external forces such as technology or consumer preferences are the fourth.

Those four forces will help shape the structure of South Dakota agriculture as it moves into the next millennium, economists at SDSU say.

There are no startling revelations about the future: South Dakota can expect fewer, bigger farms to generate most of its agricultural production, with the largest farms nabbing an increasing share of farm product sales; "part owners," who own their own land and lease additional land, will continue to dominate commercial farms, while the practice of leasing farmland from non-operator landlords will be increasingly important; off-farm jobs will be an important source of income for some; and farm specialization and concentration will continue.

Those are among the conclusions of SDSU ag economists Larry Janssen and Matthew Diersen from a study of the structure of South Dakota agriculture. Farm structure is the control and organization of resources needed for agricultural production. A study of farm structure provides insight on how individual farms are affected by changes.

Graduate research assistant Paula Loewe assisted in the study, an update of one done in 1982 that used data from the late 1970s.

The trend toward bigger, fewer farms, whether measured by acres or sales volume, will continue, Janssen and Diersen say.

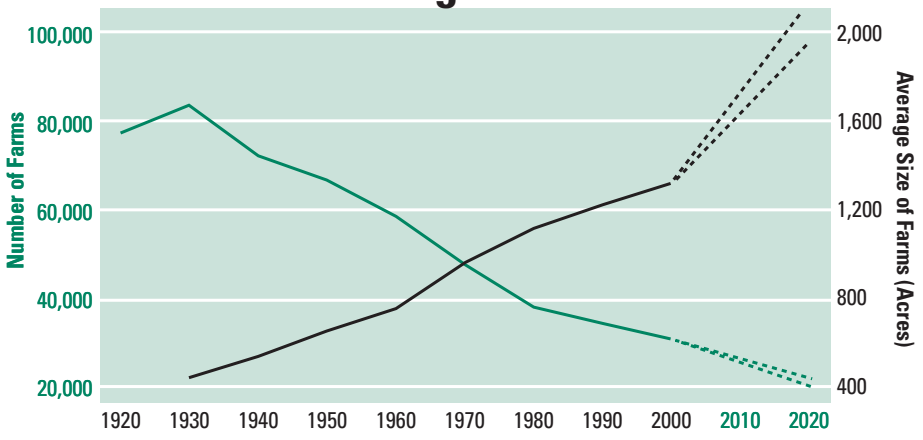
The shift has been going on since the 1930s, when the pace of decline in farm numbers was actually the most furious. From 1935 to 1940, South Dakota charted a net loss of 10,800 farms, an annual decline of 2.8%. There were 83,300 farms in South Dakota in 1935; by 1997, the number had fallen to 31,300.

Size of farms in South Dakota increased over that same period from 445 acres to 1,418 acres. The smallest farms are found in eastern South Dakota, where county averages vary from 360 to 1,030 acres. In western South Dakota, farms and ranches average 1,600 to 7,000 acres in most counties.

Diersen and Janssen sketch two scenarios of how farm numbers and farm sizes may change by 2020. If the fast pace of the 1987 to 1997 decline were to continue, there would be 20,000 to 21,000 farms by 2020, a decline of 1.8% annually. Assuming total agricultural land remains about the same, average farm size would increase about 52%, to 2,160 acres.

At a slower pace such as that of the years 1978 to 1987, there would be about 23,000 farms in 2020, an annual decline of 1.3%. Average farm size would increase by about 36%, to 1,930 acres.

South Dakota Agricultural Trends



Source: USDA-NASS

The largest 3 to 10% of farms are doing more business.

"What we're seeing is that, almost no matter how you measure it, the share of sales for the largest 10% of producers is increasing," Janssen said.

The trend was already apparent in data from 1997, when the largest 312 farms in South Dakota, each with more than $1 million in sales, made up only 1% of the state's total farms. Those farms accounted for 21% of the value of all farm products sold that year.

The 1997 data show that just 67 farms, 0.2% of the total number of farms in the state, accounted for 10% of all farm product sales in the state.

The move toward greater concentration in farm product sales has been going on steadily in South Dakota since at least 1959, when the top 50% of farms generated 75.4% of farm product sales. By 1997, the top 50% of farms accounted for 93.4% of farm product sales.

The largest 3% of farms had 18.1% of farm product sales in 1959. In 1997, the top 3% accounted for 32.8% of farm product sales. Diersen and Janssen say larger farms will continue to dominate the agricultural structure in South Dakota. Farms with more than $100,000 in sales now represent about 30% of farms while controlling 60% of the land and capital.

Off-farm employment and income will continue to increase in importance. That trend is readily apparent nationwide, where 1995 data showed the average farm operator household income was $44,392, of which 10.6% came from farming. But in the Northern Plains states of North Dakota South Dakota, Nebraska, and Kansas, there's a marked difference.

Part owners who operate land that they own and lease additional land from others will continue to be dominant players...

Farm operator household income was lower, at $39,148, and a much larger share—26.1%—came from farming.

Part owners who operate land that they own and lease additional land from others will continue to be dominant players in the state's land tenure and ownership system.

In 1997 part owners operated farms that averaged 1,905 acres—1,024 acres owned and an additional 881 acres leased. In comparison, full owners who operate only land that they own had farms averaging 1,013 acres, while tenants who operate only on leased land farmed an average 988 acres.

Although farmers owned about 69% of South Dakota's land in farms in 1997, farmland available for lease is often not in farmers' hands—a trend likely to continue. In 1997, 81% of the farmland rented to farmers, 13.8 million of a total 16.9

million acres, is owned by non-operator landlords.

South Dakota producers likely will continue to do business with more than one landlord, too, if current statistics are an indication. Some 18,700 farmers currently lease land from about 48,300 landlords.

South Dakota producers will likely specialize or concentrate on some enterprises more than others in the future.

Beef cattle were the number-one enterprise in 1997 and over the past two decades in South Dakota, both in sales volume and in the number of farms that raise beef cattle.

Janssen and Diersen found that the amount of agricultural land devoted to pasture or range, wheat, corn, or alfalfa—all key enterprises in South Dakota—has remained fairly constant in recent years. The largest changes in enterprise activity are the increase in soybean acres and a corresponding decrease in oats acres.

Soybean acres have soared from 1978's less than 400,000 acres to nearly 3 million acres by 1997. Oats acres, meanwhile, dropped from nearly 2 million in 1978 to less than 300,000 in 1997. Barley acres also have tumbled, while acres devoted to sunflowers have increased.

One of the most apparent trends Janssen sees when he compares the two reports is the increase in the number of small, part-time farm operations.

"That's been happening in other parts of the country since the 1960s, especially in the south and northeast.

One of the most apparent trends ... is the increase in the number of small, part-time farm operations.

It happens as metropolitan areas spread out or as smaller centers—the Sioux Falls and Lincolns and Omahas—have grown," Janssen said. "Now, even in South Dakota, we're getting a larger number of part-time, residential farmers."

That won't reshape South Dakota agriculture.

The lion's share of South Dakota farm products, a good 80 to 90%, still comes from full-time, commercial family farms. But Janssen finds it an interesting trend because it means South Dakota is becoming more like the rest of the developed world where small, part-time farms already are common.

These small farms, even though their owners rely on off-farm income, supply benefits to rural America, Janssen said. "These residents send their children to local schools, and they pay taxes to support those schools, road upkeep, and local police and fire departments."

Other small, part-time farm operators are retired farmers who still want to do some farming to stay busy. But Janssen said young people who have jobs in town are also in that mix. That suggests job creation and economic development policies will be increasingly important for the health of rural communities in South Dakota.

"This phenomenon is not unique to South Dakota. This is a national—if not an international—trend," Janssen said. "All we're doing is getting close to what seems to be the norm for most of the industrial world."◆

An answer to food contamination?

Ozone

by Marianne Stein

Magnification of *Escherichia coli* 057:H7.

Food-borne illnesses affect some 76,000,000 people each year in the U.S. Most victims experience only minor symptoms such as nausea and diarrhea, but an estimated 5,000 Americans die every year after consuming food contaminated with harmful microorganisms.

Scientists at SDSU are trying out a new and promising technique to make food safer by using ozone.

The research is part of a larger food safety project that also includes the use of irradiation and bacteriological methods. The scientists are testing the effects of each technique alone, as well as in combination.

This is the hurdle concept, said Dr. Kasiviswanathan Muthukumarappan ("Muthu"), a food engineer in the Agricultural and Biosystems Engineering Department at SDSU. "The objective is to find the best combination of methods that can kill as many harmful microorganisms as possible without affecting the texture, taste, or nutritional value of the meat."

Ozone for sanitation of food was recently approved by the FDA, but it is not yet applied to foods that are sold in stores. "The research is still in its early stages, and our first priority is to make sure that ozone is effective in killing as many microorganisms as possible," Muthu said.

"The research is still in its early stages and our first priority is to make sure that ozone is effective in killing as many microorganisms as possible."

–Dr. Kasiviswanathan Muthukumarappan, SDSU food engineer

The next stages of research will take a closer look at nutritional and sensory qualities of meat treated with ozone.

Ozone is generated from oxygen and pumped over meat in a gaseous form inside a closed container. The ozone kills most of the harmful microorganisms on the meat and quickly vaporizes, leaving no harmful residues on the product or in the air. Ozone is an unstable gas, which breaks down into oxygen molecules within 12 to 24 hours.

In the present technique, ozone does not penetrate meat, and only the microorganisms on the outside are killed. The SDSU scientists are hoping to soon develop a method that will allow ozone to disinfect both the exterior and interior of meat.

The SDSU research team is applying the ozone technique both to beef and pork. Pathogens under scrutiny are *Escherichia coli*, which is common in ground beef, and *Listeria*, found in processed pork products.

E.coli is a bacterium present in all humans and animals and is mostly harmless. However, virulent strains such as *E.coli* 0157:H7 have emerged in recent years to cause serious illnesses in some individuals. According to the Centers for Disease Control and Prevention, at least 70,000 people become sick and more than 50 die annually from *E. coli* 0157:H7 infections.

Ground beef is especially prone to harboring the harmful *E.coli*.

Listeria, or *L. monocytogenes*, affects about 2,500 people and causes 500 deaths annually, according to the Centers for Disease Control and Prevention. Most at risk are people with weakened immune systems, the elderly, newborn babies, and pregnant women. A pregnant woman is 20 times more likely than other healthy adults to become ill from meat infected with *L. monocytogenes*; in the most severe cases, infection can lead to miscarriage.

L. monocytogenes is predominantly found in soft cheeses and in so-called ready-to-eat meats such as canned ham, hot dogs, and bologna, explained Dave Henning, professor of dairy science at SDSU.

"People think that these foods are processed and thus safe to eat. But it is a misconception that pre-cooked meat is safe. It can still be contaminated in the packaging process, and there have been examples of hot dogs contaminated with *Listeria monocytogenes*.

"It is not a good idea to eat hot dogs right from the fridge without heating them first," Henning advised.

According to Muthu, one of the benefits of ozone is that it is non-thermal, unlike traditional procedures for ensuring food safety, which involve heating meat to a certain temperature. Thermal methods are very effective in terms of killing microorganisms, he said, but such methods also affect nutritional and sensory qualities of the product. Basically, if meat becomes overcooked, it will lose nutrients and taste will be affected.

At this point, however, ozone treatment is not as fully effective as thermal processing methods.

"If you use temperature—the thermal processing methods—you can kill 99.9999% of the microorganisms, but if you use non-thermal methods such as ozone, you cannot guarantee that much. We have found out that

The international symbol for irradiation is the radura. The FDA has approved the use of irradiation for a variety of foods, but they are not yet widely available.

we can kill 99.9% of the micro-organisms, but not 99.9999%," said Muthu.

That seems to be a small difference, but in food safety, it means a lot: "What 99.9% means is that 1 in 1,000 meat products could be contaminated with these micro-organisms. But we want to make sure that the contamination level is 1 in 1,000,000 products—that's what 99.9999% means."

To reach those higher levels of effectiveness, the scientists are combining ozone treatment with the use of Microgard®, a natural protein in powder form that is produced from a protein-based source such as milk.

Microgard® is effective against *E.coli* and *Salmonella*, but not against *Listeria*, said Henning. Very high levels of the product would be needed, which may not be economically feasible. It may also affect flavor, and it may require special labeling, because it is derived from milk protein and could cause problems for people who are allergic to milk.

Ozone, however, has none of these drawbacks and is effective against *Listeria*.

Muthu also is exploring irradiation techniques for disinfection of food, hoping to reduce the levels of irradiation by combining it with the use of Microgard®.

Irradiation is a food sanitation technique that involves exposing food to gamma rays. It is currently used on a variety of products, including fresh fruit, spices, and red meat. Irradiated food is available to consumers, and must be marked with an internationally recognized symbol and labeled either "treated with irradiation" or "treated by radiation."

Irradiation is very effective in killing microorganisms and it leaves no residues in the food, but it has been slow to gain consumer acceptance.

Muthu says irradiation is safe. "It is currently more effective than ozone; it kills basically all the microorganisms in the food," he said. "But the word 'irradiation' has negative associations for the consumer. People think there is nuclear radiation going through the product."

"That is one of the reasons to try out ozone; I suspect there will be greater consumer acceptance of this technique," said Muthu.

Another reason to use ozone as an alternative to irradiation is cost effectiveness. The necessary equipment for irradiation is very expensive to purchase and maintain. Ozone is cheaper to implement in meat processing plants, because the equipment is less expensive—all that is needed is an ozone generator. The gas is generated on site by extracting it from the air.

The irradiation research at SDSU is being conducted in collaboration with Iowa State University, currently the only university with the facilities to irradiate food. The ozone research is carried out by an SDSU team. Members of the group are Muthu and Henning, as well as James Julson, food engineer, Rajiv Dave, dairy scientist, and Duane

Ravi Jhala, Agriculture and Biosystems Engineering graduate student, adjusts the voltage on a lab-scale ozone generator, which turns oxygen from the air into ozone. Ozone to disinfect meat surfaces appears promising.

Wulf, meat scientist in the Department of Animal and Range Sciences.

While ozonation is a new technique for disinfection of food, its use as a sanitizing agent is well known in water treatment plants. For years, ozone has been used to sanitize water as an alternative to chlorine, and it is gaining popularity.

"Adding chlorine to the water is a very cheap procedure, but there is a concern that it leaves some residues that might be potentially carcinogenic in high concentrations," Henning said. He pointed out that there is probably no risk associated with the very low levels of chlorine that are used and risks associated with not sanitizing the water are much greater. But since chlorine does leave traces of chemical in the water, it is a cause for concern.

"One of the advantages of ozone," Henning said, "is that when it breaks down, none of the reaction products are harmful to humans.

"Ozone breaks down into oxygen and water; that is not a problem for any of us."

However, it is not as easy to use with organic products, Henning added. The ozone may interact with fat molecules and alter the properties of the food. When he first heard about the technique, he was skeptical, but "it appears to be very effective."

To test the effectiveness of ozonation and other techniques, the scientists must first deliberately contaminate meat with microorganisms to raise the pathogen level enough that treatment effects will show up and be measurable. The meat is then placed in a closed container inside a chamber with controlled temperature, and ozone is continuously pumped through the container and around the meat.

The gas is produced by a small ozone generator. "When power is supplied, the machine sucks in air and a very high voltage is generated between two electrodes. This splits the oxygen molecules and makes them recombine into ozone molecules," explained Ravi Jhala, a graduate student in Agricultural and Biosystems Engineering who is currently working on the project. "Different levels of voltage will result in different levels of ozone, so depending on the voltage, the concentration of ozone we produce will decrease or increase."

Then the meat samples are analyzed for presence of microorganisms, and comparisons are made between a control group and various treatment levels to determine microbial reduction under each condition.

"One of the advantages of ozone is that when it breaks down, none of the reaction products are harmful to humans."

–Dr. Kasiviswanathan Muthukumarappan, SDSU food engineer

While formal sensory studies have not yet been conducted, the researchers have made some preliminary evaluations of changes in color, texture, and hardness, finding that lower levels and time intervals do not cause any changes, but that some changes in color occur at high ozone concentrations.

"If we keep the intensity at 1 ppm for 30 to 40 minutes, we find some browning of the meat, particularly ham. But at 10-15 minutes we don't observe any changes," Jhala explained.

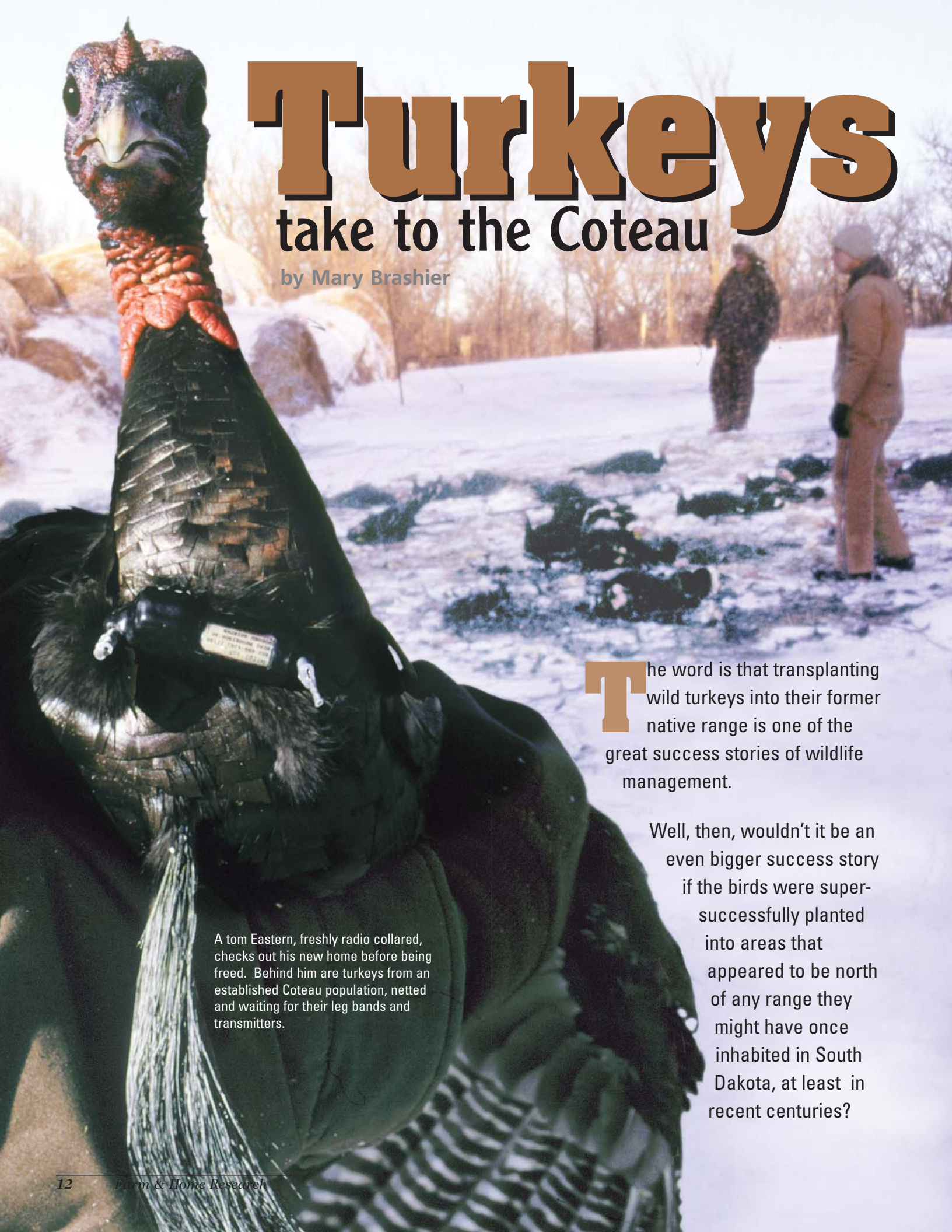
The scientists are experimenting with three different time intervals, 1, 15, and 30 minutes, and three different ozone concentrations, 0.2, 0.5, and 1 ppm. They tried humidified and aqueous environments for ozone application, but found gaseous ozone to be the most effective. They also tried two different temperatures, 50 F and 68 F, and found that the higher temperature was more effective.

Their goal is to determine the lowest level of ozone that is effective by combining ozone with Microgard® and testing different conditions that may influence the process. Once this is accomplished, the research will move on to nutritional and sensory studies, ultimately involving consumer attitudes and taste panels.

The SDSU research is funded through grants from the USDA, the National Pork Producers Council, the Ethel Austin Martin Program for Nutrition, and the Agricultural Experiment Station.◆

Turkeys take to the Coteau

by Mary Brashier



A tom Eastern, freshly radio collared, checks out his new home before being freed. Behind him are turkeys from an established Coteau population, netted and waiting for their leg bands and transmitters.

The word is that transplanting wild turkeys into their former native range is one of the great success stories of wildlife management.

Well, then, wouldn't it be an even bigger success story if the birds were super-successfully planted into areas that appeared to be north of any range they might have once inhabited in South Dakota, at least in recent centuries?

That's happening in northeast South Dakota. Eastern turkeys are thriving. Annual survival estimates for females in Grant County, for example, are among the highest reported anywhere—that's anywhere—for females of this subspecies.

"Turkeys in the northeast are reproducing at rates as good as or better than in areas where they're already established," says Les Flake, distinguished professor in the SDSU Wildlife and Fisheries Sciences Department. "We've recorded excellent reproduction. Almost all females built nests, with 57% to 86% of them, depending on the year, actually producing poults. You can hardly beat those numbers. That and 70% annual survival are good signs."

Good signs indeed for East River sportsmen who want this kind of bird watching and big game hunting close to home. Until recently they had to travel to the Missouri River and beyond if they hoped to sight a wild turkey.

When the South Dakota Game, Fish & Parks Department (GF&P) transplanted this subspecies into northeastern areas of the state, Flake sent out graduate students Chad Lehman, Roger Shields, and Dan Thompson to radio-collar and track turkeys.

"Our goal was to see if 'trap and transfer'—catching a bunch of truly wild eastern turkeys down in Iowa and Kentucky, bringing them up here safely, and finding likely places to release them—was really worth the effort," Flake explained.

"This is country north of their native range, at least in the last century or two. It's colder and snowier here than what they're used to. Could they make it through the winter? Would they adapt and reproduce well enough to be self-sustaining? "Mainly, what percentage of the landscape needed to be in forest?"

Anyone who's ever drawn a picture of Pilgrims at Thanksgiving in grade school knows trees and turkeys go together. Early biologists, too, thought that eastern turkeys could occupy only huge tracts of forested land.

"But they actually do quite well along rivers, and strips of natural forest," Flake said. He excluded tree belts.

> "Turkeys in the northeast are reproducing at rates as good as or better than in areas where they're already established."
>
> –Les Flake, SDSU professor

"They don't do too well in those places, unless natural woods are nearby.

"If there are draws, riparian habitats, adjacent uplands, and shrublands, our studies confirm that turkeys can get by with just 10% to 15% of their home range in trees."

The edges of the Prairie Coteau in northeastern South Dakota fit that description almost perfectly. The students reported back that the likeliest place to find turkeys was the edge of the Coteau where it breaks off into the Minnesota-Red River Lowlands, where oaks and maples grow in the breaks, and where mosaics of grasslands and croplands mingle with forested tributaries of the rivers.

"It works out that at the northern limit of their range turkeys actually require interspersions of grasses and agricultural fields to survive extreme snow depths and cold temperatures," Lehman said. "Normally, they would use crop fields as their major winter food source."

Shields agreed. The turkeys he tracked needed less than 10% wooded habitat. There's a catch, he cautioned. They do need a patchwork of tree, crop, and grass areas, and the more interspersed the patches, the better.

That's why "In the long run, Grant County will not have the turkey populations of places like northern Missouri or even south-central South Dakota," Shields said. "There is just not that much prime habitat."

Original habitat for the eastern subspecies of turkeys in South Dakota was limited to the southeast along the Missouri and James rivers. South Dakota is the western extremity of their range; at one time these turkeys could be found almost anywhere in the entire eastern half of the continent. Population decline matched the arrival of colonists and movements of settlers westward. Scientists attribute the virtual elimination of wild turkeys in most areas to uncontrolled year-round hunting and habitat destruction.

Since there wasn't that much good turkey habitat in South Dakota to start with, Flake thinks that year-long market hunting finished off the populations. "The last native turkeys in the southeastern part of the state were killed off in the 1930s," he said.

Other native subspecies of turkeys can be distinguished from the easterns

by the color of the tail band. Easterns have a dark band. In Texas and Oklahoma are the Rio Grande turkeys with creamy brown bands. In the Rockies, the Merriam's subspecies has very light-colored tail bands. All subspecies have been introduced into South Dakota. All subspecies interbreed.

The Merriam's came about 1950 from typical ponderosa habitat of the southwest. From a successful planting in the Black Hills they were introduced to prairie woodlands through much of western and south-central South Dakota.

"Prairies are way outside their normal habitat, but they're doing just fine along the rivers," Flake said. "There's a large Merriam's population around Bonesteel that's healthy and in excellent condition, and the area has become a popular place for spring gobbler hunts."

Rio Grandes haven't fared as well. They were introduced into northeastern South Dakota in the early 1960s, reaching a peak population of about a thousand birds in Marshall and Roberts counties in the mid 1980s but declining precipitously after that. A hundred or so survivors were estimated in 1996.

"We don't know what caused this decline," Lehman said. "Perhaps they interbred with domestic turkeys or game-farm turkeys. Perhaps they got too used to humans and became overly dependent on farmstead grain for winter survival."

> "The last native turkeys in the southeastern part of the state were killed off in the 1930s."
>
> –Les Flake, SDSU professor

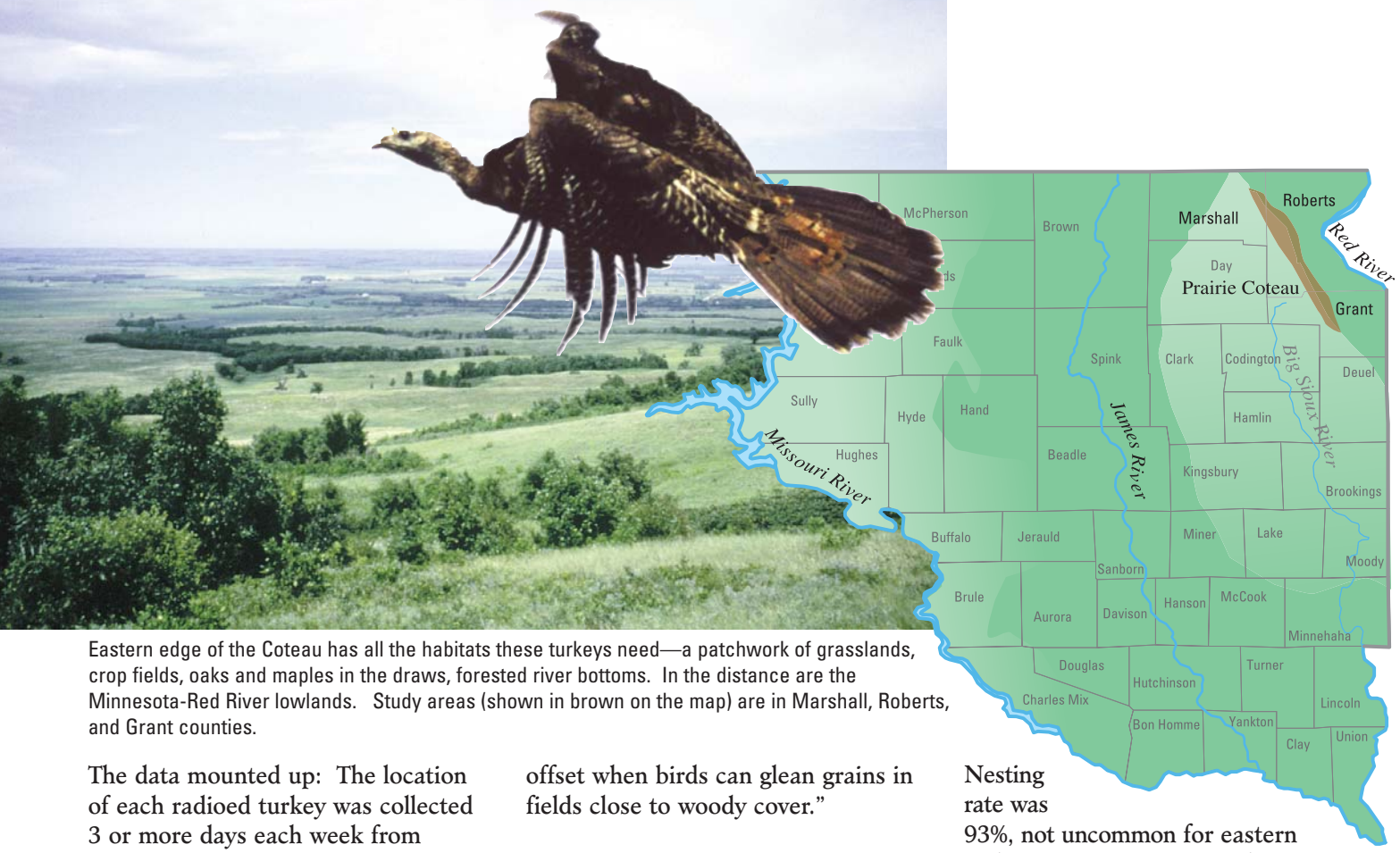
Perhaps they were just out of their element, less able to adapt to South Dakota conditions. Their native range is arid brushlands and grasslands in the south-central Great Plains.

If turkey hunters recount the difficulties of tracking, calling, and then taking a bird, then pity the graduate student who has to do the same but capture his prey live.

Lehman used every resource available—drug-laced corn bait, drop door traps, cannon nets, rocket nets, drop nets. Shields was luckier; he could collar most of his turkeys as they came out of their travel pens. Lehman worked with established populations in Labelle and Seiche hollows in Roberts and Marshall counties; Shields followed 84 easterns released in Grant County in 1999, an additional 37 released in 2000, and 9 females from South Dakota who were offspring of the 1999 release.

All birds were leg banded; most got necklace-style radio transmitters. Each transmitter had a mortality switch that changed the broadcast signal after 4 hours of inactivity. These new signals were immediately investigated on foot with handheld antennas and receivers. The inactivity often indicated egg incubation; if this was the case, the students flagged the location at a distance and retreated quietly.

Eastern explodes from travel box. "Trap and transfer" of truly wild birds raises the odds they will successfully establish.



Eastern edge of the Coteau has all the habitats these turkeys need—a patchwork of grasslands, crop fields, oaks and maples in the draws, forested river bottoms. In the distance are the Minnesota-Red River lowlands. Study areas (shown in brown on the map) are in Marshall, Roberts, and Grant counties.

The data mounted up: The location of each radioed turkey was collected 3 or more days each week from January through August in 1999 and 2000, and then weekly or biweekly for September through December.

Both Lehman and Shields found eastern females ranged far and wide, particularly in the spring. Both trackers found eastern females tended to shun civilization. Rios, in contrast, were more willing to visit farmsteads. There weren't enough radio-equipped toms for significant data to be collected.

Shields found 75% of females survived at least 274 days, 50% survived 358 days, and 25% survived more than 615 days. No one season of the year was statistically more stressful.

All told, that's among the highest reported annual survival estimates for eastern subspecies females and better than for established populations in Missouri, Wisconsin, and New York.

He was pleased with the high winter survival rate of birds in his study. "This says that a severe winter can be partially offset when birds can glean grains in fields close to woody cover."

During the 1999 and 2000 reproductive seasons, Shields tracked 65 females and found 98 nests.

And that is when the beepers became invaluable, Shields said. "If hunters think turkeys slink, they should try to follow females to their nests. They will find the deepest, densest cover around, so the nest bowl and the hen can't be seen by predators but so that there is an escape route available if it becomes necessary to use it."

For this reason, shrubland and idle grassland, which together represented only 16% of available nesting habitat, contained 75% of all nests. Lehman found the same trend for Marshall and Roberts easterns.

Grant county nest success was lower in woody cover (20%) than either shrubland (63%) or grassland (58%). Shields attributed this to a higher risk of predation. "Striped skunks and raccoons will travel forested edge habitats more than they move out into grasslands."

Nesting rate was 93%, not uncommon for eastern turkeys. Renesting rate—the proportion of females unsuccessful in their first nesting attempt that initiated another nest—was 45%, also similar to rates of established populations elsewhere. As expected, most nest failures were due to predation.

Hen success—the proportion of all females that were successful in producing one or more poults in at least one nest attempt—was 50%, "much higher than in some other places," Shields said. "In an Iowa study in prime turkey country, for example, it was 33%." Brood and poult survival to 4 weeks post hatch was comparable to survival rates reported in other studies of eastern turkeys.

Cover, or vegetation, on the study area came in six different types, Shields found: pasture; idle grass—which included CRP acres, federal and state wildlife production areas, wetland drainages, and other uncultivated and ungrazed grasslands; trees and shrubs, cropland, hayland, and farmsteads. He drew maps from aerial photos and

plotted the preferences of the radioed birds for each cover type.

Most vegetation was used in proportion to its availability in the landscape. There were two exceptions, no surprises to Shields. Both hens and toms tended to prefer woody habitat and to shun cropland.

Home ranges were much larger—up to 10 times larger—than in other eastern turkey studies. "I think this shows that their habitat was not the greatest," Shields said. "They liked woody cover, they just had to go greater distances to find it.

"There probably is sufficient habitat to support a small population of turkeys along the length of the Coteau and along the major river channels—the forks of the Yellow Bank River—that cross it. Eastward is too much cropland. Westward is too much grassland."

So Shields is guardedly optimistic about turkeys in Grant County.

"It looks like this Grant County population is capable of successful reproduction and population increase. There are enough alternative crop foods in this study area to maintain the females in good condition through the winter."

When turkeys increase to all the land can support, however, other factors such as predation may become more important, he warned. "The key is cover, particularly nesting and brood rearing cover."

License holders for one of the two seasons in Marshall, Roberts, or Grant counties for the spring 2001 hunts were fairly certain of success, says Art Smith, GF&P statistician in Pierre. Hunting success in Marshall, 30 licenses per season issued, was 63% and 30%. In Roberts,

Dan Thompson wields an antenna, strengthening the signal from a turkey's radio collar. All radioed turkeys were located 3 or more days a week the first 8 months of each year and weekly in fall and early winter.

30 licenses per season, 72% and 80%. In Grant, which got turkeys only 3 years ago and six licenses issued for each season, 33% and 100%.

> "It looks like this Grant County population is capable of successful reproduction and population increase."
>
> –Roger Shields, SDSU graduate student

Back-to-back seasons, April 8-23 and April 24-May 21 in 2001, "are a way to spread out the hunting pressure," according to Smith. "It's a good way of keeping things less crowded out there." That's important, to increase the pleasure of the hunt and for hunter safety. Turkey hunting is the nation's most dangerous sport involving firearms, according to the GF&P state hunting safety specialist Bill Shattuck. "More than 75% of turkey hunting accidents occur when hunters mistake other hunters for a turkey."

"I think a lot of people are going to appreciate having eastern wild turkeys closer to major population centers," Flake said. "Even if we don't have a great deal of 'perfect' habitat, what we do have is 'appropriate' habitat.

"Hunters, environmentalists, and landowners wanted them; South Dakota Game, Fish and Parks brought them in; we've found the best habitats for them; and a couple of our SDSU students got a lot of exercise and graduate degrees out of the project. Sounds good to me."◆

The students' projects were funded by the South Dakota Agricultural Experiment Station; Game, Fish and Parks Commission; and the National Wild Turkey Federation. Shields is now in the wild turkey management section of the Florida Fish & Wildlife Conservation Commission, and Lehman and Thompson are working on advanced SDSU graduate degrees with Merriam's turkeys in the Black Hills.

'How full can we fill the sink?'

by Lance Nixon

Scientists at SDSU are turning an old question in agriculture on its ear.

They no longer want to know simply how much phosphorus in the soil is enough to raise good crops, but how much is too much.

And the information won't go to help grain farmers alone, but also livestock producers. In an age of concentrated livestock feeding operations, the industry is keenly interested in how much phosphorus in manure can be safely applied to farmland without leading to environmental problems.

"Traditionally when we have looked at phosphorus, it has been from the deficiency side: When do we have to add phosphorus to get optimum crop yields," explained Jim Doolittle, SDSU plant science professor. "What we're looking at now is how long can we continue to add phosphorus, specifically the phosphorus in animal manure, beyond the critical level for crop production.

"Essentially what we're doing is using the soil as a sink. That's where our research is focusing, how full can we fill the sink."

Doolittle added that SDSU Soil Testing Lab Manager Ron Gelderman already has laid a good foundation for some of the research that's being done now.

"From his work, we know there are a lot of soils in South Dakota where

[Scientists] no longer want to know simply how much phosphorus in the soil is enough to raise good crops, but how much is too much.

"Phosphorus is not poisonous to people. But it does create one whale of a problem if it gets into lakes."

–David German, SDSU research associate

we can still add a lot of phosphorus," Doolittle said. "Where we run into problems is when we add phosphorus to highly erodible soils. Where you erode the soil solids, the phosphorus goes right along with them because it adheres to soil particles."

A project in the planning stages would test three common benchmark soils to see how much phosphorus they retain and how much escapes the soil in runoff. South Dakota's Board of Water and Natural Resources gave its approval for the project in October. The federal Environmental Protection Agency (EPA) also has approved the project, although a formal Project Implementation Plan must be submitted to the EPA before the agreement and funding can be finalized.

Frank Schindler, SDSU soil chemist, explained that there are about 33 benchmark soils in the state, so called because they are very common and extensive and possess chemical and physical characteristics similar to many other South Dakota soils. Schindler will be principal investigator in the study.

The study as outlined would examine three of these soils—Barnes, Kransburg and Poinset—in the area north of Watertown that ultimately drains into bodies of water such as Watertown's Lake Kampeska.

"We'll look at the three dominant soils in the Upper Big Sioux Watershed," Schindler said. "If we can identify some of our soils as having very high phosphorus-holding capacity, we can manage those soils differently. We may be able to apply more manure on those soils, provided they are considered low risk due to low erodibility and distance from sensitive water bodies."

The information gathered from the study will ultimately help producers make decisions about how to manage manure so that phosphorus doesn't end up in waterways. That, in turn, will prevent areas such as Lake Kampeska—where homeowners together have some $94 million in property—from seeing property values decline if too many ag nutrients find their way into lakes. Too much phosphorus in runoff can cause algae blooms that in turn deplete oxygen and lead to fish kills.

"This is critical in terms of protecting lakes," says David German, a research associate at SDSU's Water Resources Institute. "Phosphorus is not poisonous to people. But it does create one whale of a problem if it gets into lakes. One pound of phosphorus can result in the growth of 500 pounds of algae if everything else the algae need for growth is there."

The location of the study was chosen partly because it ties in with a project that the city of Watertown has had in place since the early 1990s to improve the water quality of Kampeska and Pelican lakes.

SDSU scientists already have purchased a piece of equipment to help carry out the study, if it proceeds. It's called a

Frank Schindler, SDSU soil chemist, says the study will show how much phosphorus three South Dakota soil types on the project area can hold. If the sink isn't full, and particularly if erodibility potential is low, farmers could apply additional manure fertilizer without fear of contributing to the pollution of streams, lakes, and groundwaters in the watershed.

rainfall simulator, a metal frame with a spray nozzle and apparatus to catch runoff. Tarps keep the wind from interfering with experiments.

Gelderman said the 3-year experiment to test the three soils carries a preliminary price tag of $200,000. If funding becomes available, this research could provide the science-based information needed to fine-tune South Dakota's manure management regulations governing animal feeding operations.

The Clean Water Act gives the EPA authority to prohibit discharge of pollutants from point sources that include Concentrated Animal Feeding Operations (CAFO). The EPA is expected to take action by Dec. 15, 2002, on a proposed rule that stipulates that land areas where manure is applied is covered by CAFO regulations.

Other factors besides soil type affect phosphorus movement, including slope, tillage technique, distance from bodies of water, and whether the phosphorus has been applied to the surface of the land or injected, Gelderman said.

In South Dakota, unlike in some eastern states where manure from poultry farms has long been applied to farmland, most soils in the state do not have too much phosphorus.

"Right now, agronomically, 80% of our soils need additional phosphorus," Gelderman said. "In some states it would be 80% that are either high or very high in phosphorus."

Schindler said it is likely the results of the SDSU study will fit many of the soils in South Dakota, though additional testing will have to be done in some cases.

Some work in the Soil Testing Lab at SDSU duplicates the field studies. If the results are similar, SDSU will be able to do more lab studies in the future, Gelderman says.

Mike Williams, coordinator for Watertown's Upper Big Sioux River Watershed Project, said the SDSU phosphorus research will dovetail nicely with the work the city has been doing since 1994 to get farmers to use Best Management Practices in the watershed that feeds Lake Kampeska and Pelican Lake.

"Back in 1990 and '91 we conducted a diagnostic feasibility study to determine what was coming into the lakes and where from," Williams said. "We determined our problem was phosphorus and silt getting into the water and causing algae blooms." Williams said not only grain farming but also livestock waste, lawn fertilizers, and even human sewage all are very likely part of the problem. But he said the solution clearly has to involve agriculture.

"We have $94 million of real estate out there, and it's going to turn into a duck slough unless we do something."

Already the Upper Big Sioux Watershed Project has been cost sharing with farmers to put Best Management Practices in place. Those include stream bank stabilization, grazing management, alternate livestock water, cross-fencing to form paddocks, lagoons to hold animal waste, and incentive payments to convert to no-till or reduced-tillage farming. On such practices the Watertown project pays 90% of the cost and the farmer pays the rest. The watershed project's funding is mainly from the EPA.

"We have probably 300 farmers out there in our watershed who are cooperating with us, some in a big way, some who are just getting started."

"The SDSU research will fill a vital gap in knowledge to make the whole plan successful."

–Mike Williams, Watertown Upper Big Sioux River Watershed Project coordinator

The comprehensive nutrient plan the Upper Big Sioux project is using works with farmers by testing soils and manure for phosphorus; calibrating manure spreading equipment; calculating crop needs for phosphorus; and identifying phosphorus hot spots and taking measures to prevent phosphorus from those areas from getting into water supplies. But, Williams added, "the SDSU research will fill a vital gap in knowledge to make the whole plan successful.

"What we don't know is how many pounds per acre of phosphorus the different soils will hold. We need to be able to tell the farmers. They need and want hard, accurate data from their locality."

With those numbers, Williams said, farmers can go on earning their livelihood and perhaps save themselves money in the process by not applying more phosphorus than the soil can hold. Watertown and its area lakes, in turn, will benefit from having cleaner water.◆

Russians, SDSU strike a deal

by Lance Nixon

Though they are nine time zones apart, South Dakota, deep in the center of the North American continent, and Krasnodar, likewise deep in the middle of Eurasia, have agricultural heartlands in common—and people working with agriculture in both places who sincerely believe each region can learn from the other.

Thanks to an agreement approved in the summer of 2001 between SDSU and Krasnodar officials, Russian crop varieties will be planted in South Dakota.

The agreement calls for cooperative work in soybean and alfalfa, no-till and conservation tillage techniques, swine production, agricultural biotechnology, and foods, horticulture, and dairy.

The arrangement will probably also have another, very modern, and value-added dimension. In a visit this fall to Krasnodar Krai (region), Kevin Kephart, director of the South Dakota Agricultural Experiment Station, and Larry Tidemann, director of the South Dakota Cooperative Extension Service, learned that the region not only produces but also processes a large share of Russia's food.

"My deepest impression is that they have significant infrastructure and significant investments in value-added agriculture," Kephart said. "Forty-four percent of Russia's food-processing industry is located in Krasnodar Krai."

Larry Tidemann, left, South Dakota Cooperative Extension Service Director, and Kevin Kephart, South Dakota Agricultural Experiment Station Director, stand before a statue of Vladimir Lenin, the "father of the Socialist movement" in Russia. The building houses the Krasnodar Duma (Legislature).

Value-added processing is still mainly in the talking stages in South Dakota, where farmer-owned processing ventures such as South Dakota Soybean Processors of Volga are the exception, not the rule. It's the opposite in Krasnodar, Kephart said.

"We visited farms that have wheat-milling operations. They produce flour, not grain. They also have a bakery there to produce bread."

Similarly, Kephart said, the manager of a vast hog farm does not think of hogs as his end product.

"He is focusing on ham and fresh meat and sausage as his product, not so much on hog production," Kephart said.

In turn, Krasnodar ag producers are hoping to learn from SDSU and South Dakota producers how to grow better corn and soybeans, according to Ivan Petrenko, general director of the Agricultural Department for the Administration of Krasnodar, who spoke through an interpreter during a visit to South Dakota.

SDSU scientists, on their part, hope to obtain germplasm from Krasnodar that could help them improve South Dakota soybeans, wheat, or other crops, said Kephart.

"In Krasnodar they have some of the best winter wheat germplasm around, and I want to see if it could benefit South Dakota producers," he explained.

It's possible, Kephart added, that some South Dakota producers might view the scientific exchange between Krasnodar and SDSU as lending a hand to a competitor. But he sees the agreement as a two-way street on which science and information flows both ways.

When Russians planted winter grains in Karsnodar Krai, Kephart noted, there always seemed to be at least one person standing on back of the drill.

"The first question we should ask is, Is it a benefit to science for us to be over there? I think it definitely is," Kephart said.

"Is there a difference between sharing our germplasm with Wisconsin as compared to Krasnodar? It's up to us to glean whatever we can from science to benefit South Dakota."

David Iverson, who farms near Toronto, said he views the exchange in a similar light. "My first reaction is that it's good for humanity," Iverson said. "The world is bigger than Brookings County and bigger than my little community. We as Americans are losers if we don't have a bigger perspective. It would be selfish not to share ideas back and forth. What we could learn from them could help our economy even more than we could help them."

Roy Scott, SDSU soybean breeder who was with the delegation to Krasnodar in February 2001, said the chance to work with his Russian counterparts could lead to big strides forward for both Russia and South Dakota.

When the Russian delegation came to South Dakota in 2000, Kephart gave this Russian hog producer, Vladimir Popov, left, the hat he is wearing. Popov has a memento of the trip for Kephart.

"As researchers we've got to learn to think globally. I've worked with people all over the country on soybeans. This is just taking it to the next level, which is international."

Armchair traveler's guide to Krasnodar Krai

The city of Krasnodar was established in 1793 as a Cossack military camp. Until 1920 it was known as Ekaterinodar after Catherine the Great. In 1860 Ekaterinodar became an administrative center of Kuban Krai, and in 1867 it was formally recognized as a town. The town developed as a trade and production center for the region of Kuban, and the city now has a population of about 720,000.

Krasnodar Krai (Region), also known as the Kuban Region, is in the southwest portion of the Russian Republic. It occupies an area of about 30,400 square miles, completely surrounds the region of Adygeya, borders the Rostov and Stavropol regions and Georgia, and has coasts on the Azov and the Black seas. From north to south Krasnodar Krai is 230 miles and from west to east 235 miles.

Krasnodar Krai is one of the largest regions of Russia, with more than five million people in 1998. Slightly over 54.2% live in the cities and towns, most residing in 14 cities with populations of more than 50,000 people. About 2.3 million people, 46%, live in rural areas.

The northern two thirds of the region are in Russia's fertile Black Earth zone, and agriculture is the largest sector of the Krasnodar economy. The farms are private stock companies. More than 20,000 private farms have been created; they rely on regional agricultural trading companies to distribute their products throughout Russia.

More than 120 kinds of crops and animals are raised in the Krai. Dominant crops are wheat, sunflowers, fruits, vegetables, wine grapes, and rice. The Krai accounts for 10% of all wheat, 26% of sugar beets, 60% of all oilseeds, 25% of the sunflowers, and 90% of all the rice grown in Russia. About 16% of the fruits and berries and 49% of the wine produced in Russia come from Krasnodar.

The Krasnodar economy also leans heavily on extracting natural resources such as oil and gas. Such raw materials make up 75% of Krasnodar's exports, while consumer goods make up 20% and machinery and equipment the final 5%. Tourism thrives along the Black Sea coast. Transportation is important, with 40% of Russia's maritime trade passing through Krasnodar's ports.

The standard of education in the Krai is high, and the region possesses 76 institutions of higher learning and scientific research.

Ivan Petrenko, general manager of Krasnodar's Department of Agriculture, inspects sunflowers near Volga, S.D. Petrenko initiated the exchange and remains commmitted to it, says Kephart.

Scott said soybean growers already owe a debt of gratitude to Russia, since the pool of soybean germplasm used by North American scientists already contains a good portion from Russia. Soybeans are native to China, so germplasm from East Asia and parts of Russia became fundamental building blocks for breeders around the world.

Krasnodar already raises some soybeans, and the Krasnodar soybean germplasm could add diversity to the materials that North American soybean breeders work with, Scott said. New traits could include those for stress or insect tolerance.

Kephart said the agreement with Krasnodar will allow for the exchange of SDSU faculty, Cooperative Extension personnel, farmers and agribusiness people, and undergraduate and graduate students. Research and cultural exchange programs are also part of the agreement. SDSU is exploring funding sources to keep the project flourishing.

Early in 2002, SDSU hosted a Krasnodar scientist who learned firsthand some of the lab procedures used in working with biotechnology. Cooperative Extension Service personnel and soybean breeder Scott will visit Krasnodar in the spring. A Krasnodar scientist may come to SDSU and its Dakota Lakes Research Farm near Pierre to study no-till techniques.

Though they are nine time zones apart, South Dakota and Krasnodar have agricultural heartlands in common.

The South Dakota Cooperative Extension Service may act as a model for a similar setup in Krasnodar. Russia has been designing a new, nationwide system for communicating agricultural information as part of the Agricultural Reform Implementation Support Project, supported by a $360 million loan from the World Bank. The new system replaces the centrally controlled system that collapsed following the change of government in 1992.

Krasnodar ag officials had visited South Dakota briefly in July 2000 as part of a whirlwind tour. They had only a few hours at SDSU, but Kephart used the occasion to point out the ties SDSU already had to Russia through legendary SDSU horticulturist N.E. Hansen. Hansen brought back a wealth of plant material from Russia and other places during eight exploration journeys through Europe and Asia starting in 1894.

The Krasnodar delegation that formalized the agreement with SDSU this past summer included Petrenko; professors Yuri Severin and Vladimir Kovalenko of Kuban State Agrarian University; Vladimir Popov, director of a major pig farm; Vladimir Nadykta, director of the All Russian Institute of Biological Plant Protection; and Alexander Trubilin, a deputy general director in the Agricultural Department for Krasnodar.

The agreement includes SDSU, the Department of Agriculture and Food for Krasnodar Krai, Kuban State Agrarian University, and the All Russian Institute of Biological Plant Protection. At least one other research entity in Krasnodar wants to be included, so the agreement will likely be amended, Kephart said.◆

On the right, visiting with three of the Russian agriculturists when they came through South Dakota in 2000, is Dave Nelson of Nelson Seeds in Miller. Nina Mitrofanova served as interpreter.

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