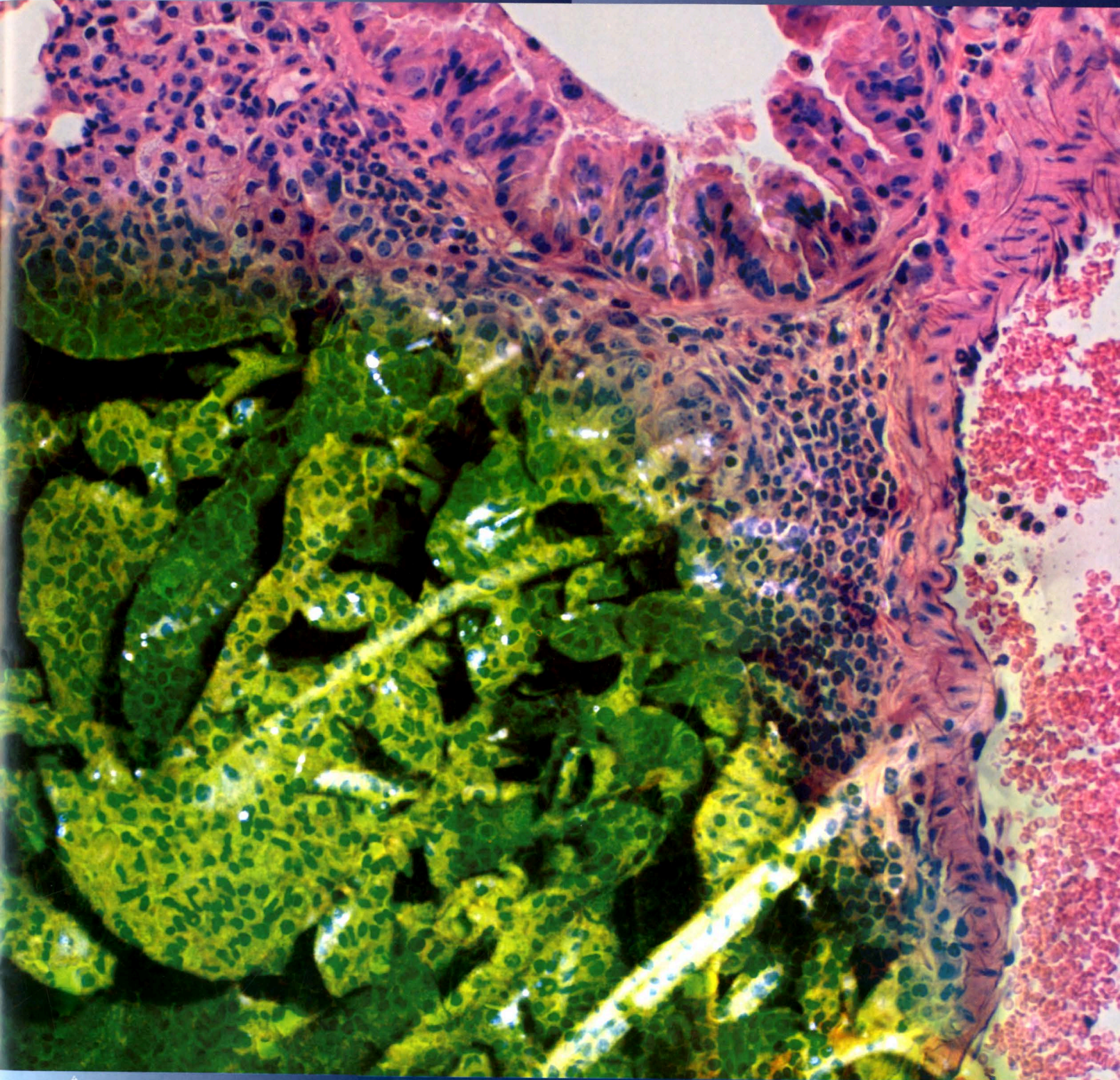


Research

SOUTH DAKOTA STATE UNIVERSITY



South Dakota
State University
Spring 2015

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CYANIDE

Prototype detects cyanide poisoning in 70 seconds

Photo by Matthew Gade of the Mitchell Daily Republic



Brian Logue

A victim of cyanide poisoning can die within 30 minutes.

The diagnostic test to determine cyanide exposure takes 24 hours.

According to U.S. Department of Health recommendations, “any delay to draw blood or collect urine could endanger patient welfare.” That’s why medical personnel simply treat the patient when dealing with a possible case of cyanide poisoning.

Associate professor Brian Logue of the chemistry and biochemistry department has a solution—a prototype that can detect cyanide exposure within 70 seconds. During the last 10 years, Logue has received nearly \$2 million through Department of Defense and National Institutes of Health grants to analyze cyanide and its metabolites and help create countermeasures for cyanide exposure.

Firefighters, industrial workers at risk

More than 1.5 million tons of hydrogen cyanide are produced worldwide, according to the United Nations Environment Programme. Nearly 20 percent is used to extract gold, silver and other precious metals from ore, while the remainder is used to manufacture paper, textiles and plastics, as well as for electroplating and etching metals.

When an industrial fire occurs, workers and firefighters can be exposed to cyanide, according to Logue. In addition, common building materials, such as carpet and plastics, contain cyanide that can be released when they burn.

Logue said foods, such as wild cherries, bitter almonds, peach pits and lima beans also contain high levels of cyanide.

Scientists and medical personnel identified the need for a quick, reliable and portable means of identifying exposure to cyanide, Logue explained, which prompted the NIH’s request for proposals.

Furthermore, early symptoms of cyanide poisoning include dizziness, headache, shortness of breath and rapid heart rate as well as nausea and vomiting, according to the Centers for Disease Control and Prevention. “A lot of these symptoms are pretty nondescript,” Logue pointed out. “That’s another part of the reason for the sensor.”

Quick diagnosis

The patent-pending sensor design uses a two-stage process—the first converts the cyanide in the sample into a gas and the second traps it in a base. “It diffuses like perfume,” Logue said. Two doctoral students have worked on the project.

The cyanide then reacts with a second substance and becomes fluorescent when exposed to light, according to doctoral student Randy Jackson. The fluorescent product containing cyanide then emits its own light, which can be measured to determine analytical concentration.

The researchers have updated the design, which is in its fourth version of development, and decreased the diagnostic time from 2 minutes to 70 seconds, Logue explained.

However, “we haven’t optimized it—we’d like that to be under a minute.”

Speed is essential when faced with a catastrophic situation, such as an industrial fire or terrorist attack, in which many victims need to be assessed quickly, Logue noted. In such a scenario, a blood sample from a finger prick, like a diabetic would do to measure blood sugar, could be used to determine if a person has been exposed, Jackson added.

Ultimately, the researchers would like to be able to test saliva, because typically cyanide exposure occurs through the mouth or nose, Logue explained. However, a consistent link between the two has not been established.

Accuracy, design optimization

Tests performed on rabbits were 100 percent accurate at diagnosing exposure to cyanide, even at levels 200 times lower than the lethal amount, Logue explained. The device detects cyanide levels below what a person is exposed to when smoking a cigarette.

A baseline blood test was done prior to exposure and then blood was drawn at 15-, 25- and 35-minute intervals as the animals were gradually exposed to low concentrations of cyanide, according to Jackson. Even at the earliest time interval, the device could detect increased cyanide levels.

Logue plans on conducting larger animal studies to statistically determine sensor accuracy. “We’re pretty confident the device is accurate diagnostically because the specificity of the reaction is very good.”

In addition, the researchers will tap engineering expertise to miniaturize the device and will optimize the replaceable cartridge that contains the reactive chemicals. Eventually, the device must be approved by Federal Drug Administration.

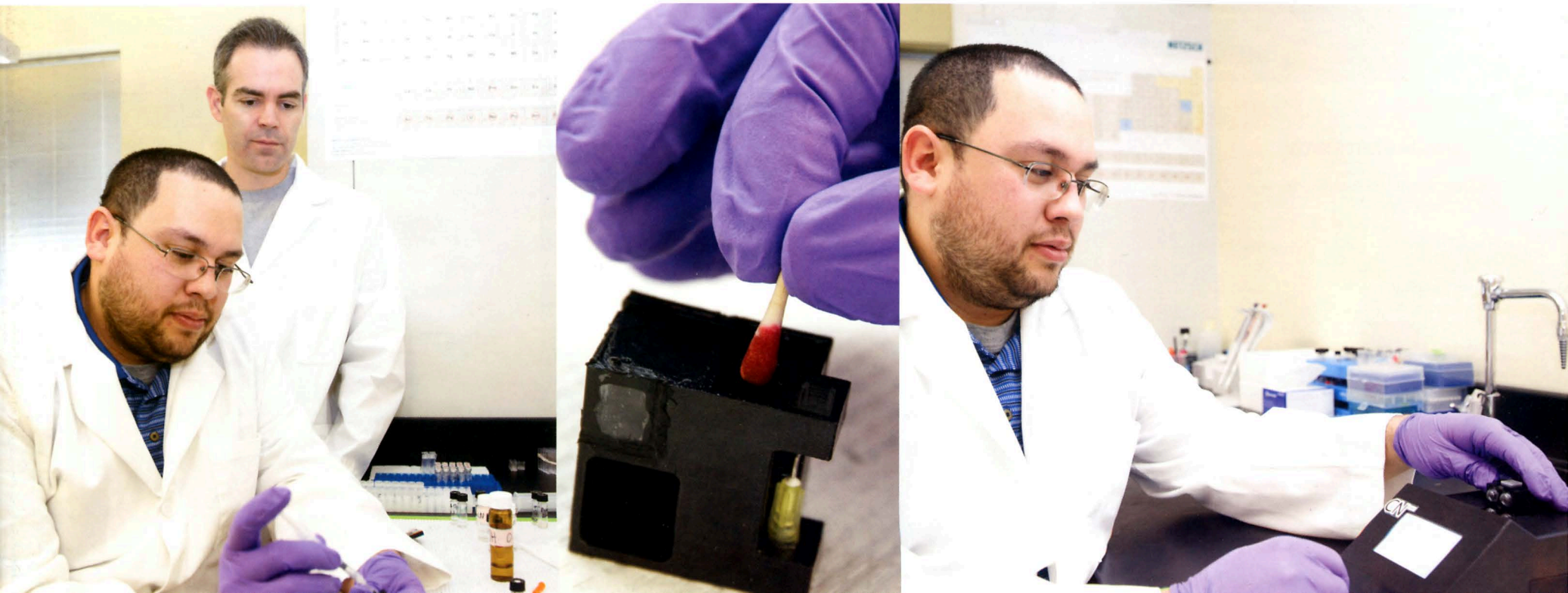
Logue has begun the search for a business partner with whom he can apply for Small Business Innovation and Research (SBIR) funding to refine and market the device. “I want to get this product to the people to help save lives.”

Above: Firefighters battle a Nov. 19 blaze in Mitchell from the perimeter to prevent exposure to chemicals. The building, which is owned by CHS Farmers Alliance grain elevator, contained farm chemicals and fertilizer.

Below, left to right: Associate professor Brian Logue, right, and doctoral student Randy Jackson fill the wells in the cyanide sensor cartridge with chemical reagents—an acid, a base and a fluorescent agent. Each cartridge can determine the cyanide level in a sample of either blood or water.

The blood sample is placed inside the cartridge.

Once Jackson inserts the cartridge into the machine, it will determine the level of cyanide in the blood sample in approximately 70 seconds. This device will help emergency personnel quickly identify patients who have been exposed to cyanide.



Research capitalizes on enterprise opportunities

"Small opportunities are often the beginning of great enterprises."

—Demosthenes

The Greek orator Demosthenes captured the essence of what higher education and research seek to accomplish. As the state's 1862 Morrill Act land-grant institution, South Dakota State University opens the doors to opportunity by making a college education accessible to all Americans and by fueling science-based discovery and innovation. Through research, our engineers, nurses and scientists seize the opportunity to solve problems that impact the state, region and nation.

As part of a multistate research team, South Dakota State plant scientists are identifying biomarkers to help breeders improve flavor and ripening of cold-climate grapes and determining the nutritional needs of the cold-hardy vines. The goal is to help the vineyard owners produce a wine that is distinctive to this region.

Researchers at the Jerome J. Lohr Structures Laboratory have developed a new approach to joining girders that are used on city and county bridges that will double their lifetime. According to the 2014 Bridge Inventory, 22.4 percent of city, county and township bridges nationwide are either structurally deficient or functionally obsolete. This research promises to save taxpayers money by making those replacement bridges last longer.

Electrical engineering researchers are developing smart power management technologies that will make it possible to integrate locally produced renewable energies into the power grid.

Nursing researchers collaborate with South Dakota Department of Health officials to encourage apartment owners and operators to adopt smoke-free policies and to help schools develop comprehensive tobacco-free policies. Nutrition researchers are identifying natural food compounds that can help our bodies fight cancer.

University chemists have developed a portable device that can detect exposure to cyanide in 70 seconds. Any possible cases of cyanide poisoning now must be treated because cyanide exposure can kill a person within 30 minutes and the lab-based test takes 24 hours. The researchers are working to commercialize their patent-pending device.

Pharmacy researchers are investigating how oxidative stress affects the body at a molecular level to help design interventions for degenerative diseases, such as Parkinson's and Alzheimer's. As baby boomers reach retirement age, a greater share of the population will be at risk. An estimated 19 percent of Americans will be age 65 or older by 2030, according to the U.S. Department of Health and Human Services Department of Administration on Aging.

Rehabilitation counselors help clients coping with physical and mental disabilities find employment and live independently, thanks to specialized training they receive in the guidance and counseling graduate program.

The dedicated researchers at South Dakota State use their talents to capitalize on opportunities by developing technologies that will impact peoples' lives for generations to come. That is the core of the university's land-grant mission.



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Grapes

Plant scientists
help improve **cold-hardy**
grape varieties, develop
local wine industry



The French have spent centuries developing grapes with the unique flavor and character of Burgundy region wines. South Dakota grape producers are counting on science to help shorten that process.

Plant scientists Anne Fennell and Rhoda Burrows are part of a research team helping cold-climate grape growers carve a niche in the American wine industry through two U.S. Department of Agriculture projects.

The Northern Grapes Project, which brings together researchers from 10 land-grant institutions, goes from soil to genome and back, Fennell explained. VitisGen focuses on mapping the genome of cold-hardy grapes. Begun in 2011, the projects are part of the Institute of Food and Agriculture Specialty Crop Research Initiative.

Fennell works with grape genetics, identifying biomarkers that will help breeders develop better

“As a national research team, we are identifying the genes expressed during ripening and chemical products of ripening, known as metabolites, and comparing levels of those with results of sensory evaluation,”

—Anne Fennell



Anne Fennell

varieties. Burrows focuses on vine nutrition to help producers properly manage the soil.

“We are using scientific information to close the gap and to make better decisions in our lifetime,” said Dave Greenlee, co-owner of Tucker’s Walk Vineyard in Garretson and a member of the Northern Grapes Project advisory council.

New cultivars and new flavors

“Cold-hardy cultivars are complex hybrids of *Vitis vinifera* and native American species including *Vitis riparia*, which is native to this region,” said Fennell, noting that the genomes can contain traits from three to seven species.

Many of the cold-climate cultivars recommended for North America have existed for less than 20 years. “Because the cultivars are new, we’re trying to get baseline information,” Fennell said.

The red Marquette grape, for instance, has only been commercially available for eight years, so the first wines are just becoming available in larger quantities. “Marquette is about 35 percent wild *Vitis riparia* by pedigree and is a tremendously hardy grapevine,” Fennell explained. It tends to break bud and ripen earlier than other varieties.

She collaborates with University of Minnesota and Iowa State University researchers on fruit chemical and aromatic composition and sensory ripening characteristics. Fennell and Burrows provide samples to both universities and will integrate gene expression and chemical information to identify signature characteristics.

Last fall, the Northern Grapes Project received \$2.6 million for the next two years, putting the 5-year total at nearly \$5 million, while VitisGen received an additional \$2.5 million. Both projects are led by Cornell University.

The ultimate goal is to help the industry give consumers quality wines that are unique to these regions, according to Fennell. Burrows estimated that the state has more than 80 vineyards and about 200 acres of grapevines. Some vineyards have 15 acres or more with roughly 450 to 500 vines per acre.

Perfecting fruit quality, harvest time

New cultivars must be tested for sustainability, yield and fruit quality, Fennell explained. The cultivars a producer

plants affect the operation longterm, because the vines take three years to fruit and up to 10 years to reach mature production.

Vineyard management is also critical to wine quality. Learning how to balance fruit load to vine size, timing of harvest for full flavor and aroma of the wine for each cultivar takes patience, Fennell explained. For instance, in another research project, Fennell harvested grapes a week early because she did not like the underlying flavors found at the traditional harvest time. The resulting wine had a more floral aroma.

“As a national research team, we are identifying the genes expressed during ripening and chemical products of ripening, known as metabolites, and comparing levels of those with results of sensory evaluation,” Fennell said. Two undergraduates—one in food science and the other in computer science—have been working with Fennell for the last two years along with a visiting scholar from China. A graduate student will be added.

“We are looking for signature biomarkers related to flavor and ripening,” she explained, by genetically tracking both good and bad characteristics. For instance, if the fruit is off-flavored, she might detect an associated increase or decrease in specific gene expression

In addition, cold-climate grapes tend to have more acid when ripe than those grown in California, so the researchers are figuring out how to minimize the acid yet maintain a pH level appropriate for fermentation.

Determining optimum soil nutrients

When Greenlee and wife, Sue, began their vineyard in 2007, he had his soil tested. He consulted SDSU Extension horticulturist Burrows about the report that recommended more nitrogen, as would be done for corn. Burrows helped the Greenlees, who have 3,500 plants on approximately 6.5 acres, identify the appropriate fertilization regime for their grapevines.

“Grapes are distinct from other crops—because they are perennials, they require quite a bit less nitrogen,” Burrows said. Had Greenlee applied nitrogen, his vines would have a lot of foliage but not many grapes, she explained. “Foliage shades the grapes and works against you.”

Burrows is determining “whether or not our particular soils and growing conditions supply the plants with the nutrients needed.”

She uses research from Concord-type grapes as a starting point, but she added, “there’s a fair amount of debate as to what part of the plant and when to test to monitor nutrient levels.” For instance, potassium levels in northern grape varieties may fluctuate differently than those in a southern variety that don’t go through extremely cold winters.

The researchers begin testing plant tissue when the vines blossom through when the grapes turn color. They compare those results with soil analyses to determine what nutrients are important at each stage of development.

“The aim is to manage the plants to provide optimal berry quality and yield,” Burrows said.

Providing support to producers

The education component, including interactive webinars, is especially helpful to producers, according to Greenlee. “That’s something we can count on.”

In addition, Tim Martinson of Cornell University has shared information on trellising systems—vertical vs. high wire cordon—and how those choices affect the grape harvest. “Dozens of little decisions make a difference in your crop,” Greenlee said.

With help from the researchers, local vineyard and winery owners hope to build a reputation for making good wine.

Far Left: While a young grape in Europe has more than 300 years of production history, cold-climate grapes, such as the Frontenac which became commercially available in 1996, have been in production for less than 20 years.

Below: Snow covers the Frontenac, left, and Kay Gray vines at the Gavins Point Vineyards in Yankton County. The nutritional needs of Northern grapevines can vary from those of California grapes that don’t experience cold winters, according to Extension horticulture specialist Rhoda Burrows. Photo by Kim Brannen

Professor Anne Fennell explains the challenges that cold-climate grape growers face. She and colleague Rhoda Burrows are part of a multistate team of land-grant institution researchers on two U.S. Department of Agriculture projects—the Northern Grapes Project and VitisGen—to help producers carve out a niche in the wine market. The projects are led by Cornell University.

The netting around the grapevines at the N.E. Hansen Research Center is designed to keep the birds at bay. The research plots contain replicated plantings of 12 cultivars and research populations for genetic studies.



Plant-derived compound

may reduce cancer recurrence, spread

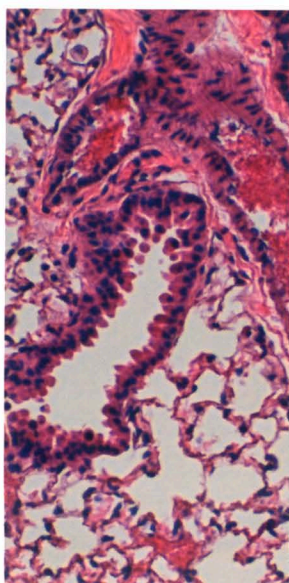
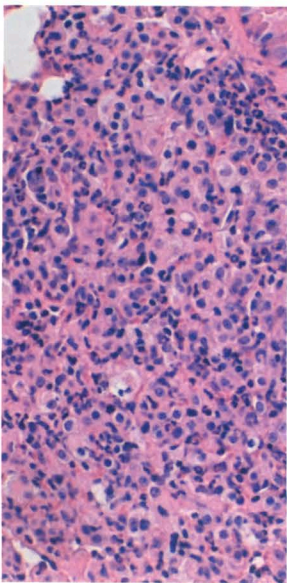


Moul Dey

An apple a day keeps the doctor away, and perhaps a serving of broccoli or watercress can help keep cancer at bay.

A compound and an enzyme that occur naturally in cruciferous vegetables—cauliflower, cabbage, broccoli and Brussels sprouts—may help prevent recurrence and spread of some cancers, according to associate professor Moul Dey of the health and nutritional sciences department. She has been doing research on phenethyl isothiocyanate (PEITC) through a five-year grant from the National Institutes of Health for more than \$875,000 and support from the South Dakota Agricultural Experiment Station.

The precursor compound and enzyme in cruciferous vegetables combine during the chewing process to produce PEITC within the body, Dey explained. Though PEITC is a good candidate to develop as a dietary supplement, studies have also shown that sufficient cancer-preventing levels of PEITC can be achieved through diet alone.



Targeting inflammation

Dey began investigating plant extracts and their potential to fight the abnormal inflammation that leads to diseases, such as ulcerative colitis and colon cancer, in 2004 as a researcher at Rutgers University. When she came to SDSU in 2009, she continued that work, focusing on PEITC. Two postdoctoral researchers and three doctoral students have worked on the project.

Dey and her team found what she called “very encouraging results” on PEITC’s ability to reduce inflammation of the large intestine and alleviate symptoms associated with ulcerative colitis. In addition, using mouse and human models, her team gathered

evidence that PEITC can epigenetically suppress the expression of genes that promote colon cancer.

However, that is only the beginning of what PEITC may be able to accomplish for those fighting cancer.

Killing cancer stem cells

When cancer is treated with chemotherapy or radiation, the tumor disappears but the cancer stem cells live on. “These cells are frequently resistant to conventional therapies,” Dey said.

Though cancer stem cells make up less than 5 percent of a tumor, they can regenerate the original tumor and migrate through the blood vessels spreading cancer to secondary locations.

“These tiny cells are very difficult to detect in a tumor,” Dey said, adding that for a long time scientists did not even know they existed. “It’s like finding a needle in a haystack.”

Using published protocols with some modifications of their own, Dey and her team grew human cervical cancer cells under special conditions so the cancer stem cells survived and multiplied in a selective manner through a process known as enrichment. The researchers then looked for three characteristic cell surface protein markers to confirm that the process has worked, Dey explained.

“As a next step, we made sure the cells were tumorigenic, meaning that the cells when injected in mice produced a tumor,” Dey said. Furthermore, the researchers confirmed the aggressive behavior of the stem cells—after injection at one site, the cancer spread to a secondary site.

When Dey and her team treated cancer stem cells with PEITC in a Petri dish, about 75 percent died within 24 hours using a 20-micromolar concentration of the compound.

One candidate drug, salinomycin, discovered as a cancer stem cell-targeting agent at Broad Institute of the Massachusetts Institute of Technology and Harvard University and now in clinical trials, can do this, she noted. When Dey and her team measured the number of viable cancer stem cells

Imaging tool

targets degenerative diseases

Neurodegenerative diseases, such as Alzheimer’s and Parkinson’s, affect more than 6.4 million Americans, according to the Harvard NeuroDiscovery Center. That number may double in the next 30 years as the population ages, unless medical researchers figure out what’s happening at a cellular and molecular level and develop ways to treat or prevent these debilitating conditions.

Aging and oxidative stress are the culprits, but the challenge is to determine which cells, and even subcellular structures, are affected, according to pharmacy professor Xiangming Guan. The medicinal chemist is developing imaging techniques that will help researchers identify what might be contributing to the course a degenerative disease takes.

Tracking the body’s natural antioxidant

Organic molecules called thiols play a major role in defending the body against oxidative stress, Guan explained. These antioxidants, which are present inside and outside of cells, counteract the effect of reactive oxygen molecules known as free radicals, which are involved in oxidative stress. Free radicals can disrupt normal cell functions.

“Oxidative stress happens all the time. Thiols are one of the factors that can effectively reverse oxidative stress,” Guan noted. “In principle, thiols are not just related to degenerative diseases.

“Thiols are consumed during oxidative stress, so we see lower thiol levels,” Guan said. “Therefore, the level of thiols is used as one of the indices that reflect whether there is oxidative stress.”

Drinking alcohol, for instance, can damage the liver, Guan explained. Thiols can quench the toxic effect of alcohol, but once they are depleted, the body cannot defend itself. Similarly,

damage to nerve cells can then lead to degenerative diseases such as Parkinson’s disease and multiple sclerosis.

Improving analytical tools

Previous methods of determining thiol concentrations required the destruction of the cells and tissue. Through National Institutes of Health grants for nearly \$800,000, Guan and his team developed the first imaging reagent that can determine thiol levels in intact living cells.

“We found a compound, which can determine thiol density in live cells in a quantitative way through a particular type of chemical reaction,” he said. In the presence of thiol, the chemical gives off fluorescence—the higher the thiol level, the higher the fluorescence. Decreased fluorescence means thiols have been consumed trying to protect the cell, meaning it is more likely to be damaged.

While other methods focused on nonprotein thiols and necessitated breaking the cells or tissues to accomplish the analysis, Guan’s technique monitors both nonprotein and protein thiols without breaking the cells.

“This method is rapid and sensitive,” he added. “The ability to detect thiols without breaking the cell offers the advantage of showing thiol distribution and density inside the cell.” For instance, thiol concentrations in cells or tissues might be normal but the distribution might not be normal under a disease state.

In addition, researchers can evaluate whether a specific treatment produces the desired effect, Guan added.

Though Guan used cancer cells to develop the reagent and imaging technique, he explained that thiol compounds protect plants and animals from oxidative stress in a similar way so the method can be used across species.

Targeting subcellular structures

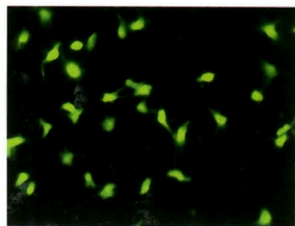
With a new three-year NIH grant for \$327,500, Guan hopes to develop reagents that can selectively show thiol density in subcellular structures, specifically the nucleus and mitochondria.

“These are crucial subcellular organs,” Guan said, comparing the function of cell mitochondria to that of the heart. Furthermore, cell nuclei contain DNA, which can be altered by oxidative stress.

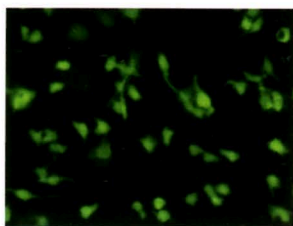
“The distribution of thiols within the cell is not even,” he said.



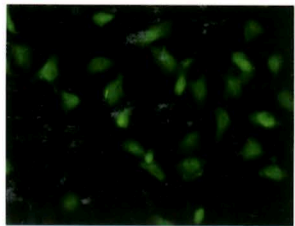
Xiangming Guan



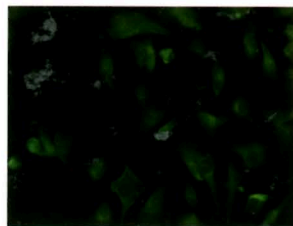
control



Sample one



Sample two



Sample three

“Our research sheds light on why and how vegetables are healthy.”

—Moul Dey, associate professor

remaining after treatment over a 48-hour period, the results from PEITC and salinomycin were comparable.

In other experiments, Dey and her team have found that lower concentrations of PEITC are still very effective. Working with SDSU veterinary pathologist David Knudsen, Dey and her team found that 10-micromolar concentrations of PEITC can dramatically prevent the spread of cancer in mouse lung tissue.

“Preliminary evidence has shown quite a dramatic difference between the lung sections from the PEITC-treated and untreated mice,” Dey said. However, she cautioned, although mice provide a model for human diseases, further testing is necessary to determine whether outcomes will be similar in humans.

Based on information from scientific literature, the concentrations of PEITC that Dey and her team typically use in their research—5 to 15 micromolars—may be achieved through diets rich in certain types of cruciferous vegetables, particularly upland and water cress.

Next, she and her team will examine how PEITC is able to overcome the resistance mechanisms that protect these stem cells from other drugs. “That’s the second piece of this work,” Dey added.

Opposite: The slide on the left shows the spread of cancer to lung tissue in untreated mice, which was not observed in the lung tissue on right taken from mice treated with 10-micromolar concentrations of PEITC.

Right: Upland cress is one of the richest sources of phenethyl isothiocyanate (PEITC), a plant-derived anticancer compound that may also help prevent recurrence and spread of some cancers.

Associate professor Moul Dey and doctoral student Bijaya Upadhyaya examine mouse tissue for evidence of cancer.



“Thiols are consumed during oxidative stress, so we see lower thiol levels. Therefore, the level of thiols is used as one of the indices that reflect whether there is oxidative stress.”

—Xiangming Guan

Medical researchers now use a centrifuge to separate subcellular structures because their weights are different. Thiol concentration in the mitochondria can be determined via this centrifugal method, but not the thiol distribution and density within the mitochondria, Guan pointed out. In addition, “thiol levels in the nucleus cannot be accurately determined since thiols leak out during isolation.”

When dealing with age-related degenerative diseases, Guan pointed out, “There are a lot of unknowns.” If Guan and his team are successful, scientists will have an analytical tool to monitor how thiols in subcellular structures affect degeneration.

“Scientists can identify the possible contribution of these thiol changes to disease states,” he said.

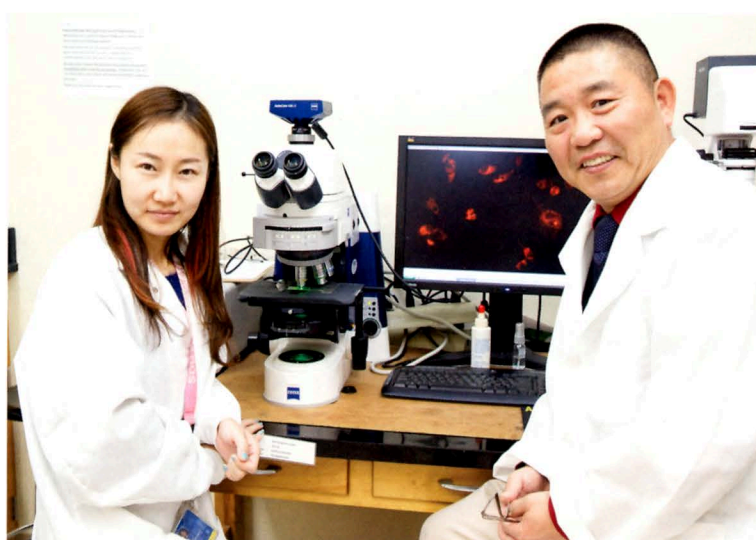
For example, if researchers see a marked decrease in mitochondrial thiol before the onset of Alzheimer’s symptoms, Guan explained, “perhaps we can find a way to deliver thiol into the mitochondria to prevent or slow that down.”

Furthermore, scientists can use this analytical tool to determine if an intervention protected the subcellular structure, Guan pointed out. He hopes to develop a nontoxic reagent safe enough to be used for diagnostic imaging, like an MRI.

Left: Pharmacy researcher Xiangmin Guan and his team have developed the first method of determining thiol levels in intact living cells—the brighter the fluorescence, the higher the thiol levels. Diminishing green fluorescence in samples one through three means that thiols have been consumed trying to protect the cell, indicating a greater likelihood of damage due to oxidative stress.

Right: Postdoctoral research associate Bhimanna Kupast mixes experimental compounds that were designed to react with thiol on the cell surface and in mitochondria.

Doctoral student Yang Yang and pharmacy professor Xiangmin Guan look at camera images of mitochondria as part of preliminary work to develop a method of imaging thiol levels in subcellular structures.



Nutrient-gene interaction research inspires Nelson scholarship winner

Associate professor Moul Dey’s research on nutrients and gene interactions drew doctoral student Bijaya Upadhyaya to the health and nutritional sciences department in August 2012.

Upadhyaya was awarded the 2015 Joseph F. Nelson Graduate Scholarship, which recognizes original scientific research. He has been working on a project to determine whether phenethyl isothiocyanate (PEITC) can prevent the recurrence and spread of cancer (see story on page 4).

“This scholarship has made me really motivated,” said Upadhyaya. “All the research efforts are tremendously rewarding.” The scholarship, which provides up to \$8,900 for tuition and expenses, has inspired him to pursue a career in academia and research.

A compound and an enzyme that occur naturally in cruciferous vegetables—cauliflower, cabbage, broccoli and Brussels sprouts—combine during the chewing process to produce PEITC within the body. PEITC can also be taken as a dietary supplement.

Dey pointed out “our research sheds light on why and how vegetables are healthy.” Upadhyaya’s preliminary results suggest that “the population that is at increased risk for cancer or cancer survivors, in particular, may benefit from regular consumption of cruciferous vegetables, Dey added.

This research reinforces a common message, she noted: “A diet rich in vegetables is healthy for one and all.”

From veterinarian to biomedical researcher

In 2008, Upadhyaya completed a bachelor’s degree in veterinary science and animal husbandry, which qualified him to practice veterinary medicine in Nepal. Two years as a veterinarian convinced him that “this bachelor’s degree is not enough.”

He began his master’s work at the University of Nebraska-Lincoln in August 2010. Although his major was veterinary science, he said, “my research was purely biomedical science.” He worked with glutaredoxin 2, an antioxidant protein first discovered in the human eye lens, which he also found in other types of eye tissue.

“It made me realize the importance of biochemical reactions within our bodies and how that modulates our health,” Upadhyaya said. For his doctoral work, he looked for a project “with a more pronounced connection between what a person eats and how that affects the body.”

He found that at Dey’s nutrigenomics research lab. “The cutting-edge research drove me here,” he added.

From reading to writing scientific papers

“When I came to SDSU, I had a good background and a clear mindset of what I should do,” he said. He chose courses in applied sciences. “This was the proper time to learn as many techniques as I could.”

Though the PEITC research has been his main focus, he said, Dey encourages her students to become involved in a variety of projects. “She wants us to see the big picture, so our horizon is broad.”

Dey explained: “They develop collaborative skills, acquire the ability to critique one another’s work in a constructive manner and learn from each other’s mistakes. This helps them develop collegiality and professionalism.”

Though he had experience reading scientific papers, Upadhyaya credits Dey for teaching him how to design and conduct research and how to write a paper. Under her guidance, Upadhyaya has collaborated with two fellow researchers to write a paper that has been published in the peer-reviewed scientific journal BMC Cancer and is working on another.

Dey said: “It’s nice to watch him gradually progress toward the level of professional maturity that one would expect from someone with a doctoral degree.”

The graduate scholarship will help Upadhyaya present his dissertation research at scientific conferences. He anticipates completing his doctorate this year.

Dey added: “My goal is that when my students face the very competitive world outside my lab, they are ready to transition to the next career level.”

“The issue of improving the performance of double-tee bridges is of great interest to the state, local governments and the local precast concrete industry. I am always pleased to see the research infrastructure at State continue to serve the needs of our constituencies.”

—Nadim Wehbe



A simple modification to precast girder design may add decades to the lifetime of new short-span bridges on secondary roads, according to research done at the Jerome J. Lohr Structures Lab. A new grid method of connecting double-tee girders, commonly used for city and county bridges, increases the lifetime of the longitudinal joints beyond that of the girders, explained graduate research assistant Michael Konrad. He and adviser Nadim Wehbe, John M. Hanson Endowed Professor in Structural and Construction Engineering, worked with two South Dakota companies—Gage Brothers of Sioux Falls and Cretex of Mitchell—to redesign the girders.

The two-year, \$160,000 research project was sponsored by the U.S. Department of Transportation through the Mountain Plains Consortium and the South Dakota Department of Transportation, which provided more than half of the funds.

“The issue of improving the performance of double-tee bridges is of great interest to the state, local governments and the local precast concrete industry, said Wehbe.

“I am always pleased to see the research infrastructure at State continue to serve the needs of our constituencies.”

Fulfilling local bridge needs

Double-tee girders are commonly used for short-span bridges because they can be installed quickly, according to Joshua Olson, region bridge engineer at the South Dakota Department of Transportation in Aberdeen. Unlike an I-girder, the double-tee has a riding surface built into the girder, so the road might only be closed for two months, rather than an entire summer.

The state has 3,948 local bridges on city and county roadways that

Bridge girder

Improved bridge girder design can save taxpayers money



span an opening of 20 feet or more, according to Doug Kinniburgh, local government engineer at the South Dakota Department of Transportation.

“The majority of bridges were designed for a 50-year life span,” Kinniburgh noted.

Approximately 2,100 of the local structures are more than 50 years old. Of these, 1,005 are more than 75 years old and 37 of them were built between 1900 and 1910—and are still in service.

Kinniburgh said approximately 1,200 South Dakota bridges have load restrictions posted because of some type of structural deficiency. The state receives \$8 million a year in federal surface transportation funds for bridges, with an average of \$6.5 million annually designated to replace local bridges. That funding has been allocated through 2025.

Olson estimated the cost of replacing a 20- to 50-foot bridge ranges from \$300,000 to \$700,000, depending on its length. Konrad’s experimental work focused on 40-foot precast girders, which Olson called “the sweet spot,” when it comes to local bridge lengths.

Evaluating conventional design

A typical bridge on a secondary road would be eight girders wide with seven longitudinal joints, according to Konrad. The conventional design, which was developed in Texas, has 6-inch steel plates placed every 5 feet along that length of the girder. These plates are then welded together to secure the two sides. Concrete is used to fill the 1.5-inch gap between the girders.

The freeze and thaw cycle wreaks havoc on the joints, Konrad explained. The steel plates act like a hinge, so when the concrete joint begins to deteriorate water leaks through the cracks and corrodes the metal plates.

This type of girder has been used on South Dakota local bridges since the 1970s, according to Olson.

Adding strength through new design

Konrad’s design uses a metal lattice connection that runs the length of the girder and a 4-inch gap. The same

concrete mixture was used to fill the gap between the girders as in the conventional design.

Konrad supervised the building and instrumentation of the girders at Cretex, which donated the materials and labor and is the only South Dakota company that makes double-tee girders.

In testing the conventional girder design, the joint broke down at 31,500 load cycles, six years of average traffic, according to Konrad. The estimated service life of the girders is 50 to 70 years.

When the first plate cracks, the load shifts, he said. “It’s like a zipper effect.”

The experimental design withstood 800,000 load cycles without any changes in performance, Konrad reported. That is equivalent to more than 75 years of service. Even after testing to simulate 146 years of service, the experimental structure did not fail.

“The results were dramatically better,” said Olson, who was at the structures lab when the experimental girder design was tested to failure. That was accomplished using a strength test in which the researchers simply applied a load until failure. The conventional bridge setup failed at 73,800 pounds of force, while the experimental design succumbed at 113,100 pounds of force, Konrad reported.

“The girders failed, not the joint—that’s what we wanted to see,” pointed out Konrad. “The longitudinal joint is no longer the weakest link.”

Michael Asmus, president of Holloway Construction Company Inc. in Mitchell, estimated the new design increased installation costs by 3.5 percent, according to Konrad.

Konrad and Wehbe presented their results at the 2014 National Accelerated Bridge Conference Dec. 4-5 in Miami. Their report will be submitted to the state highway research office and then reviewed by a technical research panel and presented to a board of program managers at the bridge office.

The process generally takes a year or two, Olson said, “but this one may be fast-tracked.”

1 Undergraduate Micah Underberg watches as the first experimental girder is unloaded.

2 Civil engineering graduate students Walker Olson and Michael Konrad prepare to align the second experimental girder with the first one.

3 Winches are used to place the girders side by side.

4 The metal lattice connection runs the length of the girder and, once placed side by side, the 4-inch gap is filled with concrete to form the joint.

5 Konrad smooths the concrete that structures lab manager Zach Gutzmer pours into the longitudinal joint of two double-tee bridge girders.

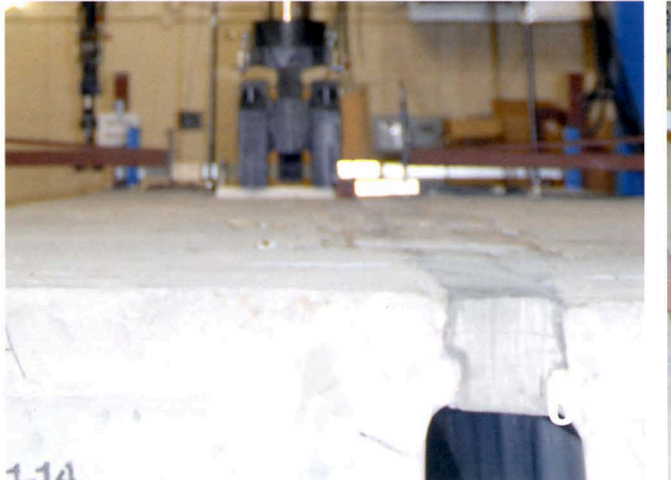
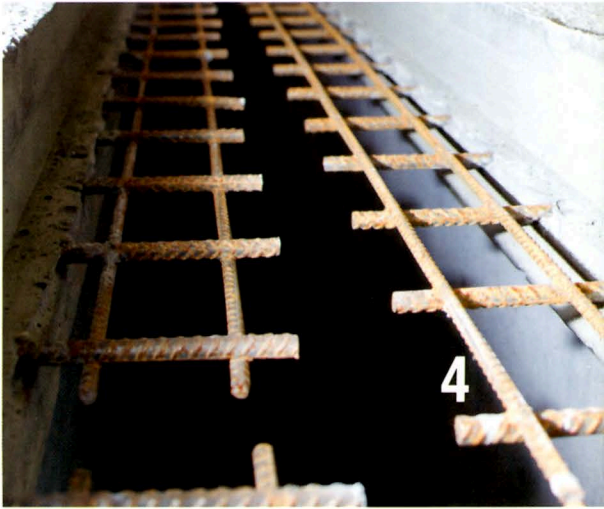
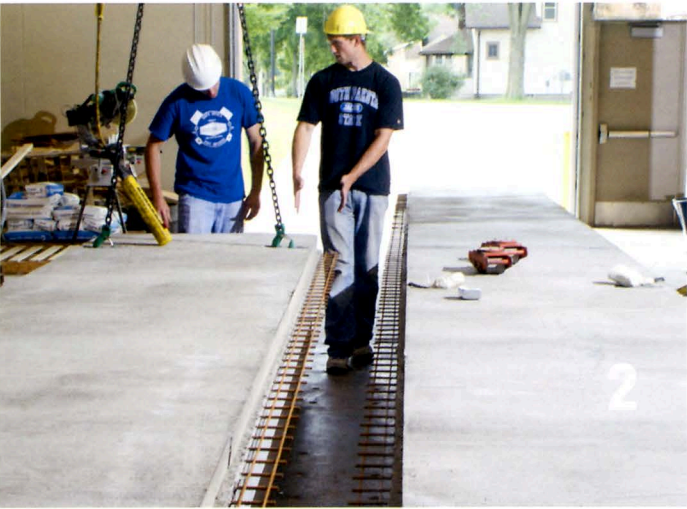
6 The concrete mixture used to fill the gap between the girders is the same for both the experimental and conventional girder joints.

7 During the testing-to-failure phase, the researchers used a strength test applying an increasing load to the experimental girder structure.

8 Professor Nadim Wehbe and Konrad monitor the cyclic load being applied to the experimental bridge girders.

9 Olson, left, marks each of the cracks in the girder that develop during the final testing to failure phase.

10 Konrad documents the areas of the girder that succumb during failure testing. During the testing-to-failure phase, the researchers used a strength test applying an increasing load to the experimental girder structure. It failed at 113,100, withstanding nearly 40,000 more pounds of force than the conventional bridge setup.



Microgrids

help integrate renewables, maintain power flow

Strategic use of locally produced, renewable energy through smart microgrids can reduce power costs and help prevent outages, according to assistant professors Wei Sun and Reinaldo Tonkoski of the electrical engineering and computer science department.

Wind turbines in South Dakota, for instance, generated an estimated 2.7 million megawatt-hours of energy in 2013, according to Brian Rounds, staff analyst for the South Dakota Public Utilities Commission. A majority of this power is exported—microgrids could change that.

Tonkoski and Sun are developing the smart power management technologies that will make it possible for communities and businesses to use locally produced wind and solar energy yet maintain a consistent, reliable power system.

Utilizing multiple energy sources

Last summer, Tonkoski and Sun began developing a microgrid that will allow data centers to utilize locally available energy sources that can be operated as power plants through support from Microsoft Corp. They are the first SDSU engineering researchers to

receive a one-year, \$40,000 Software Engineering Innovation Foundation grant.

“Data centers are high consumers of power, but that supply has to be really reliable,” Tonkoski pointed out. Though most data centers rely on the main power grid, they require locally available standby power in case of grid failure. Furthermore, integration of alternative energy sources will help reduce the demands that a data center puts on the power grid. Use of batteries and standby generators will help reduce the intermittency of solar and wind power so that it can support the grid.

“Renewables have uncertainty,” Sun said, pointing out weather conditions affect the generation of solar and wind energy. In addition, power production varies based on time, cloud conditions and the wind speed, so integrating them into the distribution system means solving problems such as maintaining power system balance, added Tonkoski. Specially designed controllers with new battery technologies can deal with these issues to get consistent power quality.

Remote power systems use diesel or gas generators, he pointed out. Adding solar or wind energy can save fuel and reduce the load on the generator. “Integrating batteries

into the system may boost the efficiency of the generator,” Tonkoski added.

The researchers will develop an algorithm that will determine when and how each power source can be efficiently used in a sustainable energy system. That includes while operating the generator or using batteries, which can increase the system’s efficiency.

With data centers being built worldwide, Sun noted, “some regions do not have a robust power grid.” Therefore, construction of a new data center and the infrastructure to handle a power load in the range of 100 megawatts can take as long as three years. Using multiple energy sources through a microgrid system may reduce the timeline to establish new facilities, Tonkoski said.

An additional \$87,000 from the South Dakota Board of Regents will support development of these power management tools, which could also benefit farms and communities. Two doctoral students and 12 master’s students are working on power management and renewable energy systems integration in the microgrid laboratory.

Redirecting power to prevent blackouts

The automated system needed to integrate renewables will facilitate development of an intelligent power restoration system called a self-healing smart grid that can help prevent power outages, according to Sun. He received a three-year, \$210,000 National Science Foundation Grant to support his research.

A U.S. Department of Energy study estimated that electrical power outages and blackouts cost businesses nearly \$80 billion a

year, with two-thirds of those losses attributed to outages lasting less than five minutes.

In the case of a blackout, a self-healing smart grid would automatically rebuild power generation, transmission and distribution, Sun explained. “It’s unrealistic to never have an outage,” he said, but this system will help avoid outages and reduce recovery time.

Power plant operators follow guidelines based on offline scenarios, simulations and experimental data to respond to a blackout, Sun explained. “There are basically no computational tools to guide them through these emergencies.”

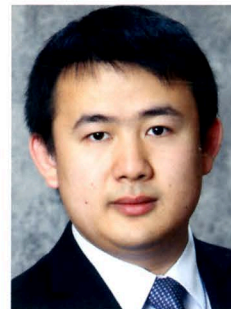
Consequently, the first step will be to develop tools to give operators what engineers call “real-time data,” meaning what is happening at the moment rather than even 30 seconds ago. Three graduate students are working on the project.

Sun collaborates with Clemson University Electrical Engineering and Computer Science Department Distinguished Professor Kumar Venayagamoorthy, who is developing advanced computational methods for the smart grid through a separate NSF grant.

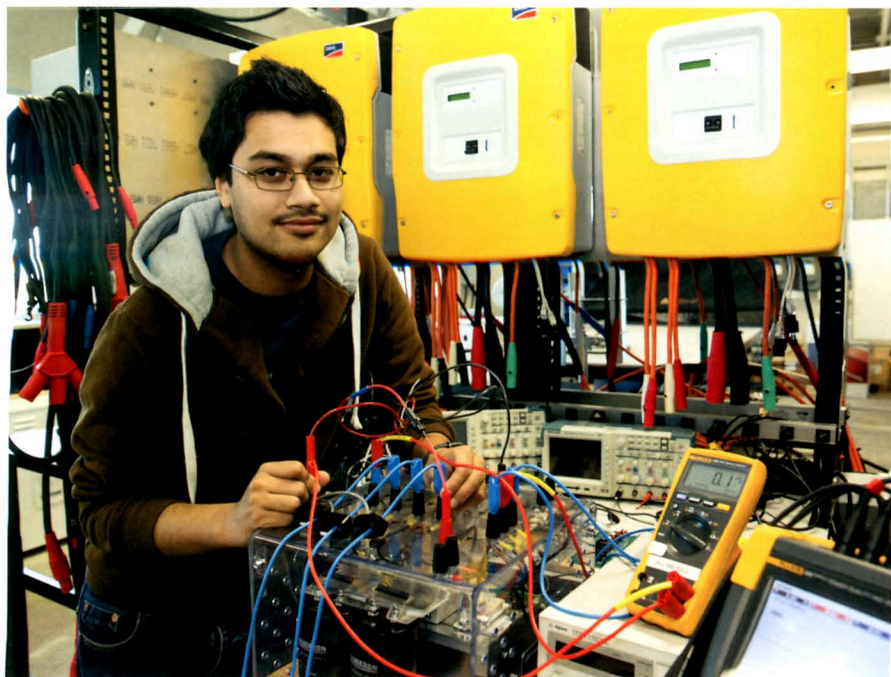
Once the algorithm, software code and hardware simulation as well as education and training materials have been completed, Sun hopes to demonstrate the system’s effectiveness to major utility companies.



Reinaldo Tonkoski



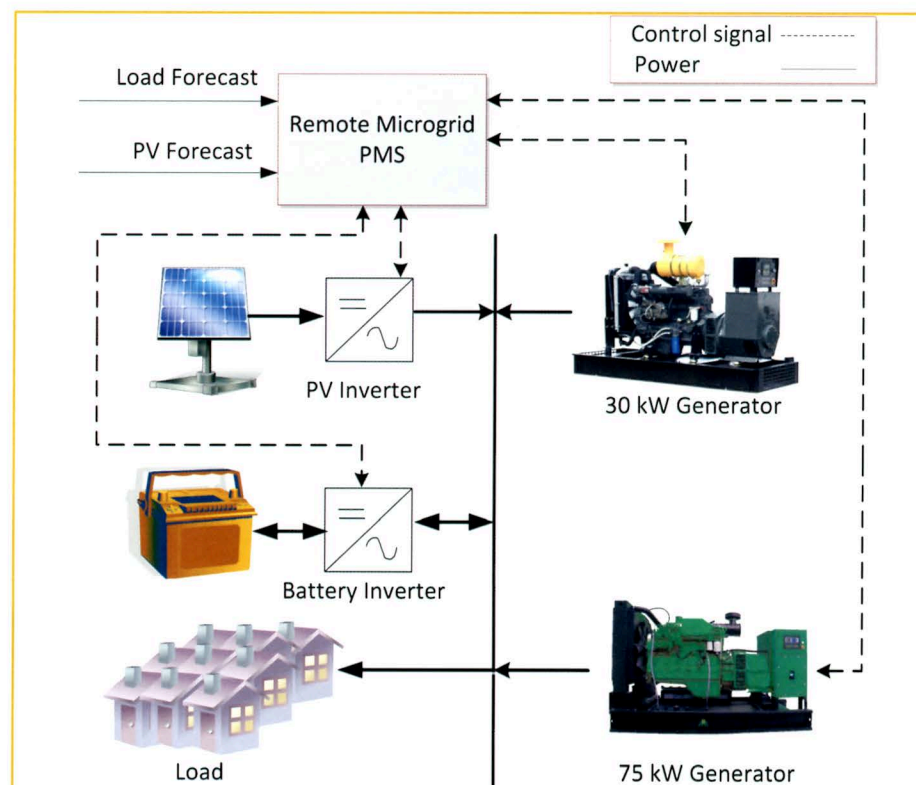
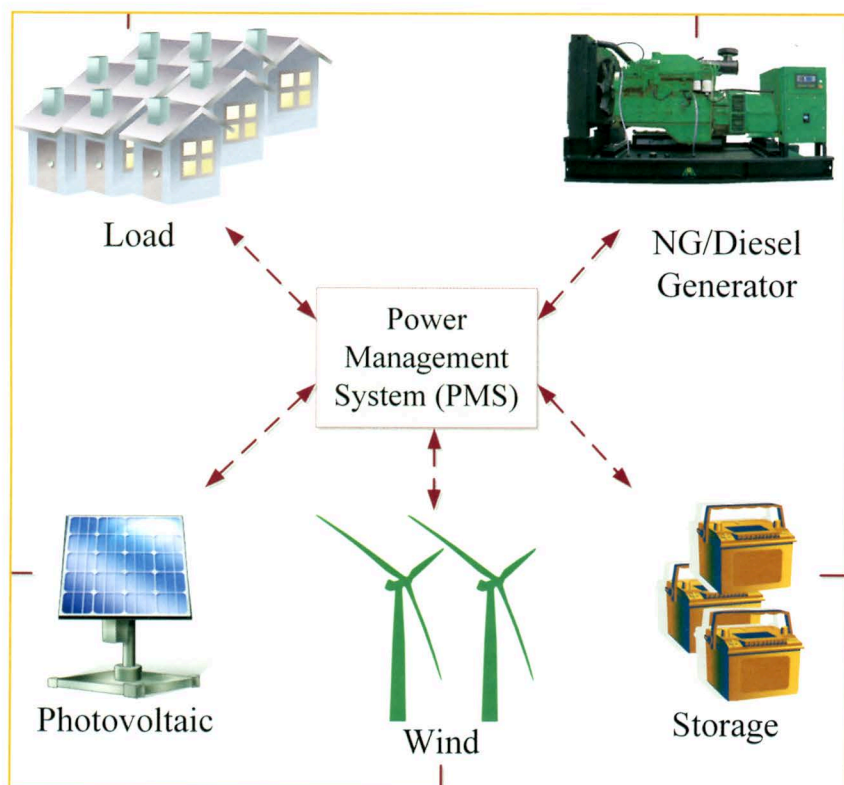
Wei Sun



Counter clockwise, from top left: Balancing power is an important aspect of utilizing renewable energy. Graduate student Ujjwol Tamrakar works on an off-grid inverter to integrate batteries into the power management system.

A microgrid power management system can integrate solar and wind power, generators and battery storage to provide consistent, reliable power to consumers in remote areas.

Using inverters along with batteries and generators in the remote microgrid power system helps manage variations in power from solar cells and wind turbines. The goal is to provide a consistent, reliable source of power.





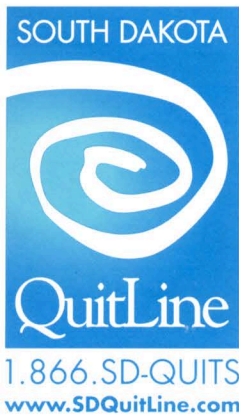
Nursing researchers document positive effects of tobacco-free policies



Jennifer Kerkvliet



Linda Burdette



Attitudes about tobacco are changing in South Dakota—for the better.

Tobacco-free and smoke-free policies are helping change social norms and creating a healthier environment for all South Dakotans, according to Dee Dee Dugstad, tobacco program coordinator for the South Dakota Department of Health. The South Dakota Tobacco Control State Plan seeks to reduce tobacco use and exposure to secondhand smoke.

Nursing researchers from South Dakota State are helping state health officials improve the quality and effectiveness of those policies.

Assistant professor Linda Burdette of the Aberdeen Accelerated Nursing Program and research associate Jennifer Kerkvliet on the Brookings campus gathered data on smoke-free policies in multiunit housing. Burdette and Kerkvliet also worked with adjunct assistant professor Gina Rowe and dean Nancy Fahrenwald to evaluate K-12 tobacco-free school policies.

“SDSU has been a vested partner in conducting these evaluations,” Burdette said, pointing to the exchange of ideas involved in designing the studies. “It’s a great relationship.”

Reducing secondhand smoke in apartments

“Secondhand smoke is a serious health hazard,” Burdette said. “We have laws in restaurants and bars to protect people but how do we address that in multiunit housing settings?”

Dugstad and her colleagues began exploring smoke-free policies in apartment buildings in 2011.

“We hadn’t worked on multiunit housing, so we didn’t have a baseline,” Dugstad explained. Three undergraduate students also worked on the project.

In assessing smoke-free policies in multiunit housing facilities, Burdette and her colleagues found that nearly 55 percent of the 324 housing owners/operators surveyed had written policies in their lease agreements. An additional 10 percent informed tenants verbally that smoking was not allowed.

Decreasing maintenance costs, improving environment

Though 38 percent of the survey respondents without a smoke-free policy thought they would lose tenants when they adopted the policy, Burdette said, “that was not the case.” Only 1 percent of property owners who implemented a smoke-free policy noted an increase in turnover rates and 3 percent felt vacancy rates had increased.

Burdette also pointed out that owners experienced little difficulty enforcing the no-smoking policy; however, the majority did permit smoking outside the buildings. In

addition, the respondents whose housing units had smoke-free policies reported a decrease in maintenance costs along with improved safety and tenant health.

Dugstad and her colleagues are using the results of the 2013 survey to encourage voluntary implementation of smoke-free policies. They developed an apartment manager’s guide and no-smoking signage, which they shared with 121 owners who expressed interest in smoke-free policies during the survey. Apartment managers can access these materials on the BeFreeSD website.

Helping schools develop tobacco-free policies

In 2009, the South Dakota Tobacco Control Program and S.D. Coordinated School Health Program joined forces with the Associated School Boards of South Dakota to produce and disseminate a model tobacco-free school policy.

The nurse-researchers compared how schools were doing in 2014 with results from a similar survey done in 2011. Two undergraduate students worked on the project.

Associate nursing professor Cristina Lammers, who worked on the 2011 survey, explained that participating school districts received feedback on their policy strengths and weaknesses. In addition, the team developed a six-page booklet to help schools improve their tobacco-free policies.

The 2014 study assesses how this feedback combined with other Tobacco Control Program efforts have impacted the development of tobacco-free policies in the state’s schools.

Burdette reported an increase in the number of school districts that had tobacco-free policies and in the percentage of schools participating in the survey. She found that 75 percent of the schools had districtwide tobacco-free policies in 2014, while only 48.3 percent had them in 2011.

However, the comprehensiveness of the tobacco-free policies has not changed, Burdette noted. Policies addressed student tobacco use in the building and grounds, but most did not have guidelines for visitors and staff. Furthermore, the policies were weak in regard to enforcement at school events, on and off campus.

School districts overall scored low on prevention and treatment services. Policies minimally addressed cessation and treatment, but neither does the model policy the schools were given, Burdette pointed out. Interviews with nine superintendents also revealed that “they were not totally aware of the scope and services of SD QuitLine.”

Tobacco-free and smoke-free policies provide “a big motivation to make healthy choices easier,” Dugstad added. The research helps health officials strengthen programs that improve the health of South Dakotans.

<http://sdquitline.com>



<http://befreesd.com>



<http://doh.sd.gov/prevention/tobacco/local-coordinators.aspx>



RESOURCES

- The K-12 Tobacco Prevention toolkit, model school tobacco-free policies, a guide for smoke-free policies in multiunit housing and other resources are available on the Be Tobacco Free South Dakota website at <http://befreesd.com/>.
- The South Dakota QuitLine, at <http://sdquitline.com/>, offers free coaching, cessation medication and resources to help tobacco users quit.
- Community-school partnership grants are available to help develop tobacco-free policies. Check <http://doh.sd.gov/tobacco> in the fall.
- Regional tobacco prevention coordinators—Roshal Rossman, Sarah Quail and Joan Lindstrom—can provide assistance for those developing tobacco-free and smoke-free policies. Contact information can be found at <http://doh.sd.gov/prevention/tobacco/local-coordinators.aspx>.

Rehab Counseling

Rehabilitation counselors improve lives of disabled clients

More than 56 million Americans live with disabilities, according to the 2014 Disability Statistics Annual Report compiled by the University of New Hampshire Institute on Disability. Of those, 8 percent are children and adolescents, 51.9 percent are between 18 and 64 years old and 40.3 percent are 65 and older.

Specially trained rehabilitation counselors can help people with disabilities find employment and live independently, according to professor Alan Davis, coordinator of the rehabilitation counseling program. The U.S. Census Bureau reported that in 2013, approximately one-third of working age civilians with disabilities were employed.

Davis came to the South Dakota State counseling and human development department in 2005 to develop the rehabilitation specialization—the first students graduated in 2007.

The program became the first in the Dakotas to receive national accreditation through the Council on Rehabilitation Education in 2011. That same year, Davis secured a five-year, nearly \$750,000 grant from the Rehabilitation Services Administration through the U.S. Department of Education to support graduate students specializing in rehabilitation counseling. Last fall, he received another five-year, \$684,000 grant. Both grants emphasize fulfilling the needs of veterans and their families.

“This program is thoroughly consistent with our land-grant mission,” Davis said.

Specialized training

As early as 1829, private organizations sought to train people with physical disabilities. The federal government became involved in 1917 when the Smith-Hughes Act formed the Federal Board of Vocation Education of Soldiers, which offered vocational training to disabled World War I veterans. However, despite the nearly 100-year history, “the field is still relatively unknown,” Davis noted.

“Rehabilitation counselors have a career they can be proud of and in which they can take a deep amount of satisfaction,” he said. “Not many people have the satisfaction that what they do for a living represents an absolute good.”

In addition to the core counseling curriculum, rehabilitation counseling graduate students must have specialized knowledge about the history, legal and policy issues that affect people with significant disabilities. This includes medical and psychological aspects of disabilities.

The training grant covers students’ tuition and fees. In exchange, graduates work for a state rehabilitation agency for two years for each year of full-time scholarship support they received. The federal government has rehabilitation services in all 50 states and the District of Columbia, and work payback can be met through employment at any of these agencies.

A combination of more clients in need of their services and a large volume of retirements within the profession means graduates are in an enviable position, according to Davis. Students find it challenging to finish the program, which typically takes 2.5 years, before being hired.

Though most find employment in South Dakota, some of the two dozen graduates have gone to Cleveland, Houston, Boise, Idaho, and Omaha, Nebraska. “They can expect to find employment anywhere in the country that they want to go,” Davis added.

Creative, rewarding work

Counselors work closely with their clients to establish a goal for employment in the community, explained Sylvia Buboltz, district supervisor at the S.D. Department of Human Services, Division of Rehabilitation Services in Brookings. “That client-centered focus is the heart of our agency.”

Buboltz received her master’s degree with a specialization in rehabilitation counseling in May 2012, but started work in July 2011. Within two years, she was promoted to district supervisor. All the rehabilitation counselors at the Brookings office are graduates of the South Dakota State counseling program.

“On the surface, it’s about finding employment,” she noted, but that often requires dealing not only with physical limitations but also mental health issues, such as depression and anxiety, and sometimes substance abuse.

Dealing with a physical disability, particularly later in life, can affect clients’ mental health. “These things tend to go hand in hand,” she added.

Davis said that counselors must have the knowledge and ability to access all the resources of a particular community. Though large urban areas have more resources, small communities benefit from personal connections.

“I encourage counselors to look outside the box, keeping the focus on the client as an individual, what that person needs to be successful,” Buboltz said.

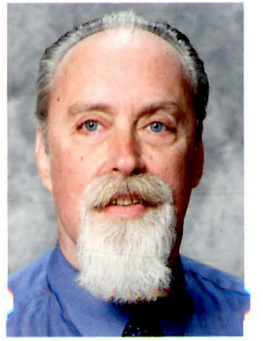
“What keeps me in rehab is the ability to make a difference, to see that growth in our clients,” she added. “They can do the same kind of work that individuals without disabilities can. It may look different, but it can be done.”

“My hope is that our clients are able to find fulfillment in their lives, fulfillment through their work and be as independent as possible,” Buboltz said.

However, she added, “we’re not a one-time only agency.” Changes happen that can bring clients back.

Davis pointed out, “It takes a dedicated, creative and ethical person to be a rehabilitation counselor.”

“There will always be individuals with disabilities, people who need our services,” Buboltz said. “To increase that ability for someone to be more self-sufficient and to have gained confidence in themselves is the most rewarding part.”



Alan Davis

“It takes a dedicated, creative and ethical person to be a rehabilitation counselor.”

Vocational rehab support puts asthmatic on university career path

He hardly thinks about it now, but as a youngster, having asthma was a big deal. It was the '70s before inhalers and the EpiPen.

“I’ve spent more than one day in the emergency room getting an epinephrine shot,” recalled Doug Wermedal, associate vice president for student affairs. In the realm of disabilities that people today face, he hesitates to give asthma that label. “It pales in comparison to what others deal with.”

Wermedal, who grew up on a dairy farm near Albert Lea, Minnesota, said, “As a kid, I was upset about all the things I couldn’t do.”

When he was 11 years old, he spent an entire summer indoors. “That was before cable and the Internet,” he pointed out.

His parents bought a set of World Book encyclopedias—he read them all. His mother taught him to crochet—the chain he made went around the house twice. He collected baseball cards and spent hours organizing them. “To this day, I can alphabetize things quickly.”

When Wermedal was a high school senior, Peter Rutherford, a vocational rehabilitation counselor from Faribault, Minnesota, contacted him about a college scholarship opportunity. Wermedal’s older brother Daryl, who had hay fever, had not qualified for the program, but had told Rutherford about his younger brother Doug, who probably would.

“I’ll never forget it,” he said. Until then, being a severe asthmatic limited what he could do.

“To have that turn into a benefit was amazing and encouraging and taught me not to limit myself in ways that I did before,” said Wermedal, who received a \$600 scholarship each year as an undergraduate at SDSU. He met

regularly with a rehab counselor to discuss his academic progress and offer ways to engage or not engage in college activities.

“Vocational rehab became another voice in helping me do well,” he pointed out.

Wermedal recalled grooming sheep for Little International, which necessitated regular hits from the inhaler he kept in his pocket. Sometimes in Hansen Hall, he’d have to ask a buddy who had come in from the horse barn, for instance, to change his clothes.

“There was a stigma associated with using an inhaler,” Wermedal said. When he went to a Loverboy concert at the Sioux Falls arena, the security guards patted him down and he had to explain what his inhaler was and why he needed it.

Though he faced far fewer challenges than those coping with mobility or learning disabilities, Wermedal said, having asthma was “more than an inconvenience.”

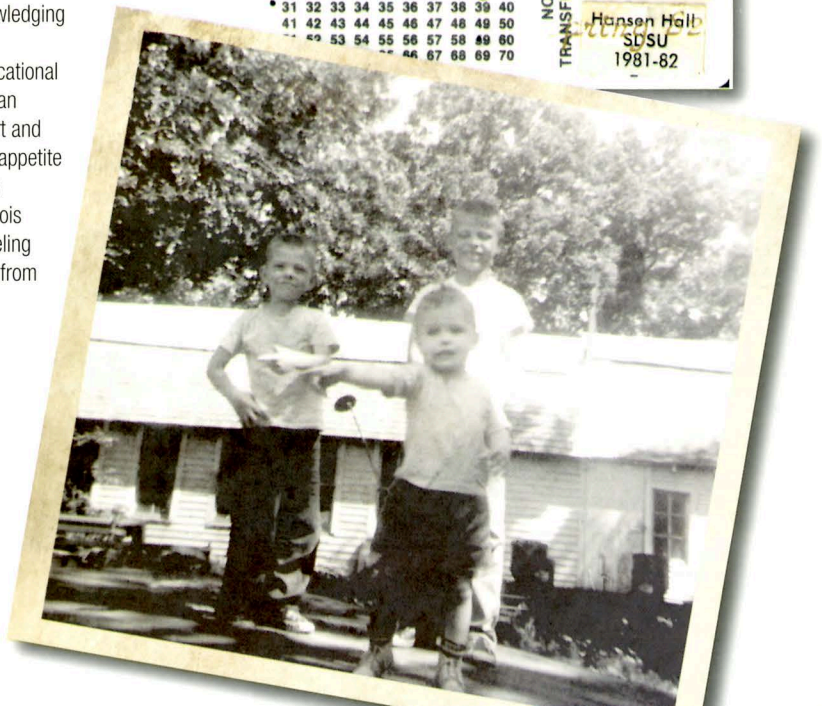
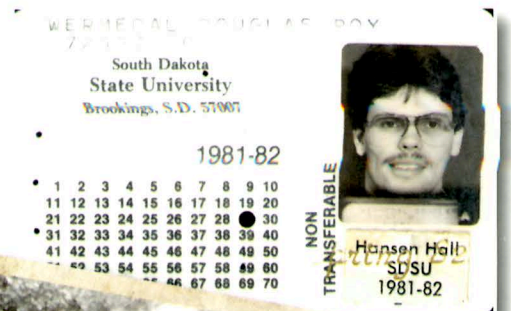
About once a year as an undergrad, he made a trip to the emergency room. “I would think I was good when I wasn’t,” quipped Wermedal, who completed his bachelor’s degree in agricultural journalism in 1985. “But that’s part of becoming an adult, acknowledging limitations.”

About his experience with vocational rehabilitation, Wermedal said, “I can honestly say that the extra support and accountability helped deepen my appetite for what was next.” He earned his master’s degree from Eastern Illinois University in guidance and counseling and later a doctorate in sociology from SDSU.

Left: As an undergraduate at South Dakota State, acting vice president of student affairs Doug Wermedal always had an inhaler in his pocket. Though he faced fewer challenges than those with physical and mental disabilities, he says having asthma was “more than an inconvenience.”

Right: Wermedal still has his freshman SDSU identification card.

The Wermedal brothers—9-year-old Brad, 6-year-old Daryl and 3-year-old Doug—pose outside the chicken coop on the family farm near Albert Lea, Minnesota. As a youngster, “having asthma was a big deal,” Doug says. Support from Minnesota Vocational Rehabilitation Services motivated him during his undergraduate work at SDSU.





Licensing agreement

puts quality seed in producers' hands

A licensing agreement with the South Dakota Crop Improvement Association gives farmers access to new crop varieties and germplasm that South Dakota State plant breeders develop. The new licensing agreement updates a century of SDSU service to the state's farmers by providing them high quality crop varieties.

SDCIA was formed in 1925 when the South Dakota Corn Growers and Breeders Association, the South Dakota Grain Growers Association and the South Dakota Experiment Association merged. It is headquartered in the university's plant science department.

The agreement delineates "how to handle the transfer of plant genetics, and by doing so, makes it a predictable, smooth process," said Daniel Scholl, director of the Agricultural Experiment Station. "This is how our intellectual plant-based properties get into growers' hands in South Dakota and elsewhere in the region."

Approving new varieties

When a variety is ready for release, the breeder sends supporting information regarding the new variety to the university variety release committee. The committee is comprised of faculty experts, the managers of the Foundation Seed Stock Division, the South Dakota Seed Certification Division and the Seed Testing Laboratory, as well as SDSU plant breeders for other crops.

The breeder must show what makes the variety new and prove its suitability for specific crop adaptation areas in South Dakota. For germplasm, its unique characteristics are of prime importance. Once the committee deems the variety ready for release, Scholl evaluates the recommendation and authorizes release and commercialization.

Producing certified seed

The SDCIA then becomes the curator for the new variety, according to Neal Foster, manager of the Seed Certification Division.

"Certified seed is a limited generation production system," Foster said. Each successive class—foundation seed, registered seed and, finally, certified seed—is field inspected and tested and must meet increasingly stringent requirements.

SDCIA oversees the production of successive generations and thus greater quantities until the seed reaches its third class level, or the certified level. After it has passed the final inspection level, the end product can be sold to farmers as certified seed.

"It has to meet minimum requirements before we put our label on it," Foster added.

The association collects royalties only when the SDCIA seed producer sells certified seed, which provides a buffer against crop failure, he explained, noting inspection fees are kept to a minimum.

"If we have a good year and a lot of sales, that's where we see the return," Foster pointed out. The university and SDCIA share the royalties, but a large portion of the proceeds support the breeding programs and seed development process.

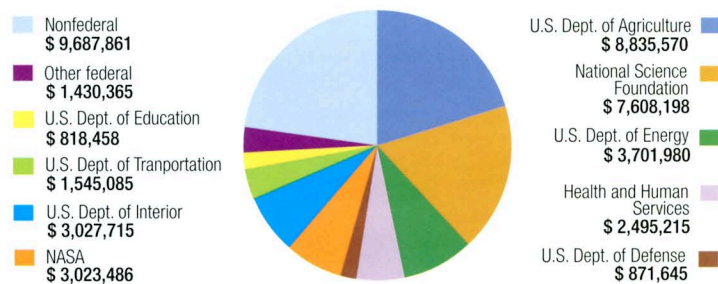
"The agreement simply puts in writing what we've been doing for nearly 100 years," Foster said. "We're a service for growers. We make sure what they are purchasing is what they want."

In addition to cereal grains, SDCIA members propagate seeds for field peas, lentils, chickpeas and cover crops, such as turnips and radishes.

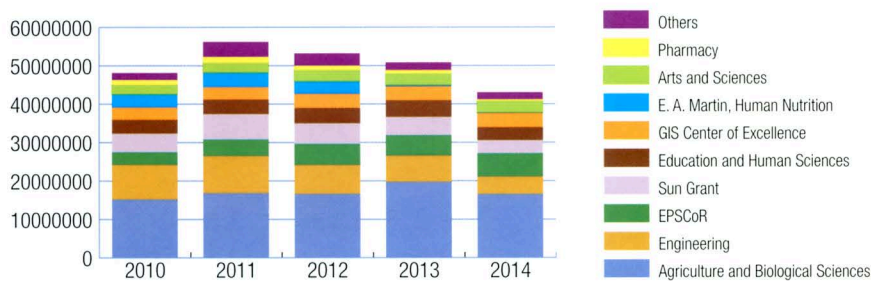
The industry supports itself and the research from which it benefits, Scholl explained. "This mutually satisfying agreement continues to ensure the smooth transfer of SDSU plant genetics to South Dakota and regional farmers."

Tracking research

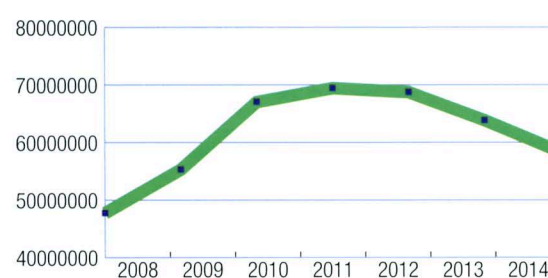
Expenditures through grants and contracts by funding source
FY 2014



Expenditures through grants and contracts by administrative unit
FY 2010-2014



Total research expenditures FY2008-2014*



*The sum of expenditures from grants and contracts, funds appropriated to the South Dakota Agricultural Experiment Station and other institutional funds allocated to research.

In 2014, SDSU executed 250 research- and technology-related agreements and received \$3 million in license income.

SDSU added three new Ph.D. programs — biochemistry, civil engineering and agricultural, biosystems and mechanical engineering.

Above Left to right: Doctoral students Golam Rasul and Yaqoob Thurston cut and bundle each line of wheat being tested at the plots east of the Performing Arts Center on a warm September day. Rasul's adviser is professor Karl Glover while Thurston works with associate professor Jose Gonzalez.

Each line of wheat is harvested individually and then documented. The bag label describes the wheat as part of the fusarium head blight screening nursery, Entry No. 22 within the uniform regional nursery. The trial was grown in North Dakota, South Dakota, Minnesota and Montana to test performance.

Doctoral student Stacy Dreis picks up a bundle along with the labeled bag.

Dreis tosses a bundle of wheat into the combine conveyor belt.

Doctoral student Thumbiko Macindwire catches the wheat from the combine in labeled bags.

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Common Cruciferous Vegetables

Phenethyl isothiocyanate (PEITC) is made within the body. When cruciferous vegetables are chewed or crushed, the plant enzyme myrosinase is released and hydrolyzes another plant-based compound called glucinasturtin, which is the active precursor of isothiocyanates like **PEITC**.

- Mice were fed PEITC or cress seed extract. PEITC byproducts are excreted in the urine which can be measured.
- Increased consumption of cruciferous vegetables such as broccoli may reduce the risk of various cancers. Myrosinase is required to convert dietary glucosinolates from cruciferous vegetables into bioactive isothiocyanates. In some studies, biological activities and health benefits were observed with as low as 68 grams/day fresh broccoli sprout consumption, but the results can always vary with crop cycles.

Just eating these vegetables can give a person sufficient levels of PEITC to make a potential difference!

See story on page 4.



Common Cruciferous Vegetables | Micrograms of PEITC per gram of fresh weight

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