SOLUTIONS

CFANS

WINTER 2015

Forever Green

New crops could be a win-win-win

ALSO

RITES OF SPRING

BEARING FRUIT

RAIDERS OF THE WILD GRAINS

College of Food, Agricultural and Natural Resource Sciences

UNIVERSITY OF MINNESOTA

SOLUTIONS

Solutions magazine is published twice a year for friends, alumni, faculty, staff and students at the College of Food, Agricultural and Natural Resource Sciences. Like the college, the magazine focuses on how science leads to solutions for today's problems in food and agricultural systems; global climate and environmental change; biodiversity; and bioenergy and bioproducts.

CFANS is composed of six divisions, 13 academic units (two are held jointly), 10 research and outreach centers throughout Minnesota, the Bell Museum of Natural History and the Minnesota Landscape Arboretum. The college also participates in many interdisciplinary centers and cooperatives.

TELL US WHAT YOU THINK.

Solutions welcomes readers' comments and story ideas.

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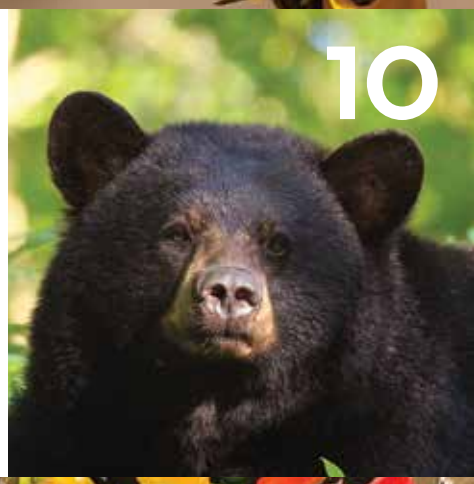

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On the Cover: Perennial sunflower is just one of the potential new crops being explored through the Forever Green Initiative.

Black bear image: stock photo.

FOREVER

Minnesota has 27 million acres of farmland dominated by corn and soybeans. Over the years, as high-yield varieties were introduced, these food and feed crops edged out prairie and pastures, and the state's agricultural landscape lost much of its biodiversity.

"There's nothing wrong with corn or soybeans," says Professor Don Wyse of the Department of Agronomy and Plant Genetics. "Over the last 75 years, the department has invested heavily in developing the wheat, corn, soybeans and barley that people were asking for. Because of their success these crops became the dominant crops in Minnesota agriculture."

But, as summer annuals, those crops are active for only a few months, leaving fields brown much of the year. Without crops covering the land it is vulnerable to erosion, fertilizer runoff and loss of nutrients. These factors can lead to water contamination and the loss of nitrogen and other valuable soil components.

"Everyone blames the farmers. 'Why don't they change?' " Wyse says. "But you can't expect a farmer to turn away from corn and soybeans if there is no profitable alternative."

Now Wyse and colleagues from across the college, the Agricultural Experiment Station and Extension are bringing together almost two decades of work in plant breeding, agronomy, conservation biology, food science and other fields to develop those alternatives—new crops that could make Minnesota's cropland more productive, more efficient and more environmentally sustainable.

Grouped under the umbrella the "Forever Green Initiative," this research could have a dramatic impact on the state's economy and ecology. To accelerate progress, the state legislature recently appropriated $1 million toward the effort, with additional funding coming from state and federal agencies and Minnesota's Discovery, Research and InnoVation Economy (MnDRIVE), a partnership between the university and state.

Don Wyse has been working with colleagues for nearly two decades to find and develop new alternative crops.

Green

By Julie C. Lund

Alternative, off-season crops could benefit economy as well as ecology

A systems approach: Building the basis for the bioeconomy

The hallmark of the Forever Green Initiative, according to Professor Nick Jordan of the Department of Agronomy and Plant Genetics, is a system approach.

"We are trying to bring together the development of new, high-value commodities with significant opportunities for conservation," he says. But the new crops being developed are not just for the economic benefit of individual farmers. They also are intended to be the basis for whole new industries that will diversify rural economies and bring employment opportunities back to small towns.

This new approach involves advancing and achieving sustainable commercialization.

"Efforts to incentivize farmers to plant perennials and cover crops haven't amounted to much in the past," Jordan explains. "With Forever Green, there is a strong emphasis on addressing the economic barriers that have existed, as well as partnering with rural communities, policymakers and business to take a more holistic approach."

Field pennycress: Extending the growing season

Research, conducted in part at the Southwest Research and Outreach Center in Lamberton and the Southern Research and Outreach Center in Waseca, has shown that rotating corn with soybeans increases yields for both crops, compared with growing either as a monoculture. Soybeans supply nitrogen to the soil, and corn thrives on that nutrient.

While this is good, Wyse and his research team think that farmers can do it one better by domesticating field pennycress—once considered a common weed—and introducing it as a relay crop into the corn and soybean rotation.

"Throughout Minnesota and the Midwest, there is nothing on the landscape between the time annual crops are harvested in the fall and the time that new plantings establish a canopy cover in June of the next year," he explains. "That leaves a lot of bare fields for a lot of the year."

Planting cover crops can reduce tillage and conserve soil by stemming erosion and nutrient loss, but many farmers find them too difficult to establish and hard to terminate when they don't add to a farm's profitability.

A relative of the mustard plant, field pennycress is a winter annual that can be planted in the fall. It survives over the winter and resumes growing in early spring, often before the snow has fully melted. Wyse has found that planting field

Post-doctoral researcher Michael Kantar is working to develop a perennial sunflower plant that creates both economic and ecological benefits.

pennycress amidst corn before it is harvested, then planting soybeans either in the pennycress in early May or following the pennycress harvest in mid-June, produces higher total yields than planting soybeans alone.

In addition to holding the soil and nutrients in place and filtering groundwater, field pennycress could be marketed as an oil seed crop. The most productive pennycress lines bred at the university are 40 percent oil by weight, with a composition that could be converted to biodiesel, aviation fuel or other industrial products. Wyse estimates that adding pennycress as a winter crop has the potential to add up to an extra $300 of profit per acre for soybean growers.

"If you want to change the landscape and add biodiversity, there has to be an economic benefit for the farmer," says Wyse. In addition to profit, farmers also want the environmental benefits that pennycress provides—cleaner water, nutrient-rich soil and wildlife and pollinator habitat, among others.

Wyse and his colleagues will continue their breeding program to try to increase seed size, oil quality and other desirable traits, while also working on developing a market for pennycress seed oil.

"The research we've done thus far proves the concept of field pennycress as a value-added cover crop," Wyse says. "Now it is moving toward commercialization."

On the wild side: Adding perenniality to annual sunflowers

Farmers grow annual sunflowers throughout the northwestern part of Minnesota, producing snack nuts and valuable seed oil that can be used in trans-fat-free cooking oil. But, like corn and soybeans, annual sunflowers produce only one crop per year, leaving the soil vulnerable to erosion and nutrient loss after harvest.

One Forever Green research team is trying to develop a perennial sunflower that would be equally productive and profitable as current commercial varieties and also provide important environmental benefits.

The idea, says post-doctoral researcher Michael Kantar ('06–B.S.; '08–M.S.; '13–Ph.D., Applied Plant Science), is to have agricultural production more closely mimic natural ecosystems and the prairie that cropland replaced. A key characteristic of native Midwestern prairies is the number and variety of perennial plants, which have extensive root systems that reach deeper for water and nutrients than those of annuals and better withstand drought and climate variations. They also are active more days of the year and provide ground cover, soil protection and wildlife habitat when dormant.

"Obviously, there are clear direct benefits from production agriculture: food, fodder, energy," Kantar says. "But there are a lot of valuable things that natural landscapes offer, what we call ecosystem services. These are such things as biodiversity, aesthetic beauty, soil retention and water quality."

The challenge, says Kantar, is to develop plants that are profitable for farmers and also deliver these ecosystem services.

And it is a challenge, according to plant geneticist Associate Professor Bob Stupar of the Department of Agronomy and Plant Genetics.

"The domestic sunflower has 17 chromosomes, while the wild perennial species that we are using has 51 chromosomes. That difference presents a real obstacle. [During breeding] there's a genetic battle going on between the domestic and native traits. It's been hard to optimize the process to get the perfect traits together," he says.

Now, new DNA marker technologies are making it quicker, easier and cheaper for breeders to identify important genes and combine them in different configurations to produce better crops. Kantar and others are looking at the genetics that underlie winter survival in perennial sunflowers to add this trait to existing commercially successful annual varieties.

"These new molecular technologies have dramatically reduced costs," explains Kantar, "while greatly improving our understanding of genomic material. We can target our experiments and test our hypotheses empirically right away. That wasn't possible a few years ago."

"In the past, domesticating a plant could take thousands of years," agrees Stupar. "Now, the question is, can we take the knowledge about plant genetics that we've developed over the past 10 years and change the paradigm to make really rapid advancements?"

Kantar and Stupar think they can.

Intermediate wheatgrass: Student and industry interest fuel research

Many new plant breeds face a chicken-and-egg dilemma: what if you develop a fantastic plant that has no market and, therefore, no one will grow it? What if, on the other hand, there is market demand for a crop that does not yet exist?

Researchers working on the development of perennial intermediate wheatgrass (IWG) are trying to tackle both questions at the same time.

Although his primary area of research is spring wheat, Professor Jim Anderson of the Department of Agronomy and Plant Genetics joined the research effort on IWG because he wanted to "see growers have other options."

The Land Institute in Salina, Kan., has had an IWG breeding program since the 1990s. The university's first IWG research plots were planted in 2010 on the St. Paul campus and at the Southern Research and Outreach Center in Waseca. Anderson and his colleagues are mapping the genes that produce greater seed size, bigger yields and a shortened stature so that the wheat stalk will stand up until harvest.

Seed growers seem fairly excited about IWG's prospects, says Anderson. So do students. "There is more interest among graduate students in sustainable crops, like intermediate wheatgrass and pennycress, than there is in spring wheat," Anderson says.

Food companies share that interest, according to Associate Professor Baraem (Pam) Ismail of the Department of Food Science and Nutrition. "Food companies are interested in producing products made from sustainable resources because consumers are interested in those products."

Ismail and her research team are conducting chemical analyses of IWG to examine nutrient composition, including fat, gluten proteins and starch, among other characteristics. In some ways the new wheat varieties produce flour that is similar to conventional flour, but there are some significant differences as well.

"Gluten protein is what gives dough its elasticity, and the protein quality is quite different in IWG," she notes. The new plants also have smaller seeds, resulting in a higher bran-to-endosperm (the "insides" of the wheat kernel) ratio. More bran and germ compared to endosperm means more fiber and enzymes, which can affect texture and flavor.

Baraem is experimenting making food with different proportions of IWG and regular wheat flour and will provide feedback to Anderson and other breeders, with the goal of producing flour that could be used, not just in baked goods, but also in nutrition bars, breakfast cereals and other products.

"The more of this wheatgrass that is used, the more farmers will want to grow it," she says. ■

To learn more about the Forever Green Initiative, visit www.cinram.umn.edu/forevergreen.

Research associate Xiaofei Zhang and agronomy professor Jim Anderson are part of the team working on a perennial wheatgrass variety that could give wheat growers additional options.

E-book Proves Fruitful

Emily Hoover, horticultural science department head, led the e-book project.

The e-book by the numbers

- 8 CHAPTERS
- 4 GROWERS FEATURED
- 130+ PHOTOS
- 3 GUIDED TOURS
- 7 WORKSHEETS
- 28 VIDEOS
- 2 QUIZZES
- 2 CALENDARS
- 3
- $0 TO READ

Cold Climate Strawberry Farming helps commercial growers make the most of a short season

One only needs to visit a farmers market, roadside stand or pick-your-own operation to witness the intense interest in locally grown produce, including strawberries.

"We're not anywhere near where supply meets demand," says Emily Hoover ('80–M.S.; '82–Ph.D., Horticulture), professor and head of the Department of Horticultural Science. And yet, "We in Minnesota have a hard time growing perennials because of our cold winter temperatures. Period."

Now, new research on a season-extending production system—along with a host of other how-to information—can literally be found in commercial strawberry growers' back pockets, on their smart phones.

Cold Climate Strawberry Farming, an e-book, is an A to Z guide for new and experienced growers on how to grow and sell strawberries commercially. It was written by a team of researchers, educators, designers and media professionals at the U of M and Minnesota Department of Agriculture.

The book can be downloaded for free and sits at the intersection of high demand for locally grown strawberries and tough, cold climates around the world. It includes videos, quizzes, worksheets and imagery. Two production methods are covered: One is traditional and time-tested. The other is innovative and shows plenty of promise.

Two cold-climate systems

The locally grown strawberries we usually see in stores, farmers markets, roadside stands and pick-your-own operations are from perennial plants known as June-bearing. The plant buds are dormant over the winter; they bloom in the spring and produce fruit in June.

"It's a daylight response. From a plant standpoint, daylight is the one given in the world for them. Temperatures may fluctuate, but day length is consistent," Hoover says.

But if one local farm has ripe June-bearing strawberries, all the other farms do, too, for about three weeks every year in cold climates. For some farmers, that timeframe works to fill in the gaps before a different fruit crop comes in. But other growers—and strawberry consumers—would like local strawberries available for a longer period.

Day neutrals are heating up

Day-neutral strawberry varieties have virtually no cold hardiness. But if you treat them as an annual rather than a perennial needing to survive winter, that point is null. The season-extending difference is that day neutrals do not rely on day length as June-bearing varieties do.

"The day-neutral varieties are neutral in terms of daylight. So they can produce flowers and subsequent fruit as long as temperatures are consistently high enough for them to continue to grow," says Hoover. This alleviates the time pressure associated with June bearers.

Because they're annuals, growers can use weed- and disease-suppressing plastic mulch with day neutrals. Why? Because they're not relying on perennials to send off runners to create daughter plants for following years' crops.

"These day-neutral cultivars don't start fruiting until late July. But then, in

Download the e-book for free at z.umn.edu/ccsfinkling.

Day-neutral strawberries can be grown in low tunnels, which eases disease pressure by eliminating rainwater falling on the plants.

this protected system, they can produce fruit all the way through October," says Emily Tepe ('08–M.S., Agriculture), research fellow and contributing author. "It extends the season for our growers and allows the consumers to have access to locally produced fresh fruit for a much longer season."

Growers' advice

The e-book team, including project coordinator Echo Martin, worked closely with growers throughout the book-creation process, particularly four farmers who represent different parts of the state, levels of experience and types of operations. Videos in the e-book chronicle their perspective.

The videos "bring personality to the book. Having words directly from these farmers makes it much more personal and connects it with people who are on the ground, growing the fruit and dealing with the issues," says Tepe. "We wanted the reader to feel like they are there in the field with the grower." *–Maggie Frazier*

The project is funded by a grant from the Walmart Foundation and administered by the University of Arkansas System Division of Agriculture Center for Agricultural and Rural Sustainability.

THREE QUESTIONS with FRANCISCO DIEZ-GONZALEZ

The new head of the Department of Food Science and Nutrition

What's surprised you the most about becoming a department head?

In the almost two months in this position there were a couple of items that surprised me the most, from one side, a very new and refreshing view of the academic endeavor and, at the same time, the realization that despite being here for more than 15 years, I have a lot to learn about my own department.

What's been the most fun so far?

Engaging in a series of group and individual listening sessions in which I have been discovering the passion and enthusiasm of our faculty and staff for our academic programs and their scientific disciplines.

What sparked your interest in a career in food safety and microbiology?

My interest in microbiology started during my bachelor's program back in Mexico. From the moment that I took the first microbiology class at the Monterrey Institute of Technology, I was fascinated by those small living beings that we call microorganisms. Eventually, my interest in microbiology took me back to graduate school after seven years working in R&D in a food ingredients company. My passion for food safety came a little later in my career during my post-doc at Cornell University when I worked with *Escherichia coli O157.* At the time, this bacterium had just recently emerged as an important foodborne pathogen. The University of Minnesota offered me an opportunity to become a productive scholar studying the ecology and control of pathogenic bacteria.

Bonus question:

Have you ever gotten sick from bad food, and if so, what had you eaten?

It has been a while since the last time that I got foodborne disease in my adult life, but I do remember growing up in Mexico, when foodborne disease was seen as part of life, almost like catching a cold. I must have gotten at least one episode of food poisoning every year when I was a kid. I believe that one of the main differences in food safety culture between developed and developing countries is that in the former food poisoning is unacceptable and the society expects that it is prevented.

Rites of Spring

By Sara Specht

Nature's patterns could help track a changing climate

Once there was a man who walked to work on the St. Paul campus each day for 50 years. And for each of those years, he watched the trees and plants on his route and took notes recording the events that signaled changes in the seasons—the first sprig of green, the early buds, the bursting flowers that signaled springtime.

It is something that many people do—remark upon the weather and the changes in the air—from avid gardeners to old friends over coffee. What makes this man unique is his individual record, consistently following the patterns of 14 different plant species from 1941 to 1991.

This man was entomologist Alexander Hodson, he of Hodson Hall on the CFANS campus, and his historical observations have become the foundation for new research into the effects of climate change on Minnesota's environment.

Armed with Hodson's record and a series of other diaries and notes from individuals and citizen scientists collected from around the state, forest ecologist Rebecca Montgomery is assembling a comprehensive historical record of seasonal plant events. She hopes to build a knowledge base that can be analyzed both to track changes in the environment and to predict and prepare for future consequences of climate change.

Spring's first blooming

It's called phenology—the observation and study of the seasonal activity of plants and animals each year. When birds migrate, when leaves appear and when plants flower are all signals of the biological rhythms of the environment, and they are closely related to climate and weather. In an era where the climate is changing, phenology can provide a way to measure how different plants and animals respond to the change and which species might be threatened by it.

"Phenology has emerged globally as one of the most coherent and widespread signals that plants and animals are sensing a difference in their environment, sensing climate change," says Montgomery, an associate professor in the Department of Forest Resources. "It made me realize we don't know that much about the phenology in our back yard. Then I found these amazing Minnesota phenologists who are passionate about tracking the changing of the seasons, and the data they had collected seemed like such a resource."

That finding and compiling of existing phenological records is just the beginning of Montgomery's project, funded by a three-year grant from the state's Environmental and Natural Resources Trust Fund. Her team is digitizing extensive collections like the Hodson

Rebecca Montgomery leads a tour through research plots of tracked plant species at the Cloquet Forestry Center for the Minnesota Phenology Conference.

record and the decades-worth of notes gathered by botanists at the Eloise Butler Wildflower Garden in Minneapolis. Montgomery also has discovered a community of northwoods naturalists and avid phenologists from around the state who have agreed to share their journals and data with her. Once the information is collated, Roger Moon, a professor in the Department of Entomology, will help analyze the patterns and compare phenological and historical temperature records.

"I'm starting with simple day-degree models to see if we can account for variation from year to year, with knowledge of what the weather was like," Moon says. "If it turns out we need to invoke other things, like day length or increasing fall chill levels, to better predict spring events, then we've already learned two things—what an individual plant needs to detect climate shifts and how to project timing of phenological events given any arbitrary weather scenario."

The temperature in Minnesota is, on average, two degrees warmer than it was in the 1940s, so how has that affected the state's environment? What if some species sense the change in seasons through day length and fall behind species that use temperature as a cue?

For instance, if one species changes the timing of its spring patterns in response to warmer temperatures—say, one tree-nesting bird nests earlier—and a second species doesn't adjust accordingly, all the nests sites may be occupied by the first, leaving the second without. This loss of nesting sites could cause the second species to decline. Highly managed urban systems also can be affected. For example, some trees might begin dropping leaves earlier than others in the fall, and corresponding changes in street sweeping schedules could improve efficiency.

"Everyone thinks, 'Oh, spring came earlier because it got warm faster,'" Montgomery says. "It's turning out that not all species have the same response to climate change—what does that mean for our ecological systems?"

The ability to predict changes in seasonal timing for individual species could identify vulnerable species, Montgomery says. Moon's data analysis will help Montgomery determine how individual species detect and react to environmental changes, and contribute to the knowledge base that informs management responses in a changing environment.

Spring forward

Assembling a comprehensive historical record of shifts in phenological timing is only Montgomery's first step in projecting the future of the state's environment. The next is to build an army of observers to extend the reach and consistency of phenology data into the future.

Researchers in her lab are following a broad set of plant species at the university field station at the Cedar Creek Ecosystem Science Reserve, coordinating with state and national phenology networks. Closer to home, Moon hopes to get the CFANS entomology club, *Frenetae,* to pick up Hodson's half-century record where he left off in 1991.

"Back in 2011, I was sitting in my house looking at my crabapple tree and was reminded of Hodson's spring events—one of them was the yearly apple bloom," Moon says. "Hodson is one of the intellectual fathers of our department. I thought it was a shame, so I'm trying to get the graduate students organized to carry on the record."

Montgomery also is beginning an outreach effort to recruit a network of citizen observers throughout the state to build a phenological record for a much larger area than her lab can cover. Beginning with training sessions about phenology practices and protocols, she and her colleagues will link the members of this Minnesota Phenology Network to a national database called Nature's Notebook that will make the information publicly available. She hopes this will give Minnesotans an opportunity to contribute real data to phenology research across the country.

"For me a part of Minnesota's natural heritage is that we have changing seasons—we're all excited when our daffodils come up or tell each other the lilacs are blooming earlier," Montgomery says. "Whether we're calling it phenology or writing it down in a notebook or entering it in a national database with an app on our phone, I feel like it can be a touchstone with the public. Teachers can use phenology as a way of educating about climate change in an era when people can get caught up in big global climate models that are hard to get a handle on. But we can say, 'Here is this aspen leafing record, and you too can go outside and look at your aspen and contribute to the research.' " ■

JULIE GROSSMAN

Department of Horticultural Science

Before joining CFANS: Associate professor, Department of Soil Science, North Carolina State University

Research and expertise: Grossman's research broadly explores the ways in which we can better manage plant-soil-microbe relationships in organic systems in order to enhance soil fertility, with the ultimate goal of developing sustainable food production systems. A central thread connecting much of her work is the examination of winter annual legume cover crops to help maintain landscape diversity and tighten nutrient cycling within both urban and rural agricultural systems. To do this, she applies microbiological and field approaches that measure both the specific functioning of microbes that mediate nutrient cycling in soils and general characteristics of soil health.

Teaching: Student Organic Farm Planning, Growing and Marketing; Holistic Approaches to Improving Food Systems Sustainability

MATTHEW RUSSELL

Assistant professor/Extension specialist, Department of Forest Resources

Before joining CFANS: Research Associate, Department of Forest Resources, University of Minnesota

Research and expertise: Russell's research interests focus on forest ecosystem health and how changing environmental conditions influence the structure and function of forests. His programming with Extension emphasizes strategies to sustain the health and productivity of Minnesota forests.

FORESTS

SUSTAINABILITY

ASHOK KUMAR CHANDA

Department of Plant Pathology; Northwest Research and Outreach Center

Before joining CFANS: Postdoctoral researcher, Louisiana State University Agricultural Center

Research and expertise: Chanda's research focuses on understanding the biology and management of sugar beet diseases. He will develop new molecular tools to detect pathogens of sugar beet and quantify inoculum levels. His research also will focus on understanding the diversity of pathogen populations across the Red River Valley. The overall goal of his applied and basic research programs is to develop better disease management strategies and also deliver this information to the stakeholders and sugar beet industry using appropriate educational and outreach programs.

WATER

BIOLOGY

SOIL

SATOSHI ISHII

Department of Soil, Water, and Climate

Before joining CFANS: Assistant professor, Division of Environmental Engineering, Hokkaido University, Japan

Research and expertise: Ishii's research focuses on environmental microbiology and biotechnology. His specific research interests are bioremediation of inorganic nutrients, removal and recovery of heavy metals and assessing the risks of environmental pathogens.

Teaching: He will likely teach a new course related to bioremediation of soil and water.

JASON BEDDOW

Department of Applied Economics

Before joining CFANS: Postdoctoral researcher, Department of Applied Economics, University of Minnesota

Research and expertise: Beddow's research interests are focused on the spatial aspects of agriculture, and how we might better use spatial data to understand agricultural systems. He has a particular focus on the ways in which research investment patterns and natural environments (including pests, diseases, climate and weather) affect agricultural production and productivity, the spatial dynamics of production, and bridging the divide between biology and economics (bio-economics).

DATA

Building an Interdisciplinary

AXEL GARCIA Y GARCIA

Department of Agronomy and Plant Genetics; Southwest Research and Outreach Center

Before joining CFANS: Assistant professor, Department of Plant Sciences, University of Wyoming

Research and expertise: Garcia's research will focus on crop rotations, integration of cover crop components or other crops into current cropping systems and cultural practices in cropping systems to optimize yield, with an emphasis on multi-functional agriculture and the delivery of ecosystem services.

NICOLAS A. JELINSKI

Department of Soil, Water, and Climate

Before joining CFANS: National Science Foundation graduate research fellow

Research and Expertise: Jelinski's research focuses on the application of soils information to problems in food security and soil genesis. He plans to develop an urban soils research program that increases engagement and awareness of issues related to soils, urban agriculture and public health in the Twin Cities metropolitan area.

Teaching: He will teach Basic Soil Science; Field Study of Soils; and Soil Judging.

ROB GARDNER

Department of Bioproducts and Biosystems Engineering; West Central Research and Outreach Center

Before joining CFANS: Postdoctoral research associate, Center for Biofilm Engineering and the Department of Chemical and Biological Engineering, Montana State University

Research and expertise: Gardner's research focuses on renewable energy and sustainability by utilizing microbes to convert sunlight, wastes and other low-cost nutrients into value-added products such as fuel, food and specialty chemicals. Gardner hopes to use microalgae as a biorefinery platform in both traditional open ponds and bioreactor cultivation, as well as in gradient mediated biofilms.

Teaching: Gardner will teach Renewable Energy and the Environment, an undergraduate online course through the bioproducts and biosystems engineering department.

CHRISTOPHER PHILIPS

Department of Entomology; North Central Research and Outreach Center

Before joining CFANS: Postdoctoral research associate, Department of Entomology, Washington State University

Research and expertise: Phillips' research focuses on sustainable integrated and organic management of arthropod pest, pollinator and beneficial species of fruit and vegetable crops. His studies are broadly based in integrated pest management, emphasizing an understanding of the impact of agricultural management on insect ecology and pest suppression. The overall goal of his program is to develop, evaluate, and help implement sound integrated and organic management practices of existing and emerging pests, to enhance the profitability and sustainability of fruit and vegetable production.

Teaching: Principles of Integrated Pest Management in Sustainable Agroecosystems, and an additional course.

CE YANG

Department of Bioproducts and Biosystems Engineering and the Department of Soil, Water and Climate

Before joining CFANS: Postdoctoral research associate, Department of Computer Information Science and Technology and the Department of Agricultural and Biological Engineering, University of Florida

Research and expertise: Yang is an expert on precision agriculture, remote sensing, machine vision, spectroscopy, hyperspectral imaging, machine learning and pattern recognition and big data in agriculture.

Teaching: Precision Agriculture, Process Control and Instrumentation

ENERGY

FOOD

AGRICULTURE

Faculty

Ten new assistant professors join CFANS

DEAN'S MESSAGE

CFANS Dean Brian Buhr

CFANS 2.0

Won't you join us?

The University of Minnesota's new strategic plan lays out a bold vision: "Be Pre-eminent in Solving the Grand Challenges of a Diverse and Changing World." At CFANS, we're trying to do just that.

Our college can create world-changing solutions, and we will. We're located in the heart of some of the world's leading private sector firms in agriculture, forestry and food production, as well as a diverse agricultural and natural resource landscape. Our renowned faculty are leaders in their fields, and we have bright, enthusiastic cohorts of undergraduate and graduate students.

In the last century CFANS and the university were central to the Green Revolution, and now we're seeking to lead in the 21st century. The world has changed, and now we need an economically savvy, more environmentally sustainable, more inclusive and more collaborative push to end global hunger and restore our natural resources. Call it CFANS 2.0.

How will we do it? Opportunities abound at the intersections where information, biological and physical technologies intersect. Those new technologies will help us lead as the best minds, facilities and financial resources from national and international academia, industry, government and related partners are brought together to advance science worldwide while also allowing globally relevant science to be deployed locally.

Our internal challenge is to create an innovation-driven culture, to "reject complacency" as the university's strategic plan specifies. To that end, we're in the process of hiring several key strategic positions to advance those goals: We've recently hired two new associate deans and are in the process of hiring new directors for the Water Resources Center and the new Terrestrial Invasive Plants and Pests Center. Further, we've just announced the hiring of Professor Philip Pardey ('86–Ph.D., Agricultural and Applied Economics) as director of our global research strategies.

Ultimately, though, it's our faculty, staff, students, alumni and private and public sector partners that together drive our innovation ecosystem. In all the activities and goals described above we're encouraging engagement and ownership of these research ambitions. The question I'll leave with you as you read this magazine is, "How will you join us in the grand challenge?"

We welcome your insights and participation!

Safety First

Good agricultural practices program helps ensure a safe food supply a few farmers at a time

In January 2011, President Obama directed the Food and Drug Administration (FDA) to establish science-based standards for the safe production and harvesting of fruits and vegetables to minimize the risk of serious illness or death. The FDA is in a several-year rule-making process to set benchmarks related to agricultural water; fertilization with manure and other animal products; worker health and hygiene; animals in the growing area; and equipment, tools and buildings.

Although the rules are not yet final and, even when they are, would apply first to large producers, they still are of interest to small farmers like Sandy Dietz and her husband, Lonny.

The Dietzes farm 136 acres of land about 100 miles southeast of the Twin Cities. At Whitewater Gardens, they raise beans, cucumbers, peppers, potatoes and other produce for farmers markets, Community Supported Agriculture (CSAs), co-ops and wholesale distributors. With all the talk about the forthcoming federal regulations, in 2012 they decided to attend a day-long workshop in Winona because they "wanted to be up-to-date on farm food safety."

That workshop was presented by Michele Schermann ('80–B.S., Horticulture) and Annalisa Hultberg ('11–M.S., Natural Resources Science), research fellows with the Department of Bioproducts and Biosystems Engineering who have been working with farmers on food safety issues since 2005. As the driving force behind the university's on-farm Good Agricultural Practices (GAP) education program, they offer

A woman buys produce from a local producer at a farmers' market in Roseville in late September.

workshops and training sessions to help produce farmers follow a set of voluntary guidelines to reduce the risk of contamination related to food-borne illnesses on their farms. The workshops include such topics as handwashing and hygiene, cleaning and sanitizing tools and post-harvest food handling and storage, as well as how to write a risk assessment and develop a food safety plan. To date, about 75 farmers have participated in their GAP programs.

Some wholesale food distributors and other buyers require third-party certification that growers follow good agricultural practices to reduce microbial contamination—a so-called GAP audit—but Schermann finds that many small farmers want to do the right thing without being prompted. "They want to know what they can do to improve their practices. For them, food safety isn't in a little box off to the side; it's part of the sustainability of their whole enterprise."

Conducting GAP training programs on site rather than in a classroom is central to Schermann and Hultberg's teaching strategy. "We look at real examples, real scenarios. We want everyone to go home with techniques and practices that they can put into practice right away," says Schermann. "Participants walk around the host farm thinking, 'If this were my farm, what might pose a risk in terms of potential contamination?' They are actively engaged in learning from each other, rather than passively listening to us tell them what to do."

Schermann and Hultberg visit the host farm ahead of time, conducting a risk assessment and working with the farmer to write a risk assessment statement to be included in his or her farm safety plan. They find that growers are eager to share the food safety practices they have implemented, such as installing handwashing stations or rinsing their fresh produce with water treated with a sanitizing agent to reduce illness-causing pathogens, like *E. coli* and *Salmonella*.

Being scrutinized by your peers like this could be uncomfortable but Schermann and Hultberg work hard to put farmers at ease.

"No one is perfect, and we are not here to judge," Hultberg says. "We just want to help growers do their best."

"We are educators, not enforcers," continues Schermann. "We are the bridge between Minnesota growers and what they need to know in terms of best practices and the regulatory environment."

Sandy Dietz, who hosted Schermann and Hultberg for a GAP training program on her farm in June of this year, wholeheartedly agrees. "The way that Michele and Annalisa present the information, it's clear that they aren't there to police anyone. They genuinely are there to help."

Local producers attend a workshop on good agricultural practices in Lakefield, Minn, cunducted by Michele Schermann (center top).

Although some might be hesitant to take part, Dietz believes that participating in farm food safety training has value as a marketing tool. "It's a comfort to our customers to know that we are actively thinking about the safety of the food we grow after it comes out of the ground, that we are offering them a safe product," she says.

Dietz, who recently visited several farms in New England, thinks that Minnesota is "way ahead of other states in promoting food safety on small farms."

Schermann and Hultberg intend to keep it that way. *–Julie C. Lund*

Learn more about food farm safety at safety.cfans.umn.edu.

Greg Cuomo named associate dean for research

Greg Cuomo has been named associate dean for research and graduate programs in CFANS. He'll oversee the college's research portfolio and will be deputy director of the Minnesota Agricultural Experiment Station. He'll also be responsible for planning and policies and other research-related matters, and will retain his role as division head for the college's 10 Research and Outreach Centers.

He also will oversee graduate programs, working closely with Mike White, associate dean for academic programs and faculty affairs.

CFANS Dean Brian Buhr noted in his announcement of Cuomo's appointment that "he worked with ROC heads to develop a cohesive network of centers with 'shared ownership' by implementing a unified budgeting system, establishing new research collaborations and increasing the visibility of ROCs both externally and internally. Greg also has served as the collegiate facilities and safety director during an unprecedented time for CFANS capital planning initiatives."

Cuomo began his faculty career at Louisiana State University in 1992, and in 1996 joined the Department of Agronomy and Plant Genetics. He was promoted to full professor in 2005. He holds a Ph.D. in Agronomy from the University of Nebraska with master's and bachelor's degrees in Range Science from Texas Tech University and Texas A&M University respectively.

OVERHEARD

"This will help families save money and this will bring sexy back to milk."

—**Marin Bozic**, assistant professor of applied economics, talking about how new milk-carton sensors that detect spoilage could reduce the amount of food that's wasted.

"We try to take both a short- and long-range view of research. I like to think of it as our applied crop production research makes mistakes on purpose so Minnesota growers don't have to."

—Southwest Research and Outreach Center Assistant Professor **Bruce Potter**, interviewed about how the center works with farmers.

"This is the Asian carp of marshes, and we need to get on it."

—**Lee Frelich**, research associate in the Department of Forest Resources, on the proliferation of cattails in Minneapolis ponds and the need to eliminate them.

HOMECOMING 2014 FOREVER GOLD

100 Years of Homecoming at the University of Minnesota were celebrated this October.

15 · 17 · 17 · 29

Four key rankings from a new *U.S. News and World Report* study of the world's top universities. Three CFANS disciplines ranked in the top 20: Agricultural science, 15; animal science, 17; and ecology/environment, 17. Overall, the U of M was ranked as the 29th best university in the world.

1951–53 Years when the Green Bay Packers held training camp on what was then known as the North Central School of Agriculture and is now the **North Central Research and Outreach Center** in Grand Rapids. During those years, the Packers practiced on a field that was once a cow pasture. Former players from the era claim that they practiced with cows, hogs and horses.

Percentage of CFANS undergraduates who took more than 15 academic credits during spring semester 2014. **62.5**

MnDRIVE funds fuel partnerships

Nineteen new research projects involving University of Minnesota researchers and more than 65 food industry partners have been awarded $3 million in funds through the U's MnDRIVE Global Food Ventures initiative. Four new faculty members have been hired, two of them in CFANS, and 15 graduate students have been named MnDRIVE Fellows.

The research proposals were chosen through rigorous peer review by the Global Food Ventures Investment Board, which comprises university faculty and leadership and industry partners. The projects address issues in food contamination, supply threats and current methods of food production, and the majority include partnerships with industry leaders and trade organizations.

MnDRIVE (Minnesota's Discovery Research and InnoVation Economy) is an $18 million annual investment by the State of Minnesota in four research areas: Global Food Ventures; Advancing Industry, Conserving Our Environment; Discoveries and Treatments for Brain Conditions; and Robotics, Sensors and Advanced Manufacturing. CFANS faculty are playing a central role in the Global Food area, but they also are partnering on transdisciplinary projects in the Robotics and Environment initiatives.

Mike White named associate dean for academic, faculty affairs

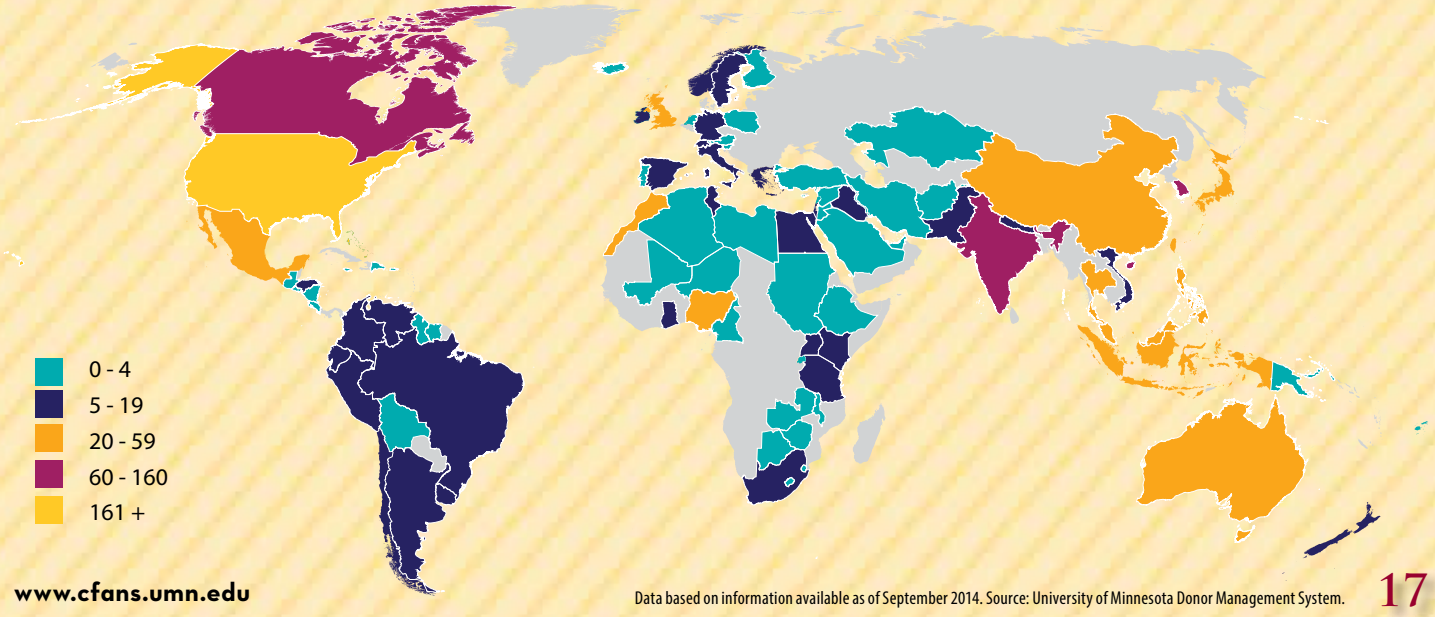
Department of Animal Science professor Mike White is the new Associate Dean for Academic Programs and Faculty Affairs in CFANS. In his new position, he will provide leadership and administrative responsibility for credit and non-credit undergraduate, continuing and distance education programs, including associated recruitment, admissions, student services and faculty development initiatives aligned with collegiate and university priorities.

White ('80–B.S., Wildlife; '86–Ph.D., Animal Science), a Morse-Alumni Distinguished Teaching Professor, has been head of the animal science department for the past three years. He began his faculty career at The Ohio State University in 1986 and in 1992 joined the CFANS animal science department. His research discipline is muscle biology, animal growth and development and cell biology, with a primary focus on the investigation of the cellular and molecular regulation of muscle growth and development in meat-producing animals. He replaces Jay Bell, who has been associate dean for the past seven years and has returned to research and teaching.

Pardey will direct CFANS global research

Renowned economist Philip Pardey will be the first director of global research strategy for CFANS. Creating a position specifically aimed at developing global research partnerships and innovation reflects the priorities of the college, as well as those of the university, says Brian Buhr, dean of the college. Pardey, a professor since 2002 in the Department of Applied Economics, will be responsible for creating new international opportunities and partnerships in policy, technology and research for CFANS and the university's Agricultural Experiment Station.

CFANS Alumni by Country



Data based on information available as of September 2014. Source: University of Minnesota Donor Management System.

In Memoriam

Associate professor of horticultural science **Christian Thill** died Aug. 7 of an irregular heartbeat. As a potato breeder, plant geneticist and professor, he was a highly respected scientist with a passion for collaborative efforts in the development of new potato breeds to improve crop yields, disease resistance and other desirable traits. He was especially excited about two of his recently developed potato varieties, including MonDak Gold, which was released for commercial production in 2014. A scholarship will be established at the university in his name.

Prominent food scientist **Koushik Seetharaman**, 48, died in early June, a few days after he became ill during a Memorial Day weekend gathering. He was named the new General Mills Cereal Chair in the food science and nutrition department in 2013; before that, he held an industry research chair in cereal technology and was a professor at the University of Guelph in Guelph, Ontario. Memorial scholarships have been established in Ontario and with the American Association of Cereal Chemists, and a scholarship has been set up for his son, Samuel.

Dayton will lead animal science department

William Dayton is the new head of the Department of Animal Science. He's been a faculty member in the department since 1975, with a research emphasis in animal growth biology, as well as teaching courses, most notably the undergraduate Animal Growth and Development course. He's advised many undergraduate and graduate students and has taken on many leadership roles in the department, including directing the graduate studies program and leading a mentoring program for new faculty members. One of his top priorities will be to lead strategic planning for the department. He succeeds Mike White, who recently became associate dean for academic programs and faculty affairs in CFANS.

Building plans include St. Paul campus

New building projects approved by the state legislature last spring will mean dramatic changes to the St. Paul campus in the coming years. Legislators and the governor approved funding for a new bee research lab on campus; a new Bell Museum and Planetarium; improvements to the Aquatic Invasive Species research lab, as well as funding for maintenance on other campus buildings. All three projects currently are in the planning and design stage, with ground expected to be broken in 2015.

Terrestrial invasive species center created

A new interdisciplinary center based in CFANS will use scientific findings to support policymaking, application and resource management practices that address non-aquatic invasive species. The Minnesota Invasive Terrestrial Plants and Pests Center, approved by the legislature last spring, will include collaborations with university partners, as well as government, private industry and citizens' groups.

The hiring process for a center director is under way; that person will set research priorities for the center with guidance from an advisory committee made up of representatives from the college, as well as the nonprofit and for-profit sectors, government and other educational and research organizations. Research projects are expected to begin in early 2015.

BEARING FRUIT

BY SHELLY GUSTAFSON

ONGOING STUDY SHOWS HOW BLACK BEARS THRIVE ON AGRICULTURAL LANDSCAPES

Looking out over the primarily agricultural landscape in northwestern Minnesota, the last thing one would expect to see is a black bear snacking on sunflowers and corn. But that is exactly what a group of researchers, including recent CFANS graduate and Ph.D. recipient Mark Ditmer, discovered in a recent study that focused on explaining the growing population of black bears in this unlikely habitat.

Launched in 2007 as a joint research project between the Minnesota Department of Natural Resources (DNR), the university and Medtronic Inc., the research initially focused on understanding the limitations of bear range and what is needed for black bears to not only survive but thrive in habitats like northwest Minnesota, says Dave Garshelis ('83–Ph.D., Wildlife), the DNR's black bear biologist and an adjunct associate professor for the Department of Fisheries, Wildlife and Conservation Biology.

In 2009 Garshelis's team needed a new graduate student to assist with the project and Ditmer, newly arrived at the U, needed a research project he could sink his teeth into. Ditmer had discovered his interest in conservation biology while doing renewable energy consulting in Washington, D.C., and was interested in

Stock photo

discovering more about the bears' behavior and how it related back to their diet, home range and overall health.

Early research showed that the bear population was not only growing in northwest Minnesota, but the bears were thriving in the area. Significantly, the team found the bears were among the biggest and most fecund in the state. The question remained, however, if the area would be able to continue to sustain the growing population.

To help answer this question, the research team fit the bears with GPS collars, which recorded their movements and showed that the bears have a much larger home range than any other black bear population. While it is common for a bear's home range to expand and contract as different food sources become available, large home ranges generally mean a habitat is lacking in significant food resources, says Ditmer. In contrast, in northwest Minnesota it appears to derive from the wide spacing of food, found in small patches of forest, as well as scattered fields of corn and sunflowers; these edible crops comprise only 2 percent of the landscape.

"We were able to see that even if the crops went away, we think the area is still pretty suitable for bears because there are a lot of younger forests and there is a lot of natural food available," says Ditmer.

Beyond their eating habits and size, Ditmer was interested in learning more about the bears' behavior. To do this he combined information from the GPS collars with information from Medtronic's cardiac biologgers implanted under the bears' skin.


Photo courtesy Mark Ditmer


Stock photo

Recent Ph.D. graduate Mark Ditmer was part of the research team that tracked the population and behavior of bears in the primarily agricultural landscape of northwest Minnesota.

A correlation soon came to light as Ditmer noted that the bears' heart rate increased sharply when they are involved in stressful behavior, such as crossing roads or open farmland.

"When bears are crossing agricultural areas that are wide open, their heart rate does spike more than you would expect given their rate of movement," says Ditmer. "In contrast, when they find the crops they like to eat, their heart rate becomes very slow, indicating not only that they are immobile but also unstressed."

Also surprising, they found that mainly the males were bold enough to help themselves to the nearby crops. Females, especially those with cubs, tended to avoid large males reigning over small cornfields and found plentiful acorns and hazelnuts in the woodlots.

The team's research has looked not only at the effect of this unusual landscape on the bears, but also has taken into account how the bears have affected farmers in northwest Minnesota. While a few are finding their new neighbors a nuisance, for the most part Garshelis says that many either don't realize or don't care that the bears are causing the crop damage. Deer are still the primary crop nuisance in the area, and a few thousand oversized bears have not changed that.

Moving forward, Garshelis will continue to partner with Medtronic and university researchers to study this ever-growing bear population. A new generation of heart rate monitors will allow them to receive more detailed information. Ditmer will be exploring his love of animals and conservation in new research areas but plans to keep up with the project and possibly assist in the field.

"Mark has been a pleasure to work with," says Garshelis. "He has an analytical mind and took the data well beyond anything we imagined." ■

RAIDERS of the WILD GRAINS

By Becky Beyers

Ancient cereals may hold secrets that address modern challenges

About ten thousand years ago, probably in the area of the Middle East known as the Fertile Crescent, early hunter-gatherers stumbled upon wild cereal species they could domesticate and figured out how to turn these grains into food.

Since then, cereal grains like wheat and barley have been cultivated for yield, for disease resistance and for hardiness, among other things. The 20th century Green Revolution brought that process even further along, adding modern fertilization and growing techniques.

But what might have been lost along the way as cereals became domesticated? CFANS scientists are examining the grains that still grow wild in the Fertile Crescent to see whether they contain genes that, combined with modern domestic varieties, could help feed the world's growing population.

A field of wild grains in Israel overlooks the Sea of Galilee and the Golan Heights as the sun rises.

Rich with diversity

Last spring, a group led by Department of Plant Pathology professor Brian Steffenson ('80–B.S., Plant Health Technology; '83–M.S., Plant Pathology) visited colleagues at Tel Aviv University, in part to refresh a 50-year partnership between the universities but also to collect more species that might have traits valuable to modern wheats and barleys.

"Even though it is such a tiny country, Israel is an extremely rich land for genetic diversity of these very important wild progenitor species," Steffenson says. The group on the recent trip was specifically looking for, collecting samples and noting the habitat of four common species of wild grasses.

"It's pretty easy to find them," he says. "Wild barley is everywhere. But some of the wild wheats have a more limited distribution; one of the main things we saw on this trip was threatened habitats where new roads or housing projects had displaced these species."

For example, a wild grass called Sharon goatgrass or Aegilops sharonensis grows mainly along the coastal plain of Israel and into southern Lebanon, a highly urbanized and very narrow strip of land. Not much space is left for the native grasses, Steffenson says.

That particular species has shown excellent resistance to a potentially disastrous threat. "The thing that really surprised us was the very high frequency of resistance to African stem rust in these wild Aegilops accessions," he says. "That was very promising… if we lose these grasses, we'll lose access to their important genes."

Seed storage

Samples of the collected wild cereal grains are stored in the Lieberman gene bank at the Institute for Cereal Crops Improvement at Tel Aviv University. Inside a large cold room, the seeds are stored in bottles and envelopes at 4 degrees Celsius and in low humidity, the optimal conditions for long-term storage.

Steffenson and his colleagues request samples from the gene bank and screen them for resistance to diseases that affect cereal crops in Minnesota and the rest of the world. Once a wild cereal sample is found that shows disease resistance, researchers begin the process of crossing it with wheat or barley. Wild barley can be readily hybridized with cultivated barley, Steffenson says, but creating a new variety of wheat from Aegilops species is a more complex and painstaking process.

Recent technology, however, provides ways to speed up the process, maybe by as much as half. Scientists at the U of M, working with colleagues in the United Kingdom, now can transfer only the key genes from a wild progenitor into an existing wheat variety. None of the wild variety's unwanted genes come along. "We're essentially making evolution go a bit faster by selectively splicing out the genes we want and putting them into an already good wheat variety," Steffenson says. While that may be controversial because it involves the genetic modification of wheat, "it is a technology that really needs to be developed and can benefit mankind greatly. It remains to be seen whether such wheats will be accepted commercially, but we have to investigate the technology."

Along with disease resistance, the scientists are looking at winter hardiness and grain quality. After a new strain is found to combine resistance with other quality traits, the process shifts to CFANS plant breeding experts.

All photos by David Hansen.

Scientists collecting, identifying and testing the grains include (from top) Brian Steffenson from CFANS and Assaf Distelfeld, Eitan Millet and Yehoshua Anikster, all from Tel Aviv University.

Wild grains grow in undeveloped areas of Israel, but rapid highway and building construction could destroy the native habitats of some grains.

More than disease resistance

In most cases, that plant breeding expert is Jim Anderson, professor in the Department of Agronomy and Plant Genetics.

"The primary motivation for this research is to bring in new resistance genes," he says, "but there is a possible second benefit of genetic diversity." While most of his work involves spring wheats developed specifically for northern climates, "there's gene material that's never been introduced in our work. It's prudent to focus on that diversity."

Beyond disease resistance, Anderson looks for grains with high yield and high protein content. Specific genes in wheat affect the quality of the bread it makes, whether that's water absorption capacity in the dough or loaf volume. "At some level there is genetic control of those traits. And if we can access some of them, we can increase the value of the commodity," he says.

Anderson's process involves crossing and back-crossing varieties he knows can succeed in Minnesota with wild species from Steffenson's work. "The idea is to get rid of more and more of the wild species' genes that we don't want," Anderson says. "At the end of that, we do field tests, hoping to find at least a couple that we want to go forward." But it's a long process. "We have a few varieties in development now that are close to being commercially available from research

started years ago. It can be 20 to 25 years from the time the process starts, using such unadapted germplasm until a farmer can buy the seed."

That timespan is one reason the genetic modification techniques offer a good alternative, Steffenson says. "Potentially we could halve the time it takes to do this, if the public will accept genetically modified wheat and see there's a value."

Global perspective

Wild grass samples in other countries in the Fertile Crescent also may have potential for improving cereals on a global scale, but violence and the ever-growing demand for food in that part of the world complicate matters. Steffenson says an international research institute in Aleppo, Syria, was destroyed earlier this year because of the civil war, although reports say germplasm from the gene bank has largely been preserved

Rust diseases can quickly destroy entire wheat crops.

and moved outside the country. In Turkey, which makes up part of the northern Fertile Crescent region for wild cereal diversity, large domestic wheat fields have taken over many habitats where native grasses once grew.

Steffenson, Anderson and their colleagues are part of a worldwide effort known as the Borlaug Global Rust Initiative, which is funded by the Gates Foundation and includes about 100 scientists from more than 30 institutions, focused on developing new wheats that can resist the deadly rust race called Ug99. They're the primary group in that effort looking at how wild grains might contribute to developing rust-resistant wheat.

But the work goes beyond disease resistance—and beyond wheat and barley. "We're trying to look at it from a comprehensive standpoint," Steffenson says. "We're cataloging the habitats where each species exists and making sure we have comprehensive collections that are preserved and maintained in good quality in the gene banks.

"As a plant pathologist, my first interest is in identifying new genes for disease resistance in these wild species, with special emphasis on the dangerous African stem rust. But I'd like to see other research groups evaluate these wild cereal collections for additional important traits such as tolerance to heat, drought and salinity. If you collect seed and it sits in a gene bank and nobody does anything with it, to me that's not a gene bank, it's more like a gene morgue. The seed might eventually die with nobody doing anything with it."

Brian Steffenson leads CFANS' work on gathering, cataloging and testing the wild grains. Right: Last spring, a group visited Tel Aviv University and the areas where these grains grow.

Modern genome-sequencing tools expand the possibilities, he adds. "It's not unrealistic that we could obtain the complete genome sequence for every one of these accessions; we're just limited by money and personnel. If we could do that for all these species and put it together with bioinformatics tools and identify the genes that control traits like zinc content or disease resistance, that would go a long ways toward enhancing our understanding and ability to breed new varieties that augment these traits."

Similar efforts are happening in other parts of the world, with other crops, Steffenson says. In each case there's a treasure trove of genes that can be exploited from the wild species. The goal is to do this for cereals, potato, soybean, apples—you name it.

"That's the value of so much great genetic diversity. It's going to take a lot of time to go through it all, but we're going to try to take as big a bite as we can." ■

Long-distance Partners

Lieberman-Okinow endowed chair keeps feeding the world as its focus

A simple family dinner six decades ago laid the groundwork for a partnership in feeding the world.

Isaac Wahl was a visiting scholar from Tel Aviv University in the CFANS Department of Plant Pathology in the mid-1950s. Through connections with the local Jewish community, Wahl was invited to the Twin Cities home of Harold and Adele Lieberman, who were strong advocates for the then-young state of Israel. Over the years, he traveled often between the universities, and the friendship between his family and the Liebermans grew.

Steve Lieberman was a teenager at his parents' dinner table then and remembers how Wahl shared a vision for preserving grains that have grown wild in Israel to ensure global food security. "He was a good fundraiser," Steve Lieberman recalls. "Over the years, we helped him with some special projects and in the '70s, he told us about how important it would be to have a climate-controlled germplasm bank to preserve the species that were being collected."

Harold Lieberman had passed away by that time. His sons and son-in-law had taken over the family business, Lieberman Companies, which specializes in amusement and vending machines sales and rental and, at that time, distributing records to major retailers. The three—Steve, his brother David and their brother-in-law Harold Okinow—wanted to solidify their connections with both Tel Aviv University and the U of M, from which their mother had graduated. They also saw the importance of Wahl's work to global food needs. They agreed to fund the Harold and Adele Lieberman Germplasm Bank at Tel Aviv University, which opened in 1982 and today houses the samples of wild cereals collected in Israel and used by scientists at CFANS.

Entrepreneurs at heart, the family saw the start of something special and were looking for a way to formalize the relationship between U of M and Tel Aviv University. Along with family contributions, they were able to leverage business relationships, including proceeds from the record "We are The World," sold by the company's record distribution arm, to create an endowed chair in the CFANS plant pathology department.

At that time, funds from the endowed chair mostly were used for small projects and researchers' travel. Again looking to build on success, the family invested money to expand the scope of the chair and hire a permanent faculty member. "We needed a main point of contact at the U," says Dan Lieberman, one of Steve's sons who today leads the family firm with his brother Hal. "Someone who could be the glue that tied this work all together."

That someone was Brian Steffenson, who was hired in 2000 as a faculty member in the plant pathology department and today leads work on finding disease-resistant traits that can be adapted to wheat and perhaps lead to a more food-secure world. "There could not have been a better choice," Steve Lieberman says. "The team right now is as good as it's ever been."

Last spring, Dan Lieberman and his wife, Suzanne, traveled to Israel with Steffenson and other plant pathologists from CFANS. That's part of the family's plan to help wherever they can and to stay involved in the research, Dan and Steve Lieberman say. The extended family now includes Harold and Adele's grandchildren and great-grandchildren, many of whom are involved in the family business and philanthropy.

"The goals of establishing this chair were to solve the world hunger issues and to build understanding between the two countries," Dan Lieberman says. "That's been our driving force, and it will continue to be." *–Becky Beyers*

Invaluable Assets

NatCap project illuminates the true value of nature

Natural ecosystems provide many benefits to society: trees reduce carbon dioxide in the air, mangrove forests offer protection from storms and flooding, watersheds filter water and retain sediment. Many of these benefits do not currently have a price, but that doesn't mean they don't have value.

As a lead researcher with the Natural Capital Project (NatCap), Regents Professor Stephen Polasky of the Department of Applied Economics evaluates the goods and services that nature provides that are of value to humans so that environmental benefits can be considered in development and land use decisions. His approach involves meshing spatial planning, ecology and economics to help achieve multiple objectives on the landscape.

"What I am trying to do is to illuminate the ways in which nature provides value to people, and find ways to have these values considered in decision-making by governments, businesses and households," Polasky says.

NatCap is a partnership among the university's Institute on the Environment, the World Wildlife Fund, The Nature Conservancy and Stanford University's Woods Institute for the Environment. Founded in 2006, NatCap has developed science-based approaches and a suite of software tools that quantify, map and value the services nature provides, giving decision-makers a way to assess the tradeoffs associated with different development scenarios.

"It's thinking about where to do what, so that we can, for example, produce high-yield crops and have high-quality water, without having to sacrifice one for the other," he says.

Investment in natural capital can yield enormous benefits for society, Polasky says. For example, wetlands and oyster reefs can provide protection from storms for coastal communities, as well as benefits from harvesting oysters and fish. Recently, NatCap produced a decision-support tool that helped coastal planners along the Gulf Coast assess how and where restoring the ecosystems could best protect shorelines while simultaneously reinvigorating the fisheries industry.

"Our long-term vision is to 'mainstream' natural capital so that the benefits of what we call ecosystem services have the same weight as other factors that are routinely considered in development decisions," Polasky says.

Steve Polasky leads the project and believes public policy needs bold changes.

Polasky sees many hopeful signs. He's consulting with scientists and policymakers as China works to establish a national system of ecosystem service conservation areas, which eventually will protect 24 percent of the landscape. Local officials will be encouraged to pursue sustainable development, and their progress will be measured in terms of both economic and environmental outcomes.

Polasky recently completed an analysis of how land use in the United States is likely to evolve between 2000 and 2050 and he notes several powerful trends that will shape the landscape.

"There's a trend toward reforestation rather than deforestation, which is positive," Polasky says. "The biggest worry is habitat loss. Several species could lose up to 10 percent of their habitat over the next 30 or 40 years."

To arrest these underlying trends, public policies governing economics and the environment "need to be pretty bold," Polasky says. "In the 20th century, development didn't consider the importance of nature. That needs to pivot in the 21st century." *–Julie C. Lund*

To learn more about the Natural Capital Project, visit www.naturalcapitalproject.org.

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TOOLS OF THE TRADE

The Bee Lab

Bees pollinate the crops that provide 35 percent of the food that winds up on the table—apples, onions, cranberries, almonds and more—a service worth $15 billion to $18 billion to the ag industry. But the disruption of natural habitats, reduced forage for bees, the widespread overuse of pesticides and numerous bee diseases and parasites have created a crisis for all bees.

Honeybees collect nectar from flowers within a radius of around 3 miles. The nectar is taken back to the **bee hive or nest**, where it is dropped into hexagonal shaped cells, which bees make out of wax. Once most of the water has evaporated, the bees cap the cells with wax to store the honey.

At the new Bee and Pollinator Research Lab on the St. Paul campus, researchers will continue to use all sorts of tools:

Beekeepers use a **smoker** to blow smoke into a beehive before managing the hive. Although European honey bees are known for their gentle nature, a smoker helps calm the bees while the beekeeper inspects the colony. The classic smoker consists of a firepot, bellows and a nozzle to direct smoke. The bellows force air through the fuel-filled firepot, while smoke exits through the nozzle.

The iconic **round hat and veil** keeps bees well away from the apiarist's face.

Ana Heck of the Bee Squad carefully uses a **hive tool** to separate the honey filled frames within the hive.

Development**Team**

The College of Food, Agricultural and Natural Resource Science's development staff is available to discuss giving opportunities with you and to answer any of your questions. Contact us anytime!

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Patented Success

Alumna Penny Aguirre pursues a passion for plants and potables

Penny Aguirre writes patents for the U of M's fruit varieties—and grows them.

Penny Aguirre's ('96–M.S., Horticulture) first love was animals. She enrolled in a vet tech training program near her childhood home in Moorhead, Minn., before transferring to the U of M. She had a strong interest in science and biochemistry and graduated with a bachelor's degree in microbiology.

It was while working as a scientist at the University of Kansas and living in Lawrence, Kansas, that Aguirre found her second love: plants.

"There were magnolias and cherry trees," she remembers. "I became a crazy gardener."

Aguirre decided that she wanted to learn more about horticulture just as the Plant Molecular Genetics Institute was being formed under Professor Alan Smith. "I told him, 'I'll work on anything but it has to be plants,' " she recalls.

After earning a master's degree in horticulture, Aguirre bought a small wholesale business field growing unusual plants for nurseries and other buyers. "I became a plant collector, just like other people collect stamps or coins," she says. She then took a job as general manager at PlantHaven in Santa Barbara, Calif., an independent agency that introduces new plant species to the U.S. market.

"'Oh, by the way,' they said, 'part of the job is writing plant patents.' "

After a few years, Aguirre took the patent bar exam and became one of the nation's few patent agents specializing in plants. The key to a successful plant patent, Aguirre says, is a plant that is not already available in the marketplace; one that is uniquely different than any other plant, whether patented or not; and one that is stable and can be consistently propagated.

Aguirre moved back to Minnesota and set up shop as an independent contractor writing plant patents.

That's when Aguirre found her current love: wine.

"I got the contract to write the patents for the cold-hardy crops that University of Minnesota researchers develop," she says. "The apples, the shrubs and perennials."

And the grapes.

Aguirre remembers visiting with fruit breeders Peter Hemstad and Jim Luby at the Horticultural Research Center near the Minnesota Landscape Arboretum in Chaska, Minn. "I tasted the wine and thought, 'this is pretty good!' "

Now Aguirre is co-owner of the Richwood Winery near Detroit Lakes, Minn. The tasting room has been open for four years, and the vineyard also serves as an event space for weddings, family reunions and other special events. "We wanted to make a community gathering place where people in the area can meet each other and become friends," Aguirre says.

The winery grows Frontenac Gris, La Crescent and Marquette grapes—all varieties that were developed at the university and all of which Aguirre helped to patent. Aguirre continues to be a patent agent. "That can be done anywhere," she says. "But the winery is very hands-on and it's here," she says. "If the winery were in the Twin Cities, I'd never be able to go to my lake cabin. Here it's just seven miles away."

Richwood Winery has yet to turn a profit, and the past winter's "polar vortex" killed or damaged many of the vineyard's vines. But, for Aguirre, at least for now, the winery is a labor of love.

–Julie C. Lund

To see more pictures and learn more about Richwood Winery, visit www.richwoodwinery.com.

Your CFANS Story

CFANS Alumni Society Board President Paul Hugunin

The CFANS Alumni Society Board of Directors is excited about the role that we can play in helping students have a positive experience on campus and preparing them for the real world. Several of us helped welcome this fall's incoming freshmen by joining them for lunch during Welcome Week. Seeing their enthusiasm (and nerves!) brought back a flood of memories about what it was like to come to campus "back in the day."

I'll always remember my first days on campus because it was such a challenging time in my life. My mother passed away just days before I left the farm to start my freshman year—at a college that my high school counselor had advised against because, in his words, "it's too big, too impersonal and you'll just be a number."

More than 25 years later, I can still hear those words. And I still treasure the many wonderful people who came into my life during that difficult time and proved him wrong. The faculty, staff and fellow students who welcomed me to campus have become such an important part of who I am, personally and professionally. They're why I'm so passionate about the CFANS Alumni Society. Here are a few ways you can join us in making a difference in the lives of today's students.

Mentor a student! The CFANS mentor program helps students build an off-campus network of professionals in their field. It's easy—you don't have to live in the metro area, state or even in the United States to participate. Just be willing to have at least one quality meeting with your student each month, by phone, in person, via Skype or whatever works best.

Participate in speed networking events. You don't need to be an expert networker; a willingness to listen and offer constructive feedback is all it takes. Watch your email for details and join us!

Volunteer to do an informational interview with a student or to make a classroom visit.

You all have your own CFANS story to tell, even if it wasn't called CFANS when you were on campus! Sharing our stories is the only sure way to make certain prospective students, policymakers and high school counselors know what an amazing resource we have. The same place that gave the world a Nobel Peace Prize winner and the HoneyCrisp apple is positioned to address many of today's greatest challenges, from invasive species to climate change to water management to the next generation of fuels. Far too many people carry the stereotype of a St. Paul campus known only for "sows, plows and cows." And while those things are all still important to the mission of a land-grant institution, it's up to us to help spread the word that CFANS is a leader in addressing the everyday issues facing our land and our society.

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The "Big Golden Minnesota M" was a soybean crop art display on the St. Paul campus in the summer of 2014. Ph.D. student Ben Campbell and several technicians in the Minnesota Soybean Breeding program planted out a golden "Minnesota M" using a mutant soybean line, MinnGold, that has yellow leaves. After the field was planted with green leafed soybeans, the Minnesota M was traced out in the field. Then the green soybean plants within the Minnesota M were removed, and yellow leafed soybeans were planted.