grow

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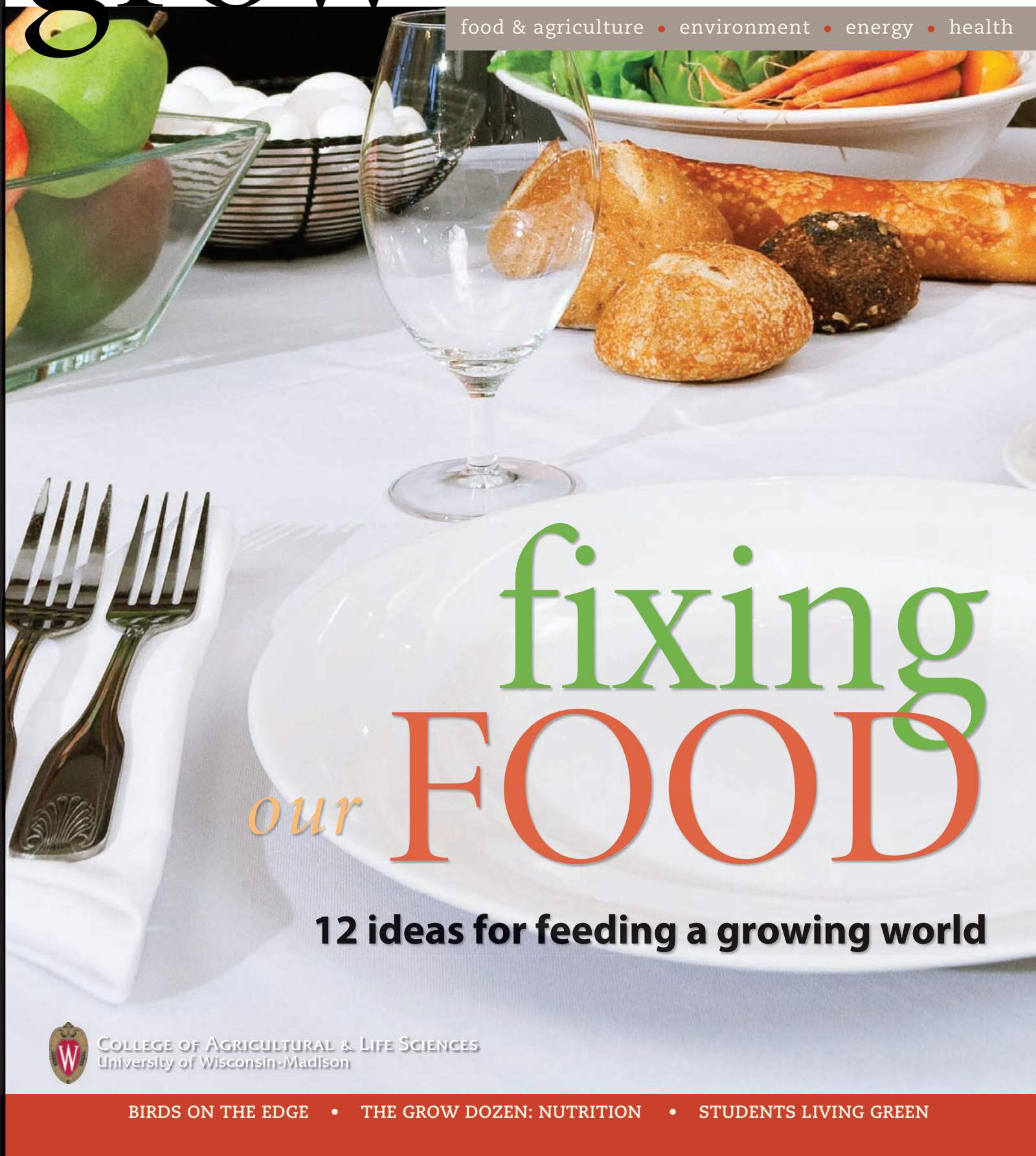

fixing our FOOD

12 ideas for feeding a growing world

College of Agricultural & Life Sciences
University of Wisconsin-Madison

Volume 3, Issue 2 • Spring 2010

grow

Wisconsin's Magazine for the Life Sciences

THE BECKONING GLOW of light from UW-Madison's Walnut Street Greenhouses casts warmth over a snowy winter evening.

On the cover: A dining table at UW-Madison's University Club sets the mood for this issue's focus on food.
Photo by Wolfgang Hoffmann

Interim Dean Irwin Goldman PhD'91

The Experience of Food

Pablo Neruda, the great Chilean poet, wrote that the tomato enters the kitchen and "takes its ease on countertops, among glasses, butter dishes, blue saltcellars. It sheds its own light, benign majesty." Food has a presence that extends far beyond our own sustenance. It is, on its own accord, the marriage of art and science, of farming and technology, of markets and opportunities. It captivates us in the way all art does. And at those moments, it seems vulgar to talk about it in terms of its calories or its futures price.

For more than 120 years, our college has had a hand in the production of food. We have taken the position that studying its elements would translate into benefits for people, animals and our natural resources. We have unquestionably advanced the frontier of knowledge about food production, food quality and nutrition. And in the process, we have focused much of our attention on food itself: its wonder and beauty as a natural object, the importance of producing it with efficiency and care, and our obligation to treat it in a manner that can be sustained by generations to come.

Food has a presence that extends far beyond our own sustenance. It is, on its own accord, the marriage of art and science, of farming and technology, of markets and opportunities.

Agriculture is among the most revolutionary innovations of humankind, a technology that has allowed us to feed a growing population, but one that creates profound effects on our world. The domestication of crops, animals and microbes renders them entirely dependent on us for their survival, giving us responsibility to steward the land and its bounty. The beauty of our job as educators, as scientists and as citizens is that we can be sure that our stewardship is well-informed and compatible with culture and tradition.

The famous epicure Jean Anthelme Brillat-Savarin said: "Tell me what you eat, and I will tell you what you are." In that spirit, we devote this issue of *Grow* to our modern food system: its complexities, its challenges, its past and its future. With the benefit of science, art and even a bit of poetry, we strive to show what we eat—and, by extension, who we are.

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Rural Route

Scholarship fund fills growing gap in student aid.

Growing up outside Osceola, Wisconsin—population 2,700—Elizabeth Peterson hauled hay bales and helped take care of the 70 head of Limousin cattle on her family farm, extracurricular labors that don't show up on many college applications. But those experiences had an indelible mark on her education.

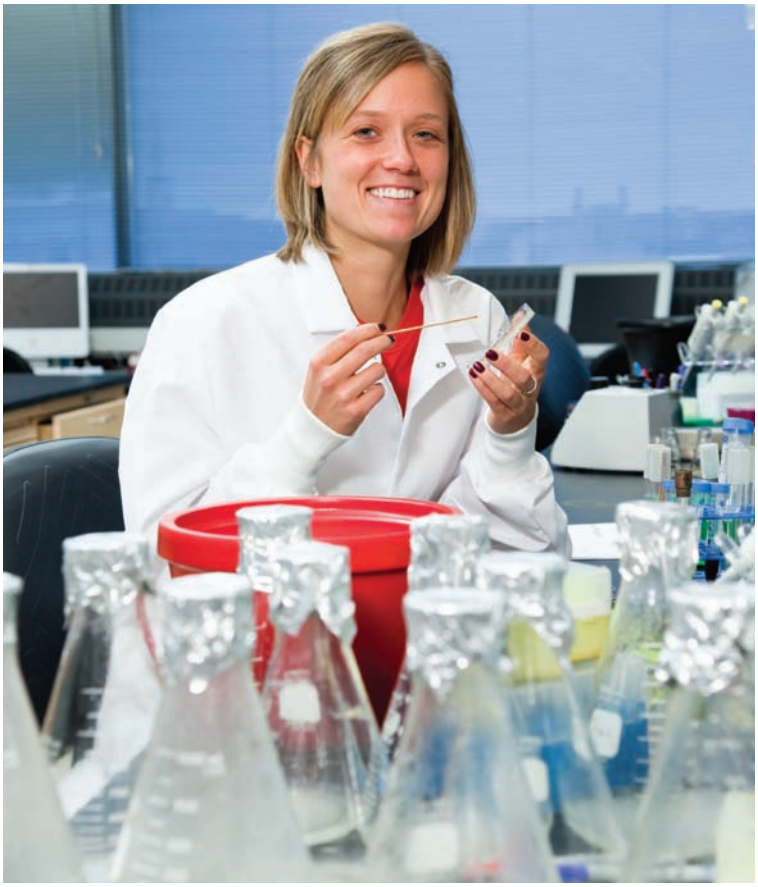
"I have learned many life lessons that I have used and hope to pass on someday," says Peterson, a senior majoring in biology.

For generations, CALS classrooms have been enriched by students who, like Peterson, have roots in rural, agrarian communities. But for many of those students, access to higher education is becoming a higher hurdle. With average incomes in rural communities lagging those in cities by some 20 percent, tuition and housing expenses are priced beyond what many rural families can afford. Federal and state financial aid often aren't enough to compensate—UW-Madison officials estimate that the total aid packages offered to students fall about $20 million short of their needs. And because of sagging budgets, the Wisconsin Higher Educational Aids Board projects that 20,000 low-income students won't receive state grants this year.

To help fill the gap, CALS launched the Wisconsin Rural Youth Scholarship Fund, a need-based program to support students from Wisconsin's more than 220 rural high schools. Started in 2008, the fund awarded its first 12 scholarships this academic year, including one to Peterson.

"(The scholarship) means more than I can express in helping me follow my dreams," says Peterson, who plans to become a pediatrician. "There are many kids out there like me who can use this same help."

Currently, only 14 percent of the scholarships and awards offered by CALS use financial need as a component. But according to UW-Madison Chancellor Biddy Martin, the gap between the total aid package available to students and the actual cost of the university grew 28 percent between 2000 and 2005, underscoring the need for a new focus on need-based aid. In 2008, Martin kicked off the Great People Scholarship campaign to significantly boost the university's pool of need-based aid, and she has charged all colleges to ramp up their efforts to address students' unmet financial need.



CALS senior Elizabeth Peterson carries out a lab experiment for a biology class.

The Wisconsin Rural Youth Scholarship fits the goals of the Great People campaign in a way that complements CALS' history and mission, says Interim Dean Irwin Goldman PhD'91. "A vibrant community of students from rural backgrounds broadens the educational experience for all of our students," he says. "This is the right thing to do because rural communities are an important part of our legacy—and they're perhaps even more important to our future."

—Arla Dauscher

Getting the Scoop

Babcock dairy plant playing a bigger role in student training

At the Babcock Hall Dairy Store, Sara Brummel is learning on the job.

After earning her degree in marketing and human resources, Sara Brummel looked around for a sweet job. And that's exactly what she found, landing a position with one of the sweetest spots on campus.

Now, as manager of the Babcock Hall Dairy Store, the 2008 UW-Madison graduate is in charge of more than two dozen employees—and a healthy scoop of university tradition.

"When I first started, I was told the dairy store is a campus showpiece," says Brummel, "and that I should try to make it even more of a showpiece."

Putting a recent graduate in charge of CALS' famed dairy store was the brainchild of Bill Klein BS'83, Babcock's plant manager. Seeking ways to enhance Babcock's mission as a training ground for future professionals, Klein converted the store manager position, formerly held by career staff, to a two-year internship. Brummel became the store's first intern in December 2008, and Klein says the experiment has gone so well that he's now planning to add interns in other parts of the dairy operation, including the plant where Babcock's famous cheeses and ice creams are produced.

"When I ask myself why (the dairy plant) was built, I always go back to the fact that it's meant to provide an educational experience for students," says Klein. "We're trying to make use of these facilities as a place where students can get some experience before they go off into the real world."

Klein says Babcock's high standards and loyal customer base mean that interns have to meet tough expectations. But fresh faces bring other advantages, he says. "What I like about it is I get an enthusiastic employee who's got a lot of ideas, who's very smart and wants to make their mark."

And so far, Brummel has proved Klein right. In her first year on the job, she has expanded store hours and introduced several new products, including fresh bakery goods and fair-trade coffee brewed specially for the store. She has also redesigned the store's web site and signage, bringing in screens that describe daily ice cream flavors and specials.

"It's pretty amazing to be put into this kind of management position right away and to be given the kinds of responsibilities that I have," says Brummel. She even gets to experiment with new ice cream flavors—and there's only one word for that kind of assignment: sweet.

—Nicole Miller MS'06

New Collagen: Better than Nature?

FOR DECADES, DOCTORS HAVE USED COLLAGEN FROM COWS to treat arthritis, severe burns and other ailments that result from a breakdown of the body's natural collagen. But a new alternative—human collagen engineered in the lab—is getting nearer. CALS biochemist Ron Raines, whose lab made the first synthetic human collagen in 2006, recently announced that his team has developed a form of collagen that is stronger than the real thing. "It's by far the most stable collagen ever made," says Raines. The breakthrough came by swapping out some of the amino acids in natural collagen with similar, but less-flexible alternatives, helping the synthetic collagen hold form. Raines says the synthetic collagen is indistinguishable from its natural form and could eliminate the risk of cross-species transplants.

Life on the Edge

Restoring grass may not be enough to help grassland birds

A savannah sparrow takes respite on a fence post in a Wisconsin pasture.

At first, all you see is the three-foot-long milk snake, a compact spiral that fills the center of the video screen. Then Daniel Schneider BS'07 points out a tiny beak, nearly obscured by the snake's banded markings. It's all that's visible of a fledgling sparrow being crushed in the tightening coils.

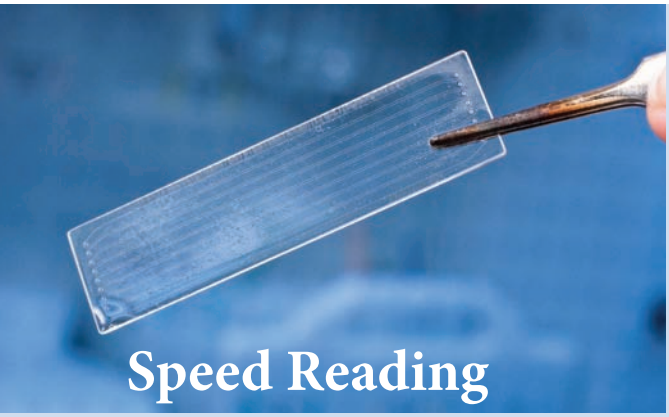
Schneider has watched a lot of this kind of mayhem. As part of a research team led by CALS wildlife ecologist Christine Ribic, he has accumulated hundreds of hours of video spying on the nests of grassland birds. He's seen chicks and eggs devoured by snakes, skunks and deer, leaving no doubt life is tough for the birds that nest in Wisconsin's tall-grass prairies. It doesn't help that those prairies are small and fragmented, putting the birds' nests in reach of woodland predators.

But the footage also shows that protecting grassland birds isn't as simple as protecting grassland. Ribic's team put cameras on nests in six grassy sites—three near tree lines and three in locations where trees had been removed to create more open habitat. While clearing trees did tend to increase nesting of some bird species, it also cleared the way for new predators. Chief among them: the grass-dwelling ground squirrel, which was the culprit in up to 75 percent of nest raids where trees had been removed.

That doesn't necessarily mean that removing trees won't work in the long run. Ribic's team will return to the sites in five years to see if the impacts on both birds and ground squirrels were short-term or permanent. But the findings are a reminder that there's no such thing as a small change in a natural system.

"When you create new grassland in an area where grassland is limited, it's not just birds that will want to live there," Ribic says. "Everything else that lives in grasslands, including predators, is going to take advantage of the new habitat. The whole system changes. You have to think bigger."

—Bob Mitchell BS'76



Speed Reading

A DECADE AGO, CALS GENETICS researchers Nicole Perna and Jeremy Glasner were part of the team that sequenced the genome of the bacterium *E. coli*, at the time one of the most complex organisms to be completely coded. The breakthrough uncovered what was then considered a treasure trove of new genetic information—some 4,200 genes, 40 percent of which had no known function.

But the coding didn't stop then. Counting unique genes across all of the strains of *E. coli* that have been sequenced, "we're up to about 25,000 genes now," says Perna, an associate professor of genetics. "So we're starting to approach the number of genes in a eukaryotic species."

New genetic information is coming faster than ever, thanks to meteoric advances in sequencing technology. In the infancy of genomics, scientists used hands-on lab work to read DNA by eye, viewing a few hundred base pairs at a time. Completing the sequence of even simple forms of life required years of effort. Now sequences are read by machines that are able to spit out increasingly huge chunks of data. The newest generation of sequencing equipment in UW-Madison's Biotechnology Center can generate the entire genome of a bacterium—roughly four to 12 million base pairs—in one read.

Speed has opened a new frontier in genomics: the freedom to hunt. In the old days, the cost and labor of sequencing meant that only obviously important forms of life were coded. Now scientists can scour genomes of multiple organisms in hopes of finding surprises. Perna and Glasner are now making comparisons across several strains of E. coli to seek out genes most responsible for key differences in ability—why some strains of *E. coli* are pathogenic to humans, for example, while others are harmless.

"We're finding out that we actually had very little information before this," laughs Josh Hyman, who directs the DNA sequencing facility in the Biotech Center. "I mean, a tiny amount of information." By comparison, today's rush of data can seem like "trying to drink out of a fire hose."

—Madeline Fisher

classAct

Sheri Nelson BS'09

Clean Water ... One Sip at a Time

After learning that a child dies every 15 seconds due to lack of clean water, Sheri Nelson decided to do something about it.

"People are good at heart, and when they hear a statistic like that they don't like it. But they don't know what they can do to help," says Nelson, who graduated in December with a degree in life sciences communication. "So I decided to put something in place—a tangible thing—that would allow people to help with the water crisis."

Last April, Nelson began selling reusable aluminum water bottles to raise awareness and money for the water crisis. She founded a nonprofit, WaterDrops of Hope, which uses proceeds from bottle sales to fund well-building projects in rural Africa. Just before graduation, she wrote its first check, which will construct a new well in Kenya.

"I can't wait to go out and see one of these wells being built," says Nelson, who grew up on a hog-and-crop farm in East Troy, Wisconsin. "That's another one of my goals."

ADVANCED to the national finals of the Intercollegiate Ethics Bowl: the **UW-Madison student ethics team.** Sponsored by the Association for Practical and Professional Ethics, the competition pits undergraduate teams from 32 universities in a battle of ethical reasoning. The five-member UW team, including four CALS students, won the Upper Midwest Regional Ethics Bowl in November.

RELEASED to rave reviews, the HyRed cranberry. Developed by horticulture professor **Brent McCown**, the fast-ripening, intensely red cultivar was harvested commercially for the first time in 2009. McCown says growers like the high yields they are seeing from the berry, as well as the fact it can be harvested earlier in the fall than other varieties.

SHORT-LISTED for a National Book Award: *Remarkable Creatures*, by CALS evolutionary biologist **Sean Carroll**. The book—an adventurous tour through two centuries of natural history—was one of five titles nominated in the nonfiction category.

PRESENTED with a Presidential Early Career Award for Scientists and Engineers: CALS associate professor **Cameron Currie.** An expert on symbiotic relationships among insects and bacteria, Currie was one of 100 scientists to win the annual award, the highest honor the U.S. government bestows on early-career researchers.

HONORED Soil science professor **Teri Balser,** with a National Teacher Award by the Association of Public and Land-Grant Universities. Balser, who directs UW-Madison's Institute for Cross-College Biology Education, teaches soil-science and biology courses, as well as an introductory course in environmental studies. The association also recognized dairy science professor **Michel Wattiaux** with a regional teaching award.

PUBLISHED by the University Wisconsin Press, ***The Master Cheesemakers of Wisconsin.*** Authors James Norton and Becca Dilley interviewed every certified Master Cheesemaker in the state to divine what makes Wisconsin cheese the cream of the crop.

Number Crunching

20 TONS OF POTATOES donated by the Rhinelander Agricultural Research Station to Wisconsin food pantries on one day in September. Many of CALS research stations contribute food grown as part of their research missions, including watermelons, okra and cabbages. And every bit helps: Food pantries estimate that Rhinelander's potato harvest provided food for more than 700 families.

how to make a **carrot purple**

In the hands of a careful plant breeder, a vegetable can become like an artist's canvas, willing to take on any color in the rainbow. Breeders have managed to turn cauliflowers orange, asparagus purple and tomatoes black. And while consumers are drawn to the unusual hues, the primary goal of these transformations is usually to boost human health. Orange, for example, is typically the mark of beta-carotene, which turns into vitamin A in the body. Here's how a carrot breeder would add a splash of purple—the color associated with cancer-fighting anthocyanin compounds—to a typical orange carrot variety.

P.W. Simon

1 Head for the wilds. A purple carrot might look odd by today's standards, but it's actually a lot closer to what nature intended. Most cultivated carrots were purple until a few hundred years ago, when orange mutants began to catch the fancy of European diners. Wild, purple-skinned carrots can still be found in parts of central Asia, and these ancient relatives hold the genes a breeder needs to return a garden-variety carrot to its original hue.

2 Let the breeding begin. Back at the greenhouse, the wild plants must be coaxed to grow. Once they flower, the breeder uses a small paintbrush to collect pollen and transfer it to the blossoms of conventional orange carrot plants. The seeds created through this assisted fertilization are true hybrids, containing approximately equal parts purple carrot DNA and orange carrot DNA.

3 Thin the patch. Invariably, these first hybrids are far from ideal. They contain too much wild carrot DNA and it shows; the vast majority are too small, too bitter or too twisted—or all of these things—to succeed in the commercial market. The trick is to weed out any other influence from the wild parent except its color.

4 Cross again... and again... and again. Even in the age of biotechnology, most plant breeders tease out favorable traits the same way farmers have for several millennia, through a painstaking cycle of trial-and-error. Promising hybrids are crossed with other promising hybrids—and in some cases with the parent strains again—through multiple generations in a process that can require years to produce desired results. For carrots, the wait is particularly frustrating as the plants flower only once every two years. But with patience comes perfection, as repeated selection slowly hones in on the right mix of genes to produce the ideal set of traits.

5 Lock it in. As soon as a breeder comes up with a perfect purple carrot, it's time to stop cross-breeding and start self-pollinating the plant. This halts the process of DNA mixing and allows this sought-after plant—with its desirable assortment of genes that were so painstakingly assembled—to be propagated intact. Voilà—a purple carrot for the commercial market.

IRAQ

Rebuilding Iraq's Farms from Ground and Sky

Nic Jelinski BS'04 MS'07 and Mutlu Ozdogan haven't had your average research collaboration. While they observed and collected data from the same farm fields and become friends, they have never met face-to-face. And while Ozdogan worked in the typical khakis-and-button-down attire of a university professor, Jelinski wore a helmet and body armor.

What they shared was a desire to help the people of Iraq rebuild their nation's agriculture after years of war and political turmoil.

The partnership began last year, after Jelinski was deployed to Iraq with the U.S. Army's 450th Civil Affairs Battalion. Civil Affairs troops serve as the liaison between coalition forces and Iraqi civilians, providing assistance on projects to return security and stability to the war-torn country. Stationed in the Al-Mada'in district, a region south of Bagdad heavy with agriculture, Jelinski became involved in projects to build better irrigation and water-management systems—a good fit for the UW-Madison grad, who had studied soil and water management while earning a master's degree in land resources.

Jelinski says Iraqi agricultural scientists and engineers have done their best to keep agricultural infrastructure functioning throughout the war, but until recently they did it without the fast-evolving technology and data that their counterparts around the world now take for granted. "They were particularly interested in using satellite remote sensing and GIS to learn about how cropland is changing and water is being used," says Jelinski, who completed his tour in January. "I'm not an expert in any of this, but I knew of people (at UW-Madison), especially Mutlu, who were. So it popped into my head that maybe there was a chance for a partnership between the Army, the Iraqis and the University of Wisconsin."

Enter Ozdogan, an assistant professor in forest and wildlife ecology and a scientist with the Nelson Institute's Center for Sustainability and the Global Environment. From his time at UW-Madison, Jelinski knew the center produced global-scale crop maps based on satellite imagery. But there's only so much you can see from the sky. "The only information I have is a measure of greenness—it's just the light information from satellites," says Ozdogan.

Jelinski organized "ground truthing," enlisting Iraqi scientists and farmers to record GPS coordinates and take pictures of fields at different stages of growth, to help Ozdogan make sense of what he's seeing. "This data helps me interpret the greenness into land cover data—whether it's corn, wheat or date palm." Ozdogan says.

The project dovetails nicely with some of Ozdogan's other work, including a project funded by NASA to map use of irrigation water throughout Iraq. But it has also forged relationships that are helping reconnect Iraqi researchers with the global scientific community.

"What Mutlu has brought to the table is a tremendous opportunity for our Iraqi friends to network with the outside world, which they have been cut off from for the last 20 years," says Jelinski. "This is really a story about the resiliency of the Iraqi people—the farmers, families, engineers and scientists who have continued their work and livelihoods through the instability of the past years."

—Bob Mitchell BS'76

In Iraq, U.S. soldiers are helping Iraqi scientists get a bird's-eye view of their country's irrigation systems.

Nic Jelinski

RUSSIA

For Saiga Antelope, A Reason to Smile

With a snout that looks like the stub of an elephant's trunk, the Saiga antelope is not the handsomest creature in the animal world. But that's the least of its problems.

Just two decades ago, nearly a million of these creatures roamed the steppes of Kalmykia, in southern Russia. Now there are about 20,000. Their

(c) Igor Shpilenok / naturepl.com

Why the long face? Once a million strong, the Saiga antelopes of southern Russia now number less than 20,000.

decline began with Soviet era farm subsidies that encouraged sheep producers to overgraze. Then, when the U.S.S.R. broke up and subsidies ended, declining sheep numbers left too much dry grass, leading to wildfires that destroyed the sagebrush that the antelope eat in winter. The post-Soviet era also brought on poaching—especially of Saiga males, whose horns are prized for medicinal use—and fragmentation of habitat from new development.

But some Kalmykians are working to save the Saiga, and they've teamed up with Volker Radeloff, CALS professor of forest and wildlife ecology, and Ph.D. student Maxim Dubinin to learn how human pressures have changed the Saiga's habitat and habits. Dubinin is analyzing satellite data to map vegetation on the steppes and using radio collars to learn where the antelope are going and what they're eating. This data will inform conservation efforts, Radeloff says.

"If we know where the Saiga are at different times of year, we can have wardens there to watch for poachers," he points out. "And if we know where they forage in the winter, we can step up fire prevention in critical areas of sagebrush habitat."

Poachers aside, he thinks Kalmykians would support such efforts.

"They're proud of the Saiga," he says. "It's a unique species that isn't found a lot of other places."

—Bob Mitchell BS'76

AUSTRALIA

Plant Scientists Nip a Costly Fungus in the Bud

After growing pyrethrum, a relative of the chrysanthemum flower, on the island of Tasmania for about a decade, Botanical Resources Australia ran into a serious problem in 1999, when a fungal pathogen began ravaging the crop.

"The disease was having a pretty dramatic effect initially," says Paul Esker, an assistant professor of plant pathology. "It was the sort of situation where if we couldn't get a handle on it, the industry would really suffer."

Esker, who specializes in epidemiology and statistics, joined an international team that set out to protect Tasmania's pyrethrum industry. Also grown in Kenya, the flower is cultivated for a suite of insecticidal compounds, which are the basis for the most widely used natural insecticide in the United States.

Over a number of years, the research team monitored the course of the disease in the fields and experimented with the timing and frequency of various fungicidal sprays. "It was pretty much a case of classic epidemiology," says Esker. "Everything was new, so we learned everything we could about the temporal and spatial dynamics of the disease. We just tackled all the new questions."

From there the team developed crop management recommendations to control the disease. The guidelines specified when to spray and when not to, depending on the extent of disease progression, giving growers decision-making tools that would help them keep fungicide applications to an absolute minimum without sacrificing yields.

"The company went from having a substantial challenge," says Esker, "to being able to handle it. The company is in a pretty good situation now. They've even expanded production into Victoria, Australia."

This work is very similar to what Esker, who holds both research and extension appointments at UW-Madison, does closer to home. In Wisconsin, Esker focuses on field crops—including corn, soybean, wheat and alfalfa—developing pesticide management recommendations that take into account all the key factors that could affect yields.

"My goal, more or less, is to combat the 'see it, spray it' mentality," says Esker. "I'm trying to develop tools that will help growers make better crop management decisions that are based on good, grounded research."

—Nicole Miller MS'0

William D. Bachman / Photo Researchers, inc.

The white flowers of pyrethrum, a relative of the chrysanthemum flower, produce a widely used natural insecticide.

Rooms with a Hue

Veteran professor **Jack Kloppenburg** takes on a new role helping students figure out what it means to live green.

So we hear you're starting a greenhouse … What are you going to grow?
(*Laughs*) Well, it's not that kind of greenhouse. What we're doing is creating a new residential learning community here on campus, where students share a portfolio of courses and activities with other residents and faculty. GreenHouse is going to have a theme of sustainability—that will be the unifying element to our community and the programming we offer. So, in fact, I do hope that we will be growing sustainable citizens.

Was this your idea?
It emerged from work I've been doing with a student organization called REthink Wisconsin, which is promoting recycling and waste reduction on campus. Cal Bergman, from University Housing, asked me if I would be interested in helping get these themes into a learning community, and I surely was.

Sustainability is a pretty broad concept. What does it mean in this context?
Well, that's an interesting question, and I think that's something that students will be encouraged and guided to decide for themselves. For me, it means living in material comfort, peacefully with each other, within the means of nature. Now how do you achieve something like that? I think it involves both the biophysical world and the social context. It's about creating an environment where no one is in need, where we're mindful of our impact on our natural resources and on other people. The learning community is a small way that we can begin to model what that looks like in practice.

How do you imagine that experience might look different from life in a typical dorm?
There will be programming that brings the students together and introduces some common ideas. I'm going to lead a freshman interest group that will probably draw from the GreenHouse residents, and the hope is that because these students are living together, they'll take some of the ideas raised in class back home, to their dorm, and discuss and debate them and maybe implement them. But we're also creating opportunities that are unique to this community. We plan to offer a variety of one-credit course options, which will involve thinking and doing, and could be anything from planting flower bulbs on Madison's South side, to maintaining Indian mounds in the Lakeshore Nature Preserve, to canoeing the Wisconsin River, to reading A Sand County Almanac and visiting Leopold's shack.

But we also want to allow students to find their own way into what sustainability means to them.

As one of the anchors of the CALS Department of Community and Environmental Sociology—formerly Rural Sociology—Jack Kloppenburg was talking about sustainability before sustainability was cool. He teaches the popular Food, Culture and Society course, as well as a large introductory lecture course in environmental studies, and is co-director of both the Program on Agricultural Technology Studies and the Center for Integrated Agricultural Systems. This fall, he will help launch the GreenHouse, a new residential learning community, in Cole Hall.

That's really the idea of a learning community—that students not only assess and consider the things they are learning in class, but also find ways to enact them in the world around them. Students aren't just consumers of information. They are citizens, and we'd like GreenHouse to give them opportunities to create some kind of change in the real world.

This will be housed in Cole Hall, which is 50 years old and probably not the greenest building on campus. Does that present a challenge for someone trying to live sustainably?
It surely is. Cole has that Soviet-style look to it, and when I first looked at it, I wondered if it was the right place to do this. But being older, it has some aspects to it that students can transform to make it greener. We're going to be installing solar collectors on the roof, for instance. And we're remodeling the kitchen, which was this one-stove, one-refrigerator facility in the basement that got really haphazard use. We're working with Housing to transform that space into a place where residents can come together to create community by efficiently and pleasurably learning to cook meals for each other.

Do you see food playing a big role in this community?
Absolutely. One of the most intimate ways that we're engaged with the world around us is through the food we eat. That's going to be one of the central, unifying themes in GreenHouse programming. With University Housing's food service staff, we're planning to offer training sessions for all GreenHouse students on cooking techniques. So you could imagine students coming back with a bag of vegetables from the farmers' market and using the knife skills they learned to make a dinner as quickly as they could get it at a fast food restaurant.

Are you getting interest from faculty and staff in offering those kinds of opportunities?
Definitely. It's certainly not your typical pedagogy, where you stand up in front of a room of a hundred students and talk for an hour straight. This is an opportunity for faculty to get out of the classroom and engage in some innovative and concrete activities that let them learn too. It's very kinesthetic, and I think people like that aspect.

I also want to emphasize the role of staff in this project. The staff at University Housing and facilities have been deeply involved in the planning, and they're going to be a key to our success. An important part of this project is to show that staff can and should be a vital part of the pedagogical mission of the university and that it's not just faculty who have things to offer our students.

> "Students aren't just consumers of information. They are citizens, and we'd like GreenHouse to give them opportunities to create some kind of change in the real world."

One of the things that I try to get out of students' heads is that the only place they're going to learn is in a lecture hall. We're all learning all of the time, and the most important teacher that you ever have will be yourself. If students aren't aware of and open to the learning opportunities that constantly surround them, then we're not doing what I hope a University of Wisconsin education should do.

Including each other?
That's critical. With this first class, we're admitting freshmen, but we'd like to see the community expand. We hope that we'll be able to add more floors (in Cole) as sophomores and juniors stick around and new freshmen come in. Ultimately, we want a full spectrum of students living in the GreenHouse, so that seniors and juniors can act as mentors and teachers for each new class coming in.

So the community becomes sustainable.
Exactly—you took the words right out of my mouth.

fixing *our* F

Safe food.

Healthy food.

Enough food.

Can we secure the bounty we take for granted for future generations? A team of CALS experts says that we can meet the world's food challenges—and here are their best ideas for how to do it.

OOD

By Nicole Miller MS'06 and Michael Penn

She will arrive without ceremony, with no visible sign of her significance. She may be born in the United States or abroad, into wealth or poverty. But whatever the circumstance, her birth will mark an unprecedented and daunting milestone. She—or perhaps it will be he—will become the nine-billionth human being alive on Earth. A nine-billionth person to find a place in the world. A nine-billionth body to feed. And she will be here, some estimates predict, in less than 30 years.

Nine billion people is a staggering figure for a world that struggles to provide comfort for considerably fewer. Consider our most basic of animal necessities: the need to eat. While enough food is grown on Earth to support its current population of just under 7 billion people, distribution and consumption of food is wildly uneven.

According to the United Nations Food and Agriculture Organization, more than 1 billion people are hungry, mostly because they lack the resources to grow or buy enough food to nourish themselves. Roughly the same number of people are overweight. In the United States, both obesity and hunger are blooming national crises, underscoring the complex web of social, cultural and economic forces that swirl around our relationship with food.

These problems will grow no easier as the planet approaches 9 billion people. The FAO estimates that the world will need to produce 70 percent more food by 2050 to keep pace with population growth and increased demand for calories. And this productivity boom will have to occur despite depleting natural resources, a diminishing supply of suitable land and a changing climate that could drastically alter the growth of crops we lean on most heavily to feed the world.

So how will our nine-billionth child eat? Will her food be abundant and accessible? Will it be secure from threats? Will it fulfill her nutritional needs? And how will our food systems balance the health and demands of people with the health and demands of the Earth?

On the following pages, you'll see how a dozen CALS scientists are beginning to tackle those questions. Their ideas envision a range of alternatives for how we grow, prepare, distribute and even eat food. We offer them as food for thought—or more fittingly, as thought for food. These are not the only possible answers to the challenges that face our food, but they offer a glimpse of a different kind of future with food, one in which our nine-billionth child—and all who come after her—are born into a world of plenty.

Start a New Green Revolution

Josh Posner We don't just need to grow more food. We need to grow it better.

Seen in color on a world map, agricultural yields are telling. When it comes to corn, for instance, the American Midwest blazes brick red, a powerhouse of agricultural output. By comparison, most of the corn-growing tracts across Africa, Asia, South America and the former Soviet Union are yellow, a color that means these lands yield less than half the grain that Midwestern farms do.

There are other maps for other crops—all revealing significant yield gaps that add up to a disheartening atlas of hunger and poverty. But inside the yellow zones, many of the farms have the potential to produce much more—and in the near future, we're going to need them to do just that.

"There's not enough virgin farmland out there to meet the growing demand for food, so we're going to have to increase production on the farms we have," says CALS agronomist Josh Posner, who studies cropping systems in tropical countries. "It's critical, however, that we do it in a sustainable way."

The last significant uptick in global crop yields came during the Green Revolution of the 1950s, '60s and '70s. An international cohort of researchers, led by the late Nobel laureate Norman Borlaug, led a push to develop higher-yielding varieties of wheat and rice that dramatically boosted yields in Mexico, India, Pakistan and parts of Asia. The project helped turn Mexico into a net exporter of wheat and doubled wheat production in India and Pakistan. But the new crop varieties required irrigation and significant doses of chemical fertilizers and pesticides, which has made yield gains difficult to sustain.

"The Green Revolution model of breeding crops that respond to higher and higher levels of petrochemical inputs was very successful," says Posner, "but it is increasingly being questioned as we learn more about the environmental impact of these systems and the rising costs of inputs make their economic logic questionable."

So while the yield maps call out for a new Green Revolution, Posner says this time it has to be different kind of revolution. Instead of breeding crop varieties that depend on expensive and environmentally taxing chemical inputs for their yield gains, he says the focus should be on applying biology-based approaches to improve productivity, enhance soil quality and manage pests. That means developing more minimum-tillage systems, planting more cover crops and designing improved crop rotation systems. It also means breeding crops for factors beyond yield, including enhanced nutritional quality and for efficient use of limited resources.

"The future of food production in the tropics will include a mosaic of different farming systems," he says. "However, there's little incentive for the private sector to develop these systems, so the challenge of leading this greener Green Revolution really falls to the agricultural colleges of the world."

A world map shows global "greenness," a measure scientists use to study vegetation patterns in forest and croplands. Darker areas reflect denser, healthier plant life.

Reform Crop Subsidies

Ed Jesse Federal agricultural programs are beginning to reward farmers for more than just yield, but there's still more room to incentivize best practices.

Since 1996, America's farmers have been receiving between $5 and $6 billion each year in federal agricultural subsidies that are based solely on historical crop production levels. That needs to change, says Ed Jesse, an emeritus professor of agricultural and applied economics.

"If you look at what our society wants out of agriculture, it's more than just protecting farmers' income," says Jesse. "People want food security, food quality, food safety, and to protect soil and water quality, and I believe these broader social goals should be explicitly incorporated into our agricultural policy."

This sort of thing is already being done in Europe, notes Jesse, where farmers receive direct payments each year that are independent of production. To receive these payments, European farmers must maintain their land in good agricultural and environmental condition. "If we want to, for example, prevent further erosion or deterioration of our soils, we could make our direct payments conditional on farmers adopting practices that are known to be sustainable in terms of preventing soil erosion and soil infertility," says Jesse. "The European Union has shown it can be done."

U.S. farm policy has taken steps in that direction. The Conservation Security Program, created as part of the 2002 U.S. Farm Bill, encourages farmers to continue good stewardship practices—and to adopt additional ones—on actively farmed lands. This program was expanded and re-named the Conservation Stewardship Program in the 2008 Farm Bill, the first U.S. farm bill to support farmers making the transition to organic agriculture.

But wide-scale reform of crop subsidies is far from universally embraced. Federal crop support programs generally reward farmers based on current or past levels of production with only limited restrictions on farming practices. Commodity groups argue that these programs ensure America's affordable food supply and protect farmers from market volatility that might otherwise put them out of business. While recent farm bills have imposed caps on direct payments, Congress has so far shown little appetite for wholly dismantling the production-based model.

"I think ag policy has to be an evolutionary process, and I'm pleased to see that it has evolved to the point where these other goals are being considered," says Jesse. "But I think that perhaps this evolution could be jolted a bit by removing some of the program principles such as direct payments on the basis of either current or historical production levels, and moving that money into programs that will help us meet the broader social goals we want our agricultural system to achieve."

Soybeans are among a handful of crops that can earn federal subsidies based on historical yields.

Diversify Crops Regionally

For virtually every bag of salad greens purchased anywhere in the United States, the journey begins in California's Salinas Valley. The fertile band east of Monterey bills itself as "America's salad bowl"—and with good reason. Nearly 80 percent of the country's lettuce and more than half its spinach is grown there.

But eating from one bowl has its risks, as Americans discovered after an *E. coli* outbreak on a Salinas County farm in 2006. Tainted spinach leaves sickened more than 200 people nationwide, causing three deaths, and bagged spinach virtually disappeared from American grocery shelves.

CALS agronomist Erin Silva says the spinach scare underscores one of the dangers of our current food system, which tends to concentrate production of many crops into small geographic areas. While economically advantageous for processors, the practice leaves significant portions of the nation's food crops vulnerable to pathogens, plant diseases, bioterrorism and vagaries of weather. And consumers pay the price: when heavy rains hit central Illinois last fall, for example, the bulk of the nation's crop of canning pumpkins was ruined, making a once-plentiful product instantly scarce.

These vulnerabilities could be fixed by thinking regionally, says Silva, who conducts and coordinates research on organic production systems at CALS. "If we diversified the crops we grow within our agricultural regions," she says, "that would do much to improve our food security."

Erin Silva Concentrating agricultural production is becoming expensive and risky. We need a broader array of foods grown closer to home.

The key, says Silva, is matching a region's food-production capacity with its market demand. Silva is part of a team of researchers who are trying to do that for Midwestern vegetable growers. The project aims to assess the opportunities and limitations associated with expanding the region's vegetable production systems, including the creation of entirely new systems for crops that have traditionally been in California's domain.

"Obviously, we're much closer to the eastern markets and our own markets here in the Midwest, so it would definitely have an impact in terms of reducing food miles, as well as helping to diversify these crops out of California," says Silva. Regional food production also could be a boon to America's struggling mid-sized farms, which are large enough to produce quantities of food desired by wholesalers but nimble enough to adapt to shifting demands.

So what makes now the time for change? Silva thinks the growing interest in local foods offers an opportunity for regional food systems to take off. Consumer interest in locally grown foods has been stoked by farmers' markets and community-supported agriculture, but those outlets may not supply enough food to satisfy the demands of institutional buyers, such as schools and businesses.

"If we want to increase the number of people that local food systems reach," says Silva, "we have to think in terms of bigger scale."

Nearly 80 percent of the country's lettuce and more than half of its spinach is grown in one valley in California.

Preserve Our Farmland

Steve Ventura As urban development sprawls deeper into the heartland, we need to counter the market forces that cause us to lose the best land for growing food.

Growing houses—that's what the old-timers say about the land that lines highways like U.S. 18 in Wisconsin's Waukesha County. Pancake flat and topped with a layer of rich, black soil, stretches such as this one, less than an hour west of Milwaukee, were once among the state's most productive farmland. But as the city crept nearer, the farms were cleared one-by-one to make way for the county's new bumper crop: suburban developments.

With nearly half of its 1963 farm acreage now growing houses, Waukesha County is an extreme example of a widening trend. From New England pasture to California valley, America's best land for growing food is rapidly turning over to other uses, primarily residential development. According to the U.S. Department of Agriculture, 442 million acres of U.S. soil grew crops in 2002, down 28 percent from 1978 and the lowest figure since World War II. And while there's still plenty of bread coming out of the breadbasket, the American Farmland Trust estimates that 86 percent of the country's fruits and vegetables and 63 percent of its dairy products are produced in areas affected by urban sprawl.

"We're well past the tipping point for many of these formerly agricultural communities," says Steve Ventura, a professor of soil science and environmental studies, and director of UW-Madison's Land Information and Computer Graphics Facility. "And once productive farmland is converted to residential or commercial use, it's converted forever. It's practically impossible to bring it back."

Ironically, it's never been easier to identify farmland that merits preservation. Technologies such as geographic information systems (GIS) allow planners to assess biophysical assets of farmland in the context of broader economic forces and identify regions best suited for long-term agricultural use.

But few communities are able to back those plans up with the laws or monetary incentives necessary to keep developers at bay.

So what can help? Public programs like Wisconsin's Working Lands Initiative, which helps local communities buy agricultural conservation easements to protect prime farmland, are a start. But Ventura is among a growing group of scientists who are exploring ways to compensate farmers for the environmental benefits that accrue by keeping their land in farming. There are already efforts toward that end—such as the carbon-trading arrangements where businesses offset carbon outputs by paying farmers to take steps to sequester carbon in their soils—but Ventura suggests the incentives could be bigger and wider, recognizing the role of farmland in recharging groundwater, for instance.

"Society is benefitting from keeping that land open, and farmers are not getting any compensation for it," he says. "This is a good role for the university—to understand and quantify those 'ecosystem services' in a way that would provide the basis for future incentives."

442 million acres of American soil grew crops in 2002, the lowest amount of land in farming since World War II.

Corn grows in southern Wisconsin, where agricultural lands face increasing pressure from development.

Teach More People to Farm

Dick Cates Our food production depends on a shrinking number of farmers. Who will succeed them?

Twenty-five years ago, fresh off a Ph.D. in soil science, Dick Cates weighed a career in academia. But that would have meant giving up the farm. "I just couldn't do that," says Cates, who raises grass-fed livestock on a portion of his old family farm near Spring Green. "I couldn't get that bug out of me."

Cates hasn't beaten the bug yet. But these days it's accompanied by another infectious desire: to inspire a new generation to take up farming. As director of CALS' School for Beginning Dairy and Livestock Farmers, Cates helps would-be farmers gain footing in what he considers the ultimate entrepreneurial venture. More than 300 students have graduated from the program since its inception in 1995, and about half of those have gone on to launch farm businesses.

The program is helping inject new blood into an industry that desperately needs it. Fewer than 1 million Americans list farming as their primary occupation, and among those, 40 percent are age 55 or older. Fewer people farming also means fewer people growing up on farms, traditionally the most reliable pipeline into agricultural occupations.

But the recharged consumer interest in food and agriculture may offer an opportunity to expand the pool of future farmers. According to a survey of land-grant universities by the U.S. Department of Agriculture, enrollment in agriculture degree programs rose by 21 percent from 2005 to 2008. Many of the newcomers are students from urban or suburban backgrounds who are seeking alternatives to the corporate path. "It used to be that I would rarely see a student in my class who didn't grow up on a farm," says Cates. "Now at least a third of them have no family agricultural background at all."

What's missing in many cases is a curriculum to match students' interests. In most high schools, agriculture receives barely a whiff of attention, save for a few vocational courses. That's not enough, says Cates. "We can't just teach about how to weld something or how to feed a cow. We have to instill in young people the role that farmers play in this culture. Farmers are stewards of our natural resources and an important engine for our economy, but they are also guardians of the values that built our rural communities."

Cates supports a bill before the Wisconsin State Assembly that would allow high-school students to receive science credit for coursework in agriculture. He also would like to see basic science classes discuss the role farmers play in the management of ecosystems and conservation of natural resources, which he says could motivate this environmentally minded generations to consider farming.

"I think we're going to see farming become more like other professions, where it's open to any young person to consider, just like choosing to become a doctor or a lawyer," he says. And as he knows from his own experience, once you catch that bug, it's hard to shake.

Aerial view of farms in Wisconsin's Kickapoo Valley.

Go Vertical

Doug Reinemann **High-rise greenhouses and other indoor farming systems can get more food into cities that need it the most.**

It takes a big footprint to feed a big world. Today we use land roughly the size of South America to grow food and raise livestock, and that's just to keep pace with the demands of 7 billion people. So what happens when there are 2 billion more mouths to feed? We can't expect food to fall from the sky.

Or maybe we can.

Given the potential environmental impacts of putting more land into agriculture—and losing more carbon-storing forest in the process—some experts are advocating alternatives that require less room than traditional methods of growing food. One of the more intriguing ideas is to take advantage of vertical space by stacking greenhouses on top of other structures. These farms-in-the-sky would use soil-free methods such as hydroponics to grow fresh produce, fish and even fruit trees, without the risk of flood or drought or the potential for downstream contamination.

There's a lot to like about the concept, says Doug Reinemann, a CALS professor of biological systems engineering who studies renewable-energy systems. Greenhouses integrated into urban structures could conserve energy by keeping buildings cooler in the summer and warmer in the winter and mitigate the heat-island effect in urban areas. Nutrient-rich municipal wastewater could be recycled to feed plants. The real payoff, though, would be to put a source of year-round fresh produce in the heart of the city.

"More than half of the people on Earth will be living in highly concentrated urban areas within the next few decades," says Reinemann. "If we can produce food at the point of use, that could greatly reduce the energy that we currently expend to transport food to where people live."

True, the amount of food that could be produced in a single rooftop greenhouse is miniscule compared to the output of traditional farms. But ventures such as Eurofresh Farms, a 318-acre greenhouse in the Arizona desert, are beginning to push indoor farming to an industrial scale. And at least one vertical-farming advocate imagines much more: Columbia University professor Dickson Despommier has sketches detailing skyscraper-like farm structures that could grow enough food for 50,000 people in one city block.

Can we get there? It will take some serious advances in engineering and design, says Reinemann. "I wouldn't even think about trying to explore something like this without expertise in engineering, horticulture and marketing," he says. "But of course we have those experts (at the university)." And it just may be that the only thing crazier than giving vertical farming a chance is not to.

Reduce Food Waste

Jed Colquhoun **We could be doing better in the battle against hunger if we made fuller use of the food we grow.**

Ask Jed Colquhoun about the efficiency of our food supply, and he'll tell you a story about a Wisconsin farmer who last fall watched 40 acres of the most beautiful carrots he'd ever grown die in the field.

"He'd put in the resources to do it, he put in the labor and he had a great growing season," says Colquhoun, an associate professor of horticulture who works with vegetable growers around the state. "But there just wasn't the capacity in the system to handle that last 40 acres. So they froze under the snow."

Colquhoun has seen this scenario play out repeatedly: Farmers work tirelessly to coax the most from their lands, but often—especially in years of exceptionally bountiful yields or when weather shortens the harvest window—processing facilities just can't keep up. And that means a considerable amount of food gets left in the field, particularly after great growing seasons. It's something that growers hate to see, says Colquhoun. "Growers have a passion for producing food," he says, "and it is terribly bothersome to them to see any of it left behind." By Colquhoun's estimate, that one frozen carrot field could have filled about 3 million 8-ounce cans of carrots.

That kind of waste would seem appalling, especially considering that one in five U.S. children live in households that struggle to put food on the table. But our food system is full of such inefficiencies. An astounding amount of the food we grow—as much as one-quarter of the total harvest, according to a 2000 U.S. Department of Agriculture report—never completes the journey from farm gate to dinner plate. Food gets thrown out at every step, from processing facilities to warehouses to groceries to cafeterias, restaurants and homes. A 2004 study from the University of Arizona estimates that the extent of our food waste may actually be closer to 50 percent—an astounding 50 million tons of food waste each year. By that math, for every American, roughly 1.3 pounds of food are trashed every day.

The problems with this waste are both obvious and subtle. Beyond the missed opportunity to alleviate hunger, leaving food to rot carries an environmental cost. As it decomposes, food releases methane, a greenhouse gas that pound for pound traps significantly more heat in the atmosphere than carbon dioxide. The danger is such that many communities, including Dane County, have begun experimenting with anaerobic digesters to capture the methane from food and convert it into electricity.

But Colquhoun says more can be done to keep food from going to waste in the first place. He has begun working with Second Harvest, one of the nation's largest hunger-relief charities, to figure out how to route some of Wisconsin's excess vegetable crop into food pantries. The project is fraught with complexities, namely how to collect and process several tons of excess vegetables in a short window of time. But Colquhoun says the problem is too important to ignore.

"We need to get this food to the people that could really benefit from it," he says. "We can't afford to just say it's too difficult. We need to figure out the logistics and make this happen."

By some estimates, one-quarter to half of all food grown in the United States never makes it to a dinner plate.

For vegetable crops like carrots, a great growing season doesn't always translate into more food in the system.

fixing our FOOD

CALS food scientists work to perfect methods of freezing ice cream, one of the many popular foods that would not exist without processing.

Give Processed Foods a Break

Andy Milkowski Don't believe the reputation: Processing extends the life, safety and quality of foods, and processed foods deserve a place on our shelves.

It's in vogue right now to hate processed foods, and certainly there are some freakish concoctions out there that we'd probably be wise to avoid. But it's not fair to vilify the whole lot, says Andy Milkowski, a CALS adjunct professor of animal science.

As Milkowski notes, humans have been processing foods for centuries, and in some cases millennia. We've done it for reasons of safety, as with curing meats to curb spoilage and pathogen growth. We've done it to smooth out the availability of fruits and vegetables that are plentiful in one season but scarce in another. We've done it to create new flavors, like the sweet taste of refined chocolate or aged cheese. We've done it to make foods like ocean fish available to those who otherwise wouldn't have access to them.

And yes, we've done it for convenience. "Processed foods allow you to spend time doing other things rather than preparing meals," says Milkowski, who directed food-safety research for Madison-based Oscar Mayer before retiring from the industry in 2006. "And Americans want it that way."

Part of the problem is in the casual way that "processed food" gets used in pejorative fashion. Processing can refer to just about any method that brings change to the natural state of a food, a broad sweep that could encompass everything from canning fruits to fabricating a Pop-Tart. "Many of the things you do in making processed products are exactly what you would do in a at home," says Milkowski, such as chopping and freezing vegetables or combining tomatoes and ground beef to make spaghetti sauce.

And that means that few generalities apply. While some processing steps undoubtedly diminish the nutritional profile of foods, others, such as pasteurizing milk, rid products of potentially harmful bacteria. Chemical additives can preserve flavors and extend shelf life, and some are natural products of plants and animals. Even packaging has its benefits, safeguarding against product tampering and keeping foodborne pathogens at bay.

So processed foods aren't always bad, and in some circumstances, they are critically important. Processed foods give options to people with food allergies or diseases that make it impossible to consume natural foods. They greatly ease the stress on large-scale food operations, such as the ones that feed schoolchildren or military troops deployed abroad. The ease of transporting and storing processed foods also makes them an invaluable asset to food pantries, international food aid and disaster relief efforts.

"What happened after hurricane Katrina? We had to get food and water to the people stranded in New Orleans," says Milkowski. "We would never have anything available if we didn't have stores of food—processed foods—as a buffer to address those times."

THE EASE OF TRANSPORTING AND STORING PROCESSED FOODS MAKES THEM AN INVALUABLE ASSET TO FOOD PANTRIES, INTERNATIONAL FOOD AID AND DISASTER RELIEF EFFORTS.

Keep Finding What Makes Food Healthy

James Steele Exploring the science of how foods interact with our bodies will lead to healthier foods and lifestyles.

Which is better for you—a tomato or an Oreo?

Most of us would answer "tomato" without hesitation. But how do we know? Is it instinct that tells us to heap on the tomato slices and be wary of too many Oreos? Experience? Or something else—the vague lessons we retained about fats and sugars and some substance called lycopene?

Anyone living and eating in the United States tends to absorb a fair amount of food science, much of it through health claims made by various food products. Authors such as Michael Pollan often rail on this mindset, arguing that we rely too much on a food's nutritional profile—and not enough on common sense—to tell us whether foods are good for us. But that's no reason to turn away from the chemical roots of nutrition, says CALS food scientist James Steele.

"There's some nostalgia for not wanting things to get too complicated, and to just say tomatoes are good for you," he says. "We need to understand (what makes foods healthy) so that we can control the beneficial properties of foods all the way from the breeding of plants through the manufacture of processed foods."

As the birthplace of vitamin research, CALS has significant history in that endeavor. Scientists such as E.V. McCollum, Conrad Elvehjem and Harry Steenbock made links between micronutrients and human health, leading food companies to fortify staple products such as salt and milk with key nutrients and wiping out diseases such as rickets and pellagra in the process.

But we're not done discovering the good stuff in good foods. Scientists now are tracking down phytonutrients—tiny chemicals found in plants that have been shown to ward off the deleterious effects of aging and fight diseases such as heart disease and cancer.

"We're at the point of trying to identify bioactive, health-promoting compounds that are naturally present in foods—whether it's tomatoes, onions or garlic—in order to be able to breed cultivars that have higher levels of these compounds and to find ways to retain those compounds during food processing," says Steele.

Steele believes such phytonutrient-rich foods will play an increasingly important role in the treatment of chronic diseases in the coming decades. "How do you deal with diseases that are longer and slower in developing? Diseases like cancer or hypertension?" he asks. "They're not going to be solely food-solved, but food is going to be a component. Lifestyle, exercise and food will all play a role."

At this point, medical scientists still have a long way to go to understand how chronic diseases work at the population and individual levels. Likewise, food scientists must identify and assess the hundreds, if not thousands, of phytonutrients that remain to be found in fruits and vegetables.

But when these two lines of inquiry converge down the line, the results could be extremely powerful, giving doctors the ability to prescribe custom-designed, disease-fighting diets based on a patient's individual genetic makeup. So while an apple a day might keep the doctor away for one patient, for you, it might be a tomato.

An apple a day? Food science reveals nutritional factors that guide such healthy choices.

Get Creative About Food Safety

Kathy Glass We'll never be 100 percent at spotting threats to our food. But what if the pathogens gave themselves up?

When Kathy Glass spends the weekend at her in-laws' house, she usually finds herself cranking down the temperature on their refrigerator. "When I arrive, it's usually at 47 or 48 degrees Fahrenheit," well above the recommended 40-degree level, says Glass, associate director of the UW-Madison Food Research Institute. "If you keep food in there for a long time at that temperature, it's a bad thing."

A bad thing, but an all-too-common one. Each year, an estimated 76 million cases of foodborne illness are reported in the United States, leading to 325,000 hospitalizations and 5,000 deaths. And while the sources of food contamination range from on-farm outbreaks to processing mistakes to improper storage at home, nearly every foodborne illness could be prevented if contamination were detected quickly enough to keep tainted food off the shelf. But despite a national network of food inspectors, tough industry standards and Glass' own personal refrigerator checks, some problems sneak through.

The latest thrust in food-safety research, however, is to deploy technology as an unblinking watchdog for potential food problems. For example, scientists have developed sensors that can measure the amount of time foods spend above their ideal storage temperature, alerting consumers to potential spoilage. The sensors, which change color when a food is likely unsafe, are already used by wholesalers and may soon be affordable enough to affix to the labels of consumer goods. If that happens, Glass says the sensors would not only keep consumers safe but help educate them about proper food storage and encourage better habits.

At the same time, FRI researchers are experimenting with higher-end sensors that use nanotechnology to rapidly detect toxins and pathogens such as E. coli or Salmonella in the production process. With current testing methods, it can take days to confirm the presence of these potentially life-threatening microbes in foods such as ground beef, making it difficult to sniff out tainted foods before they leave the facility.

"It would be better to have something more like a (biosensor) dipstick, where you can find out something within a fairly short period of time—real time, even," says Glass, "so that when there's a contamination in the meat there would be this little glowing light that says, 'Divert. Get this out of the stream.'"

Glass cautions that these nanobiosensors are "still very pie-in-the-sky at this point," but they do have the potential to revolutionize the food-inspection process, bringing it one step closer to where society wants it to be: failsafe.

A line of pizzas in a UW-Madison kitchen appears appetizing—but is it too much of a good thing?

Michael Forster Rothbart / UW Communications

Eat Less

James Ntambi Want to preserve the world's food supply? Start by limiting your own. It might just save your life.

In theory, maintaining a healthy body weight should be a piece of cake. There's just one rule to obey: Calories in must equal calories out.

"That is the equation you want to follow," says biochemist James Ntambi, who studies the genes involved in fat metabolism.

The problem also turns out to be a piece of cake—too many of them, to be honest. "We are overeating," says Ntambi. "We are taking in more calories than we need, and the excess calories are getting stored as fat. Once you have those calories stored, it is very difficult to get rid of them. That's what people struggle with."

Struggle, indeed. According to the Centers for Disease Control and Prevention, the average American male consumed 132 more calories per day in 2000 than in 1971, while women added a staggering 335 daily calories—a 22 percent increase. It's hardly a surprise, then, that fully one-third of Americans are now obese. An additional one-third is considered overweight, and many of those are on the path toward obesity, a destination with dire consequences. Although it doesn't kill directly, obesity plays a significant role in a number of life-threatening diseases, including diabetes, cardiovascular disease, atherosclerosis, hypertension and some cancers. Diabetes alone affects some 23 million Americans, costing the country around $113 billion to treat each year. By 2034, these numbers are expected to skyrocket to 44 million and $336 billion. Experts believe the disease shortens the average patient's lifespan by five to 10 years.

According to Ntambi, the best way to stop these premature deaths is through education. But the din of trendy fad diets and commercial weight-loss products can be hard to overcome. It doesn't help that official health messages haven't been exactly consistent over time.

"Until recently," explains Ntambi, "people were being told that when they exercised they would lose weight, and so that is what they were doing. But the weight wasn't going away, and many lost hope." It's now widely recognized that exercise increases hunger, and people who focus solely on exercise often eat back the calories they burn at the gym. To lose weight, explains Ntambi, there's no way around the fact that exercisers must also cut calories.

But Ntambi acknowledges that many people won't be able to do that alone. He would like to see doctors—who often leave it to nutritionists to discuss the touchy subject of weight control—voice more urgent concern with patients. Likewise, he says parents can do more to teach their children healthy eating habits, something Ntambi is working on with his own kids.

"I say to them, 'This food is going to be here tomorrow. There will be food here next week. You don't have to eat so much.'" And that lesson is no piece of cake.

By 2034, some 44 million Americans are expected to have diabetes, costing the country $336 billion a year in treatments.

Get Back in the Kitchen

Monica Theis The skill to cook good food is rapidly disappearing in the average American family. Can we get it back? Yes—but not by watching the Food Network.

At the outset of a recent food-science class, Monica Theis held up a rutabaga and asked a room full of students, "How many of you know what this is?" Not a single hand rose.

That might sound like an indictment of the poor rutabaga, but Theis, who teaches nutrition and food management courses for UW-Madison's dietetics program, says it's symbolic of a deeper trend. Despite their allegiance to reality shows like "Top Chef" and "Chopped," today's students—like so many Americans—are largely lost in the kitchen, lacking the ability to prepare even simple meals from scratch.

"We're not talking about culinary skills. They don't have the basics—how to use a knife or how to stock a kitchen," says Theis. "Those aren't skills you learn by watching celebrity chefs on television."

But the odds are that students aren't learning them at home, either. Forty years ago, the average American spent more than an hour a day preparing meals. Today that time has shrunk to 27 minutes, not quite half an episode of Bravo's "Top Chef." According to the U.S. Food and Drug Administration, the average American now eats at least four meals a week that are prepared away from home, and fewer than a third of households report making meals from scratch.

Reasons abound for the move away from home-cooked meals, including longer work hours, the rising prevalence of prepared foods and changing gender roles in the home. But the decline of home cooking may bring with it even greater dependence on sugar- and salt-laden processed foods, potentially worsening already troublesome rates of obesity, diabetes and heart disease.

In her dietetics classes, Theis stresses the importance of cooking during once-a-week labs in UW-Madison's instructional kitchen, where the assignments can range from hard-boiling eggs to making lemon-pepper chicken. She recently worked with UW's athletics department to begin teaching cooking skills to student-athletes, a pilot program that she hopes to expand to other campus groups.

But Theis acknowledges that such approaches only reach a fraction of people who could stand to benefit from them. "I really worry about where people are going to acquire these skills, particularly people who don't have good access to kitchens or fresh food," she says.

One step would be to rethink how food and nutrition are handled in public schools. Some critics, such as chef and food author Alice Waters, have suggested that schools treat lunch as a part of the curriculum, much like physical education. Theis would also like to see more time and resources given to family and consumer education courses, which she says are too often relegated to doling out lessons from a bygone era.

"I still see schools that are just doing the minimum, teaching things like cake decorating," says Theis. "But really, how often do you need to decorate a cake?"

The average American spends 27 minutes each day preparing food, not quite half an episode of Bravo's "Top Chef."

Theis *(middle)* **helps students from UW-Madison's women's crew team get acquainted with the lost art of healthy cooking.**

The Grow Dozen


Christian Abnet


Sheila Cohn Weiss


Jessica Donze Black


Michelle Dudash


Erin Dummert


Leslie Goldman

Christian Abnet **PhD'98, Environmental Toxicology** • Abnet explores the nutritional causes of cancer as an investigator with the National Cancer Institute, where he's investigating whether factors such as diet and poor oral health raise the risk of developing esophageal and gastric cancer. Much of his work focuses on high-risk populations, particularly people in developing countries. He has collaborated with epidemiologists, clinicians, statisticians and lab scientists in China, Iran, Kenya, Ireland, Brazil and the United States, among other places.

Sheila Cohn Weiss **BS'99, Dietetics** • A registered dietitian with extensive experience in nutrition communications and public policy, Cohn Weiss is a resident nutrition expert with the public relations firm Porter Novelli. Working with the company's food, beverage and nutrition practice, she helps clients translate the science of nutrition into language consumers can understand and tools that health care professionals can use to help educate their patients and clients. Prior to her current position, she served as the director of nutrition policy for the National Restaurant Association. Cohn Weiss says she has always been fascinated by the effects of food on the body and the mind—she used to sit on the counter as a child while her mother baked to smell each and every ingredient.

Jessica Donze Black **BS'96, Dietetics, Nutritional Sciences** • Donze Black directs the healthy schools program at Alliance for a Healthier Generation, an initiative aimed at reversing the epidemic of childhood obesity by advancing healthier choices and increased levels of physical exercise for young people. She and her staff work with more than 7,500 schools in all 50 states to foster healthy lifestyle habits. She previously lent her public health advocacy talents to the Campaign to End Obesity, the American Heart Association and the American Dietetic Association. When she's not working, Donze Black says she spends most of her time focused on her two young sons—and their laundry.

Michelle Dudash **BS'99, Dietetics** • A classically trained chef, Dudash combines her culinary skills with a passion for healthy living as a nutritional consultant. Based in Phoenix, she works with a range of individual and corporate clients to promote healthier eating and lifestyles, where her services might include anything from one-on-one nutrition coaching to analyzing recipes and menus to help organizations serve more nutritious food in cafeterias. When she's not consulting, Dudash is often dispensing diet and lifestyle advice on social networking sites or through the media. She plans to begin work on a cookbook for time-pressed families—something that she can relate to as a multitasking mom.

Erin Dummert **BS'98, Dietetics** • Dummert is president of Madam Nutrition, a wellness company dedicated to "positive nutrition," which emphasizes adding healthy foods to a diet rather than eliminating unhealthy ones. Dummert trails clients to the places where they make their eating choices—in homes and groceries—to make recommendations about healthy additions to their regular diets. A special emphasis of her work is on the role of healthy eating in preventing cancer, inspired by time she spent directing nutritional services for an oncology practice in Milwaukee. Since graduating from CALS, she credits her former instructors as invaluable professional resources, continuing to provide everything from advice on starting her own business to input on consulting jobs.

Leslie Goldman **BS'98, Nutritional Sciences** • After setting off on a pre-med path at CALS, Goldman discovered a passion for communicating about health, nutrition and fitness. She went on to write Locker Room Diaries: The Naked Truth About Women, Body Image and Re-Imagining the Perfect Body, a book that reflects on her own experiences handling body image issues and interviews with hundreds of women. After a 13-city tour of college campuses to spread the message about healthy body images, Goldman is now a full-time freelance writer who regularly contributes to Health, Parenting, Runner's World, Self, Women's Health and other national magazines.

Erica Lesperance Stelton **BS'99, Nutritional Sciences** • After five years working as a metabolic dietitian at Emory University, where she helped patients with PKU, MSUD and other metabolic disorders, Lesperance Stelton began applying her technical, culinary and nutritional expertise to design and develop new specialty food products for Cambrooke Foods. These protein-modified foods have significantly improved the quality of life of tens of thousands of patients with metabolic disorders. She has also been working side-by-side with a UW-Madison research team to bring to market a

12 Alumni who are making a difference in nutrition


Erica Lesperance Stelton


Forrest Nielsen


Sarah Roller


Mary K. Russell


Julie Thayer


Monica Woldt

groundbreaking new PKU treatment. When she's not finding ways to make the metabolic diet more manageable and enjoyable, you can find her training for her next marathon or triathlon.

Forrest Nielsen **BS'63, Biochemistry** • In 1970, Nielsen was the first scientist hired at USDA's new human nutrition research center in Grand Forks, North Dakota. In his 40 years with the center, his discoveries have established Nielsen as a leading expert on the nutritional importance and health benefits of mineral elements, notably boron, nickel and silicon. Since 2005, his research has focused on the nutritional importance of magnesium, particularly its effect on inflammation that leads to chronic diseases such as atherosclerosis, diabetes and osteoporosis. When not in the lab, Nelson is often globe-trotting: he and his wife have visited all seven continents.

Sarah Roller **BS'80, Dietetics** • A registered dietitian and former clinical research nutritionist with Mt. Sinai hospital, Roller now regards the food industry with a legal eye. As a partner with the law firm Kelley Drye & Warren, she focuses her practice on food and drug law, working with U.S. and global companies, industry and trade organizations to ensure that food products' health and nutrition claims are adequately substantiated by scientific evidence. Roller also counsels clients on how food is marketed to children and legal and policy developments surrounding obesity and diet-related public health concerns.

Mary K. Russell **MS'81, Nutritional Sciences** • Currently the director of nutrition services at the University of Chicago Medical Center, Russell has long specialized in clinical dietetics and patient care. Before moving to Chicago, she spent 17 years working at Duke University Hospital, eventually serving as director of nutrition services. Russell enjoys the science of nutrition beyond the practice and the interdisciplinary collaboration that goes into providing the best possible care for a patient. She is also the 2009 recipient of the Medallion Award from the American Dietetics Association for outstanding service and leadership to the dietetics profession. In her free time, she enjoys exploring the fascinating architecture of her new city.

Julie Thayer **BS'02 Biology, Nutritional Sciences** • As youth development specialist for the nutrition and fitness for life program at the Boston Medical Center, Thayer runs weekly sessions during the school year and a five-week summer program to train youth on issues related to nutrition, food systems, physical activity and health. By engaging the local community, she aims to decrease chronic disease risk and improve access to healthy food and fitness opportunities. She also organizes a farmers' market in the medical center to make fresh, locally and sustainably grown food more accessible to hospital staff, patients and visitors. Studying abroad in Uganda during her time at CALS spurred Thayer's interest in the socioeconomic aspects of public health.

Monica Woldt **BS'88 Biochemistry, MS'93 Nutritional Sciences** • Woldt has 15 years of experience in developing, managing and evaluating international community health and nutrition programs. She currently serves as a maternal and child health and nutrition advisor for the Academy for Educational Development, which works in cooperation with the U.S. Agency for International Development. She guides and supports projects in areas such as nutrition, HIV prevention, child survival and health, and food security. Woldt previously served as a Peace Corps volunteer in Guatemala, worked four years as a technical advisor on nutrition and health for World Vision International in Mozambique, and provided technical assistance in emergency relief to World Vision in Ethiopia.

About the Dozen

These 12 alumni represent the depth and breadth of CALS graduates' accomplishments. Selections for the list are made by the Grow staff and are intended to reflect a sample of alumni stories. It is not a ranking nor a comprehensive list. To read more about CALS alumni, go to www.cals.wisc.edu/alumni/

Next issue: Medicine

Know someone who should be in the Grow Dozen? Email us at: grow@cals.wisc.edu

Catch up with …

Yeonhwa Park PhD'96 Food Science

MORE THAN 30.5 MILLION CHILDREN in the United States are fed each day by the National School Lunch Program, and 10.5 million students eat breakfast at school, as well. For these children, as many as half of their daily calories can come from meals served at school. Yet nutritional standards for school meals have changed little since 1995. Yeonhwa Park, an assistant professor of food science at the University of Massachusetts in Amherst, was the only food scientist on a national panel that took a critical look at school lunch standards. In October, the group released recommendations for new nutritional standards, which Park says reflect how much more we know about what our kids should be eating to stay healthy.

Ben Barnhart / UMass Amherst Magazine

● Reviewing the national school lunch and breakfast programs sounds like a big task. How did you get started?
Well, our overall goals were to get students eating more fruits, vegetables and whole grains and to make sure that the total level of calories, sodium and saturated fat per meal are appropriate for different age groups. It was challenging to figure out how to achieve these goals in a form that students would accept and would be affordable for schools.

● You have particular expertise on reducing sodium content and increasing fiber. Can you tell us more about what changes you'd like to see in these areas?
For whole grains, there is pretty good acceptance already among school-age children, but availability is limited and the cost differences between whole and processed grains are significant. Ultimately we decided that schools should aim for achieving at least 50 percent whole grain-rich content in both breakfasts and lunches within three years of the final regulations' adoption.

Sodium is a bit more tricky. Reducing sodium levels in foods causes a noticeable change in the way that they taste. That's why we ended up recommending an incremental reduction—10 percent every two years for the next 10 years. This gives students' taste buds some time to adapt and makes it more practical to implement for the schools preparing meals. We also hope industry will respond with lower-sodium alternatives.

● Did the panel recommend any other major changes?
Well, we recommended that for the first time menu planning standards set a minimum and maximum level of calories. We came up with these calorie ranges based on the age groups of school children and the meal type. Currently the amount of calories in school meals is really varied, both across schools and from day to day. Also, the requirements in place now don't differentiate based on the nutritional needs of different ages—younger children are served the same amount of food as older students.

● What impacts do you think these adjusted guidelines will have on the health of school children?
Implementing the improvements we've recommended is going to be a big change for some schools, but many other schools are already doing really well. But once these new standards are up and running, we hope that they will foster healthier eating habits for kids across the country.

SPRING springs forth at Allen Centennial Gardens with the help of volunteers.

LEARN ALL ABOUT FOOD during the **UW-Madison Food Summit** on April 23. Sponsored by the Wisconsin Alumni Association, the day-long event is a capstone to Chancellor Martin's Go Big Read project exploring our relationship with food and will feature an engaging look at food from social, economic, environmental and cultural perspectives. Former U.S. Sen. George McGovern, winner of the 2008 World Food Prize, will deliver the keynote address on overcoming the global problems of hunger and malnutrition. Six CALS faculty will be among the day's presenters.

TURN THE CLOCK on a new century for the departments of **genetics** and **plant pathology**. Both departments are hosting three-day events to celebrate their anniversaries. Genetics will put on festivities May 20-22; Plant Pathology will gather June 24-26. If you can't make it back to campus, try diving into some virtual nostalgia by exploring the departments' new online histories.

PLANT A FLOWER by volunteering at ***Allen Centennial Gardens***. Each year, dozens of alumni experience the splendor of spring by helping plant and maintain the unique garden in the center of UW-Madison's campus. Garden director Ed Lyon says volunteers need no gardening experience, and the garden can use both regular and occasional help.

LOG ON to **walsaa.org**, the new web site of the Wisconsin Agricultural and Life Sciences Alumni Association. CALS' alumni organization is rolling out a new face to help grads stay connected to their college. The site features updates on classmates, events and ways to interact with CALS from near and far.

RELISH HOMEMADE PICKLES and relishes using recipes from UW-Extension's Safe Food Preservation Series. Authored by CALS food scientist and extension specialist Barb Ingham, the brochure outlines safe and tasty methods for preparing and preserving all manner of pickled produce, from standard cucumbers to elk meat and venison. Take a bite at UW-Extension's **Learning Store**.

*For links to more information, go to: www.cals.*wisc.edu/grow/.

somethingHappeningHere:

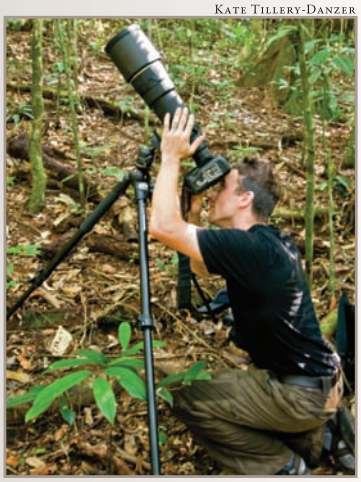
Boulder, Colorado

As a globe-trotting freelance photographer, **Erick Danzer** MA'04 has used his lens to expose illegal logging, record endangered species and shed light on corners of the world that few people get to see. Now, he's backing up the social power of photography with cash. Danzer, who operates the Photocrati.com camera-gear blog, has launched the Photocrati Fund to aid non-professional photographers with projects that advance humanitarian goals.

"Very few newspapers or magazines are willing to send photographers on assignment any more," Danzer explains. "So in the future, major photographic projects are going to depend more on philanthropy. That's the role we see for the Photocrati Fund—to provide funding for photographers to cover important stories that might otherwise go untold."

The winner of the fund's first $5,000 grant will be selected by a panel of esteemed shooters, including Steve McCurry, Art Wolfe and Michael Nichols, and announced in June. Check the Photocrati.com site for updates.

KATE TILLERY-DANZER



Erick Danzer on assignment in Indonesia.

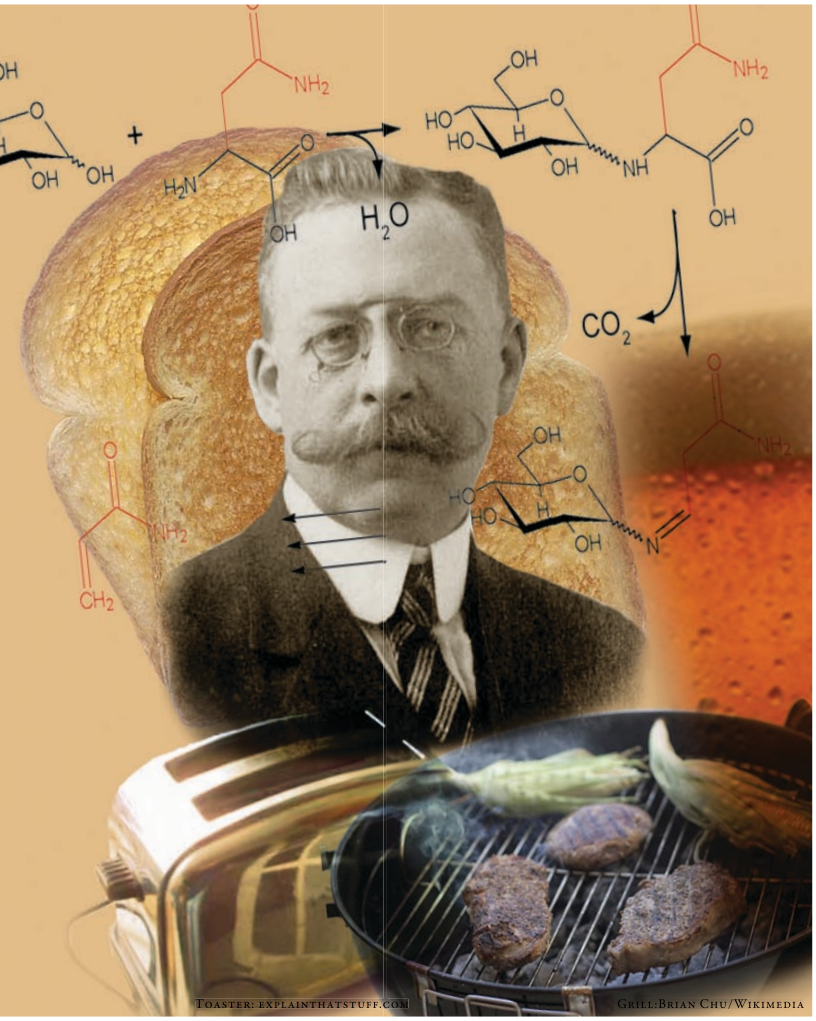
Know a CALS alum doing good things in your neighborhood? Send it to grow@cals.wisc.edu.

Five things everyone should know about . . .

The Maillard Reaction

By Robert Lindsay and Rich Hartel

1 | **What do toast, raisins, caramels, chocolate and beer all have in common?** They are all examples of the Maillard reaction, a chemical process that occurs when certain foods are cooked or processed. Triggered by the interaction of reducing sugars and proteins within foods, the Maillard reaction helps create the unique colors and flavors of all of the above items. It's also one of the key reactions at work when grilling red meats or roasting coffee beans.



Louis-Camille Maillard: Godfather of grilling

2 | **Think of it as what browning can do for you.** People have known since ancient times that foods take on new aromas and tastes as they brown. But it was only in the last century that someone figured out why. In 1913, French chemist Louis-Camille Maillard discovered that under high heat carbon atoms from reducing sugars such as lactose, glucose and fructose combine with nearby amino acids to form new compounds. While processes like carmelization can produce similar pigments, these chemical recombinations produce rich, savory flavors that are unique to grilled, fried or roasted foods.

3 | **The Maillard reaction is an indispensable tool of the flavor industry.** Maillard-induced flavors are often meaty, brothy, roasty, toasty, nutty or gravy-like in taste and smell, making them useful as natural ingredients to add flavor to processed foods. Food chemists use industrial processes to create and capture these unique flavor compounds, which are commonly added to a variety of foods. And there's more where those flavors came from. Many of the compounds created by Maillard reactions—including some important to flavor—have yet to be characterized.

4 | **It can be fast—or slow.** While Maillard reactions occur quickly in cooking, they can also unfold over longer periods of time in foods stored at lower temperatures. The flavors that emerge in ripening cheese, for example, are due in part to the Maillard reaction. It's also the secret to Serrano ham, a raw meat that is dry-cured for several months to bring out smoky flavors.

5 | **Yeah, but it's a dry heat.** If you're looking to master the Maillard reaction in your cooking, it's important to create the right environment for a little food chemistry. The reaction moves fastest at high temperatures with little moisture and neutral to slightly alkaline conditions. Water tends to slow or stop the reaction, which is why boiling doesn't cause foods to brown. So turn on the grill and enjoy the results.

Robert Lindsay and Rich Hartel have 60-plus years of teaching, research and outreach experience with CALS. Lindsay, a retired professor of food science, is an expert on flavor chemistry who has identified pathways for the formation of flavors in dairy, seafood and vegetables. Hartel is a professor of food engineering who studies crystalline structures in food. In 2008, he co-authored the book *Food Bites: The Science of the Food We Eat*, with his daughter, Annakate Hartel.

Take the Final Exam!

QUESTIONS FROM ACTUAL CALS EXAMS

Fill out your answers online. Ace our quiz and we'll enter you in a drawing for a gift box of Babcock Hall cheese. Go to www.cals.wisc.edu/grow/ for more details.

Genetics: **1. Which of the following human cells contains a gene that specifies eye color?**

a. Cells in the eye
b. Cells in the heart
c. Gametes (sperm and egg)
d. Cells in the eye and gametes
e. All of the above

From Genetics 160: Heredity, taught by Chris Day

Nutritional Sciences: **2. One of the Dietary Guidelines recommends that Americans increase our intake of plant fiber. Which of the following food substitutions would accomplish that?**

a. Whole wheat bread for enriched white bread
b. An apple for apple juice
c. Baked beans for pork chops
e. All of the above

From Nutritional Sciences 132: Nutrition Today, taught by Peter Anderson

Plant Pathology: **3. The ultimate size of a population is limited by:**

a. the net photosynthetic productivity of its habitat
b. (births – deaths) within the population
c. the carrying capacity of its environment
d. genetic bottlenecks that alter allele frequencies

From Plant Pathology 123: Plants, Parasites, and People, taught by Andrew Bent

Biological Systems Engineering: **4. From which of the following renewable materials can biodiesel be made?**

a. Starch
b. Cellulose
c. Lard
d. Protein

From Biological Systems Engineering 460: Biorefining: Energy and Products from Renewable Resources, taught by Xuejun Pan

Animal Sciences: **5. Which of the following animals produces the highest concentration of sperm?**

a. Bull
b. Ram
c. Boar
d. Stallion

From Animal Science 434: Reproductive Physiology, taught by John Parrish

LAST ISSUE: Answers were 1: D; 2: A, 3: A; 4: D; 5:B. Congratulations to Susan Kalvonjian BS'77, of East Lansing, Mich., who was randomly selected from the six people who aced our Final Exam and wins a gift certificate to Babcock Hall.

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CLEAN HOUSE At CALS' Rhinelander Agricultural Research Station, the potatoes are plentiful—and pure. New potatoes are propagated in a germ-free environment to ensure a supply of disease-free seed for Wisconsin growers. For more cool science, visit us online at **www.cals.wisc.edu/grow/.**