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<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microbes in Natural Illinois Wetlands Protect Water Quality</td>
<td>4</td>
</tr>
<tr>
<td>Study Predicts an Uncertain Future for Forests</td>
<td>5</td>
</tr>
<tr>
<td>Research Recommends Compromise When Choosing Conservation Site</td>
<td>6</td>
</tr>
<tr>
<td>Consumers Choose Locally Grown and Environmentally Friendly Apples</td>
<td>8</td>
</tr>
<tr>
<td>Research Highlights Importance of Minimizing Air Exposure in Catch-and-Release Angling</td>
<td>10</td>
</tr>
<tr>
<td>Focusing on Outcomes Instead of Growth Redefines Rural Prosperity</td>
<td>11</td>
</tr>
<tr>
<td>Soy Peptide Lunasin Has Anti-Cancer, Anti-Inflammatory Properties</td>
<td>12</td>
</tr>
<tr>
<td>Natural Ingredient Preserves Meat Quality in Precooked Supermarket Offerings</td>
<td>13</td>
</tr>
<tr>
<td>“Stealth Nutrition” to Improve Health of Honduran Children</td>
<td>14</td>
</tr>
<tr>
<td>Public Policy Should Promote Family Mealtimes</td>
<td>16</td>
</tr>
<tr>
<td>Dad’s Early Connection with Child Writes Script for Future Life</td>
<td>18</td>
</tr>
<tr>
<td>Increased Carbon Dioxide in Atmosphere Linked to Decreased Soil Organic Matter</td>
<td>20</td>
</tr>
<tr>
<td>Performance Traits Best Measure of Animal Welfare</td>
<td>22</td>
</tr>
<tr>
<td>Soybean Aphids: Search for Resistance Brings Both Success and New Challenge</td>
<td>24</td>
</tr>
<tr>
<td>Understanding How Weeds Are Resistant to Herbicides</td>
<td>25</td>
</tr>
<tr>
<td>Illinois Team Builds Solar House to Compete in International Decathlon</td>
<td>26</td>
</tr>
<tr>
<td>University of Illinois’ Students Explore Agricultural Innovations and Sustainability in Brazil</td>
<td>28</td>
</tr>
<tr>
<td>Geothermal Technology Can Cut Power Bills in Half</td>
<td>29</td>
</tr>
<tr>
<td>Student-Run Farm Supplies Produce to Campus Dining Halls</td>
<td>30</td>
</tr>
</tbody>
</table>
The U.S. government defines the word “sustainable” as “to create and maintain conditions under which humans and nature can exist in productive harmony that permits fulfilling the social, economic, and other requirements of present and future generations of Americans.”

Daniel Anderson, a research specialist here at the College of Agricultural, Consumer and Environmental Sciences (ACES), provides a more succinct version of this definition that rings true for me: real sustainability must always address three factors—ecology, society, and economy. Anderson’s work with College of ACES students studying in Brazil (see page 28) demonstrates the exciting possibilities when scientific inquiry considers all three factors as integral to the quest for sustainability.

Such a wholistic vision of sustainability is crucial in today’s world. And it is what this publication is about—highlighting research from the College of ACES at the University of Illinois that sustains not only agriculture, but also natural resources, health, families, communities, and the economy. As you review this document, I think you’ll see that although research often focuses on very specific topics of inquiry, the threads of ecology, society, and economy intertwine as our scientific discoveries are translated into sustainable solutions for the local, national, and global challenges at hand.

Jozef Kokini
Associate Dean for Research
College of Agricultural, Consumer and Environmental Sciences
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sustaining ecology
Microbes in Natural Illinois Wetlands Protect Water Quality

Wetlands are filled with highly diverse plant and animal life that creates self-sustaining ecosystems and benefits the overall water quality and environment. But in the past 200 years, due to increasing land development and agriculture, the United States has lost 53 percent of its wetlands and Illinois has lost 90 percent. "The 'No Net Loss' federal policy was established in 1989 to begin replacing the wetland acreage lost to development," said Diana Flanagan, University of Illinois graduate student in microbial ecology. "But what we learned from looking more carefully at the populations of microbes in Illinois wetlands is that the replacement or constructed wetlands were less effective at providing water quality functions than the natural wetlands."

Flanagan and Angela Kent, her U of I advisor, collected and analyzed soil samples from six pairs of constructed and natural wetlands across Illinois. "Microbial populations all perform different functions in the environment," said Flanagan. "We wanted to identify the composition of microbes in each of the samples.

Although the microbes are all unique, they have one gene in common. Each group of microbes has a slightly different DNA sequence for this gene, and we were able to use these differences to determine the makeup of the microbial populations in those wetland samples.

When we compared the activity in the natural wetlands to the constructed wetlands, we found that the differences seen in the denitrification rates were correlated to the pattern seen in the microbial community composition. This suggests that the microbial populations responsible for denitrification have not been restored in the constructed wetlands."

"Denitrification is a microbial process, so it makes sense that composition of the microbial community would impact this process," said Kent, who is an assistant professor in the Department of Natural Resources and Environmental Sciences. "Soil microbes are very diverse, however there can be 5,000 or more different kinds of bacteria in a gram of soil. We were concerned that this diversity was so great that we wouldn't be able to detect the connection between microbial community composition and the denitrification process. Given this diversity, it's also interesting that we saw clear patterns of microbial community composition among natural and constructed wetlands."

Flanagan said she hopes this information and further research into environmental factors that influence wetland microbes and their activities, "Next we will carry out experiments where we change some environmental factors and observe the impact on wetland microbial communities to determine if our hypotheses are correct. Ultimately, we hope to make recommendations about how to enhance beneficial microbial processes in wetlands."

Funding for this study was provided by the University of Illinois and USDA.

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Microbial populations all perform different functions in the environment.

—Diana Flanagan
Study Predicts an Uncertain Future for Forests

The composition of some of our nation’s forests may be quite different 200 to 400 years from today, according to a recent study at the University of Illinois.

The study found that temperature and photosynthetic active radiation are the two most important variables in predicting what forest landscapes may look like in the future.

Using computer models, the researchers were able to simulate 209 scenarios, including 13 tree species and 27 possible climate profiles, to predict how the landscape will look over time.

The study found that the most important source of uncertainty in the forest composition prediction is temperature. The second most important source is photosynthetic active radiation, the third is carbon dioxide, and the fourth is precipitation.

Research was done by a team consisting of George Gertner, a U of I statistician and quantitative ecologist; Chonggang Xu, his Ph.D. student; and Robert Scheller, a landscape ecologist at the Conservation Biology Institute in Corvallis, Oregon.

“You have to have an understanding of the biology and the physiology as well as statistics as it relates to uncertainty. If you don’t, then the results might not mean anything. You have to be able to interpret everything and make sure it all makes sense,” Gertner said.

Gertner explained that in traditional uncertainty analysis, the variables are considered to be independent of one another. “But in reality, they are all interrelated. We try to account for the actual correlation of these inputs—these relationships. And that’s where the methodology is new.”

The relationships of the variables are more complicated than just raising the temperature and lowering the amount of rainfall. “One scenario might be if we establish a policy to reduce CO2 greenhouse gas emissions by a certain level,” Gertner said.

“If we have agencies around the world who adopt these policies to make these reductions, over time the scenarios predict what will happen, but with uncertainty.”

Given that uncertainty, what should be the course of action? How should we adapt? How can the forest be managed for global change?

“The bottom line is that we have to have very robust systems that can handle this variability. They can’t be rigid. If we have robust systems, whatever happens, they can handle it. Sustainability comes into play in the robustness. You try to manage those areas by having more diversity, not monocultures.”

Gertner said that management can be easier with agricultural systems. “Over short intervals you can adapt very quickly. You can make big changes very quickly, but with a forest, the lifespan is 100, 200 years, so once you do something it’s longer term. We need to be making policies now that will affect our forests hundreds of years from now.”

“Uncertainties in the Response of a Forest Landscape to Global Climatic Change” was published in Global Change Biology in 2009. Funding was provided by USDA McIntire-Stennis and the U.S. Army Corps of Engineers Construction Engineering Research Laboratory.
Multiple variables come into play when selecting a site for environmental conservation, including wildlife needs, species and vegetation uniqueness, and cost to the government or community. When decision-makers are presented with a choice, University of Illinois economist Amy Ando and graduate assistant Payal Shah recommend choosing the site with the closest proximity to people, because people are more willing to financially support something close to them.

In their study, Ando and Shah weighed the benefits and costs of land conservation that provides amenities such as songbirds, prairie grasses, and other features of the natural landscape that people enjoy. Their research also included variables such as the distance between the conservation area and concentrations of population.

“There’s an inclination in the conservation community to target conservation activities at the point of the highest ecological value—the hot spots where there’s lots of biodiversity,” said Ando. “Depending on how unique, how critical those areas of ecological importance are, our analysis shows that if you can get pretty good benefits—maybe not as many benefits, but pretty good benefits—and be a little bit closer to people, it might be worth shifting a little bit away from the site of highest ecological value to be closer to people because then you get a little bit more human value of the stuff that you’ve protected.”

Ando and Shah’s study, “Demand-Side Factors in Optimal Land Conservation Choice”, appears in a special issue of Resources and Energy Economics.

There’s a tension between conservationists and economists, and this paper is an effort to strike a balance between setting aside land as pristine and an approach that might be more economically pragmatic. “We try to address that tension very directly,” Ando said.

Suppose you’re a wildlife manager and your goal is to maximize the production of waterfowl. So you have a natural production function that has to do with where the lands are and how fragmented they are. But you’re going to be able to raise more money if it’s near where people are, because people are more likely to pay for it if the conservation area is close to them.

“It’s really expensive to set land aside and say nobody can use it. Increasingly you see more easements that don’t necessarily prevent any use of the land but do prevent uses that are harmful to the natural services that the group wants to protect,” Ando said.

Ando said that choosing a site to protect is very case-specific, but the key is knowing when to compromise and when not to compromise. “If it’s a species that has to live in one place or if it’s an ecosystem that needs to not be fragmented, then it’s non-negotiable,” she said.

“We’re just saying that in places where nature gives you a little bit of flexibility, go ahead and think about where the people are in the landscape, too. At the end of the day, you’ll be able to do more for nature if you get more people buying in, willing to support it, and wanting to give money to it.”

Protecting grasslands in Illinois is one example. “One of the goals of our statewide wildlife action plan is to have more restored grasslands. We’ve got a lot of area to restore grasslands that’s reasonably homogeneous in its restoration potential,” Ando said.

“So when you have that flexibility ecologically in the restored grasslands, why not put them a little bit closer to Champaign-Urbana where you have a bunch of people, rather than in the middle of nowhere where there aren’t many people gaining value from what you’ve restored?”

Ando recognizes that there is a difference in focus between the conservationist’s and the economist’s perspective.

“For us economists, value isn’t just how many ducks, but who cares about the ducks,” she said.

“If you’re going to have money to do conservation, people have to want to give you the money or they have to be willing to vote for the tax referendum or the bond issue.”

Ando cited incidents where cities and counties set aside their own money to purchase local lands for open space for conservation.

“I increasingly think that conservation and wildlife managers are running up against this constraint—they want to protect this area over here because it has the greatest ecological value, but people want to protect land near where they are. There’s a tension there.”

The U of I research is based on other empirical work showing that public willingness to pay for conservation falls off with distance from what is being protected, except in the case of global causes.

For big charismatic things like polar bears and salmon and pandas, it doesn’t matter where you are,” Ando said. “People want to protect polar bears, and it doesn’t matter if you’re never going to see one. Proximity isn’t a big deal because the value people get out of it isn’t going to depend on where exactly the polar bears are.”

But Ando cautions that willingness to pay can’t be the only deciding factor.

“If you were to maximize the willingness that people have to pay for networks, then you would put all of the networks near the wealthy communities. And I think that a lot of us are pretty uncomfortable with that approach. Everybody ought to have some access to wildlife.”
One other dilemma that surfaced in the research concerned the fact that well-being and ecological service potential are always lower when people’s preferences are very localized. “If people only care about stuff that’s really close to them, you’re often just doomed because it gets very hard to do that balancing act. You may want to have an area of great ecological potential over here, but if it doesn’t happen to be close to people, if people’s preferences are very localized, then there’s not going to be much that you can do to make things better.”

Ando says that more wildlife conservation education is needed to encourage people to appreciate not just what’s in their backyard but also what might be a little farther away. “If you can broaden what people value, all of your outcomes are better. You’re able to raise the money you need for effective conservation efforts.”
When asked to compare apples to apples, consumers said they would pay more for locally grown apples than genetically modified (GMO) apples. But in a second questionnaire consumers preferred GMO apples—that is, when they were described not as GMO, but as having a “reduced environmental impact.”

The research conducted by University of Illinois economist Michael Mazzocco and Augustana College marketing professor Nadia Novotorova demonstrated that product labeling makes a difference when it comes to consumer acceptance. Mazzocco says it’s about selling the benefits. “When GMO crops were first introduced, people called them ‘Frankenfood’ and emphasized the laboratory processes used in breeding. The benefit seemed to be for farmers who saved money by not having to spray their crops with chemicals.”

The reality is that apples can be bred to be disease-resistant, so they don’t have to be sprayed with fungicides and other chemicals 15 to 20 times per growing season. This attribute gives them reduced environmental impact.

One thing we learned was that if you’re going to get any benefit from technology, you’re going to have to communicate the benefits of it,” Mazzocco said.

“People aren’t willing to pay you for the technology just so they can have another attribute. There’s an equal trade-off. But, when you don’t call it GMO and instead you communicate the benefit to the environment, it’s more than a one-to-one trade-off and consumers are willing to pay more for it.”

No apples were tasted, handled, or even seen by survey participants. Both surveys began by giving participants an identical short lesson in apple-growing which included information on how disease-resistant apples are developed.

“A conventional apple, a non-cloned apple, grown in a typical apple growing region in Washington, Michigan, or New York probably is not susceptible to apple scab and has fewer sprays. In order to have a locally grown apple in the Midwest, you’re going to have to do something about apple scab—otherwise you may not have a crop,” Mazzocco said.

A scab-resistant apple variety for the Midwest can be made by inserting a scab-resistant gene from another apple variety into the DNA of a target Midwest variety. The resulting cloned variety requires 15 to 20 fewer herbicide applications per season than the original non-GMO variety.

Given that information, 200 people rated 12 combinations of attributes of apples. For example, one apple might be described as costing $1.39 per pound, produced far away, and conventionally grown. Another apple might be described as costing $1.39 per pound, produced far away, and conventionally grown. No apples were tasted, handled, or even seen by survey participants. Both surveys began by giving participants an identical short lesson in apple-growing which included information on how disease-resistant apples are developed.

“The message is that we need to be careful how we label things to communicate the benefits,” Mazzocco said.

Impact of Product Attribute Wording on Consumer Acceptance of Biotechnology Applications in Produce” appears in the November 2009 issue of the Journal of Food Distribution Research.

“The message is that we need to be careful how we label things to communicate the benefits.”
—Michael Mazzocco
Research Highlights Importance of Minimizing Air Exposure in Catch-and-Release Angling

Recreational catch-and-release fishing may seem like just good fun, with released fish going on to live happily ever after, but a recent study at the University of Illinois shows that improper handling techniques by anglers can increase the likelihood of released fish being caught by predators.

After the stress of the catch and the lack of oxygen from being out of water, the fish is in a weakened state. When fish are eventually released back into the water, those that haven’t been handled properly are more likely to be caught by predators.

A study on the effects of catch-and-release angling on bonefish was conducted by a team led by University of Illinois researcher Cory Suski. The article appears in Comparative Biochemical and Physiology Part A.

“Whenever a fish is caught and reeled in, it expended a lot of energy. So that’s one stressor,” said Suski. Depending on the skill of the angler, the catching can last a long time and put additional stress on the fish. When the fish is brought up on the deck or into the boat for measuring and picture-taking, it faces an additional challenge; it cannot obtain enough oxygen and continues to accumulate physiological disturbances.

“Our recommendation to catch-and-release sport anglers is that they minimize the time it takes to actually land the fish and take a picture, and then get it back into the water as soon as possible,” said Suski. Depending on the skill of the angler, the catching can last a long time and put additional stress on the fish. When the fish is brought up on the deck or into the boat for measuring and picture-taking, it faces an additional challenge; it cannot obtain enough oxygen and continues to accumulate physiological disturbances.

The study also showed that the longer the duration of the catch-and-release, the longer the time a fish needed to recover and the greater likelihood of its being caught by predators.

How long can a fish be out of water? Results from the study showed that the duration of an angling event can interact with the length of exposure to air and will result in a proportional increase in negative effects on a fish’s physiological condition.

The project was supported by Bonefish and Tarpon Unlimited, the Charles A. and Anne Morrow Lindbergh Foundation, the Canadian Foundation for Innovation, the Ontario Research Fund, Carleton University, the Cape Eleuthera Foundation, and the University of Illinois.
Focusing on Outcomes Instead of Growth Redefines Rural Prosperity

In many minds, “rural” is synonymous with low incomes, limited economic opportunity, and poor schools. However, a recent study at the University of Illinois found that much of rural America is actually prosperous, particularly in the Midwest and the Plains.

The study analyzed unemployment rates, poverty rates, high school drop-out rates, and housing conditions to identify prospering communities. According to the study, one in five rural counties in the United States is prosperous, ranking higher than the national average in all these categories.

“Growth and income are the conventional measures of community success,” said U of I economist and planner Andrew Isserman. “But in talking with farm groups, elected leaders, and rural development professionals from across the country, I realized how few were happy. Some worried about growing too much, and others fretted about growing too little.”

Isserman decided to focus on outcomes instead of growth. Do communities keep their kids in school? Are their unemployment and poverty rates low? Are housing conditions good and the folks healthy?

“When we started our research, people wondered whether we would find any prosperous rural communities at all using those criteria. But more than 300 of the nation’s rural counties did better than the nation.”

“Why Some Rural Places Prosper and Others Do Not” was coauthored by Isserman, Edward Feser, and Drake Warren and published in the International Regional Science Review in July 2009.

Counties in America’s Heartland came out on top, with half its rural counties prospering. The USDA defines the Heartland as Illinois, Indiana, and Iowa and parts of six adjacent states.

In the Southeast and Southwest, fewer than one in 20 rural counties prosper.

Prosperous rural counties have more off-farm jobs, more educated populations, and less income inequality than other rural counties. Geographical factors like climate, topography, distances to cities and airports, and interstate highways are unimportant in distinguishing prosperous counties from others.

“Instead, the results supported what many rural people believe to be true—civically engaged religious groups and a common ancestry can really matter,” Isserman said. The prosperous rural counties in 2000 averaged 2 percent growth over the previous decade. The worst-off counties, which met no prosperity criteria, averaged five times the growth at 11 percent, and had much lower incomes.

This finding supports our view that growth and prosperity are different dimensions and that much can be learned from studying rural prosperity,” Isserman said.

Having analyzed the data on 1,300 rural counties, the research team is studying communities up close to learn the story behind the statistical results. “We want to figure out how and why these places prosper in order to help other rural places do well, too.”

Mallory Rahe, a member of the research team, recently completed a master’s thesis on two prosperous rural counties. “Her findings are strikingly consistent with the statistical results. They suggest that local action can make a big difference,” Isserman said.

“Now we are working on a research design to help us determine more conclusively whether local action really can bring sustained rural prosperity.”

The research team also wants to study the few prosperous rural counties with a minority concentration. According to the published study, only six rural counties are prosperous of the 260 where African Americans are 10 percent or more of the population, only one county out of 98 for American Indians, and only 17 of 181 for Hispanics.

Isserman said these numbers have important implications for broader policy. “The strong empirical findings for rural places with American Indian and African American populations are forceful reminders that the United States has not overcome the legacies of its original racial policies,” he said. “Rural development policy cannot ignore race. Conditions are worse in those rural communities than other factors predict. How some rural places succeeded against those odds might have important lessons for all rural places trying to prosper.”
Soy Peptide Lunasin Has Anti-Cancer, Anti-Inflammatory Properties

Two new University of Illinois studies report that lunasin, a soy peptide often discarded in the waste streams of soy-processing plants, may have important health benefits that include fighting leukemia and blocking the inflammation that accompanies such chronic health conditions as diabetes, heart disease, and stroke.

“We confirmed lunasin’s bioavailability in the human body by doing a third study in which men consumed 50 grams of soy protein—one soy milk shake and a serving of soy chili—daily for five days. Significant levels of the peptide in the participants’ blood give us confidence that lunasin-rich soy foods can be important in providing these health benefits,” said Elvira de Mejia, a U of I professor of food science and human nutrition.

In the cancer study, de Mejia’s group identified a key sequence of amino acids—arginine, glycine, and aspartic acid (the RGD motif)—that triggered the death of leukemia cells by activating a protein called caspase-3. She was also able to quantify the loss of leukemia cells in vitro in the presence of lunasin.

In another study, the first to report lunasin’s potential anti-inflammatory activity, de Mejia and her students showed that lunasin suppressed inflammation by blocking or reducing the activation of an important transcriptional marker called NF-kappa-B, a link in the chain of biochemical events that cause inflammation.

De Mejia also found statistically significant reductions in interleukin-1 and interleukin-6, both important players in the inflammatory process. The reduction in interleukin-6 was particularly strong, she said.

Although inflammation is linked in the public mind with chronic health problems such as heart disease, diabetes, and rheumatoid arthritis, de Mejia said it also plays a role in the development of cancer.

“We know that chronic inflammation is associated with an increased risk of malignancies, that it’s a critical factor in tumor progression,” she said. “And we can see that daily consumption of lunasin-rich soy protein may help to reduce chronic inflammation,” she added.

Although the high cost of obtaining lunasin from soy waste limits its use for nutritional interventions, soy flour does contain high concentrations of the peptide.

De Mejia utilized the USDA soybean germplasm collection at the U of I, studying 144 soy genotypes to learn which varieties contain the most lunasin.

“Some genotypes contain very high concentrations of lunasin, others contain no lunasin, and some locations yield more lunasin-rich beans than others,” she said.

De Mejia spoke recently about her work with lunasin at the Latin American Congress of Food Science and Technology in Brazil, the Latin American Congress of Nutrition in Chile, and the Institute of Food Science and Technology at National Taiwan University.

The leukemia study was published in Molecular Nutrition and Food Research. Wenyi Wang and Vermont Dias are co-authors. Lunasin’s anti-inflammatory effects were described in Food Chemistry. V.P. Dia, W. Wang, and V.L. Oh of the U of I and B.O. de Lumen of the University of California, Berkeley, were co-authors.

Both studies were funded by the USDA Future Food Initiative.

The lunasin’s bioavailability study appeared in the Journal of Agricultural and Food Chemistry. The environmental conditions study was published in the Journal of AOAC International.
Natural Ingredient Preserves Meat Quality in Precooked Supermarket Offerings

Grapeseed extract is a viable natural alternative to synthetic ingredients that preserve meat quality in precooked, frozen, and refrigerated ready-to-eat meals, such as individual diet entrees or family-sized trays of frozen lasagna, according to a new University of Illinois study published in the Journal of Food Science.

“In the last five years, the section of the supermarket that contains fully cooked, ready-to-eat products has grown tremendously as consumer demand for convenience foods has increased. I’d estimate that 10 percent of all meals served at home feature these foods,” said Susan Brewer, a U of I professor of food science.

For years, the food industry has been using synthetic ingredients—BHA, BHT, and TBHQ—to preserve the quality of meats in precooked foods by slowing the oxidation of fats. But Brewer’s study shows that a natural product may be an even more effective antioxidant.

That product, grapeseed extract, is a byproduct of fermentation, and its efficacy is due mainly to its phenolic compounds, Brewer said.

“We’ve known for years that certain natural compounds, including some herbs and spices, have powerful antioxidant activity. Food scientists have been trying to isolate the flavoring parts of these spices from the components that have the functional effects we’re looking for,” she said.

Brewer was frankly skeptical when a study to determine the effectiveness of grapeseed extract in preserving the quality of precooked meats was suggested to her.

“But we’ve done three studies in a row now, and I’m a believer,” she said.

Brewer and her graduate student Martha Rojas compared the natural antioxidants oregano, rosemary, and grapeseed extract in a study that evaluated their effectiveness in cooked, reheated beef and pork at different concentrations, for different lengths of time, and at different temperatures.

“I really think grapeseed extract is a viable, natural way to preserve meat quality in the precooked entrees that are so popular now.” – Susan Brewer

The meat was then evaluated by a 10-member panel for oxidative markers and sensory attributes.

“The higher concentration of grapeseed extract yielded better results than we see with synthetics, which is certainly not what you’d expect. Synthetics, after all, have been engineered to maximize effectiveness, but sometimes Mother Nature comes up with a better product,” Brewer said.

Another plus was that the sensory panel couldn’t detect grapeseed extract in the products it tested, whereas foods containing oregano and rosemary retained an herbal odor.

“They must be carrying some of the volatile aroma compounds at low levels,” the researcher said.

Studies are ongoing in Brewer’s lab, this time comparing the efficacy and sensory qualities of natural versus synthetic antioxidants.

“I really think grapeseed extract is a viable, natural way to preserve meat quality in the precooked entrees that are so popular now,” Brewer said. “And when companies can use the word natural on a label, it’s attractive to consumers. It takes some of the guilt out of using a convenience food.”

Brewer and Rojas co-authored the study, which was funded by Kikkoman.
"Stealth Nutrition" to Improve Health of Honduran Children

A partnership between scientists at the University of Illinois and Zamorano University is bringing "stealth nutrition" to Honduran children with micronutrient deficiencies. But the partnership’s Nutrigems project has repercussions that go beyond the immediate goal of getting iron into malnourished children’s diets. This effort promotes international understanding by giving Illinois students insight into global nutrition issues and bringing Latin American graduate students to study in the U of I Department of Food Science and Human Nutrition (FSHN).

"With the help of former Zamorano students now doing research in our laboratory, we’ve developed a low-cost, culturally accepted way of getting micronutrients, such as iron, into the diets of Honduran children,” said Bill Helferich, a U of I professor of nutrition.

Previous failed attempts at improving nutrition in Honduras have complicated this challenging problem. The micronutrient supplements routinely offered to Honduran children contain so much ferrous sulfate, a type of iron, that the children’s teeth become discolored and their stools turn black. Honduran parents are understandably reluctant to use them or to try anything new, Helferich said.

Helferich and his associates have gained credibility through their affiliation with the U of I and their partnership with the Pan-American School of Agriculture, known as Zamorano, a U.S. university on Honduran soil that attracts scholars and students from all over Latin America.

“We’re teaching Honduran teachers and mothers to fortify rice with iron in amounts that are significant but undetectable to the senses. The schools are able to use it successfully because the children can’t taste it and their parents are sold on its benefits,” Helferich added.

The project uses iron sodium EDTA, a chelated form of iron that is more biologically available than other forms and doesn’t cause problems when it is mixed with food, even in the typical Latin American diet, which is high in phytates. Phytates reduce the bioavailability of minerals by sequestering them so that they are not absorbed and are instead excreted by the body, Helferich said.

The micronutrients are mixed with flour, oil, and water. Then the dough is processed through a handheld extruder. It is then dried and broken into pieces.

Helferich said fortification can be done for 1,000 children for less than a dollar a day. He believes that governments will use the process because the very low cost plays a major role in making the Nutrigems project sustainable.

In the undergraduate class he teaches, Helferich exposes students to the Nutrigems work. “Initially my students in FSHN 220 will use virtual videoconferencing to interact with their peers at Zamorano, exchanging both cultural and scientific knowledge. Later, undergraduate students will be able to study abroad in Honduras and get hands-on experience in the field by participating in this project and others like it,” he said.

“Master’s students will do evaluation interviews with the kids and their mothers and teach some of the courses there. It’s great for FSHN students to go down and work with students from all over Latin America who are interested in the same issues they are,” Helferich said.

These sentiments were echoed by Juan Andrade, an Ecuadorian postdoctoral research associate in Helferich’s lab and a former Zamorano student who obtained his Ph.D. from Purdue University. He spends 25 percent of his time working with Nutrigems.

“W hat’s missing with most study-abroad programs is that you usually don’t have a structured project with clear learning objectives,” Andrade said.

“As students work with the Nutrigems project in Honduras, they see the applied nature of their research and how their work in the lab is affecting people. We’re creating a technology that’s sustainable, that people are going to use. Being part of it is very rewarding. “Zamorano students want to do graduate work at Illinois because of the university’s reputation. They realize they can gain tremendously by being here for a short time,” he added.

Helferich said that the work of Nicki Engeseth, a U of I associate professor of food chemistry, and of two Zamorano alumni who are now FSHN graduate students, Eliana Rosales of Bolivia and Julio Lopez of Guatemala, have been critical in forwarding the project. They have conducted vital sensory research with Honduran children and strengthened the U of I’s relationship with Zamorano.

Faye Dong, FSHN department head, enthusiastically supports collaboration between the two schools. “We’re educating students to make a difference in the world. Our department has a long history of recruiting Zamorano students for internships and graduate school. And many of our faculty and students have benefited from educational activities there,” she said.

Engeseth added, “We know that students who participate in this unique project will strengthen their social consciences, and when they continue with their careers, they’ll have a greater appreciation of global food issues. They’ll understand that culture is a strong driving force in consumer decisions.”

The Nutrigems project is partially funded by a USDA CSREES International Science and Education Grant.
Public Policy Should Promote Family Mealtimes

In a new report, University of Illinois professor Barbara H. Fiese urges local, state, and federal governments, businesses, and community leaders to promote family mealtimes as a matter of public policy.

“New things parents can do that are as effective in protecting their families as taking 18 to 20 minutes to eat together and talk with each other three to five times a week,” said Fiese, a U of I professor of human development and family studies and director of the U of I’s Family Resiliency Center.

Research indicates the following benefits of family mealtimes:
- For young children, family mealtimes mean fewer behavior problems.
- Teens who eat five or more meals a week with their families are less likely to smoke cigarettes and marijuana and to abuse alcohol.
- Children who take part in regular family mealtimes have greater vocabulary growth and higher academic achievement.
- Frequently shared mealtimes protect against obesity in children and eating disorders in preteens and adolescents.
- Teens who dine regularly with their families tend to eat more fruits and vegetables.
- Meals prepared at home tend to be lower in calories and fat than restaurant fare.

“Most people don’t think of family mealtimes as a policy issue, they think of them as private events. But sometimes policy makers work against the best interests of families,” Fiese noted.

According to Fiese, many decisions made at the local, state, and federal levels alike affect families’ ability to consume healthy foods.

In poorer neighborhoods of cities, residents are far more likely to find a convenience store stocked with snack foods than a grocery store that sells fresh produce and more healthful foods, she said.

When families have to make an effort to create healthy meals, they’re likely to choose convenience foods,” she said.

Inaccessibility of nutritious foods and lack of resources combine in low-income areas to create food insecurity.

“The ability to find and afford healthy foods is compromised,” said Fiese.

She urged cities and communities to support zoning laws, low-interest loan programs, and food labeling programs that allow families to make healthful food choices in all neighborhoods. Communities could also launch campaigns to stress the importance of family mealtimes and work with schools to promote the idea that families should eat together at least once a week.

Fiese would also like to see policy makers tackle food marketing to children.

In 2006, the food and beverage industry spent $1.6 billion advertising to children and teens. Of that amount, $870 million was spent on ads geared to children under 12. “Young children are easy targets for these marketers’ messages, especially when the pitch is delivered by a cartoon character or another media personality they trust. These ads create a demand for unhealthy foods, and parents often feel ill-equipped to say no,” she said.

“It’s a battle because even two-year-olds can recognize the symbols for fast-food restaurants and lobby their parents for items they’ve seen advertised,” she noted.

She asks the food advertising industry to support the recommendations of the Federal Trade Commission that would make nutritious foods more widely available to children and teens.

Fiese would also like to see industry partner with communities to develop effective public service announcements that promote shared family mealtimes.

The federal government could also use the school lunch program and the Women, Infants, and Children (WIC) program to better advantage. Although there have been many changes in the contents of food packages, they provide no information that promotes family mealtimes as a way to improve nutrition and reduce stress in families,” she said.

Finally, Fiese said, parents must make the effort to set aside regular times for shared meals and set limits on activities—such as watching television and using cell phones for conversation and texting—that interfere with family interaction.

“Sadly, almost 46 percent of families have a television in their kitchen or dining room. Research shows that this kind of multitasking during meals makes people more likely to eat food that’s high in sugar and fat and less likely to consume fruits and vegetables. Shared mealtimes aren’t just about food, they’re about helping family members relax,” she said.

Fiese is confident that a policy push can make a difference. “Because of the advocacy of behavioral and social scientists, people have learned to wear seat belts and bike helmets for their own protection. Now it’s time for policy makers to promote family mealtimes as a proven way of protecting your family’s health and well-being,” she said.

These recommendations appeared in Social Policy Report, a publication of the Society for Research in Child Development. The report was co-authored by Marlene Schwartz, deputy director of the Rudd Center for Food Policy and Obesity at Yale University.
Dad’s Early Connection with Child Writes Script for Future Life

When a dad changes diapers and makes pediatrician’s appointments, he’s more likely to stay interested and involved when his child makes the transition to school, said a new University of Illinois study that explores the role of parent involvement on student achievement.

“If we want fathers to be involved in school, we need to focus on men building close, loving relationships with their children in the preschool years. When fathers do this, they’re writing a script that says they’re involved in their child’s life, and their expectation is that they’ll go on being involved in that child’s life,” said Brent McBride, a U of I professor of human development.

“If you, as a dad, develop an affectionate way of interacting with your preschooler, later when your child comes home and tells you what he’s done in school that day, the warm, close relationship you’ve built will allow him to approach you with trust, and it will allow you to respond to your child’s enthusiasm or frustration in a positive way,” he said.

“ar fathers wait to seek a closer relationship with their child until later in the child’s life, the moment has passed,” he said.

The study involved 390 children and their families from the Child Development Supplement data set of the Panel Study of Income Dynamics.

The study showed that the paths are different for mothers and fathers, and the researcher believes that teachers and parents should acknowledge that and build on these differences.

For example, although mother involvement in household-centered activities, parent-child child-centered activities (for example, reading to kids), parental limit setting, responsibility (such as making doctor’s appointments), and demonstrating affection. Later the mothers’ and fathers’ involvement in school and the children’s student achievement were assessed.

The study is unique because it looks at mothers and fathers simultaneously, said McBride. “No one person in a family system does anything without being influenced by every other person in that system. Having both parents in these analyses is a big advantage and a step above the previous research.”

The study, which appeared in a recent issue of the Journal of Educational Psychology, was co-authored by W. Justin Dyer, Ying Liu, and Sungjin Hong of the University of Illinois at Urbana-Champaign and Geoffrey L. Brown of the University of North Carolina at Chapel Hill. It was funded in part by grants from the American Educational Research Association and the National Science Foundation.
sustaining our economy
Increased Carbon Dioxide in Atmosphere Linked to Decreased Soil Organic Matter

A recent study at the University of Illinois created a bit of a mystery for soil scientist Michelle Wander. Increased carbon dioxide in the atmosphere was expected to increase plant growth, increase plant biomass, and ultimately beef up the organic matter in the soil—but it didn’t.

“Going into the study, the assumption was that higher levels of carbon dioxide in the atmosphere will increase crop yield and soil organic matter,” said Wander.

“We did see a 30 percent increase in above-ground and below-ground soybean biomass, so we expected that to be mirrored in soil organic matter, but there wasn’t an increase. In fact, organic matter levels may have even been lower than in plots not exposed to elevated carbon dioxide levels.”

The study was conducted at U of I’s SoyFACE facility, an open air laboratory in which rings of pipes surround corn and soybean crops so that the plants can be exposed to various levels of carbon dioxide and/or ozone pumped through the pipes. The findings from the study are published in Plant and Soil.

“My student Ariane Peralta and I were looking at younger soil organic matter that would be most influenced by today’s practices, and we were expecting a big change—a 30 percent increase in soil organic matter, reflecting the changes we saw above ground.

“The source of carbon is plant biomass, so we would expect increased yield, increased biomass, increased soil organic matter in the soil. This kind of positive feedback would be good, because it could offset the increases in decay that will result from rising temperature,” said Wander.

She explained that the increases in carbon dioxide levels in the atmosphere insulate the earth and contribute to global warming. Average annual air and soil temperatures are increasing. By the end of the century, maximum daily temperatures could rise by 5 or more degrees Fahrenheit in winter even more in summer.

“We know that microbial activity is directly influenced by an increase in temperature if other factors, like moisture, aren’t limiting microbes’ growth,” Wander said.

Success in using agricultural land to mitigate climate change depends on keeping carbon in soil reserves.

“Increased decomposition of organic matter is undesirable from a soil quality and climate perspective; microbial degradation of organic stocks releases carbon and nitrogen, and over the long term this reduces soil’s productivity and ability to resist erosion, plus it returns the carbon dioxide to the atmosphere,” Wander said.

She added that carbon dioxide levels are rising every year in the atmosphere because of human use of fossil fuel and deforestation. “We attribute the higher soybean yields over the past several decades to the rising carbon dioxide levels in the Earth’s atmosphere—some attribute a 10 percent increase in soybean yields already, due to this carbon dioxide ‘fertilization’ effect.

“Most models or projections of the future assume the carbon dioxide fertilization effect would be a good thing for agriculture and the world’s food supply and have a benefit to soil organic matter, but more and more we are finding things are a little more complicated. What our study shows is that in this system, rising carbon dioxide levels are not contributing to soil health after all.

“Where did the organic carbon that was added by increased plant growth go? We know for certain that soil organic matter stocks result from the balance of inputs and decay, so we had to look at factors that influence decomposition. Nutrient levels, soil pH, and available nitrogen were all high in this fertile field, and so we ruled these factors out.” Wander and Peralta suspect soil moisture plays a role. Wander points out that changes in rainfall are another important aspect of climate change and notes that we are already seeing shifts in the distribution of rainfall, with increases in winter and spring rains followed by drier summers.

“Dry conditions can constrain plant growth and microbial decay rates. What the researchers saw in the SoyFACE plots was important feedback—crops exposed to elevated carbon dioxide became more efficient at water use.”

“When plants take up moisture they open their stomata—the pores through which they transport both carbon dioxide and water,” Wander said. “When plants satisfy their need for carbon dioxide, they can close those stomata and conserve water. This appears to have happened at SoyFACE in both corn and soybean crops.”

Wander said it’s a little tricky to project the future with these findings, because previous research projects on the SoyFACE plots manipulated carbon dioxide, but not rainfall.

“We have learned that we can’t say ‘yield equals organic matter.’ We have to understand the nuances of the time and place. SoyFACE is giving us early clues about what could happen in the future and where to direct our research attentions,” Wander concluded.

“What our study shows is that in this system, rising carbon dioxide levels are not contributing to soil health after all.”—Michelle Wander
The best indicator of animal comfort is still measurable animal-performance traits, said a University of Illinois Department of Animal Sciences professor in a new journal article.

“An important issue in animal agriculture nowadays is the public demand for evidence that animals on farms and ranches are being treated humanely, that animal state of being (ASB) is high most of the time,” explained Stan Curtis in The Professional Animal Scientist.

“As important as this question is, scientists have yet to reach consensus on how to accomplish that task. It is an unsettled area of knowledge that is seriously in need of more concerted attention.” It is not possible, Curtis noted, to objectively measure an animal’s feelings in the laboratory, let alone in a production setting.

“It is the interpretation of such observations of behavior patterns putatively indicative of negative feelings where the ‘feelings approach’ is still wanting as to its practical usefulness on farms and ranches,” he said.

“Therefore, others advocate more objectively measurable animal-performance traits as more valid indicators of ASB today.” Curtis noted that what cannot be measured cannot be managed.

“We can directly, objectively measure productive and reproductive performance but not feelings (e.g., suffering); and performance reductions are early, sensitive indicators that ASB is being compromised.”

In the absence of an adequate scientifically informed understanding of an animal’s conscious feelings, the best single set of measurable—hence, manageable—indicators of its state of being will be its rates of productive and reproductive performance relative to its predicted potential to perform.

“The community of animal-welfare scientists should be enlarged to include more people specializing in state-indicative animal traits in addition to behavioral and cognitive ones,” Curtis said.

Farmers have long recognized the effectiveness of performance as a measurement of ASB, he added.

“They know that—all other things being equal—the highly productive animal will be the animal that appears to be experiencing low stress and enjoying a high state of being,” he said. “If scientists would recognize this and more attention were accorded the performance axiom, then the recognition of performance as an indicator of ASB would be resurrected from an unfortunate hiatus that has lasted for several decades. The performance axiom would experience a Cinderella moment.”

If progress is to be made in the assessment of ASB, Curtis concluded, the importance and use of objective measures of animal performance must be markedly increased.
Predicting the Perfect Predator

Garlic mustard (*Alliaria petiolata*) has become an invasive species in temperate forests across the United States, choking out native plants on forest floors and threatening ecosystem diversity.

University of Illinois ecologist Adam Davis has created a computer model that he believes, in combination with quarantined research tests, will be able to predict the “perfect predator”—a pest that can be introduced into a forested area that will help reduce the garlic mustard population.

“The traditional method has been to release multiple agents into the environment and overwhelm the pest,” said Davis. “But with multiple introductions comes an increased likelihood that one of the agents will become invasive as well. So we’re trying to figure out which one is the most likely to actually have an impact on garlic mustard and release as few agents as possible.”

Davis is a member of the research team for USDA’s Invasive Weed Management Unit at the U of I. He has been working since 2004 on a project along with scientists at Michigan State and Cornell universities and the Commonwealth Institute of Biological Control in Switzerland.

Davis’s computer model creates a simulation of the population dynamics of the pest species—its seed and growth cycle, stressors, and so on. “Then you can introduce the biological control agents that you’re considering one at a time and see whether you can get away with just introducing one agent,” said Davis. “I collected data from field experiments and entered them into the computer model, which then projects forward which agent will be most effective.”

The computer simulation selected a tiny weevil, about the size of an “o” in 12 point type. “There are actually several weevils that feed on garlic mustard. This particular weevil that we’re looking at, *Ceutorhynchus scrobicollis*, feeds on the plant at several stages in its life cycle, so it’s a much more effective agent than some of the other ones,” Davis said. What happens if the control agent also becomes invasive? “A stringent battery of tests is performed on each biocontrol agent in quarantine before it is ever released. For example, garlic mustard is in the same family as cabbage (*Brassicaceae*), so one test might be to only feed the weevil cabbage and see if it survives on it or can reproduce on it. If it does, then the possibility exists that it could move from the garlic mustard and threaten cabbage plants, which we don’t want to happen. But this particular weevil has passed that test for a wide variety of plants.”

One strategy for biological control is inundative, meaning that the control agent eats its way through the garlic mustard and then dies out itself because there isn’t anything left to support it. The other strategy is to introduce a natural enemy that will just bring the population down to a lower level, and the plants and pests continue to coexist.

“T”he idea is that you reunite plants with a natural enemy from back home—which in garlic mustard’s case is Europe. In Switzerland, garlic mustard and the weevil coexist, and neither one is invasive.”

Garlic mustard was brought to the United States from Europe innocently in the 1870s as a culinary herb, but its natural enemy didn’t accompany it. Davis said that the beauty of using simulation models to guide biocontrol is that this approach can be adapted for use in controlling other invasive species, not just garlic mustard.

Davis’s journal article, “Demographic Models Inform Selections of Biocontrol Agents for Garlic Mustard (*Alliaria petiolata*),” was published in *Ecological Applications*. 
Soybean Aphids: Search for Resistance Brings Both Success and New Challenge

This year farmers in the Midwest are growing a new variety of soybeans developed by University of Illinois researchers that has resistance to soybean aphids.

After soybean aphids made their first appearance in North America in the summer of 2000, Illinois researchers began searching for a variety of soybean resistant to the new pest. Dowling and Jackson were the first two resistant varieties identified.

“We have the U.S. Soybean Germplasm collection here at Illinois. It houses about 18,000 different accessions,” said Glen Hartman, soybean plant pathologist with the USDA and U of I. “We didn’t screen all 18,000, but we went through a small set of 4,000 to 5,000; that’s where Jackson and Dowling came from.”

With additional screening, a third soybean resistant to aphids was found—a Japanese variety known as PI 200538. “After we mapped the genes from these sources, we discovered that Jackson and Dowling had genes mapping to the same place on a chromosome and the PI had a gene mapping to a different place. This means that Jackson and Dowling likely have the same resistance gene and PI 200538 has a different gene we can use in breeding.”

U of I plant breeder Brian Diers said that both Jackson and Dowling originated in the southern United States, so neither could be grown to seed in the Midwest. The researchers used traditional breeding techniques together with marker-assisted selection to breed the resistance genes into varieties adapted to the Midwest.

“Because the aphid resistance is conferred by a single gene in the resistance sources, we were able to breed these genes into Midwest-adapted varieties quickly and easily,” Diers said. “This year is a milestone because we now have a variety that’s being commercially produced that carries the resistance gene. This is its first commercial production of an aphid-resistant variety in the Midwest.”

Unfortunately, the celebration didn’t last long. While studying soybean plants, the scientists discovered a new type of aphid. In tests, this newly discovered aphid was able to infest Dowling as well as it could any susceptible genotype of soybean.

The good news is that the PI 200538 gene for resistance is different than the one in Dowling and Jackson.

“We found that this second resistance gene in the PI protects the plants against this new biotype of aphid. We are currently breeding the PI 200538 gene into varieties, but it will be at least a few years before any varieties with this gene will be released.”

Even after the appearance of this new aphid, Diers is still optimistic. “Our hope is that we can combine these two genes and get more durable resistance,” Diers said. “We hope that we can develop a plant with a number of resistance genes so that if any one of them breaks down, the plant would still be resistant.”

Diers said that resistant varieties can save farmers money and help the environment. “Farmers have been controlling soybean aphids by spraying insecticides. If we can deploy resistance, this could reduce the use of these insecticides, which will have many environmental benefits.”

This work was supported by funding from the United Soybean Board and the Illinois Soybean Association.


Yan Li, Curtis B. Hill, Shawn R. Carlson, Ki-Seung Kim, M.A. Rouf Mian, and Laura Crull contributed to the research.
Understanding How Weeds Are Resistant to Herbicides

In a little over seven hours, University of Illinois weed scientist Patrick Tranel got more genetic information about waterhemp than in two years in his lab. The genetic information was obtained using pyrosequencing technology in the Keck Center at the U of I. The genetic sequence will allow scientists to study herbicide resistance in waterhemp.

“With this type of technology, you can generate all of this genomic data relatively cheaply and quickly, so it’s worthwhile doing in some of these non-model species like weeds.”

Tranel believes waterhemp is the first weed to be partially sequenced using this technology.

The pyrosequencing machine emits a light signal that’s captured every time a nucleotide is incorporated into a growing DNA strand. “The reason it’s so fast is that it’s done in parallel,” said Tranel. “The plate has thousands of tiny wells, and a sequencing reaction going on in every one of them simultaneously. There’s a camera that monitors the light for each of these wells simultaneously, and so in one 7½-hour run you generate a million reads.”

Tranel said that identifying weed resistance is an immediate outcome of having the genetic data. “Once we obtain the sequence of a resistance gene, we can develop molecular tests that are specific for the resistance mutation.” “We can take a sample of waterhemp from a field that was sprayed and the waterhemp hasn’t died and we can confirm whether it is resistant or not because we know the gene sequence and we know the mutation and the mechanism.”

Having the complete genomic data on waterhemp will help scientists not only to identify but also to understand resistance and how resistance evolves. “If you understand how it evolves, that can help you devise strategies that cannot prevent it from evolving, but at least can slow the rate at which the change happens,” said Tranel.

“If you use the same herbicide year after year, you’re exerting selection pressure—you’re selecting for that rare plant or mutation that will survive. When you do that, and you kill all of the siblings that are weaker, the mutant survives and all of its progenies will survive and that’s how resistance evolves. It’s evolution in action,” said Tranel.

Waterhemp is a midwestern problem, Tranel said, but it’s a member of the genus *Amaranthus* that includes weeds that are a problem worldwide, such as pigweeds. “Because they all belong to the same genus, their genomes are very conserved. So if we have the sequence for the PPO gene in waterhemp you can use that information to get the PPO gene in redroot pigweed. It would be a similar sequence.”

Having this information is like building a tool kit, said Tranel. “We’re developing all of these resources and putting these resources in our freezer. When we have an interest in resistance to herbicide A which targets enzyme B, we can go to the freezer, or to the computer, and get the sequence of the gene for that enzyme.”

Tranel said that because waterhemp is in the group of amaranthus weeds, it’s a good model for weed genomics. “A weed scientist in Georgia, where there’s a lot of Palmer amaranth—another pigweed evolving resistance—can go straight to that data base and get gene sequence data.”

Another outcome of having this genomic data is being able to design markers, meaning that you can “fingerprint” individual waterhemp plants and use that information to do population genetic studies. “If you see herbicide resistance in northern Illinois and a year later you see the same resistance in a population in southern Illinois, one of the things you want to know in managing resistance is, did resistance evolve or occur in northern Illinois once and then a farmer moved a combine and that’s how resistance got in southern Illinois? Or did resistance occur independently in both places?”

Understanding how the resistance occurred has implications for weed management. “If resistance is evolving multiple times, you need to pay attention to what you’re doing in your field, whereas if it evolved once and is moving around then you’ve got to pay attention to what your neighbors are doing. It’s important to know how resistance is evolving, how it’s spreading.

“If you use these genetic fingerprinting tools, which we’re able to do because of this research, you can go look at...
Illinois Team Builds Solar House to Compete in International Decathlon

Members of the Department of Agricultural and Biological Engineering (ABE) played an important role in the design and construction of the “Gable House,” the University of Illinois solar house that took second place in the 2009 Solar Decathlon design competition sponsored by the U.S. Department of Energy (DOE).

The DOE hosts 20 college and university teams from around the world and challenges the students to design, build, and operate the most attractive and energy-efficient solar home. The competition took place on the National Mall in Washington, D.C. October 8 through 18.

Xinlei Wang, an associate professor in ABE, was the mechanical systems adviser for the 2009 competition. Mark Adams, an ABE graduate student, was the student lead for all mechanical systems in the house, including hot water, appliances, and heating, ventilation, and cooling systems (HVAC). Adams personally constructed the HVAC system from scratch.

Adams said the team wanted to focus on simple design concepts and simple engineering in designing and constructing the home. “That’s not to say simple is easier. Many times it’s actually harder to take the simple approach. But we really wanted to stress conservation, reliability, and cost-effectiveness,” he said.

Adams said most people think of solar panels when they think of energy-efficient homes. “Solar panels focus on generation and they are very expensive, so they don’t have the quickest payback. There are other, smaller systems that focus on conservation, such as the heat pump hot water heater we used in the house. It has a very quick payback. You can save a few hundred dollars every year, and the system only costs about $700, so there’s about a three-year payback on that alone.”

Adams said the home’s performance in the objective division of the contest proved how well all the systems worked. The competition included tests in 10 categories. Five were objective (hot water, appliances, comfort zone, home entertainment, and net metering) and five were subjective (architecture, market viability, engineering, lighting design, and communications).

U of I dominated the objective division, taking first place in three of the categories (hot water, appliances, and home entertainment) and second place in the other two (comfort zone and net metering).

“All our systems worked well,” said Adams. “They were very reliable and they proved our design intent.” U of I also took second place in one of the subjective categories, lighting design.

The U of I team was in first place at one point in the competition, but Germany moved ahead when it received a perfect score (150 points) in the biggest category, net metering. Net metering measures a home’s energy use.

The U of I Gable House used a 9-kilowatt solar energy system and produced four times the energy it needed, earning 137 points. But Germany’s house was covered in black solar panels. Using an 18-kilowatt system, it generated a surplus of power even during three days of rain.

Mark Taylor, architecture professor and project manager, said Illinois “just couldn’t beat a house wrapped in solar panels,” but team members pointed out on the team blog site that taking “second place in net metering with a photovoltaic array HALF the size of the winning team is truly impressive.”

Other features of the Gable House included 10 inches of high-performance insulation in the walls, roof, and floor; laminated bamboo (a strong, renewable material) for structural wood; and high-efficiency lights and appliances.

Adams said many people who toured the house were impressed with its comfort. “It’s a little deceiving from the outside. It looks small. But once people came inside they thought it was large and very spacious. They could see themselves living in the house. That’s always a good thing to hear.” Overall, the Gable House was the second most affordable structure in the competition.

When the house returns to Champaign, it will be installed by a pond near the I Hotel, with prairie landscaping around it. Sponsored by the federal Department of Energy, the Solar Decathlon brings together teams from colleges and universities to design, build, and operate solar-powered houses.

Among the focuses of the competition are the attractiveness, effectiveness, and energy-efficiency of the completed houses.

In addition, the goals for the project include educating participants about the benefits of energy efficiency, renewable energy, and green technologies; raising awareness among the public regarding these technologies; and fostering collaboration among students of differing academic disciplines.

For more information on the Illinois Solar Decathlon team, visit www.solardecathlon.uiuc.edu.
Students in the Department of Natural Resources and Environmental Sciences at Illinois spent their 2009 spring break making a coffee plantation in Brazil truly sustainable.

Daniel Anderson, a research specialist in agriculture, teamed with 10 students on a research trip to the Fazenda Ambientel Fortazela (FAF), an organic coffee plantation near Mococa, Brazil.

According to Anderson, sustainability always addresses three factors: economy, ecology, and society. “Economic sustainability means profit-ability for the farmer. Lots of food companies are making money, but to be sustainable on the land, farmers have to be productive and profitable.

“Ecological sustainability means farming in a way that protects the integrity of the soil, water, and biodiversity of an area. Sustainable agriculture also has to be socially acceptable and contribute positively to the health and well-being of society,” said Anderson.

The trip allowed the students to “learn first-hand about agricultural sustainability and develop ideas for potential research projects that will help the owners of FAF to realize their vision of a truly sustainable farm,” Anderson said.

All the students’ proposals differed. “One student focused on bird species’ diversity in the different coffee production systems, another proposed investigating natural weed control strategies for yellow nutsedge, and another looked at the impact of organic transition production strategies on the hired employees on the farm,” Anderson said.

Elizabeth Bowman, a junior majoring in agricultural and consumer economics with a focus in agricultural finance, focused her proposed research project on the benefits and liabilities of shade-grown coffee in the rainforest.

Her project would examine the soil chemistry and the nutrients for coffee grown in the sun, the shade, and the non-organic system. Soil samples would be taken from each plot and compared to determine which system was the best.

“The results would be interesting because when it comes to organic farming, you simply have to let nature take its course,” Bowman said.

Anderson thinks the ramifications of this trip could be far-reaching.

“The plan is to complete at least some of the research project proposals on the farm in Brazil, with the hopes of the trip becoming an annual event, building each year on past years’ projects.”

Organic farming is not a popular form of production in Brazil. However, if the student research projects bear positive results, the Brazilian hosts hope to use those results to encourage interest among farmers outside of FAF in organic farming. “Hopefully our research will speed up that process,” Anderson said.

FAF benefited greatly from the research the students from the University of Illinois conducted while in Brazil, but according to Anderson, “the trip was a powerful experience for most of our students; for some it was life-changing. Who knows what those students will do with their lives based on what they learned in Brazil?”
Geothermal Technology Can Cut Power Bills in Half

There is an age-old but little-used source of energy available to just about everyone, just about everywhere. It can save you as much as 50 percent on your heating and cooling bills—and it’s right beneath your feet.

Six to eight feet below the earth’s surface, the ground remains at a relatively constant temperature. The stable, even heat of the earth can be used as a heat source in the summer, to provide residential and commercial buildings with heating and air conditioning by using a geothermal heat pump.

“The geothermal heat pump (GHP) is one of the most efficient and environmentally friendly heating and cooling systems available today,” said Xinlei Wang, a professor in the Department of Agricultural and Biological Engineering at the University of Illinois.

A normal heat pump system extracts heat from outdoor air and transfers it inside, where it is circulated by a fan through a home’s ductwork, said Wang.

“If you want to keep it 70 degrees inside and it’s below zero outside, a heat pump would have to work pretty hard,” Wang explained. “But if we use underground heat as our source, even on the coldest day, the temperature is still 45 to 50 degrees six to eight feet below ground. Going from 50 to 70 degrees, your efficiency will be much higher.”

A GHP works by collecting the earth’s natural heat through a series of pipes (called a loop) that are installed below the surface of the ground. Loops can also be submerged in a pond or lake. Fluid in the loop, either water or an environmentally safe antifreeze solution, circulates through the pipes in a closed system and carries the heat to the house. An electrically driven compressor and a heat exchanger concentrate the energy and, using typical ductwork, release it inside the house.

In the summer, the loop draws excess heat from the house and transfers it back into the ground. The system works the same way a refrigerator keeps food cool—by pulling heat from the interior, not by blowing in cold air.

Several loop configurations can be used, said Wang, but one of the most common is the horizontal ground loop.

“Horizontal ground loops are used where there’s sufficient land available and where trenches are easy to dig,” said Wang.

Workers dig trenches 4 to 6 feet deep and 2 feet wide, and then lay a series of parallel plastic pipes. A typical horizontal loop is 400 to 600 feet long for each ton of heating and cooling, and an average residence requires a 3- to 4-ton unit.

If you have little yard space or you don’t want to disrupt the landscape, a vertical ground loop can be used, said Wang.

In a vertical ground loop, holes about 4 inches in diameter are bored into the ground 150 to 450 feet deep. A single loop of pipe with a U-bend at the bottom is inserted before the hole is backfilled.

The vertical pipe is then connected to a horizontal underground pipe that carries fluid to and from the indoor exchange unit.

A third alternative is the pond loop system. If a property has a pond or lake with an adequate water supply, a pipe can be run underground from a residence to the water, coiled into circles at least eight feet under the surface to prevent freezing. The water source must meet minimum volume, depth, and quality criteria.

Because of the technical knowledge and equipment needed to properly install a GHP system, Wang advises finding a qualified installer to do the job. Local utility companies or the Geothermal Heat Pump Consortium should have a list of qualified installers in the area.

A geothermal heat pump system may cost about $2,500 per ton of capacity, although a horizontal system will generally cost less than one with vertical loops.

“Most of the components are sheltered from the harsh weather, and the underground piping is guaranteed to last anywhere from 25 to 50 years, so there’s very little maintenance. These systems generally pay for themselves in five to eight years.”

People may worry about the reliability or durability of some alternative energy technology, said Wang, because it’s not mature yet. “But this is one technology that is very mature,” Wang concluded. “People can use it.”
A student-operated farm that went into production on campus in spring 2009 puts locally grown, fresh vegetables and fruits on the table for students and others who eat in University of Illinois dining halls.

A cooperative venture of the Department of Natural Resources and Environmental Sciences (NRES), the Horticulture Club, and Students for Environmental Concerns, the farm supplies fresh produce for campus diners, and contributes to campus sustainability initiatives by reducing the carbon emissions associated with transporting fresh produce from distant farms to campus. The farm also will provide a laboratory for students to learn about fruit and vegetable farming and for researchers to investigate sustainable agriculture technology.

Two acres of farmland at the southwest corner of Lincoln Avenue and Windsor Road in Urbana are allocated for the farm. The acreage may be increased to as many as 10 acres over time if the project is successful.

Crops are being selected and planted to coincide with Dining Services’ needs. In 2009, a crop of salad greens was planted, with plans for tomatoes, peppers, melons, sweet corn, and herbs. There are also plans for planting about 300 fruit trees, including peach and apple trees.

Dining Services’ request for strawberries and blueberries will be met with produce from the University’s Dixon Springs Agricultural Center in southern Illinois, along with cucumbers, squash and cantaloupe, according to Dawn Aubrey, senior assistant director of Dining Services. As the student farm grows and diversifies, more of those crops may become available locally.

A recent graduate has been hired as farm manager, and two student interns will help tend and harvest crops throughout the summer. Volunteers probably will need to be recruited from student groups to help with the fall harvest because bringing in vegetables is labor intensive.

“The long-term goal for the farm is to produce food not just for campus diners but for delivery to other universities,” said Bruce Branham, professor in NRES.

If we’re going to have an impact, we have to be able to make enough food to make a difference. There are a lot of universities that have student farms but they are, in my experience, more hobbies than actual operations that produce a significant amount of food.

“Our goal is to essentially become self-sufficient to where we can sell enough produce at market rates to Dining Services to fund the operation and produce enough food to really make a difference.

We may start canning food to extend the season and make a significant impact. My ultimate goal is for us to be the Newman’s Own of university food systems,” said Branham, referring to the food company founded by Paul Newman, the actor and philanthropist who died in 2008.

Branham envisions labeling preserved produce under a university-branded label a few years from now. To start that type of operation, funding would be needed to upgrade a food-processing lab in the Department of Food Science and Human Nutrition to human- consumption standards. Student interns could be employed to process the food, perhaps as part of a scholarship program.

If this year’s harvests yield more than Dining Services can use, the average may be donated to local food banks, Branham said.

To help extend central Illinois’s relatively short growing season, the farm uses three hoop houses—unheated greenhouses constructed from large hoops covered by heavy- weight plastic that use solar energy for heating and the wind for cooling.

The farm also uses low-impact production systems, minimizing pesticide usage and using natural fertilizers such as cover crops and compost.

“We may have to treat for some insect and disease pests, but we minimize pesticide usage in our production system,” Branham said. Since Dining Services requires that sweet corn it buys be shucked prior to delivery, the farm workers can cut off any rootworm damage, which typically occurs at the tips of the ears, when they shuck the corn, eliminating the need for a corn rootworm insecticide application.

The farm’s first year of operations was funded by a $50,000 grant from the Student Sustainability Committee, which decides how to spend the sustainability fee of $5 per semester paid by students to support eco-friendly projects on campus.

“The long-term goal for the farm is to produce food not just for campus diners but for delivery to other universities.”

—Bruce Branham
Whether it’s developing improved crop varieties, creating robotic components for more efficient weed control in fields, or developing the next breakthrough in bioenergy, the College of Agricultural, Consumer and Environmental Sciences at the University of Illinois is all about providing solutions for the challenges that face the citizens, communities, and businesses of Illinois.

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