Acres of Illinois Research

The formula for scientific discovery is straightforward: you need a scientist with an idea, and facilities. Myriad experiments based on such ideas can be conducted in laboratories with specialized equipment and computers. This is certainly true at the University of Illinois, and the main campus in Urbana-Champaign is filled with labs of all kinds.

In addition to traditional indoor laboratories, however, researchers in the College of Agricultural, Consumer and Environmental Sciences (ACES) require other environments to conduct agricultural science—greenhouses, pastures, and cropland.

The College of ACES is fortunate to have those environments available: large greenhouses, acres of farmland, and numerous livestock and breeding facilities on our campus in east-central Illinois, supplemented by research and education facilities located strategically throughout the state.

Illinois is a relatively large state—it stretches longer than 400 miles from north to south and about 200 miles east to west at its widest point, with about two-thirds of its acres in cropland. With that size comes a lot of variation: soil scientists have identified nearly 500 soil types in the state, and the climate differs widely from north to south. (On average, there are 12 inches more precipitation and 30 more frost-free growing days at the southern tip than at the northern border.) Because climate and soil composition play such a large role in agricultural research, being able to conduct experiments in a variety of environments is critical.

In addition to being done on farmland and in facilities owned and operated by the College, agricultural research takes place through private partnerships. The cooperation of individual farmers and producers throughout Illinois allows ACES researchers to do studies on a much larger scale. Valuable insights are gained when a project is taken from a laboratory bench, greenhouse flats, or small test plots to a full-scale operating farm.

The results from research conducted throughout Illinois are communicated to agricultural industries, farmers, and the public—converting real science into real agricultural products and practices for farmers, livestock producers, community planners, and entrepreneurs.

Our facilities throughout the state also provide ACES undergraduate and graduate students with a wide range of opportunities for experiential learning. Coursework, assistantships, and internships in the field enhance our ability to prepare the College’s students for what they will encounter as they enter the workforce.

In this publication, you’ll learn about some of the innovative research projects done in one or more locations throughout Illinois. I hope the variety will expand your understanding of the statewide activity of the College of ACES and your appreciation for the breadth of scientific discoveries taking place on Illinois acres.

Joel L. Kokini
Associate Dean, Research
University of Illinois researchers have identified a new soybean aphid biotype that can multiply on aphid-resistant soybean varieties. Soybean aphids are the No. 1 insect threat to soybean production in the north-central region of the United States. In 2009, aphid infestation on soybean was high enough that many growers had to spray their fields to control the pest. Despite this, many aphids survived and took flight last fall, causing a public nuisance. Migrating soybean aphids have delayed Major League Baseball games, closed outdoor cafes, and curtailed outside activities.

The soybean aphid is the only insect pest of soybean known to have multiple biotypes, said Glen Hartman, U of I professor of crop sciences and USDA research plant pathologist. Aphid-resistant soybean cultivars with the Rag1 resistant gene became widely available to soybean growers in 2011. They will provide protection against Biotype 1. Another biotype named Biotype 2 that can overcome soybean aphid resistance genes, even before soybean varieties with these resistance genes were deployed in production, suggests high variability in virulence within soybean aphid populations,” said Curt Hill, U of I principal research specialist.

“This gives the pest a high potential to adapt to and reduce the effective life of resistance genes deployed in production.”

What does this mean for soybean farmers? A limited number of soybean varieties carrying the Rag1 resistance gene were planted in 2009, and more varieties are now available. The discovery of an aphid biotype that can overcome the gene means breeders and seed companies will need to keep pace with the pest.

Hartman recommends that farmers plant aphid-resistant varieties if they have experienced aphid problems in the past. In addition, farmers should closely monitor aphid populations in their fields and spray when populations reach the economic threshold level, about 250 aphids per plant. If farmers find threshold populations on resistant varieties, they should contact their local University of Illinois Extension office.

Fortunately, aphid infestations can easily be controlled with insecticides, Hill said. However, proper timing is a key factor, requiring scouting of fields and following entomologists’ recommendations regarding threshold levels. Hartman said farmers can save some of their yield if they follow guidelines found in U of I Extension literature.

“Soybean aphids have a closer relationship with their host than other bugs,” Hill said. “They can feed on other plants, but they only readily reproduce during the summer months on soybean. They suck all of the life out of the plant in a matter of weeks, causing tremendous yield loss for farmers. This makes scouting crucial.”

U of I researchers are continuing to look for new resistance genes while studying the genomics of the soybean aphid to better understand its virulence. Hill believes plant resistance can provide an effective, economical, and sustainable method of insect control.

“We hope the use of molecular markers to identify biotypes will be available soon so we can take samples in the field and perform quick DNA tests to determine distribution of these biotypes,” Hill said. “Our goal is to help the soybean seed industry determine where to market soybean varieties with particular soybean aphid resistance genes to ultimately help producers select appropriate resistant varieties based on the virulence potential in their area.”

This research was published in the Journal of Economic Entomology and funded by the United Soybean Board. The research team included Curt Hill, Laura Crull, Theresa Herman, Glen Hartman, and David Voeglin at the U of I.

**Northern Illinois Agronomy Research Center**

Established in 1948 near Shabbona in DeKalb County, the 160-acre Northern Illinois Agronomy Research Center is the northernmost facility of the University of Illinois system. It provides land and support for campus-based researchers working in plant breeding, soil fertility/soil management, weed science, crop production, pest management, and environmental quality. The center superintendent also carries on applied research and demonstration programs in these and related specialties. Some 45 different projects are conducted here annually.
Biomas wxhich includes both agri-cultural waste and crops grown specifically for use as an energy source, could be provided by several perennial grasses in the future. Many perceive these grasses as requiring little management for insects or other pests, but researchers are instead finding that the identity of insect pests and their effects on harvestable biomass are simply not yet known.

A small caterpillar known as the tiller-killer has been documented in switchgrass across the Midwest by a team of researchers at the Energy Biosciences Institute (EBI) at the University of Illinois. The team has also identified fall armyworms, corn leaf aphids, and yellow sugarcane aphids as potential pests of Miscanthus x giganteus.

Mike Gray, a U of I entomologist leading this team of researchers, said, "Our goal is to discover perennial grass pests now so we can study their potential impact before these grasses become widespread. However, finding insects does not necessarily indicate a problem."

For the past two years, the team has been conducting surveys and searching for pests on biomass crops.

As biomass production increases, pests will react to the new resources we put out and make available to them," said Jarrad Prasifka, a U of I postdoctoral research associate. "In the United States, soybeans were considered a pest-free crop for many years. But now soybeans, just like any other crop, have management issues related to both insects and diseases."

Fall armyworms were found feeding on the whorls of Miscanthus and switchgrass. The fall armyworm is a seasonal migrant that comes to the Midwest in August from southern Texas and Florida. More research is needed to determine how serious a threat these insects pose to perennial grasses. Prasifka encourages producers to be aware of this potential pest, particularly in areas where multiple cuttings of switchgrass are desirable, as fall armyworm larvae prefer the succulent regrowth.

The tiller-killer is a stem-boring caterpillar that feeds on switchgrass and causes browning of whorl leaves and halts the growth of infested tillers. It spends the winter as a larva in the ground, which Prasifka believes may help keep the population suppressed in Illinois. Because the injury from this insect occurs early, it is possible that switchgrass could compensate for the loss of some tillers.

Corn leaf aphids are another low-threat migrant to the Midwest; they show up in mid-August on the whorls of transplanted (first-year) Miscanthus. While they don’t cause much visual concern, with slight yellowing of leaves, they can transmit barley yellow dwarf virus.

The yellow sugarcane aphid can winter in Illinois. The aphids are known to infest the lower leaves of Miscanthus and cause red stippling, which eventually can lead to leaf death. They are also capable of transmitting sugarcane mosaic virus.

Prasifka said it’s hard to forecast the effects of pests on perennial biomass crops. "If you were to ask me the outlook on a certain pest for next year, I might be able to make a good prediction," he said. "But if you are looking 10 more years down the line at Miscanthus, that’s very difficult to do. We are talking about a scale of time that actually permits evolution of insect and pathogen populations."

In addition, Prasifka said, one of the challenges is having to aim at a moving target. The optimum distribution of feedstocks can change through improvements in plant breeding or incentives to grow particular crops in certain areas. Also, the economic situation changes depending on the value of the commodity and the cost of management.

Despite the challenges, researchers are optimistic about how these pests will interact with biomass crops.

"Biomass crops should be able to tolerate significantly greater amounts of injury before you need to consider intervening to preserve the yield of biomass," Prasifka said. He encourages biomass crop producers to utilize wise breeding efforts.

Prasifka said, “If you put out one variety that you think is a world-beater, remember that it really doesn’t provide the same level of protection from evolving pathogens or insects that a mosaic of several similar feedstocks would have with different levels of resistance to those pests.”
Taming wild grapes for better wine

When you think about “wine country,” Illinois may not come to mind. But wine making is actually big business on the prairie. Illinois is home to 90 licensed wineries and 1,500 acres of wine grapes. One acre of wine grapes can bring in as much as $8,000 in sales (though more commonly sales range from $3,000 to $5,000). The largest wineries in Illinois produce 90,000 gallons per year, while many produce 3,000 to 10,000.

“In many cases, growing wine grapes is supplementary to the producer’s entire farming operation. The break-even point for a winery is about 10,000 gallons to make it a full-time endeavor that the State University of Illinois research to conduct research on grapes at the Center. For one of his latest projects, he is crossing wild grapes with proven wine grape varieties to develop a good wine grape that can withstand the cooler northern Illinois weather.

“There are wild grapes growing along the roadside on I-57,” Shoemaker said. “The interstate grapes root easily with no further help. Their native genetics mean that they have already adapted to this climate, but they aren’t good for eating or wine making. We’re crossing them with European grapes that have high quality to create new varieties that will grow in our climate and be good wine grapes.”

Unfortunately, the wild grapes have low yield as well as poor flavor. But Shoemaker is looking at three wild species that have excellent disease resistance to create breeding lines that will require less use of pesticides. Right now growers sometimes have to spray in order to grow a good wine grape, so this would be a great step forward for the industry.

“There isn’t much grape breeding being done to create improved varieties globally. We’re working to improve the fruit quality and develop new flavor profiles in wine,” he said.

The northern and southern hilly parts of the state have more potential for vineyards, with Galena in Jo Daviess County part of a new American viticulture region, said Shoemaker.

Since 1998, grapes, particularly cold-hardy wine grapes, have been a subject of studies at the St. Charles Center. The research was initiated by U of I scientists Robert Skirvin and Alan Otterbacher with a trial of 26 grape varieties planted on a southwest-facing slope. Shoemaker noted that it was the only southwest-facing slope available in the area.

Today Shoemaker conducts research at the St. Charles Center on cultivar evaluation; cultural research, including integrated pest management; and breeding new varieties of grapes.

“Cultural practices are all the methods growers use to manage the grape crop, such as pest management,” Shoemaker said. “Grapes are popular with many pests. There are insect challenges at every point in the growing season, especially during harvest. There are also several fungal diseases that can infect current varieties, and weeds, particularly perennial weeds such as Canada thistle, are constantly challenging growers and their grape crops.”

Perhaps worst of all are the animals that love to eat grapes, Shoemaker said. Birds can decimate vineyards.

At the St. Charles Center, Shoemaker manages a 1-acre vineyard of Frontenac grapes that was established as a research platform in 2006. “We knew we needed a vineyard dedicated to studying the cultural practices growers use, or need to use, to successfully grow grapes for high-quality wine,” he said.

On one of the research projects in the Frontenac vineyard, Shoemaker is working with U of I researcher Rick Weinzierl on methods to control Japanese beetles. “We are evaluating three pesticide regimes and two cultural controls for the pest. We are also looking at spun-bonded polypropylene row covers over the top of the vines as an exclusion barrier to the beetle. This could be attractive to organic grape growers if there are no negative effects on the vines or fruit development,” Shoemaker said.

Weinzierl said they hope to identify reduced-risk insecticides and non-chemical methods, such as the polyester covers, that will allow conventional and organic growers to prevent losses to Japanese beetles without too frequent sprays of insecticides that might result in greater residues or toxicity to beneficial insects. “This would result in greater profits for the Illinois wine industry,” he said.

Evaluating new grape varieties for their potential use in the grape wine industry is time consuming, Shoemaker said. “The Europeans, especially the French, created thousands of varieties of interspecific hybrids, many of which have never been grown in the Midwest—most never will be, as they were not exported to North America. But many were, and some are planted here at St. Charles. We are also evaluating new varieties and breeding lines from other breeding programs at St. Charles so we can identify which have the greatest potential for our industry.”

Support for this work has been provided by the State of Illinois and the Illinois Grape Growers and Vintners Association since 2005.
Farmers who don’t rely on or who want to minimize the use of chemical herbicides need creative solutions to win the battle against aggressive perennial weeds. In ongoing research at the University of Illinois on Canada thistle, sudangrass is proving to be a worthy contender as a summer smother crop.

“Sudangrass gets very tall. It outcompetes the thistle for light. The sudangrass creates shade, so photosynthesis cannot occur in the thistle,” said U of I weed scientist John Masius. “In our test plots, primarily in the northern part of Illinois, we’ve seen 95 percent control, so farmers can plant a cash crop the following year in the patch that had been infected with Canada thistle.”

Planting time is critical for using sudangrass as a smother crop, said Masius. “It’s got to be seeded in the first couple of weeks in June. If you get much past mid- to late June, the sudangrass is not able to compete adequately because the thistle grows rapidly in that time period.”

A combination of mowing and tilling the thistle before planting the sudangrass is also recommended. “Tilling and mowing the thistle interrupts its life cycle so that it can’t put energy back into the roots,” Masius said.

Mowing the sudangrass also is important. “You can mow to prevent seedheads from forming and reseeding the sudangrass, and mowing helps to control the amount of residue. If you let the sudangrass grow the entire season, you’ll have a plant 7 or 8 feet tall, with a lot of shoot tissue, a lot of biomass to deal with. So when you mow it, you just leave it as a surface mulch.”

Research on the use of sudangrass conducted by graduate student Abram Bicksler originated from questions organic farmers asked about Canada thistle. “Particularly for sustainable or organic farmers, Canada thistle was becoming very difficult to manage and was becoming the problem weed,” Masius said.

After Bicksler’s project was completed, Masius received funding from Sustainable Agriculture Research and Education (SARE) for additional research with farmers around the state. For the past three years research specialist Dan Anderson has been working with 9 to 20 farmers each summer on environmentally friendly ways to control Canada thistle.

“The farmers I’ve been working with are primarily in the northern part of Illinois,” Anderson said. “I’ve seen some horrible fields in northern Illinois, just full of thistle. The sudangrass was planted on patches of ground where Canada thistle was prevalent, some larger patches and some smaller. That’s one of the advantages to sudangrass—you don’t have to devote the entire field to it.”

Masius stressed that the Canada thistle problem is usually found in patches. “What we’re aiming at is to eliminate a problem in patches that occur in a field. Our purpose is not to manage Canada thistle on 100 acres but in areas that might be 100 square feet,” he said. “The hope is that the farmer would catch the Canada thistle in a relatively small patch in an intensively managed farm. If they’re doing a lot of tillage, they’re not going to have as severe a case of Canada thistle. If they’re doing reduced tillage and staying on top of the weeds, they might have a small patch of Canada thistle, but it shouldn’t have taken over a whole field.”

Anderson said that some of the farms he has been working with also have a livestock component. “The sudangrass can be mowed and left as a smother crop, or it can be grazed,” he said.

Is this a strategy that a conventional farmer would consider trying? Masius said that conventional farmers might incorporate sudangrass as an integrated pest management approach if they’re trying to diversify their management strategies. “You’re generally not going to get 100 percent control with any type of herbicide that you can use against Canada thistle—95 to 98 percent control is about the best you’ll get with the best application of herbicides. And we’re getting a similar level of control with sudangrass.”

Farmers who participate in the weed project are paid $250 at the beginning of the study and another $250 at the end, after they submit a report.

“It helps us a lot because we’ve been able to explore what works and what doesn’t work on actual farms,” Masius said.

“Canada Thistle (Cirsium arvense) Suppression with Buckwheat or Sudangrass Cover Crops and Mowing” was co-authored by Abram Bicksler and John Masius and published in the journal Weed Technology.
Richard Johnson paved the way by studying date of planting and plant population or planting date responses. The result, Nafziger said, is that the "perfect" planting date with only a few studies and accurately predict yield responses based on the results, said Nafziger, a University of Illinois Extension agronomist. But weather is inconsistent, so researchers need to gather data on planting dates over years to find out not only the average response, but also the range in responses.

Hybrid, rainfall, and temperature are just a few reasons that the answer to the question of when to plant corn is continually changing. Years ago, planting in mid-May was considered normal, and, with luck, producers could plant with success in early May or even late April. With help from planting date studies, yield benefits of earlier planting have been discovered. As a result, such data have become more useful in predicting effects of planting too late, rather than too early.

U of I researchers assemble unbiased, neutral research-based information such as this in various formats, including the Illinois Agronomy Handbook, to help farmers make important decisions, such as when to plant and how much to plant.

"Our goal is simple," Nafziger said. "We want to see how much yield is lost as planting gets delayed so that farmers have options to consider. We also want to see whether other things, such as plant population or even fungicide use, should change with the planting date."

For the past five years, Nafziger and a team of U of I researchers have been studying these questions at six locations in Illinois, evaluating both date and plant population responses. The research locations include the Brownstown Agronomy Research Center, the Dixon Springs Agricultural Center in Simpson, the Northwestern Illinois Agricultural Research and Demonstration Center in Mommouth, the Ore Research and Demonstration Center in Perry, the Northern Illinois Agronomy Research Center in Shabbona, and the Crop Sciences Research and Education Center in Urbana.

In each study the first planting date occurs as early as possible, which ranges from late March to mid-April. From then, planting takes place at 3-week intervals for a total of four dates, with the last date in late May or early June. On each planting date, a range of stands is established, from 20,000 plants up to 40,000 or 45,000 plants per acre. Data were combined from the two sites each in northern, central, and southern Illinois over several years to predict the effects of planting date and plant population on yield. Comparing these planting date responses together provides a better picture of the variability that occurs over time, Nafziger said.

"We can't do everything in Urbana," he said. "That would be much easier on us because we're here, but that would fail to provide farmers with the information they need. One of the strongest influences on yield is where the crop is grown. We get distinctively different responses at different search centers."

The "best" planting dates tend to fall between the second and third week of April, regardless of location, Nafziger said. However, with delays yields drop off more in the north than in the central and southern regions of the state because of the north's shorter growing season.

In the 1970s, U of I researcher Richard Johnson paved the way by studying date of planting and plant stands, Nafziger said.

"I believe Dr. Johnson was one of the first people to develop a 'replant model' that would help farmers decide, based on stand and current date, whether to replant a deficient stand or to keep it," Nafziger said.

In the late 1980s, Nafziger started another round of these studies, taking plant populations to a higher level—up to 30,000 plants per acre instead of 25,000. With better hybrids and better seeds and seed treatments, he also started the planting earlier to better reflect farmer practice.

Nafziger discovered there was less danger in early planting, and in higher plant populations, than many people thought at the time. "In 2005, we decided to start this study again," he said. "Today, planting to establish 35,000 plants per acre is not uncommon. It was time to adjust our numbers and make them applicable in today's planting environment, so we increased populations to 40,000, and in some cases even higher."

In addition, the researchers compared corn following corn and corn following soybeans. So far they have seen no real difference in plant population or planting date responses between these two crop sequences.

U of I researchers also added a foliar fungicide variable to see if late-planted corn responds more to fungicide applications.

"We are repeating this study to form better predictions, but of course predictions are never exact for a given year," Nafziger added. "As much as any research we do, these predictions can provide real dollars-and-cents value when we use results from several years to predict yield losses with delayed planting and to provide advice on the response to replanting a low corn stand."

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Planting predictions provide real value to producers
Human-driven changes in the earth’s atmospheric composition are likely to alter plant diseases of the future. Researchers predict carbon dioxide will reach levels double those of the preindustrial era by the year 2050, complicating agriculture’s need to produce enough food for a rapidly growing population.

University of Illinois researchers are studying the impact of elevated carbon dioxide, elevated ozone, and higher atmospheric temperatures on plant diseases that could challenge crops in these changing conditions.

Darin Eastburn, U of I associate professor of plant pathology in the Department of Crop Sciences, evaluated the effects of elevated carbon dioxide and ozone on three economically important soybean diseases under natural field conditions at the soybean free air concentrating enrichment facility (SoyFACE), located at the Crop Sciences Research and Education Center in Urbana.

The diseases downy mildew, Septoria brown spot, and sudden death syndrome were observed from more likely to have a direct effect on the three pathosystems varied considerably, Eastburn said.

At the same time, plants grown in high carbon dioxide environments also close their stomata, pores in the leaves that allow the plant to take in carbon dioxide and release oxygen, more often. Because plant pathogens often enter the plant through the stomata, the more frequent closing of the stomata may help prevent some pathogens from getting into the plant.

In elevated ozone, plant growth is inhibited and this results in shorter plants with less dense canopies. This can slow the growth and reproduction of certain pathogens. However, ozone also damages plant tissues, which can help pathogens infect the plant more easily.

“Plants growing in a high carbon dioxide and ozone environment tend to grow faster and larger, and they have denser canopies,” Eastburn said. “These dense plant canopies favor the development of some diseases because the low light levels and reduced air circulation allow higher relative humidity levels to develop, and this promotes the growth and sporulation of many plant pathogens.”

The diseases downy mildew, Septoria brown spot, and sudden death syndrome were observed from.

Elevated levels of carbon dioxide and ozone can make a plant more susceptible to some diseases, but less susceptible to others,” Eastburn said. “This is exactly what we’ve observed in our climate change experiments.”

U of I’s SoyFACE was the first facility to expose plants to elevated ozone under completely open-air conditions within an agricultural field.

“The SoyFACE facility allowed us to evaluate the influence of natural variability of meteorological factors such as drought and temperature in conjunction with imposed atmospheric composition [elevated carbon dioxide and ozone] on naturally occurring soybean diseases across several growing seasons,” Eastburn said.

He believes rising temperatures and changes in rainfall patterns will also affect development of plant disease epidemics.

“In some cases, changes of only a few degrees have allowed plant diseases to become established earlier in the season, resulting in more severe disease epidemics,” Eastburn said.

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“In some cases, changes of only a few degrees have allowed plant diseases to become established earlier in the season, resulting in more severe disease epidemics,” Eastburn said.

“The ranges of some diseases are expanding as rising temperatures are allowing pathogens to overwinter in regions that were previously too cold for them.”

For example, warmer winters may allow kudzu to expand its range northward. Because kudzu is an alternate host for the soybean rust pathogen, one result of rising temperatures may be that soybean rust arrives in Illinois earlier in the soybean growing season, Eastburn said.

“Information derived from climate change studies will help us prepare for the changes ahead by knowing which diseases are most likely to become more problematic,” he said. “Now is the time for plant pathologists, plant breeders, agronomists, and horticulturists to adapt disease management strategies to the changing environment.”

Eastburn’s soybean research, “Elevated Atmospheric Carbon Dioxide and Ozone Alter Soybean Diseases at SoyFACE,” was recently published in Global Change Biology. Researchers also included Melissa DeGennaro from the Department of Biology, Saint Joseph’s University in Philadelphia, Evan DeLucia of the U of I, Orla Dermody of Pioneer Hi-Bred Switzerland, and Andrew McErone of the University of California – Davis.

This research was funded by the National Science Foundation, an SJU Sigma Xi grant, the Illinois Council on Food and Agricultural Research, the Soybean Disease Biotechnology Center, the Illinois Soybean Association, USDA Hatch funds, and the Office of Science, Department of Energy Grant.
In the battle against soil fungi that discolor horseradish roots and can render an entire crop unsellable, University of Illinois researcher Mohammad Babadoost found that subjecting the roots to hot water before planting was most effective in killing pathogens in propagative rootstocks.

The final recipe: submerge in water heated to 47 degrees Celsius (117 degrees Fahrenheit) for 20 minutes.

Babadoost was looking for a reliable, nonchemical method to control Verticillium and Fusarium—soil-borne fungus species that cause internal discoloration of horseradish roots. “The discoloration doesn’t affect the taste of the horseradish, but it does affect the color of the processed horseradish sold in glass jars. Consumers expect horseradish to be a light color, said Babadoost, a plant pathologist.

Horseradish producers save root cuttings from their harvest from which to propagate plants the following season, Babadoost said. “Most of the cuttings are apparently healthy, showing no symptoms, but they are often infected with Verticillium and Fusarium. So starting horseradish production from pathogen-free cuttings is essential to managing the internal discoloration of roots.”

To find a treatment, Babadoost experimented with immersing the horseradish rootstocks in water at temperatures from 44 to 50 degrees Celsius (111 to 122 F) for 10, 20, and 30 minutes. At temperatures lower than 46 degrees Celsius (115 F), the treatment did not control the pathogens. Treatments at 48 degrees Celsius (118 F) or higher affected the germination and vigor of the plant.

“We found that the most effective treatment for control of the pathogens without adverse effects on plants was 47 degrees Celsius for 20 minutes,” Babadoost said.

The beauty of this treatment, he said, is that it is simple, safe, reliable, and cost-effective. “Hot-water treatment of horseradish roots is simple, it can be done using equipment and tools that are readily available to producers, and it requires no license. It’s environmentally safe because no chemicals are used, and it’s effective,” Babadoost said.

Horseradish is an important and high-value cash crop in the Midwest, with half of the total commercial supply for the United States grown in the Mississippi River Valley near East St. Louis.

Internal discoloration of roots is the main production problem for horseradish growers. Since the early 1980s, producers in Illinois have experienced substantial reductions in marketable yield—sometimes as high as 100 percent—as a result of discoloration.

“Thermosterapy for Control of Fungal Pathogens in Propagative Rootstocks of Horseradish” was published in HortScience. Other authors are Anas Eranthodifrom the University of Illinois and Bernhard Trieweler from the Max Rubner-Institut in Karlsruhe, Germany.

Funding for the research was provided by the Illinois Department of Agriculture; the USDA North Central Region Integrated Pest Management Program; the American Farmland Trust; and the U.S. Environmental Protection Agency.
Will Miscanthus make a difference in the Midwest?

From cow grazing to tropical maize production, researchers are seeking ways on the U of I Dudley Smith Farm to advance technology and apply knowledge to Illinois’s complex and dynamic agricultural system.

In the project “Biomas Heat and Power in Illinois,” researchers proved that perennial grasses can be grown on an Illinois farm, processed, and utilized to make biomass furnace fuel, which then was used to heat the 5,000-square-foot building housing the Christian County Extension Unit.

“We wanted to help farmers and rural communities incorporate biomass energy crops into their cropping portfolios,” said Gary Letterly, U of I Extension energy and environmental stewardship educator. “Rising energy costs and growing environmental concerns were two major reasons we decided to test the use of Miscanthus as a potential heating and power source.”

One of the project’s goals was to displace fossil fuel with biomass energy sources, said Rebecca Arundale, a U of I doctoral student in plant biology.

“Biomass has two big advantages,” Arundale said. “First, biomass energy sources are generally carbon neutral. Plus, rhizomatosus grasses such as Miscanthus and switchgrass may actually sequester additional carbon into the soil, making them carbon negative. Second, biomass energy sources are renewable and allow farmers to continue to use the crop year after year instead of depleting the limited supply of a natural resource.”

In the Dudley Smith trial, Miscanthus was established in a 9-acre plot to examine methods of planting, crop care, harvesting and storage, ensuring survival, and transportation from farm to market. Letterly said the project was initiated by U of I researchers and local Extension and FFA volunteers, then duplicated, adapted, and replicated by members of the farming community in Christian County.

“We successfully grew and harvested biomass crops on the Dudley Smith Farm,” Letterly said. “We also stored the Miscanthus and developed biomass pellet furnaces from revisions to popular corn furnaces built by the Mel Repscher family in Christian County.”

The biggest challenge researchers faced was finding a processor who could create useful fuel from crops it had never handled before, for a market that doesn’t exist, and for use in ways yet to be determined. Eventually, researchers looked for answers outside of Christian County.

“The condition of the bailed Miscanthus prior to creating pellets is a challenge for processors who would rather not add additional levels of process grinding to their existing pelletizing and densification systems,” Letterly said. “The high silica content of Miscanthus and many other biomass crops is abrasive and causes additional wear on chipping blades, grinding plates, and extruder units. The wear on equipment added to the cost of this process.”

Still, cost and availability factors need more investigation. “Cost-wise, biomass fuel beats almost everything except natural gas for dollars per Btu,” Letterly said. However, he added, the availability of processors who can densify Miscanthus for use as a fuel source is a concern.

“There are plenty of furnaces and boilers that will burn biomass feedstock materials, and there are many regional HVAC installers who can install the systems,” Letterly said. “However, being able to source the processing of specific fuel types such as densified biomass from grasses is a problem in our region of the country.”

Still, Letterly expects processing locations for biomass energy grass to increase in number and capacity this year.

“We will soon have more capacity than we have areas of defined raw material resource locations,” he said. “We are on that producer—processor—manufacturer pivot point in the Midwest. The parallel argument to this development will continue to be, Where do we go with this stuff and who will pay for it?”

Letterly believes it is critical to identify and assist potential biomass densification and processing and end-user locations.

“We’ve shown that biomass can be burned successfully as a fuel source in Illinois,” he said. “Now we need to educate and make growers, processing manufacturers, and end users aware that our energy supply and price issues are unlikely to disappear and may never be completely behind us. The elements of this project are locally preeminent as a need and globally relevant as an outcome.”

A renewable “green” biomass feedstock for energy could be a more favorable option in the future when greenhouse gas emissions and fuel prices are considered, he said.

Leaders of the Dudley Smith biomass project are continuing to explore more end-use options and ways to develop a processing infrastructure. They are also looking at additional annual crops such as tropical maize or “sea-fuel” and other perennial crops that have a very low input profile.

“People don’t always see how research affects them,” Letterly said. “Our goal is to communicate our research results to the public in a way that they can readily utilize and adapt by themselves.”

Dudley Smith Farm

In 1996 Dudley Smith, Jr., left a substantial Dudley Smith endowment to the College in honor of his father, building on an earlier gift of cash and 226 acres of farmland in Christian County. Dudley Smith, Sr., wanted agriculture and agricultural communities to thrive. He advocated adoption of technological advancements and a concentration on long-term stewardship and sustainability of agricultural practices. An initiative was created to study and apply knowledge about the system that makes up the agricultural community — farmers, consumers, products, profits, natural resources, production, and many other components. The Dudley Smith Initiative supports innovative research and outreach that advance its fundamental goal of invigorating the agricultural system in Illinois.
A bout half of all bird nests don’t survive due to predators, particu larly in fragmented forest areas—but why? University of Illinois researchers monitored both predator and prey to find an answer.

“Rat snakes accounted for a high percentage of cases of nest predation,” said U of I researcher Patrick Weatherhead. “Our hypothesis was that because snakes spend so much more time on the edges of the forest, that’s where bird nests should be most vulnerable. But in fact, we never found that.”

He explained that rat snakes, which in eastern North America are the number one predator of nesting birds, go into the forest to feed, then return to the edges to regulate their body temperature, breed, and shed their skin. “Clearly, a lot of the time they are on the edges they’re not actively hunting, because nests on the edges were not at greater risk from the snakes than the nests on the interior of the forest.”

Fragmented forests result in more snake predation, fewer birds. Fit for more perimeters, which are beneficial to the snakes. “Snakes really like that interface between the open and closed habitat, whether it’s an edge where the forest opens onto a wetland or a rock outcrop or a manmade habitat such as a hay field. These benefits ultimately result in more snakes, which in turn results in more nest predation. So if your priority is to conserve the birds, you’ll want to preserve unfragmented forest habitats,” Weatherhead said.

Ornithologists have been interested in fragmentation for a long time, Weatherhead said. “It’s not just that you’ve lost habitat, but the smaller chunks you’re left with aren’t as good for a variety of wildlife. The smaller fragmented areas attract birds, but they don’t do very well there. The fragmented areas have been called ecological traps.”

The message, says Weatherhead, is that if you’re going to clear land for agriculture or other development, try to avoid breaking forest into bits and pieces. He concedes that in southern Illinois the land doesn’t lend itself to this kind of clearance. “Most of the good agricultural land occurs in the valley bottoms, whereas on the slopes it’s too rocky and too steep to make it practical to use for agriculture.”

The study, conducted in southern Illinois, used data from radio transmitters implanted in rat snakes combined with information from over 300 bird nests that were located and their fate tracked. Independently, a number of nests that weren’t officially part of the study were monitored with video cameras to document the nest predators.

“Everywhere there have been camera studies, as long as it’s in wooded or semi-wooded habitat, rat snakes emerge as the single most important predator. They’re common throughout the range, and they’re really good at finding bird nests,” Weatherhead said.

The miniature video cameras make identification of nest predators possible because they can record activity at the nests around the clock. How do snakes on the ground see nests up in trees?

Weatherhead says the evidence is circumstantial. “Snake predation is much higher on nests where the young are being fed than when the eggs are being incubated. There’s a lot more parental activity when the young are being fed. The limited evidence available all seems to point to the snakes observing the parents flying back and forth to the same place, an indicator to the snake that there’s a nest there. There are anecdotes of people watching a nest and noticing a rat snake watching that same nest, and from the snake’s head movements it was obviously tracking the movement of the adult pairs back and forth.” In one case, a snake was then observed going to the nest and eating the young.

Rat snakes get their name because they are primarily predators of small mammals. “But rat snakes are very opportunistic,” Weatherhead said. “I have a picture of a rat snake eating a full-grown squirrel. So that’s a mouthful. They’re generalists in terms of both the mammals they eat and the birds they prey on. They’ll take whatever birds they encounter, and because they’re such good climbers, they can get to both low nests and high nests. They can climb just about any kind of tree. They eat bird eggs and fledglings, and sometimes they’ll even get the mom if she’s sitting on the eggs.”

Animals including hawks, raccoons, badgers, foxes, and coyotes prey on rat snakes.

“Linking Snake Behavior to Nest Predation in a Midwestern Bird Community” was published in Ecological Applications. Gerardo Carfagno, Janelle Sperny, Jeffrey Brawn, and Scott Robinson contributed to the research.

Brownstown Agronomy Research Center

Established in 1937—which makes it one of the first comprehensive field research centers operated by the Department of Crop Sciences—the Brownstown Agronomy Research Center consists of approximately 208 acres; 160 acres are owned by the University of Illinois Board of Trustees, and 48 are crop-shared by adjacent or nearby landowners. The property has 117 acres of land suitable for agronomic purposes; the remainder is 55 acres of long-term coniferous and deciduous trees, 4 acres of ponds, and 32 acres of grass alleys, waterways, roads, and building sites.

Research on soil fertility and crop variety began in the 1930s with equipment that included horse-drawn discs, a Hayes corn planter, a walking plow, and a sulky plow. Weed science and tillage work began in the 1950s, as did cooperative relationships with entomologists, plant pathologists, and agricultural engineers.
The traditional practice of finishing cattle on corn may not be the only way to achieve high marbling, a desirable characteristic of quality beef. Researchers at the University of Illinois have discovered that high-quality beef and big per-head profits can be achieved by starting early-weaned cattle on corn and finishing them on a diet high in co-products.

“The goal is to get the highest quality beef product in the most profitable way,” said U of I animal scientist Dan Shike. “If you can initiate marbling at a young age with corn, calves are smaller and they eat much less, so feeding them corn for 100 days early saves on feed costs. This system will use considerably less corn and achieve the same effect.”

For the study, heifers from the Dixon Springs Agricultural Center were weaned at an average age of 77 days and fed a high-corn ration for the next 146 days to initiate marbling. Then the cattle were divided into four feeding groups: pasture, high starch, intermediate starch, and low starch. The cattle remained on these treatments for 73 days, and then all of them were fed the intermediate-starch diet for the remainder of the finishing period.

Before the calves were divided into groups, ultrasounds were done on them to determine marbling. The tests revealed that marbling was initiated with the early corn diet. Ultrasounds were performed again at the completion of the 73-day treatment period.

“The cattle on pasture had significantly lower marbling,” Shike said. “But there were no differences in the cattle fed varying levels of starch.”

These results remained consistent through harvest, with pasture-fed cattle receiving lower marbling scores and fewer cattle grading low-choice. The cattle fed varying levels of starch had no difference in marbling scores.

However, there were differences in profit per head. “If you look at the overall profitability, we actually lost a little money on the high-starch group, and the pastured cattle barely made any money, but the intermediate- and the low-starch groups showed a big swing. There’s about a $45 difference between the high-starch and intermediate-starch treatment groups, and low starch was comparable to intermediate.”

Why were the intermediate- and low-starch groups more profitable? Cattle fed these diets achieved higher gains as efficiently as or more efficiently than the high-starch group.

Another advantage to weaning calves earlier and starting them on feed means they can be harvested much earlier. “Our system is really an accelerated finishing system.”

It’s not uncommon for our cattle to reach market end point and be harvested at 12 to 13 months of age, whereas in a more traditional weaning system, they might be 15, 16, or even 17 months of age. So we’re really taking 4 or 5 months off of that,” Shike said.

Shike commented that when corn prices are high, this system is more cost effective because it utilizes lower priced co-products such as distillers dried grain, corn gluten feed, and soy hulls without sacrificing marbling quality.

“Additional research is needed,” Shike said. “But we believe feeding a high-grain ration to cattle at a young age and finishing them on co-products is the most profitable way to produce high-quality beef.”

Camilo Arango Rueda rides horses to get around on his cattle ranch in Colombia, South America. But “in southern Illinois, farmers ride ATVs,” he said. That’s just one of the differences Arango Rueda noticed while participating in an 11-week summer internship at Dixon Springs Agricultural Center.

“I was able to see firsthand how the cattle business works in the U.S.,” he said. “And from a personal perspective, it was a really great experience—to be exposed to the countryside, to the culture, what people think about government, religion, many aspects of the American culture. That’s different than what you see in a city like Chicago or New York. It was a unique experience.”

Arango Rueda had already completed an undergraduate degree in business administration at Pontificia Universidad Javeriana in Colombia. “I saw that I had a talent in managing and thought that getting a formal education in business would give me the tools to create an agribusiness,” he said.

During his first year at the University of Illinois, he took a class in entrepreneurship. After completing a project about southern Illinois cattle ranchers, he learned about the internship opportunity and saw it as a way to continue studying the topic. “The internship program,” said Jozef Kokini, associate dean for research, “was created in order to give students a chance to see how research is conducted—from experimental design and layout to data collection, analysis, and reporting—to gain practical experience from working with researchers, and to build leadership skills.”

The program’s faculty advisor, Elvira de Mejia, said, “In order to be selected, students must complete an application and be a currently enrolled College ofACES student with an overall GPA of at least 3.75.”

Arango Rueda was accepted into the summer internship program in its third year. He lived with the other interns on the Dixon Springs property in a house with a common kitchen and living space while working on a variety of research projects. After he met with local producers and studied the options with researchers Dan Faulkner and Frank Ireland and with Theresa Steckler from University of Illinois Extension, Arango Rueda presented several recommendations for ways cattle producers could add value to their operations and help improve the economy of southern Illinois.

The Processed Verified Program for Age and Source verification was what Arango Rueda believed is the first step. “Consumers want to know where cattle come from. It’s a trust issue, and it needs to start the moment a calf is born,” he said. “Everyone who works with cattle is moving in this direction, to certify using age and source. But just a few of the bigger southern Illinois cattle ranchers are doing it.”

Arango Rueda recommended that after implementing age and source verification, producers start changing some processes on the farm and move toward naturally raised cattle. “In the long run the farmers will be able to reach higher certifications and be eligible to export to higher-end markets that pay significant premiums, like Japan, Korea, and some of the European countries. The more natural and organic your cattle have been fed and raised, the higher premiums you can get.”

Some of what Arango Rueda learned from the internship he will use as he manages his own ranch in Colombia. “I realized that on my ranch I’m almost producing organic cattle. I don’t implement antibiotics or hormones. My cattle are pasture-fed, and I don’t use fertilizers and pesticides on those crops. So my process is 90 percent organic. I just have to figure out how to eliminate one vaccine that we use in Colombia as a preventative vaccination against a tropical disease that attacks cattle. Colombia is now recognized as free of this disease, but we still vaccinate our cattle. The sooner I can certify my cattle, the sooner I’ll be able to export to those other markets,” he said.

After the Dixon Springs internship, Arango Rueda refocused his MBA toward agribusiness. “The internship clarified me. It was a turning point. It was a good marriage of cattle and finance. I plan to work in agribusiness for a couple of years and get experience, then go back to working with my brother on the ranch.”
Research facilities and affiliates

ACES Beef/Sheep Research Facility
The College of ACES beef/sheep research facility ensures continuing support for the cutting-edge animal science discoveries made by its faculty members.

ACES Plant Care Facility
The Plant Care Facility is the primary greenhouse space available to faculty, staff, and students working in the Department of Crop Sciences, the Department of Natural Resources and Environmental Sciences, and with affiliated USDA projects.

ACES Poultry Research Facility
The six-building Poultry Research Facility, ACES Poultry Research Facility with affiliated USDA projects.

The College of ACES beef/sheep research
http://pcf.aces.illinois.edu

CABER works closely with nine U of I colleges, multiple disciplinary and professional units, and faculty and students to facilitate campus outreach, teaching, and research in areas related to bioenergy systems.

Center for Advanced BioEnergy Research (CABER)
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Center for Advanced BioEnergy Research (CABER)
http://bioenergy.illinois.edu

College of Veterinary Medicine Research
The College of Vet Med’s profiles, projects, and research promote health and production, alleviate animal suffering, conserve animal resources, and protect public health.

David Miller Lab
This laboratory conducts research to develop more accurate fertility assays and to improve animal fertility.

Energy Biosciences Institute
Founded by BT; the Energy Biosciences Institute is a research partnership between the University of California Berkeley, the University of Illinois, and the Lawrence Berkeley National Lab exploring how bio-science can be used to increase energy production and reduce the impact of energy consumption on the environment.

Environmental Change Institute
Established by the College of ACES in 2008, the Environmental Change Institute promotes research into the causes and consequences of environmental change.

Farmdoc
Farmdoc provides comprehensive risk management information and analysis.

Family Resiliency Center
Established in 2006, the Family Resiliency Center advances knowledge and practices that strengthen families’ abilities to meet life’s challenges and thrive through research, outreach, and education centered around four themes: child and family health and wellbeing; child care as a resource; immigrant families and their children; and positive child and youth development.

The Six-Building Poultry Research Facility, ACES Poultry Research Facility with affiliated USDA projects.

Illinois–Indiana Sea Grant
Sea Grant provides up-to-the-minute information on Great Lakes issues, emphasizing concerns in the southern Lake Michigan region.

Illinois Gap Analysis Project
This project provides focus and direction for proactive, rather than reactive, land management activities at the community and landscape levels.

Institute for Genomic Biology
This institute was established in 2003 to advance life science research and stimulate bio-economic development in the state of Illinois.

Illinois Natural History Survey (INHS)
INHS is a state institution, part of the Prairie Research Institute, conducting research on the taxonomy, ecology, and management of insects, plants, and animals. The site presents online research databases, research project pages, publications, contacts, history, and more.

Illinois Soybean Research Laboratory (NSRL)
NSRL’s mission is to expand the scope, size, and profitability of the U.S. soybean industry.

Illinois Plant Breeding Center
This center’s mission is to educate future generations of plant breeders involved in all areas related to cultivar improvement and seed product development and provide ongoing support through continuing education.

Laboratory of Mammalian Genome Biology
Research, publications, and activities related to bovine leukemia virus and gene mapping are the purview of this lab.

Landscape and Human Health Laboratory
Landscape and Human Health Laboratory site examines ways in which the physical environment affects the healthy functioning of individuals, families, and communities and ways ordinary citizens can participate in shaping the environment.

National Great Rivers Research and Education Center (NGRREC)
NGRREC is the product of a unique educational partnership between the University of Illinois, the Illinois Natural History Survey, and Lewis and Clark Community College.

National Soybean Research Laboratory (NSRL)
NSRL’s mission is to expand the scope, size, and profitability of the U.S. soybean industry.

Office for Futures and Options Research (OFOR)
OFOR promotes and supports academic research and education on commodity futures and options markets.

PorkNet
PorkNet provides the Illinois swine industry with timely information to facilitate decision making and strengthen its ties with the University of Illinois.

Southern Illinois Regional Assessment Project
This site presents research conducted by rural sociologists in the College of ACES.

Stiletto Flies (Theoridae: Diptera)
This site chronicles collecting trips to obtain therevid specimens, progress reports, a specimen-based database system, and more.

W.M. Keck Center
The W.M. Keck Center for Comparative and Functional Genomics conducts research on the comparative genetic organization, evolution, and function of plant, animal, and microbial genomes.

W.M. Keck Center for Comparative and Functional Genomics
http://www.bioteck.illinois.edu/centers/wmkeck