# Legacy

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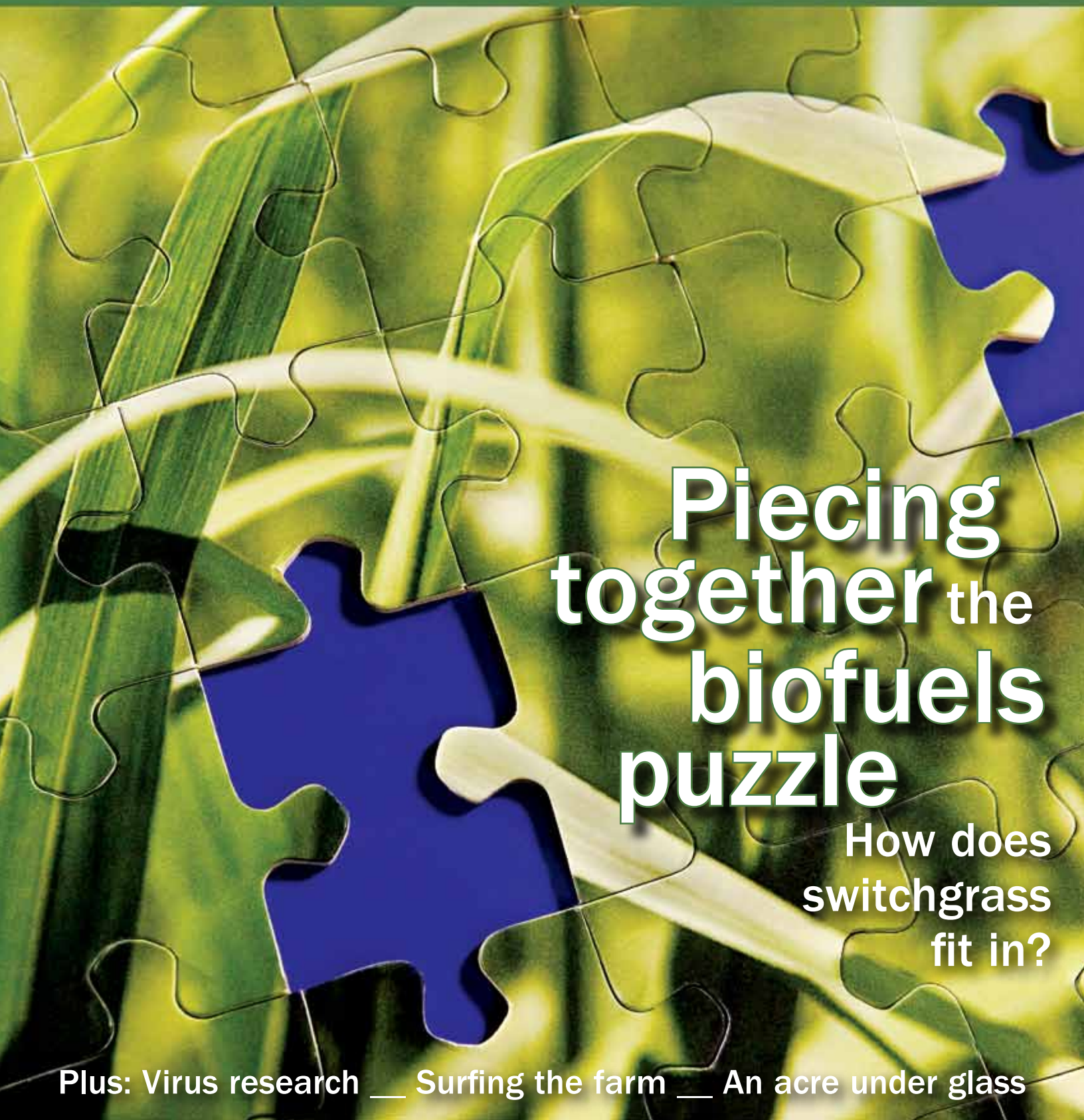


# Piecing together the biofuels puzzle

## How does switchgrass fit in?

Plus: Virus research __ Surfing the farm __ An acre under glass

# Inside this Issue



**On the cover:** The emerging biofuels industry continues to puzzle many, but switchgrass may be one answer.
*Illustration _ Broderick Stearns*

## 10 An acre under glass

With more than 47,000 square feet of enclosed space, the Noble Foundation greenhouse is one of the largest research greenhouses in the United States, but that's just the beginning of this amazing facility.

The illuminated ceiling of the Noble Foundation greenhouse shines at night.
*Image _ Broderick Stearns*

> Noble Foundation people share a vision for the potential of their research. They embody Lloyd Noble's grand vision, seeing beyond limitations and expecting greatness.

# A legacy in motion

To our readers,

There can be more to a legacy then just remembrance. A legacy can establish a lasting vision. A legacy can be forward thinking. A legacy can inspire innovation and extend for generations.

Lloyd Noble established The Samuel Roberts Noble Foundation, not as a way to be remembered, but as a way to give back to his fellow man and as a way to continue his desire for progress and exploration. It is with this understanding that I proudly present to you the inaugural issue of *Legacy*.

*Legacy* honors the Noble Foundation's rich heritage, while highlighting the best of our present efforts and offering a glimpse into future endeavors. *Legacy* provides an inside look at the exceptional programs and even more exceptional people that define the Noble Foundation. It is a snapshot of the people who propel our mission.

The Noble Foundation's mission revolves around improving agriculture to benefit farmers and ranchers. Within this pursuit, we combine two primary activities: building generational relationships with the stewards of our agricultural resources, actual farmers and ranchers; and conducting research, in the laboratory and in the field, that will ultimately improve plants, provide better forages and enhance production agriculture systems.

Noble Foundation people share a vision for the potential of their research. They embody Lloyd Noble's grand vision, seeing beyond limitations and expecting greatness. Their work will – not may – have a profound impact on the world, and our continued interaction with farmers and ranchers remains true to a fundamental belief that science and innovation cannot realize its full potential unless it is driven by a genuine understanding of the needs and challenges of the ultimate users and delivered with the same understanding to enable adoption and integration into the users' agricultural systems.

This approach is never more evident than in this magazine's cover story. The Noble Foundation's work with switchgrass, as a biofuels crop, exemplifies how our three divisions work in unison to move science from the lab to the field. As Noble Foundation scientists work to improve switchgrass, our agronomists are solving the practical issues of integrating this unfamiliar crop into the existing production systems of farmers and ranchers, who will ultimately determine the success of the emerging biofuels industry.

In the future, *Legacy* will announce our proudest moments and spotlight the individuals whose efforts will make a difference in your world. For now, *Legacy* begins here with this first edition. Each story offers another view of the Noble Foundation, but, more so, the words that fill these pages reflect a fundamental truth – Lloyd Noble's legacy is not focused on remembering the past, but is striving to better the future.

Sincerely,

Michael A. Cawley
President and Chief Executive Officer



# From the Rain Forest to the Prairie

## Virus research in Costa Rica holds the potential to assist farmers and ranchers in the U.S.

*Story _ J. Adam Calaway*
*Images _ Marilyn Roossinck*

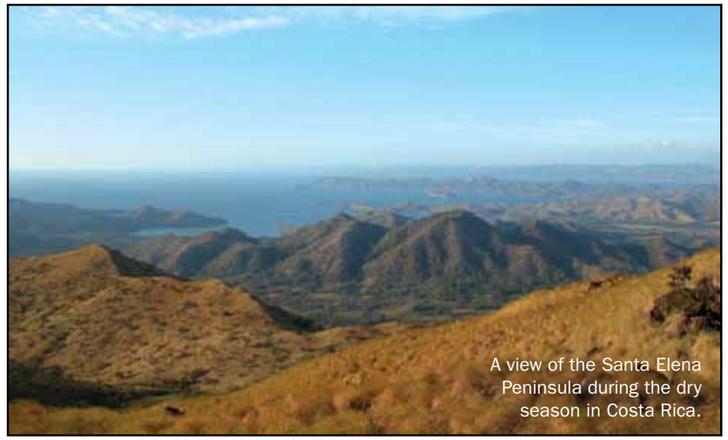
Marilyn Roossinck's favorite decorative items in her office are a pair of fake plants – a pair of sick fake plants.

"See those silk plants; they are showing virus symptoms," said Roossinck, Ph.D., grinning as she pointed to the color variations on their leaves. "Of course, the people who made them didn't know that's what those mean, but I saw them at the store one day, and I just had to get them."

Roossinck sees viruses in places others might not because, as a professor and principal investigator in the Plant Biology Division of The Samuel Roberts Noble Foundation, she has dedicated more than a decade to studying one of nature's biggest mysteries. Her work frequently takes her to the jungles of Costa Rica and recently earned her a million dollar grant to continue charting this virtually unexplored territory.

One of Roossinck's primary research objectives is to compare wild plant viruses with domesticated varieties that appear in the local agriculture. By analyzing this relationship, she hopes to uncover how viruses move through the environment and impact production agriculture.

"We know virtually nothing about plant viruses in the wild," Roossinck said. "The vast majority of what we know about viruses comes from our study of domesticated plants and animals. I am looking for viruses in individual host plants. If we know the host, then we can find out what the viruses are doing. It's important to understand how viruses emerge." ▶



A view of the Santa Elena Peninsula during the dry season in Costa Rica.

> “I fell in love with viruses, and I’m still in love. They are extraordinary. They have almost no genetic information, but they do these dramatic things, and most people don’t know this, but there are many beneficial viruses.”

Roossinck’s interest in viruses began during her study at the University of Colorado at Boulder, where she earned her bachelor’s degree with a double major in Molecular, Cellular and Developmental Biology and Environmental, Populational and Organismal Biology before going on to earn her doctorate in Microbiology and Immunology at the University of Colorado School of Medicine.

“I fell in love with viruses, and I’m still in love,” she said. “They are extraordinary. They have almost no genetic information, but they do these dramatic things, and most people don’t know this, but there are many beneficial viruses.”

In 1995, Roossinck attended a biodiversity conference in Costa Rica and posed a single question. As the discussion touched on various biological taxa, Roossinck finally asked, “What about viruses?”

Her question lead to a workshop with virologists the following year, and, by 2003, she had established her own Costa Rican lab dedicated to virus study.

The wildlands of Costa Rica are prime virus-hunting turf because of the extensive plant diversity. Roossinck said the small Central American country possesses more than 4 percent of the earth’s plant species and has more plant variations than the continental United States. Plus more than 25 percent of Costa Rican land is in conservation. “Costa Rica is a hot spot for plant research, because a plant inventory is currently underway and the infrastructure is excellent,” she said.

Roossinck recently returned from another trip to Costa Rica – her second of 2007. It’s a trek she makes two or three times a year since establishing her lab. Each trip down, she reviews the work of her lab, handles other on-site duties that cannot be addressed through e-mail, and – make no mistake – spends a considerable amount of time in the field.

Her many Costa Rican adventures include a variety of creature stories, including eyelash vipers (don’t put your hands down anywhere), scorpions (she’s been stung a couple of times) and toilet frogs (don’t ask).

“Not all science takes place in the sterile environment of the lab,” she said. “This type of science requires us to hike miles into the jungle, to get really dirty and face the elements. To be honest, it’s great fun.”

The process of determining if a plant contains a virus is one part explorer, two parts advanced science, and begins with a jeep ride and a hard walk into the Cloud Forest. Each team consists of a botanist and a team of collectors to identify plants. They target five specific families of plants related to agriculture: beans, melons, tomatoes, rice and coffee.

Once a plant has been identified, team members take a variety of photographs and harvest about 20 grams of tissue. If possible, they try to collect an individual plant. The team marks each collection site using a Global Positioning System (GPS). When they return to the lab, they freeze their samples until processing.

Roossinck said the virus check begins by flash-freezing the samples with liquid nitrogen. The hardened material is then pulverized and an organic solvent is added to separate the cell membranes and proteins from the nucleic acids. Finally the sample is spun in a centrifuge to extract the RNA.

“What we are interested in is double-stranded RNA,” she explained. “Double-stranded RNA is mostly unique to RNA viruses; it’s their hallmark.”

Roossinck’s work is already yielding a connection to agricultural production. Her team discovered a virus in Costa Rican wild beans that has also been identified in melons and squash from around the world, including in southern Oklahoma. “We want to determine if the viruses are moving from crops to wildlands or from wildlands to crops,” she said. “This can answer the important ecological questions about how human interaction affects the world around us. Are we impacting the wildlands or vice versa?”

Roossinck’s lab has collected more than 1,000 plants a year since 2003, but, with a recent grant of more than $1,100,000 from the National Science Foundation and United States Department of Agriculture for her project, Five Thousand Virus Genomes, they’re aiming to collect many more.

With the grant, her team will work to discover and catalog as many wild plant viruses as possible, sequence the RNA with Bruce Roe, Ph.D., professor of biochemistry from the University of Oklahoma, and develop bioinformatic tools to analyze the wealth of data with another collaborator, Jonathan Wren, Ph.D., assistant professor at Oklahoma Medical Research Foundation.

The data collected during the project will be deposited and freely available in an internationally accessible database.

“If a scientist encounters a new type of virus in a crop, they can go to this database and find information about what the virus is and how it works,” she said. “This will provide scientists, as well as farmers and ranchers, with a great resource.” For real plants that is; the fake ones are still on their own. ●

Roossinck team members take a GPS reading after collecting a plant.

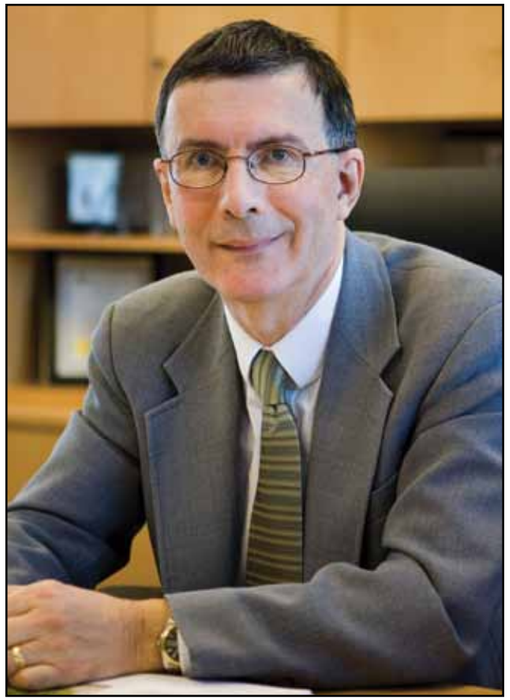
Costa Rica holds a wide variety of plant life as demonstrated by the above species.

The Central American country has more varieties of plant species than the U.S.

# The honor of a lifetime

## Rick Dixon achieves a career highlight and is elected to the National Academy of Sciences

*Story _ J. Adam Calaway*
*Image _ Broderick Stearns*



Rick Dixon was 14 years old when he made the decision that would define his life.

Growing up in England, Dixon was required to select a field of study that would ultimately become his career before entering the United Kingdom's equivalent of high school. "I was actually toying with the idea of studying English and going the arts route, but I had a headmaster who was a chemist," said Dixon, beginning to laugh. "He called me up and told me in no uncertain terms that I was going to be a scientist."

And he did. In the subsequent four decades, Dixon established himself as one of the world's foremost authorities in plant science research with a body of work so impressive he received one of the highest honors accorded a scientist in the United States. This May, Dixon was elected to membership in the National Academy of Sciences, the most prestigious scientific organization in the United States.

"I have always regarded election to the Academy as the ultimate peer recognition in the U.S. When I was starting my career in the U.K., election to the Royal Society (the U.K. equivalent of the National Academy) was a far-off dream," said Dixon, D.Phil., who serves as Senior Vice President and Director of the Plant Biology Division for The Samuel Roberts Noble Foundation. "It is an honor I have aspired to my entire career."

Dixon is the first Noble Foundation faculty member to be elected to the Academy and only the second active Academy member in Oklahoma.

He is currently a co-author of more than 340 scientific papers; he serves on the editorial boards of five international journals and holds adjunct faculty positions at three comprehensive universities. In 2002, the Institute for Scientific Information named him as one of the 15 most cited authors in the plant and animal sciences. Dixon is the founding director of the Noble Foundation's Plant Biology Division, which began in 1988.

"Dr. Dixon is an exceptional scientist and an innovator in plant science," said Michael A. Cawley, President and Chief Executive Officer of the Noble Foundation. "Moreover, as the founding director, he is more than a scientist; he evidences those leadership qualities and the vision required to initiate and sustain a truly world-class research organization."

Dixon's research focuses on understanding how plants produce certain natural compounds. He uses metabolic engineering to modify the production of such compounds to improve plant performance and, in many cases, benefit human and animal health.

He is endeavoring to understand the natural biochemical pathways that produce certain compounds, in particular, flavonoids/isoflavonoids and condensed tannins.

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**Michael Udvardi made his way from the Land Down Under to the Oklahoma prairie via Germany to become a principal investigator and lead one of the Noble Foundation's 18 research laboratories. These are 7 facts you need to know about the 45-year-old Aussie from Cooma, New South Wales.**

1 Udvardi's research focuses on "understanding the molecular genetic basis of important plant processes, including symbiotic nitrogen fixation, seed development and storage metabolism, and adaptation to abiotic stress such as drought and salinity."

2 The end result of his work will be better plants for farmers and ranchers. "By identifying the genes and processes that help plants cope with the challenges of their environment, we hope to contribute to efforts to improve plant performance in the field through classical and molecular plant breeding."

3 Coming from Australia, he really wanted to be a professional surfer instead of a scientist, right? "Well, I wish there was a good story to tell about why I chose science, but, in reality, I just enjoyed mathematics and science at school, and one thing led to another. Call it destiny or just dumb luck."

4 It wasn't all lab coats and sunshine along the way, however. Among his various pre-scientist jobs, Udvardi spent one blistering Australian summer sorting nuts and bolts in a warehouse. "It was dirty and overheated. All day long, I'd think about getting into the cool waters of Murrumbidgee River."

5 The ocean, lakes, rivers, pools – it doesn't matter for Udvardi, water sports are his other passion. "If I had to pick my favorite sport, it would be a triple dead heat between sailing, surfing and skiing. Around here, windsurfing on Lake Murray definitely wins out."

6 His most endearing childhood memory is even water-related. His fondest recollection is of "the flapping sails of boats on the edge of Lake Jindabyne in the Snowy Mountains as we prepared to race."

7 Lake Jindabyne holds historic significance for movie buffs as well. "The Snowy River flows out of Lake Jindabyne, where I spent a considerable amount of time as a kid. So that means I am just about *The Man from Snowy River*."

*Image _ Broderick Stearns*

# Wide Open Spaces

*Story _ Caroline Lara*

## Suburban Ag Program assists land owners from urban settings with farm management

Like many Dallas-Fort Worth Metroplex residents, Owen Lyon dreamed of someday having a place in the country — a quiet retreat far from the daily stresses of city life.

Lyon, 49, owner of a successful Lewisville-based certified public accounting business, realized his dream in 2003 when he and his wife acquired about 70 acres of property in Cooke County near Moss Lake.

"We currently live in (town), but we manage to spend three days a week at our country property, where we raise registered Brangus cattle and Appaloosa horses," Lyon said. "I like that our property allows me to work outdoors, and I enjoy the rural setting."

Though Lyon's wife grew up on a ranch and his own grandparents were ranchers, he faced one primary challenge — a lack of hands-on experience in farm/ranch management. It is an issue shared by numerous others new to owning rural property, including Dr. Steve Young. Young, 40, is an optometrist who lives with his family on 90 acres in Wise County near Bridgeport, Texas. Young recalled his initial difficulty in explaining his family's choice to live in a rural setting.

"It's hard to put the feeling into words, but I love the freedom and watching my children play out on our place," said Young, who has owned his land for five years.

While Young enjoys gardening and keeping chickens on his place, he also runs a commercial cattle herd and is beginning to establish a horse hay business. While many assume Young brought experience to his operation, such is not the case — he helped out on his family's farms growing up, but he wasn't familiar with farm management.

As more and more urban dwellers seek the relative peace of the surrounding countryside, the number of farms in areas surrounding Dallas-Fort Worth has increased.

According to the latest Census of Agriculture data from the National Agriculture Statistics Service, 55 percent of rural property owners in Dallas, Tarrant, Denton and Collin counties have a primary occupation other than farming.

"We're seeing many people moving out of the Dallas-Fort Worth metroplex," said David Annis, specialist with the Noble Foundation. "These folks want to get back to nature and out of the city. They want open space. Often, they are in a good financial position and see rural property as a solid investment."

While many of the property owners are well accomplished in their chosen professions, Annis said they typically don't have experience in the day-to-day issues of owning a farm or ranch with some not even knowing where to seek information and advice on handling their agricultural challenges.

"Landowners in southern Oklahoma and north Texas looking for free expert advice may contact the Noble Foundation," Annis said. "We are a private, nonprofit agricultural consultation and plant research foundation dedicated to helping landowners and managers through a unique team-based approach. We provide agricultural consultation to more than 1,400 agricultural producers."

In 2005, the Noble Foundation started a new program specifically for landowners in north Texas like Lyon and Young.

The suburban agriculture program is intended to help these landowners learn the basics of land stewardship. Seeking professional advice is better than "getting it from the guy who's trying to sell you fertilizer," Young said. "Like anything, however, professional agricultural advice may not always give you the answers you want to hear, but my experiences have always found it to be good, sound information."

Annis said the ideal time to contact agricultural specialists for assistance would be before purchasing rural property.

"That's often not realistic," he said. "If you've bought the property already, you still need to talk to someone knowledgeable. It's best to seek help as early as possible in the planning stages. Experts can work with you on achieving your goals for the property and help with preventing potential problems before they occur."

Lyon has been receiving counsel from Noble Foundation specialists on how to "operate properly and profitably," he said.

The Noble Foundation has helped Lyon primarily with improving the grass that grows on his property and supports his cattle and horses. "They provided a plan to divide the property into pastures and improve the grass from native to Coastal bermudagrass," Lyon said. "Since I'm a hands-on operator and I don't hire people to do things for me, I've gotten a lot better at building fence than I ever wanted to be."

As Lyon makes plans to live full-time at his rural haven in Cooke County, he looks forward to devoting even more time to his agricultural enterprises.

"An agricultural operation is not a business that you just jump into," Lyon said. "You need a long-range plan and need to enlist the help of agricultural experts." ●

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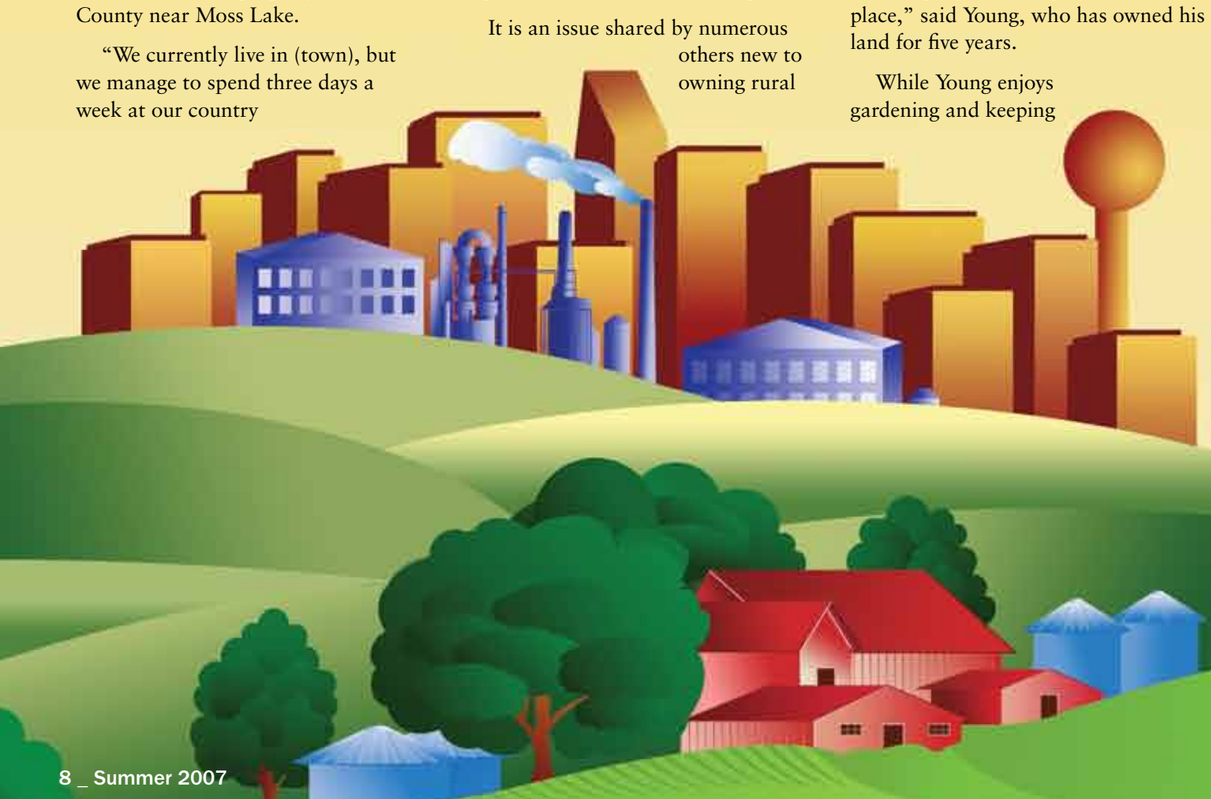


# An Acre Under Glass

**Top**: A view of the greenhouse illuminated at night.
**Bottom left**: Rows of alfalfa sit in one of the climate controlled greenhouses.
**Bottom center**: Scientists can automatically program each cell's conditions from their computer.
**Bottom right**: A scientist checks cultivars.

*Images _ Broderick Stearns*

1. At 47,280 square feet, the Noble Foundation greenhouse is about 4,000 square feet larger than an acre of land (43,560 square feet). The greenhouse is one of the largest research greenhouse facilities in the Western Hemisphere.

2. The greenhouse is considered one of the most technologically sophisticated greenhouses in North America. The facility is divided into two ranges (east and west) and contains a total of 34 independent, high-tech rooms, or cells.

3. At more than 10,000 square feet, the west range is the largest air-conditioned greenhouse range in North America with 17, 20-ton air conditioners cooling 18 cells.

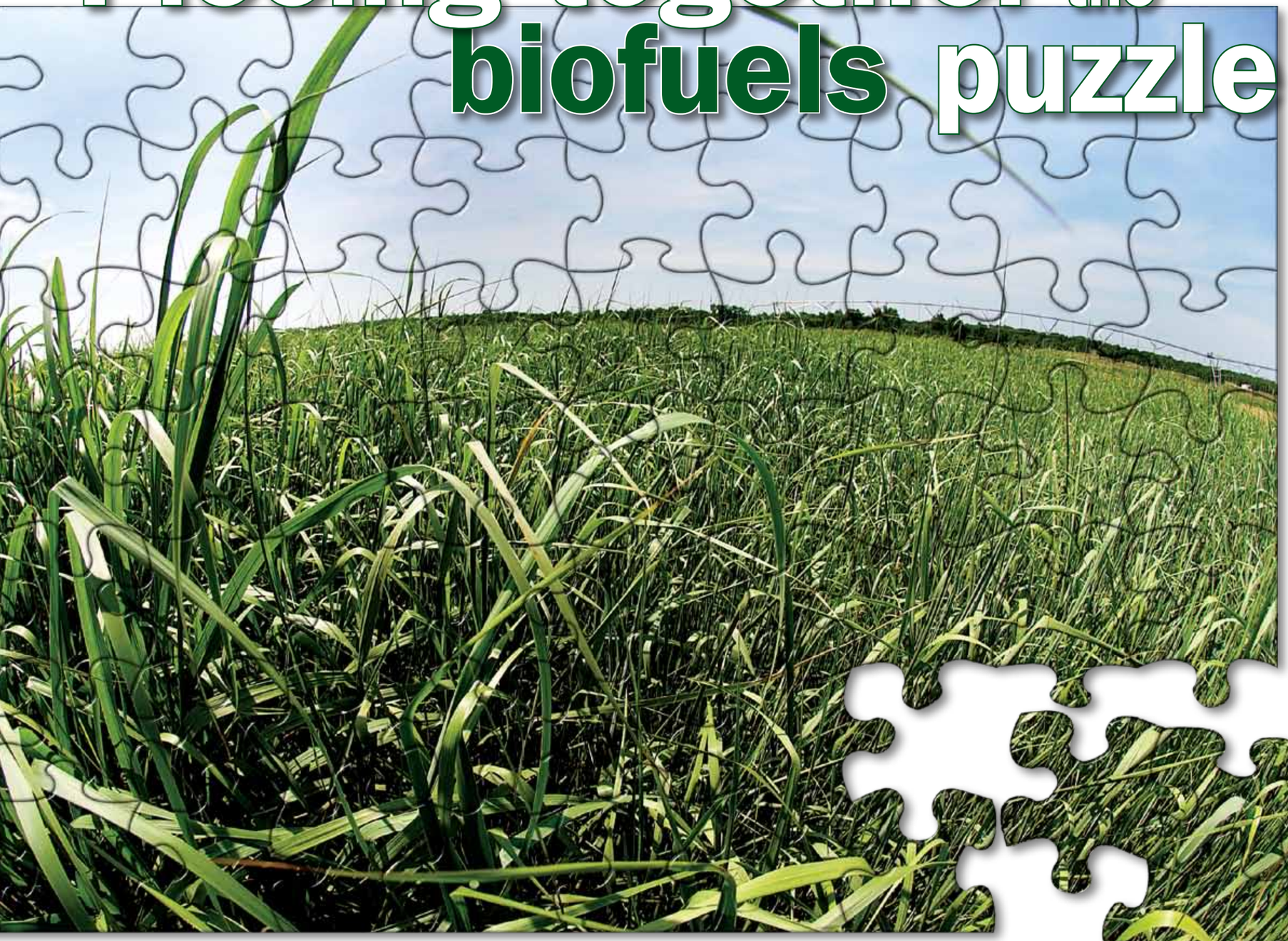
4. The temperature and humidity can be independently controlled for each cell. In the air-conditioned west range, the degree of control is much greater, allowing experiments conducted in the winter months to be replicated in the summer.

5. Each cell permits independent control of both natural and artificial light. Each cell has motorized shade systems and artificial light sources, and five cells possess a "total blackout" system to simulate a nighttime environment or fully control day length.

6. Automation extends to each bench within each cell. Scientists can select and deliver specific water and nutrient requirements for their research plants. As automation is controlled through a central computer, records of all variables are generated for evaluation.

7. The Noble Foundation greenhouse combines numerous environmental control systems and meets BL2-P biohazard level containment, which includes insect screening systems.

# Piecing together the biofuels puzzle



## The Noble Foundation's work with switchgrass may provide the missing piece to the U.S.'s biofuels industry

A Rubik's Cube. The New York Times crossword. The biofuels industry. All of them are difficult puzzles to solve in their own right, except, in the case of biofuels, not all the pieces exist, and never has so much been riding on the solution to a puzzle.

While many pieces to the biofuels puzzle remain uncertain – What plants can serve as viable feedstocks? What is the most efficient conversion technology? How can harvest and transport capabilities be scaled up to meet the necessary demands? – two pieces have been established: need and near-term production goals.

Inarguably, a new energy source is paramount for U.S. energy security. In 2005, the International Energy Annual reported that, despite possessing only about 2 percent of the global oil reserves, the U.S. uses more than 25 percent of the world's supply. More dramatically, the U.S. consumes the same amount of petroleum as Japan, China, Germany, Russia and India combined.

"To compound the issue, the political situation in many of the countries from which we import our oil raises concerns as to the stability of our supply," said Joe Bouton, Ph.D., Senior Vice President, Director of the Forage Improvement Division and a scientist for The Samuel Roberts Noble Foundation. "Our lives and livelihoods can be severely impacted with little provocation."

The federal government set out to address this issue in 2005 by establishing the "30 by 30" goal, which aims to replace 30 percent of imported oil with renewable alternatives by 2030. A more aggressive goal was issued in early 2007 when the federal government mandated the annual production of 35 billion gallons of biofuels by 2017. In 2006, the U.S. produced only about 5 billion gallons of biofuels, mostly from ethanol.

The quest to find the world's next energy source may end in a familiar place, though. Oklahoma, where oil production has been a staple of the state's economy for more than a century, may again hold the key elements necessary to supply an important renewable energy source. Scientists at the Noble Foundation are working with industry, researchers from around the world and regional agricultural producers to develop bioenergy crops to produce cellulosic ethanol. "We are witnessing the creation of a new industry," Bouton said, "an industry that can provide the world what it's been waiting for – a renewable, economically viable and environmentally friendly energy source." ▶

*Illustrations _ Scott McNeill* *Images _ Broderick Stearns*

## The ABCs of biofuels

Understanding the production of biofuels – and thus the issues that surround the industry – begins with the pieces that make up the industry. Biomass is any type of plant material or living organism, and biofuels are the liquids developed from biomass for use in transportation fuel. The two primary types of biofuels today are ethanol and biodiesel.

"Biodiesel is not ethanol. It is chemically different and cannot be used in the same ways," Bouton said. "Biodiesel, which is largely produced from oilseed crops, such as canola, sunflowers and soybeans, is an alternative for diesel, while ethanol is mixed with gasoline to reduce the need for traditional gasoline."

For ethanol, the industry is developing around two "types" – starch ethanol (produced from corn kernels) and cellulosic ethanol (produced from cellulose plant fibers). "Starch ethanol and cellulosic ethanol are chemically identical," Bouton said. "We begin with different sources, but we end with the same product that can be used the same way."

While starch ethanol is produced mostly from corn kernels, sources of cellulose are abundant and include wheat straw, quick-growing trees (poplar and willow) and countless grasses. Because cellulosic ethanol capitalizes on non-edible portions of plants or crop residues, it does not compete with human food or animal feed supplies, Bouton said. He added that cellulosic material yields higher relative energy outputs than its starch-based counterparts.

"Studies have shown that with corn, for every unit of energy used to produce the ethanol, you get about 1.4 units of energy in return," Bouton said. "Cellulosic feedstocks are estimated to produce about five times more energy than corn. That is a significant and relevant increase."

This energy output and the availability of the cellulosic crops are important factors when considering the United States production goals. Some estimates conclude that biodiesel will contribute a small percentage (less than 5 billion gallons annually) of the required 60 billion gallons to meet the "30 by 30" goal. Starch ethanol could ultimately be limited to about 12 to 15 billion gallons each year due to corn production and its competing uses (food, animal feed and exports), so the balance of the national production goal will fall to cellulosic ethanol. The Noble Foundation is playing a significant role in achieving that benchmark.

## Switchgrass for the future

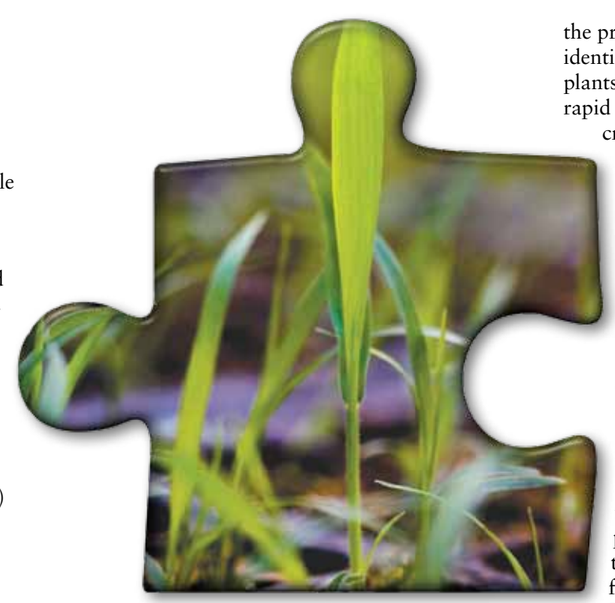
For more than six decades, the Noble Foundation has focused its research and agricultural programs on improving those plants and production systems necessary to support livestock production in the southern Great Plains. Many of the Noble Foundation's efforts target the use and improvement of forages – plants grazed by livestock or used for hay.

Much of the nation was introduced to switchgrass in President George W. Bush's State of the Union speech in January 2006 in his brief discussion of plant materials that might be used to produce alternative transportation fuels. Noble Foundation scientists and agricultural specialists, however, were already familiar with switchgrass's attributes and potential, but for other reasons.

Switchgrass, a perennial, native prairie grass, was one of many grasses the Noble Foundation was using to manage pastures and open ranges. Switchgrass naturally exhibits many desirable qualities, including drought and heat tolerance, disease and pest resistance, low input requirements (e.g., nitrogen) and an ability to produce significant tons per acre.

"It is an excellent feedstock to produce cellulosic ethanol for most regions in North America since it can grow in 40 states, Canada and Mexico," Bouton said. "Once established, current varieties found in the south and southeast are capable of producing more than 6 to 7 tons per acre."

Switchgrass is not currently a cultivated crop. While there is much to learn about how switchgrass will perform in such an environment, Noble Foundation scientists are confident that switchgrass possesses those qualities that will make it an excellent subject for rapid improvement and adaptation to production agriculture. Encompassed within the scope of its mission, the Noble Foundation has engaged in a multidisciplinary approach to improve and implement the use of switchgrass as a bioenergy crop.



## Building a better switchgrass

"Our work has the potential to affect each stage of biofuels production," said Mike Cawley, President and Chief Executive Officer of the Noble Foundation, "from creating high-yielding bioenergy crops and enhancing crop production and management to ultimately increasing biofuel production by delivering a feedstock that is specifically tailored to the [ethanol] conversion process."

At least eight of the Noble Foundation's 18 principal investigators have research projects directly related to improving switchgrass.

At the forefront, Bouton and his group of plant breeders are working to develop improved varieties of switchgrass through conventional plant breeding. These varieties are intended to excel across the continental U.S. In addition, Bouton and his team are developing hybrid switchgrass varieties to achieve the most desired trait in bioenergy crops – more tons per acre.

Bouton's work is complemented by the work of Malay Saha, Ph.D., who is developing a breeders' "molecular marker" map for switchgrass that can accelerate the traditional plant breeding process. This map will correlate genetic markers to genes within a plant's DNA that deliver desired characteristics or traits. When markers are used in breeding, the presence of such traits can be identified within newly produced plants at the seedling stage, permitting rapid screening of newly produced crossed varieties and saving months of research time.

Bouton's and Saha's work is conducted in furtherance of the Noble Foundation's long-term collaboration with Thousand Oaks, Calif.-based, Ceres, Inc. (see sidebar).

The Noble Foundation's efforts go far beyond variety development. Noble scientists are using molecular biology, strategic genetic engineering and the latest in plant science technologies to make specific plant improvements to deliver the next generations of biofuels feedstock. Rick Dixon, D.Phil., Senior Vice President and Director of the Plant Biology Division, focuses a part of his research program on ways to reduce lignin, a structural polymer defining the cell walls of all plants. Dixon and his research group have recently shown that decreasing lignin content by genetic manipulation can greatly enhance sugar release for ethanol production. Further, this work could lead to the development of biological conversion systems that do not require costly and, in some instances, environmentally unfriendly pretreatment stages in the ethanol production process.

Working closely with Dixon is Zengyu Wang, Ph.D., whose work in transformation systems enables the genes associated with a desired trait, such as reduced lignin, to be moved from one plant to another. Wang's project to create a low-lignin switchgrass was the first of many federally funded projects at the Noble Foundation that have focused on improved feedstock development for bioenergy production.

Kelly Craven's research takes a different approach to improving switchgrass. Craven, Ph.D., is studying naturally occurring grass endophytes, fungi living inside plants that can have a mutually beneficial relationship with their host. Through such relationships, the host plants can exhibit new beneficial qualities, such as drought ▶

## Oklahoma Bioenergy Center established

On June 5, Oklahoma Governor Brad Henry signed legislation that created the Oklahoma Bioenergy Center (OBC). In addition, the Oklahoma legislature appropriated $10 million to fund the OBC's first year of operation. The OBC is planned as a four-year, $40 million initiative.

Charged with designing, developing and coordinating an integrated research program that spans the cellulosic biofuels/alcohols production chain – from feedstock development through conversion – the OBC will focus the established research programs found at the **Noble Foundation**, **Oklahoma State University** and the **University of Oklahoma**.

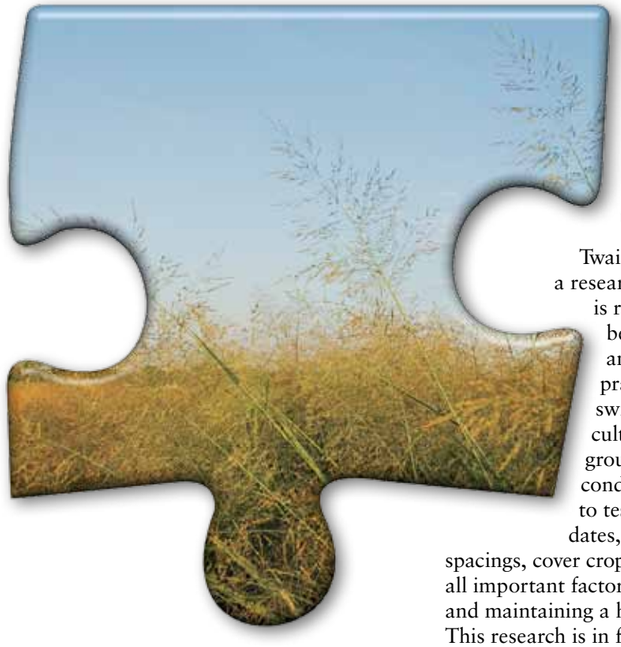
Additionally, the OBC will fund strategic research projects in other biofuel areas, such as for biodiesel and non-cellulosic ethanol production.

## Noble, Ceres collaborate to improve switchgrass

In 2006, the Noble Foundation signed a long-term research collaboration with Thousand Oaks, Calif.-based, Ceres, Inc.

Ceres (www.ceres.net), a privately held company founded in 1997, is the leading developer of high-yielding energy crops that can be planted as feedstocks for cellulosic ethanol production. Its development efforts cover switchgrass, miscanthus, poplar and other energy crops.

The collaboration focuses on switchgrass improvement and understands the agronomic requirements and potential economics of this crop in a full-scale production system. This work, intended to fuel the emergence of switchgrass as a dedicated bioenergy crop, will play a critical role in understanding this crop not only in the southern Great Plains, but across all North American geographies.



tolerance. Craven's research group is developing a warm-season grass endophyte symbiosis. Since most fungal endophytes are specific to cool-season grasses, a warm-season variety could enhance crops grown in the spring and summer, which will represent the majority of bioenergy feedstocks.

"Our goal is focused on increasing switchgrass yield," Craven said. "With endophytes, we are looking at 'non-traditional' mechanisms that have the potential to help achieve this goal." Other Noble Foundation research scientists are providing valuable research tools and insight into the functionality of monocot species – grasses – that can be used to more fully understand the plant, identify value-added traits and, potentially, engineer these crops to produce improved feedstocks.

### Oklahoma's bioenergy foundation: the agricultural producers

The Noble Foundation's impact on the emerging cellulosic biofuels industry is not limited to variety development and plant improvement. The institution is answering critical questions regarding agronomic issues, as well as the economic questions, that will assist in the creation of this industry in Oklahoma and impact its successful development across the nation.

Twain Butler, Ph.D., a research agronomist, is researching the best establishment and management practices for switchgrass as a cultivated crop. His group is currently conducting field trials to test various planting dates, seeding rates, row spacings, cover crops and weed control, all important factors in establishing and maintaining a healthy stand. This research is in furtherance of the Noble-Ceres collaboration with the ultimate goal of producing a freely available educational reference for the benefit of agricultural producers new to bioenergy crops.

Complementing this work, the research group of the Noble Foundation's Agricultural Division is studying the specific input requirements and harvest variations possible to optimize production yield in balance with achieving long-term sustainability – from the perspectives of the land and producer economics. They further are assessing the value of switchgrass, as a cultivated monoculture, for promoting wildlife habitats as well as how such a crop could be integrated into existing livestock operations – a dominant industry, particularly throughout the Great Plains and southeastern United States.

"This research will provide agricultural producers with the tools to establish and productively maintain these crops," said Wadell Altom, Senior Vice President and Director of the Agricultural Division at the Noble Foundation.

"Education will be one of the keys to the success of this industry," Altom said. "Not having the benefit of generations of knowledge of this crop, farmers and ranchers must be able to understand how to bring this crop out of the ground, productively grow it and, at least initially, integrate it into their existing production systems. They must have tools to help them succeed, because without them there is no industry."

In the end, the Noble Foundation's role in the bioenergy industry remains consistent with its mission: to assist farmers and ranchers.

"The ultimate goal of the Noble Foundation's research and initiatives in the area of cellulosic feedstock development is to facilitate and foster a strong biofuels industry in Oklahoma knowing that this work will have a broader, national influence," Cawley said. "In the span of less than a single generation, we could see the emergence of a biofuels industry capable of rejuvenating rural economies, giving agricultural producers new opportunities and providing for improved energy security for our nation. It's a significant challenge, but I am confident we will solve the puzzle." ●

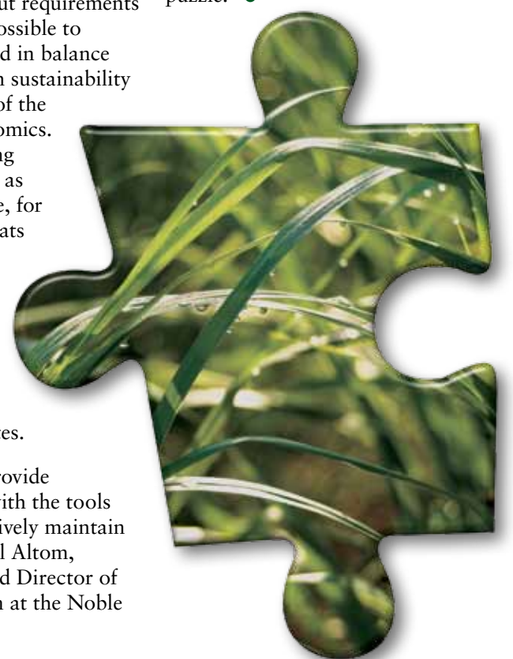


*Image _ Scott McNeill*





# Launching a career

## Maria Harrison looks back at her time as a Noble Foundation postdoc, and the years that shaped her life

*Story _ J. Adam Calaway*
*Image _ Broderick Stearns*

Maria Harrison, Ph.D., has many vivid memories of her days as a postdoctoral fellow at The Samuel Roberts Noble Foundation.

She remembers the excitement that brought her from her home in Yorkshire, England, to the Oklahoma prairie. She remembers the seemingly endless days spent working to grow the Noble Foundation's new Plant Biology Division. She remembers the groundbreaking research that shaped her career and the kindness of the local community. And she also remembers one very educational trip to the grocery store.

After paying the check-out clerk, Harrison gathered her groceries and walked toward the door when the clerk offered a common southern farewell, saying, "Y'all come back."

"When she said that, I turned around and walked back," said Harrison, her bright British accent flavoring each word. "I assumed there was a mistake with the change or that I had forgotten something. I was looking at her and she was looking at me. After a while I got to understand not to take those phrases literally."

Harrison quickly moved beyond the differences in cultural mores, and found her life's passion at the Noble Foundation. She arrived in February 1988 for her three-year, postdoctoral fellowship tenure after finalizing her Ph.D. from the University of Manchester, Institute of Science and Technology. Harrison was the first postdoc in the newly formed Plant Biology Division.

"I was there when we unlocked the lab and unpacked the first boxes. I remember wondering what to do because the labs weren't really ready," Harrison said. "Of course, nobody could understand me at first, and I couldn't understand them. Everybody sounded like John Wayne."

Harrison's early research focused on legumes, specifically a gene promoter that protects the plant against pathogen attacks. The work consumed her, and she spent countless hours bunkered in the lab, while finding friends and fulfillment outside. Her three years slipped by in a blur of research and windsurfing.

"It was a great time in my life, but I didn't expect to stay," she said. "I thought I'd work on my project and then decide what to do from there."

Rick Dixon, the founding and current Division Director, proposed another alternative – stay on as an assistant faculty member and pursue her own research. "It was a generous offer," she said. "I was excited that they thought I was worth the gamble."

So Harrison rolled the dice and stayed, initiating work on a model legume, *Medicago truncatula*, and the mycorrhizal symbiosis with a fungus, *Glomus versiforme*. The fungus lives in plant roots and helps the plant obtain minerals, such as phosphorous, from the soil. Her group worked on understanding how the symbiosis functioned at the molecular level with the purpose of using its beneficial properties in agriculture.

In 1995, Harrison advanced again. She was named an associate faculty member, a position she held until earning full faculty status six years later. "It was clear during Dr. Harrison's time as a postdoc that she was ready for so

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# Surfing the Farm

## AgExchange revolutionizes agriculture management

*Story _ Caroline Lara*
*Image _ Broderick Stearns*

Craig Watson uses quite a few tools as he manages and maintains his cow-calf, stocker and hay operation west of Sherman, Texas. Along with traditional tools like pliers, wrenches or drills, Watson has come to rely on a new online tool developed by the Noble Foundation's Information Services Department – the AgExchange Web site.

Designed exclusively for the Noble Foundation's 1,400 cooperating agricultural producers, AgExchange allows users to remotely access their farm's or ranch's information from the Noble Foundation's databases. Users can see items such as soil and forage test results, property maps and recommendations from their consulting team.

"I find it handy to have hay and soil tests right there in a [readily usable] format," Watson said. "I also like the fact that when I log in, the e-mail addresses and phone numbers of everyone on my team are right there under the 'Team Contact' link."

Watson, who has been a participant in the Agricultural Division's consultation program since 1999, said he enjoyed being able to access the news feeds that are available from outlets such as the Texas Parks and Wildlife Department or the U.S. Department of Agriculture's Economic Research Service.

"The changing content keeps me coming back to check the site more often," he said. Watson has a unique perspective on AgExchange because, in addition to being a user, he served on the advisory panel that provided valuable assistance during the project's development phase.

"When I was asked to be a part of the panel, I agreed because I think that's the way things like that should be done, seeking the opinions of the people who will use it," Watson said. "I think involving the intended users from the beginning made AgExchange a more useful and practical tool."

Melanie McAdams, software development coordinator for the Noble Foundation, said the AgExchange advisory panel was a first for the department.

"This was a unique Web project because it included input from the end users from the beginning," she said. "We were able to build interest among the agricultural producers and go from there."

The advisory panel first met in November 2005. Noble Foundation staff members presented their ideas about what the site would contain and collected feedback. The panelists also broke into small groups to discuss what would be most useful to them and relayed that information to Noble Foundation staff.

"After compiling survey data and meeting with Agricultural Division personnel, we decided on the top 10 priorities for the site," McAdams said. "After pre-releasing the site to the advisory panel for review and feedback, we sent a letter out to each of the consulting program's participants in November [2006] letting them know the site was up and running."

Efforts continue to improve AgExchange based on valuable user input. "We are constantly working on new features to make the site as helpful as possible," McAdams said. "It will keep evolving."





## Grants

**Rick Dixon**, D. Phil., Senior Vice President and Plant Biology Division Director, was awarded $90,000 for a two-year research project funded by the Oklahoma Center for the Advancement of Science and Technology (OCAST). Dixon's research in this particular project focuses on the kudzu plant, which has historically received negative attention in the southeastern United States for its aggressive growth, but has been found to have health benefits due to the presence of chemicals called isoflavones. Dixon aims to discover novel genes that determine the special health-promoting properties of the kudzu isoflavones.

**Joe Bouton**, Ph.D., Senior Vice President and Director of the Forage Improvement Division, and **Malay Saha**, Ph.D., are co-principal investigators on a $600,000 three-year grant awarded to the Agricultural Research Service (Western Regional Research Center).

Entitled *Linkage Analysis Appropriate for Comparative Genome Analysis and Trait Selection in Switchgrass*, this project will create a comprehensive marker set for switchgrass based principally on simple sequence repeats (SSR) and initiate development of a linkage map.

**Bouton** and **Saha** were also co-principal investigators on a $400,000 three-year grant awarded to the University of Georgia for the project entitled *Resource Development in Switchgrass, An Important Bioenergy Crop for the USA*. This project will construct a simple sequence repeat (SSR)-based detailed genetic map of switchgrass and align it with maps produced in rice, maize and sorghum.

This will allow the exploitation in switchgrass of resources and sequence information generated for these well-studied cereals. Both Bouton and Saha grants are two of 11 projects funded jointly by the Department of Energy and the Department of Agriculture for bio-based fuels research that will accelerate the development of alternative fuels.

## New PI

Guatemala-born **Maria Monteros**, Ph.D., is the newest principal investigator in the Forage Improvement Division. Monteros arrived on campus this spring to establish a lab geared toward improving forage legumes, particularly alfalfa, white clover and red clover. Her goal is to identify the genes of desirable traits in these plants, including stress tolerance, enhanced nutritional value and disease resistance.

## Nonresident Fellows

The Noble Foundation's nonresident fellows program brings together an exceptional group of scientists, researchers and industry leaders to assist each of the foundation's three operating divisions. The nonresident fellows perform candid review of each of the division's programs, offer objective advice and guidance, and provide fresh perspectives. In 2007, four new nonresident fellows joined the Noble Foundation to provide insight and assistance.

**Richard M. Amasino**, Ph.D., is the Wisconsin Distinguished Professor of Biochemistry at the University of Wisconsin at Madison (Plant Biology). **Douglas R. Cook**, Ph.D., is a professor in the Department of Plant Pathology and the Faculty Director in the College of Agricultural and Environmental Sciences Genomics Facility at the University of California-Davis (Plant Biology). **David Sleper**, Ph.D., is a professor in the Division of Plant Sciences at the University of Missouri (Forage Improvement Division). **James William Turner**, Ph.D., is the San Antonio Livestock Exposition Chair Professor, in the Department of Animal Science at Texas A&M University (Agricultural Division).

## Publications

Professor **Marilyn Roossinck**, Ph.D., was published in the January edition of *Science*. Roossinck's paper – entitled *A virus in a fungus in a plant: three-way mutualistic symbiosis required for thermal tolerance* – was co-written with Luis Márquez, Regina Redman and Rusty Rodriguez. Research on endophytes in Yellowstone National Park has the potential to impact future agriculture world wide. The paper describes Roossinck's efforts to better understand the mutually beneficial relationship between plants and endophytes – a naturally occurring fungus that imparts beneficial characteristics to the hosting plant, including improved tolerances to environmental conditions.

## U.S. Legislature

**Joe Bouton**, Ph.D., a scientist and Senior Vice President with the Noble Foundation, provided testimony before a subcommittee of the United States House of Representatives in Washington, D.C., this May. Bouton was invited to comment on the agricultural research programs of the USDA as well as proposals being considered by the Subcommittee on Conservation, Credit, Energy, and Research for the upcoming 2007 Farm Bill.

# The rest of the story

**Dixon**: Continued from page 6

"The objective is to move these production pathways into plant species that cannot naturally make these specific compounds," he said. "Plants modified in this manner may benefit from improved disease or pest resistance. It is believed that flavonoids/isoflavonoids and tannins convey chemopreventive responses in humans to postmenopausal health problems, cancer and cardiovascular disease. In ruminant animals, such as cattle, tannins can prevent bloat and can improve protein use efficiency." Dixon's other research focus – to reduce lignin, a structural polymer defining the cell walls of all plants – will improve feedstock digestibility in grazing crops, but also will likely play an important role in the emerging field of cellulosic ethanol. Dixon's group has recently shown that low-lignin feedstocks can greatly enhance sugar release for ethanol production per unit of feedstock.

"My research career has always been gratifying because of the people it has allowed me to meet and my belief that the outcomes will ultimately make a difference in agriculture," Dixon said. "Having my research recognized by membership in the Academy is also a recognition of the wonderful scientific colleagues I have worked with these past 30 years." ●

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**Harrison**: Continued from page 17

much more, and she excelled at each level," said Dixon, D. Phil, Senior Vice President for the Noble Foundation. "She is a dedicated scientist with a keen mind and an excellent vision for her research. Her work was a key component of the Noble Foundation's research mission and continues to impact us to this day." Harrison, whose three-year stop turned into a 15-year stay, finally decided to move on in 2003. She joined the staff at Boyce Thompson Institute for Plant Research at Cornell University in Ithaca, N.Y.

"I owe so much to the Noble Foundation. You couldn't ask for a better, more enjoyable place to work," she said. "But I finally grew to the point that I knew it was time to be exposed to new challenges and new opportunities." To this day, Harrison collaborates with her mentor and now colleague, Dixon, and other Noble Foundation scientists, such as Elison Blancaflor, Ph.D., and Zengyu Wang, Ph.D. As she leads her lab, she knows her experiences at the Noble Foundation prepared her well.

"The Noble Foundation gives each scientist solid research training in a state-of-the-art research environment," Harrison said. "I had access to a huge array of instrumentation and research opportunities that I would not have received anywhere else. The Noble Foundation puts their postdocs in a good position to be competitive in the job market. It did more than help me advance; it shaped the direction of my research career." ●

THE SAMUEL ROBERTS
NOBLE
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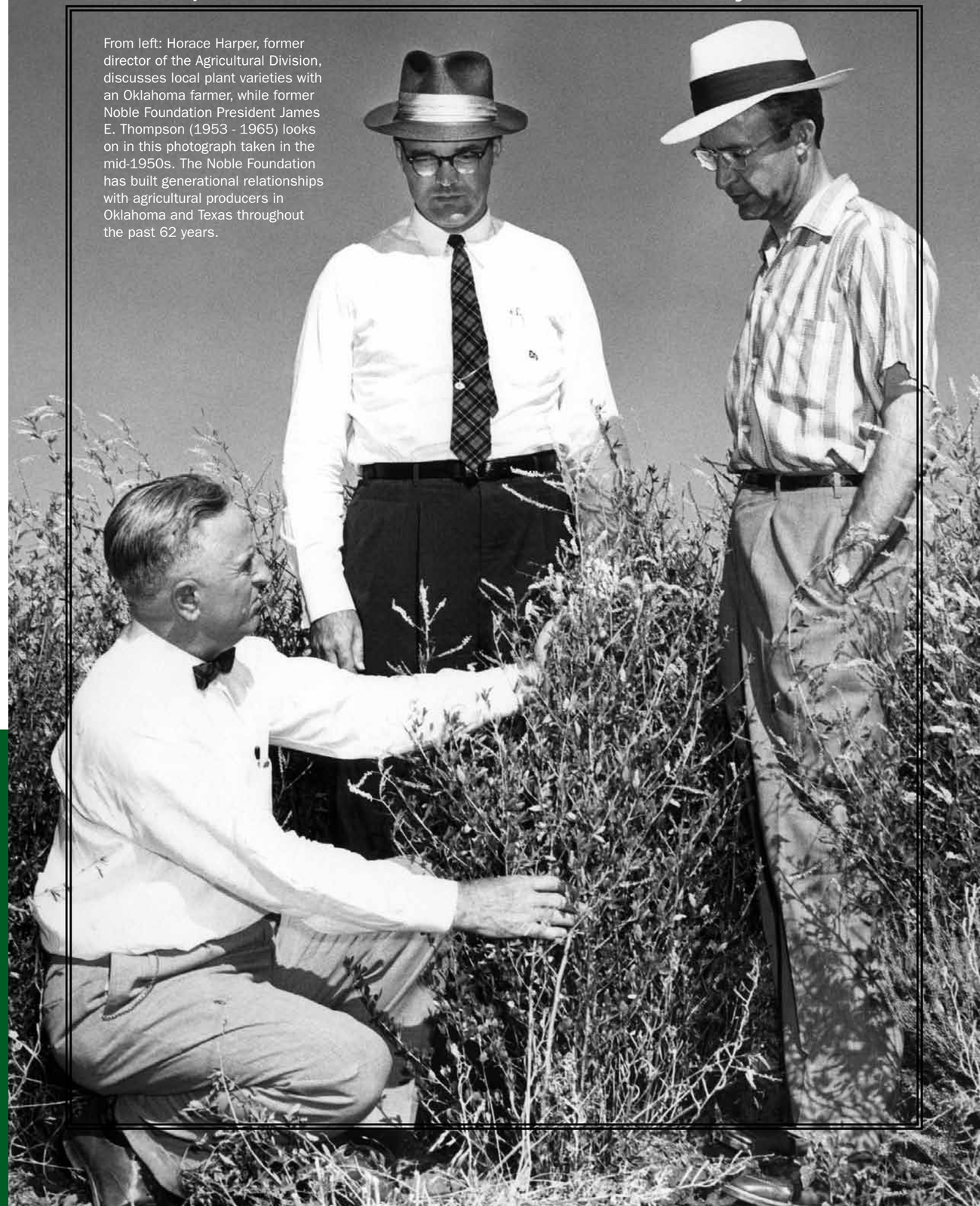
# A snapshot in Noble Foundation history - 1950s



From left: Horace Harper, former director of the Agricultural Division, discusses local plant varieties with an Oklahoma farmer, while former Noble Foundation President James E. Thompson (1953 - 1965) looks on in this photograph taken in the mid-1950s. The Noble Foundation has built generational relationships with agricultural producers in Oklahoma and Texas throughout the past 62 years.

# Speakers Bureau (For August - December 2007)

**Bouton, Joe**
*July 31 - Aug. 2*: Southeast Bioenergy Conference 2007, The University of Georgia, Tifton, Ga.

**Childs, Dan**
*July 28-31*: American/Western/ Canadian Agricultural Economics Associations Joint Annual Meeting, Portland, Ore.

**Dixon, Rick**
*Aug.*: Phytochemical Society of Europe Symposium on Plants for Human Health in the Postgenome Era, Helsinki, Finland.
*Sept.*: The University of Kentucky Fall Symposium "Through the Looking Glass of Molecular and Cellular Genetics of Plants," Lexington, Ky.
*Oct.*: VIth International Symposium on Natural Products, Chillan, Chile.
*Nov.*: RIKEN Plant Science Center, Yokohama, Japan.
*Nov.*: American Society of Agronomy International Annual Meeting, New Orleans, La.
*Nov.*: Annual Symposium of the Phytochemical Society of Japan, Tokyo, Japan.

**Monteros, Maria**
*July 24-27*: Converciencia 2007, National Council for Science and Technology (CONCYT), Guatemala City, Guatemala.
*Nov. 5-8*: American Society of Agronomy (ASA)-Crop Science Society of America (CSSA)-Soil Science Society of America (SSSA) International Annual Meetings New Orleans, La.

**Roossinck, Marilyn**
*Sept. 11-12*: Advances in Virology, Association of Applied Biologists (AAB), University of Greenwich, Kent, UK.

**Sumner, Lloyd**
*Sept. 16-20*: Association of Analytical Chemist (AOAC) 121st Annual Meeting & Exposition, Anaheim, Calif.
*Nov. 4-7*: 63rd Southwest Regional meeting, American Chemical Society (ACS), Lubbock, Texas.

**Young, Carolyn**
*July 31*: American Phytopathological Society (APS) annual conference, San Diego, Calif.
*Sept. 14*: Seminar, Hope College, Holland, Mich.

**Zhao, Patrick**
*Nov.*: Seminar, J.B. Speed School of Engineering, Computer Engineering and Computer Science Department, University of Louisville, Ky.

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