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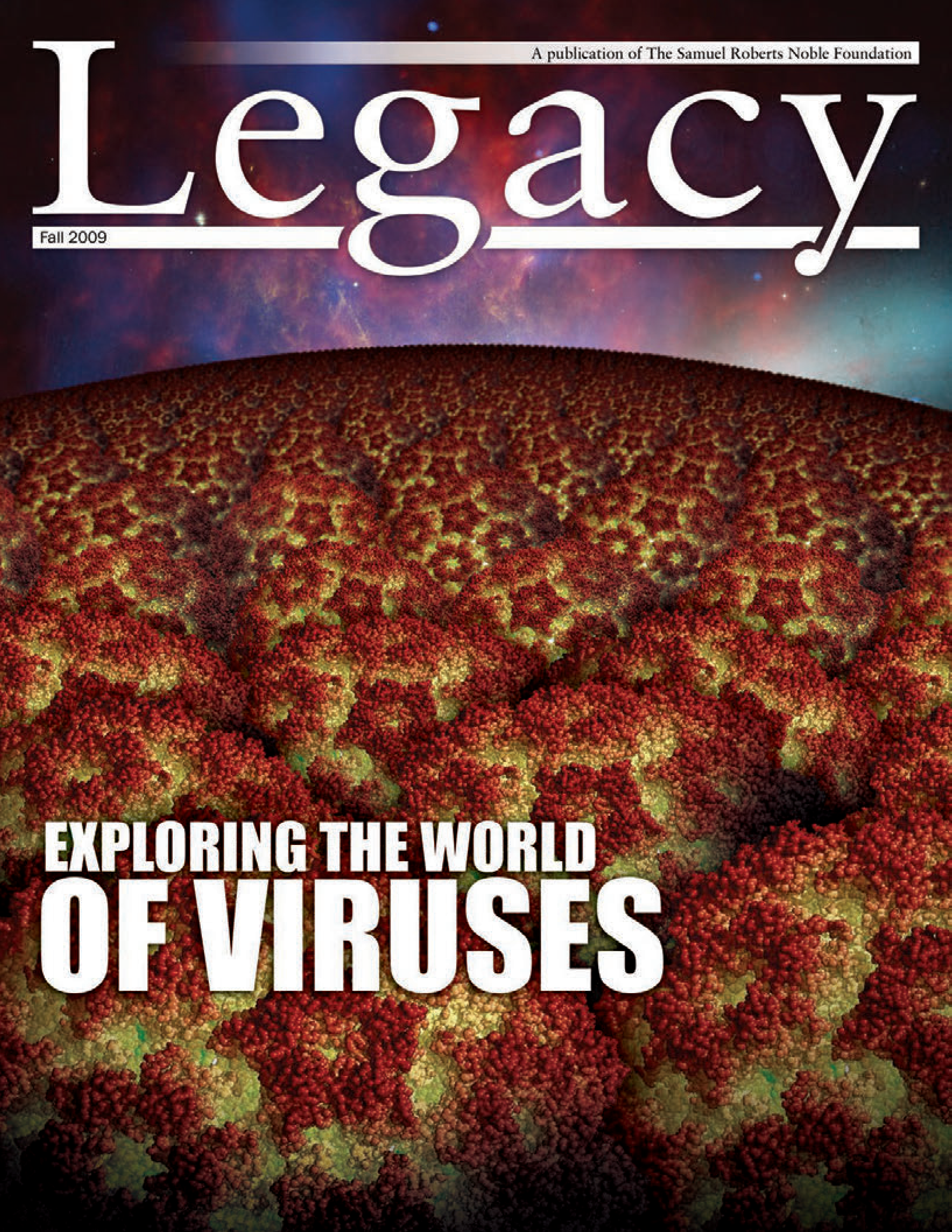
Legacy

Fall 2009



EXPLORING THE WORLD OF VIRUSES

More than 2.8 million head of cattle are within a 100-mile radius of the Noble Foundation's Ardmore campus, making forage-based beef cattle production the primary agricultural enterprise and a focus of Noble Foundation research. Currently, researchers are conducting projects to study livestock genetics, pasture management, stocker cattle health and performance, and mitigation of costs associated with forage-based beef cattle production.

Photograph by Broderick Stearns

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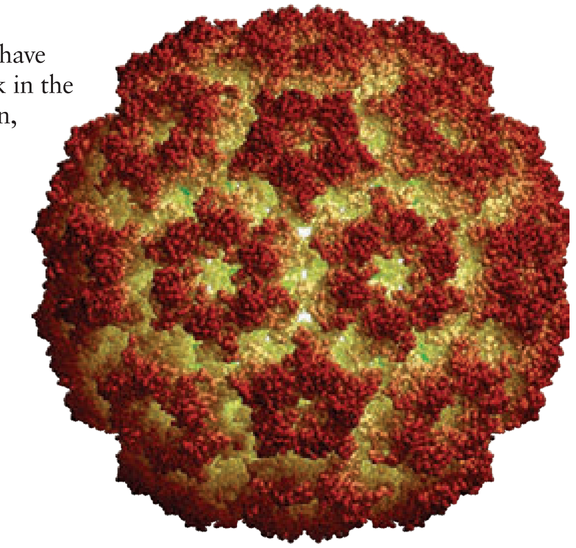

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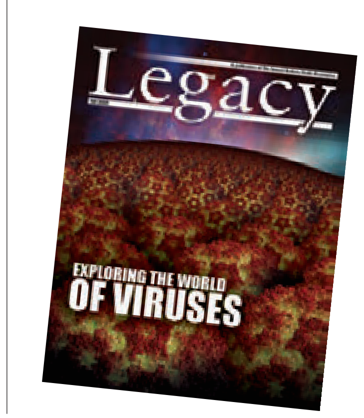
On the Cover

The cover of the Fall 2009 issue of *Legacy* illustrates that virology is a journey into a unique and often misunderstood world. Viruses may be miniscule in size, but the potential of the research has global implications.

Designed by Doug McAbee, the illustration's primary visual element is cucumber mosaic virus (red and yellow) repeated to form a planet-like image. A special thank you goes to Jean-Yves Sgro at the Institute for Molecular Virology, University of Wisconsin-Madison, for a Rasmol image of the virus (PDB 1F15) that serves as the basis of the illustration.



THE SAMUEL ROBERTS
NOBLE
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Legacy is published by the Office of Public Relations and the Office of Publications and Visual Media at The Samuel Roberts Noble Foundation. Headquartered in Ardmore, Okla., the Noble Foundation is an independent, nonprofit institute conducting plant science research and agricultural programs to enhance agricultural productivity. *Legacy* offers detailed insight into the outstanding scientists and agricultural consultants, and their programs and research, who collectively serve to pursue the vision of Lloyd Noble, the founder of the Noble Foundation, to benefit mankind.

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About the Noble Foundation

The Samuel Roberts Noble Foundation is an independent, nonprofit institute headquartered in Ardmore, Okla. Founded in 1945 by philanthropist Lloyd Noble, the Noble Foundation's mission is to benefit mankind by assisting regional agricultural producers and land stewards.

The organization accomplishes this charge by providing no-cost consultation to more than 1,700 regional farmers and ranchers, helping them achieve their individual financial, production, stewardship and quality-of-life goals.

Additionally, the Noble Foundation conducts plant science and agricultural research and programs to enhance forage grasses and legumes. The coordinated efforts of the Noble Foundation's agricultural consultants and scientists enable the organization to move science and innovation from the laboratory to the field, giving life to discovery and improving agriculture in Oklahoma, the United States and around the world.

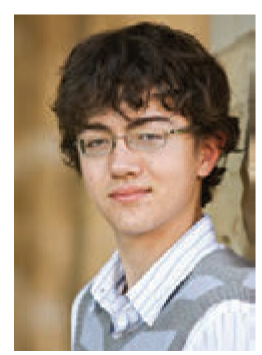
Contributors

Laura Beil is an independent journalist specializing in medicine, health policy and science. She writes frequently for the *New York Times*, *Science News* and *Cure*. Her work has also appeared in *Reader's Digest*, *Self* and *Newsweek*, and she has upcoming features in *Ladies' Home Journal* and *Parenting*.

She began freelancing in 2007 after working as a medical writer for the *Dallas Morning News* from 1992-2006 and then was a media fellow with the Kaiser Family Foundation until 2007. She has won numerous reporting awards during her career.

At the age of 16, aspiring journalist **Arthur Dixon** is the youngest writer to have work published in *Legacy*. Dixon is a high school junior in Ardmore, the Noble Foundation's hometown. He penned his first essays in elementary school, and his literary work includes poetry, song lyrics, short stories and nonfiction. Mostly, he enjoys writing about history, science and peoples' lives.

Dixon has received several awards for his writing. When he is not in school or writing, he's creating music with friends, studying new languages and playing video games.



Katie Reim has been involved in the communications industry for a decade. Reim has written for several Oklahoma publications, covering topics from the agriculture industry to health and financial management. Reim earned bachelor's and master's degrees in agricultural communications from Oklahoma State University. Beyond her writing, Reim enjoys fitness, travel and playing the piano.

Finding tomorrow's answers today

Outside of farmers and ranchers, not many people think about agriculture each day. Why should they? Life is busy, and all the food we need is just down the road. The system is functioning correctly, so agriculture rarely makes a blip on our collective radar screens.

Of course, the domestic process of growing and harvesting food functions with such efficiency because it is fueled by a dedicated core of agricultural producers and is supported by a broad range of agricultural research directed to the plant, animal and food sciences, as well as production agriculture.

Agricultural research is the linchpin to keeping pace with the world's ever-growing food demands, and it is engineering new opportunities previously thought to be unrelated to the industry. Modern corn production serves as an excellent illustration of how agricultural research can provide tangible solutions to complex challenges.

In 1953, Byron Shaw wrote an academic article entitled "Impact of Research in Agriculture." As Shaw peered into the future, he grew concerned that – by his calculations – 190 million people would live in the United States by 1979, meaning farmers were going to need to produce 30 percent more food, including a billion additional bushels of corn. It seemed like an overwhelming task.

When Shaw wrote his article, farmers were producing an average of 63 bushels per acre. Today, average yield is about 163 bushels per acre with some growers regularly exceeding 200 bushels per acre. Which leaves the obvious question: How have we almost tripled production?

Since 1930, modern farming practices, including improved fertilizer and pesticide usage, and new tillage and management systems, have played key roles in increasing production. However, studies suggest that almost 60 percent of corn's gains are due to genetic improvement of the plant material, the introduction of hybrid seed and, more recently, the use of genetically engineered crops, the process by which a desirable gene is moved from one plant to another.

Genetically engineered crops, which have been commercially available for just more than a decade, have increased corn's productivity by improving weed control and pest management – all with fewer applications of chemicals. Today, corn carrying these engineered traits individually or in combination is grown on more than 91 million acres worldwide.

While the advancements made in corn are impressive, it is but one crop, and it alone cannot feed the world. Just as Shaw peered into the future and saw a great need, so do we in this generation. In the next 25 years, agriculture will need to support 1.5 billion more people under amazingly challenging conditions.

As a hungry world, we will demand that the resources, technology and ingenuity of the agricultural research sector again help solve the vital food production quandary. The scientists, researchers and agricultural consultants at the Noble Foundation understand this challenge.

While our focus is not corn, the Noble Foundation is using modern technology and the experience gained from six decades of working with farmers and ranchers, and managing our own research farms to create new technologies and management systems to improve the productivity and value of forages – grasses and legumes.

Noble researchers and scientists explore the fundamental elements of plants to learn more about how plants grow, develop and survive in trying conditions. We use this knowledge to produce improved varieties, whether through classical breeding or genetically engineered crops. We believe these scientific approaches will continue to provide valuable tools for forage-based livestock production systems both regionally and around the world. Notwithstanding these traditional applications, agricultural research is reshaping far-reaching sectors of society usually insulated from agricultural policy and production.

In the past five years, global energy policy has shifted from nonrenewable fuels to agriculturally based biofuels. Agricultural research, both at the Noble Foundation and across the nation, is working to make this next generation of energy a reality. This industry has the potential to reduce the nation's dependence on foreign oil and bring new economic development to rural America. Additionally, our scientists and other researchers around the world are working to unlock the potential of plants to benefit human health, including finding solutions for heart disease, cancer and Alzheimer's disease.

It's true that most people do not think about agriculture each day, but the research driving this industry will soon make it impossible to ignore.

Sincerely,

Michael A. Cawley
President and Chief Executive Officer

Glaucia Souza shares experiences from Brazil.

International researchers visit Noble Foundation for information, inspiration

Each year students from elementary school to college, political dignitaries, agricultural producers and international researchers as well as curious members of the public visit the Noble Foundation's 800-acre campus.

Visitors have an opportunity to tour the facility, interact with scientists and agricultural consultants, and learn how plant science and agricultural research combine with applied agricultural programs to benefit farmers and ranchers regionally, nationally and globally.

This fall the Noble Foundation welcomed two distinguished visitors, both on pilgrimages of knowledge, both looking to return to their native lands equipped with information that could assist their region's production agriculture. Below, a Brazilian scientist and a farmer from Northern Ireland discuss life and agriculture as they spend a day at the Noble Foundation.

Glaucia Souza, Eisenhower Fellow

Glaucia Souza was destined to be a plant scientist. When she was born in São Paulo, Brazil, her parents named her after a species of poppy. She was given a chemistry set at the age of 10, learned genetics by 15 and then began studying molecular research when she reached college in 1984. Her education culminated in a doctoral degree in gene expression in microorganisms from the University of São Paulo in 1993.

Today, Souza is an associate professor at the University of São Paulo, where she has become one of the country's leading researchers in bioenergy produced from sugarcane. She serves as program coordinator for the State of São Paulo Research Foundation's bioenergy program, known as BIOEN.

Souza was so highly regarded that she was selected as one of only 15 international Eisenhower Fellows for 2009. The fellowships provide outstanding midcareer (age 32-45) professionals intensive development training in the United States. This year, each of the Eisenhower Fellows' work is centered on energy production, under the theme of "Fueling Growth."

Brazil has been utilizing its vast sugarcane resources to produce ethanol for 80 years. The country currently uses about 0.5 percent of its land for ethanol production. However, Souza said the country plans to boost that number to 7 percent. This will require an expansion of the country's agriculture sector and increased reliance on plant biotechnology. While requiring tremendous growth of the nation's biotechnology industry, the result could be Brazil's ability to offset 10 percent of the world's gasoline usage.

As part of her fellowship, Souza sought solutions to some of the key problems facing Brazil in achieving this growth. The country is the world leader in sugarcane production and research (as measured by the number of peer-reviewed publications), but patenting still lags behind. Despite sugarcane having been in production since 1532, Souza estimated sugarcane biotechnological research to be at least 10 years behind United States' corn research. More so, she identified a significant societal barrier that must be overcome: Brazilian scientists focus more on basic science than crop biotechnology, and there are very few examples of biotechnology spin-off companies.

As part of her Fellowship, Souza is crisscrossing the country from Philadelphia to San Francisco on a six-week tour, visiting research institutes focused on synthetic and systems biology, bioinformatics, intellectual property, biomass and cellulosic biofuels research.

The Noble Foundation has played a key role in developing switchgrass, a native prairie grass, as a potential cellulosic biofuel source in Oklahoma and the United States.

Souza came to the Noble Foundation interested in how the organization conducted projects along the entire value chain of cellulosic research. Souza visited with researchers from across the Noble Foundation's three operational divisions, viewing the switchgrass projects from the fundamental scientific endeavors in lignin biosynthesis to plant breeding programs and the development of crop management systems.

"I thoroughly enjoyed my time at the Noble Foundation," she said. "All my discussions have direct correlation to what we're trying to do in Brazil. So much of what I've learned will play directly into my programs. I'm hopeful we can put together collaborations and, in doing so, benefit two countries."

Souza also detailed Brazil's current sugarcane research for the Noble Foundation scientists. "It's always interesting to see what our colleagues from around the world are working on. Invariably there are parallels with your research," said Richard Dixon, senior vice president and director of the Plant Biology Division. "These types of interactions help foster a communal spirit and can lead to valuable collaborations."

William Haire, Nuffield Farming Scholar

Standing in the Noble Foundation's research greenhouse, William Haire, 34, shook his head in disbelief. "It's simply amazing," he said. "The whole Foundation is simply amazing."

It's late September and Haire is on a five-week blitz through the United States. He will make dozens of stops in eight states before venturing to Australia and New Zealand for six weeks of tours. Such is the life of a Nuffield Farming Scholar.

Funded by the agriculture and food industry in the United Kingdom (UK), Nuffield Farming Scholarships are awarded to fewer than 20 individuals in the UK each year. Only 800 individuals have been awarded the scholarship from the handful of participating countries since it began in 1947.

Recipients are responsible for designing global tours to study various agricultural industries (e.g., livestock, horticulture, etc.). Then, for a minimum of two months, they travel the world gathering the best knowledge and information.

"During the initial meeting, the program advisors said, 'What you've accomplished up to this point in your life means nothing. Your life will change from now on,'" Haire said. "They were right."

In his everyday life, Haire is a "practical" farmer in Belfast, Ireland, where he breeds registered poll Herefords and commercial cattle on 220 acres of land that have been in his family for – as best he can figure – four generations. "The program really focuses on an 'individual knowledge transfer mechanism,'" Haire said. "They want you to develop leadership skills, influence policymakers and educate others in your field. In my case, I'll be able to share my knowledge with a country that has more than 150,000 beef producers."

Haire's scholarship has allowed him to focus on beef production, specifically breeding issues like Expected Progeny Differences (EPD) and genomics, and how those factors could influence the whole livestock value chain.

During his time in the United States, Haire visited universities across the Midwest, large cattle ranches, feed yards and research institutions like Pioneer Hi-Bred International. Hope Pjesky, a native Oklahoman and 2008 Eisenhower Fellow, who hosts traveling Nuffield and Eisenhower scholars, suggested Haire visit the Noble Foundation.

"Interactions like this are always important," said John Blanton, Ph.D., agricultural research programs manager. "We have an opportunity to serve as an agricultural ambassador and positively influence production in a whole other part of the world. Lloyd Noble established this organization to benefit mankind by supporting agricultural producers. This is just another way to take this message to a global audience."

His day at the Noble Foundation was particularly fruitful for Haire, who discussed the challenges of interpreting EPDs and other breeding selection tools with the Agricultural Division's livestock consultants. He also met with the Agricultural Research Team to discuss DNA markers for breeding as well as the issues surrounding the adoption of the new technologies.

"I'm leaving the Noble Foundation with a new understanding of these technologies," Haire said. "I hope that the farmers feel appreciative of what they have in the Noble Foundation. It's absolutely outstanding. And if I buy a farm in the United States, it will be in Ardmore."

William Haire snaps a photo of the Noble Foundation greenhouse during a campus tour.

Noble Foundation, OSU collaborate on project to benefit tomorrow's agricultural leaders

Developing the next generation of agricultural industry leaders is the focus of a joint project between The Samuel Roberts Noble Foundation, Oklahoma State University (OSU) and the Oklahoma Agricultural Leadership Program (OALP).

Charles Rohla, Ph.D., horticultural consultant and researcher at the Noble Foundation, and Drs. William Weeks and Penny Pennington, OSU Department of Agricultural Education, Communications and Leadership, recognized a need to support agricultural leadership programs at two-year colleges. The trio became co-principal investigators on a project that received a $46,000 grant from the United States Department of Agriculture (USDA) to initiate or further fund programs at six two-year colleges in Oklahoma and Kansas.

"As each generation passes, fewer and fewer people are directly related to agriculture," Weeks said. "This distance causes a vacuum between the public and the agricultural industry. It is vital that we work to develop the next generation of agricultural leaders who can effectively communicate the successes, challenges and needs of those who dedicate their lives to feeding this country and the world."

Through the USDA grant, Rohla, Weeks and Pennington will help develop agricultural leadership courses at junior colleges serving Oklahoma college students. Additionally, they will offer mini-grants (up to $2,500 each) to the colleges to provide funding for books and curriculum in leadership. The six colleges are Connors State College, Eastern Oklahoma State College, Murray State College, Redlands Community College and Western Oklahoma State College in Oklahoma, as well as Coffeyville Community College in Kansas.

As an extension of the program, OALP alumni will serve as mentors for each college. "We're attempting to provide them a solid foundation to build upon," said Rohla, an alumni of OALP's Class 14, who will oversee the mentors program. "The funding helps with the tangible aspects of setting up and supporting an agricultural leadership program, but the greatest benefit will come from interacting with the mentors and learning from their experience and guidance."

Five Noble Foundation scientists receive funding from Oklahoma Bioenergy Center

Five scientists at the Noble Foundation received more than $750,000 in funding to conduct research on renewable energy as part of the Oklahoma Bioenergy Center (OBC), the state's first coordinated biofuels initiative.

Started in 2007, the OBC brings together Oklahoma's comprehensive higher education institutions – the University of Oklahoma (OU) and Oklahoma State University (OSU) – with the extensive plant and agricultural research of the Noble Foundation to begin a cellulosic biofuels industry within the state. Together, the OBC institutions address the entire production chain for biofuels – from growing bioenergy crops in the field through the biorefining process.

The five Noble Foundation scientists to receive state and federal funds through OBC are:

John Blanton, Ph.D., $194,647. Blanton will evaluate switchgrass in a dual purpose bioenergy and stocker cattle production system.

Fang Chen, Ph.D., $88,940. Chen will study increasing lignin content for production of biomass better suited to gasification (supplemental funds).

Rick Dixon, Ph.D., $250,000. Dixon will work on the performance of transgenic plants to improve efficiency for bioethanol processing (supplemental funds).

Maria Monteros, Ph.D., $146,480. Monteros will study the development and application of genomic tools for enhancement of drought tolerance in alfalfa (continuation of existing project).

Jagadeesh Mosali, Ph.D., $88,371. Mosali will study the effects of different winter legumes as nitrogen sources for switchgrass grown for cellulosic ethanol. Mosali will also do large-scale research on the sorghum connection to develop the Oklahoma sorghum-as-fuel industry.

Switchgrass, a native prairie grass, is being researched as a potential bioenergy crop.

Yuhui Chen, Ph.D., is one of 119 researchers at the Noble Foundation.

Noble Foundation earns top 10 ranking in national survey for academic institutions

For the second consecutive year, The Samuel Roberts Noble Foundation has ranked as one of the top 10 scientific institutions for academic faculty in the United States.

The Noble Foundation ranked No. 9 out of 94 institutions in "The Scientist" magazine's annual "Best Places to Work in Academia" survey. This year's ranking closely mirrors the Noble Foundation's ranking (No. 8 out of 70 institutions) in 2008 – the first year the organization participated in the survey.

TheScientist
BEST PLACES TO WORK 2009
ACADEMIA

"Even as these surveys draw more competition from around the country, the Noble Foundation remains at the elite level," said Michael A. Cawley, president and chief executive officer of the Noble Foundation. "The results serve as a valuable benchmark against important peer institutions and illustrate the high level of scientific and agricultural research the Noble Foundation is performing."

The magazine's Web-based survey gathered 2,355 responses from life scientists at 119 institutions worldwide. Participants were asked to rate their institutions on 38 criteria in eight different areas that make up their working conditions and environment. The Noble Foundation received top scores for research resources and management and policies.

The Noble Foundation employs 85 life scientists from more than 25 countries to perform fundamental and translational plant science research as well as applied agricultural research at the organization's facilities in Ardmore, Okla.

Cunningham family earns 2009 Leonard Wyatt Memorial Outstanding Cooperator Award

The Noble Foundation presented Jack Cunningham and Jack "Jackie" Cunningham Jr. with the 2009 Leonard Wyatt Memorial Outstanding Cooperator Award during a special presentation at the annual Southern Plains Beef Symposium.

The Leonard Wyatt Memorial Outstanding Cooperator Award is given annually to one of the more than 1,700 farmers and ranchers who work with the Noble Foundation's Agricultural Division. As part of its mission, the organization provides farmers, ranchers and other land managers – called cooperators – with consultation services and educational programs in an effort to help them achieve their financial, production, stewardship and quality-of-life goals.

Criteria for the Leonard Wyatt Memorial Outstanding Cooperator Award is based on accomplishments within the farmer's or rancher's operation, their community service and their willingness to assist other farmers and ranchers, said Billy Cook, senior vice president and Agricultural Division director.

"Jack and Jackie Cunningham have the work ethic, the know-how and the flexibility that make them great stewards of the land," said James Locke, soils and crops consultant. "The Cunningham ranch is what a true family farm is all about."

The Cunninghams moved from the Kerrville-Junction area in Texas to Springer, Okla., in August 1981. When they came to Oklahoma, they had 70 registered cows, five registered herd bulls and 31 head to sell. "We contacted the Noble Foundation in December 1981. Our biggest need was to learn how to farm and ranch in a totally different environment," Jack Cunningham said. "The Noble Foundation consultants specifically helped us focus on pasture and cropland fertilization, and weed and brush control. It made an immediate difference in our operation."

Jack and Jackie Cunningham earned recognition as outstanding cooperators.

The Noble Foundation consulting team brought the Cunninghams a wealth of information about soil and forage analysis, stocker cattle health and feeding programs, cattle marketing, pasture management and rotational grazing, as well as weed and insect management. Noble Foundation agricultural economists further assisted in developing record-keeping systems and risk management tools.

"The Noble Foundation's assistance has meant a great deal to us," Cunningham said. "We've partnered with them for almost 30 years – through the good times and the bad – and I know we wouldn't be where we are without them."

Noble Foundation virologist selected to join the American Phytopathological Society

Rick Nelson, Ph.D., a virologist at the Noble Foundation, works on virus movement and accumulation.

Rick Nelson, Ph.D., was selected as a Fellow of the American Phytopathological Society (APS), an elite honor among plant scientists. Nelson has been a virologist at the Noble Foundation for 20 years.

To be selected as an APS Fellow, candidates are anonymously nominated and then can spend up to three years in the review process. Only a handful are selected each year from the APS's membership which includes more than 2,000 scientists from more than 100 countries.

"The Noble Foundation's support of the science allows us to advance our research and achieve more results, so the recognition really goes to the organization, the people from within my laboratory and our support staff across divisions who have helped me throughout my career," Nelson said.

Addition by Subtraction

Agricultural researchers look to refine the cattle culling process and improve the bottom line for livestock producers by Katie Reim and J. Adam Calaway

There's an old adage that says "Buy low, sell high." For generations, livestock producers have ridden the ebbs and flows of the market, attempting to purchase cattle in the valleys and selling them – as best they could estimate – at the peaks.

Good markets, however, do not always align with farmers' and ranchers' yearly production models, leaving them no choice but to sell during depressed markets. Such is the case with culled cows. Culling is a process in which producers remove specific, nonproductive cows, including those that are determined to be "open" (not pregnant) and those that have exceeded their prime production years, from the herd to sell at market.

Culling is a vital management function in Oklahoma and north Texas. The Noble Foundation Agricultural Division's service area – roughly a 100-mile radius around Ardmore, Okla., stretching from Oklahoma City to Dallas – is dominated by livestock operations, supporting more than 2.8 million head of cattle. According to Noble Foundation economist Job Springer, culled cows represent between 15 and 30 percent of the income annually for regional cow-calf operations. "It is a much larger portion of their bottom line than most people realize," Springer said. "Unfortunately, producers usually cull cows during the worst markets."

Historically, producers cull cows from their herds in the fall at the time they wean spring-born calves. The substantive influx of cows saturates the market in the fall, reducing prices. "Based on these historic practices, farmers and ranchers have been resigned to conceding a significant amount of their annual revenue," Springer said. "For generations, this has been considered a cost of doing business in the cattle industry."

A new solution

In the past five years, the Noble Foundation's Agricultural Division has established a research team to provide scientifically proven answers to questions generated from farmers and ranchers who work directly with the organization's agricultural consultants.

One of the recent studies focuses on determining if cull cows can be managed in a way to add value by retaining them on the farm until there is a higher market, usually in the spring. *Adding Value to Cull Cows* is a three-year study at the Noble Foundation in partnership with Oklahoma State University's Department of Agricultural Economics.

While the study is taking place at the Noble Foundation's Oswalt Ranch, the collected data is sent to OSU economic professors and graduate students for analysis. In fact, Zakou Amadou, an OSU student, is summarizing this data as his master's degree thesis. "The research collaboration of these great institutions is beneficial to producers by allowing a larger statewide audience to be reached and, therefore, more cattlemen potentially benefit from the research findings," said Jon Biermacher, Ph.D., assistant professor and agricultural economist. "Furthermore, the graduate students whom we work with gain valuable real-world research experience."

By using alternative management systems and varying the timing the cull cows are taken to market, the producers may be able to increase net revenues for their operations. "Cull cows are typically not given much thought beyond the usual process of herd owners removing them and hauling them to auction at the time of calf weaning. The study's primary goal is to help provide producers with economically viable alternatives for their cull cows," said Billy Cook, Ph.D., senior vice president and director of the Agricultural Division at the Noble Foundation. "Many factors influence the decision on when to market cull cows. Our study may reveal the conventional practice is correct; however, we don't want to settle for the status quo if there is a better answer for our producers. The bottom line will dictate which option or combination of options is best."

The experiment, which is entering its third year, tests two management systems made up of cull cows from the Noble Foundation's spring-calving herds. One management system feeds half the cull cows on hay and supplement in dry lot confinement, while the second management system utilizes standing native forages with much less supplemental feed.

Cook pointed out an obvious caveat to the concept of "holding" cull cows. Injured, unhealthy or generally

unsound cows should be sold immediately upon culling. "There is no point in trying to keep unhealthy cows," he said. "To contribute toward profitability in the spring, cows must be healthy and in a thin to moderate body condition to give them the ability to gain a considerable amount of weight during the feeding period."

The first year of this experiment – conducted from October 2007 to November 2008 – data was collected on weight, estimated USDA grade, estimated USDA dressing percentage, cost and estimated market value during five intervals. "Retaining the cows past the typical culling date in October means the producer is going to incur added expense," Cook said. "We had to see how much it was going to cost and at what point in the process it became uneconomical to retain the cows."

One of the project's key factors centered on average daily gain (ADG). Simply put, the team evaluated whether the cows in either of the two management systems gained enough weight to justify recommending either method (dry lot versus pasture) over the current practice of selling cows when they are culled from the herd in the fall.

The initial results

The initial data suggests that holding culled cows about three months until the market rises is profitable. Many factors impact these early findings, though.

The level of profitability depends on what the cows are fed – native grass forages or low cost diets of hay and supplements – during the holding period. The study shows that ADG declined generally for both groups over the period they were retained. The forage-based cows gained less weight overall, but the spring market and the lower cost associated with feeding native forages resulted in net returns greater than would have been realized by selling open cows at the time of culling. "Cows that were on the dry lot system were not profitable for any of the feeding periods in the study," Biermacher said. "The cost of feed was higher than the value of holding them until spring and selling them at the higher seasonal price."

In addition to considering feeding protocols, the study allows researchers to better determine the time of year it is most profitable to sell cull cows.

"The data shows that for cows culled in October, net returns were positive for the cows fed native pasture and then sold at 111 days (February 12) and 134 days (March 6)," Cook said. "During the first year, the best option would have been to keep the cows on the native grass and then market them the middle of February. That does not mean this is a risk-free option. If the spring market is not as robust as the average, profitability might not be achievable in that year."

The completed study will either confirm that the current model is the most sound over the long term or it could provide a foundation for a justifiable alternative.

"I believe findings from this study will help producers across Oklahoma and north Texas with this key financial decision," Cook said. "In two years, we hope to provide producers with a new possibility for managing their cull cows, creating a knowledge resource that will help them find the right timing and management practices to sell high." ●

"In two years, we hope to provide producers with a new possibility for managing their cull cows, creating a knowledge resource that will help them find the right timing and management practices to sell high."

Billy Cook, Ph.D., senior vice president and director of the Agricultural Division

Malay Saha, Ph.D., checks data during a visit to test plots that hold new forage varieties developed using molecular markers.

Photographs by Broderick Stearns

From Mendel to Molecules

Molecular breeding program fast forwards development of new forage varieties

by Laura Beil

The 19th century friar Gregor Mendel made one of the greatest discoveries in all biology and never knew it. Before Mendel, the laws of heredity were assigned a variety of creative explanations, including one theory that each plant and animal contained its own descendants in miniature, like Russian nesting dolls.

In 1865, Mendel embarked on a now famous set of experiments. Over the next few years, he bred pea plants (he had the peas and the time), making detailed notes of various characteristics: whether stems were tall or short, whether flowers were purple or white, whether seeds were smooth or wrinkled. He discovered that the next generation inherited each trait in mathematically predictable patterns. Not until decades after Mendel's death did scientists figure out the reason – the instructions for each plant were passed down through its genes.

Scientists are still breeding plants in Mendelian fashion, selecting plants with the most desired characteristics and crossing them to improve the next generation. But Mendel and decades of plant breeders following him had to wait for a plant to grow before they knew what they had. Improving complex characteristics that involve many genes, like yield, proved frustratingly difficult. And ▶

there were logistical problems trying to enhance traits that were difficult to see and measure, such as digestibility.

Today, scientists don't need whole plants. They don't even have to wait for plants to mature. They can breed the genetic material, take a look at the genes themselves and select the best candidates for the next generation. Instead of plant breeders, they are more like gene breeders. "I was a traditional breeder originally," said Malay Saha, principal investigator of the Noble Foundation's Forage Improvement Division. "When I saw this advancement early in my career, I thought this is the future."

It is also the present. Molecular breeding is to crop improvement what the Concorde was to air travel in the mid-70s – it can get you to the same place faster and more efficiently. The technique is particularly useful for traits involving several genes – traits much more complicated than Mendel's flower color and wrinkled seeds. When trying to enhance a complex trait such as drought tolerance, "it would normally take 10 or 11 years to get to the progeny you want," said Maria Monteros, assistant professor, leader of one of the Noble Foundation's legume breeding laboratories. Even crossbreeding the best of the lot, each generation may come with a lot of clutter you don't want, along with the traits you do. "You would have to do multiple years of field testing," she said. "With molecular breeding, you can develop a better plant with the traits you want in about five to seven years."

It was, in fact, the idea of more efficient breeding in a laboratory that got her interested in the process. As an undergraduate student in Guatemala, she spent her time propagating plants the old-fashioned way, in test fields. "You would have to get up early in the morning and be out in the heat," she says. When she learned that desirable plants could be identified in a laboratory with more precision, she was sold.

Not that molecular breeding isn't difficult, meticulous work, even in air-conditioned comfort. Scientists first have to identify which genetic instructions are important to the trait – a process that can take years. Those genes are then tagged with molecular markers. Molecular markers are like road signs for the genome, allowing you to easily spot whether the plant has the gene. (In the same way an exit for Indian Nation Turnpike lets you know, even without looking at a map, you're in eastern Oklahoma.) By identifying the telltale signposts of inherited traits – usually these are distinct patterns in the building blocks of the genes – scientists can follow a plant's makeup through generations of progeny without having to see how the plants look and behave.

Take, for example, developing disease resistance. The traditional approach is to expose plants to something that causes disease, such as fungal spores. Some of the plants exposed to the fungus will die, but some will survive. If you breed only the plants that remain, the next generation has a greater ability to withstand the fungus. Then you breed the hardiest of those. And the best of the next crop. But selecting for disease resistance this way not only takes time, it can be imprecise. For one thing, you can't tell by looking at the plant if it was truly resistant or just lucky. It may have survived simply because no spores happened to find it. "Whether it escaped or whether it was resistant, you don't have any way of knowing," said Saha. "You may select a susceptible plant as resistant."

But let's say you know genes that help confer disease resistance – maybe they enable a plant to produce a certain chemical that protects it or gives it the ability to resist any damage – and you flag them with molecular markers. You don't have to expose the plants to know which ones have kept their resistance from generation to generation. The markers will tell you. Also, you can experiment with many more plants in a batch. "In three months, you can evaluate 1,000 plants," Saha said.

Maria Monteros, Ph.D., examines white clover being studied in the Noble Foundation's greenhouse facility.

"It would normally take 10 or 11 years to get to the progeny you want. ... With molecular breeding, you can develop a better plant with the traits you want in about five to seven years."

Maria Monteros, Ph.D., assistant professor

Once the genes become concentrated in a particular generation, you can then grow them the old-fashioned way for testing. "Molecular breeding does not override traditional breeding," Saha said. "It's a tool to facilitate the breeding process."

"Molecular breeding can better concentrate the quality you're looking for," said Stephen Moose of the University of Illinois, Urbana-Champaign. "It doesn't always speed things up," he said, "but you can achieve more progress in the same amount of time. The end result can be more dramatic." Molecular breeding has already assisted the development of soybean varieties that are resistant to certain diseases and corn plants that are able to grow with less thirst for water.

Scientists in Monteros' group at the Noble Foundation are using molecular breeding to try to improve traits that involve multiple genes, including biomass production under drought conditions and the ability to grow in soils with aluminum toxicity problems. The identification of markers – identifying the signposts – can be the first and most labor intensive step in molecular breeding. Recently, Monteros' group has made significant progress in identifying markers with the potential to enhance biomass yield in alfalfa under limited water availability. "Alfalfa plays a significant role in the agricultural industry, contributing more than $9 billion to the national economy each year," Monteros said. "Increased biomass, especially with limited water, could have a substantial impact on an already valuable crop."

Among other projects, Saha's laboratory is trying to identify genes that make tall fescue more digestible to livestock. "Digestibility has a really huge impact on animal gain," Saha said. "If we can increase digestibility by 1 percent, it leads to a 3.2 percent increase in daily life weight gain." Through molecular breeding, he has developed three new varieties of tall fescue that are now undergoing field tests.

More projects are underway, at Noble and elsewhere. Eventually, molecular breeding will become the standard for plant improvement efforts, Monteros predicts. "With molecular tools, you can make breeding more efficient and faster," she said. "We're still using the principles of Mendel, but in a modern way."

Building on Experience

Mary Sue Butler Clyne brings unique experiences to nonresident fellows program

by J. Adam Calaway

Mary Sue Butler Clyne spent three decades skipping rungs on the way to the top of the IBM corporate ladder. Her steely resolve and knack for problem solving made her a dream employee. Her affinity for *all* people made her a natural leader and a customer favorite.

She quickly became a company utility player, a fixer, a go-anywhere-and-succeed leader. IBM sent her into underperforming business units, and she consistently turned them into top performing teams They provided her resources, authority and a goal, and she built bridges into unexplored markets.

Through it all, Clyne had only one career constant – change. It became her hallmark, her badge of honor. She helped change a company's culture. She helped change minds about women and working mothers in upper management. And she certainly changed locations. But spend five minutes with her today, and it's easy to see that retirement has not changed her. "I'm the same woman I've always been," she said, flashing a quick smile and running her hands through her auburn hair. "I just have more flexibility in how I spend my time and energy now."

Indeed, retirement has afforded Clyne the opportunity to use her unique business and interpersonal skills to serve others. When she retired, she formed a consulting business focused on assisting nonprofits in developing their business strategy and operational plans.

When her good friend Karen Hughes, once a special counselor to President George W. Bush, founded a ministry to help educate Afghani women and children, Clyne was asked to be a board member. The ministry's work funded the construction of two schools in northern Afghanistan, as well as provided for teacher training to increase qualified female teachers.

"Organizations are made up of individuals who want to be successful," Clyne said. "The key is finding how to galvanize all the unique personalities and abilities into a productive team that advances the institution's mission."

The 57-year-old has now brought her talents to the Noble Foundation, signing on last year as a nonresident fellow (NRF, see sidebar) for the Agricultural Division, a group that was nearing its own significant change. (Billy Cook, Ph.D., would become division director for the retiring Wadell Altom just months after Clyne signed on as a NRF).

"We were looking for an intelligent, insightful individual with the ability to approach our entire platform of services – from research to consultation – with a completely fresh perspective," said Cook, senior vice president and director of the Agricultural Division. "We wanted someone with real-world marketing experience and the knowledge to help us enhance our division's impact. Mary Sue was a perfect fit."

What is a NRF?

The nonresident fellows (NRFs) program brings together an exceptional group of scientists, researchers and industry leaders from around the country to perform a candid review of the programs within each of the Noble Foundation's three operating divisions.

"It is easy to be lulled into complacency when you experience success; everything is going well, and you simply become content with the status quo," said Michael A. Cawley, president and chief executive officer. "The NRFs help maintain our momentum and set even higher standards to reach. They offer objective advice and insight while providing counsel to our scientists, agricultural consultants and the Board of Trustees."

A career in motion

Clyne's expertise was not so much learned, but forged through the fire of personal experience. She graduated from Oklahoma State University in 1974 with a bachelor's degree in marketing. Spurred by her father, she immedi-

Photographs by Broderick Stearns

ately went to work for IBM as a systems engineer in Tulsa. She worked with a sales representative to understand a client's business environment and challenges. "I was the technical conscience of the team," she said. "I was responsible for the successful implementation of the solution. This job taught me the value of building strong business relationships based upon trust and confidence in delivering what was promised."

Clyne knew that being a systems engineer was a temporary stop on the way to the sales superhighway. Her superiors were not so sure as all sales reps at the time were men. In the early 1970s, women flooded the workplace, and the culture shock was still reverberating. Undeterred, Clyne "earned her spurs" and soon moved into sales. "I was a pioneer for the Tulsa branch office," she says. "I dealt with large oil and natural gas companies, which put me in with the big boys. I was an anomaly, which I always thought was an advantage. I knew I was under the magnifying glass, so I over-prepared. When you prepare, and you do a good job, it will be noticed."

By 1980, Clyne's work and potential had been recognized. She was offered a promotion to the regional staff in St. Louis. Instead of relocating for this two- to three-year assignment, she asked IBM to allow her to be based out of Tulsa. It was a successful experiment, and IBM began changing its policy of requiring employees to continually relocate to advance their careers. It was during this year-and-a-half assignment that she married. The pair eventually moved to Kansas City where she earned two new titles: marketing manager and mom as her daughter, Mary Beth, joined the family.

The next three years saw three more promotions and three more moves. Clyne helped build and lead a new independent business unit that focused on increasing IBM's market share in top research universities across the United States. A return to Oklahoma brought her oversight of IBM's sales and support of all public sector clients across the state. More importantly, Clyne's son, John, was born. Soon the family of four was headed to White Plains, N Y., where Mary Sue reported directly to the division president for 10 months.

The constant willingness to move paid dividends as Clyne was awarded a senior management position in Austin. "I wanted to get the moves behind us so we could settle in and provide our children some continuity growing up," Clyne said. "My daughter was 4½ years old, and we had lived in four different states, but we remained in Austin until she graduated." While she was in the Lone Star State, Clyne and her husband divorced, but Clyne once again adapted, finding harmony between work and children. She recalls her time in Austin not from a work perspective, but as a mother. "Austin will always be where I raised my family and watched them grow into adults," she said. "I coached their youth athletics, and later I cheered them on from the stands. I am their biggest fan. Even though they are grown, they are the center of my world."

While Clyne's home became stationary in Austin, her position within the company did not. She continued to rise within the organization, finally landing as global director in IBM's Global Services Division. Her international travel was extensive as she hopped from Paris and London to Singapore and Tokyo. At each stop, she brought people together from around the world to work through cultural barriers and become a highly functioning team. "It was like getting OU and OSU fans to work together the week before Bedlam," she says. "We worked through everything from cultural barriers to tangible aspects – like international labor law. Every project brought its own unique challenges. It was a lot of fun."

Mary Sue Butler Clyne meets with other Agricultural Division nonresident fellows.

"I realized my adult life had been focused on the pursuit of success, and I wanted the second half of my life to be focused on significance."

Mary Sue Butler Clyne, nonresident fellow for the Agricultural Division

Clyne retired in 2004 after three decades. "Many people asked why I retired at the height of my career," she said. "I realized my adult life had been focused on the pursuit of success, and I wanted the second half of my life to be focused on significance. I didn't know exactly how to get to significance, but began by forming my consulting company to assist nonprofits."

From Stillwater with love

On a sunny spring day soon after she retired, she traveled to her alma mater for a campus visit with her college-bound son. The stop in Stillwater would change her life.

During the visit, Clyne looked up a friend, Kirk Jewell, who had become CEO of the Oklahoma State University Foundation (OSUF). During their conversation, Jewell expressed an interest in Clyne consulting with the foundation during the annual fund process.

Jewell introduced Clyne to his new vice president of development, Bob Clyne, a retired AT&T executive, who asked her to provide recommendations to improve the annual fund process. OSUF implemented her recommendations, and the annual fund set records in the first two years. After her consulting engagement, Bob and Mary Sue became a matched set and soon married. Today, they spend their time doting on their four grown children, traveling and providing consultation in their specific areas of expertise to nonprofit organizations.

Mary Sue's success with the OSUF also caught the attention of one of its trustees, Dennis White, Ph.D., who happens to serve as a nonresident fellow for the Noble Foundation. White suggested Clyne to the management team. After a few phone interviews and a campus visit, she was quickly asked to be a NRF. In the last year and a half, Clyne and the division's other NRFs have provided insight and guidance as the division continues to foster its agricultural research group, alter its no-cost consultation services to meet the changing clientele and expand its educational and outreach efforts. "You could not ask for a better team of NRFs," Cook said. "We've brought together agricultural experts and complemented their capabilities with Mary Sue's skills in marketing and organizational change. It has been highly productive, and Mary Sue has played an instrumental role. The Noble Foundation's Agricultural Division is stronger because of her."

As for Clyne, the Noble Foundation has become a passion. "This is an amazing organization and an amazing resource for farmers and ranchers," she said. "Change is inevitable but this organization remains true to its mission and the vision of its founder while embracing the possibilities of tomorrow."

EXPLORING THE WORLD OF VIRUSES

For two decades, the Noble Foundation has pioneered plant virus research, seeking to better understand these often feared forces of nature.

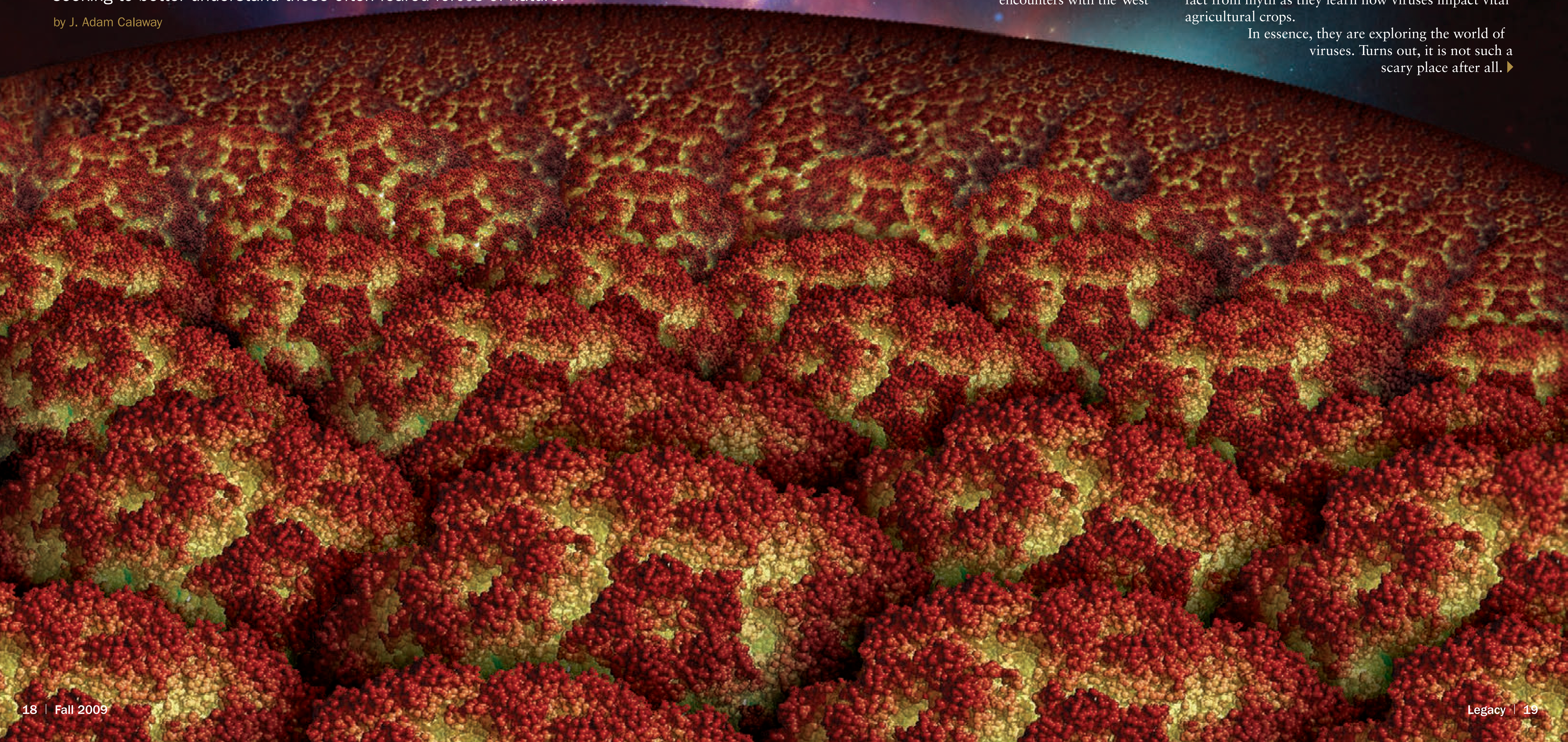
by J. Adam Calaway

Any story about virus research has to begin with one simple truism: not all viruses are bad.

It's a tough sell, though. Most people react negatively to the thought of viruses because they've never heard of or experienced a virus in a positive way. The only time a virus truly captures society's attention is when it is wreaking havoc on the human population. In fact, the movement of viruses has become a focal point of fascination and fear, driven by instant accessibility to global news. Even before the H1N1 "swine flu" virus began rooting around in the world's daily headlines, the last decade had brought the world unwelcome encounters with the West Nile virus and avian flu. So in society's collective consciousness, viruses are bad.

Drs. Marilyn Roossinck and Rick Nelson know that viruses defy such a simple label. As virologists and principal investigators at the Noble Foundation, they have indeed seen firsthand how viruses can systematically break down an organism. They've also witnessed how viruses can promote life instead of taking it. Most of all, they know the key to combating viruses is in understanding them. Through the past two decades, Roossinck and Nelson have pioneered specific fields of virus research, unraveling the complex processes of how viruses evolve and move. They are distinguishing fact from myth as they learn how viruses impact vital agricultural crops.

In essence, they are exploring the world of viruses. Turns out, it is not such a scary place after all. ▸



Rick Nelson: Virus movement and accumulation

Rick Nelson has spent a career chasing viruses through plants. By understanding how plant RNA viruses move and accumulate, he hopes to mitigate their influence on agriculture. "You can stop disease caused by viruses in three ways," Nelson said. "You can prevent viruses from replicating in the first cell they encounter. You can stop them from moving cell to cell and into other parts of the plant. Or you can mitigate disease symptoms after virus movement and accumulation."

In more than 25 years of research, Nelson has investigated all three phases of virus control. After earning a doctorate in biology from the University of Illinois, Nelson took a postdoctoral fellowship with acclaimed scientist Roger Beachy at Washington University in St. Louis (Beachy was recently appointed as the first director of the National Institute of Food and Agriculture). It was 1985 and research directed toward the production of transgenic plants – the procedure by which genetic information from an organism is inserted and expressed in plants – was just beginning.

Beachy's group cloned a small piece of a virus gene and inserted it into the plant genome. They theorized that the plant would become resistant to the virus, somewhat similar to injecting a human with a viral vaccine. The experiment led to one of the earliest plant transformations in the United States and the first demonstration of transgenically derived virus resistance in plants. "It was like science fiction," Nelson said. "No one had ever done this before. No one had taken a viral gene, put it into a plant and shown its potential for practical usefulness in such a striking way."

The transformation led to another historic event – the first field test of virus-resistant plants. In 1987, Beachy's group collaborated with researchers from Monsanto to grow virus-resistant tomatoes along with tomatoes Monsanto had modified to be Roundup Ready- and caterpillar-resistant (two other technologies that are commercially available today). "We had extraordinary resistance to viruses in the field, but later aspects of this work have been frustrating," Nelson said. "We can produce virus-resistant plants in almost all crops using this and related transgenic technologies developed 20 years ago, but we have yet to take full advantage of this technology because of public resistance to transgenic plants."

Less than a year later, Nelson joined the Noble Foundation, which had initiated its fundamental plant research a few months prior with the founding of the Plant Biology Division. He continued to build on his postdoctoral work, using a strain of tobacco mosaic virus (TMV) that exhibited mild symptoms in infected plants. TMV is a particularly devastating pathogenic virus so Nelson's initial question was simple: Why is this strain of TMV milder? Ten years later, he found his answer.

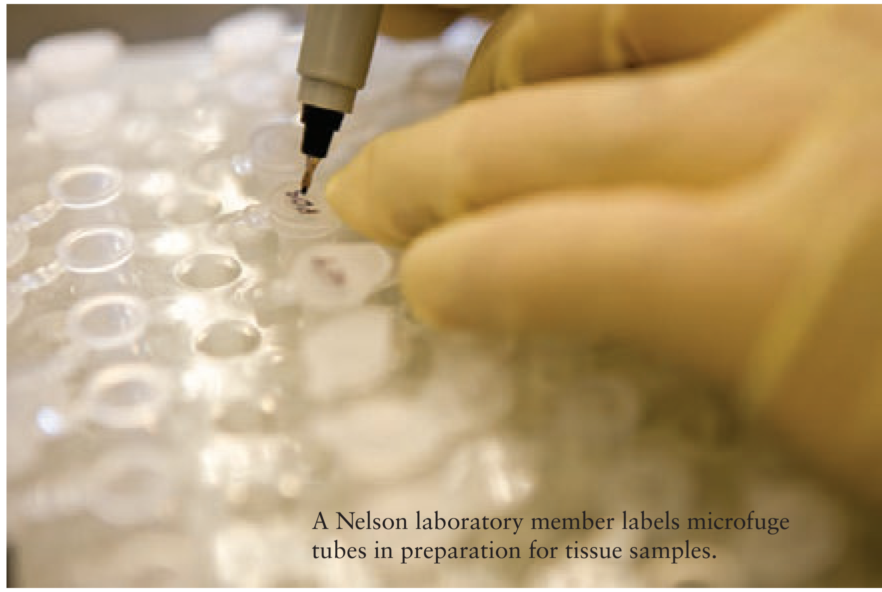
Nelson discovered this particular TMV strain possessed 50 substitutions in its 6,400-nucleotide building blocks (molecules that when joined together form DNA or RNA), any one of which could cause the mild effects. Nelson's group took a piece of the mild strain and put it into a severe strain of TMV and vice versa, and observed the disease produced by these chimerical viruses.

The goal was to identify the gene responsible for the mild symptoms. After almost a decade of moving genetic material back and forth, and characterizing the activities of the different viral proteins, they pinpointed a gene that encoded a key protein responsible for moderating the disease symptoms. All plants have a defense system – called an RNA silencing system – that protects them against viruses. It turns out Nelson's protein was responsible for defeating this defense system. In the mild strain of TMV, this protein was naturally defective, resulting in milder disease symptoms since it could not defeat the RNA silencing system. The knowledge gained revealed how other TMV strains operated to damage their plant hosts. "To understand how to inhibit the virus, we had to understand the function of this particular protein," Nelson said. "It was clearly a marker for disease."

The protein became the focal point of Nelson's research while also paving the way for a unique way of studying gene function.

Rick Nelson, Ph.D., discusses *Chenopodium amaranticolor* with Hema Rammana, a postdoctoral fellow. *Chenopodium* often serves as a virus lesion host.

Photographs by Broderick Stearns



A Nelson laboratory member labels microfuge tubes in preparation for tissue samples.

Walk the line

While Nelson's laboratory was identifying this specific TMV protein as a marker for disease, another research group in Japan determined the protein played a role in virus movement between cells. Nelson furthered this concept by verifying the mechanism by which this protein could modulate movement.

Viruses do not have cells of their own so they require a host cell for their replication and movement. They literally must overpower the plant's RNA defense system, all the while accumulating and moving their "virus replication complexes" – usually composed of a ball of RNA and proteins – through the cell. As viruses move cell to cell, they repeat the process thousands of times.

Nelson's group helped determine that many viruses move through the cell on a road made up of protein (actin) building blocks (like bricks that together form a

"It was like science fiction. No one had ever done this before. No one had taken a viral gene, put it into a plant and shown its potential for practical usefulness in such a striking way."

Rick Nelson, Ph.D., professor

“Virus-induced gene silencing has advanced the study of gene function light years. ... This, in turn, opens up endless possibilities for plant improvement – a key to sustaining agriculture in the coming generations.”

Richard Dixon, Ph.D., senior vice president and director of the Plant Biology Division

road). As it turned out, the TMV protein (the 126 kDa protein) which was responsible for modulating disease also attached to the actin road.

In addition, Nelson’s group determined that a plant protein called myosin, was also required for moving virus replication complexes in the cell. Myosin is the protein that connects the virus replication complex to the actin “road” (microfilament). It is attached to the complex and walks it along the microfilament to the other side of the cell like a child walking on a sidewalk holding a balloon.

Nelson recently determined that a specific myosin (of the 17 known plant myosins) is responsible for moving TMV through the cells in the model plant *Nicotiana benthamiana*. Additionally, he learned this particular myosin did not assist other viruses. “This tells us that different viruses use different myosins to move across the cell, something like using different brands of cars to travel on highways,” Nelson said. “If you can identify the specific myosin the virus requires for movement and control its presence, you should be able to keep that virus from spreading.”

Nelson is now looking at two other steps in the process. Once a virus moves across a cell, there is a complex series of chemical interactions that takes place to allow the virus to leave the cell. “It’s as though the virus is paying a toll to get out,” Nelson said. “We are investigating if we can prevent it from arriving at or getting through this toll gate, which would prevent it from exiting the cell and spreading through the plant.”

The group is also exploring the content of the virus replication complex, hoping that its makeup reveals another way of halting virus movement. “By understanding how viruses interact with their host, move and accumulate, we can begin to design ways to make plants resistant to viral infections,” he said. “These processes could be combined with other proven strategies to create a potentially impenetrable barrier to viral infection.”

Silence of the genes

A serendipitous outcome of Nelson’s work with the 126 kDa protein was that it could be used to improve a method to study gene function. Called “virus-induced gene silencing” (VIGS), Nelson’s group takes a portion of a gene of interest and inserts it into a virus. The virus will then replicate and accumulate it. The researcher then puts the gene fragment back into the plant by inoculating the plant with the virus. The plant’s defenses respond and destroy the virus, but in the process the plant is tricked into “knocking down” or destroying the function of the gene whose fragment was present in the virus.

Researchers can then see what function the target gene controlled. “Maybe the plant’s flower turns from purple to white,” Nelson said. “In that case, the target gene was necessary for pigment production.”

The expression of the 126 kDa protein at low levels actually enhances VIGS. Thus the study of a single viral protein has resulted in multiple findings, helping to define how viruses accumulate through the control of plant defense systems, move within the plant and alter host gene expression.

Currently, the Nelson laboratory is working on a project for the Department of Energy involving ethanol production from cellulosic material such as switchgrass. Scientists are interested in modifying plant cell walls to improve access to sugars for fermentation to ethanol. Many candidate genes have been suggested to be involved in plant cell wall formation, but most have yet to be functionally characterized, and doing this by traditional transformation methods will take many years. “Virus-induced gene silencing has advanced the study of gene function light years,” said Richard Dixon, senior vice president and director of the Plant Biology Division. “It provides a rapid method for understanding gene function, which is one of the most vital branches of plant science research today. This, in turn, opens up endless possibilities for plant improvement – a key to sustaining agriculture in the coming generations.”

Marilyn Roossinck, Ph.D., peers into a growth chamber to examine tomato plants.

Marilyn Roossinck: Virus evolution and biodiversity

Marilyn Roossinck admires viruses on many levels.

As a scientist, she marvels at their influence on the planet: “The human genome has about 3 billion nucleotides, and viruses have as few as 3,000,” she said, “but they can have an overwhelming impact on our lives and environment.”

As a co-inhabitant of this diverse global population, she appreciates their ability to survive and adapt. “We think of evolution over the course of hundreds or thousands of years,” she said. “Viruses can evolve in a few weeks, making them extremely adaptable.”

And to Marilyn, who once was a little girl awestruck by all things science, they’re just plain cool. “What can I say? They’re fascinating. They’ve always fascinated me,” she said. “They have very little genetic material, and yet they do these dramatic things.”

Roossinck has dedicated more than 25 years to understanding viruses in a way that many researchers cannot even conceive – as beneficial organisms. Her research seeks to know how and why viruses evolve, which requires her to move past preconceived stereotypes and accept the possibility that viruses may do more good than harm. It's a unique vantage point even among her fellow virologists. "Most virology research is inherently biased because we only focus on viruses that cause disease in humans and their domestic plants and animals," she said. "We're unlikely to control virus diseases until we understand why normally benign or beneficial viruses evolve to cause disease."

Also unlike her peers, Roossinck studies viruses from a variety of platforms that span from the evolution of RNA plant viruses to assessing the biodiversity and ecology of wild plant and fungal viruses. This provides her a universal and historic view of viruses.

The ever-evolving virus

Roossinck's research begins with virus evolution. To understand virus evolution, one must first understand virus behavior. "The only goal of a virus is to replicate itself," she said. "But they are sloppy replicators. They make mistakes, and that's how they mutate."

When Roossinck came to the Noble Foundation in 1989, she began measuring the frequency of the mutation. The group discovered that the diversity of the virus population was different among closely related viruses in different host plants. Roossinck's laboratory built from this initial research and began studying bottlenecks – random events that drastically reduce the size of a population – seeking to understand why the populations were so different in different plants.

Bottlenecks affect an organism's ability to naturally adapt to new environments because they reduce the mutants in the population that might have an advantage in a new environment.

To demonstrate that bottlenecks impact virus evolution, her group infected a plant with a virus population that could be traced and showed that the number of mutant variations was reduced by half as it moved through the plant. Additionally, moving the virus from one plant to another using an aphid reduced the number of mutants by about two-thirds. A natural effect of these bottlenecks is a slow change called genetic drift; however, viruses do not experience this process because they regenerate a whole new spectrum of mutants so rapidly that such changes are never detected.

"If viruses didn't have such a rapid evolution rate, there might be a way to counteract them when they go through a bottleneck," she said. "However, we discovered that a virus so easily generates a huge variant population that the bottlenecks barely slow it down."

To inoculate a tomato plant with a virus, scientists put a grit on the leaves, then add a suspension of the virus and rub the leaves with the frosted end of a microscope slide. This breaks open the walls of a few plant cells and allows the virus to enter the plant and start the infection process.

"There's never been a broad-based virus biodiversity study that looked at the virus in the context of the host. Until ours."

Marilyn Roossinck, Ph.D., professor

Today the laboratory is still working to understand why viruses have different population structures (i.e., the diversity of mutants). The group is using two strains of cucumber mosaic virus (CMV), one that has low diversity and another strain that has high diversity, and recombining each of their three genes into six new varieties. "We're mapping which gene of this particular virus is responsible for low or high population diversity," she said. "If we can pinpoint the gene, we get a better understanding of how the virus controls population diversity."

Expanding on her research, Roossinck has aggressively conducted a biodiversity study that examines viruses in the context of their hosts.

Home on the range and Costa Rica

Most virus biodiversity studies so far have begun with researchers collecting viruses from – of all places – seawater. They filter the water until they are left with only viruses and then decipher the type of virus they've uncovered (usually bacterial viruses) by determining the genetic sequence of the entire sample.

"To someone interested in ecology and evolution, this is not a very satisfactory study because they do not tie the virus to a specific host," Roossinck said. "There's never been a broad-based virus biodiversity study that looked at the virus in the context of the host." She paused. "Until ours."

Roossinck's group at the Noble Foundation, along with her other laboratory in Costa Rica, has inventoried thousands of plant viruses, sampling them in their natural ecosystems. In Oklahoma, they conducted a biodiversity study of the Tallgrass Prairie Preserve, randomly collecting almost 1,300 plants that had no evidence of disease. Of those plants, nearly 40 percent had detectable viruses.

The findings were more astounding in Costa Rica. More than 5,000 samples have been assessed in four different ecosystems, and nearly 70 percent of plants show detectable viruses, but no disease symptoms. "This supports the idea that the majority of viruses are not disease-causing viruses," Roossinck said. "In fact, there's significant evidence to suggest many viruses benefit their hosts." While her group demonstrated in a laboratory setting that a virus (tobacco rattle virus) can benefit a plant (in this case by imparting drought resistance), Roossinck and several of her colleagues unearthed a historic mutualistic relationship occurring naturally in the wild.

In 2002, Roossinck was searching for a different population structure for virus evolution research, and fungal viruses were an obvious next step. Fungal viruses are persistent and do not spread from host to host like the acute plant viruses she typically studies.

She contacted Drs. Regina Redman, Rusty Rodriguez and Joan Henson, who had recently concluded a study involving panic grass in Yellowstone National Park. The group had discovered a microscopic fungus within the panic grass that was enabling it to survive in the geothermal soils where temperatures were much too high for most plants. Roossinck asked to examine the fungi isolated from harvested plant material. Soon she found what she was looking for – a virus living within the fungi.

"To my surprise, I found the virus was only in the fungus isolated from the geothermal plants and not in the same fungus species from other areas that were not geothermal," she explained.

To see if the virus contributed to the plant-fungus relationship, Roossinck had to "cure" the fungus of the virus and examine whether the plant changed due to the absence of the virus. Collectively, the research team attempted a variety of experiments to remove the virus, but nothing worked at first. "It was serendipitous, really," Roossinck said. "I was freezing a sample to do another experiment. When we thawed the sample and began work, we realized the virus was gone."

She began comparing plants having the fungus and the virus with plants having only the virus-free fungus. Roossinck discovered that the plant could not tolerate elevated soil temperatures, such as those found in Yellowstone, without both the fungus and the virus. "The plant, the fungus and the virus formed a mutualistic relationship that benefited all three entities," she said. "This clearly demonstrates how viruses can benefit their hosts."

Research on how viruses and fungi assist plants in environmentally challenging circumstances could yield new crops having valuable, naturally induced traits including enhanced heat, drought or salt tolerances.

"With climate shifts, population explosion and depleted soil conditions, agricultural crops are going to have to survive in more extreme environments," Roossinck said. "Knowing how plants naturally do this will be important to sustaining agriculture. It's clear that viruses are going to play a key role in this process."

Because not all viruses are bad.

Photograph by Broderick Stearns

Patrick Zhao

by Arthur Dixon

The work of Patrick Zhao, Ph.D., has always been about keeping things on track. Before his time at the Noble Foundation, he was a central player in the creation of computer networks that governed the pattern of trains moving along China's complex railroads. These days, the patterns he works with are more botanical than mechanical as he punches numbers and manipulates genetic data as the head of his bioinformatics laboratory. Zhao has come a long way from working on the railroad, but he has never lost touch with his affection for technology or his knack for numbers. In a personal interview, Zhao discussed the shifts, diversions and inspirations of his life's twisting track.

On the railroad

I was born in a small town near Shanghai called Huashi, and I studied electrical engineering at Tongji University in Shanghai. After graduating with a master's degree, I was hired by a company that supported China's railroad network. I worked with other engineers to create a computer dispatch system which would time the trains and keep them flowing smoothly. This was a complex system that involved mathematics, graphical models and a lot of data.

On transitioning to biology

In 1993, my father suffered from a stroke that nearly killed him. That inspired me to return to the university and pursue a doctorate degree in information science so I could learn to use my skills for medical purposes. After years of studying at Shanghai Jiaotong University and months of medical informatics-related work in China, I was invited by a professor to move with her laboratory to the University of Louisville in Kentucky. I spent four years there, working on microarray technology for age-related diseases. When the opportunity to work in bioinformatics at the Noble Foundation came up, I decided to make a move. I made that decision largely because the Foundation is devoted to benefiting mankind, allowing me to apply my skills to help people.

On bioinformatics

Informatics empowers people to transfer raw data into knowledge, and then, perhaps, to wisdom. I enjoy my current work in bioinformatics, which is the use of computer science and mathematics to model and analyze biological systems. It is a relatively new field with an abundance of new technology, which I like, and it gives me the opportunity to manipulate large-scale data sets. Also, it supports other scientists and makes their work easier.

On coincidental similarities

In a way, my work with railways was similar to my current biological work. Just as our computers controlled the flow of trains along the railroads, biological operators control the flow of chemicals and proteins in living organisms. The graphs and statistics we worked with for the railroads were similar to the data analysis I do now at the Noble Foundation. Although I work in a very different field now than I used to, certain elements of my work seem to have remained constant.

On his affection for technology

Bioinformatics is a field that requires a lot of technology and computing, and that is something I enjoy about it. I've always been interested in how things work and how all their components fit together. As a child, I would take apart my father's watches and then try to put them back together; but, of course, I was rarely successful. I also liked to build radios, computers and other electronic devices, and I enjoyed playing computer games.

On his inspiration

I am passionate about my family. I have a young son and a baby girl, and when I am not working, I am with my children. We play together and I read to them. My wife and my children are what inspire me.

Photographs by Broderick Stearns

The Road Less Traveled

Million Tadege rose from abject poverty to acclaimed scientist, walking a path through life that few could even imagine by J. Adam Calaway

It's 3 a.m. and a waifish 14-year-old Ethiopian boy walks down a barely noticeable dirt path on the high plateau of his native country. He will travel 20 miles alone in the dark, guided only by his memory. The crisp bite of the nighttime air and the clamor of unseen dangers in the darkness will swirl around him, but he will walk on.

He will feel every step of this journey. His bare feet serve as stark reminders that poverty is a price he pays in small ways. The morning frost will sting his cracked soles, but soon the sun will rise. The land will swelter and the stones will sear what was already broken. Years will pass and the grit of the Earth will callous his feet, but never his heart, and he will walk on.

Every step will bring him closer to a makeshift school, the only path to a different tomorrow. Every step will draw him toward a future he craves, but has yet to fully envision. Every step will find hope as his only true companion and so he will walk on.

Three decades later, Million Tadege is still walking, but today he sees where the path has taken him.

The price of education

Tadege, now 43 and wearing sneakers, has slid into a high-backed chair in the Noble Foundation library. This Friday in late August is his final day as a research scientist at the Noble Foundation. In the midst of finalizing his research and saying his many goodbyes, he sat down to share his story. "They say to truly understand a man, you have to walk a mile in his shoes," said Tadege as he settled into his chair. "But what if that man had no shoes?" He smiled, then started at the beginning, the very beginning.

Three millennia ago, the land that is now Ethiopia stood at the center of the ancient world. The Queen of Sheba ruled, and her domain flourished. By the time Tadege was born in 1966, poverty had replaced prosperity. Tadege's parents were peasant farmers. They were poor, but owned enough land to provide for the family and employ helpers. At 6 years old, Tadege was already tending cattle and sheep, dreaming of his 8th birthday and the gift of education. In December 1973, Tadege launched into his eagerly anticipated schooling. Two months later, a military junta ousted Emperor Haile Selassie in the name of socialist revolution. The people rejoiced until the government began confiscating the land. His family lost virtually everything.

Two months later, Tadege's mother died. "The mother plays a significant role in the life of an Ethiopian child, providing almost all care," he said. "I knew right then I was alone." Tadege immersed himself in school. He finished six years of primary education in just four, receiving the school's highest grades.

He prepared to advance to middle school, but his father grew weary of his obsession with education. Farming came first. So he gave Tadege a choice: leave school and help farm or leave the house. "Traditional farming was too tough for a 12-year-old boy. It was beyond my ability. No child in my village took plowing responsibility before the age of 15," he said. "I decided to continue my education although I had nowhere to go."

Tadege began secondary school, homeless and orphaned. His teacher, Lulseged Demisse, saw the weary child and showed him compassion. Demisse took in Tadege and six other students. He fed, clothed and taught them, giving literally everything he had to keep them alive. It was an oasis of reprieve in a young life blistered by the deserts of life. "If he had not helped me, I might have resorted to …," Tadege's voice trailed off. "I know that he changed my life."

During these formative years, the analytical child became a Christian, viewing God as an anchor in his turbulent life. "It became clear to me God would never leave me," he said. "I reasoned out that He wouldn't start me down this path if He wasn't going to see me through."

Just as soon as he found faith and friendship, though, Tadege would be alone again. He finalized his secondary school – again with the highest grades – and returned home to his father, who was now ill, to broker a deal. He would work on the weekends and peak harvest times, but he must continue his education. With the high school 20 miles away, Tadege would make an arduous journey twice a week. "My father was not convinced this could be done," Tadege said. "I knew I could do it."

Million Tadege studies the model legume *Medicago truncatula*. Tadege helped develop the *Tnt1* resource which is used by scientists from around the world.

Beginning when he was 14 years old, Tadege rose at 3 a.m. every Monday and walked through the darkness to attend school. "I had no fear, no hesitation whatsoever," he said. "I was rather happy because I felt empowered."

The weekly trip was far from his only hardship. The school had no electricity, so he could not study at night. He slept on a bare floor with only a cow skin as covering, and most days he had an empty stomach.

On every walk from the farm, Tadege took a hefty bag of wheat grain, almost more than he could carry. He sold a portion of the grain to buy wood to make a fire so he could cook, but the food supply was usually exhausted by Wednesday evening. He sometimes combed a small wooded area to find leaves and twigs so he could keep all of the grain. It was a disgusting task considering that these woods were also the school's outhouse. Tadege traveled home each Friday, having not eaten in almost two days. He'd eat and then work until late Sunday evening. He repeated the cycle every week for four years.

The journey was only beginning

Tadege walked almost 7,000 miles during his high school career, but he realized as he took the Ethiopian Schools Leaving Certificate Examination (ESLCE) that his journey was just beginning. Tadege scored one of the highest grades in the country and earned an opportunity for higher education.

University was paradise. Beyond the endless supply of knowledge, the government paid for food and lodging. "For the first time in my life, I didn't have to worry about preparing my own meals, so I could study as long as I wanted," he said. "I also bought my first pair of real shoes." Tadege graduated with honors after four years and became a lecturer (similar to adjunct faculty in the United States).

Most university lecturers received additional training until they earned a terminal degree. Tadege yearned to study molecular biology, but Ethiopia did not possess the proper facilities. Customarily, he would have received a scholarship to an international institution. However, Ethiopia had undergone several political transformations under the regime that gained power when Tadege was a boy. During his college years, the administration operated under the Communist Party banner. When Tadege refused to join the party, he lost several opportunities to travel abroad. "They were inhuman. They were killers," he said. "They killed innocent and educated people. It was a terrible time."

Tadege was stuck. For four years he worked and waited. The only ray of sunshine came from the bright smile of a beauty named Yetemwork Estifanos. The pair met through Yetem's sister, who also worked at the university. They became friends and soon fell in love.

At the end of his fourth year as a lecturer, the Communist Party collapsed and the power shift once again left the country's political landscape in ruins, but it opened a window of opportunity. Tadege received a scholarship from the University of Wageningen in the Netherlands and fled his native country to pursue his education. "At this hectic moment of transition, and, by God's miracle, I got out," he said. "If the overthrow had come a year later, I would not have been allowed to take the scholarship, and I would not have been able to leave."

Living among the Dutch, Tadege earned his master's degree in biotechnology in two years and secured another scholarship to begin work on a doctoral degree in plant molecular biology at the University of Bern in Switzerland. Soon after he began, Tadege returned to Ethiopia and married Yetem. The couple began their new life nestled in the shadow of the Alps. Tadege finished his doctoral degree in a breakneck three years, finding time to work and visit Europe's most notable research institutions, including the University of Ghent in Belgium, Max Planck Institute in Germany, the Pasteur Institute in France and University of Cambridge in the United Kingdom. He also served as a postdoctoral fellow at the University of Bern before winning the highly competitive Swiss National Science Foundation Prospective Scientist Award, which allowed him to select his next career move. He took a postdoctoral fellowship at Australia's acclaimed Commonwealth Scientific and Industrial Research Organization (CSIRO) in September 1999.

"For the first time in my life, I didn't have to worry about preparing my own meals, so I could study as long as I wanted. I also bought my first pair of real shoes."

Million Tadege, Ph.D., assistant professor
Plant and Soil Sciences Department, Oklahoma State University

Four years slipped by and the couple, who had welcomed daughter Lucy to the family, dreamed of finding a new home in the United States. Familiar with the Noble Foundation's research in plant science, Tadege applied for his third fellowship. In 2003, he began a six-year stint in Ardmore, Okla., that would once again redirect his life while providing scientists with an amazing new resource.

The next step

Tadege joined Principal Investigator Kiran Mysore's laboratory and began work on developing a new genetic resource in *Medicago truncatula*. Since the 1990s, the Noble Foundation has led an international effort to study *Medicago* as a model legume in hopes of applying its research to agriculturally significant crops such as alfalfa. In collaboration with Dr. Pascal Ratet at Centre National de la Recherche Scientifique in France and with financial support from the Noble Foundation and the National Science Foundation, Mysore and Tadege conducted a large-scale project in which they transferred *Tnt1*, a retrotransposon (a piece of DNA), from a tobacco plant into *Medicago*. The retrotransposon randomly interjects itself in the plant's genome. In the process, it disrupts the genes within the plant, causing a mutation. Researchers can then study the mutant plant and gain a clearer understanding of the function of the disrupted gene.

The Noble Foundation has already created more than 15,000 lines, becoming the largest resource for *Medicago* insertion mutants in the world. International scientists flock to Ardmore each year to identify mutants for a particular gene of interest. "Developing the *Tnt1* resource is one of the most important resources that the Noble Foundation has to offer to the scientific community," Mysore said. "It will remain the lifeline for legume research for many years to come."

Tadege's professional accomplishments were only matched by his personal joy at home. Tadege and Yetem welcomed son, Daniel, to the family within their first year in Ardmore. As his family grew, Tadege continued to expand his research. He used the *Tnt1* resource to clone a gene that determines a plant's leaf size and therefore, indirectly, the capacity for photosynthetic carbon assimilation. Overexpression of this gene in plants has the potential to increase biomass. As the cellulosic biofuels industry develops, biomass becomes the prominent issue. The more biomass a plant produces, the more ethanol can be produced.

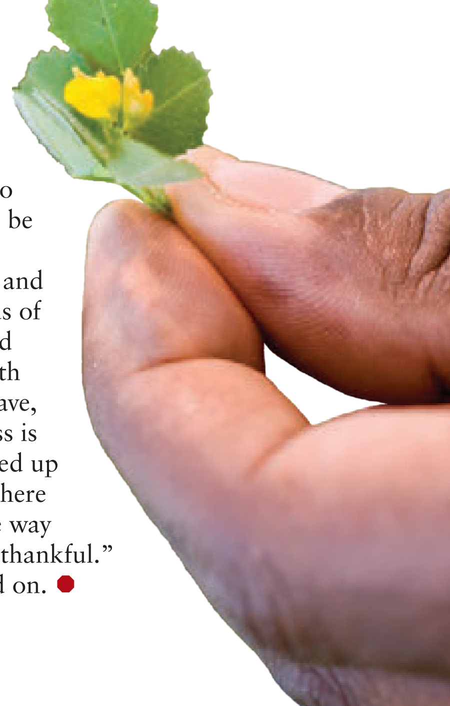
As his fellowship at the Noble Foundation began to draw to a close, Tadege sought an opportunity to build on his research and the professional relationships that he had cultivated. He soon became the newest assistant professor with the Plant and Soil Sciences Department at Oklahoma State University (OSU). He was the perfect candidate for OSU's new Institute for Agricultural Biosciences, currently under construction less than a mile from the Noble Foundation's Ardmore campus. "He had already established himself as a world-class scientist in all the right areas of research," said David Porter, head of the Plant and Soil Sciences Department. "Then we went to dinner and talked about his life and his research, and what it meant. I was just blown away."

The boy of faith, the man of faith

Before Tadege moved on to claim his new post, he sat in a quiet library, attempting to conclude a story that has yet to end. By the look in his eyes, it was clear the past was not so far away, but that his destination was closer than ever. He finally grinned and said: "After all my travels and all the organizations I've visited and worked for in the world, the Noble Foundation is the best place to work," he said. "I was very fortunate to be here."

As he prepared to leave, he stood up and offered one more thought – a few words of devotion that came from a boy who had walked alone in a dark desert. "My faith in the Lord is the only weapon I ever have, and any past, present and future success is to His glory," he said. "The Lord opened up opportunities for me – a boy from nowhere – and paved my way, guiding me all the way through to where I am now. I am truly thankful."

With that, Tadege turned and walked on.



Photograph by Broderick Stearns

Postdoc Revisited

The Heart of the Matter

Former postdoc recalls how his experiences at the Noble Foundation helped solidify his career

by J. Adam Calaway

In the fall of 2008, Mohamed Ali Farag returned to southern Oklahoma to celebrate the 20th anniversary of the Noble Foundation's Plant Biology Division. Farag, Ph.D., had served as a postdoctoral fellow (postdoc) in the division only four years prior, but he relished the homecoming as though he had spent a lifetime away.

On the first evening of the celebration, postdocs from every era gathered for a welcome-back reception. The room's light cast a warm glow as friends reunited to swap stories about old times and discuss new projects.

Farag stood near the doorway of the crowded room immersed in quiet conversation, delighting in the reunion. He greeted each new conversation companion with the same bright smile and kind eyes, bending his 6'6" frame over to politely listen. As the evening drew to an end, the slender Egyptian offered a unique perspective, "The Noble Foundation is known for having great resources, but that's not what makes this place so great. Do you know what does? It's not the resources, but the people, the spirit of this place." He looked around the room. "It is this."

Farag's perspective seems to inevitably return to his passion for people. Born within the shadows of Egypt's great pyramids, Farag sought a career in science, realizing his country's need for skilled educators and researchers. He earned bachelor's and master's degrees in phytochemistry (which in its simplest terms means chemicals derived from plants) from the College of Pharmacy at the University of Cairo.

When it came time to select a school for his doctoral studies, Farag looked to the other side of the world. "In most cases, Egypt lacks integration of its research. You only work on your project and don't really interact with other fields," he said. "The research in the United States is highly integrated, so, to be a better scientist and to endeavor into new research fields, I had to move."

Farag reached out to acclaimed professor Tom Mabry at the University of Texas in 1999, but discovered he was retiring. Mabry recommended his ex-student Dr. Paul Paré, a young professor who was in the initial stages of establishing a molecular phytochemistry laboratory at Texas Tech University.

Farag became one of Paré's first graduate students, helping to develop the laboratory while working on his doctorate in plant biochemistry. Four years slipped by in a mix of research and educational bliss, and, in 2003, Farag prepared to return home. He was prepared to join the University of Cairo as an assistant professor, but a few months before graduation he read a review article by Noble Foundation principal investigators Drs. Richard Dixon and Lloyd Sumner about plant metabolomics.

Primary metabolites serve as building blocks (amino acids) or as energy sources (sugars and fats) in plants, while secondary metabolites – a major interest of the Dixon and Sumner laboratories – function as unique communication signals and defense compounds during plant interactions with the environment. Large-scale profiling of hundreds to thousands of metabolites, known as metabolomics, offers a definitive view of the "metabolic status" of an organism. "At the time, it was a fairly new area of science," Farag said. "I wanted to learn about this new field, so I applied for a postdoc position at the Noble Foundation."

Soon after, Paré came to the Noble Foundation for a scholarly presentation, and Farag tagged along to see the organization's Ardmore campus. Sumner and Farag crossed paths during the visit, which led to an official interview opportunity and, eventually, Farag being offered the position. "Mohamed is an amazing person and a great scientist," Sumner said. "He is one of the most genuine and compassionate people I've ever met, and he's a thorough and dedicated researcher. I knew his time at the Noble Foundation would be the beginning of a brilliant career, and I am extremely proud of his achievements."

In February 2004, Farag settled into Sumner's laboratory for a 16-month stay that helped shape his future career. The Noble Foundation researchers were investigating stress responses in *Medicago truncatula*, a model legume with a fairly simple genome, using functional genomics. Scientists hoped to apply the knowledge they gained from *Medicago* to alfalfa, an agriculturally significant legume that possesses a complex genome that makes it a poor species for genetic and genomic research.

Farag set out to study how a plant responds at the metabolite level when it experiences environmental stresses (e.g., drought or disease). His work was a treasure-trove of discovery as the group developed novel analytical tools and critical data evaluation approaches. One key finding was the gene that produces the antimicrobial compound hispidol in response to pathogen stress signals. Farag identified two genes correlated with hispidol production and subsequently showed that these genes were directly involved in the synthesis of the compound. These discoveries can now be used to engineer plants to produce hispidol to fight against fungal pathogens and disease. Farag's research ultimately provided a more complete picture of how natural products are produced and regulated during stress responses in plants.

"You cannot proceed with metabolic engineering of beneficial natural products and favorable traits until you understand and define your target compounds," Farag said. "In that sense, I helped the process a little bit, but the credit goes to the team and Lloyd. He encouraged me to pursue the research and provided direction and feedback. When I would get excited about some findings, he'd get excited as well. There is continuous mentorship at the Noble Foundation. The principal investigators genuinely want you to succeed."

The project reaped the young scientist six highly rated publications, laying the foundation for his career. With a successful postdoc stay behind him, Farag jumped from the Noble Foundation to the Brown Cancer Center in Louisville, Ky., where he married Maggie Abbassie, Ph.D., a researcher in drug pharmacokinetics at the University of Kentucky. The pair returned to Cairo in 2007, and Farag became an assistant professor and researcher at Cairo University.

Once again his plans to stay in Egypt were temporarily diverted by success. Farag was awarded a coveted Alexander Von Humboldt Fellowship – one of the most prestigious fellowships offered in the world. He will spend the next year and a half at the Leibniz Institute for Plant Biochemistry in Germany, studying the metabolomics of medicinal plants. The work is an extension of his research at the Noble Foundation. Since most of the world's prescription drugs are derived from plants (called "phytomedicines"), Farag proposes to employ metabolomics as a better quality control measure to ensure consistency in phytomedicines.

No matter where he travels, the Noble Foundation remains his benchmark for a quality scientific experience. "So much is said about the resources of the Noble Foundation – and they are extraordinary," he said more than a year after the reception. "But the difference stems from the Noble Foundation's vision, leadership and, of course, the amazing people who work there." ●

"Mohamed is an amazing person and a great scientist. I knew his time at the Noble Foundation would be the beginning of a brilliant career, and I am extremely proud of his achievements."

Lloyd Sumner, Ph.D., associate professor

What Hollywood movie best relates to your research?

Beyond the larger-than-life characters and the fantastical settings, movies are – at their core – a reflection of life. Moviemakers exude tremendous energy to build themes that ring true with their audiences: capturing society's collective hope for the future, reveling in overcoming adversity or basking in the adventures of an ambitious explorer. All these themes feel genuine because they reflect the greatest attributes of human nature. It's true – art imitates life. So it's only natural that every once in a while moviegoers recognize a little slice of their existence flickering back at them from the silver screen. Scientists are no exception. It's not uncommon for them to spot parallels between motion picture fantasy and research reality.

Frank Hardin, Ph.D.
Postdoctoral Fellow
Forage Improvement Division

When I think of my work involving the genetic modification of lignin biosynthesis, I am reminded of *The Pursuit of Happiness*. Lignin is a structural polymer that is a major component of the plant cell wall. It enables plants to stand upright, but also makes it difficult to access sugars for biofuel production. We are seeking new ways to reduce lignin levels in switchgrass in an effort to improve the production of biofuel. Like the movie, with patience, perseverance and a little bit of luck, we will achieve our goals and find our happy ending.

Jagadeesh Mosali, Ph.D.
Staff Scientist
Agricultural Division

My research focuses on soils and crops, specifically looking at ways to improve production aspects and long-term sustainability of our land. A movie has actually been produced about soil research. It's called *Dirt! The Movie*. It's an award-winning documentary that details the vital nature of preserving the world's soil, which is being rapidly depleted by erosion and urban sprawl. It's an amazing piece of cinema and highly interesting even if you're not a soils researcher because soil affects everybody due to its social, political and economic impact. I'm hoping for a starring role in the sequel.

Catalina Pislariu, Ph.D.
Postdoctoral Fellow
Plant Biology Division

Gene discovery for the improvement of key plant traits is the core of my research, specifically understanding symbiotic nitrogen fixation in the model plant *Medicago truncatula*. Performing this type of research reminds me of the Indiana Jones movies because I'm looking for hidden secrets deep within the plant. I have to dig a little, follow a lot of little clues, enjoy conquering every step and sometimes fight the enemy of all scientists (occasional failed experiments), but eventually I'll reach that treasure.

Charles Rohla, Ph.D.
Horticultural Coordinator
Agricultural Division

My research in pecans is very much like the 1939 western classic *New Frontier*. I focus on the establishment of pecans and improving their management. This research will ultimately improve the diversification and economic sustainability of farms and ranches in this area. Just like John Wayne led settlers into the new frontier of the western United States, I plan to be the cowboy leading those looking for a new agricultural endeavor.

J. Adam Calaway
Director of
Public Relations

A farmer's wife

The fall always reminds me of my grandmother.

Colleen Carson was a farmer's wife, cut from the pioneer mold. Married at 18, three children by 24, she was my grandfather's best farmhand. If he was up at 5 a.m., she had breakfast waiting on the table. When he ran cattle in the pouring rain, she weathered the storm right beside him. She could string barbed wire just as easily as mend his overalls. She could teach Sunday School in the morning and plow wheat fields that afternoon. She managed the intricate farm finances with an accountant's precision, but only a high school diploma on the wall.

And for 50 years she forged a life with the most stubborn man the prairie ever produced. His iron will broke the unforgiving ground, and her soft spirit tamed his heart. Tradition dictated his leading role, but there was little doubt of her authority. One day when he rose from the dinner table and seemingly fell dead to the floor, she stood over him and yelled, "Eugene, you better come back, we have too many bills to pay for you to die now." He did what he was told, because there is no one tougher than a farmer's wife.

No one was more gentle or patient either. My grandmother spent a lifetime tending to faith, family and farm with equal vigor, an endless circle of responsibility, an ever-expanding ring of pride. She was the glue that bound together four generations. She was the peacemaker, the great communicator, the tireless teacher.

The farm had taught her about life, and she generously shared all she knew – so many lessons, so many memories. I still recall the summer days spent nursing calves and collecting eggs from cranky hens. I can still see the fist-sized tomatoes we picked in the garden and smell the haystacks in the barn. But most of all I remember spending cool summer evenings sitting on her back porch, listening to the hum of boisterous cicadas and the sweet laugh of a farmer's wife. I may have lived in the city, but my heart belonged to the farm.

It seems only fitting that 25 years later I have the privilege to work for an organization dedicated to benefiting mankind by assisting regional agricultural producers and land stewards.

For three years, I've watched our consultants support farmers and ranchers across southern Oklahoma and north Texas. At first blush, it seems so practical: help agricultural producers develop goals, address challenges, provide sound education and, ultimately, improve their bottom line. But – as my grandmother would point out – that's not the heart of the matter. In the simplest (and grandest) of terms, the Noble Foundation changes lives.

Jack Cunningham and his son, Jackie, can attest to that. They credit the Noble Foundation's agricultural consultants with helping them survive everything from drought to army worms.

Fifty miles away is the Howard Ranch and a similar story. Steve Howard's family has shared a generational relationship with the Noble Foundation spanning 30 years. The Noble Foundation has helped the Howards endure the inevitable ebbs and flows of running more than 10,000 head of cattle each year, finding success while others fail.

Then there is Dave Wingo. He openly wept as he retold the story of how the Noble Foundation altered his entire perception of farming, making his struggling operation flourish and enabling him to support his local church. It's a story that is repeated over and over; one farm, one family at a time. So I write their stories, and I cherish the fact that I'm a part of an organization that believes simple actions can make lasting impressions. I know that's how I view my grandmother's life.

It's true the fall always reminds me of her – not just because Thanksgiving was her favorite holiday – but because it's when she died. She spent the last 40 days of her life in a simple, beige hospital bed in my living room.

The cancer had all but chased her from her body. My indestructible grandmother, who seemed strong enough to bear the worries of an entire family, was suddenly frail.

As she slowly slipped from one world to the next, she refused regret or pity. The faith that sustained her in life would comfort her in death.

Her last words came in the still of a blustery evening, two days after Thanksgiving. She had not spoken for days, lost to a coma, when her voice broke a quiet, bedside conversation. With a burst of strength, she proclaimed a blessing over her family and thanksgiving for her life. I had never heard words so pure in my life. They hung in the air and then silence. She never opened her eyes. She never said another word. It was the last prayer of a farmer's wife.

Lloyd Noble was a man of remarkable vision. In the early 1900s, Noble witnessed the importance of agricultural production to Oklahoma and its people. He also saw the devastating effects of poor farming practices on the soil's fertility. Recognizing the land as essential to the future of Oklahoma and the nation, the successful oilman and philanthropist established The Samuel Roberts Noble Foundation to expand agricultural knowledge and assist farmers. Although Lloyd Noble died in 1950 at age 53, the institution he established continues to benefit mankind.

THE SAMUEL ROBERTS NOBLE FOUNDATION

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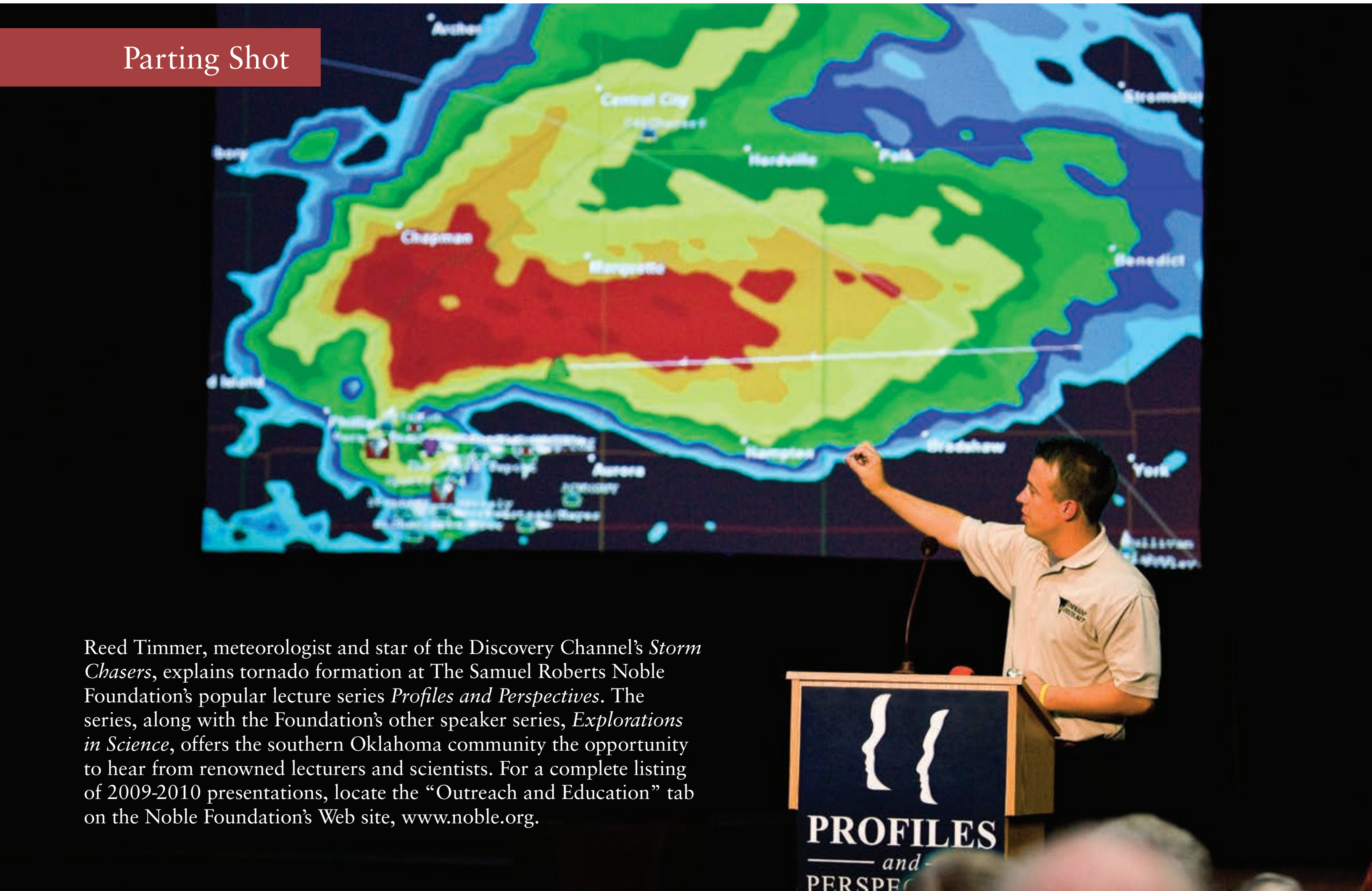

Reed Timmer, meteorologist and star of the Discovery Channel's *Storm Chasers*, explains tornado formation at The Samuel Roberts Noble Foundation's popular lecture series *Profiles and Perspectives*. The series, along with the Foundation's other speaker series, *Explorations in Science*, offers the southern Oklahoma community the opportunity to hear from renowned lecturers and scientists. For a complete listing of 2009-2010 presentations, locate the "Outreach and Education" tab on the Noble Foundation's Web site, www.noble.org.