EXPLORING THE WORLD OF VIRUSES
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.

Cover story

Exploring the World of Viruses
For the past 20 years, the Noble Foundation’s virology programs have conducted groundbreaking work in the fields of plant virus accumulation, biodiversity, evolution and movement. As they explore the world of viruses, Drs. Rick Nelson and Marilyn Roossinck are generating a wealth of knowledge about these often feared, rarely understood organisms.

Features

Addition by Subtraction
Calling cows is a time honored practice conducted each fall by farmers and ranchers throughout the Great Plains. However, an ongoing research project in the Noble Foundation’s Agricultural Division may provide an alternative method to the current system, improving the producer’s bottom line.

From Mendel to Molecules
Researchers at the Noble Foundation have conducted plant breeding research since the 1950s, developing new forage varieties for use in the southern Great Plains. Today, the use of modern molecular breeding programs has improved the efficiency of the process and cut down the time required to develop a new forage.

Building on Experience
Mary Sue Butler Clyne climbed to the top of the corporate ladder at IBM through the course of a 30-year career. Now retired, she is applying her skills and experiences to the Noble Foundation’s Agricultural Division as a nonresident fellow.

The Road Less Traveled
Million Tadege has walked a path through life most people cannot even imagine. Born and reared in Ethiopia, Tadege clung to his education and faith as he forged a life and a career. Seven years ago, he came to the Noble Foundation and assisted in a vital project.

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
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 downstream. The system is functioning correctly, so agriculture rarely makes a blip on our collective radar screens.

Of course, the entire 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 plants, soil, 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 61 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 crop 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, with fewer applications of chemicals. Today, corn carrying these engineered traits individually or in combination is grown on more than 91 million acres across the United States.

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 to 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 supported by a broad range of agricultural research efforts of the Noble Foundation’s 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.

The 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.

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us your thoughts or queries. Please submit Questions
and
For reprint information, see page 4.

President’s Message

Sincerely,
Michael A. Cawley
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Susan Belay
Director of Publications & Visual Media

Field, and Newsweek, and she has upcoming features in Ladies’ Home Journal and Parenting.

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.

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.

About the Noble Foundation

T he 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.

Findings from 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

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William Haire snaps a photo at the Noble Foundation greenhouse.
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 bio-energy crops in the field through the biorefining process.

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

- 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).
- Jagadresh Mosalii, Ph.D., $88,371. Mosalii will study the effects of different winter legumes as nitrogen sources for switchgrass grown for cellulosic ethanol. Mosalii will also do large-scale research on the sorghum connection to develop the Oklahoma sorghum-as-fuel industry.
- Fang Chen, Ph.D., $119,000. Chen 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. 8 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.

“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.

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,” 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.”

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., 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’s 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 20,000 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.
Agricultural researchers look to refine the cattle culling process and improve the bottom line for livestock producers

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.

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 culled 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 culled 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 culled cows, creating a knowledge resource that will help them find the right timing and management practices to sell high.”

“...we hope to provide producers with a new possibility for managing their culled 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

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 this same 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 advance- ment 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 compli- cated 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, assis- tant 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 desir- able 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 symptoms of inher- ited 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 suscep- tible 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.

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 indus- try, 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 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.”
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.”

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...
Mary Sue Butler Clyne, nonresident fellow for the Agricultural Division

"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
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 (Beachte 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.

Nelson discovered this particular TMV strain – called an RNA silencing system – that protects them from viruses. “To understand how to inhibit the virus, we had to understand the function of this particular protein,” 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.”

“Walking 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 >>>

A Nelson laboratory member labels microfuge tubes in preparation for tissue samples.
“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 understand- ing 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: 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.”

Marilyn Roossinck, Ph.D., peers into a growth chamber to examine tomato plants.
Roossinck has dedicated more than 25 years to understanding viruses in a way that many researchers cannot even conceive – as beneficial organisms. Her research sheds light on 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 domesticated 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 and spread,” she said. “We’re unlikely to control virus diseases until we understand why normally benign or beneficial viruses evolve to cause disease.”

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.

“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.”

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 that has high diversity, and recombinating 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 1,350 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 (cucumber mosaic 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 for the future. It’s clear that viruses are going to play a key role in this process.”

Because not all viruses are bad. 
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.
Million Tadege rose from abject poverty to acclaimed scientist, walking a path through life that few could even imagine.

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 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. “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….”

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

“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 studies the model legume Medicago truncatula. Tadege helped develop the TiTl resource which is used by scientist 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 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 daunting task considering that these woods were also the school’s outhouse. Tadege traveled home each Friday, having not eaten in almost two days. Held 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. The 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 across all 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 thing.”

Tadege was stuck. For four years he worked and waited. The only ray of sunshine came from the bright smile of a beautiful young Ethiopian woman who had been the proper escort. 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. “The offer was very good, an opportunity to come a year later, I would not have been allowed to take the scholarship, and I would not have been able to leave.”

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. “The offer was very good, an opportunity to come a year later, I would not have been allowed to take the scholarship, and I would not have been able to leave.”

Landing among the Dutch students, 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.”

The next step

Tadege was appointed Principal Investigator Kiran Mysero’s laboratory and began work on developing a new genetic resource in Medicago truncatula. Since the 1990s, the Noble Foundation has invested 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, Mysero 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 integrates 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 disrupted gene. The Noble Foundation has already created more than 15,000 lines, becoming the largest resource for Medicago truncatula in the world.

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 conclude a story that has yet to end. I am truly thankful.”

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.
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,
One key finding was the gene that produces the anti-inflammatory 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 thwarted 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 team and Lloyd. He encouraged me to 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."

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.
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, 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 first-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 bounteous 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 supporting 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.
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.