A publication of The Samuel Roberts Noble Foundation

Legacy

Winter 2010

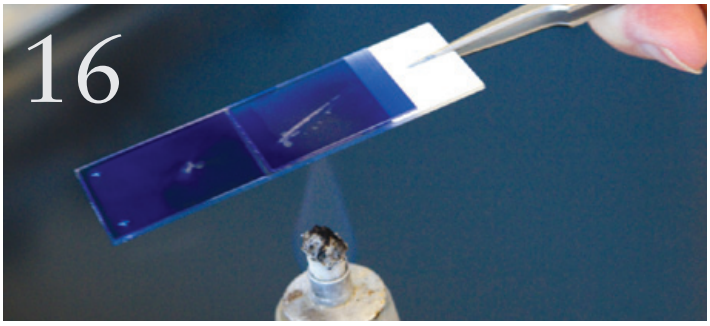
THE UNSEEN REVOLUTION

These blue squiggly lines are fungi living within the plant tissue, supercharging the host plant and helping to reshape agriculture.

(on the cover) Microbes including fungi, bacteria and viruses – collectively known as endophytes – often live within plants and sometimes provide growth benefits to their hosts. The cover image shows one such endophyte (a fungus that appears as a blue, squiggly line) thriving between the cells of a grass stem. (microscopy: Carolyn Young, Ph.D.)

(above) A herd of cattle graze beneath a pecan grove at the Noble Foundation's Red River Farm. The Noble Foundation conducts research on 425 acres of pecan trees located on two of the seven farms operated by the organization. (photo: Broderick Stearns)

Winter 2010 | Vol. 4, Issue 3



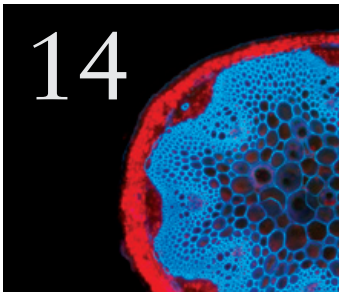


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photo: Broderick Stearns

The Heart and Soul of Agriculture

Conversations about agriculture inevitably focus on the industry's products. Agriculture is responsible for the three "F's" – food, feed and fiber. We eat, nourish livestock and clothe ourselves all as a result of one industry. And, in the next generation, agriculture will contribute heavily to the fuel we put in our gas tanks through the emergence of the bioenergy sector. These products are the lifeblood of our world, serving as the bedrock from which we build our society.

What is lost in this assessment of the agricultural industry are the individuals – the farmers, ranchers and land stewards – who virtually support the global population, but receive little fanfare.

Our founder, Lloyd Noble, established this organization as a means to support the agricultural community. He understood better than most the value of these individuals, not only to the survival of our population, but as the embodiment of our greatest characteristics – hope, generosity and compassion.

Growing up in Ardmore during the early 1900s, Noble saw these attributes firsthand. He worked in his father and uncle's hardware store, serving the region's many agricultural producers. He stocked shelves, loaded wagons and developed an admiration for these pioneering men and women who broke the untamed prairie through sheer determination and endless work.

Noble understood early in his life that depending on the land for one's livelihood instilled an unimpeachable character. He once said, "If you find a man or a woman who is interested in growing things, whether it's a plant, whether it's a major crop, or whether it's in the field of animal life, I'll show you someone who has interest in something else except themselves."

Less than two decades later, Noble redefined the oil drilling industry through ingenuity, technology and loyalty to his employees, who often came from agricultural backgrounds. Noble found great success in the early oilfields, and he endeavored to give back to his beloved state.

In the desperate post-Dust Bowl era, Oklahoma's land lay stripped of its ability to produce crops, and agricultural producers fled to the West Coast, seeking sanctuary from the strife. Noble realized the devastating effects a dwindling population and economy would have on Oklahoma and its population. He established this organization in 1945 as a lasting solution, safeguarding the land for future generations and benefiting those who depend on it.

While our programs have expanded and our research has circled the globe, Noble always wanted us to remain focused on the people. Our mission statement does not say "improve agriculture." No, Lloyd Noble gave us a grander charge – to "benefit mankind."

So every day the men and women of the Noble Foundation work tirelessly to support the individuals – whether in the Southern Great Plains or elsewhere – who produce the food, feed and fiber for our world: the farmer standing in a dry wheat field praying for rain as he tries to feed his family and the world; a rancher hoping for healthy cattle and markets; and land stewards who meticulously conserve our natural resources.

We admire their inexhaustible dedication. We are humbled by their values, which they continuously plant in our society like spring crops. And we strive to demonstrate our appreciation for their sacrifice. Because, in the end, it is not just about the products; it's about the people who produce them, and a world that should be more appreciative of them.

Sincerely,

Michael A. Cawley
President and Chief Executive Officer

photo: Broderick Stearns

(above) Egyptologist Kara Cooney, Ph.D., explains the development of pyramids in Egypt and elsewhere around the world to more than 750 attendees of her Profiles and Perspectives *talk.*

Profiles and Perspectives entertains and informs

In 1999, the Noble Foundation initiated its popular speaker series, *Profiles and Perspectives*, as a way to bring high caliber, nationally recognized speakers to residents of southern Oklahoma.

Halfway through its 13th season, *Profiles and Perspectives* has already entertained and informed audiences with tales of sending plants into space by Noble Foundation scientist Elison Blancaflor, Ph.D., and an exploration of the origin of pyramids by renowned archeologist and TV host Kara Cooney, Ph.D.

"For more than a decade, *Profiles and Perspectives* has provided informative, thought-provoking and entertaining speakers to residents of southern Oklahoma," said Mary Kate Wilson, Noble Foundation director of granting and chair of the *Profiles and Perspectives* Committee. "This year, we've assembled another diverse and exciting group of speakers that audiences will enjoy."

In early 2011, *Profiles and Perspectives* will return with a special offering for landscapers. On Thursday, Feb. 17, 2011, popular gardening expert Neil Sperry will present *Designs On a Great Landscape*. Sperry will discuss the fundamentals of effective landscape design, including bed layout; plant selection and placement; effective use of color; and the elements of a fine garden. Sperry has been a radio host for more than 30 years and is a member of the Texas Radio Hall of Fame. His book, "A Complete Guide to Texas Gardening," is the fourth best-selling gardening hardback in American history.

The 2010-2011 season will wrap up on Tuesday, April 19, 2011, with Greg Marshall's *Crittercam: A Wild Point of View*. Almost 20 years ago, Greg Marshall, a biologist and filmmaker, was snorkeling in Belize when he saw a small suckerfish hitching a ride on a shark. The moment sparked his imagination and led to the development of Crittercam, a small, lightweight camera that is attached to animals, providing breathtaking glimpses of the world from their view.

Marshall will take audiences through the development of several of his award-winning films for National Geographic, detailing how his team uses innovation, creativity and engineering to lead the field of animal-borne imaging.

The 2010-2011 *Profiles and Perspectives* series is offered at no cost, courtesy of the Noble Foundation. All programs will take place at 7 p.m. at the Ardmore Convention Center. Additional information can be obtained by calling the Noble Foundation at 580.224.6246 or visiting www.noble.org/profiles.

Bioinformatics research garners $1 million grant

Noble Foundation researcher Patrick Zhao, Ph.D., associate professor, recently received a $1,183,305 grant from the National Science Foundation (NSF). Zhao will use the NSF grant to advance his study in bioinformatics, a scientific field that uses computers to analyze large amounts of biological data.

As part of the project, Zhao will seek to understand the regulatory networks between the thousands of genes that control plant development and their interaction with the environment. This interaction is highly complex and dynamic, and is difficult to decode.

"Deciphering the gene regulatory networks is a challenging task," Zhao said. "However, through bioinformatics, we seek to develop innovative methods to understand these plant gene regulatory interactions and fulfill the needs of the plant biology research community. We also hope that this work will lead to the development of better economically important crops in the future."

Sam Noble Scholarship applications now available

Applications for this year's Sam Noble Scholarships in agriculture and technology are now available from The Samuel Roberts Noble Foundation.

Entering its 13th year of assisting students, Sam Noble Scholarships are available to southern Oklahoma students in all stages of higher education – from incoming freshmen to those seeking graduate degrees.

"The Sam Noble Scholarships play a pivotal role in providing educational opportunities for southern Oklahoma students," said Mary Kate Wilson, director of granting at the Noble Foundation. "We encourage all eligible students to take advantage of this unique scholarship opportunity."

The scholarship is named in honor of the late Sam Noble, who created the program through a gift to the Noble Foundation. Sam Noble was a long-time member of the Noble Foundation Board of Trustees and son of Lloyd Noble, who founded the organization in 1945.

"Sam Noble believed a quality education was one of the keys to leading a successful life," said Michael A. Cawley, president and chief executive officer of the Noble Foundation. "He once said, 'An excellent education is something that no one can ever take away from you; you can use it the rest of your life.'"

For complete eligibility criteria, visit www.noble.org/Philanthropy/scholarship.html or call 580.224.6247. Completed scholarship applications must be received on or before Tuesday, Feb. 15, 2011.

Bouton receives Crop Science Society of America award

Noble Foundation Professor Joe Bouton, Ph.D., received the 2010 Martin and Ruth Massengale Lectureship from the Crop Science Society of America (CSSA). The award recognizes the significant impact of an individual's career in the field of plant science.

Bouton was selected for the honor because of his many contributions to the research, breeding and advancement of forage grasses and legumes throughout his 30-year career. Bouton conducts research on temperate forage species for use in pasture and livestock systems. He has commercialized 17 cultivars, but is best known for releasing Alfagraze alfalfa, MaxQ tall fescue, and Durana and Patriot white clovers.

Sumner receives grant to study plant natural products

Most people have never heard of triterpene saponins. However, Noble Foundation Principal Investigator Lloyd W. Sumner, Ph.D., and collaborator Nevin Young, Ph.D., from the University of Minnesota, have received a $690,000 grant from the National Science Foundation (NSF) to develop a deeper understanding of triterpene saponins, important natural products made in plants.

Plant natural products are chemical compounds that often serve some defense function within a plant, such as fending off unwanted pests or diseases. In some cases, plant natural products can also promote human health and nutrition, providing assistance with everything from inflammation and cholesterol to cancer. About 25 percent of all commercial drugs are derived from plant natural products.

Plant natural products can also be of benefit in livestock production. Triterpene saponins can alter the nutritional quality of forages, such as alfalfa. Drs. Sumner and Young are working to uncover the genes responsible for producing these chemical compounds.

"If we can identify and understand the genes behind triterpene saponins, we can potentially engineer plants with specific levels of these naturally occurring chemicals," Sumner said. "This would be a great benefit to agriculture and humans."

photo: Broderick Stearns

Sumner's recent NSF award was based upon initial research that was funded through a two-year, $88,833 plant science grant provided by the Oklahoma Center for the Advancement of Science and Technology (OCAST).

"OCAST plant science grants provide researchers within Oklahoma the initial resources to pursue basic research that often leads to larger, national grants," Sumner said. "The initial OCAST grant enabled us to leverage additional funding from NSF to expand the scope and scale of our research. Both grants are enabling us to investigate plant natural products that have the potential to make a lasting impact on sustainable agriculture. I am thankful to both agencies for their support of fundamental plant science."

photo: Broderick Stearns

Reuter recognized as Leonard Wyatt Outstanding Cooperator

Rancher Jeffrey Reuter received the 2010 Leonard Wyatt Memorial Outstanding Cooperator Award, which is given annually to one of the 1,750 farmers and ranchers who work with the Noble Foundation's Agricultural Division. The award was presented during the Southern Plains Beef Symposium in August.

As part of its mission, the Noble Foundation provides farmers, ranchers and other land managers – called cooperators – with no-cost 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 are based on accomplishments within the farmer or rancher's operation, community service and willingness to assist other farmers and ranchers," said Billy Cook, senior vice president and director of the Agricultural Division.

"There are few people that operate stockers and such a diverse set of resources so well," said Hugh Aljoe, consultation programs manager, of Reuter. "It is truly impressive to observe the results of such talented management and dedication."

The Reuter family has deep roots in the El Reno, Okla., area, as previous generations homesteaded their land in Oklahoma's historic land run. Reuter represents the third generation to make his living from their land. The operation includes 125 mixed breed commercial cows with high-performance Charolais bulls and runs about 350 stockers year round. They also raise alfalfa and rye, primarily for grazing. In addition, Reuter runs a stocker/feeder buying company.

Reuter discovered the consultation program by chance. During a farm tour in 1992, he was handed an article about the Noble Foundation. When he got home, he made a phone call that has resulted in an 18-year relationship.

"They have a great organization, great people, and they have developed an effective way to get information to people," Reuter said. "Their information and materials are presented clearly. Their consulting recommendations are applicable and cost-effective. What I have been most impressed with about the consultants is they know my operation and understand my objectives, and can readily provide practical solutions to issues that I present to them."

Reuter credits his consultation team with assisting him with feeding programs; bull selection; a cow herd health program; analysis and usage of fertilizer; better production and utilization from winter pastures and introduced perennial forages; developing stronger native grass pastures; fencing and rotational grazing strategies; and controlling areas prone to erosion. However, there is one aspect of agricultural production in which he has received the most assistance from the Noble Foundation.

"If I had to pick one thing the Noble Foundation has helped me with the most, it would have to be my management skills," Reuter said. "The relationship with the consultants has greatly improved my skill level, allowing me to become a better manager which has improved my bottom line. I have also become a better steward of my land."

(above) Jeffrey Reuter was named the Leonard Wyatt Memorial Outstanding Cooperator for 2010. The award recognizes a Noble Foundation consultation client who has excelled in stewardship of their farm or ranch. The Noble Foundation's consultation program is open to land managers within 100 miles of the organization's Ardmore, Okla. headquarters. Consultation is provided at no cost to the farmer or rancher.

Pursuing Dreams

The Noble Foundation's Basic AG program provides sound education to first-time agricultural producers

by J. Adam Calaway

On an unusually cool summer day in West Texas, Ed and Tavia Morris stood on the edge of the beautiful Palo Duro Canyon, looking at their past and their future.

Above them, thick grey clouds bunched together, then scattered like children on a playground, cooling the sun-baked land for a handful of visitors to the couple's 1,500-acre JE Ranch.

The Morrises concluded a two-hour tour of their family homestead at "lookout point," a peninsula of land that juts out into the 120-mile long canyon, providing an unbroken view of the grand vista they so cherish.

The expansive panorama is an oil painting come to life. The strata in the canyon walls alternates hues of cinnamon and burnt orange, and stretches to the horizon like slow-rolling waves in the ocean of rock. The emerald-colored juniper trees scatter in clumps throughout the canyon, which derives its name specifically from their "hard wood." And a dozen individuals stand speechless, drinking in the natural marvel that has served as a backdrop to the couple's fondest memories.

"I love it here," says Tavia Morris, looking at her husband of 45 years. "I never get tired of this view. I could stay up here for hours."

While the scene in front of them connects their past and future, the land behind them is shaping their present. The JE Ranch, which runs partially down the canyon, has been in the family since 1945 and has belonged to Ed and Tavia for more than a decade. The couple never actively managed the land, instead using the remodeled cabin and bunkhouse for weekend retreats, while leasing the land for others to graze their cattle.

In early 2010, the couple decided to become ranchers, pursuing a dream of escaping the office environment and joining countless others who are fleeing urban settings for rural escapes.

The Morrises hope to provide a breath of fresh air to a ranch that – at the beginning of the year – was in need of CPR. Neglect by lessees left pastures overgrazed and overgrown with noxious weeds and mesquite bushes. The corrals stood in disrepair and downed fence lines required immediate attention.

Their first step was to get educated. Their first call was to the Noble Foundation, which has developed the Basic AG program, a series of courses specifically tailored to educating the first-time agricultural producer. Almost a year has passed, and the couple has learned some tough lessons; but, from the grins on their faces, it's clear that they are ranchers.

Life before ranching

Before the grand tour of JE Ranch, Ed and Tavia served lunch in the bunkhouse, which sits adjacent to the property's chocolate-colored, split-log cabin. The bunkhouse with its plump leather couches, lamps constructed from pistols and carved wood furniture served as home base for the day. Here, perched on barstools, the couple retrace the story that stretches back more than half a century.

Ed was raised in West Texas. Tavia, a self-professed Air Force brat, skipped across the country, before landing at Amarillo Air Force Base. They met in Mrs. Ballard's Spanish class their junior year at Amarillo High School and became sweethearts.

College brought distance, though. He attended Yale University, studying German literature with an eye on the diplomatic route. She returned with her family to southern Illinois and took ▶

(opposite) With the dramatic Palo Duro Canyon as a backdrop, Ed and Tavia Morris take a break at "lookout point" on their JE Ranch. After years of practicing law in the city, Ed is giving it up to become a rancher. The Morrises are representative of urban professionals who are leaving the city for a life on the land. (photo: Broderick Stearns)


2010
TSRA

> "Nobody will take care care of your land like you will. But we needed a place to learn."
>
> *Ed Morris*

accounting classes at Bellville Junior College outside of St. Louis, Mo.

During the summer between Ed's sophomore and junior years, he moved into a house a block from Tavia's family, found a job and spent the summer wooing her. As autumn approached, he proposed. Weeks later, he was winging his way to Germany for a year of study abroad. "He wanted everything nice and tied up while he was gone," said Tavia with a chuckle. Ed returned in May, and within weeks the pair married in 1965.

Ed finalized his undergraduate work and attended law school at Harvard University. Patriotic duty delayed his completion, though. The boy, who had been in ROTC throughout high school and college, could not wait for graduation. "Serving my country was something I had to do," Ed said. "I knew it was the right thing to do."

For three years, Ed tromped around the world as an infantry officer – first to Germany (with Tavia), then to Vietnam with the 101st Airborne Division. "We lived that war every night on television in living color," said Tavia, who returned to St. Louis during his tour. "It was compelling and frightening."

Ed finalized his three-year commission in Maryland and headed back to Harvard to finish his degree. The fresh graduate landed a job in the Houston office of a large, international law firm.

In Texas, the couple welcomed their only child, Celee, and Tavia attended Rice University seeking a bachelor's degree in managerial studies. While family life was perfect, Ed became restless with the mega-law-firm scene and quit to rejoin the Army, this time with the Judge Advocate General's Corps. Speaking fluent German, Ed became the U.S. Armed Forces liaison to various German authorities. Letters from home brought another move. Ed's mother penned a series of letters outlining her business dealings, and it was clear to Ed that she needed him closer to home.

In 1978, the Morrises returned to Amarillo. The city where they met would be home for the next 32 years. Ed served as a transactions attorney at a local firm. Tavia finished her degree and worked various jobs. And together they raised Celee. Life had come full circle – almost.

Back to school

Throughout Ed's life as a child and married man, the JE Ranch had always been his oasis. While they lived in town, the ranch hosted special family events from birthday parties to summer breaks.

Ed's mother bought the ranch the year before he was born, naming it JE after Ed and his sister, Jane. Ed's father, Leon, was killed in an automobile accident when he was just a few years old, and his stepfather, Richard Bell, raised Ed, trying numerous times to teach his stepson about agriculture. "I wouldn't let my stepfather teach me the cattle business. I wasn't interested," Ed said. "I was just a normal kid. I didn't know how important it would be. He passed away in 1970, and I missed a real opportunity."

In 1996, Ed's mother died, and Tavia insisted that they lease the land, allowing the family to use the cabin while keeping the land useful. It seemed like the best of both worlds. But her perfect plan faded in the light of reality. The lessees overgrazed the ranch, frustrating the couple to the point where they left it open for a year. "I remember saying, 'the next cow on this land will be mine,'" Ed recalled. "Nobody will take care of your land like you will. But we needed a place to learn."

JE Ranch blog

Since summer 2010, Tavia Morris has kept a blog since she and Ed began the adventure to transform the JE Ranch into a functioning and successful operation. Follow their progress at www.noble.org/BasicAG.

(above) Ed Morris examines the barn and corral area of the JE Ranch. Morris, along with his wife Tavia, are using information they learned from the Noble Foundation's Basic AG program to improve their ranch. (photo: Broderick Sterns)

A year slipped by. Each morning over breakfast, they discussed their first move. "Several thoughts came to us when we talked about doing this," Ed said. "Do we really need to get in the farming business? How do we pick our first cows? And we were too dumb to know the rest of the questions."

Invariably, action faded as they became entangled with the day's business. But on a particularly momentous late March morning, Tavia kick-started their quest by simply asking: "OK, so how is this going to happen?" Ed scraped down his last forkful of eggs and answered: "If you want to do it, find a place where we can go to school to become ranchers."

A basic solution

A friend at Tavia's Bible study told her about the Noble Foundation. That afternoon she placed a phone call to Hugh Aljoe, consultation program manager for the Agricultural Division.

"Ed and Tavia's story is becoming increasingly familiar," Aljoe said. "In years past, we worked with producers who had grown up in agriculture. Farming and ranching was their heritage. Today, agriculture has changed. More and more people who have made their living in other industries now want to have a piece of the American dream away from the city. The problem is – just like with Ed and Tavia – they don't know where to start or even go to look for help."

In response to this increasing number of inexperienced farmers and ranchers, called rural life producers, the Noble Foundation initiated Basic AG, a series of educational events providing practical, foundational knowledge tailored specifically for these producers.

"Basic AG events offer straightforward information and interactive experiences to give participants a better understanding of agriculture principles and get them started toward achieving their production goals," Aljoe said. "This information can be immediately applied to a farmer or rancher's day-to-day operations."

Aljoe told Tavia of an upcoming Basic AG Field Day in McKinney, Texas. With that, the Morrises made the the commitment – and the 350-mile trip – to begin their agricultural education.

Lesson No. 1: Wear the right shoes. "I was wearing really nice shoes, thinking we'd be sitting in a classroom. We walked around in the dirt all day," Tavia said, laughing. "The presentations were great, though, and the information was spot on. We just realized how much we needed to learn and how far we had to go."

> "We had been on the edge of the cattle business our entire lives, but we didn't know anything yet."
>
> *Ed Morris*

The second lesson of the day ruined the couple's plan of running a stocker cattle operation (in theory, a simple concept: buy and raise calves, then sell them). "We learned right away that our core concept was wrong," Ed said. "Our biggest misconception was that you'd buy baby cows cheap, leave them in the field and then sell them. Boy, were we wrong."

Tavia added, "I just thought Mother Nature just took care of them. I had never seen any cow owners do the things the Noble guys were talking about. This was a whole new level."

Their goal quickly morphed into running a cow-calf operation (buy cows, take care of cows, breed cows and then sell calves). "With each new lesson, I became a little more overwhelmed," Ed said. "We had been on the edge of the cattle business our entire lives, and we thought we knew about it, but we didn't know anything yet."

The Morrises returned to the Basic AG Cattle School in May for a series of hands-on demonstrations, learning everything from how to properly give a shot to supplemental feeding. "All we ever saw was cattle turned out and neglected," Tavia said. "Now we understand the fundamentals to successfully running an operation. The more knowledge we got, the more we wanted."

"We took notes for two solid days," Ed said. "Then we decided we needed a week, but we knew if we got a week, we would need a month."

With their goals firmly entrenched, the couple turned their attention to fixing up the ranch.

The most pressing need was fencing or the lack thereof. With a little help from the cost share program through the Natural Resources Conservation Service (NRCS), they replaced almost 1.5 miles of fencing. The Morrises then focused on brush management (removing one field of mesquite bushes at a time), utilizing the ranch's water wells better and rebuilding the corrals. They have even attended their first regional farm and ranch show to learn about equipment and will continue making the long trek to southern Oklahoma for Basic AG events.

'I need to do this.'

On Jan. 16, 2011, Ed will officially retire from his law firm, trading neckties for work boots. By then, almost a year will have passed since the couple began their process to turn the JE into a working ranch and themselves into ranchers. The discussion of the looming retirement and shift to full-time agricultural producer inevitably brings up Ed's stepfather.

"It sounds romantic – to return after all these years to do what he always wanted me to do," Ed said. "I'm at the point in life where I want to do this; I need to do this. I think he'd be pleased. Of course, it's 40 years later, and he's not here to teach me; but we have the Noble Foundation, and we're willing to roll up our sleeves, work hard and do things right."

Sounds like something an old pro would say.

Unsung Heroes

Noble Foundation's programs achieve success through the invaluable contributions of research associates and assistants

by Arthur Dixon

Research is a team effort. A single researcher cannot be successful without the help and support of others. Nowhere is this more true than at the Noble Foundation, where devoted workers in the positions of research associate and research assistant (RA) provide vital support across the complete spectrum of the organization's operations. These critical employees are not always recognized, but their presence ensures the smooth operation and steady progress of their respective areas.

A research associate or assistant essentially serves as a jack of all trades. They must be endlessly adaptable so they can work successfully with a variety of researchers as they advance the laboratory's scientific endeavors. "My job is always changing and always full of problems to solve," said Christy Motes, research associate. "But that's what I love about it."

Daily duties

RAs handle tasks ranging from keeping supplies stocked to having farm equipment operating properly. Their work may even include their own research projects. "I'm performing research, but I'm also an equipment repairman, a maintenance person or anything else I'm needed to be," said Jack Blount, research associate.

Teaching is also a large part of the job. Most scientific research is carried out by postdoctoral fellows ("postdocs" for short), who earn a doctorate degree and then spend three or four years gaining valuable research experience in temporary positions. They will move on to permanent research or faculty positions after their time at the Noble Foundation.

Research associates and assistants, on the other hand, are permanent employees. The stability of their positions allows them to provide a sense of continuity in the laboratory and assimilate new postdocs quickly into the social and scientific environment of the group. "Because we're not rotating in and out," Blount explained, "the techniques and technologies that are useful for our principal investigator's type of research are familiar to us, and we often provide tutorials for the postdocs."

(above) Alan Sparks, research assistant, collects data on plant seedlings that are growing in a research growth chamber. (photo: Broderick Stearns)

Added Motes: "It creates a more stable environment. It's difficult to advance the science when you constantly have to go back and reinvent the wheel."

The rotational nature of postdoc tenures also means that RAs must sometimes take over a project left by an exiting postdoc. Blount and Yaxin Ge, senior research associate, both spoke of occasions when they had taken the reins

on a research project from a departing postdoc and oversaw it until his or her successor arrived. "This work ensures that the science will not stagnate," Ge said. "Our involvement in these instances keeps the research progressing."

The field as laboratory

The Noble Foundation's wide variety of agricultural research and plant science requires an equally diverse set of RAs. Beyond the laboratory, Noble RAs provide support in the greenhouse, where projects go through "proof of concept" before moving outdoors to the small- and large-scale research plots for field testing and animal trials. Every step of the way, RAs provide the proverbial elbow grease to keep the research moving.

Research Assistant Kevin Lynch is one of a handful of RAs who handles virtually every stage of the day-to-day maintenance on the research plots.

Lynch and his RA colleagues also oversee the Noble Foundation's five small grains variety tests, which have been ongoing since the 1960s, and harvest all these plots.

With more than 60 half-acre to 2-acre plots, the team of field RAs may work at the macro level, but they must be as precise in their weights and measurements as if they were in a laboratory. If the experiment requires 6.1 pounds of a particular input, for example, nitrogen, then it has to be exactly that amount or it will skew the data set.

"The experiments we help manage allow our researchers to develop precise management plans for the farmer," Lynch said. "We understand that we are fine- tuning the use of complex systems, and that's highly important. They are going to have to take what we do and apply it on a much larger scale."

That larger scale often includes livestock. With more than 2.6 million cattle within a 100-mile radius of the Noble Foundation's Ardmore, Okla., campus, livestock production remains one of the primary agricultural enterprises in the Southern Great Plains. Therefore, much of the organization's research uses cattle as the means of testing the effectiveness of specific forages (crops that are commonly grazed or hayed).

Devlon Ford, research assistant, is a member of a team that processes, oversees and collects data on the 400 cow/calves and between 600-800 stocker/steers that comprise the Noble Foundation herd at any given time. Armed with his laptop, this modern cowboy keeps meticulous records on each animal, including age, weight, vaccination records, hide color and proper electronic identification numbers. "Give me my laptop and I can tell you just about anything you want to know about any one of our cows," he said.

Experiments vary from average daily gain on a particular forage to the impact of cattle management techniques on deer habitat. Once the cows have been used for a project, Ford and fellow research assistants collect all the necessary measurements and then prepare the cattle for the next project.

"What we do helps the agricultural consultants and researchers, and together we all help the farmers and ranchers," Ford said. "And that's what we are here to do: Help others do more than what they originally thought they could do. I gain a lot of personal satisfaction from helping with that process."

Immeasurable contribution

Although RAs play a vital role in the world of science, the outside world often does not see their contribution. Having been in research for more than 30 years, Richard Dixon, D. Phil., senior vice president and director of the Plant Biology Division, understands the invaluable role of RAs. "Research – be it in a laboratory or a field – would virtually not exist without their dedication," Dixon said. "Their contribution cannot truly be measured, but our successes are their successes. They give a tremendous amount of time and energy to making the research excel."

And sometimes that research gives back in the form of a remarkable life experience. Research Assistant Alan Sparks recently worked with Associate Professor Elison Blancaflor's team, which earned an opportunity to grow plant seedlings in space as part of a NASA shuttle mission.

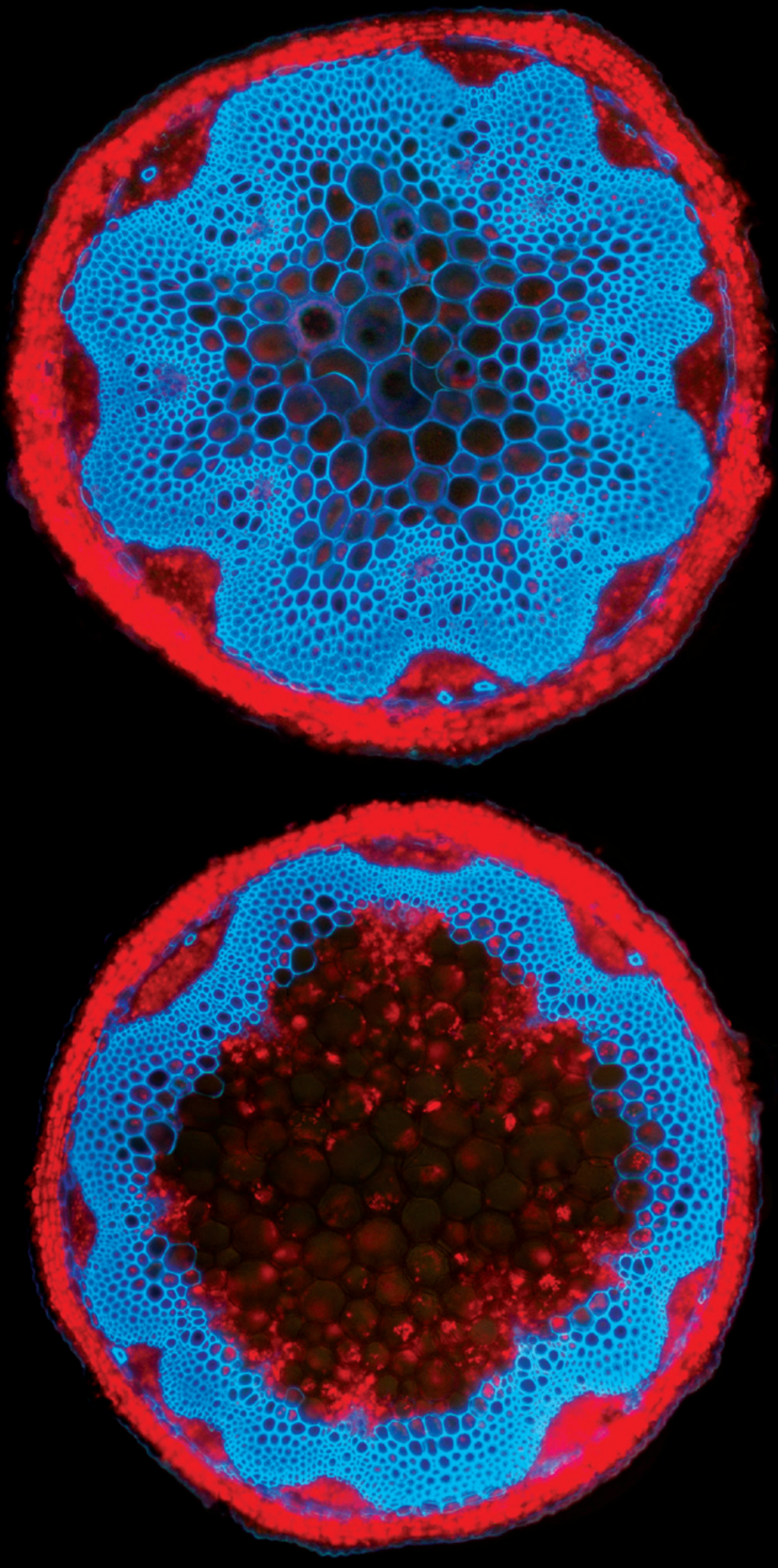
Sparks traveled with the team to Kennedy Space Center and participated in the extensive preparation process. On launch day, Sparks stood beside Blancaflor as the shuttle rumbled into space, standing in awe of the magnitude of the day and the experiment.

"I was able to be part of every test and experience we had at NASA," Sparks said. "How many times do you have an opportunity to do something like that? For the rest of my life I can say I helped send an experiment into space. Not many people can say that." ●

(above) Kevin Lynch, research assistant, (foreground) and Shawn Norton, agricultural research programs supervisor, load a seed drill to prepare for the planting of a research plot. Research assistants and associates on Noble Foundation farms are responsible for the care of research fields and plots. (photo: Broderick Stearns)

(top, right) Yaxin Ge, senior research associate, examines grasses under a microscope. Research assistants and associates serve as permanent employees and help maintain the continuity of a laboratory's research over time. (photo: Broderick Stearns)

(bottom, right) Devlon Ford, research assistant, sorts cattle in preparation for obtaining research data. Ford uses computers and electronic tracking devices to maintain meticulous records on each head of cattle. (photo: Broderick Stearns)



Breakthrough

Recent discovery holds potential for biofuel production and forage crops

by J. Adam Calaway

Noble Foundation researchers celebrated a landmark discovery this fall. Huanzhong Wang, Ph.D., a postdoctoral fellow in Professor Richard Dixon's lab, working with Research Scientist Fang Chen, Ph.D., uncovered a gene responsible for controlling the density of biomass in two model plants (*Medicago trancatula* and *Arabidopsis thaliana*).

The outcome of the research could increase the amount of biofuel produced from an individual plant or improve the yields of important forage crops.

"This is a significant breakthrough for those studying plant-based biofuels," said Dixon, senior vice president and director of the Plant Biology Division. "This discovery opens up new possibilities for producing plants that have been specifically engineered for biofuel production."

The newly discovered gene controls the production of lignin in the central portions of the stems in the model plants. Lignin is a compound that helps provide strength to plant cell walls, basically giving the plant the ability to stand upright. When the newly discovered gene is removed, there is a dramatic increase in the production of biomass throughout the stem instead of merely around the circumference.

Lignin is difficult to digest for grazing animals, so the majority of research on lignin modification looks at reducing its production within the plant. However, increasing lignin in bioenergy crops, such as switchgrass, may be desirable for increasing the density of the biomass throughout the stem, particularly if the biomass is to be converted to gas. "In switchgrass, as the plant matures, the stem becomes hollow like bamboo," Dixon said. "Imagine if you knock out this gene and that hollow portion is then filled in with lignin. The potential increase in biomass in these new plants could be dramatic. We are looking forward to doing these experiments."

Further research by collaborators at the University of Georgia revealed that removal of the gene also increased the production of cellulose and hemicelluloses in the central portions of the stem of the plant. These are the components of the biomass that are converted to sugars for fermentation to liquid biofuels, such as ethanol or butanol.

"If you build a structure that is a cylinder like the stem of a plant, you only need support around the circumference. You do not need the whole cylinder filled in," Dixon explained. "In a similar fashion, plants normally only produce enough lignin to meet their needs; making more lignin, cellulose and hemicellulose is inefficient and wastes vital energy."

Noble researchers compared the densities of plants with the gene and those without by weighing the dried plant stems. The stems of the plants without the gene increased in density by about 50 percent, and the overall aboveground weight of the plants (called biomass) was also increased by up to 30 percent.

"Science often progresses in increments," Dixon said. "Every once in a while, though, you have a significant breakthrough that helps redefine the research. This is certainly one of those moments for our biofuels program."

The project, which is supported by the United States Department of Energy and the Oklahoma Bioenergy Center, also holds the potential to increase both biomass and digestibility in agricultural crops. Through decades of research, Dixon's group has already demonstrated the ability to remove lignin from plants. If he can now combine that work with the recent gene discovery, then presumably new plants can be produced with both reduced lignin and more biomass from the additional cellulose and hemicellulose.

This research was recently published in *Proceedings of the National Academy of Sciences*, one of the world's most cited multidisciplinary scientific serials.

(opposite) These microscopic cross sections of stems from two Arabidopsis plants show the expression of a gene recently discovered by scientists at the Noble Foundation. The plant stem seen on top has much more lignin (the blue material) than the control plant seen below it. The stems were photographed under ultraviolet light to better reveal the presence of lignin.
(microscopy: Huanzhong Wang, Ph.D.)

The Unseen Revolution

Microscopic organisms within plants hold the potential to change agriculture forever

by J. Adam Calaway

Norman Borlaug saved a billion lives during the 1960s. The Nobel-Prize-winning plant breeder is credited as the father of the Green Revolution, the agricultural renaissance that introduced high-yielding crops and Western society's modern production practices to the starving masses of India, Pakistan and Mexico.

The Green Revolution was based on a simple concept: enhance agricultural production by increasing inputs. By taking improved varieties of crops, then adding substantial amounts of fertilizer and water, agricultural producers in these impoverished countries were able to produce abundant crops.

The concept worked in the 1960s, but half a century later Borlaug's solutions are no longer feasible. The next generation of farmers and ranchers will be required to produce record amounts of food, feed and fiber, as well as potential new renewable energy sources, while using less land and fewer resources. Agricultural producers also face significant erosion issues, urban sprawl, a pending pollution explosion and ever-changing geopolitical policies.

Bottom line: A new green revolution is needed.

This microscopic image shows the presence of an endophyte –in this case, a fungus – living between the cells of a switchgrass stem. The brown and tan areas are the plant cells, while the endophyte stands out as blue lines due to a dye that is used to stain the sample. (microscopy: Carolyn Young, Ph.D.)

(above) Kelly Craven, Ph.D., uses a microscope to confirm the presence of fungal endophytes in a grass sample. Craven's laboratory is seeking symbiotic microbes in plants that have the potential to reduce needed fertilizer and water inputs. (photo: Broderick Stearns)

(above) Carolyn Young, Ph.D., slices a grass stem infected with endophytes in preparation for microscopy. Young's laboratory is working to develop grasses that retain the positive effects of endophytes on plant growth while eliminating any potentially negative health consequences on livestock. (photo: Broderick Stearns)

"It's time to change the formula," said Kelly Craven, Ph.D., mycologist and assistant professor at the Noble Foundation. "It's time for a green revolution based on a 'low input, high output' formula. We must increase production while using less fertilizer, water and land. This is a fundamental shift in thinking."

Part of the solution to the "fewer resources, increased production" problem will be found in one of nature's smallest groups of organisms – endophytes. In the simplest of terms, endophytes are microscopic organisms like fungi, bacteria or viruses that live in plant tissue. They form symbiotic relationships with their hosts. In exchange for room and board, endophytes impart special abilities to the plant, such as disease and pest resistance, increased drought tolerance or supercharged growth.

> "If you want to want to improve plant efficiency and production, tap into what nature has already done."
>
> *Kelly Craven, Ph.D., assistant professor*

Craven and fellow Noble Foundation mycologist Carolyn Young, Ph.D., seek to understand the power of these natural relationships and harness endophytes' beneficial effects to increase agricultural productivity. "If you want to improve plant efficiency and production, tap into what nature has already done," Craven said. "Our goal is to find the microbes and combine them with new crops to maximize the potential of the symbiosis."

New variety. New opportunity.

More than a decade ago, Noble Foundation researchers began development of a new type of cool-season perennial grass. The goal was to provide a quality forage for livestock that saved ranchers the expense and time of replanting annual crops like wheat or ryegrasses for grazing. The new forage might also displace a need for costly hay.

As the name implies, cool-season grasses thrive during the cooler months. However, existing commercial varieties could not survive the swelter of southern Oklahoma's blistering summer heat.

Noble researchers soon discovered a variety of tall fescue at one of their research farms that persisted through the summer. Research revealed the grass harbored a fungal endophyte that imparted drought tolerance and persistence to its host. However, the endophyte also produced a compound that caused "fescue toxicosis." The compound (known as an ergot alkaloid) causes cattle to overheat and spend grazing time in water or mud cooling off. "In mild cases, the animal does not eat and simply loses weight, which causes a loss in productivity," Young explained. "In extreme cases, the toxins can lead to the animal's death."

Researchers wanted to keep the positive attributes afforded by the endophyte, but without the devastating side effects. A collaboration with colleagues at AgResearch, an agricultural research and development company in New Zealand (see page 28), provided a perfect solution – a "novel" endophyte association. By replacing the existing endophyte with the animal-friendly version, the tall fescue managed both to persist through the summer and not cause fescue toxicosis.

The new variety of tall fescue, known as Texoma MaxQ II, is currently in field trials before its scheduled release in 2011. Because these endophytes are found throughout nature, researchers can use them without the lengthy regulatory processes associated with genetically modified organisms or transgenic plants. "All we are doing is capitalizing on naturally occurring relationships between two species," Young said. "Of course, those two species are also benefiting another species – humans."

Texoma MaxQ II and endophyte research could also benefit farmers and ranchers in climate regions dramatically different from the Southern Great Plains. Moving east from Oklahoma, tall fescue remains a staple for agricultural producers. The new variety will help alleviate concerns for ranchers who still use an older version of the grass despite potentially negative side effects from endophytes. For these producers, it will be important to determine the endophyte infection rate – another place Young believes her research could help.

"I envision the day when we can take samples of tall fescue leaf samples in the field that can then be rapidly tested in the laboratory to let the farmer know the endophyte status of his field," Young said. "It will be a quality assurance, providing confidence, knowledge and options to producers with tall fescue."

Beyond Texoma MaxQ II, the Noble Foundation's grass breeders and endophyte researchers continue to work toward making land in arid climates more productive. Young's focus now shifts to the possible impact of endophytes in summer-dormant varieties, which hold potential for western Oklahoma.

Further research will be required to truly harness the microscopic marvels that are endophytes. The next generation of mycologists will have to drill deeper to clarify their full range of abilities. Young explained that using advanced genomics, scientists are seeking to understand why endophytes are compatible with their hosts and identifying improved endophyte varieties that could far surpass today's already impressive selections.

"We see a sick plant and try to figure out why it is sick, but we don't always look at the healthy plants and wonder why they are healthy," Young said. "Endophytes are hidden treasures, and, until we go hunting, we will not know the full extent of what they can do."

Luckily, Craven is on the hunt just down the hall from Young.

The smallest prey on Earth

Craven is stalking new endophytes, and he's looking in places most ignore. The endophytes found in cool-season grasses, like the tall fescue Young helped develop, are largely derived from the Mediterranean region. These microbes have been well studied with many types identified and their characteristics documented. Craven is delving into warm-season grasses, where the knowledge of these symbioses is slim.

Switchgrass, a warm-season grass native to the Great Plains, has been targeted as a potential bioenergy crop. The grass also holds promise for traditional agriculture – it grows on marginal land and uses less water and fewer inputs than crops such as wheat and corn, and early studies show that it could be part of a year-round forage system. On the downside, the lack of research into switchgrass has left a hole in the knowledge base. On the upside, the Noble Foundation is located in southern Oklahoma, the center of biodiversity for several warm-season grasses, including switchgrass.

"We want to take advantage of natural symbiotic relationships that occur in switchgrass," Craven said. "This is an amazing plant that takes in so little, but returns so much. We know some of the positive characteristics are likely influenced by endophytes. We need to figure out which ones are playing major roles."

The process is much easier said than done. Craven and his laboratory members collect wild switchgrass (showing no obvious signs of disease) from the extensive grasslands virtually in their backyard, then culture hundreds of fungal and bacterial endophytes found in the roots and shoots. Each strain is evaluated to understand the identity of the endophyte and its putative impact on the plant.

The team tests endophyte impact by introducing each strain into noninfected grass. If the plant shows enhancement in any of a number of growth parameters, then they can assume the endophyte has imparted the effect. While many endophytes offer minimal to moderate enhancements, the team's goal is to find endophytes with dramatic outcomes.

One promising fungal endophyte – *Sebacina vermifera* – has shown astounding results, enhancing both biomass and drought tolerance. In Noble Foundation tests, switchgrass with the addition of *Sebacina* produces over 120 percent more aboveground biomass. Additionally, plants colonized with this *Sebacina* and exposed to severe drought still produced more biomass than uninfected plants under normal water conditions.

> "All we are doing is capitalizing on naturally occurring relationships between two species."
>
> *Carolyn Young, Ph.D., assistant professor*

"These results are remarkable and demonstrate what we can hope to achieve," Craven explained.

Since *Sebacina* is not native to the Great Plains, Craven must find an equivalent strain suited to the region. Other endophytes may prove even more effective under the environmental conditions and soil types of the region. "The goal is to custom design a group of endophytes for a given crop," Craven said. "We can base the endophytes on the crop's deficiencies in a particular ecological habitat."

These deficiencies are being addressed not just by *which* endophytes are being studied, but by *when* they are gathered. Collecting throughout the growing season allows Craven to assess how the endophyte community varies throughout the year and which strains predominate in particular seasons. This insight may help agronomists with one of the trickiest issues – switchgrass is difficult to establish. As a perennial, it puts down extensive roots early, while aboveground biomass lags. This allows weeds to choke out the grass and prevent stand establishment.

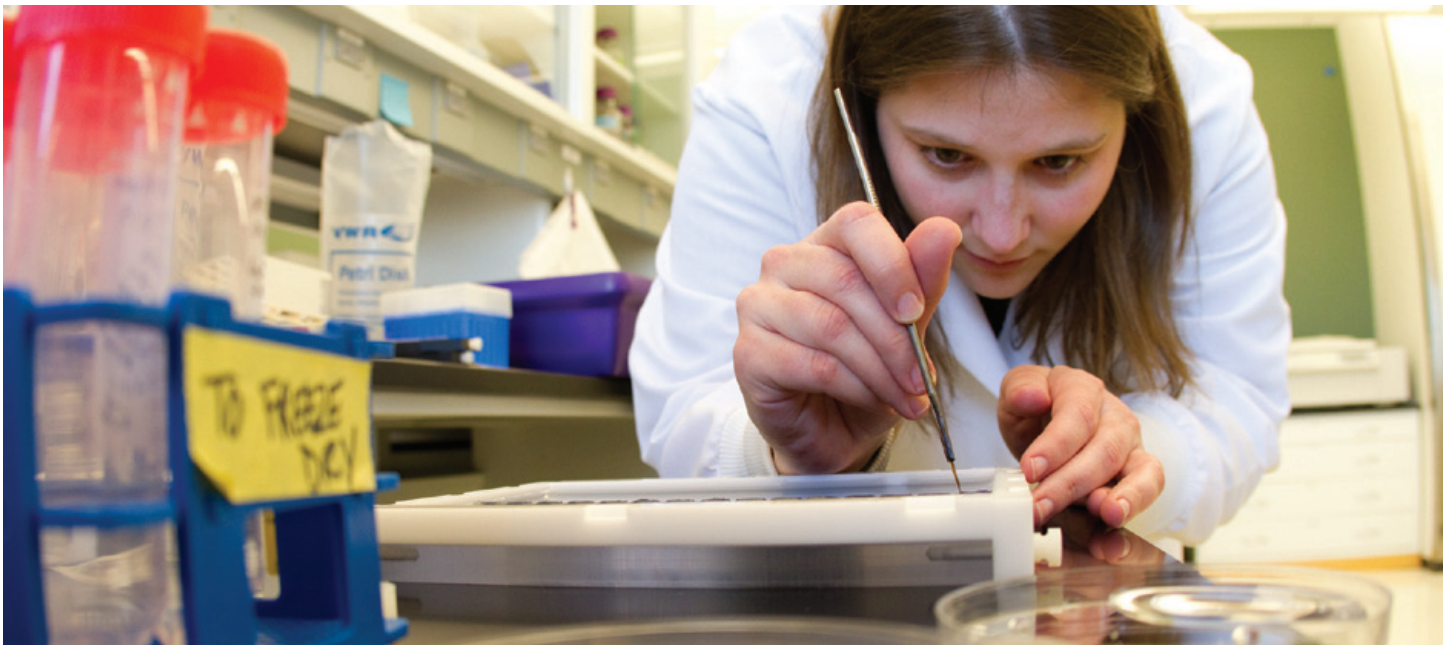
Craven's team specifically searches for endophytes that might be active or predominant during the early months of the growing season, improving switchgrass's chances of establishment. "These symbioses will help solve some of the initial issues facing switchgrass as well as minimize input costs, such as the need for fertilizer," Craven said. "This will help make biofuel crops more cost-effective and competitive with petroleum."

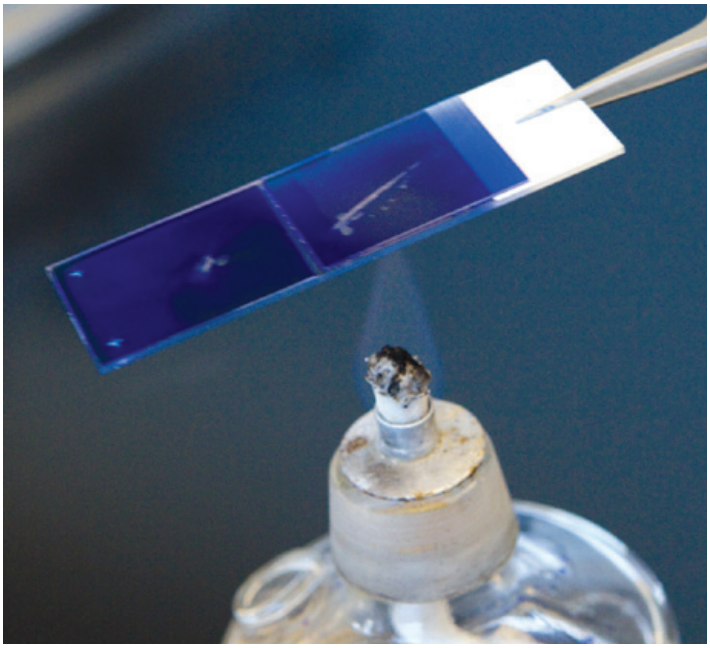
Another friendly endophyte

While Craven's focus has remained primarily on the endophytic fungi, he has amassed a large collection of endophytic bacteria from native switchgrass. Craven is collaborating with Daniel van der Lelie, Ph.D., from Brookhaven National Laboratory, to evaluate these strains. Research from van der Lelie has already shown that hybrid poplar trees – another promising bioenergy crop – can grow on soils laden with heavy metals or toxic toluene when colonized with a particular strain of bacteria. A similar project is underway to see if bacteria-infected switchgrass can grow on toxic or nutrient-deficient soils.

Craven and fellow Noble Foundation researcher Michael Udvardi, Ph.D., are investigating the potential of these endophytic bacteria and what role they may play in nitrogen acquisition in switchgrass. Craven also believes that endophytic bacteria might be able to fix nitrogen for the plant much like rhizobia bacteria do in legumes.

"Endophytes will undoubtedly play an increasingly larger role in the low-input age," Craven said. "The Green Revolution saved a billion lives, but required extensive fertilizer inputs which are too expensive and environmentally damaging. We need another revolution; but one that is cheaper and built on a model from nature. These hidden endophytes can help facilitate that. I guess you could say this is an unseen revolution." ●





(top) Johanna Takach, Ph.D., a postdoctoral fellow in Dr. Carolyn Young's laboratory, carefully places tiny slivers of a gel bearing the DNA of a fungal endophyte into a larger mold. After a 15-day incubation, the gel will reveal the chromosome structure of the endophyte. (photo: Broderick Stearns)

*(bottom, left) Switchgrass (*Panicum virgatum *L.), a warm season grass, has demonstrated improvements in both yield and tolerance to drought when infected with endophytes. The grass, which is native to the Great Plains, is a candidate for use as a biofuel feedstock as well as a forage crop for livestock. (photo: Broderick Stearns)*

(bottom, right) A slide with thinly sliced pieces of plant tissue, is heated to remove air bubbles in preparation for microscopy. A blue dye penetrates any fungal endophytes that are present in the sample and makes them visible under a microscope. (photo: Broderick Stearns)

Destined for the Role

Recently named director leads the Forage Improvement Division into the next generation of plant breeding

by Debra Levy Martinelli

You might say that destiny brought E. Charles Brummer, Ph.D., to the Noble Foundation. In one way or another, the new director of the Noble Foundation's Forage Improvement Division has spent his entire life in plant science. As a small child, his family moved from his birthplace on Long Island, New York, to a farm in central Pennsylvania, where the family business was retail vegetable farming.

He obtained a bachelor of science degree in agronomy from Pennsylvania State University. As he contemplated graduate school options, he met Joe Bouton, Ph.D., who at the time was teaching and conducting research into forages at the University of Georgia at Athens. Bouton made quite an impression on the young undergraduate, who applied and was accepted to UGA. Bouton became his professor and mentor.

After earning master's and doctorate degrees in agronomy with a specialization in plant breeding, Brummer left UGA for Iowa State University, where for a dozen years he taught and conducted research in his chosen field.

Back in Georgia, Bouton was finalizing his career at UGA, retiring from the institution to assume the directorship at the Noble Foundation. Brummer – with encouragement from his mentor – applied and landed the job as full professor at UGA and became the first director of UGA's Institute of Plant Breeding, Genetics and Genomics.

"In some ways, it was a difficult decision to return to Georgia," Brummer recalled. "I started a program from nothing at Iowa State. I'm a plant breeder, so it takes a long time to get the right materials put together and try to develop a new variety. I was just at the point where things were starting to come together. But returning to UGA meant assuming leadership of Joe's excellent program, which was well set up for the things I wanted to do."

Four years later, he once again had an opportunity to follow in his mentor's footsteps. Bouton, the first and only director of the division, announced that he wished to relinquish that role, but remain on the faculty and continue to run his research programs. Once again, Brummer was the perfect person to fill Bouton's shoes.

(opposite) Charles Brummer, Ph.D., an internationally renowned plant breeder, assumed leadership of the Noble Foundation's Forage Improvement Division in August 2010. (photo: Broderick Stearns)

About the Forage Improvement Division

Formed in 1997, the Forage Improvement Division translates fundamental plant science into tangible plant varieties that can be used by agricultural producers in the Southern Great Plains and similar climates worldwide. Forage Improvement researchers use a broad range of techniques, from conventional breeding to emerging biotechnology, to improve forage plants.

"Dr. Brummer is known throughout the United States and around the world as one of the best in forage breeding and improvement," said Michael A. Cawley, president and chief executive officer of the Noble Foundation. "Beyond this wealth of experience and vast subject knowledge, his character and leadership make him the ideal steward of the Forage Improvement Division."

So in August 2010, Brummer took another destiny-fulfilling step and moved to Ardmore, Okla., headquarters of the Noble Foundation. "Ardmore is a nice community, and the people are friendly and welcoming," he said. "And there's a lot going on in the region. Besides the

local Charles B. Goddard Center for Visual and Performing Arts, Norman and the Dallas-Fort Worth area are both only an hour and a half away. So you get small town charm and metropolitan entertainment options."

At work, Brummer became director of a division with more than 50 scientists, researchers and support personnel that translates basic plant science research into tangible plant varieties for use by farmers and ranchers.

In addition to being reunited with his mentor, colleague and friend, Brummer was drawn to the position because he already knew the division's other scientists as well. "The forage breeding world is not large, so even if you don't know people worldwide, you know their names," he explained. "I knew the people here and had collaborated with many. That helped me make the decision to come. I'm very glad I did."

So is Bouton.

"In just a short time, Charlie has proven that he is a perfect fit for the Forage Improvement Division," he said. "He is an outstanding scientist and has devoted his career to helping the forage producer. I am delighted that he has joined us and that we have the opportunity to work together once again."

Brummer returns the compliment.

"This division works as a team, which is a testament to Joe's leadership," Brummer said. "The fact that we have great people here sets us up to do great things. With our resources and faculty, we are at the forefront of developing and applying new technologies that fit directly into farmers' production systems and improve their profitability. That's the bottom line. If our work doesn't do that, then it isn't really useful."

To that end, Brummer focuses his research efforts on increasing yields of alfalfa and tall fescue. On alfalfa, he collaborates with Bouton and Assistant Professor Maria Monteros, Ph.D.; on tall fescue, he partners with Bouton, Associate Professor Malay Saha, Ph.D., and Assistant Professor Carolyn Young, Ph.D.

"My program is mostly in the field, while Maria and Malay's are primarily in the laboratory. Carolyn works with endophytes, a fungus that gives a plant stress tolerance and resistance to certain pests, but can also make animals sick," Brummer says. "Joe's role has evolved into the end of the cultivar development process: increasing seed, ensuring the necessary paperwork is in place for product release and working with our commercial partners, all of which are critical to our success."

Other members of the scientific dream team are Zeng-Yu Wang, Ph.D., professor and associate division director, who uses genetic modification to improve forages, and Associate Professor Twain Butler, Ph.D., who is responsible for evaluating the cultivars and developing the best management practices for them.

Their specific interests may vary, but their goal is the same: work as a team, avoid duplicating each other's programs and head in the same direction. "Teamwork is the foundation for developing cultivars," Brummer explains. "Then we all apply our specific science to help improve the process."

That science could be new and improved traditional breeding methods or technologies derived from molecular breeding. Either way, he says, there are plenty of opportunities for success.

While the division's chief objective is improving grass, legume and small grains forages, it recently has expanded into the realm of cultivating perennial grasses for bioenergy use.

"Breeding grass for bioenergy is basically the same as breeding it for forage," Brummer explained. "At the Noble Foundation, we are set up to do this work better than anybody. Through external grants and private industry partnerships, we are working to develop switchgrass as a bioenergy source."

With the programs in constant motion, Brummer has no intention of disrupting an already humming operation. He is, however, looking toward the future.

> "Teamwork is the foundation for developing cultivars. Then we all apply our specific science to improve the process."
>
> *Charles Brummer, Ph.D., senior vice president and division director*

In November, he convened a strategic planning retreat for division scientists. A major topic was how to find the right person for an open faculty position.

"We could go in a number of different directions, and we want to make sure we get the expertise that is going to set us up for the next 10 to 15 years or more," he explained. "With forage breeding, everything is long-term – it takes 15 years to develop a new variety. Seven years from now we don't want to say, 'Why are we doing that? Let's change.'"

Whether it's today or a decade down the road, though, Brummer aspires to be a careful, yet visionary steward of the Noble Foundation's mission.

"My goal is to get what we develop out to farmers and ranchers," he said. "If we have a commercial partner, that's great. If we work with a group of farmers to put together a seed production program, that's fine, too. But if we don't release varieties, we're not doing the job that we set out to do. The Noble Foundation has an outstanding reputation that is well deserved, but we can't rest on our laurels. We have so much expertise and so many opportunities. There aren't many places in the world that do what we're doing. That's what makes the Noble Foundation an exciting place to be."

And, possibly, Brummer's destiny. ●

(above) Charles Brummer, Ph.D., discusses the progress of alfalfa research with Xuehui Li, Ph.D., a postdoctoral fellow in Brummer's laboratory. (photo: Broderick Stearns)

Malay Saha, Ph.D.

Associate Professor, Forage Improvement Division

When Malay Saha was 7 years old, he recited poetry to a large crowd. As he stood on the podium, he was amazed at how the microphone amplified his voice. That night, he went home and successfully built his own microphone with two coconut shell halves and a rope intended to be used to tie cattle to a peg. He knew then that he wanted to be a scientist and so began a journey that would lead him to the Noble Foundation and the exploration of plant genes for the improvement of forage crops.

On becoming a plant breeder:

Bangladesh is about two-thirds the size of Oklahoma with more than 150 million people. In a country so densely populated, many people go without food and shelter. Plants can provide shelter, food and clothing, and a breeder can create something new by designing a plant to meet specific needs. I thought it would be so interesting to be able to manipulate the plant growth process to produce a more nutritious and higher yielding plant. I cannot imagine a greater way for me to contribute to my country and the world.

On coming to America:

While I was working at the Bangladesh Agricultural Research Institute, I received a scholarship from a project funded by the World Bank to pursue my doctorate degree from a university of my choosing. I never imagined coming to the United States before this opportunity. I mulled over countless options before deciding on North Dakota State University (NSDU). It is funny because I had never even heard of North Dakota State, but I had a friend who went there and encouraged me to attend NDSU. Before I finished my Ph.D., I learned of an opening at the Noble Foundation, which was perfectly suited to my field. Everything just lined up perfectly.

On Lloyd Noble's vision:

Before I came to Ardmore, I read about Lloyd Noble. I was amazed that an oilman could care so much about the land and benefiting mankind. He reminded me of a man from my home district in Bangladesh named R.P. Saha, a successful businessman. He founded a charity hospital for the poor, a residential school for girls and a few colleges for mass education. I fell in love with Lloyd Noble's vision right away, and I am honored to work at the Noble Foundation.

On molecular markers:

Molecular markers are a primary tool in my research. They allow plant breeders like me to screen large populations of plants for traits of interest. Molecular markers are like road signs for the genome, allowing you to spot whether the plant has the gene of interest. They significantly speed up the plant selection process. A digestibility selection cycle that previously took a year and a half now can be done in three months. We are currently performing the first marker-assisted breeding program ever attempted with tall fescue. Though we are analyzing many traits, this could eventually lead to a more digestible and disease-resistant tall fescue for cattle.

On his career:

I came to the Noble Foundation in 2002 as a postdoctoral fellow. In 2004, I got the opportunity to lead the grass genomics and small grains breeding program of the Forage Improvement Division. I was interested in expediting the plant breeding process. I have been given the freedom and the resources to follow the research wherever it leads me.

On his hobbies:

I grew up playing the tabla, a type of drum. I rarely have time to play anymore, but I played as much as I could throughout school and even into university. I also enjoy cricket. I played a lot in my youth. I follow the Bangladesh national team closely. There are a few cricket fans at the Foundation, and we have been known on occasion to get the bats out and play a little bit.

On his family:

When I'm not working, I want to be with my family. I love my wife, Rita, and my children, Moumita and Raman, so much. They are the best part of my life.

by Baxter Stewart

Partners in Success

Collaborations are moving scientific and agricultural research to the farmer's doorstep and the world

by Debra Levy Martinelli

Winston Churchill once said, "If we are together, nothing is impossible." Such are the relationships forged between The Samuel Roberts Noble Foundation and its collaborators across the country and around the globe to advance research, generate productive solutions and develop commercially viable innovations for agricultural producers.

While the Noble Foundation collaborates with countless universities on research, it relies upon its commercial relationships to move new and improved plant varieties to the marketplace. Three specific entities play key roles in bringing the final product of Noble Foundation agricultural research and plant science to the public: Forage Genetics International, the world leader in value-added alfalfa genetics; Ceres Inc., a premier developer of energy crops for biopower and biofuels; and Grasslanz Technology Limited, a research and development company dedicated to growing food and textile farming within New Zealand.

Improving Alfalfa

The Noble Foundation's association with Forage Genetics International, a wholly owned subsidiary of Land O' Lakes Inc., began a decade ago when Forage Genetics purchased the assets of a bankrupt company that had an existing research agreement with the Noble Foundation.

"We specifically bought the assets because we were interested in the collaboration that had been formalized with the Noble Foundation," said Forage Genetics President Dr. Mark McCaslin, who is based in Minneapolis. "Two days after the transaction was completed, we flew to Ardmore to discuss continuing and expanding that collaboration."

When the relationship began, the primary research focus was lignin. Lignin is a component of plant cell walls that makes them hard to degrade and, therefore, more difficult for livestock to digest. A team led by Richard Dixon, D. Phil., Noble Foundation senior vice president and director of the Plant Biology Division, identified the steps in making the lignin molecule and isolated the genes that control such steps. "By knocking out any one step, the plant produces less lignin," Dixon explained. "We have done that to successfully develop lines of alfalfa with lower levels of lignin in stems and leaves. That trait has been introduced into Forage Genetics' alfalfa varieties and tested in different parts of the United States."

The technology is far enough along that Forage Genetics has initiated the deregulation process necessary to offer the improved varieties to commercial growers. "It took 10 years to develop those varieties, and it will take another five to six years to deregulate them," McCaslin explained. "But 15 years is not atypical for going from proof of concept to commercialization."

A second Noble Foundation/Forage Genetics project has yet to reach the proof-of-concept stage, but is well under way. "About six years ago, Forage Genetics told us it was interested in a solution to pasture bloat, a condition often attributable to alfalfa," Dixon said. "Because of the high protein content in alfalfa, grazing animals can produce excessive amounts of methane gas that can build up and cause discomfort or even death."

Tannins are chemical compounds within plants that can bind to proteins, causing them to be digested more slowly, which reduces gas production. Less bloat means more meat and milk, and less urinary excretion of nitrogen. "The catch is that tannins in alfalfa are expressed in the seed coat. Our job is to move tannin

(opposite) Hem Bhandari, Ph.D., (center) research scientist, and Malay Saha, Ph.D., (center, right), associate professor, discuss switchgrass field trial results with representatives from Ceres, Inc. (photo: Broderick Stearns)

production to the stems and leaves of the alfalfa plant," Dixon explained.

He said that plant breeders have tried to get tannins into alfalfa by conventional breeding, but haven't succeeded. "We need biotechnology to do it. We know that tannins can be engineered into research plants, but we need to prove that concept in alfalfa. When we do, we will have a very important trait."

The Noble Foundation/Forage Genetics collaboration continues to expand. "What's exciting to me is how broad it is," McCaslin said. "Our work with Dr. Dixon on lignin and tannin modification is basic research where we ask, 'What can we do to make alfalfa a more valuable forage crop?' With Dr. Joe Bouton (professor of the forage breeding lab), we take that a step further by asking, 'How can we work together on breeding?' And with Assistant Professor Dr. Maria Monteros, we're working on molecular markers to speed up that development."

Dixon is equally enthusiastic, explaining: "Not only does Forage Genetics provide a commercial outlet for our technology, the company also works closely with us to develop it. As Forage Genetics moves our technology into alfalfa breeding programs, we receive valuable feedback that helps us better target the basic science behind it. It is a mutually beneficial relationship."

Switchgrass: Energy's Future

In 2006, the Noble Foundation and California-based Ceres Inc. established a strategic relationship to develop and commercialize energy crops made from switchgrass. Initial projects expanded the Noble Foundation's conventional and molecular breeding program with Ceres' markers and other genomics technologies.

"Ceres has been in the biotech traits discovery and development area since 1997," said Dr. Jeff Gwyn, the company's vice president of breeding and genomics. "In the mid-2000s, we decided to advance into areas of energy crops. As a biotech company, however, we didn't have access to germplasm varieties and looked to the important players in that area."

The Noble Foundation was one of those players. At the time, Joe Bouton, Ph.D., served as director of the Forage Improvement Division. His reputation as a plant breeder was a leading factor in Ceres selecting the Noble Foundation to develop switchgrass for biofuel and bioenergy applications. "Bouton, along with the entire Noble Foundation team, is renowned in his field and has an excellent history of improving perennial grasses," Gwyn said. "The high performing switchgrass plants they develop are robust with high biomass yields and good biofuel properties. That was attractive to us."

In addition to expanding the Noble Foundation's conventional and molecular breeding programs, the collaboration provides Ceres with access to its extensive breeding infrastructure and an exclusive license to elite switchgrass cultivars.

The collaboration already has resulted in Ceres licensing and commercializing the world's first switchgrass varieties developed specifically for bioenergy production. To date, the company has launched three switchgrass varieties, as well as several sorghum varieties, under the trade name Blade Energy Crops®.

"We are developing varieties that will serve the entire North American market, certainly," Gwyn said. "But the climate in which switchgrass grows on this continent is similar to the climate in other places in the world, so there also will be a global market for our products."

In addition to world-class expertise in varietal development, Gwyn said, the Noble Foundation offers field experience and an understanding of the practical needs of agricultural producers.

"With its breeding, agronomy and practical educational expertise, the Noble Foundation offers growers a complete support package, which will be needed as the industry moves to larger scale projects," Gwyn said.

Mutual Trust and Respect

The Noble Foundation's current collaboration with Grasslanz Technology Limited is the consequence of a long-standing relationship between the Noble Foundation's Joe Bouton and New Zealand's AgResearch Limited, Grasslanz's parent. Bouton's work with AgResearch began in 1993 when he was at the University of Georgia. This history established a basis for a new, productive interaction between Grasslanz Technology Limited, a research and commercialization subsidiary of AgResearch and Noble when Bouton came to head the Forage Improvement Division a decade ago.

"The relationship between Grasslanz Technology and the Noble Foundation has been built on mutual trust and respect for the strengths of both organizations, at the researcher-to-researcher level and at the senior management level," said John Caradus, Ph.D., Grasslanz Chief Executive.

The initial aim, Caradus said, was to link AgResearch's strengths in endophyte research and clover breeding with the Noble Foundation's breeding programs to provide better forages for farmers in Oklahoma and the Southern Great Plains.

Current projects include:

- Use of novel endophytes (a bacterium or fungus that lives within a plant for at least part of its life without causing apparent disease) that provide better persistence to perennial grasses.
- Breeding drought-tolerant varieties of Mediterranean tall fescues.
- Breeding improved white clover, red clover and annual legumes.
- Mapping and researching the biology of endophytes.

Several Noble Foundation/Grasslanz collaborations have yielded products that will soon be in the marketplace. Caradus said a tall fescue that contains an AgResearch novel endophyte is expected to be commercially released in 2011. Two legume cultivars are undergoing final testing prior to release, and another two varieties are about a year behind them.

"Much of the research has a local focus on assisting Oklahoma farmers to improve the profitability of their farming systems," Caradus said. "But we also are focused on assessing the potential benefits of new technologies we develop together across other international markets." ●

What's your soundtrack?

American Bandstand host Dick Clark often said, "Music is the soundtrack of your life." Clark's iconic statement still rings true today as lyrics and melodies so often intertwine with an individual's fondest memories and landmark life moments. Likewise, music plays a smaller role in the daily rituals of life, including at work, where oftentimes a song just seems to encapsulate one's occupation. Four Noble Foundation employees revealed their on-the-job playlists and discussed how particular songs are the soundtracks to their work. And some of these songs Clark surely has never heard.

David Huhman
Facility Coordinator

"I work in the mass spectrometry laboratory where we sort and weigh individual atoms and molecules, so obvious musical choices include the classic *It's a Small World, All the Small Things* by Blink 182 or *2 Atoms in a Molecule* by Noah and the Whale. However, none of these come close to *Reach That Peak*, a funny promotional video by Agilent, the company that makes the mass spec instruments. They manage to discuss chemistry, sample matrixes and peaks – all to a poppy disco beat, Barry White mash up. It's a classic ditty in my world."

Johanna Takach, Ph.D.
Postdoctoral Fellow

"Our mycology laboratory is staffed entirely by women scientists, so two songs pop immediately to mind. The first is *She Blinded Me With Science* by Thomas Dolby, a classic early '80s pop tune that's best known for its synthesizer-driven melody. The song represents my view of my fellow laboratory members, who are truly amazing scientists. The second is the Beatles' *Come Together* because we study the relationships between our fungal endophytes and their plant hosts, and all the fascinating things that happen when two organisms combine."

Will Moseley
Wildlife Consultant

"Van Morrison's *Days Like This* describes my job perfectly. To me, the song is about the perfect day. A day when "no one is complaining," and "everything falls into place like the flick of a switch," and "when people understand what I mean." That's my job as a wildlife consultant. I am one of the lucky people in the world who truly has a job that they love. I help agricultural producers and land stewards every day so they are all *Days Like This*."

David McSweeney
Greenhouse Manager

"My musical selections depend on what task I'm performing in the greenhouse. If working among the redwood-sized stacks of papers in my office, it would be The Cure's *A Forest*. If I'm scouting for pests, it's *I Still Haven't Found What I'm Looking For* by U2. And if I am spraying, I listen to *I Got You (I Feel Good)* by James Brown. But, ironically, the number one most commonly played song on my iPod right now is *Photosynthesis* by Frank Turner. It's a great song about staying young; perfect for someone working with seedlings all day."

photo: Broderick Stearns

Burning the Midnight Oil

by J. Adam Calaway

For the record, this column was my wife's idea. About a year ago, we took in a late movie that let out about midnight. As we passed the Noble Foundation campus on our way home, she noted that offices in every building were illuminated, seemingly full of activity despite the late hour. Like most wives, she said something that ultimately ended up causing me more work. "That's amazing to see all those people up there this late," she said. "I wonder who is up there and why? You should write a column about that." There it was – my assignment. She had managed to give me a honey-do at my own job. That takes skill.

However, the idea was too good to pass up so I filed it away for another day, which ended up being a completely average Tuesday in late fall. As I pecked at stories for the magazine you're reading, I found myself compelled to finally answer her question.

As I contemplated a romp around campus, Dennis Bunce, one of our 24-7 security guards, walked into my office. When I told him my intention to explore, he laughed and said, "There's always someone here. I've never seen a day that there wasn't someone here late. Experiments have to keep going. Plants in the greenhouse need attention. Science doesn't stop just because the sun goes down or it's a holiday." Then he provided a piece of advice: "The tunnels are a little creepier at night, so steer clear." I, of course, ignored this advice. It was the first really cold night of the year and using the underground tunnel system to jump from building to building only made sense. Besides, as a child of the '80s, I ain't afraid of no ghosts. Turns out I am.

I've walked through the 1,200-foot tunnel system hundreds of times. And even though there are no windows to distinguish between day and night, the steam pipes were not adjusting to the colder weather well. They popped and crackled like a horror movie soundtrack, and I walked (OK, I sprinted) to the Forage Improvement Division building, where I found postdoctoral fellow (postdoc) Chuanen Zhou, Ph.D.

Postdocs put in long hours, honing their craft to become full-fledged scientists. With a Chinese talk show playing on his laptop, Zhou carefully dissected the prickly seed pods of *Medicago truncatula* wearing Band-Aids on his forefinger and thumb to keep them from becoming pin cushions. The project, which aims to discover the results of breeding experimental plants, could ultimately improve both agriculture in the Southern Great Plains and his career. "Postdocs work under pressure – not just from their superiors or the industry – but internally," he said. "We work late because we want to help our laboratory, agricultural producers and our careers. I'm working to better myself."

Across campus in the Plant Biology Division building, I heard Yasuhiro Ishiga long before I saw him. Light from his laboratory streamed into the blackened hallway as did the unmistakable rhythm of techno dance music. Ishiga, another postdoc, sequenced DNA while the chest-thumping cadence overwhelmed every other sound. Most days, Ishiga goes home at 5 p.m., helps his wife get their two children to bed and then returns to work several more hours. "I love my research," he says. "In the evenings, I'm able to work without interruptions. The music – it relaxes me." He laughed. "It sounds funny, but the system works."

One more building over, Dan Childs, agricultural economics consultant, sat in his office writing an article that will go out to several thousand farmers and ranchers who participate in the Noble Foundation's consultation program. Childs has spent 33 years at the Noble Foundation and, during his tenure, he has burned his share of midnight oil. His personal insight provided the ultimate summation of the night. "We all have that internal bar that we must reach," he said. "I want to satisfy my expectation of myself so that I can go home and lay my head down on my pillow and say I did the best I could today."

With that, it was time to go home. I had a lot to tell my wife.

image: Noble Foundation Archives

(above) Photos from a 1950s research notebook show small grains research plots and harvest on the Noble Foundation's Headquarters Farm. Nearly 60 years later, similar research continues in these same fields. Small grains studied by the Noble Foundation include rye, wheat, oat and triticale, a rye/wheat hybrid. (image: Noble Foundation archives)

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(below) Integrity Beef cattle are sold under the watchful eye of an auctioneer for OKC West Livestock Market in El Reno, Okla. Integrity Beef is a program under which cattle are raised using a strict health and tracking protocol developed by the Noble Foundation's Agricultural Division. (photo: Broderick Stearns)