Legacy

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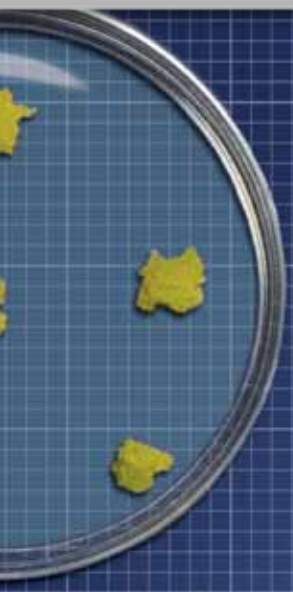
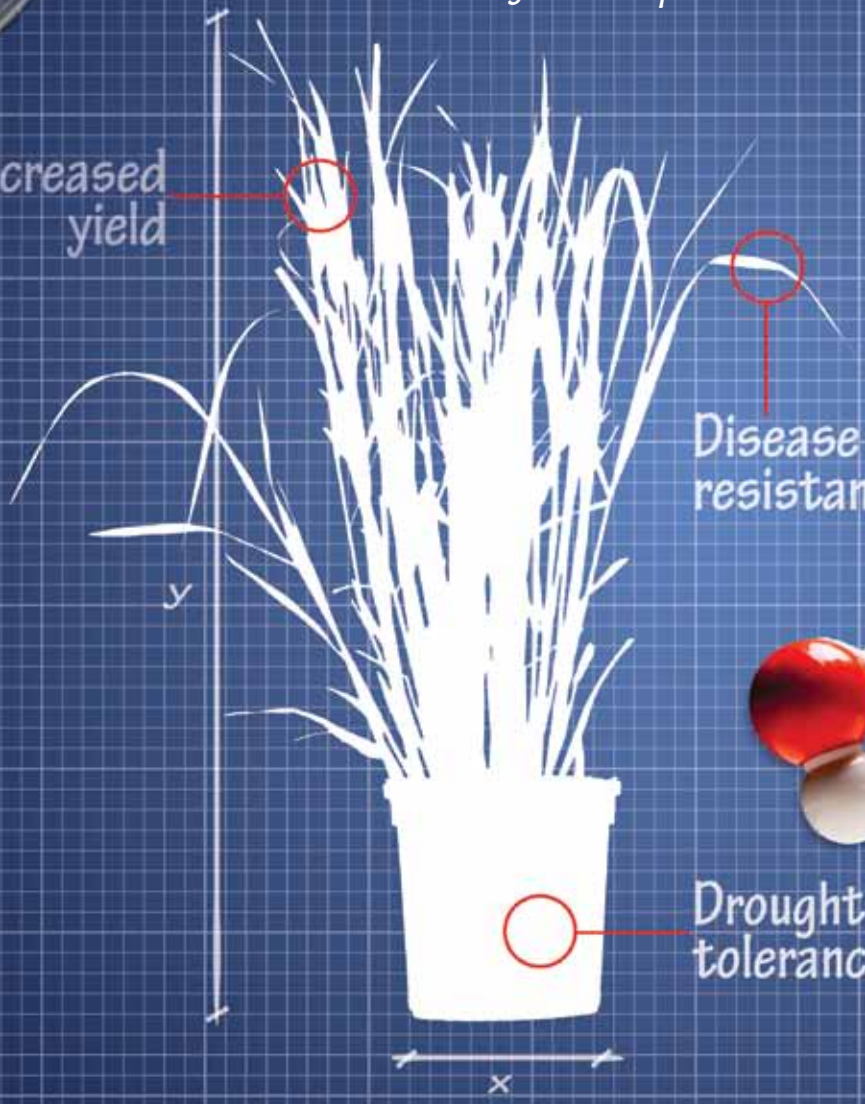
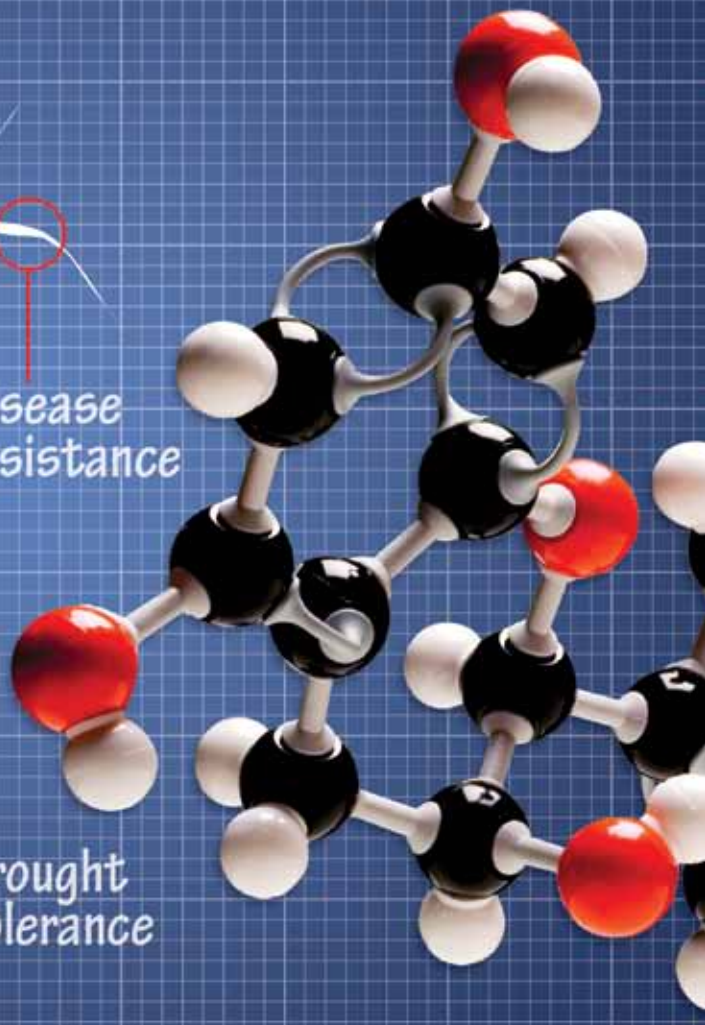


Building better forages

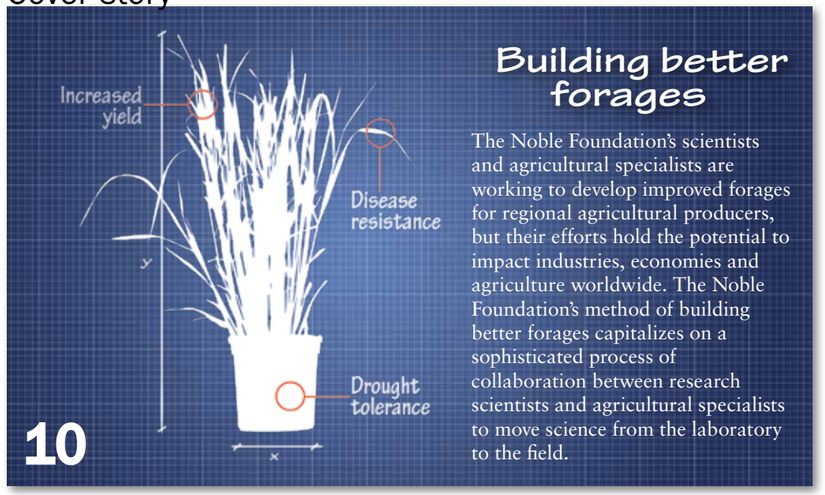
The Noble Foundation's development of new forages for regional agricultural producers holds the potential to impact the world





Plus: Guardians of the Land __ Dear Diary __ Beakers and Bikes

Cover story



Building better forages

The Noble Foundation's scientists and agricultural specialists are working to develop improved forages for regional agricultural producers, but their efforts hold the potential to impact industries, economies and agriculture worldwide. The Noble Foundation's method of building better forages capitalizes on a sophisticated process of collaboration between research scientists and agricultural specialists to move science from the laboratory to the field.

Features

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On the Cover

The cover illustration depicts the Noble Foundation's process of forage development, which begins with plant molecular science or advanced plant breeding, with the ultimate goal to produce improved forages.

Illustration _ Scott McNeill

16 Guardians of the Land

For more than five decades, the Noble Foundation's agricultural specialists have been assisting farmers and ranchers in Oklahoma and north Texas. Their work continues a rich heritage and serves to fulfill one of the Noble Foundation's primary missions.

Hugh Aljoe (left) and Jeff Ball (right) consult with a farmer. Agricultural specialists tailor a plan to help each farmer and rancher meet their quality-of-life goals.

Photograph _ *Broderick Stearns*

THE SAMUEL ROBERTS NOBLE FOUNDATION

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

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> "Lloyd Noble held a steadfast belief that a small band of dedicated individuals with a common goal would undoubtedly make a significant difference."

The pursuit of purpose

To our readers,

If history teaches us anything, it is that if we are persistent in our endeavors, we will find success. Renowned British Prime Minister Benjamin Disraeli believed in a similar affirmation saying, "The secret of success is constancy to purpose."

A man named Lloyd Noble shared this idea. In fact, he embodied it. Dedication to his pursuits – as a visionary oilman, a humble philanthropist and a committed land steward – was one of Noble's greatest attributes. It was also a fundamental building block of The Samuel Roberts Noble Foundation, which Noble established in 1945 to help preserve Oklahoma's greatest natural resource – the land. Noble held a steadfast belief that a small band of dedicated individuals with a common goal would undoubtedly make a significant difference.

Throughout the past six decades, the Noble Foundation has grown into a world-class research organization, making landmark discoveries, while strengthening its generational relationships with the stewards of our land. Success has driven growth, and growth has offered an array of new opportunities.

The seduction of success, however, has not redirected us from our charted course. Rather, success propels us to stretch and embrace new possibilities that bolster our prescribed undertaking, while never abandoning our true identity. Even as the Noble Foundation puts the weight of its expertise and experience behind state and national efforts to create a cellulosic biofuels industry, we remain focused on our core mission.

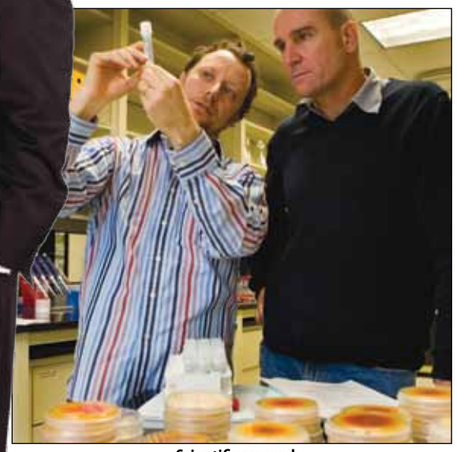
At the heart of the Noble Foundation's efforts remain two primary pursuits – the agricultural consultation program and scientific research to improve plants. These two activities are the core of the Noble Foundation, working jointly, but in unique manners, to achieve our mission.

The Agricultural Division's consultation program has assisted thousands of farmers and ranchers through five decades of service and currently helps more than 1,400 agricultural producers achieve their quality-of-life goals. Likewise, Noble Foundation scientists push the boundaries of plant science to discover novel manners of building better forages, work which will impact the lives of farmers and ranchers not only in our region, but in our country and around the world.

So this, the second issue of *Legacy*, is a view inside the Noble Foundation's principal activities. This is more than a mere explanation of agricultural and scientific programs. This is a snapshot of who we are. This is a glimpse into our purpose and our steadfast pursuit of it.

Sincerely,

Michael A. Cawley
President and Chief Executive Officer



Scientific research

Agricultural consultation

Dear Diary

For 11 weeks each summer, the halls of the Noble Foundation fill with the buzz of youthful enthusiasm. Interns from all corners of the United States arrive in southern Oklahoma. Each brings a wealth of energy and education. Each comes with expectations and anticipation. Each arrives focused on sharpening their skills and gaining invaluable, real-world experience.

While internships will always remain a discombobulating experience when the application of education collides head on with the reality of daily duties, Noble Foundation internships stand far removed from the coffee-fetching, paper-sorting experiences typically designated for youth.

At the Noble Foundation, interns instantly become full-fledged team members, working side-by-side with professional scientists and agricultural specialists. The Noble Foundation supports several unique internship opportunities including laboratory internships, Internships in Applied Agriculture and the Summer Research Scholars Program.

As interns with the Noble Foundation's Agricultural Division, students work with members of the agricultural consultation or research teams on applied agriculture research projects aimed at directly impacting the farmers and ranchers of southern Oklahoma and north Texas. As part of the Summer Research Scholars Program, interns are matched with a mentor scientist and conduct their own scientific research.

More than just work, these internships are – if only for a few weeks – a dip into the pool of life, both refreshing and frightening. In the following pages, two interns – Myriah Johnson (agricultural) from Oklahoma State University and Stacy Schaefer (plant science) from Emory University in Georgia – open up their diaries to reveal the summer they spent at the Noble Foundation. From their quiet victories and embarrassing missteps to their outside activities and fond farewells, this is a peek into the founding moments of two careers.

It's a rare and honest perspective from a future scientist and a future agricultural specialist. And it's probably the only one where softball and dancing play supporting roles. ▶

Photographs _ *Broderick Stearns*
Edited _ *J. Adam Calaway*

Monday, May 14 (Day 1)
I was pretty apprehensive today, but my fears were eased when I arrived and was greeted by many friendly co-workers. I spent much of my first day going through my Human Resources training, where I also met the other interns for the Agricultural Division – all boys.

Tuesday, May 15 (Day 2)
I received my project for the summer: determining the profitability of preconditioning cattle in Oklahoma for the past 10 years. I don't know much about it, but I'm ready to get going. I started on my literature review. I was also invited to softball practice. I've never played softball before, so I was a little worried, but I took my turn at bat. I did all right, so I think I'll keep going.

Friday, May 18 (Day 5)
I attended two presentations by candidates who are applying for the open economics specialist position on one of the consulting teams. It was really helpful to see the interview process and learn what I will have to do after I graduate. I doubt many other interns get this experience.

Tuesday, May 22 (Day 9)
I continued my literature review. There is a lot to learn. Our first league softball game was tonight. I was a little terrified when I was told I would be playing catcher. All I could think about was one of the bats coming around and smacking me in the side of the head! Everything went well, though. The after-work activities have really helped me get to know my co-workers and the other interns.

Thursday, May 31 (Day 18)
I had an unbelievable experience today. I went on two farm visits in Texas. The Noble Foundation works with more than 1,400 farmers and ranchers within a 100-mile radius of Ardmore. By going on these farm visits, I am able to learn more about the purpose of the Noble Foundation and how my project is applied to the real world.

Friday, June 1 (Day 19)
I haven't had a class on the futures market yet, but part of my project involves the futures market, so Scott Boyd, Ph.D., an economist with one of the consultation teams, spent the better part of the afternoon explaining it to me. He was a great teacher.

Tuesday, June 5 (Day 23)
I started to construct my preconditioning budget for my project. I finally feel like I'm getting somewhere. AgVenture (an annual summer camp sponsored by the Noble Foundation which gives a select group of high school students a hands-on experience in various agricultural fields) also began today. As an intern, I am able to attend the different activities. I can't believe how much I'm learning.

Wednesday, June 6 (Day 24)
Youth Leadership of Oklahoma toured the Noble Foundation. In high school, I was a part of this group. It was how I first learned of the Noble Foundation. I was able to tag along with the tour today and then speak to the students at the end. It felt like things had come full circle.

Myriah Johnson
Ag intern - summer 2007

Thursday, June 7 (Day 32)
What a hectic week! We lost our softball game, but that's OK. Now, after sports, several of the interns get together and have dinner. The food is always better when we grill together; it gives us time to hang out. I've gone on several farm visits, including today. At each place, I learn new things, especially outside my discipline (economics). I have learned how to identify several grasses, and I'm learning how to provide consultation to farmers and ranchers. It seems like I can no longer get away with just standing there either. The farmers and ranchers want to know what I think, as well!

Monday, June 11 (Day 36)
My internship is half over! It is going by way too fast! I am thoroughly enjoying my time here, learning a lot and having fun.

Thursday, June 15 (Day 39)
I continued working on my project. Finding historical prices for different ingredients in a feed ration is frustrating. As I started going back through some of my formulas, I found a couple of mistakes which caused a domino effect through my whole project. Grrr!

Wednesday, June 20 (Day 45)
I began work on my PowerPoint for my final presentation. This makes me realize that my time here is growing shorter. Since my budget is almost done, I have been going back, tweaking a few things and changing formulas to make the evaluation more accurate.

Friday, June 22 (Day 47)
I discussed different graduate school programs with the other consultation team economists today. They had some great advice. Due to rain, softball was canceled again, but we have now started playing volleyball. Man, I stay busy after work!

Tuesday, July 3 (Day 58)
It's almost the Fourth of July. I helped one of the other interns

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Stacy Schaefer
Summer Scholar 2007

Monday, June 4 (Day 1)
The Summer Scholars group and other interns were whisked around campus all day. Everyone we met was friendly and eagerly welcomed us to campus. I also met Carolyn Young, Ph.D., the principal investigator of the lab where I'll be working. She was nice, outgoing and energetic, plus she had a great New Zealand accent.

Carolyn introduced me to Cindy, a research associate, who works in her lab. She was also incredibly helpful and offered assistance whenever I needed it. We went into the laboratory where I was instantly impressed. Everyone has their own spacious, clean bench. Everything looked so new. Cindy helped me do some subculturing (a process where new liquid media is added to existing cell cultures) and let me grind mycelia (the vegetative part of a fungus) to be placed in liquid media. I was definitely grateful and surprised since this was my first day. Cindy also showed me the greenhouses, which were very spacious. The automatic watering system was really impressive.

Tuesday, June 5 (Day 2)
This morning, Carolyn explained the research focus of her lab and then mapped out my entire project on the white board in her office. I understood each part of my project, but I just didn't see how all the pieces fit together. I'm optimistic, though.

Thursday, June 14 (Day 11)
Today, Carolyn helped me do more subculturing. This was fun because it requires some manual dexterity. It was a little frustrating at first for the same reason. After work, Cesar, Megan (two of my fellow Summer Scholars) and I went to the Noble Foundation annual all-employee picnic – lots of people and lots of fun.

Friday, June 15 (Day 12)
I was thinking today how relatively easy it has been to fit in with everyone in the lab. They are always so friendly and ask me how I like working in the lab or how my weekend was. I appreciate that.

Sunday, June 17 (Day 14)
The Summer Scholars have decided to have weekly dinners every Sunday evening. I made a strawberry salad. We ate and then played games for the rest of the evening. It was a blast.

Monday, June 18 (Day 15)
I spent most of my day setting up and carrying out a recombination reaction. When I came into work this morning, I had no idea what the purpose of this recombination was, but, through a discussion with Carolyn and by asking questions, I now understand the next several steps in my project. The recombination reaction, involving a bacteria, used transformation plates and required incubation. We will not know if we were successful for a few days.

Wednesday, June 20 (Day 17)
Carolyn and I pulled my transformation plates out of the incubator and saw that I had colonies growing on all of my plates except for the negative control plates. That was encouraging because it meant that some of my project's transformation work was successful.

Monday, June 25 (Day 22)
I attended the microscopy workshop today. We used a gene gun to introduce selected DNA into a plant. We shot gold particles, coated with DNA-encoding fluorescent proteins, at the plant's leaves. After work, Cesar, Megan and I went to a dance class. We learned some of the basics of salsa dancing. I felt like I must have looked ridiculous, but the class was fun.

Tuesday, June 26 (Day 23)
The second part of a microscopy workshop was held today. The first microscope had a laser that could be used to cut out sections of tissue. I cut a star shape out of a nodule of the plant. Next, there was a microscope that could do time-lapse photography and play the photos back in a movie. I thought these two microscopes were really impressive. It was interesting to see the results of the work we had done only the day before.

Wednesday, July 4 (Day 31)
Megan, Cesar and I went to see fireworks tonight at nearby Lake Murray. We walked a long time before finding a small clearing in the trees through which we could see the fireworks. It was a nice experience.

Tuesday, July 10 (Day 40)
I gave a presentation on my recent work at the lab meeting today. I was able to ask some questions during my presentation, which was really helpful. After work, several of the interns went to a Cuban art exhibit. We saw a documentary about Cuban painters and saw their works.

Friday, July 13 (Day 41)
Today, I worked on the resuspension of some material that had been segregated earlier. I accidentally added too much water to one sample, but I went to another lab that has a centrifuge and vacuum machine that removed some of the water.

Saturday, July 14 (Day 42)
After I studied for my Medical College Admission Test (MCAT), Megan, Cesar and I went to a contra dance in Oklahoma City.

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TEAM EFFORT

Noble Foundation brings plant research expertise to national biofuels consortium

Story _ *J. Adam Calaway*
Illustration _ *Scott McNeill*
Photographs _ *Broderick Stearns*

THE SAMUEL ROBERTS NOBLE FOUNDATION

The Noble Foundation's work represents the largest plant science component in the BESC. For a detailed list of the Noble Foundation's projects, turn to page 8.

When Richard Dixon, D.Phil., began researching lignin more than 20 years ago, he had no idea this area of work would become a national priority.

However, this portion of Dixon's research, along with projects from eight other Noble Foundation scientists, will form a significant research component of a national consortium of public and private research institutions and commercial entities which received a $125 million Department of Energy (DOE) grant for the development of a bioenergy research center.

Coordinated through Oak Ridge National Laboratory (ORNL) in Tennessee, the newly named BioEnergy Science Center (BESC) was one of three such centers funded by the DOE in June 2007. The center will perform cutting edge research aimed at understanding how to convert plants, including switchgrass and poplar trees, into liquid fuels.

A major mission of the BESC will be to understand the nature and formation of plant cell walls, an essential step for the development of new methods of processing plants into biofuel. The strategy involves breaking down the lattice of cellulose, hemicellulose and lignin – a major component of plant cell walls – into simple sugars. Once the sugars are obtained, they can then be processed into fuel.

"A significant portion of the Noble Foundation's plant science research has been focused on improving forages – whether the improvement is in plant performance or to enhance animal productivity – in an effort to assist agricultural producers," said Dixon, a Senior Vice President and Plant Biology Division Director for the Noble Foundation. "However, much of our work can be directly applied to resolving the issues facing this new cellulosic biofuels industry."

To date, no cost-effective bioprocessing methods for cellulose-based bioenergy sources have been developed. However, the Noble Foundation's extensive research and experience with improving forages – plants used for cattle feed or hay – have the potential to provide new answers.

As a result, the Noble Foundation received the largest portion of funding directly related to the plant science component in the consortium, more than $8 million through the next five years.

Seven of the Noble Foundation's 18 principal investigators will receive funding, including Drs. Joe Bouton, Kelly Craven, Dixon, Rick Nelson, Malay Saha, Michael Udvardi and Zengyu Wang. Noble Foundation Genomics Facility Manager Yuhong Tang, Ph.D., and research scientist Fang Chen, Ph.D., will also be a part of the funded program.

"The Noble Foundation is among the leading institutes in switchgrass genetics," said ORNL's Martin Keller, Ph.D., Director of the BESC. "We here at the center know that the Noble Foundation is a superb institution, and we are glad they are a part of the team to further advance the efforts of using switchgrass in the production of biofuels."

The Noble Foundation projects will address a broad spectrum of basic science issues surrounding the use of switchgrass, a native Oklahoma grass that can be easily grown in most of the U.S., as a significant contributor to the biofuels industry.

There will be emphasis on understanding how to deconstruct the cell walls of this plant to yield sugars for subsequent fermentation, as well as consideration of plant performance and sustainability. Approaches used at the Noble Foundation will include genetic transformation, lignin and endophyte research, development of genomics resources, gene mapping and cultivar development (see sidebar for project details).

"We believe our efforts will ultimately provide improved bioenergy crops with enhanced yield and processing efficiency, and will lead to discoveries that will impact both our nation and our world," Dixon said. "We have seen our scientific process of plant improvement work to assist regional farmers for decades. Now we ▶

BESC BioEnergy Science Center

Research Institutions

1 National Renewable Energy Laboratory Golden, Colo.

2 The Samuel Roberts Noble Foundation Ardmore, Okla.

3 **Oak Ridge National Laboratory** (Coordinator) **Oak Ridge, Tenn.**

4 University of Tennessee Knoxville, Tenn.

5 Georgia Institute of Technology Atlanta, Ga.

6 University of Georgia Athens, Ga.

7 Dartmouth College Hanover, N.H.

Private Companies

8 Verenium Corp. San Diego, Calif.

9 ArborGen Summerville, S.C.

10 Mascoma Cambridge, Mass.

Individual Researchers

11 Charles Wyman University of California-Riverside Riverside, Calif.

12 Norman G. Lewis Washington State University Pullman, Wash.

13 Simo Sarkanen University of Minnesota Duluth, Minn.

14 Y.H. Percival Zhang Virginia Polytechnic Institute Blacksburg, Va.

15 Robert Kelly North Carolina State University Raleigh, N.C.

16 John Brady Cornell University Ithaca, N.Y.

17 Daniel van de Lelie Safiyh Taghavi Brookhaven National Laboratory Upton, N.Y.

have the opportunity to deliver the same successful outcomes on a national scale."

The other two DOE bioenergy centers will be located in Madison, Wis., and Berkeley, Calif. Each consortium involves numerous universities, national laboratories and private companies. The centers, each to be supported at $25 million a year, will receive initial funding before the end of 2007.

"The DOE's investment in these three centers highlights the United States' commitment to develop lignocellulosic biomass for the production of biofuels," said Michael A. Cawley, President and Chief Executive Officer of the Noble Foundation. "The Noble Foundation's pursuit of a broad, agriculture enhancement mission has resulted in the development of complementary expertise, which permits us to address complex research problems from many different perspectives, but in a coordinated effort. This capability places the Noble Foundation at the forefront of the biomass to biofuels movement." ●

Growing on one of the Noble Foundation's research and demonstration farms, switchgrass (above) will be one of the primary focuses of the BESC's efforts.

The Noble Foundation's BESC projects


Blancaflor


Bouton


Chen


Craven


Dixon


Nelson


Saha


Tang


Udvardi


Wang

Project: Lignin biosynthesis and lignin modification in switchgrass
Scientists: Chen, Dixon and Wang
Impact: Provides proof of concept for improving ethanol production efficiency in switchgrass by genetic modification.

Project: Genomics of vascular development in switchgrass
Scientists: Blancaflor, Chen, Dixon and Tang
Impact: Accomplishment of this goal will lead to a better understanding of lignin formation in specific tissues of switchgrass and, therefore, improve ethanol conversion.

Project: Switchgrass functional genomics
Scientist: Udvardi
Impact: The resources produced by this project will enable the discovery of genes and molecular processes important to the biology of switchgrass, especially those related to nutrient-use efficiency, biomass production and efficient conversion of cellulose to ethanol.

Project: Sustainable nutritional inputs for biofuel feedstocks associative nitrogen fixation and nutrient acquisition and re-cycling
Scientist: Udvardi
Impact: This project will identify switchgrass varieties that are most conservative in their use of nutrients to produce biomass for ethanol production, as well as unravel mechanisms underlying nutrient recycling in switchgrass shoots and support breeding programs aimed at minimizing nutrient losses in harvested shoot material, which will impact the sustainability of switchgrass production.

Project: Switchgrass endophyte genomics
Scientist: Craven
Impact: Success in this project could improve biomass qualities, including stress tolerance, and lead to co-product development, such as pharmaceuticals, after fermentation of cellulosic materials.

Project: Assessment of candidate biomass quality improvement genes in switchgrass
Scientist: Nelson
Impact: Gives the ability to rapidly and precisely determine which candidate genes actually do affect cellulose, lignin or other biochemical syntheses leading to their placement in the stable transformation pipeline.

Project: Improving transformation efficiency of switchgrass
Scientist: Wang
Impact: Develop more efficient transformation protocols for the production of a large number of transgenic plants.

Project: Molecular marker development for switchgrass
Scientist: Bouton, Saha
Impact: Assist scientists to identify markers associated with important traits and use those makers for the genetic improvement of switchgrass for increased biomass yield and quality.

Growing up in Langfang, China, Zeng-yu Wang **was a reserved and thoughtful child, who discovered inspiration in the scientists of the 1970s. The brilliance of their minds and the limitless potential of their revolutionary work ignited his imagination and cemented his life's work. After years of studying under giants in the scientific community, the 44-year-old now leads one of the Noble Foundation's 18 labs as a principal investigator. These are the 7 facts you need to know about the quiet boy who grew up to be quite a scientist.**

1 Wang's research focuses on "developing novel germplasm by direct introduction of agronomical genes into important forage crops. The main aspects of the program include establishment of efficient genetic transformation systems for different forage species; cloning of potentially useful agronomical genes and promoters; and generation of transgenic forage plants with improved agronomic characteristics."

2 The end result of his research "could lead to novel plant materials with improved quality, drought tolerance and phosphate uptake. Such materials will improve cattle production, and, thus, benefit farmers and ranchers."

3 Wang, Ph.D., served as a postdoc for Ingo Potrykus, Ph.D., who developed the vitamin-A enriched golden rice. "I learned great ideas can lead to great results, such as golden rice, but sometimes great ideas may not be realized for many years or decades. You must be patient and forward thinking. So I approach my research, trying to accomplish short-term projects, while also looking for long-term challenges and more risky projects."

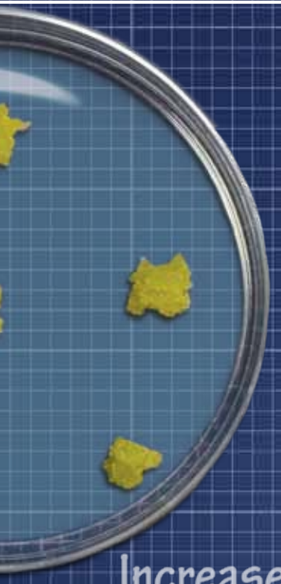
4 Another of Wang's mentors was German Spangenberg, Ph.D. Together Wang and Spangenberg produced the first transgenic fescue and ryegrass by direct gene transfer to protoplasts and biolistic transformation. "It was with German that I developed my passion for working with forage crops, specifically grasses. I have been working on forage crops ever since."

5 Wang finds little time for his favorite hobby – photography. Always an innovator, though, the shutterbug integrated his pastime with work. "I enjoy taking pictures of landscapes and people but, typically, I take pictures of plants and experimental materials. That's just as much fun."

6 Wang's greatest happiness is his family: wife, Kuihua Zhang, and his daughters Jie, 17, and Lydia, 7. "They have always been patient and supportive. They are everything to me."

7 Then in a moment of pure parental delight, Wang revealed that Jie was a senior at the Oklahoma School of Science and Mathematics, a select high school for 150 juniors and seniors academically gifted in mathematics and science. "She is an excellent student," he said smiling. Looks like a scientist was Jie's inspiration as well.

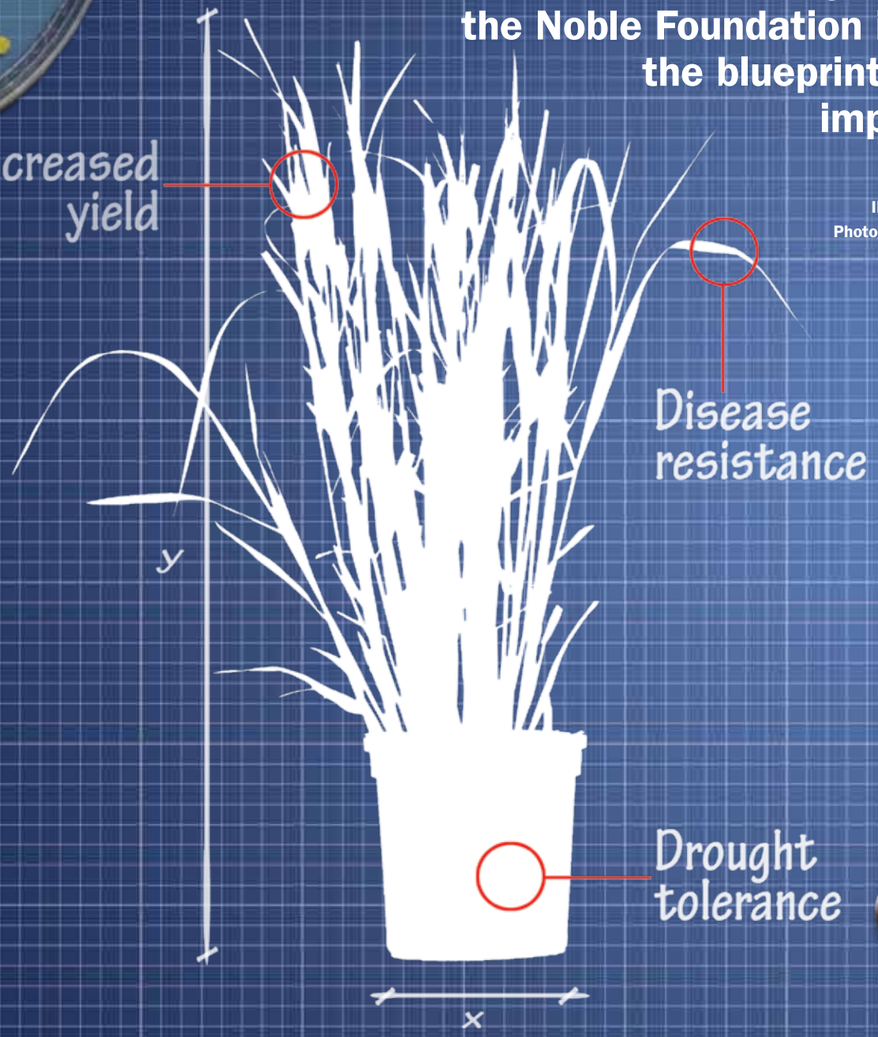
Photograph _ *Broderick Stearns*



Building better forages

Capitalizing on a sophisticated process of moving science from the laboratory to the field, the Noble Foundation is creating the blueprint for forage improvement.

Story _ *J. Adam Calaway*
Illustrations _ *Scott McNeill*
Photographs _ *Broderick Stearns*



For scientists and agricultural specialists at The Samuel Roberts Noble Foundation, forage research is not just a job; it's a way of life. And when they say "life," they mean life for everybody on Earth.

"Grasses directly or indirectly feed the majority of the humans and livestock on the planet," said Joe Bouton, Ph.D., Senior Vice President and Director of the Forage Improvement Division at the Noble Foundation. "They also sustain rangelands, impact industries and economies, and contribute to the very air we breathe. Not many people would consider research on grasses, especially grasses in forage and livestock systems, to be glamorous, but it may be some of the most influential research to our world."

The Noble Foundation houses 18 laboratories and an agricultural research team dedicated to plant science research with an emphasis on the improvement of forages (plants used for hay or grazing by livestock) with the focus on grasses and legumes.

The pursuit of forage improvement resides at the core of the Noble Foundation's original mission to assist agricultural producers in Oklahoma and north Texas. While the Noble Foundation addresses regional agricultural needs, the knowledge generated from the scientific process impacts plant science on a national and global stage.

"One outcome of the Noble Foundation's research is providing tangible products to the region's forage-based agricultural producers," Bouton said. "While this seems like a narrow focus, it is actually a platform for broad exploration. Forage research requires a critical mass of expertise in the fields of biochemistry, genetics, genomics, plant breeding, metabolic engineering, cell biology and transformation. The Noble Foundation coordinates these fields of research to focus on a specific target – forages, but the research also has broader scientific applications."

The Noble Foundation's efforts to build better forages reaches back more than six decades. It's a story that begins with one man's vision … and some finicky soil.

Lloyd Noble and the Land

Pioneering oilman and philanthropist Lloyd Noble established the Noble Foundation in 1945 to assist with land stewardship in Oklahoma. By supporting the stewards of natural resources through education and practical services, such as soil testing, Noble hoped to inspire improved farming practices regionally.

In the early 1950s, the Noble Foundation ventured into forage improvement for the first time when agricultural specialists and plant breeders helped develop and integrate new varieties of cereal rye able to grow in soil with low pH levels. At the time, the decreased pH levels cut into the production of wheat, the main small grain forage industry. Throughout the next three decades, the Noble Foundation introduced five new varieties of cereal rye, which, in turn, caused a secondary effect on the region. Rye could also be used as a winter pasture, giving area agricultural producers a never-before-tapped resource.

"This was a nontraditional enterprise that they had never considered before," said Hugh Aljoe, who leads one of the Noble Foundation's four agricultural consulting teams. "The impact can still be seen today."

By providing farmers and ranchers with rye, southern Oklahoma and north Texas became a staging ground for winter stocker cattle. Today, the cattle industry remains the predominant ▸

> "Not many people would consider forage research to be glamorous, but it may be some of the most influential research to our world."

> Forage crops are the most sustainable crops that can be grown. Forages provide a host of benefits to the environment and play an integral role in maintaining soil productivity.

enterprise in the region with more than 2.8 million head of cattle.

"If you were to take a 100-mile radius around Ardmore and make it a state, it would be the fifth largest cattle-producing state in the country," said Billy Cook, Ph.D., manager of the Agricultural Division's research team. "The Noble Foundation's mission is to assist agricultural producers in that region. If those farmers and ranchers are primarily focused on cattle, then it only makes sense that we work to provide them hardier, higher quality forages."

Said Aljoe, "Forages, such as grasses, are the basis for our entire agricultural industry. If you are in cattle, you have to be a grass farmer first. It's the initial product that has to be captured and transferred into a marketable product, either through beef or hay."

Today, the Noble Foundation's work with forages centers on two specific forage families – grasses and legumes. Working in concert, these forages provide a host of possibilities for regional agricultural producers and play a fundamental role in the agriculture industry. Furthermore, these two forage families significantly impact the majority of Earth's population .

Forages for Everyone

Grasses seem commonplace, but look a little closer and their global impact is obvious. First, grasses, including forage grasses, comprise 25 percent of the world's vegetation. Secondly, each of the six habitable continents possesses vast grasslands from the prairies of North America and the veldts of Africa to Asia's steppes and South America's pampas.

"The importance of forage grasslands to the global ecology is obvious by their worldwide presence," Bouton said. "Forage grasses fill many large and diverse niches in our society and clearly serve as the base for our food chain."

Forages as crops are indispensable components to farmers worldwide. Forage grasses possess a natural adaptive ability that allows them to persist in a variety of environments. In the United States, forage grasses cover five times more acreage than all cereal grain crops combined.

While legumes, such as alfalfa, soybean and clover, are not as widespread as their grass cousins, they play a key role in cropping systems. Legumes contain higher protein and produce a significant amount of nitrogen, making them an economical and environmentally important resource.

"Forage crops are the most sustainable crops that can be grown," said Beth Nelson, President of the National Alfalfa and Forage Alliance. "Forages provide a host of benefits to the environment and play an integral role in maintaining soil productivity by reducing soil erosion, providing essential organic matter, and, in the case of legumes like alfalfa, fixing nitrogen and returning it to the soil. When included in a managed crop rotation, forages also reduce the need for costly pesticides as they disrupt the natural cycle of weeds and insects."

Forages' economic implications are broad reaching as well. A recent Agriculture Research Service (ARS) report concluded that forages and grassland agriculture provide between 60 and 90 percent of the feedstocks consumed by livestock. According to Nelson, this contribution allows the forage industry to claim a portion of the $49 billion and $90 billion the cattle/calf industry and the dairy industry, respectively, contribute to the national economy each year. Alfalfa alone contributes more than $7.5 billion to the national economy.

"These figures do not take into consideration other forage industry contributions to the economy, such as equipment purchased, jobs created, wages earned and the corresponding multipliers which accompany them," Nelson said. "Although it is difficult to quantify the contributions of any one industry to the economy, the impact of forages on the national economy is significant, easily reaching into the billions of dollars."

Beyond food and finances, forages serve a vital function in the air cycle, producing oxygen for humans and sequestering carbon.

"We don't have forests here so something has to fill the air-cycle need and that's forages and grasslands," Aljoe said. "They handle the bulk of carbon sequestration in many areas around the world."

Forages also provide a specific function for the arid Great Plains and similar global regions.

"We've been as dry in recent history as the Dust Bowl days, but the difference is we have a lot of land covered with grasslands and forages," Aljoe said. "This is a tribute to the Noble Foundation and other area conservation groups that have worked to protect the land."

The Noble Foundation continues its efforts to secure the future of the land and assist farmers and ranchers through the improvement of key traits within forage legumes and grasses. While grasses possess a natural adaptive ability, they exhibit lower energy and protein outputs than other plants and require a steady diet of nitrogen. On the other hand, legumes have higher protein and fix their own nitrogen, but are less hardy. Noble Foundation researchers and agricultural specialists seek to improve the traits that affect forage and animal productivity, as well as improve methods for managing the integration of the two crops into a production agriculture system.

The Noble Foundation has undertaken a "whole system" approach to this effort, conducting research in genomics, metabolic engineering, plant-microbe interactions, cell and developmental biology, plant breeding and plant transformation, as well as complementary applied research in production agriculture.

In the end, the process to move scientific discovery from the laboratory to the field resulted in the creation of a sophisticated and coordinated effort between the Noble Foundation's three operating divisions, combining plant scientists with plant breeders and agricultural specialists. While the idea of a "pipeline" – through which knowledge and research pass from one group to the next – is only a metaphor, the results are very real.

Photograph _
Broderick Stearns

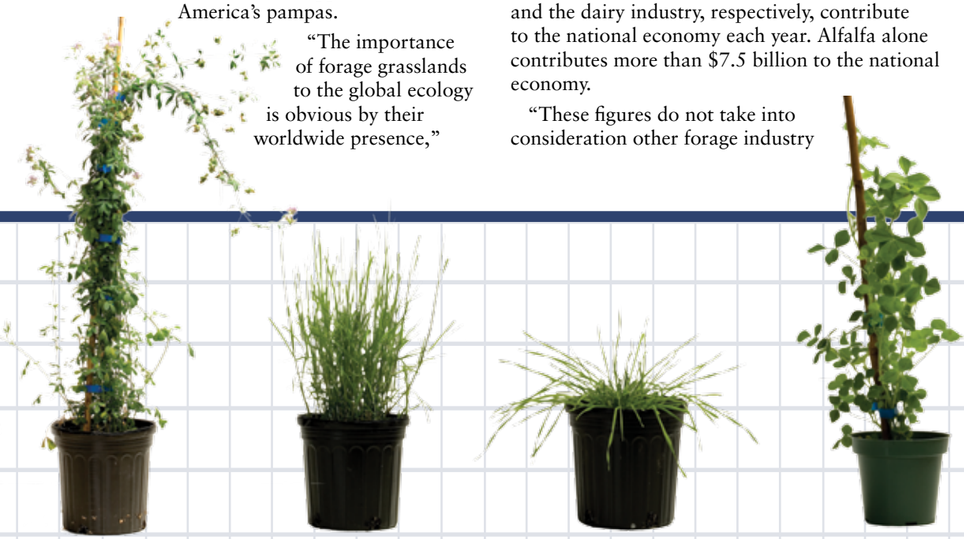
Bob Gonzales, Ph.D., monitors tall fescue as part of one of the Noble Foundation's research projects. Tall fescue is one of the primary forage grasses being researched at the Noble Foundation.

The Pipeline

Forage improvement at the Noble Foundation can (but does not always) begin with basic plant science, which answers fundamental questions regarding plants at the molecular level.

Plant scientists conduct basic biochemical, genetic and genomic plant research and seek to understand or improve natural plant mechanisms for resistance to disease or physical/chemical stresses, such as drought and toxic metals in the soil. They also hope to enhance the ▶

Noble Foundation scientists work to improve numerous forage grasses and legumes. The following nine plants play a significant role in many Noble laboratories.



Alfalfa

Bermudagrass

Hardinggrass

Barrel Medic
(*Medicago truncatula*)

Red Clover

Ryegrass

Tall Fescue

Wheatgrass

White Clover

formation of beneficial interactions with other organisms in the environment, for example, nitrogen fixation. Finally, their work is directly targeting forage quality traits, such as digestibility, protein quality and pasture bloat resistance.

"By focusing on these areas, we increase both the quality and yield of forages for farmers – that's the primary objective," said Richard Dixon, Ph.D., Senior Vice President and Plant Biology Division Director.

In recent years, the basic plant researchers have focused on understanding and improving legumes. The Noble Foundation is recognized internationally for its efforts to advance the legume *Medicago truncatula* as the genomic model for the study of all legumes, including economically significant crops such as soybean, alfalfa, clover and peanut. The Noble Foundation was a catalyst in the international effort to sequence the DNA (genome) of *M. truncatula* and today continues to develop and disseminate genomic resources for the scientific community from this project.

Mark McCaslin, President of Forage Genetics, said the Noble Foundation's basic plant research will have long-term benefits for forages.

"The Noble Foundation's basic research on engineering metabolic pathways has generated an exciting new opportunity to improve forage quality," McCaslin said. "The forage genomics and metabolomics programs at the Noble Foundation are cornerstones to understanding gene function and driving new trait discovery, and have the potential to greatly increase the value of forages for U.S. forage producers and end users. In the next 10-20 years, we will be able to redesign forages for optimum performance under various growing environments and for various end uses."

Translation

To continue the flow of research through the "pipeline," scientists and plant breeders must perform translational research, where fundamental work, such as basic plant science, is built upon to produce an actual product.

Noble Foundation plant breeders are key in this translational work, using breeding and selection processes, as well as biotechnologies, to identify and enhance traits that will positively impact forages.

"Our goal is to produce a tangible product – a cultivar – that can be tested, evaluated and, eventually, provided to agricultural producers to improve their operations," Bouton said.

Noble Foundation researchers use a broad range of techniques to accomplish plant improvement and variety development from conventional breeding to the use of emerging biotechnologies.

Conventional plant breeding – which involves the selection and crossing of parent plants – has been a staple of the Noble Foundation research since the introduction of cereal rye in the 1950s.

Through the past five decades, the Noble Foundation has continued to advance conventional breeding, and, within the next five years, new varieties of conventionally bred tall fescue, oats and rye will be available to farmers and ranchers.

"Each of these varieties has been bred to improve particular traits such as disease resistance," Bouton said. "In the case of the new tall fescue variety, it looks like we have finally produced a cool-season perennial grass, which will provide farmers a forage that will return each year without replanting. It's our hope this will revolutionize agricultural production in this region yet again."

Plant breeders also capitalize on modern biotechnologies in plant science, concentrating on two evolving areas – genomics and transgenics.

"Genomics concern the study of the actions and interactions of all genes in an organism rather than focusing on a single gene," Bouton explained. "Genomics enable researchers to identify key genes and their function through understanding the complex interactions induced by changing environments and conditions."

Researchers using transgenics, more commonly called genetic engineering, precisely move a gene from one plant to another to impart a desirable trait or function. "Both genomics and transgenics accelerate the process of locating traits, transferring them into a plant and testing the outcomes," Bouton said. "Traditional breeding is still a staple in plant breeding, but genomics and transgenics allow us to do research more efficiently and accurately."

The Results

Whether a new variety is produced through conventional breeding or biotechnologies, each cultivar moves through an extensive regime of testing and evaluation. Improved forages move from greenhouse tests to small and large test plots and then make their final stop with agricultural researchers and specialists, who have the capabilities to complete the developmental process.

Agricultural researchers determine a plant's or trait's value through conducting multi-year performance evaluations across locations, designing crop management plans that capitalize on the plant or trait value, and performing animal trials that assess the impact and safety of the plant or trait.

Researchers also look at the applied management of the new offering by taking the new forage into farm-scale agricultural settings for on-site testing.

"We conduct research on how to take this new variety and determine best management practices for its use and, ultimately, determine how it fits economically into a real-world production setting," Cook said. "With this type approach, we can positively impact producers by giving them additional forage options for utilization in their production systems.

In the end, the pipeline of forage improvement offers an improved variety to regional farmers and ranchers with the promise of broader application for agriculture and industries.

"When we develop a new variety, we are targeting it for a specific region like the southern Great Plains," Bouton said. "While that seems like a localized improvement, new varieties have the ability to be used in areas around the country or the world with similar environments.

"Furthermore, the enormous amount of scientific knowledge that is generated from the process will trickle into other research, undoubtedly impacting areas of our lives we've never before imagined would be affected by forage research. That means the Noble Foundation's research is standing on a global stage."

Because, in the end, building better forages is important for everyone. ●

How does forage management impact water?

The importance of forages to agricultural producers is unquestionable. Forages provide a foundation for this fundamental industry and, through it, interject billions of dollars into the economy. They also impact the majority of Earth's inhabitants in ways most never consider. Below, four Noble Foundation Pasture and Range Specialists examine how forages serve a primary role in preserving humanity's other vital resource – water.

The following discussion represents the inaugural outing of Legacy's new, recurring commentary – Agriculture Roundtable – which delves into the practical application of agriculture on the world. In this first Agriculture Roundtable, Noble Foundation specialists seek to answer the question: "How does forage management impact the water supply?"

Hugh Aljoe: Forages are vital to the majority of our country and, really, the world. The amount of forage range and pasture, such as grasslands, directly affects the infiltration of rain into the soil and the amount of water retained in the water table. Conversely, the lack of forages increases the amount of runoff you will have.

Russell Stevens: Imagine this table was bare soil – there are no forages – and this napkin was rain. (Stevens slides the napkin across the table.) Rainfall hits and slides off, taking soil and nutrients, such as phosphorous, with it.

Chuck Coffey: So now, not only are you not capturing the rain for the water table, you're pulling nutrients off the land, and they have the potential to pollute surface water.

James Rogers: The removal of soil then leads to the danger of eroding land.

Coffey: That's right. The rain will only soak into ground a few inches without forages, and then it begins to run off and take soil with it. When it rains on a field, the grasses first serve to catch the rain, minimizing the impact of the raindrop on the soil surface, and the roots allow a pathway for water to move deeper into the soil.

Stevens: If you could watch rain hit bare soil in slow motion and up close, you'd see that every time a raindrop hits, it's like a mini bomb going off – it would look like those videos you see of World War II. Rain dislodges the soil and moves it away.

Coffey: We're literally talking tons of soil per year.

Aljoe: And soil erosion is why we're all here. It's why the Noble Foundation was established. Lloyd Noble would fly over Oklahoma's abandoned farms and see all the barren, eroding land that was cutting gullies in the landscape, and he decided the best way to prevent that was to provide soil conservation and land stewardship advice. The Noble Foundation and conservation organizations are having an impact. Do you know, before this year's deluge, it was as dry as the Dust Bowl days? The main difference is now we have forages and grasslands covering the ground.

Rogers: Which brings us back to why runoff is so bad. If all the water is running off into the rivers and streams, none is getting saved in the water table, and that's dangerous.

(Each person at the table shakes their head in agreement).

Aljoe: The water table or aquifer is the largest supply of fresh water we have. It's important to have an abundance of water in the aquifer because it's typically cleaner and better water than surface water.

Coffey: Imagine the water in the lakes and streams as your checking account. Imagine the water in the water table as your savings account. You want to make sure and save as much as possible because you don't know when you'll need it. Some more arid parts of the country depend solely on the aquifer for their supply of water. Grasslands are the primary source of recharging our aquifers.

Stevens: Another important point is that there is only a finite amount of water. All the water we have is just recycled and redistributed as surface water, salt water, ice or ground water.

Aljoe: Yep, less was distributed to us last year and a lot more was redistributed this year. (Laughter erupts around the table.) Really, though, it's important for arid regions to keep forage cover because forages are vital to the water supply and the ground water recharge process. Most people aren't aware of that.

Coffey: It's all about precipitation versus evaporation. Do you know we have twice the amount of evaporation as precipitation in grasslands, which doesn't seem possible, but it is. This all means it is important for us to store what water we get to move down into the water table.

Rogers: Water is the lifeblood of an ecosystem. Healthy pastures are the only means we have to preserve what water we get through precipitation. So it's important to store water and prevent evaporation and runoff, all of which are functions provided by forages.

Aljoe: The key is the extensive root systems

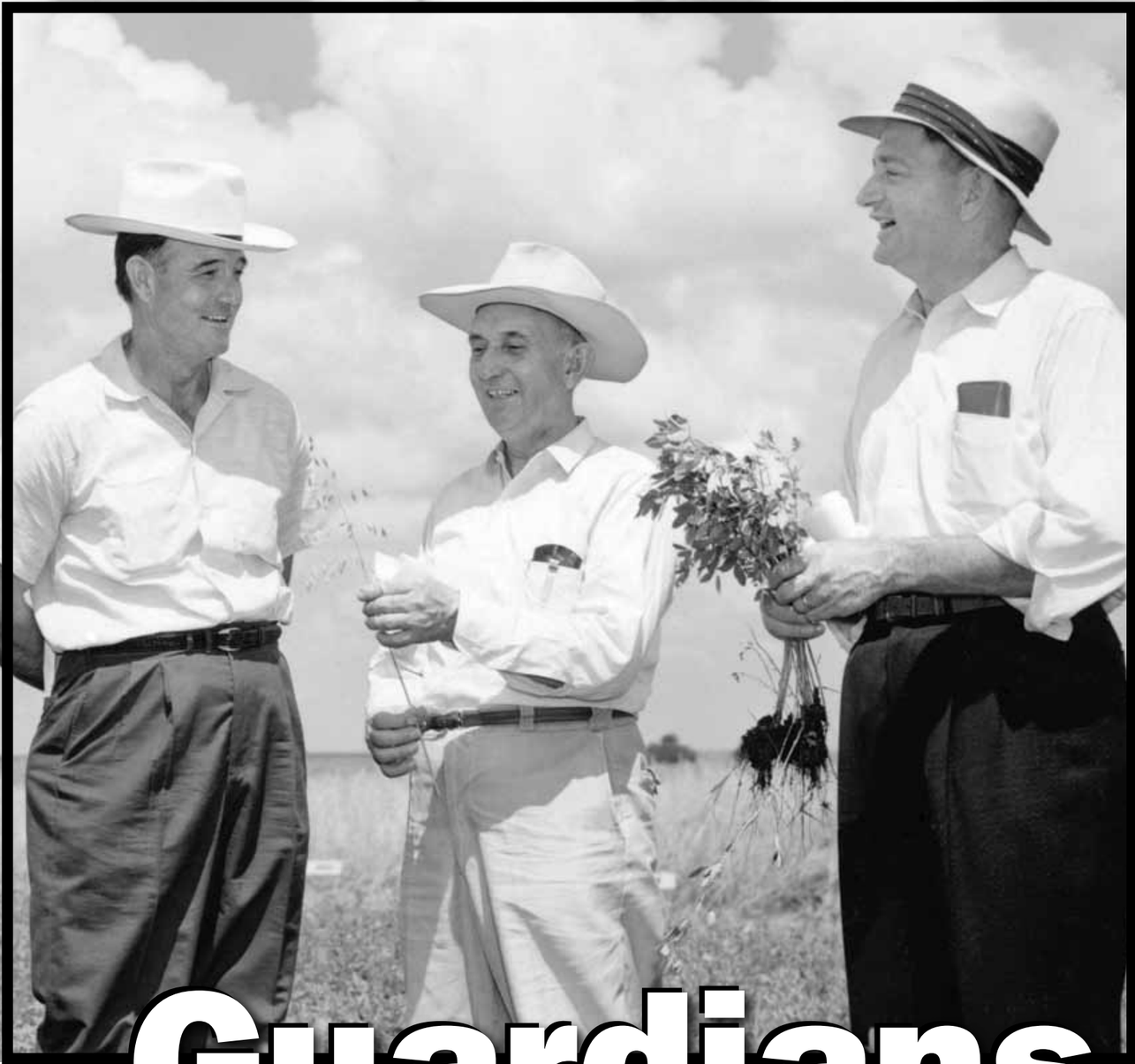
▶ Page 24

Aljoe

Coffey

Rogers

Stevens



Guardians of the land

For more than five decades, the Noble Foundation's agricultural specialists have been fulfilling a legacy

Story_ *Scott McNeill*
Photographs _ *Broderick Stearns*
Historical Photograph _ *Noble Foundation Archive*

You don't have to talk to an Oklahoma rancher for long before you sense the reverence that they feel for the land. They see themselves not so much as owners of a piece of property, but as caretakers of a solemn gift.

Dave Wingo, a cow-calf producer from Spaulding, Okla., shares this sentiment. "Most of the land in Oklahoma has been owned in families for generations," he said with obvious emotion in his voice. "To keep that tradition, you better do everything you can to stay ahead." To Wingo and more than 1,400 other Oklahoma and Texas agricultural producers, doing "everything you can" includes participation in an ongoing collaboration with the Noble Foundation through its comprehensive consultation program.

According to Senior Vice President and Agricultural Division Director Wadell Altom, consultation stands at the core of the division's purpose. "The Agricultural Division's mission is to help land managers achieve their financial, production, stewardship and quality-of-life goals," Altom said. "We achieve these goals through our extensive consultation program, which is the division's primary focus."

A Seed is Planted

Lloyd Noble grew up in Oklahoma during the exciting and turbulent days of the early twentieth century. While he personally prospered after entering the oil business in 1921, he witnessed the upheaval of the local agricultural community as it fell victim to poor farming practices. Early farmers plowed up the fertile prairie and eventually exhausted the soil by failing to rotate crops. The 1930s brought further devastation as the area was engulfed in the Dust Bowl, brought on, in part, by ▶

earlier mismanagement of the land. In 1945, Noble established The Samuel Roberts Noble Foundation, which quickly set out to conduct agricultural research and to educate farmers and ranchers to be better land managers.

Through the mid-1950s, the Noble Foundation offered soil testing and educated the public through field days and demonstration farms. But, by the time the 1957-1958 annual report of the Agricultural Division was written, frustration about the slow adoption of technology by the agricultural community was obvious. A passage from the report read, "Because of the time lag between experimental work and its application on the farm, it is estimated that only one-half of the research information available at the present time is being used by the operators. It is also estimated that net farmer income could be increased by at least 50 percent by applying available research information to the farm enterprises." To bridge this knowledge gap, the report outlined the consultation program, through which Noble Foundation specialists would begin direct and ongoing interaction with area farmers.

The first, formal consultation program of the Agricultural Division began in 1958. The consultation model established then operated much the same as it does today, almost 50 years later. Once a farm was selected to participate in the program, a team of Noble Foundation specialists conducted a complete survey of the farm's assets, capabilities, soil fertility and the goals of the farm family. The specialists then wrote a farm plan tailored to the operation. Then, as now, the decision on which improvements to implement lay with the landowner. Continued participation by the farmers, who came to be known as Noble Foundation "cooperators," was encouraged by subsequent visits to the farms by Noble specialists.

In the beginning, participation was limited to farmers in an eight-county area around Ardmore. After only a year, the Agricultural Division had completed 12 farm plans and conducted 180 farm visits. There was one consulting team, consisting of a livestock specialist, a soils and fertility specialist, a crops and pasture specialist, and a horticulturist.

Five Decades Later

The initial eight-county service area was eventually expanded to counties within a 100-mile radius of Ardmore. Today, the program is open to farmers and ranchers in 29 Oklahoma and 18 Texas counties. By the summer of 2007, the program had 1,444 active participants.

To accommodate this growth, the division now has four consulting teams. In addition to the original roster of specialists, consulting teams now include experts in agricultural economics and wildlife and fisheries.

To join the consulting program, a farmer or rancher is required to own or manage property within the 47-county area and apply to join the program.

Tim Haines, a cow-calf operator, moved from the northwestern part of the state to Lexington – within the service area – and applied in 2004.

"We had been reading Noble Foundation research all our lives and wished we could get in on the program, but lived outside the service area," Haines said. "As soon as we acquired land in the service area, one of the first calls I made was to the Noble Foundation. They met with us, and we qualified to participate as a cooperator. The recommendations by our team have been phenomenal. You don't need to reinvent the wheel; they've got all the data for you. They are such a great group to work with."

The Noble Foundation has never charged a fee for its consulting services, but does require active participation to remain in the program. This may include sharing production, financial and other data with the team.

"The consulting program requires a significant investment of time by both parties," Altom said. "We begin by agreeing upon goals for enhancing the operation, and then both parties work to follow through to achieve [those goals]."

In return for the participant's commitment, they receive ongoing support and advice from their team through office visits, telephone, e-mail and, when appropriate, farm visits. They can also tap into a wealth of Noble Foundation support services including soil and forage testing, digital mapping of their property, invitations to educational events and access to exclusive online tools through the AgExchange Web site.

"Since its inception five decades ago, the Agricultural Division's consulting program has continued to fulfill the original purpose of the Noble Foundation – to benefit mankind through the support of production agriculture," Altom said. Just as important is what the program has accomplished for the individual participants. Dave Wingo says that being a Noble Foundation cooperator changed his whole approach to ranching. "It changed my mindset from being a farmer-rancher to being an agri-businessman," Wingo said. "It focused my talents and resources on things that helped me make money and improvements to the land. When you get to the bottom line, it improved my family's peace of mind and the quality of our lives."

That's what Lloyd Noble would have wanted. ●

Robert Wells, Ph.D., consults with an area farmer. The Noble Foundation works with more than 1,400 farms and ranchers.

A real good cowboy: Adcock earns Leonard Wyatt award

Story _ *J. Adam Calaway*

Yates Adcock stands in a field at Middle Creek Ranch, which he manages. Adcock was given the 2007 Leonard Wyatt Memorial Outstanding Cooperator Award.

Photograph _ *Broderick Stearns*

Growing up, Yates Adcock didn't even want to be a rancher. Today, he's one of the best in Oklahoma.

The Samuel Roberts Noble Foundation presented Adcock with the 2007 Leonard Wyatt Memorial Outstanding Cooperator Award during a special presentation at the Southern Plains Beef Symposium in August. The Leonard Wyatt award is given annually to one of the 1,400 farmers and ranchers from Oklahoma and Texas who work with the Noble Foundation's Agricultural Division through the division's consultation program (see main story).

For the 42-year-old, who manages Robert Lorton's Middle Creek Ranch in Oklahoma's McIntosh and Hughes counties, the award highlights his personal transition from an undecided youth to a motivated and driven rancher. "I grew up in a cow-calf operation, and, ironically, my heart wasn't in it. I didn't have a passion for it as a young man, but now I just can't get enough," Adcock said. "I love the challenge. I love to take a place and make it better and get the most out of it. I eat, sleep and breathe ranching. It's like my golf game."

Corralled in a conference room at the Noble Foundation's Ardmore campus, Adcock leaned back in a plush leather chair, his cowboy hat politely removed and placed on the table, while he talked about being the fifth recipient of the Leonard Wyatt award.

"This is pretty humbling," Adcock said. "I don't think I deserve it. I have had good people help me along the way. I feel very blessed. I owe a lot to Mr. Lorton. I appreciate all the opportunities and support he has given me through the past 20 years."

While Adcock has worked at the Middle Creek Ranch for more than two decades, he began looking for ways to improve the ranch's stocker cow operation 11 years ago when he became ranch manager. "In my heart, I knew there was a better way to do it, a better way to run this place, but I didn't know how to get there," said Adcock, running his hand through his salt-and-pepper hair. "Then I found the Noble Foundation."

Adcock struck up a relationship with a member of the Noble Foundation Agricultural Division, who introduced him to the consultation program. He eagerly began the process of implementing significant changes to the Middle Creek Ranch.

"It was tough at first," he said. "There was a steep learning curve, but we were fortunate to have a resource like the Noble Foundation to pull from. They were there to provide guidance and consultation, and they have continued to help us whenever we need assistance. I have recommended the Noble Foundation to several producers. It's a tremendous resource right here at our disposal."

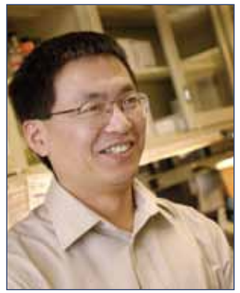
Criterion for the Leonard Wyatt Memorial Outstanding Cooperator Award is based on accomplishments within the farmer's or rancher's operation, their community service and their willingness to assist other farmers and ranchers, all of which are hallmarks of Adcock, said Wadell Altom, Agricultural Division Director.

"When we discuss cooperator successes, Yates Adcock is always held up as an example of the best of the best," Altom said. "Not only has Mr. Adcock helped guide the ranch he manages to great success, he is also a tremendous person. His service to his family, his church and the local conservation district clearly reflects his commitment to others. He demonstrates the caring and generosity that are characteristics we look for in the recipient of this award." ●

> "This is pretty humbling. I don't think I deserve it. I have had good people help me along the way."

If you did not become a plant scientist, what profession would you have selected?

It's only human nature to reflect on past choices, to wonder what might have been if a single decision had been different. So, in this, *Legacy*'s inagural Q&A, four Noble Foundation scientists ponder the road not taken. It's a journey that uncovered some surprising answers.



Rujin Chen, Ph.D.
Assistant Professor
Plant Biology Division

Maybe a cowboy. I've thought that I would have made a great cowboy. I have only ridden a horse one time, but I loved it. It was an amazing experience. Of course, I would then get caught up in thinking about how to best manage and nurture the animal, which would bring me right back to plant research.

Carolyn Young, Ph.D.
Assistant Professor
Forage Improvement Division

I would have been a veterinarian. No doubt. Who doesn't want to work with animals? They wag their tails, meow and look longingly at you. You just want them to be better. Plus, they don't complain like humans do.

Francis Kirigwi, Ph.D.
Postdoctoral Fellow
Forage Improvement Division

Teach philosophy. In philosophy, you seek to understand life and answer fundamental questions. It's really not much different being a scientist. We seek to understand how plant systems work and why. We attempt to enhance them by combining various desirable attributes and, thus, improve their production and positively affect our lives.

Jeremy Murray, Ph.D.
Postdoctoral Fellow
Plant Biology Division

I seriously thought about being a pharmacist before I went into plant science. I also thought about being an artist or writer. I love art and writing. I always thought that, if I applied myself, I could have been good at either one, but then I really didn't want to be a starving artist, so science seemed like a better choice.

Beakers and Bikes

As a postdoc, Kentaro Inoue discovered his future in the laboratory and left his mark on the trail

Story_ *J. Adam Calaway*
Photographs _ *Broderick Stearns*

Two passions permeated Kentaro Inoue during his days as a postdoctoral fellow at The Samuel Roberts Noble Foundation – plant science research and rocketing past plants while mountain biking.

As a youth in his native Japan, Inoue developed a love for both research and biking. While he rode headlong into his life's work first, spending nine years at the University of Tokyo, where he earned a bachelor's degree, a master's degree and his doctorate in pharmaceutical sciences, Inoue forged a unique perspective on life, viewing it at once through test tubes and beakers in the laboratory and then again from the seat of his bicycle.

"Biking and research may seem very different," Inoue said. "But both require you to be focused, patient and determined to be successful. Each offers different rewards, but they are equally enjoyable to me."

Inoue quickly matured into a skilled plant scientist focused on molecular biology and biochemistry, in particular the proteins that mediate various biochemical reactions within plant cells. Soon after he completed his dissertation in 1996, Inoue began his search for a postdoc position. He turned to National Academy Member and University of California-Davis Professor Emeritus Eric Conn, Ph.D., for advice. Conn was a personal mentor Inoue met in 1995 after a scientific research conference in Chicago.

"Dr. Conn was adamant that the Noble Foundation was a perfect fit," Inoue said. "He was right."

After a successful interview, Inoue joined the Noble Foundation in the spring of 1997 and spent two years working with Rick Dixon, Ph.D., Plant Biology Division Director, before moving to Michigan State University for further postdoctoral research and then becoming an assistant professor in plant sciences at UC-Davis in fall of 2002.

On a picturesque California day, Inoue stood on the balcony of the UC-Davis Plant Science building, preparing ▶

for a presentation and recalling life in the southern Great Plains.

"It was a good time in my life," he said. "I'll never forget my years at the Noble Foundation."

Building off his Ph.D. thesis, Inoue studied the role of specific enzymes involved in the biosynthesis of lignin – a major component of cell walls. Lignin is an important area of biochemistry research at the Noble Foundation, as Noble scientists are focused on improving the digestibility of forages – plants used for hay or grazing by livestock – to improve production agriculture.

"Dr. Inoue was one of those postdocs you point to as an example of a great postdoc," Dixon said. "His research was thorough and well executed, and you couldn't have asked for a more congenial colleague. He is a talented researcher and a phenomenal professor."

Even great postdocs get homesick, though. Inoue admittedly longed for the familiarity of Japan and buzz of Tokyo for the first few months, but found comfort and kinship in his fellow employees.

"The people at the Noble Foundation made the transition much easier," he said. "Everybody from fellow postdocs and the other researchers to those in the administration offices lifted my spirits and helped me to feel at home. I wouldn't have made it without them."

And then there was Inoue's biking, an old friend that always made him feel right at home.

Inoue discovered a mountain biking group in Oklahoma City and immediately shipped in a bike from Japan. Upon its arrival, there was one immediate problem – the bike did not include an adapter that enabled him to air up the tires. He called a team member from his new group and waited for him to deliver the adapter.

"I just sat there and waited, wondering where he was. I thought he was just coming a short distance," Inoue said. "He finally arrived and dropped it off. I thanked him for his time and he left. I found out later he drove more than an hour-and-a-half to give me this adapter. He barely knew me, but he made such a great effort; that said a lot to me about the people in Oklahoma."

While Inoue enjoyed riding with his new mountain biking group, he was still finding his stride with English.

"We could not always communicate verbally, but we'd find a nice view somewhere and stop, and we could share that – that's universal," he said.

Inoue's most remarkable biking feat came when he took part in an "enduro" race, which mixes difficult mountainous terrain with a 24-hour riding requirement. Usually teams of four alternate turns with only short breaks. Inoue completed the race by himself. Twice.

"It was something I wanted to accomplish.

Kentaro Inoue, Ph.D., jets downhill during a mountain bike race. Inoue served as a postdoc at the Noble Foundation for two years, spending his days in the lab and his weekends receiving accolades for his tremendous mountain biking skills.

It was a personal goal and several people helped me along the way," said Inoue with an understated tone. While Inoue may shrug off the accomplishment, the story of his achievement remains famous in the Oklahoma biking community.

As a professor at UC-Davis, Inoue has now set aside his six bikes, only riding as a commuter or on jaunts with his friends. He spends his days as a researcher, teacher and mentor now, utilizing the skills he learned at the Noble Foundation.

"If it wasn't for Eric Conn, Rick Dixon and many others at the Noble Foundation, I would not be here," said Inoue, smiling as he looked out over a main campus thoroughfare filled with students whisking by on bikes. "I am grateful for my years at the Noble Foundation. Those years provided me experiences I would not have had at any other institution." ●

Grants

The Samuel Roberts Noble Foundation was awarded a $369,000 grant from the National Science Foundation (NSF) for the acquisition of a spinning disk confocal microscope.

The Noble Foundation's grant request was funded through the NSF's Major Research Instrumentation Program. A spinning disk confocal microscope is an advanced microscope system that allows scientists to capture rapid, dynamic processes in living cells.

Honors

The Noble Foundation received one of two Difference Maker of the Year awards from the Higher Education Alumni Council of Oklahoma (HEACO).

The Difference Maker of the Year Award honors persons, organizations or corporations that have provided significant support to higher education.

The Noble Foundation has provided more than $70 million to Oklahoma's universities through scholarship programs and grants, providing life-changing educational opportunities for countless students in Oklahoma.

Awarded

Michael A. Cawley, President and Chief Executive Officer of the Noble Foundation, presented Oklahoma Secretary of Energy David Fleischaker, J.D., with The Samuel Roberts Noble Foundation Pioneer Award for his support of the state's emerging bioenergy industry.

Fleischaker was given the award during the Noble Foundation's quarterly all-employee meeting this summer.

The Noble Foundation presents the Pioneer Award to individuals outside of the agricultural and scientific communities who have made a significant contribution to the advancement of agriculture or plant science in Oklahoma. The award honors Lloyd Noble, whose pioneering spirit made him a leader in the oil and gas industry, and a trailblazer in his support of the stewards of Oklahoma's natural resources.

Throughout the past two years, Fleischaker has led the effort that brings together Oklahoma's two heritage industries – agriculture and energy production – to contribute to the national cause of reducing our dependence on foreign petroleum.

He conceived of bringing together and focusing the existing research programs of the Noble Foundation and Oklahoma's two comprehensive universities – the University of Oklahoma (OU) and Oklahoma State University (OSU) – to advance the bioenergy industry in Oklahoma, a project that culminated in the formation of the Oklahoma Bioenergy Center (OBC).

Oklahoma Governor Brad Henry signed legislation that officially created the OBC in June.

Published

Richard Dixon, D.Phil., a Senior Vice President and Director of the Plant Biology Division at the Noble Foundation, along with Noble Foundation scientist Fang Chen, Ph.D., has been studying the effects of lignin on biofuels production.

Their work received national and international attention when it was published by *Nature Biotechnology*, one of the world's foremost weekly scientific journals, this summer.

Dixon's and Chen's paper – entitled *Lignin modification improves fermentable sugar yields for biofuel production* – discusses their research, which has shown that decreasing the amount of lignin – a major component of plant cell walls – by genetic manipulation can greatly enhance sugar release from cell wall carbohydrates for ethanol production.

Summer Scholars Program

The Noble Foundation Summer Research Scholars Program offers students the opportunity to conduct plant science in a real-world laboratory setting with some of the profession's greatest minds.

The Summer Research Scholars Program is more than just a paid internship; it's a chance to conduct actual research. Working side-by-side with a mentor scientist and laboratory members from the Noble Foundation's scientists, Noble Scholars perform a research project specifically tailored to their interests and educational background.

Noble Scholars can conduct research in any one of the Noble Foundation research programs including: applied genomics, biochemistry, bioinformatics, cell biology, developmental biology, genetics/genomics, genetics of disease, molecular biology, molecular breeding, molecular plant pathology, phytochemistry, structural biology, transformation and viral evolution.

Applications are available online at www.noble.org, or candidates can request an application booklet by calling 580.224.6206. Applications for summer 2008 must be submitted by Jan. 15, 2008.

Johnson: Continued from page 4

with his project today. We were sitting there working, and we both realized how much we've done in just a few weeks.

Tuesday, July 10 (Day 65)
It's crunch time. I give my presentation next week, but I'm still missing a few final pieces. The prices of soybean and cottonseed hulls are essential to my project, and I can't quite seem to get them. ARGHH!

Thursday, July 12 (Day 67)
Finally! Success! Shan Ingram, special events coordinator for the Agricultural Division, gave me the name of a cottonseed crushing company in Oklahoma City, which helped me get the historical prices! Maybe I will get my project done now.

Friday, July 13 (Day 68)
I spent some of my time after work fishing on the Noble ponds, which are available to Noble employees and interns. I was glad I got to spend some time outside. It was good before my final presentation. I was able to reflect on my time here – this has just been truly amazing.

Monday, July 16 (Day 71)
Today is the beginning of my last week. I have the missing pieces, and my presentation is done! Since I got done early, I attended the winter stocker seminar, which was informative, and then rushed off to my last softball game.

Wednesday, July 18 (Day 73)
My presentation went smoothly. I couldn't have asked for better. I was nervous, but I felt like I really knew my stuff. The knowledge and confidence I have gained from my project will benefit me well in the future.

Friday, July 20 (Day 75)
Today is the last day. I have loved every minute of my summer at the Noble Foundation and am thankful for the opportunities. I learned more than I could imagine, met so many wonderful people and had great experiences. Wow, what a summer! ●

Schaefer: Continued from page 5

I had never heard of contra dancing. It was fun, but really confusing. I didn't know how to do any of the steps and had to pick them up quickly.

Monday, July 23 (Day 51)
I met with Carolyn today. We discussed the purpose of the PCR characterizations I've been working on and the results. We also looked at the plates from the fungal transformation I did. We were really excited to see that I had some colonies! It was really nice of Carolyn to spend all day with me.

Wednesday, Aug. 1 (Day 60)
I have a cold. I don't know where it came from, but I have it. It makes working in the lab difficult because I have to wash my hands and change my gloves every time I attend to my nose with tissues.

Thursday, Aug. 2 (Day 61)
My cold is much worse today, so I avoided the lab because I didn't want to get my germs everywhere. I spent the day at my desk working on my end-of-summer presentation. The presentation will involve all of the Summer Scholars, and the whole campus will have an opportunity to attend.

The high point of the day: We went to the Downtowner for lunch and then the Old Time Soda Pop Shop for ice cream. I have wanted to go to both places all summer long.

Tuesday, Aug. 7 (Day 63)
I was getting very nervous about my presentation this morning. Carolyn went with me to the auditorium to listen to me practice. She gave me several useful pieces of advice. At the end, I was feeling much more confident about my presentation. Still, I stayed late and went through my presentation three more times. It's been a long day.

Wednesday, Aug. 8 (Day 64)
I gave my presentation this morning. I usually get very nervous before speaking in front of a group, but it wasn't too bad this time. I was asked about four or five questions when I was done, a few of which I could not answer, so I had to look to Carolyn for help. After our presentations, the Summer Scholars held a celebratory dinner.

Thursday, Aug. 9 (Day 65)
Today was my last day at work. I've been dreading saying goodbye to everyone because I am so sad about leaving. I said goodbye to Carolyn, Cindy and the rest of the lab. As expected, I had difficulty doing so. Tonight, I'm packing and preparing to return home. ●

Ag Roundtable: Continued from page 15

provided by forages. The more forages present, the more roots there are in the soil profile. The roots till the soil and add organic material as they grow and die back, thus causing the soils near the surface to act like a sponge ....

Stevens: And a highway. Roots provide highways into the soil, and that assists water in getting deeper into the soil profile.

Rogers: Forages further serve as filtration systems for water management. You can select forages, like a legume, that will help to prevent nutrient loading in a particular area, keeping too much of a particular mineral from getting into the water supply. It's an amazing advantage of forages.

Aljoe: All of these points explain why the Noble Foundation works to improve forages. We need forages that can survive and be productive in increasingly difficult environments. Not only are we helping farmers and ranchers, but we're supporting the water systems. The more adaptive the forages are, the better they will grow in harsher conditions. The more we can grow, then the more ground cover and root growth we'll have, and the more water we'll allow to return to the ground. It's a positive cycle. ●

A Snapshot in Noble Foundation History: 1921

Photograph _ *Courtesy of the Noble Foundation Archive*

Wildcatters stand on the first oil rig owned by Lloyd Noble and his partner, Art Olson (far left), as part of Noble Drilling Company. Noble's mother, Hattie Noble, co-signed a $15,000 loan so Noble could begin his business. From these early beginnings, Noble became one of the most successful and respected onshore drilling contractors in the United States. His reputation was defined by his principles and his appreciation of technology which allowed him to drill faster and deeper than his contemporaries. Noble Drilling Company, now known as Noble Corporation (NE:NYSE), continues to this day as one of the largest independent offshore drilling contractors in the world. In addition, Noble founded an oil and gas exploration and production company, Noble Energy, Inc. (NBL: NYSE), which today remains a successful domestic production company. Noble's success in the oil industry enabled him to champion causes, such as land stewardship, which led to the formation of The Samuel Roberts Noble Foundation in 1945.

Speakers Bureau (October - January)

Dixon, Rick
Oct. 24-26: Chilean Society of Chemistry, VIth International Symposium on Natural Products and their Applications, Chillan, Chile
Nov. 4-8: American Society of Agronomy (ASA)-Crop Science Society of America (CSSA)-Soil Science Society of America (SSSA) International Annual Meetings, New Orleans, La.
Nov.: Annual Symposium, Phytochemical Society of Japan, Tokyo, Japan

Ball, Jeff
Nov. 4-8: American Society of Agronomy (ASA)-Crop Science Society of America (CSSA)-Soil Science Society of America (SSSA) International Annual Meetings, New Orleans, La.

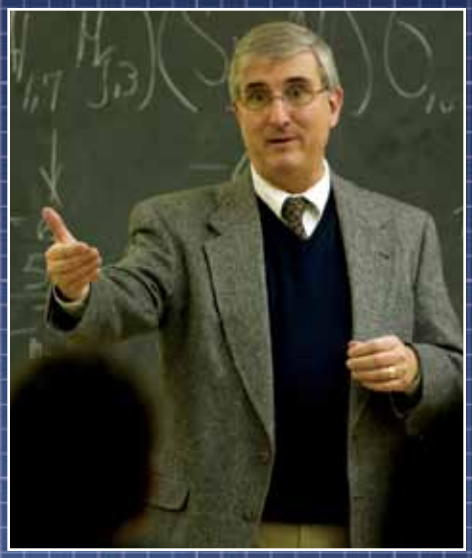
Biermacker, Jon
Jan. 28-31: American Forage and Grassland Council/Society of Range Management 2008 Annual Meeting, Louisville, Ky.

Guretzky, John
Nov. 4-8: American Society of Agronomy (ASA)-Crop Science Society of America (CSSA)-Soil Science Society of America (SSSA) International Annual Meetings, New Orleans, La.
Jan. 28-31: American Forage and Grassland Council/Society of Range Management 2008 Annual Meeting, Louisville, Ky.

Monteros, Maria
Nov. 4-8: American Society of Agronomy (ASA)-Crop Science Society of America (CSSA)-Soil Science Society of America (SSSA) International Annual Meetings, New Orleans, La.

Roossinck, Marilyn
Nov. 4-7: 63rd Southwest Regional Meeting, American Chemical Society (ACS), Lubbock, Texas
Nov. 9-11: Biochemistry and Genetics of Plant-Fungal Interactions, University of Washington, San Juan Islands, Wash.

Saha, Malay
Nov. 4-8: American Society of Agronomy (ASA)-Crop Science Society of America (CSSA)-Soil Science Society of America (SSSA) International Annual Meetings, New Orleans, La.



Sumner, Lloyd
Oct. 25-26, 2007– Mass Spectrometry in the Heartland, Osage Beach, Mo.
Nov. 4-7: 63rd Southwest Regional Meeting, American Chemical Society (ACS), Lubbock, Texas

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

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