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Rc
Research Connection

Dr. Yanqi Wu and Graduate Student James Todd, Oklahoma State University

Photo courtesy of Oklahoma State University

OKLAHOMA NSF EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH

The Greening of Gasoline

Dwindling fossil fuel reserves and increasing environmental concerns have brought alternative fuels to the forefront of the United States' energy policy. Today, there is widespread consensus that alternative fuels derived from lignocellulosic, non-food biomass products have the greatest potential for positive impact, according to Dr. Lance Lobban, OK EPSCoR co-principle investigator and director of the University of Oklahoma's School of Chemical, Biological and Materials Engineering. Wood, agricultural refuse, and dedicated energy crops, such as switchgrass, are viable sources of green gasoline, he said.

The renewable fuel standard, as expanded by the U.S. Energy Independence and Security Act of 2007, mandates the production of 100 million gallons of cellulosic Biofuels per year by 2010 and rises to 16 billion gallons per year in 2022. It is estimated that the United States could sustainably produce over 1.3 billion tons of biomass a year for energy generation, with 90 percent originating from lignocellulosic sources, according to the Billion Ton Report issued in 2005 by the U.S. Department of Energy and the U.S. Department of Agriculture.

Oklahoma EPSCoR researchers at Oklahoma State University, Samuel Roberts Noble Foundation and University of Oklahoma are working to meet government standards and our nation's escalating energy needs by providing a renewable, clean energy source from switchgrass. Switchgrass is an inexpensive and plentiful native grass that grows well on marginal lands that aren't suitable for traditional food crops. Identified by the U.S. Department of Energy as a preferred dedicated energy crop, switchgrass is a promising source for ethanol production and conversion to liquid fuels.

90%
of energy-generating biomass could be produced from non-food plant materials.

The interdisciplinary EPSCoR team has a multi-pronged research focus that includes increasing the biomass yield of switchgrass through genetic engineering and classical breeding techniques, and ultimately enhancing Biofuels conversion through microbial fermentation and thermocatalysis. The research is made possible by a five-year $15 million award from the National Science Foundation and $5.5 million in matching funds from the Oklahoma State Regents for Higher Education.

EPSCoR was developed by the NSF 30 years ago to expand research opportunities in states that have traditionally received less federal funding support for university research. Oklahoma EPSCoR is a partnership among colleges and universities, industry, and research institutions.

MODERN MOLECULAR GENETICS:
EPSCoR scientists are working to improve the biomass yield of switchgrass.

BOTBALL ROBOTICS:
Educational robotics program integrates engineering and BioFuels.

UPCOMING EVENTS:
Mark your calendars to participate in these upcoming OK EPSCoR-sponsored events.

RESEARCH HIGHLIGHTS:
OK EPSCoR researchers are starting a bioenergy revolution with switchgrass.

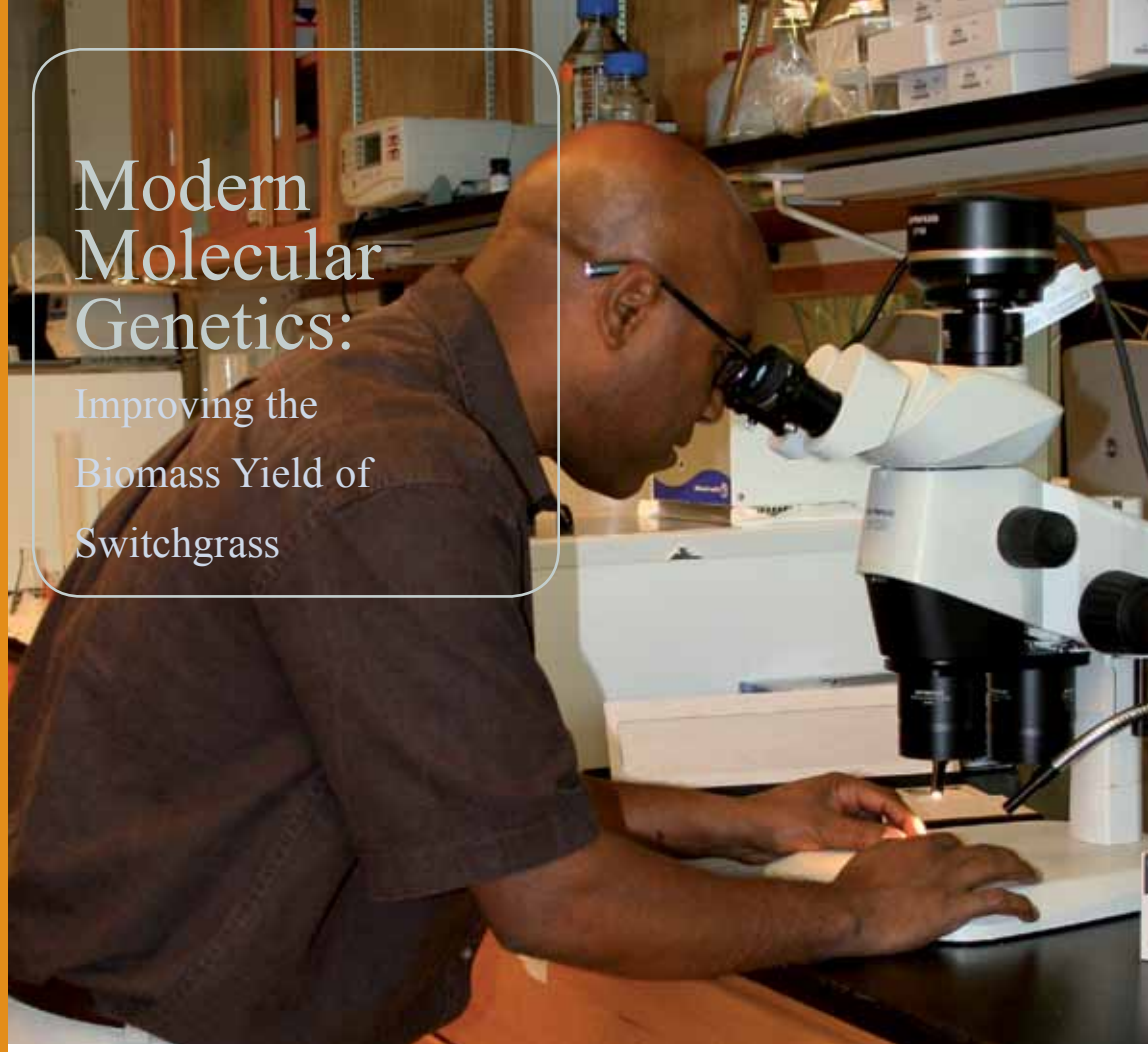
Researchers Receive DOE EPSCoR Award

$2.9 MILLION RESEARCH GRANT

OK NSF EPSCoR researchers Dr. Daniel Resasco and Dr. Friederike Jentoft recently were awarded a $2,901,363 grant from the U.S. Department of Energy EPSCoR program. The award will establish the new Center for Interfacial Reaction Engineering, which will focus on applications of both biofuel and fossil fuel upgrading. The research will pay specific attention to the fundamental aspects of interfacial chemistry.

"The new center will be an excellent complement with the activities we're doing under the NSF EPSCoR program," explains Dr. Resasco. "And while the center incorporates some of the NSF EPSCoR-funded researchers, it expands the team by bringing in people from other disciplines and institutions," he said.

The extended team includes Dr. Jeffrey Harwell, OU professor, representing the colloidal chemistry discipline; Dr. Sanwu Wang, University of Tulsa professor, theoretical modeling of interfaces; and Dr. Khaled Gasem, OSU professor, who will research the redirection of thermodynamic properties. Drs. Resasco and Jentoft, OU professors of chemical, biological and materials engineering, will act as principal investigators on the multi-institutional project.



Modern Molecular Genetics:

Improving the Biomass Yield of Switchgrass

OKLAHOMA EPSCOR RESEARCHERS ARE MANIPULATING THE FLOWERING GENES OF NATIVE SWITCHGRASS TO DEVELOP ENGINEERED PLANTS THAT WILL PRODUCE MORE BIOFUELS PER ACRE THAN THEIR WILD COUNTERPARTS. THIS INCREASED PRODUCTIVITY WILL MEAN MORE MONEY FOR FARMERS, LOWERED BIOENERGY PRICES FOR CONSUMERS AND LESS DEPENDENCE ON FOREIGN OIL.

When switchgrass plants flower, the plants' energies are redirected from increasing foliage growth to reproductive growth. Additionally, lignin, a component of the cell wall that is resistant to enzymatic digestion during bio conversion, increases during flowering.

Drs. Million Tadege and Yanqi Wu, OK EPSCoR researchers and Oklahoma State University Department of Plant and Soil Sciences professors, are studying and manipulating the flowering time genes of switchgrass to address these issues.

Dr. Tadege, in collaboration with Dr. Kiran Mysore, OK EPSCoR researcher and Samuel Roberts Noble Foundation associate professor, recently generated late-flowering mutants in a model plant species (Medicago truncatula) that produced double the plant height and canopy of wild-type plants, effectively increasing above-ground biomass. Another key finding was that cell walls of the modified plants contained fifty percent less lignin than non-modified plants, which minimizes recalcitrance to saccharification.

According to Dr. Tadege, reduced lignin content in switchgrass will decrease the amount of chemicals needed during the conversion process. Less chemical usage benefits the environment and helps consumers' pocketbooks by lowering the cost of Biofuels production.

> "...working to **bridge the gap** between classical breeding techniques and modern molecular genetics."

By working to bridge the gap between classical breeding techniques and modern molecular genetics, the EPSCoR research team is optimistic that they may ultimately achieve unprecedented success in biomass feedstock improvement that will significantly enhance Biofuels productivity and lower overall energy costs.

Seed Funding Inspires Creepy-Crawly Collaboration

STUDENTS INVESTIGATE TARANTULA SKINS AT THE 2010 DISCOVER INSECTS SUMMER CAMP HELD RECENTLY ON THE OKLAHOMA STATE UNIVERSITY CAMPUS IN STILLWATER. THE EVENT IS CO-SPONSORED BY THE OKLAHOMA WONDERTORIUM AND THE OSU DEPARTMENT OF ENTOMOLOGY AND PLANT PATHOLOGY'S INSECT ADVENTURE.

Two organizations previously supported by OK EPSCoR grant funding are teaming up to bring even more hands-on science experiences to the children of north central Oklahoma. The Oklahoma WONDERtorium (OWL) and Oklahoma State University's Insect Adventure are hosting summer camps designed to expose elementary-age children to science through the world of bugs! Campers touch, explore and learn about millipedes, arthropods and a variety of other insects at the three-day camp. Held at the OSU Department of Entomology and Plant Pathology's Insect Adventure facility on the OSU campus, the summer camps have hosted more than 100 children since the program began in 2007.

Just six years ago, this collaborative project wouldn't have been possible.

In early 2000, OK EPSCoR provided key funding that brought about much-needed renovation and expansion of the Insect Adventure program and facilities. Through the grant award, walls were removed to establish a large showroom-like classroom for future presentations and events, insect rearing facilities were repaired and updated, and the live insect collection was enhanced with new and novel additions.

During the same time period, the newly founded Stillwater Children's Museum, now known as the Oklahoma WONDERtorium, received a grant from OK EPSCoR to support the fledgling Museum without Walls initiative. Through the grant award, a hands-on plant virus exploration program was introduced into more than 700 fifth grade classrooms in Payne County. Student participants eagerly engaged in two-hour interactive classroom presentations and hands-on exploration of the nano-sized world of viruses.

As a new decade begins, the OSU Insect Adventure is established in its upgraded facility and now successfully hosts more than 200 individual programs a year for Oklahoma children, including those co-sponsored by OWL.

"Our mission at the Insect Adventure is to open the door to the fascination of science through hands-on entomological experiences with kids of all ages," explained Andrine Shufran, program coordinator. "We're working as hard as we can to collaborate with lots of other entities to fulfill our mission, and we never would have gotten to this point without the initial support of EPSCoR, OWL and the like," she said. "It's definitely beneficial to have the WONDERtorium as our friends!"

Debbie Williams, OWL coordinator, agrees that partnerships are the key to success.

"Currently the museum does not have a permanent home where children and families can come to engage in hands-on educational activities," explained Williams. "By partnering with the Insect Adventure program, we are able to provide opportunities for children to touch, explore and learn about insects," she said. "Andrine Shufran, the Insect Adventure coordinator, has become an invaluable resource for the museum as we strive to develop programs that inspire curiosity to learn through play."

For more information about any of these programs, visit www.okepscor.org, www.insectadventure.okstate.edu or www.okwondertorium.org or contact Gina Miller, EPSCoR outreach coordinator, at gmiller@okepscor.org or 405.744.7645.

Women in Science Conference Encourages Students to Pursue STEM Careers

STUDENT PARTICIPANTS AT THE 2010 WOMEN IN SCIENCE CONFERENCE IN OKLAHOMA CITY ENGAGE IN HANDS-ON SCIENCE EXPERIMENTS AT AN OUTREACH BOOTH AT THE EVENT IN FEBRUARY. MORE THAN 400 PEOPLE REGISTERED TO ATTEND THE ONE-DAY CONFERENCE THAT ENCOURAGES YOUNG PEOPLE TO EXPLORE STEM OCCUPATIONS THROUGH A MULTI-FACETED EVENT PROGRAM.

The 2011 Women in Science Conference will be held Tuesday, February 8 at Science Museum Oklahoma in Oklahoma City. Registration for the ever-popular event will open in late fall 2010. To be placed on the event registration notification email list, send your request to Gina Miller, outreach coordinator, at gmiller@okepscor.org.

The free, one-day conference is designed to allow students in grades six through 12 to engage in hands-on science activities; learn first-hand about science and technology career opportunities from Oklahoma's top female sciZZentists and engineers; and receive college preparation information from Oklahoma college, university and outreach representatives.

The goal of the Women in Science conference is to show students that STEM careers are exciting, attainable and rewarding. The conference provides young people with real-world examples of science and engineering career opportunities and allows them to meet successful women scientists, doctors and engineers from our state.

Past keynote speakers have included NASA astronaut Dr. Susan W. Lucid; Kylah McNabb, wind maven and Oklahoma Department of Commerce wind energy development specialist; and other professional women at the top of their fields.

Women constitute only one-fourth or 26% of the college-educated workforce in STEM occupations.

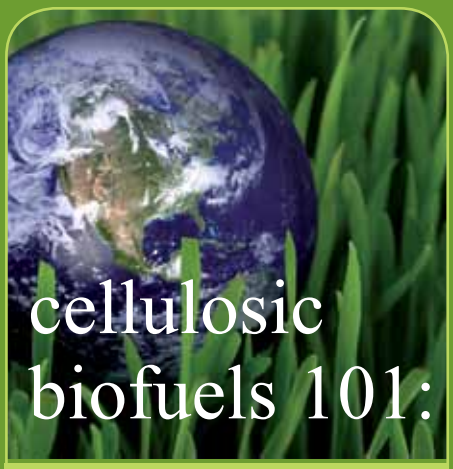
-- Science and Engineering Indicators Report, 2008

Teachers attending the event receive valuable information about summer research opportunities, classroom resource materials and suggestions for supporting and encouraging young women's interest in STEM disciplines.

Women in Science Conferences are sponsored by the Oklahoma Experimental Program to Stimulate Competitive Research (EPSCoR), in collaboration with the Oklahoma State Regents for Higher Education, National Science Foundation, Science Museum Oklahoma and other funding agencies.

Applications to attend the conference are accepted through the EPSCoR Web site at www.okepscor.org in November and space is limited. Teachers may register a maximum of twelve students and two adults per school.

For more information, contact Gina Miller at gmiller@okepscor.org or 405.744.7645 or visit www.okepscor.org.



cellulosic biofuels 101:

5 FACTS YOU SHOULD KNOW

1 Cellulose--a fibrous molecule found in all plants--is the most abundant biological material on Earth. Plants' cellulose fibers may be broken down into glucose and converted into Biofuels, such as ethanol.

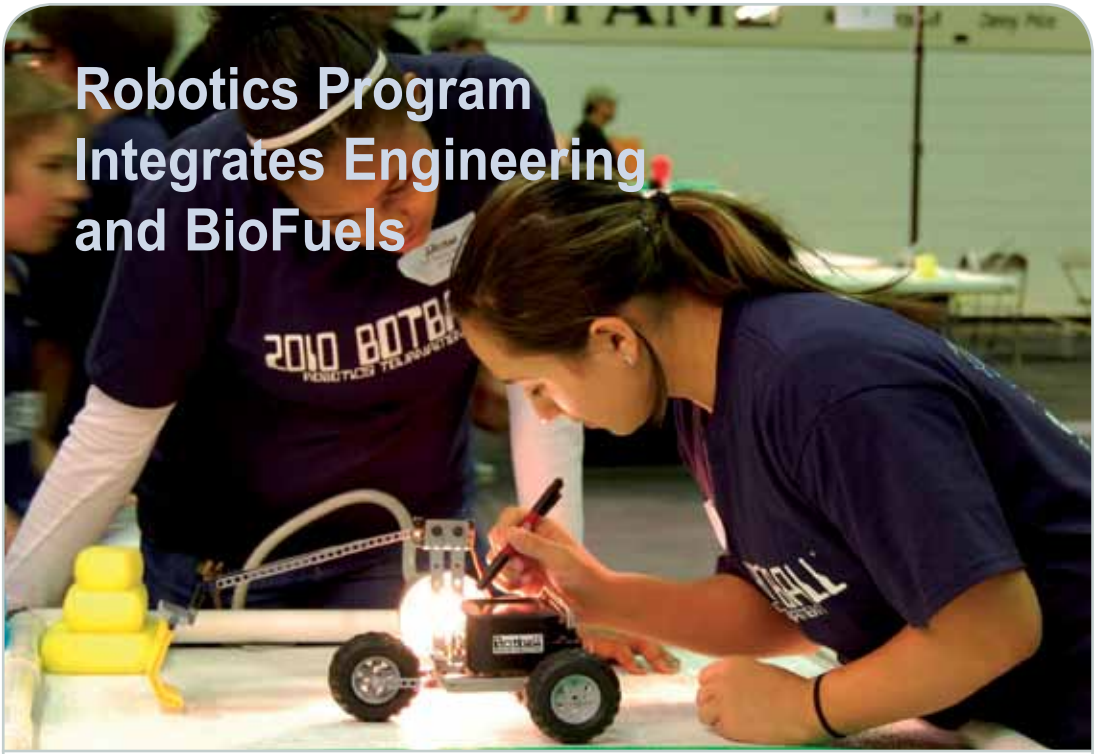
2 Unlike fossil fuels, which are exhaustible, cellulosic Biofuels are renewable energy sources that regenerate and can be sustained indefinitely. They are a source of environmentally-friendly energy that can lower dependence on foreign oil.

3 Switchgrass is a hardy bioenergy source that can be grown in most parts of the U.S., including swamps, plains, streams, and along shores and interstate highways. Plants may reach heights of 10 feet or more.

4 The renewable fuel standard, as expanded by the Energy Independence and Security Act of 2007, mandates the production of 100 million gallons of cellulosic biofuels per year by 2010 and rises to 16 billion gallons per year in 2022.

5 Based on published, proposed changes to the renewable fuel standard program, the United States Environmental Protection Agency predicts that 85 percent of dedicated energy crops in the U.S. will be grown in Oklahoma by 2022.

Robotics Program Integrates Engineering and BioFuels



STUDENTS PREPARE TO LAUNCH THEIR TEAM'S ROBOT DURING QUALIFYING ROUNDS AT THE 2010 BOTBALL REGIONAL TOURNAMENT IN NORMAN THIS YEAR. THIRTY NINE OKLAHOMA TEAMS PARTICIPATED IN THE BOTBALL EDUCATIONAL ROBOTICS COMPETITION IN 2010.

The KISS Institute's Botball Educational Robotics program engages more than 6,000 middle school and high school students a year in a team-oriented robotics competition. Two rural Oklahoma schools will participate in the 2010-2011 Botball experience, through an award from OK EPSCoR.

Science, technology, engineering, math, critical thinking and writing skills are enhanced through the inquiry-based learning program that appeals to kids' hearts and minds. Students learn the value of teamwork, as they design, program and document robots, with the goal of competing in regional and national Botball tournaments.

While devising a strategic plan for their robots, students are also required to research, understand and generate solutions to a global challenge. The theme of the 2009-2010 competition was prophetic, with students challenged to neutralize oil slicks and rescue water fowl with their robots.

The 2010-2011 Botball theme expands on the environmental and sustainability lessons learned last year, by exposing students to an alternative to the fossil fuel dilemma. Although the exact nature of the game theme is a protected secret until the 2010-2011 season is officially launched, Biofuels will play a significant role in the games, according to Steve Goodgame, KISS Institute executive director.

In addition to sponsoring two rural Oklahoma teams, OK EPSCoR is providing those students with preseason, personalized training during ten two-hour weekly workshops held at the students' school sites. Their teacher mentors will receive Botball and Biofuels training during a two-day activity training seminar prior to the weekly student workshops. This augmented instruction will broaden students' understanding of robotics, STEM and bioenergy, which will lead to increased confidence and success during the upcoming competition, says Goodgame.

The formal Botball season gets in full swing in January, when student teams begin designing and building their competition robots. Mentors provide guidance, but no hands-on assistance, during the seven-week construction period. Regional tournaments are held in the spring, with teams' robots battling head-to-head in fast-paced, non-destructive competitions. The season culminates in July with an international competition.

For more information on the program, visit www.botball.org.

National SBIR Conference: NOVEMBER 8-10, OKLAHOMA CITY

OKLAHOMA CITY WILL HOST THE SBIR NATIONAL CONFERENCE NOVEMBER 8-10. THE EVENT IS DESIGNED TO HELP RESEARCHERS AND SMALL BUSINESSES SECURE DEVELOPMENT CAPITOL FROM A LONG-STANDING FEDERAL PROGRAM.

The SBIR National Conference will be held November 8-10 at the Cox Convention Center in Oklahoma City. An estimated 500 individuals from around the nation will attend the three-day event titled Making Connections. The Small Business Innovation Research (SBIR) program is a set-aside program (2.5 percent of a federal agency's extramural budget) for domestic small business concerns to engage in research and development that has the potential for commercialization. The SBIR program was established under the Small Business Innovation Development Act of 1982 (Public Law 97-219).

The conference will inform participants of specialized forms of funding available for small advanced technology firms who wish to perform cutting-edge R&D that addresses the nation's most critical scientific and engineering needs. Attendees will learn about funding that is available from 11 federal agencies.

OK EPSCoR is proud to support this important program. To register for the conference or for more information, visit www.SBIROK.

WHO WANTS TO BE AN ENTREPRENEUR WORKSHOP: NOVEMBER 5, DOWNTOWN OKLAHOMA CITY

Young entrepreneurs, college students and faculty advisors will gain a better understanding of the critical steps involved in starting a business at the annual "Who Wants to be an Entrepreneur?" workshop to be held on Friday, November 5 at the Coca Cola Events Center in downtown Oklahoma City.

The workshop is free to all participants and lunch is provided. However, registration is required.

The interactive workshop is open to all college-level entrepreneurs, students and faculty members. Participants learn the key elements involved in starting a business, including how to write a business plan; what investors are looking for in an entrepreneur; how to successfully present a plan to investors; and locating local resources for start-up, technology-based businesses.

Attendees have the opportunity to network and dine with community leaders, investors, entrepreneurs and economic development experts throughout the action-packed day.

Participants also learn about the Governor's Cup, Oklahoma's annual statewide collegiate business plan competition, and hear ways to improve the odds of winning $250,000 in cash awards, scholarships and fellowships.

The workshop is led by top Oklahoma business professionals, entrepreneurs, service providers and investors who share their experiences and knowledge of the commercialization process.

"Who Wants to be an Entrepreneur?" is an annual event sponsored by OK EPSCoR, the National Science Foundation Oklahoma State Regents for Higher Education and i2E, Inc.

For more information, visit www.okepscor.org or email Gina Miller, outreach coordinator, at gmiller@okepscor.org.

upcoming events

MARK YOUR CALENDARS

OK EPSCoR BIOFUELS RESEARCH MONTHLY TELECONFERENCES
Third Wednesday of each month, 2 p.m.
Next meeting: September 15
Presenter: Dr. Ajay Kumar, OSU

OU SUPERCOMPUTING SYMPOSIUM
October 5-6, 2010
University of Oklahoma, Norman
http://symposium2010.oscer.ou.edu/

WHO WANTS TO BE AN ENTREPRENEUR?
November 5, 2010
Bricktown Events Center, Oklahoma City
www.okepscor.org

OKLAHOMA RESEARCH DAY
November 12, 2010
Cameron University, Lawton
http://www.cameron.edu/okresearchday

WOMEN IN SCIENCE CONFERENCE
February 8, 2010
Science Museum Oklahoma, OKC
www.okepscor.org

Langston Professor Experiences Lab Research

CHARMAINE NAIDOO (LEFT), LANGSTON UNIVERSITY PROFESSOR OF BIOLOGY, WORKS IN THE OKLAHOMA STATE UNIVERSITY BOTANY LAB OF GERALD SCHOENKNECHT (RIGHT), OSU PROFESSOR OF BOTANY THROUGH A $9,000 OK EPSCOR RESEARCH OPPORTUNITY AWARD.

Langston University Professor Dr. Charmaine Naidoo is experiencing lab research at Oklahoma State University this summer, through an Oklahoma EPSCoR Research Opportunity Award (ROA). Dr. Naidoo is working in the lab of Dr. Gerald Schoenknecht, professor of botany at OSU. Together, Drs. Naidoo and Schoenknecht are exploring potassium channels in plants using a cell-free protein expression system.

The collaborative research focuses on the expression of vacuolar potassium channels, which plays a key role in plant growth and development. By enhancing the efficiency of a plant's usage of soil minerals, plant growth and biomass production are increased, according to Dr. Naidoo's ROA proposal.

In addition to obtaining hands-on experience with cell-free protein expression, Naidoo says she is also gaining insight into how she can integrate classroom and laboratory exercises into the courses she teaches at Langston.

"By watching Gerald working with his student in the lab, I have a better understanding of ways I can help my Langston undergraduate students best benefit from lab experiences and to understand the processes they are exploring," explained Dr. Naidoo.

The ROA recipient says she looks forward to future lab research, and she believes the EPSCoR-funded project will allow her to become more competitive when submitting future grant research proposals, she says.

ROA participants are selected annually on a competitive basis by Oklahoma EPSCoR. The awards offer regional university faculty members from primarily undergraduate institutions the opportunity to perform summer research in laboratories at comprehensive research campuses in Oklahoma.

For more information visit www.okepscor.org.

OK EPSCoR Research Highlights

Starting a Bioenergy Revolution

Bioenergy crops are projected to bring about a "bioenergy revolution" to address our increasing energy needs.

Because bioenergy crops, such as switchgrass, have never been grown and managed in a broad production setting, we have limited knowledge about pests and pathogens that will affect these crops. Pathogens could become one of the major limiting factors for seedling establishment, biomass quality and yield of these crops. Soon these crops will be planted in large-acreage monocultures, and plant pathologists will be compelled to develop strategies to manage or control these pathogens.

Several previous studies suggest that switchgrass is susceptible to several fungal diseases, including Panicum mosaic virus, spot blotch (Helminthosporium sativa Pam.), brown spot (Bipolaris oryzae), and rust fungi (Puccinia emaculata, P. graminis and Uromyces graminicola Burn). In fact, leaf rust caused by P. emaculata is a growing concern in switchgrass and severe outbreaks of the diseases have been observed in several research field trials across the country. The question then becomes, "Are we prepared for large-scale, crop monocultures in bioenergy crops?"

To improve disease resistance or tolerance in switchgrass, Dr. Rao Uppalapati in Dr. Kiran Mysore's laboratory at the Samuel Roberts Noble Foundation, with support from the EPSCOR RII award, is identifying genes that confer nonhost resistance from plants that are immune to switchgrass rust. In the future, this will help us to genetically engineer switchgrass for broad resistance to switchgrass rust and possibly to several other pathogens. Nonhost resistance, shown by an entire plant species to a specific parasite or pathogen, is the most common and durable form of plant resistance to diseases. Mysore's lab has adapted Medicago truncatula and Nicotiana benthamina as model plants to study nonhost disease resistance and they have been applying both genetic and functional genomic approaches to identify novel genes involved in nonhost fungal resistance to switchgrass rust.

A forward genetic screen is setup to identify M. truncatula genes conferring nonhost resistance to switchgrass rust pathogen, P. emaculata. Since wild-type M. truncatula displays a resistance phenotype, a Tnt1 insertional mutant population of M. truncatula is being used to identify altered phenotypes (e.g., altered resistance response) and genes associated with these phenotypes. Screening of more than 1,200 Tnt1 lines, with approximately 25,000 insertions, identified a Tnt1 insertion mutant, irg1 (Inhibitor of rust germ-tube differentiation) that displays resistance to P. emaculata by supporting less germ-tube elongation and formation of penetration structures. Interestingly, irg1 shows a five leaf phenotype, and in collaboration with Dr. Rujin Chen's lab at the Noble Foundation, the gene encoding IRG1 is identified as a Cys(2) His(2) zinc finger transcription factor, PALM1. These results highlighted the discovery of a gene involved in surface signaling during host-pathogen interactions and the potential for improving plant biomass (five leaves) and rust resistance by down-regulating the IRG1/PALM1 gene. Dr. Uppalapati, in collaboration with Dr. Yasuhiro Ishiga, a postdoc in Mysore's lab, is presently focused on understanding the mechanisms of inhibition of differentiation of fungal structures in irg1 mutant. These results may have broader impact in developing strategies to improve broad spectrum rust resistance in crops including switchgrass, soybean and wheat.

Article submitted by Dr. Rao Uppalapati, OK EPSCoR researcher and Samuel Roberts Noble Foundation research scientist, Division of Plant Biology.

Oklahoma Researchers Targeting Green Gasoline

SHAOLONG WAN, UNIVERSITY OF OKLAHOMA POSTDOCTORAL RESEARCH ASSOCIATE, PERFORMS RESEARCH USING THE PYROLYSIS REACTOR IN THE CHEMICAL, BIOLOGICAL AND MATERIALS ENGINEERING LAB OF DR. LANCE LOBBAN ON THE UNIVERSITY OF OKLAHOMA CAMPUS IN NORMAN.

University of Oklahoma researchers are focusing on technologies to convert cellulosic biomass to gasoline and diesel fuels that can be dropped directly into the existing transportation fuel infrastructure.

Researchers are first converting biomass into a type of synthetic oil using a process called fast pyrolysis. In the pyrolysis process, biomass is rapidly heated to around 500 degrees Celsius, which is over 900 degrees Fahrenheit. At that temperature, enough chemical bonds are broken to convert most of the solid biomass to liquid and gas. This mixture is then quickly cooled to prevent further reaction. Fast pyrolysis results in as much as 60 percent of the biomass converting to a complex, viscous liquid called bio-oil. Although the bio-oil resembles crude oil in appearance, its chemical composition is very different. Chemical processing analogous to petroleum refining is required to convert the bio-oil to gasoline and diesel fuels. This processing presents the greatest technical challenge for producing fungible fuels from biomass, and OU researchers' efforts are concentrated heavily on developing these necessary technologies.

OU chemical engineers have extensive experience and expertise related to the catalytic processes used in petroleum refining. They are now applying these skills to the bio-oil conversion challenge, by using switchgrass grown by research collaborators at the Samuel Roberts Noble Foundation in Ardmore. OU researchers envision a process involving several conversion steps, or a catalytic cascade, that will convert the bio-oil to hydrocarbon streams that can then either be added to a petroleum refinery for final polishing or be blended directly with gasoline and diesel. The multi-step process is necessary because of the wide range of molecules in the bio-oil. A significant fraction of the bio-oil compounds are too small – i.e., have too few carbon atoms – to be used as gasoline or diesel, and nearly all the compounds contain too much oxygen. The oxygen makes the bio-oil corrosive, water-soluble and chemically unstable. These are all characteristics that are undesirable in transportation fuels. To solve this problem, one phase in the catalytic cascade combines small molecules into larger ones using chemical condensation reactions. For example, two 4-carbon molecules would combine to form an 8-carbon molecule, which is the right size range for gasoline. The condensation reactions also have the added benefit of removing some of the oxygen. Even more oxygen is removed from the larger molecules in another step of the process.

One of the most innovative approaches being developed at OU combines several catalytic steps into a single chemical reactor, reducing the expense of the conversion process. This approach was recently reported in the prestigious journal *Science* by Dr. Daniel Resasco's research group at the University of Oklahoma, and it is also an important part of the new Center for Interfacial Reaction Engineering at the University of Oklahoma funded by the U.S. Department of Energy. A special catalyst known as a Janus particle, named after the two-faced Roman god, is used at the interface of a water/bio-oil emulsion. Because the Janus particle has both a hydrophobic (water-hating) side and a hydrophilic (water-loving) side, it can simultaneously catalyze condensation reactions in the aqueous phase and deoxygenation reactions in the oil phase. A remarkable feature of this system is that as the molecules on the water phase increase in size due to condensation reactions, they become less and less soluble in water and more soluble in oil. Eventually the molecules transfer to the oil phase, where they are deoxygenated!

In addition to the catalytic conversion investigations, OU researchers also engage in fundamental studies of the catalysts, striving to improve the catalysts' activities and durabilities. In these studies, the catalysts are characterized at the atomic level to fully understand how they facilitate the desired reactions and how to improve their performance. Additional research projects are examining the effects of switchgrass composition on the fuel products, using plants supplied by the Noble Foundation that have varying lignin, cellulose and protein contents. Other researchers are developing computer simulations of the catalytic reactions and of the entire pyrolysis-upgrading process. This will allow researchers to optimize the real catalytic cascade, making the process as efficient and economical as possible. The vision of these Oklahoma scientists and engineers is that one day the green fields of Oklahoma will be the source of "green" gasoline and diesel fuels.

Article submitted by Dr. Lance Lobban, OK EPSCoR Co-PI and academic director, Department of Chemical, Biological & Materials Engineering, University of Oklahoma

MicroRNAs:
Investigating Impact on Biomass Production

OK EPSCOR RESEARCHERS AT OKLAHOMA STATE UNIVERSITY ARE INVESTIGATING MOLECULES CALLED MICRORNAS IN SWITCHGRASS TO DETERMINE THEIR IMPACT ON DISEASE AND GROWTH PATTERNS IN THESE NON-CROP NATIVE GRASSES. THROUGH THEIR RESEARCH, SCIENTISTS HOPE TO INCREASE THE BIOMASS OF SWITCHGRASS AND MAXIMIZE THE EFFICIENCY OF BIOFUELS PRODUCTION.

Proteins are the building blocks of all living cells. The type of cell, its function, and the timing of its death are determined by which proteins are produced in the cell, and at what quantities and time they are produced. However, these proteins are the end product of a complex process, which begins with the genetic code present in DNA.

Before a protein is expressed, or produced, relevant parts of the DNA are copied into a messenger RNA. Each messenger RNA holds a code with instructions on how to build a specific protein, using a process called translation. Although one messenger RNA molecule is capable of translating thousands of protein molecules, the number it actually produces is regulated by microRNAs (miRNAs). Plants encode and process 21 nt miRNAs, which regulate the expression of miRNA targets by directing cleavage and/or translational repression. Silencing of miRNA target genes at appropriate places and times allows the plants to grow normally. Otherwise, plant growth and development is severely affected. MicroRNAs are also critical regulators of gene expression, which is important for plant stress tolerance.

Because miRNAs are involved in a wide variety of biological processes, cataloguing miRNAs is as important as cataloguing all protein coding genes in a plant species. Switchgrass has been chosen as a dedicated source of Biofuels production in the United States because of its ability to grow on wastelands and for its tolerance of drought and heat stress. "How many different miRNAs are encoded in the switchgrass genome?" "Does miRNAs play a role in biomass production in switchgrass?" These are some of the questions that Dr. Raman Sunkar, Oklahoma State University assistant professor of biochemistry and molecular biology, and his co-researchers are addressing as part of the NSF EPSCoR RII Award.

EPSCoR researchers at OSU have constructed small RNA libraries and sequenced more than 10 million small RNA reads to determine the various miRNAs expressed in switchgrass. The sequencing of small RNA populations to such great depth has revealed the identity of 260 miRNAs belonging to 45 miRNA families. The researchers' survey has also identified 12 new miRNAs that are absent in different plant species that have been looked at to date.

"...more than **10 million** small RNA reads" have been sequenced.

The EPSCoR project is revealing the complexity of miRNA-guided gene regulations operating in switchgrass and laying the foundation for future functional genomics research in the plant species.

"Do miRNAs have any role in biomass production? If so, which miRNAs are important?" These are obvious questions for scientists working with biofuel plant specimens. Recent studies in Arabidopsis, a model plant species, have shown that manipulation of miR156 has the potential to increase biomass production. MiR156 over expression prolongs the vegetative phase and delays the flowering. These characteristics have led to a several-fold increase in biomass accumulation in transgenic plants. EPSCoR researchers at OSU have identified miR156 in switchgrass. This finding provides an attractive and important target for increasing switchgrass biomass production.

High tiller number is another contributing factor for increased biomass production. Researchers have identified several miRNAs that are highly expressed in emerging tillers, which may play a role in tiller emergence numbers. Normal growth and development of plants depends upon optimal levels of nutrients in the soil. Insufficient or excess amounts of nutrients in the soil negatively impacts plant growth and development. Numerous genes or gene products play an important role in nutrient acquisition, assimilation and distribution. Besides the genes encoding proteins, miR395 and miR399 play an essential role in sulfate and phosphate homeostasis, respectively. So far, scientists working on different plant species have shown that these miRNAs are not expressed in plants grown on soils with optimal content of sulfate or phosphate, but are induced when sulfate or phosphate levels dropped from the media.

When the same experiments were conducted on switchgrass, the results were surprising. miR395 and miR399 were expressed in plants grown on optimal sulfate or phosphate levels and their abundance did not change when sulfate or phosphate was dropped from the growth media. Therefore, the gene-regulatory mechanisms were different in switchgrass. This difference could be attributed to switchgrass' adaptability to marginal soils and the plants' efficient use of limited resources. So, the OK EPSCoR research is already revealing that miRNA regulation is different in switchgrass.

"Do miRNAs play a role in drought or heat stress tolerance of switchgrass?" "Do miRNAs play a role during rust infection in switchgrass?" These questions will be answered by Dr. Sunkar and his lab associates in the coming years, through the OK EPSCoR project.

Article submitted by Raman Sunkar, OK EPSCoR researcher and assistant professor, Department of Biochemistry and Molecular Biology, Oklahoma State University.

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MEET THE NEW FACULTY

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THE OKLAHOMA NSF EPSCOR RESEARCH INFRASTRUCTURE IMPROVEMENT AWARD 2008-2013, "BUILDING OKLAHOMA'S LEADERSHIP ROLE IN CELLULOSIC BIOENERGY," IS A MULTI-INSTITUTIONAL COLLABORATIVE PROJECT THAT INCLUDES RESEARCHERS FROM OKLAHOMA STATE UNIVERSITY, UNIVERSITY OF OKLAHOMA AND SAMUEL ROBERTS NOBLE FOUNDATION. RESEARCHERS FROM THESE INSTITUTIONS ARE WORKING TOGETHER TO DEVELOP EFFICIENT ALTERNATIVE FUELS FROM SWITCHGRASS.

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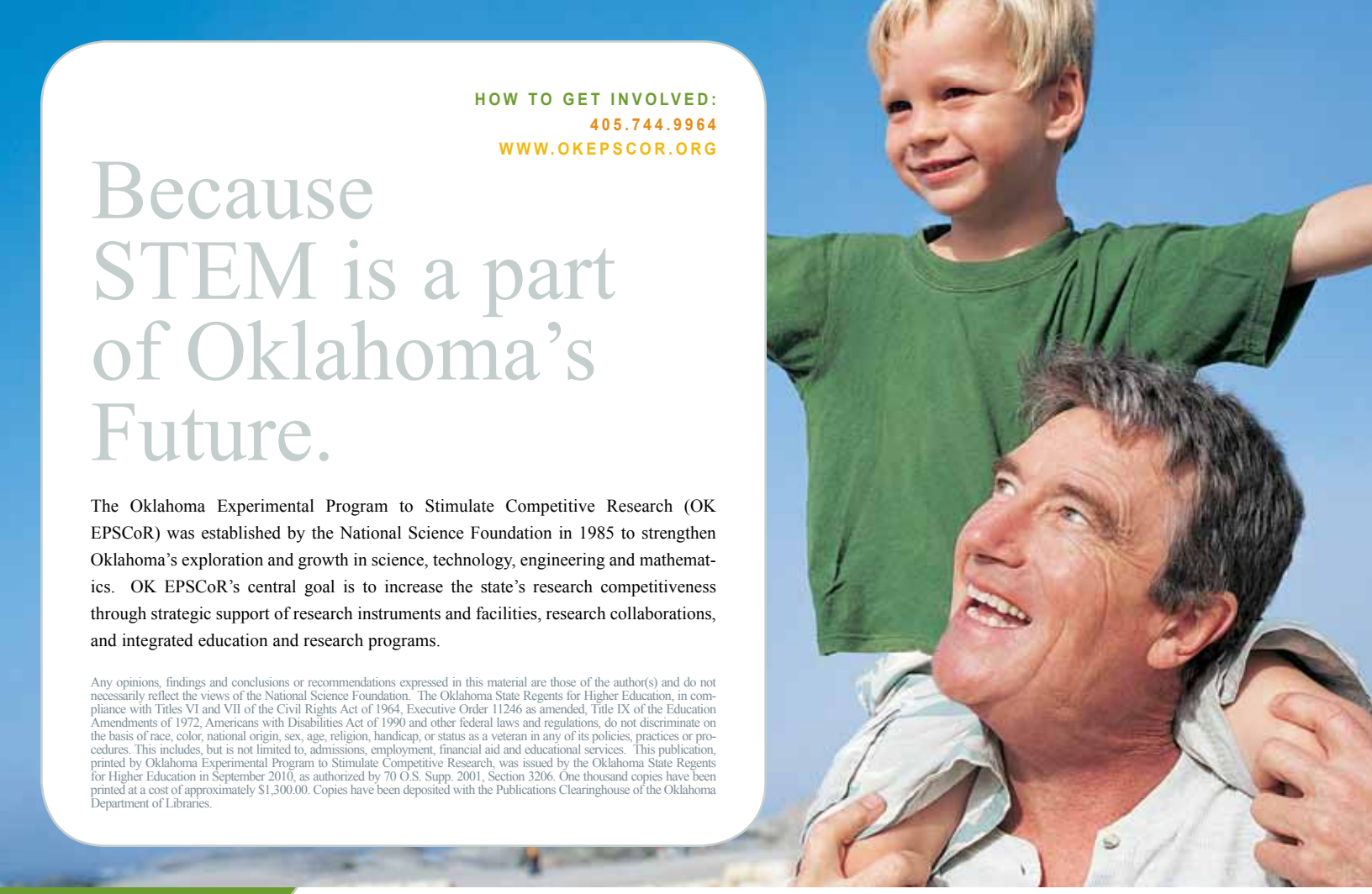

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