SPECIAL EDITION: RENEWABLE ENERGY

ER

2009

Environmental Report

THE UNIVERSITY OF GEORGIA COLLEGE OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES










DEAN'S STATEMENT

Scott Angle

Dean and Director
College of Agricultural
and Environmental Sciences

As we faced serious shortages at the gasoline pump last summer, we were reminded of our deep dependence on petroleum. Reducing our reliance on foreign oil is important to safeguard our energy supplies, environment, political stability and economy. To highlight this issue, we are devoting the 2009 Environmental Report to our college's efforts to meet this great challenge.

Since this challenge is monumental and interdisciplinary, we are working closely with the Georgia Energy Innovation Center, the Agricultural Innovation Center, laboratories and universities throughout the country as well as colleges and schools across the University of Georgia. In this report, you will discover how our engineers and scientists conduct research through the Bioenergy Science Center, one of three new $125 million research centers funded by the United States Department of Energy in the quest to make cellulosic biofuels cost competitive with gasoline by 2012. Our researchers also participate in UGA's Biofuels, Biopower, Biomaterials Initiative comprised of faculty working toward sustainable bionergy.

Each state is looking to their natural resources for raw material to convert to kilowatts and transportation fuel. In Georgia, we see potential energy in the biomass on our farms and in our forests. Because 90 percent of the state is covered by farms and forests that generate millions of tons of waste such as peanut hulls, poultry fat and litter and timber waste, we have a rich stock pile to choose from. This waste along with fuel crops grown on marginal land that require little fertilizer, pesticides and water could provide 30 percent of our state's energy.

Current research focuses on a variety of plants that can be converted into cellulosic ethanol and fuel oil. The genetics of sunflowers and switchgrass are being studied to determine their potential for ethanol production. Algae, once deemed a nuisance as pond scum, is being grown in waste water generated by carpet manufacturers to produce fuel oil. Our plant breeders are developing traits in feedstock that are needed by the biofuel industry.

Our future farms will produce food, fiber, feed and fuel. They may even use wind and solar power to pump water to cattle. The future farmstead featured in this report will be an efficient operation that will use the latest technology to relieve the farmer of endless trips to the fields to check whether the crops need irrigation and fertilizer.

Our years of efforts to advance the state and the nation toward a renewable energy future have not gone unnoticed. UGA was among 13 institutions nationwide to win "The Grand Challenge," a competition sponsored by the U.S. Department of Agriculture and the 25x'25 Alliance, a coalition of leaders from the agricultural, forestry and renewable energy communities. The Grand Challenge recognized universities that have taken leadership roles in renewable energy research, teaching and outreach.

I hope you find this report of our efforts informative and inspiring.

J. Scott Angle

ER Environmental Report 2009

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THE UNIVERSITY OF GEORGIA
COLLEGE OF AGRICULTURAL & ENVIRONMENTAL SCIENCES

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Breeding bioenergy crops isn't difficult: Creating a biofuel industry is

By Brad Haire

Charlie Brummer believes there is room for improvement — at least when it comes to plants.

"I'm a plant breeder, which means my job is to develop new plant varieties with improved traits," said Brummer, a crop and soil sciences professor with the University of Georgia College of Agricultural and Environmental Sciences.

April Sorrow

Plants begin to grow in a petri dish.

Whether creating better crops to fuel the United States in the future, ones to help farmers make more money — or just one with a prettier bloom, plant breeding is basically a simple concept, he said. Man's been doing it for 10,000 years.

"What we do, and what those early humans did, is to select plants that have the traits we want — large seed size, green leaves, big red flowers, etc.," he said. "We look for good plants, cross them together and get even better plants."

Brummer started his career as an undergraduate potato breeder at Penn State in 1985. As the director of the UGA Institute of Plant Breeding, Genetics and Genomics, he now breeds alfalfa, white and red clover, tall fescue, orchard grass and perennial ryegrass.

He is also part of some major grants awarded to UGA to develop bioenergy crops such as switchgrass.

Biofuel is a political topic that's tough to predict, he said. When or if the alternative energy industry strengthens in the U.S. depends on what programs are put in place now and in the future.

"We can manipulate plants in various ways through breeding to make better feedstock for whatever biofuel platform ultimately develops," he said.

From Brummer's perspective as a breeder, it's hard to select for one trait one year and another trait the next. The process takes time and needs consistent goals or targets to work.

"I don't think breeding will be the deciding factor, though, in whether a biofuel industry develops or not," he said. "Breeding can certainly tailor better biofuel crops, but some combination of government and private enterprise nurturing the industry as it gets going has to occur for us so that growing biofuel crops in the first place is economically feasible. Once that happens, (breeders) can work our magic and further increase the productivity and profitability of the sector."

Plant breeding has undergone huge changes since the early part of the 20th century when it was formalized as a discipline, he said. Gregor Mendel and Charles Darwin crossed plants to produce new varieties. But the later application of genetic principles to the plant breeding process opened up the discipline's possibilities and helped breeders predict what could be.

"More recently, the application of biotechnology and genomics has given plant breeders a more precise understanding of the crops or plants they work with and presents opportunities to manipulate traits more efficiently and effectively," he said. "The use of these tools is rapidly expanding, and together with more sophisticated statistical tools, opens up many possibilities to develop superior plant varieties in the future."

One thing hasn't changed, though. A good plant breeder still has to be a kind of Jack-of-all-trades, so to speak, Brummer said. From pathology, entomology and agronomy to biology and statistics, breeders have many tools in their toolboxes. ■

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April Sorrow

Charlie Brummer observes some soybeans growing in his lab.

Brad Haire is a news editor with the University of Georgia College of Agricultural and Environmental Sciences.

"We can manipulate plants in various ways through breeding to make better feedstock for whatever biofuel platform ultimately develops."

~ Charlie Brummer, director, UGA Institute of Plant Breeding, Genetics and Genomics

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For more information, visit www.caes.uga.edu/institute/plantbreeding/index.html.

Sunflowers and switchgrass may be Georgia biofuel crops

By Faith Peppers

University of Georgia researchers were recently awarded two grants totaling $2.5 million to help find better ways to produce biofuels from sunflowers, a crop currently grown mostly for vegetable oils, and switchgrass.

UGA was one of eight schools to receive grants from a program jointly funded by the U.S. Department of Agriculture and U.S. Department of Energy. The UGA grants were awarded to scientists in the College of Agricultural and Environmental Sciences and the Franklin College of Arts and Sciences. The program aims to accelerate research in biomass genomics and further the use of cellulosic plant material for bioenergy and biofuels.

"Developing cost-effective means of producing cellulosic biofuels on a national scale poses major scientific challenges. These grants will help in developing the type of transformational breakthroughs needed in basic science to make this happen," said Raymond Orbach, a DOE undersecretary.

"USDA is committed to fostering a sustainable domestic biofuels industry at home in rural America," said Gale Buchanan, a USDA undersecretary and former UGA CAES dean and director. "These grants will broaden the sources of energy from many crops as well as improve the efficiency and options among renewable fuels."

CAES professor and Georgia Research Alliance Eminent Scholar Steven Knapp, UGA researchers Jeff Dean and Joe Nairn, DOE researcher Mark Davis and USDA researcher Laura Marek received $1.2 million to study sunflower genomics.

"Certain wild species of sunflower produce woody stems and high biomass yields, often reaching heights of 18 to 21 feet," Knapp said. "Our grant focuses on understanding genetic mechanisms underlying wood production and biomass accumulation in sunflower."

Jeffrey Bennetzen, the Norman and Doris Giles/Georgia Research Alliance professor of molecular genetics in FCAS, received a grant for $1.295 million. It will fund a cooperative project with Katrien Devos, a CAES professor of crop and soil science and plant biology. They hope to develop genetic and genomic tools to study foxtail millet, a close relative of switchgrass.

Switchgrass is an excellent source of biomass for producing ethanol. Unlike corn, which is used now to make most U.S. ethanol, switchgrass is a perennial crop that grows on poor soil with little water, fertilizer or pesticides.

"Ethanol from switchgrass is a very different story than ethanol from maize grain," Bennetzen said. "Ethanol from maize grain requires large inputs and produces no net carbon capture to reduce carbon dioxide in the atmosphere. Switchgrass captures carbon dioxide very effectively and will not lead to increased food costs because it does not take acreage away from food production."

But switchgrass has limitations, he said. Researchers need to find more efficient ways to convert lignocellulose, the material that makes up wood, leaves and stems, into ethanol.

Learning more about foxtail millet, he said, will help and it's easier to study than switchgrass.

Don Hamerman

Switchgrass captures carbon dioxide very effectively and will not lead to increased food costs because it does not take acreage away from food production."

~ Jeffrey Bennetzen, the Norman and Doris Giles/Georgia Research Alliance professor of molecular genetics in FCAS

"Once the foxtail millet genome is sequenced, we will be able to quickly find the genes involved in making lignocellulose in foxtail millet, and this will make them easy to find in switchgrass as well," he said. "We can then study these genes and find ways to improve the performance of switchgrass so it is easier to convert to ethanol."

Improving this process is part of another project at UGA called the BioEnergy Science Center. The center researches and develops plants with cell walls easily converted into sugars and microorganisms that can efficiently break down those walls and convert sugars into fuel. From the UGA CAES, the team includes scientists Charles Brummer, Katrien Devos, Wayne Parrot and Shavannor Smith. They are led by Alan Darvill, director of the UGA Complex Carbohydrate Research Center.

"For the average Georgian, the outcome of the research in this project will be less expensive liquid fuels, less dependence on foreign oil, lower food costs and less release of carbon dioxide into the environment," Bennetzen said. "We won't see these outcomes in the next year or two, but there is every reason to believe that they will come into effect over the next five to 10 years." ■

Faith Peppers is a news editor with the University of Georgia College of Agricultural and Environmental Sciences.

"For the average Georgian, the outcome of the research will be less expensive liquid fuels, less dependence on foreign oil, lower food costs and less release of carbon dioxide into the environment."

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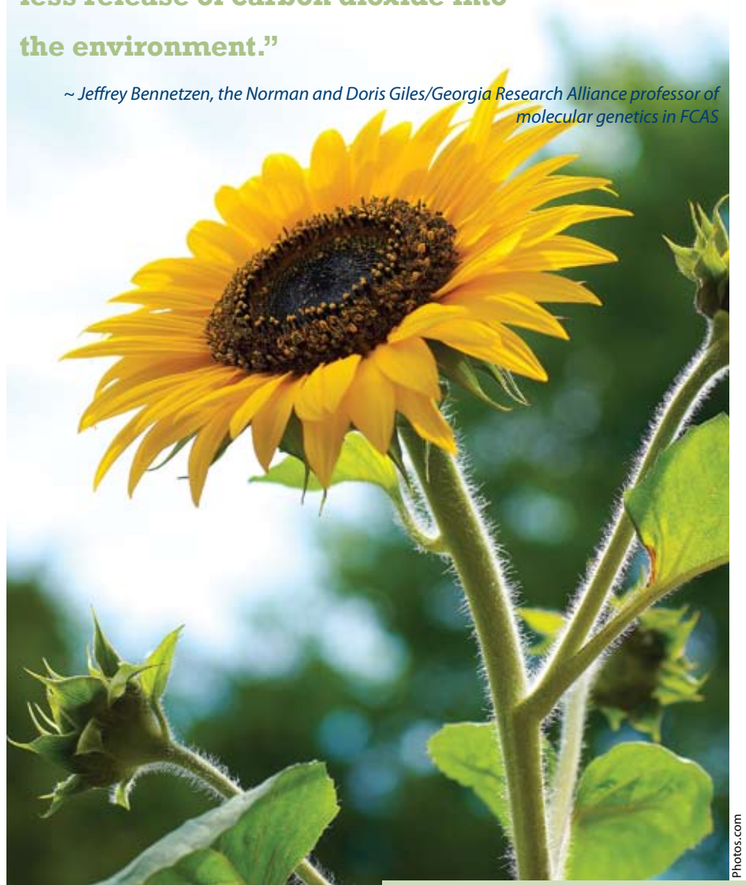

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For more information, visit www.ccrc.uga.edu/research/index.php.

Algae holds promise as biofuel

Story and photos by Stephanie Schupska

Wastewater generated by carpet production could be used to grow yet another crop for biofuel — algae.

Yes, algae. The stuff that clouds swimming pools, mucks up ponds and clings to the sides of boats and buoys. More than 2,000 gallons of oil can be made from one acre of algae. One acre of soybeans produces 48 gallons per year. Only 18 gallons can be made from one acre of corn annually.

UGA faculty K.C. Das and Senthil Chinnasamy aerate algae in a growth chamber at the University of Georgia's Bioconversion Research and Education Center. The algae is yellow because of the nutrients found in the water it's feeding on.

Dirty water left over from carpet production is perfect for growing algae, said K.C. Das, director of the University of Georgia Biorefining and Carbon Cycling Program.

In Dalton, Ga., the "Carpet Capital of the World," 85 percent of the wastewater flowing into Dalton Utilities comes from local carpet factories. In total, the utilities company treats and releases between 30 million and 40 million gallons of treated wastewater a day, said Senthil Chinnasamy, a postdoctoral research associate with the UGA College of Agricultural and Environmental Sciences.

Instead of applying this treated wastewater to designated areas, it could be used to cultivate algae in open ponds. With that amount of wastewater, a million gallons of biodiesel made from algae could be produced annually, enough to run the city of Dalton's entire fleet of government vehicles for a year.

Wastewater already contains nitrogen, phosphorus and other minerals, nutrients that would cost extra money to add. Algae can be grown in saltwater, too.

Right now, Chinnasamy and his lab assistants are growing it in large plastic tubes and oversized plastic bags. He's got samples of different algae in closed beakers in a growth chamber. Later, they'll place promising species in plastic ponds to see how well they grow in uncontrolled environments.

The UGA researchers are working to find cost-effective ways to harvest algae and express oil from it. The oil can be turned into biodiesel, the protein can be added to livestock feed and the remaining carbohydrates can be used in ethanol and methane production.

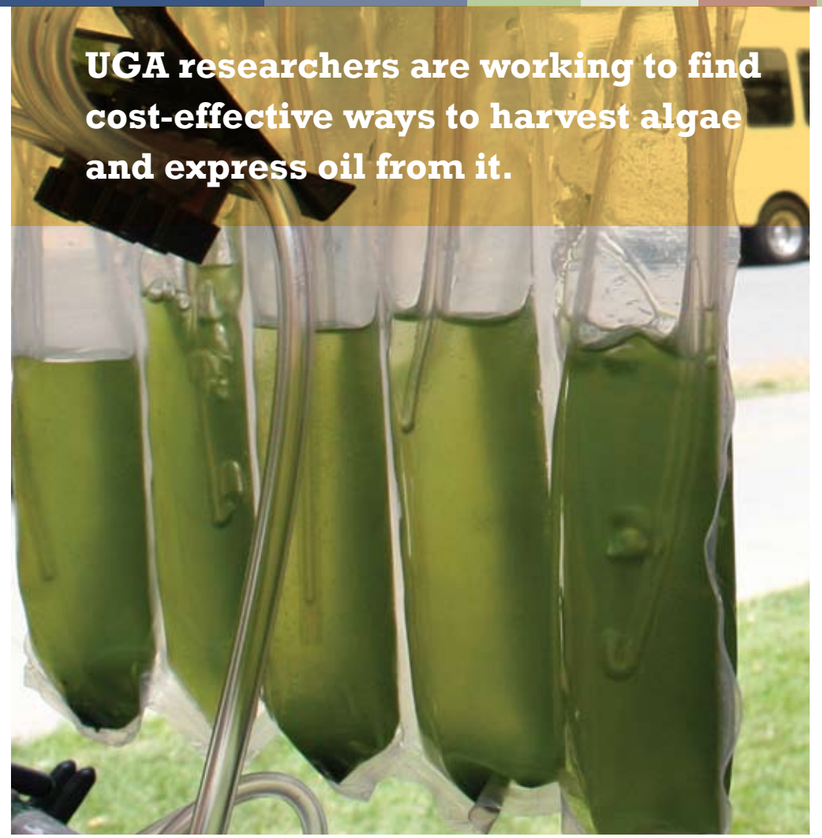
The U.S. Renewable Fuels Standard, signed into law in January 2008, calls for the production of 36 billion gallons of biofuel annually by the year 2022. Currently, the country produces 8 billion gallons a year.

It would take 750 million acres of soybeans, or an area twice the size of Alaska, to produce 36 billion gallons of biofuel, Chinnasamy said. The same amount could be produced on 7 million acres of algae, or an area half the size of West Virginia.

In addition to its biofuel possibilities, algae can help reduce carbon dioxide in the atmosphere. It is considered carbon negative, meaning it uses more carbon than it produces. A kilogram, or 2.2 pounds, of algae pulls 1.8 kilograms, or 4 pounds, of carbon dioxide out of the air.

Despite its upsides, algae are difficult to produce. The ideal growing location, which is outside in ponds, is hard to regulate. It's hard to harvest, too, and must dry. It's now harvested mainly for its protein, which can bring manufacturers $6 an ounce.

One big downside is that it costs about $5 to make a gallon of fuel from algae.



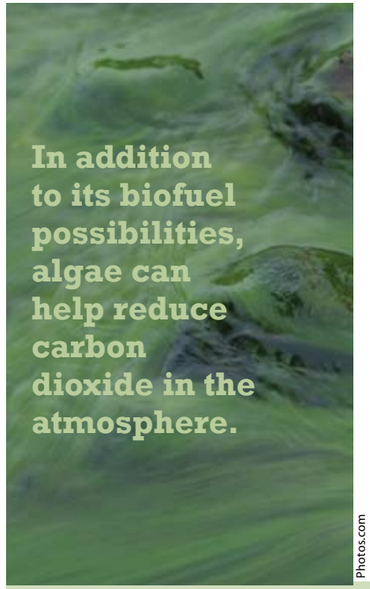
Top left: Algae floating around these small growth chambers are only a miniature example of the tanks and oversized plastic bags Chinnasamy and his research team use to breed algae on UGA's campus. Chinnasamy is a post-doctoral research associate with the UGA College of Agricultural and Environmental Sciences.

Bottom left: Chinnasamy checks algae production at the Bioconversion Research and Education Center. His research is designed to find a cost-efficient way to grow and convert algae into an affordable biofuel.

Chinnasamy and Das hope their work will lower the cost to $1.50 a gallon, which would lower the cost of biodiesel and diesel blends and still give producers a profit.

Fuel made from algae could be available commercially in five years, Das said. ■

Stephanie Schupska is a news editor with the University of Georgia College of Agricultural and Environmental Sciences.



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For more information, visit www.biorefinery.uga.edu/biomassdevelopment.html.

The future farmstead: Solar panels, turbines and robo-tractors the norm

Story by April Sorrow and Illustrations by Jay Bauer

A web of sensors, cameras and control systems monitor the farm, checking on plants, animals, equipment and people. A fleet of mini-machines works in the fields, planting and spraying. Solar panels track the sun and provide shade for cattle. Cotton stalks are baled and converted into diesel at the local biofuels plant. When something is out of the norm, the grower receives pictures, sounds and dates via cell phone.

This will be a typical scene on the future farmstead. It is an ultra-efficient, self-regulating, environmentally-friendly and economically-sound farm business. It highlights the integration of the best of today's tools with a research thrust toward the future.

"The future farmstead project shows the potential of today and is a partner in helping develop the tools of the future," said Craig Kvien, a University of Georgia College of Agricultural and Environmental Sciences professor and leader of the National Environmentally Sound Production Agriculture Laboratory.

To Kvien, the potential lies in creative partnerships.

"The farm will highlight energy generation and conservation along with advances in food, fiber, flowers and forest production."

~ Craig Kvien, University of Georgia CAES professor and leader of the National Environmentally Sound Production Agriculture Laboratory

THE VISION

"The goal of the future farmstead project is to create a model home and farm that helps the family and the rural community. We want to use this model as a research and education tool," he said. "The farm will highlight energy generation and conservation along with advances in food, fiber, flowers and forest production. We believe the farm home and office can be designed to be a business partner and a family partner."

Kvien envisions a farm operation with an information and control system that constantly monitors the critical aspects of the farm operation. This includes water and pest conditions, equipment operations and the status of orders and markets. The system relays only important information and filters out the rest. The farm's crops are better adapted to very local conditions, which reduce the need for additional inputs and saves time and energy.

"Today we recognize a greater portion of our energy supplies must come from renewable resources, and we also see a greater need for a safe domestic food supply," he said. "To accomplish these goals, U.S. farmers will need to improve efficiencies along with food quality and yield, combining advanced genetic materials with new communication and control technologies."

Many of the technologies and techniques needed to make farms more efficient already exist. Others still need to be developed or modified. "The challenge is to identify those that can be robustly inserted into current farming operations," Kvien said.

To help meet this challenge, UGA will join with other universities, USDA and private sector partners to form collaborative research and implementation teams. These teams will provide working examples for famers.

"The solutions to our greatest challenges are out there in creative minds, young and old. Soon we will see ideas brought to reality that are completely different than those we have heard so far."

~ Craig Kvien, University of Georgia CAES professor and leader of the National Environmentally Sound Production Agriculture Laboratory

One example of what can be accomplished comes from a team's success in irrigation systems.

IRRIGATION SYSTEMS

Variable rate center pivot irrigation systems allow the application of the appropriate amount of water to each spot within the field. Water is applied dependant upon crop need, topography, soil and climate conditions. The system saves water, energy and time and enhances productivity.

Because the same amount isn't always the right amount of irrigation water, Stuart Pocknee, Calvin Perry and others began prototyping a new kind of irrigation control system. To do so they reached out to partners across the nation and across the world. The result is a system that can efficiently apply water in the right amounts at the right time.

This technology allows farmers to easily apply varying rates of irrigated water based on defined areas of difference called "management zones."

The irrigation controls retrofit onto existing center pivot systems and work by integrating GPS positioning. Individual sprinklers or groups of sprinklers are cycled on and off and travel speeds are varied to achieve a desired rate within management zones.

Currently used on more than 50 farms, the technology has resulted in increases in crop yield and quality. The systems eliminate watering non-crop areas and boggy spots and reduce irrigation runoff, saving an estimated 12 percent of water. This also decreases potential stream sediment pollution, which is good for the environment.

"We have found if we focus on efficiency, generally you save economically and environmentally," Kvien said. Next generation controllers that include field sensors that wirelessly send soil moisture data to the controller are currently being developed by UGA engineers George Vellidis and Mike Tucker.

FIELD MONITORS

Through wireless Internet communication, farmers can now check on nearly anything from nearly anywhere. Tifton vegetable grower Bill Brim checks on his packing shed while making a sales call in Chicago. From his farm network, he can pull up a week- or month-old image from his loading dock camera to prove a truck was loaded, or never arrived. He also keeps a close electronic eye on his fuel and fertilizer.

Advanced Internet communication and control systems are also being used to reduce the amount of time and energy needed to manage multiple fields. Vegetable growers often spread their crops across several counties, in part to reduce risk. However, this practice also reduces efficiencies.

Simple Internet-based systems can monitor farm operations remotely. Monitors can be placed in fields, packing houses, on gates and irrigation systems. Monitors on fuel and ammonia tanks can help with security issues.

"Along with using the Internet to retrieve news, weather and the best buy on a tool, farmers will find it increasingly useful to monitor fields, control pumps and irrigation systems and check on animals. It will save them energy and make them more efficient," said Vickie Garrick, IT project manager.

ENERGY PRODUCTION

Farms of the future will be energy producers. The types of energy produced will be as varied as the crops they now manage. Some energy may be on-farm production and consumption, some may be through a co-op structure and some sources may simply be sold as biomass or electricity.

The biggest challenge is reducing the risk of change so farmers can take advantage of this opportunity as soon as possible. Kvien recalls the small town of Luverne, Minn. More than a decade ago, local growers decided to build a small corn-to-ethanol plant. Their hard-fought success enabled them to see other energy opportunities, like wind. Soon one turbine led to a second, then five, and now they are moving toward 50. Today, this small town of 10,000 is a thriving community that spends more money per child on education than anywhere else in the country with the exception of Boston, Mass.

"To me, clean energy holds great promise for Southeastern U.S. farms," Kvien said. "Not every place has the wind that Luverne does, but we have the sun, plenty of biomass and a lot of undiscovered opportunities. We plan to highlight these opportunities at the future farmstead site."

LOOKING INTO THE FUTURE

Kvien believes that farm energy consumption can be cut by 50 percent over the next 20 years or less, with equal or greater production. He points toward many areas of savings, noting that our current tools were developed when energy was cheap and available.

Plant and animal genetics are among the first things he mentions. Resistance to environmental stresses, diseases and insects are often a moving target for breeders. Plants and animals better adapted to the environment they live in saves time and resources.

Advanced Internet monitoring and control systems, small fuel-efficient autonomous tractors that operate around the clock, small on-farm energy systems and small local biomass-based energy businesses will help conserve resources.

ENGAGING CREATIVE MINDS

"The solutions to our greatest challenges are out there in creative minds, young and old," Kvien said. "Soon we will see ideas brought to reality that are completely different than those we have heard so far."

Engaging creative minds is the most significant goal of the future farmstead project. The physical and virtual future farmstead sites are being designed to foster this goal.

The team has partnered with the SE Bioenergy Conference Committee, 4-H and others to sponsor energy competitions in four categories: energy conservation, bioenergy, other renewable energies, and home and farm energy audits. Competition winners will be encouraged to present their ideas at the SE Bioenergy Conference in Tifton, Ga., in August of 2009. First place winners in each of the categories will receive $1,000 and, when appropriate, will be encouraged to commercialize their idea with help from the Georgia Energy Innovation Center. ■

April Sorrow is a news editor with the University of Georgia College of Agricultural and Environmental Sciences.

For more information, visit www.nespal.org and click emerging research areas.

Sun, wind pump water to cattle

By Brad Haire

Cattle sometimes walk to the nearest stream and or river to get water when it's not readily available. But in doing so, they can pollute the water downstream. A University of Georgia expert is setting up sites near Georgia's coast to show cattlemen how to use the wind and sun to take the water to their herds.

Using solar panels and wind turbines to produce electrical power is nothing new, said Gary Hawkins, a water specialist with the UGA College of Agricultural and Environmental Sciences. But using them to power water pumps in Georgia is. They are more common in the Midwest and western United States.

"The goal of this project is to provide cattlemen who are already involved with other conservation and grazing management programs a sustainable alternative for getting their cattle the water they need," Hawkins said.

Five farms are participating in the three-year project. It's a partnership with Seven Rivers and Coastal Georgia Resource Conservation and Development, Inc. Funding for the project comes from the Natural Resources Conservation Service Conservation Innovation Grants Program.

The water pumps are powered by a hybrid system, one that uses both wind and solar energy, said Hawkins, the project's coordinator.

Georgia isn't considered a windy state.

Gary Hawkins

Brad Haire

Georgia cattlemen are using electricity harvested from the sun and wind to power water pumps for their herds.

But the wind blows consistently along the coast during cooler months when days are shorter. The wind dies off in the summer when the days are longer.

The hybrid system uses wind turbines for power in cooler months and the solar panels in the summer. Both sources are enough to provide power to pump as much as 3,000 gallons a day — enough water to easily sustain a herd of up to 150 animals.

The cattlemen get the power systems free, but must agree to take data and open their farms for field days so others can learn about the technology, he said.

Traditionally, cattlemen have used electricity or diesel to fuel pumps. Diesel costs more than $4 a gallon now, as much as four times what it did just five years ago. And it costs between $2.50 and $3 per foot to install electrical line, depending on the location and company.

The biggest limiting factor for the new hybrid system is the price. It varies depending on the configuration needed. The systems in this project cost about $12,000, but the price of solar panels and wind turbines is coming down.

Hawkins is studying the economic benefit of the hybrid system, too. Considering current prices for electricity and diesel, a hybrid system may pay for itself in a decade. Instructional publications will be created to guide cattlemen on how to build similar systems.

Another NRCS grant funded a solar-powered irrigation system on a pecan orchard in Pierce County, Ga., in 2006. This small system pumped 40 gallons a minute from a holding pond to 45 mature pecan trees and cost $10,000 to install.

"The idea behind the project was to demonstrate the feasibility of using such a system in a location where electricity was not available and show the cost associated with installing and operating the system," Hawkins said. ■

Brad Haire is a news editor with the University of Georgia College of Agricultural and Environmental Sciences.

For more information, contact Gary Hawkins at ghawkins@uga.edu.

Governor honors farmers' environmental stewardship

By Faith Peppers

For more than 40 years, Danny Hogan has cared for the land that has supported his family for four generations. For his efforts, Gov. Sonny Perdue gave Hogan the third annual Governor's Agricultural Environmental Stewardship Award in 2008.

"Georgia farmers are the original stewards of the land," Perdue said. "My father used to always tell me that we should leave the land better than we found it. That's just what these farmers do."

Hogan competed against four other district winners, who were saluted for their extraordinary efforts to protect and preserve the environment on their farms.

Georgia Farm Bureau

Danny Hogan's farm includes timber and pasture acreage. The 2008 Governor's Agricultural Environmental Stewardship Award winner uses conservation tillage to grow wheat, oats, peanuts, cotton and soybeans. Hogan participates in numerous conservation programs to provide wildlife habitat and protect soil and water resources.

Along with his partner and son, Richard, Hogan grows wheat, oats, peanuts, cotton and soybeans near Dexter, Ga. They manage pasture and timber and raise Black Angus, Limousine and Belgian Blue cows. They raise quarter and paint horses, too, for show and to sell. They want to protect it all and keep it as pristine as they can for the future, Hogan said.

On their 950-acre farm, they use conservation tillage to grow their crops and use chicken litter to fertilize them. Hogan says the litter is more than worth the cost of getting it hauled to his farm.

Hogan implements strategies to protect the soil where his livestock walk the most and to help keep it from eroding. And he does whatever he can to protect both land and water by participating in environmental quality, wildlife habitat, forestland enhancement and other conservation programs. He plans to continue to find ways to conserve water while finding new and better ways to protect the streams and wetlands that flow through his land.

"This was an incredibly close competition," said Duren Bell, the University of Georgia Extension state agricultural and natural resources coordinator. "[Hogan] embodied the whole picture from his forestry program to conservation tillage in row crops and his protective practices in his livestock operation."

Hogan also participates in community activities that "allow him the opportunity to influence others in the community to use good environmental practices," said Bell, who was a judge for the award.

The district winners were Marty McLendon of Leary, Bud Butcher of Senoia, Jeff Deen of Baxley, and Ted Hughes of Comer.

"Farmers are leaders in technology and innovation, their love of country, love of land, love of the soil and service to others," Perdue said. "Today in agriculture, we are growing energy and we are growing pharmaceuticals. Our young people are in an enviable spot with a bright future ahead in agriculture." ■

Faith Peppers is a news editor with the University of Georgia College of Agricultural and Environmental Sciences.

For more information, on environmental stewardship go to www.gaaged.org/awareness/gov_ag_enviro_award.htm.

Agricultural Innovation Center assists bioenergy industry

By Sharon Dowdy

From helping a Georgia cattleman find new markets for his beef to determining which feedstocks work for bioenergy production, the Centers of Innovation for Agriculture has one goal — seeing agricultural industries grow and succeed in Georgia.

"We find agricultural businesses that need research out of the university system to help their business grow and we connect them with the university that can best help them," explained Bill Boone, director of the center.

Located on the Tifton campus of the University of Georgia College of Agricultural and Environmental Sciences, the agricultural center focuses on precision agriculture, nutraceuticals and organics, energy feedstocks, biotechnology and forest products. The other centers focus on aerospace, life sciences, manufacturing, information technology and maritime logistics. It is one of six Centers of Innovation created by Governor Sonny Perdue in 2003.

Centers of Innovation for Agriculture

Above: Wood pellets are being studied as a cost-effective and efficient means to heat poultry houses.

Below: As part of precision agriculture, wireless broadband technology is often used to maximize irrigation efficiency.

Centers of Innovation for Agriculture

"The Centers of Innovation work directly with the industry community to proactively identify problems and solutions through connections to university research, commercialization, innovation and proprietary processes," said Boone. "This creates new revenue sources as well as cost savings via efficiencies and speed. The centers also help orient the state's economic development around clusters of businesses where Georgia has a competitive advantage and a successful amount of industry already."

The mission is to promote innovation and cutting-edge technology that will keep these Georgia industries competitive statewide, nationally and globally, he said.

Pioneering agricultural companies have access to the center's 10,000-square-foot laboratory and office space in the business incubator on the UGA Tifton campus. They also directly benefit from the collective knowledge of the UGA and USDA scientists working on the campus.

The fact that Tifton is home to more than 100 Ph.D.s providing agricultural research was yet another selling point for locating the center there. "In addition to the association with the UGA CAES, there are additional scientists with the USDA here in Tifton," Boone said. "This forms a center of gravity for agricultural research in Tifton that provides a significant competitive advantage for agribusiness companies wanting to do business in Georgia."

Centers of Innovation for Agriculture

Developed on the Tifton campus, the sipping tractor is operated by remote control and uses the smallest amount of energy required.

After four years of leading the center, Boone can now tout numerous success stories of agricultural businesses that have, and continue to, benefit from working with the center. "We help them do the research they need to make their business and their product better," he said. "This is essential for them to grow, be competitive and stay in Georgia."

Although many of the center's projects are confidential, he did share a bit of general information on one current project.

The center is collaborating with the CAES poultry science department, Georgia Forestry, the UGA Warnell School of Forestry and Natural Resources, FRAM Fuels and other private companies to see if heating poultry houses with wood pellets and other local wood products is feasible. So far, the results have been promising that the process can be both cost-effective and beneficial to the chickens, Boone said.

The agriculture center also works closely with CAES scientists researching bioenergy foodstocks and value-added uses for agriculture by-products. "These prospects run the gamut from determining which biodiesel feedstocks will grow well in Georgia to which varieties of sweet potatoes and sweet sorghum might grow the best in Georgia for ethanol production," Boone said.

To date, the center has conducted more than 75 projects with existing Georgia agricultural companies and helped 23 new companies establish footholds in Georgia. ■

Sharon Dowdy is a news editor with the University of Georgia College of Agricultural and Environmental Sciences.

For more information, visit http://agribusiness.georgiainnovation.org/about/us.

GIFT program shows teachers ways to educate students on biofuels

By Brad Buchanan

For the past three years, University of Georgia and USDA scientists have engaged middle and high school science teachers in bioenergy topics through the Georgia Intern-Fellowships for Teachers program.

A summer internship program for teachers, GIFT is coordinated by the UGA Tifton campus but involves all UGA campuses. Through the GIFT program, scientists provide teachers access to cutting-edge research and first-hand opportunities to experience the increasingly important efforts to find bioenergy solutions to meet energy needs.

Teachers participating as GIFT interns become effective agents to deliver knowledge learned from their research experiences to their schools.

Susan Reinhardt

Through the GIFT program, one high school teacher learned how to make biodiesel in the laboratory with his students.

GIFT teachers develop lesson plans and teaching materials and become points of contact within their schools for other teachers seeking knowledge on relevant research.

Partnerships between GIFT scientists and teachers have led to opportunities for work begun during summer internships to be continued after the teacher returns to the classroom.

Some highlights of recent educational outreach accomplishments involving bioenergy include:

- **A service-learning grant through the Georgia Department of Education provided equipment and supplies to two high schools** — one in Berrien County and one in Rockdale County. The materials are being used to teach students how to make ethanol and biodiesel.
- **Teachers have led workshops at two biofuels conferences held on the UGA Tifton campus.** After attending one of the conferences, a Tift County High School teacher returned to his classroom and made biodiesel with his students. The students entered an environmental contest and won first prize for their efforts.
- **In partnership with Abraham Baldwin Agricultural College, the UGA Tifton campus received an Intellectual Capital Partnership Program grant.** The funds will be used to develop a biofuels class and curriculum. The objectives of the K-12 outreach portion of the grant are to educate more teachers about alternative fuels, thus increasing the number of students who become more knowledgeable about them. The outreach efforts will also give high school science, technology, engineering and mathematics students a direct pathway to more information on alternative fuels, hopefully encouraging them to pursue undergraduate degrees useful to alternative fuel production. Workshops are being presented for both teachers and students across Georgia.

Susan Reinhardt

- **Collaborating with the Chattanooga Children's Discovery Museum, the GIFT program's outreach efforts are being shared through a national education outreach initiative.** The goal is to educate teachers and students about cellulosic ethanol. An educational outreach component of the Bio Energy Sciences Center grant, this project is a partnership between UGA, the University of Tennessee and the Department of Energy Lab at Oak Ridge.

For more information on the GIFT program, contact Brad Buchanan at bbuchana@uga.edu or (229) 386-7274.

Brad Buchanan is a research professional working at NESPAL.

Susan Reinhardt

Throught the GIFT program, middle and high school teachers learn about cutting-edge biofuel research and are taught how to deliver that knowledge to their students.

Susan Reinhardt

For more information, visit www.ugastars.org/gift.htm.

UGA takes bioenergy work to Washington

Story and photos by Stephanie Schupska

From bicycle-powered light bulbs to algae bubbling in plastic bags, 30 universities showed off their biofuels research under a circus-size tent at the second annual Bioenergy Awareness Days in Washington on June 19.

The three-day event took place at both the Whitten Federal Building of the U.S. Department of Agriculture and at the National Arboretum. Close to 80 exhibitors were featured.

Erin Macheski-Preston, left, and Brad Buchanan, researchers on UGA's Tifton campus, take UGA's sipping tractor for a remote-controlled spin at the National Arboretum.

The University of Georgia is among 13 winners of the Grand Challenge, an honor that allowed them to exhibit at both locations. The title recognizes universities for their leadership in renewable energy research, teaching and outreach and for their collaborations with other private or public institutions.

"The Grand Challenge was challenging universities to work with other universities and industries and other institutions to develop a vision on how to meet the energy concern in the next few years," said Gale Buchanan, USDA under secretary for research, education and economics and former dean and director of the UGA College of Agricultural and Environmental Sciences.

The USDA and the 25x'25 Alliance sponsored the challenge. 25x'25 is a coalition of leaders from agricultural, forestry and renewable energy communities. They are committed to providing 25 percent of the nation's energy from farms and forests by 2025.

Researchers from UGA's Athens and Tifton campuses hauled algae, chicken fat, wood pellets, a remote-controlled tractor and sugar cane through Georgia, the Carolinas, Virginia, D.C. and finally Maryland to participate in the event at the National Arboretum. For three days they faced cameras and fielded questions like, "Chicken fat? Really?" Mention algae and chicken fat together, and visitors, reporters and dignitaries alike headed eagerly toward UGA's lab-like display, which was set up in a walk-through trailer.

K.C. Das, a CAES associate professor and director of UGA's Biorefining and Carbon Cycling Program, estimates algae will be commercially viable as a source for biofuel in about five years. Algae have the potential for producing 2,000 gallons of oil per acre annually. In comparison, soybeans produce 48 gallons an acre. Corn produces 18 gallons an acre.

Much of the research UGA displayed is already being put to commercial use. In north Georgia, chicken fat is manufactured into biodiesel. Pellets made from both peanut hulls and Georgia's timber scraps are being burned for fuel.

Above left: Algae stays warm and flourishes under bright lights in a growth chamber at the University of Georgia.

Above: Using UGA's examples of wood pellets, bark and wood chips, a television crew from Clean Skies TV films a segment about BioEnergy Awareness Days on June 20 at the National Arboretum in Washington, D.C.

Left: K.C. Das, an associate engineering professor for the College of Agricultural and Environmental Sciences and director of UGA's Biorefining and Carbon Cycling Program, talks to visitors outside the Whitten Federal Building at the second annual Bioenergy Awareness Days on June 19.

The UGA remote-controlled "sipping" tractor runs on both ethanol and solar power and earns its name by sipping just enough fuel to keep going. And sugar cane is just one of many crops UGA researchers are putting through the grind in search of better biomass.

More than 80 researchers and economists are working on basic and applied biofuels research, collaborating through UGA's Biofuels, Biopower and Biomaterials Initiative (B3I). From rotten fruit to cotton stalks, they're searching for the second generation of biofuels — which will produce energy without eating up valuable food crops. ■

Stephanie Schupska is a news editor with the University of Georgia College of Agricultural and Environmental Sciences.

For more information, visit www.bioenergy.uga.edu.

Up Close with K.C. Das

By Susan Varlamoff

K.C. Das is an associate professor of engineering in the department of biological and agricultural engineering and director of the Biorefining and Carbon Cycling Program. He manages the biofuel research for the University of Georgia College of Agricultural and Environmental Sciences.

Stephanie Schupska

Background and education

Das came from India to study at UGA in 1989 when gasoline cost 68 cents a gallon and $6 filled his VW Scirroco tank for two weeks. He remembers seeing John Goodrum's laboratory with diesel engines collecting dust. (John Goodrum was a pioneer in the field of alternative fuel in the early 1980s.) There was no interest in developing biodiesel with the price of gasoline so low. Das received a Ph.D. from Ohio State University in 1995. His thesis was Organic Waste Recycling.

UGA Work History

Das was hired in 1995 to work in the newly established Bioconversion Center commissioned by the Georgia Research Alliance. His initial work focused on organic biomass recycling. In 2003, the focus expanded to include biofuels. Operations began with a $1 million grant funding a chicken fat/biodiesel project. What began with two researchers is now a robust bioenergy program of 30 researchers and graduate students. The program has drawn in millions of dollars in grant funding.

Guiding Philosophy

Kashmiri Proverb—
We have not inherited the world from our ancestors, we are borrowing it from our children.

What kind of biofuel research does your team conduct?

Essentially, we try different processes on a variety of agricultural and forestry wastes and fuel crops to create bioenergy. The wastes include peanut shells, poultry litter and forestry residues and promising fuel crops include algae, bamboo and kenaf. In fact, we're not opposed to trying any feedstocks as long as there are great quantities available. Through a thermochemical process called pyrolosis, we heat biomass in the absence of oxygen to produce oil, gas and charcoal. We collaborate with soil scientists to characterize the char and determine its value as a fertilizer or soil amendment. We examine the entire carbon cycling process as part of our research plan. Gasification is another thermochemical process we can use to make liquid fuels. We accomplish this by heating the feedstock with a little oxygen. We are collaborating with the UGA Warnell School of Forestry and Natural Resources to convert wood waste from sustainably managed forests into cellulosic ethanol. We look at the full life cycle of making biofuels and part of that involves pre-processing the waste. Through torrefaction, biomass is heated at low temperatures to increase its energy density and remove less desirable properties. This works well for wood waste and makes it easier to transport and more efficient in co-firing with existing power plants.

In your opinion, is any one feedstock more viable than another?

Algae shows great promise because it grows rapidly in warm climates like what we have in Georgia. It can produce 2,000 gallons of oil per acre whereas soybeans generate about 48 gallons an acre. Extracting the oils from the algae is difficult and we are working to resolve this problem.

We hear so much about cellulosic ethanol as part of the next generation of bioenergy? Is it economically viable?

Yes, at the current price of oil, it is economically viable. But we must mass produce it. It should be in large scale production in five years.

How much petroleum-based energy can be replaced with bioenergy in Georgia?

About 30 percent of our energy needs can be met with bioenergy today. By patching together multiple strategies we can achieve this amount. This would include burning chicken litter to heat farms in north Georgia, fermenting outdated cola products for ethanol, generating biogas from cow manure on diary farms, harvesting landfill gas for electricity and producing cellulosic ethanol from pine waste in south Georgia. All of these projects exist today in Georgia and many more are coming on line.

Does Georgia have an advantage in bioenergy production?

Yes, because we can grow great quantities of biomass through our agriculture and forestry industries. Universities like the University of Georgia, Georgia Tech and others provide the technology. The UGA Complex Carbohydrate Research Center is strong in the biological sciences. In addition, the Agricultural Innovation Center and the Georgia Environmental Facilities Authority assist companies interested in getting into the business through their "One Stop Shop."

Do you think we will achieve the goal set by the national 25 by '25 Alliance to produce 25 percent of our energy from the nation's farms and forests?

With the current high price of oil, there is a strong incentive to meet it. However, we need more investment in research, development and production. The Europeans are advanced in bioenergy production because they have a high tax on gasoline that is used to fund it. ■

Susan Varlamoff is director of the UGA CAES Office of Environmental Sciences.

A new era

By Susan Varlamoff

Technology combined with concerns for energy security, global warming and economic stability are driving the nation in the direction of renewable energy. Universities are in the forefront of the innovation that will lead the United States in this new direction.

Last summer, I attended the Grand Challenge exhibition in Washington, D.C., where universities from across the country showcased their efforts to transform local renewable resources into energy and transportation fuel. The University of Georgia's winning entry "Not Your Usual Power Plant" featured the abounding opportunities the state's abundant biomass — from wood chips to chicken fat — provides for energy production.

This year, *Forbes Magazine* rated Georgia number three in potential bioenergy production. Governor Sonny Perdue, who signed the 25 X '25 Vision pledge to produce 25 percent of Georgia's energy from the nation's farms and forests by 2025, announced at the 2008 Southeastern Bioenergy Conference that as far as energy is concerned, he wants to "grow it here, convert it here, use it here."

To meet this ambitious goal will require many things —

- Identifying new feedstocks to reduce the competition between crops grown for food and fuel.
- Developing highly efficient methods for growing, harvesting and processing feedstock.
- Maintaining soil fertility.
- Identifying sites for biorefineries near feedstock production to reduce transportation costs.
- Scaling up bioenergy production facilities from the laboratory to industry.

In addition, extension agents, currently being trained through the UGA Bioenergy Task Force, will need to educate farmers and communities about all aspects of regionally produced energy. Students will have to be recruited into the science and engineering fields to make the necessary technological breakthroughs and research funding must be increased to fuel the scientific studies. Lastly, if the federal government requires a certain portion of our energy to be produced from renewable sources, the transition to a greener economy will move more quickly.

April Sorrow

Susan Varlamoff

The day is drawing closer when we will see the end of the Oil Age and the dawn of the Biofuel Age. ■

Susan Varlamoff is director of the UGA CAES Office of Environmental Sciences.