

By Susan Cotton and Mike Downey

# BioEnergy Alliance: Seeking Nontraditional Fuels

Fueling cars and the nation from products like manure, mesquite and sorghum takes great minds.

To lead the way in this bioenergy research, some of the best minds in the Texas Agricultural Experiment Station (TAES), and the Texas Engineering Experiment Station (TEES), have joined to form the Texas A&M Agriculture and Engineering BioEnergy Alliance.

The BioEnergy Alliance is based on decades of joint research like that of Kalyan Annamalai and John M. Sweeten.

Annamalai, a TEES researcher and Paul Pepper Professor in Texas A&M University's Department of Mechanical Engineering, and Sweeten, a TAES researcher as well as professor and resident director of the A&M System's Agricultural Research and Extension Center in Amarillo, have worked together for 25 years to turn cattle manure into an energy source.

"I joined the faculty in mechanical engineering in 1981, and it was sometime in 1982 when I received a call from Dr. Sweeten for some help with combustion and energy conversion of animal wastes," Annamalai says. "Since then, John has become the fuels man and I've become the combustion man."

Their projects have included 100 percent manure fuel, coal-manure blends for direct combustion, manure-based air pollution control, manure-fueled combustion, manure-heated ethanol plants and manure-supplemented coal power plants.

"We've studied a succession of technologies over the years and jointly published many papers and journal articles largely through Dr. Annamalai's excellent graduate student program," Sweeten says.

The Texas Commission on Environmental Quality and the U.S. Department of Energy have funded Annamalai and Sweeten's project to use manure to reduce mercury and nitric oxide pollution from coal power plants.

Sweeten supplies manure harvested and prepared to specification for Annamalai from feedlots around Amarillo, including TAES' research feedlot near Bushland; researchers from Texas A&M's Department of Biological and Agricultural Engineering test the manure; and Annamalai burns the manure with coal in his laboratory. When the coal ignites with the manure, ammonia from the manure transforms nitric oxide from the coal into nonpolluting nitrogen and water.

"We wish to keep our fingers crossed until [this process is] demonstrated in a large-scale power plant," Annamalai says.

"We are also investigating the production of hydrogen gas, using steam gasification of coal and biomass with potential application to FutureGen-type gasifiers."

The U.S. Department of Energy has selected two sites in Texas, Heart of Brazos and Odessa, as two of four finalists for its zero-emissions coal power plant, FutureGen. Heart of Brazos is less than 100 miles from Texas A&M.

Annamalai and Sweeten intend to continue their collaboration for years to come.

"We've got grants and future plans," Sweeten says. "It's an excellent collaboration."

TEES director Dr. G. Kemble Bennett, vice chancellor and dean of Texas A&M Engineering, says bioenergy like this is emerging as an important part of the energy solution.

"This BioEnergy Alliance is accelerating our abilities to transfer new technologies from the lab to the marketplace," Bennett says. "Combined with emerging ideas and technologies, the Alliance can create a range of products to help the people of Texas and beyond."

The BioEnergy Alliance expects to contribute to the national Biofuels Initiative, part of the federal government's goal to reduce American dependence on foreign oil by replacing 75 percent of oil imports by 2025.

One way to reduce dependence on foreign oil is cars that get 100 miles to the gallon — and that fill up with fuel derived from plant life. Mark Holtzapple, a TEES researcher and professor in Texas A&M's Artie McFerrin Department of Chemical Engineering, undertakes this part of bioenergy research's enormous potential.



The StarRotor engine is designed to run on a variety of fuels, including biofuels from sorghum and other biomass products.

Add near-zero pollution to that car, and it is Holtzapple's StarRotor engine. The engine is designed to run on a variety of fuels, including biofuels from sorghum and other biomass products produced by the MixAlco process, also a Holtzapple invention.

Typical car engines are inefficient and lose energy when they release hot exhaust gases.

"The StarRotor engine captures the heat given off in car exhaust and uses it to power the car," Holtzapple says.

The more efficient engine with a cooler exhaust also will save consumers money. Current automobiles use about 600 gallons of gasoline annually. Multiply that by \$2.10 per gallon, and it costs nearly \$1,300 per year to fuel one car. The StarRotor engine would cut that in half without sacrificing performance. Two-car families would save that \$1,300 every year, Holtzapple says.

"By lowering fuel consumption and using alternative fuels, dependence on foreign oil would be greatly reduced," Holtzapple says. "Because the United States now imports more than half its oil, any change in foreign markets affects our ability to fuel vehicles. This engine and the MixAlco process will reduce the vulnerability of our economy."

TAES director Elsa Murano, vice chancellor and dean of Texas A&M Agriculture, says that what researchers have going in the A&M System are the agricultural scientists developing the drought-tolerant crops as a sustainable supply of biomass for use in biofuels.

"Also, we have these engineers working on the technologies to maximize the effectiveness of these bioenergy fuels," Murano says.

Texas' highly productive agriculture industry can become a major source of renewable energy. Bioenergy can use high-productivity feedstocks, such as sugar cane and sorghum.

TAES is recognized as the world leader in sorghum-based research, led by plant breeder Bill Rooney, a professor in Texas A&M's Department of Soil and Crop Sciences, and geneticist John Mullet, a professor in Texas A&M's Department of Biochemistry and Biophysics. They, along with A&M System researchers throughout the state, "are working to better understand the sorghum genome to produce better biomass and a better biofuel," Rooney says.

Jim Ansley, a TAES researcher as well as a professor at the A&M System's Agricultural Research and Extension Center in Vernon, is researching methods to harvest mesquite brush so that it can be converted into ethanol. A combination of the United States' dependence on foreign oil and a growing problem with mesquite brush in Texas has led Ansley to develop this potential biofuel. Hundreds of ethanol plants could be built to harvest and convert part of the millions of acres of mesquite and enhance rangeland productivity for livestock, hunting or other uses.

Another researcher looking at unique solutions to biofuel issues is Sergio Capareda, a TAES researcher and assistant professor in Texas A&M's Department of Biological and Agricultural Engineering. Capareda has worked with industry and researchers from other fields to get energy from biomass, or agricultural waste.

The Cotton Foundation, Temple-Inland Inc. and TEES' Food Protein Research and Development Center are among his collaborators.

"The bioenergy problem revolves around systems efficiencies and economics," Capareda says. "The only way you understand these is to know production, conversion and economic issues. And the only way you learn those is by working with others."

With the Food Protein Research and Development Center, Capareda has worked on converting cottonseed oil into biodiesel, which can run crude-oil diesel engines without adjustments to the engines.

"I was an invited speaker for their biodiesel training program during February and August 2006," he says. "They learned of my expertise and our laboratory capabilities — such as having an engine dynamometer laboratory for testing performances of engines running on biofuels — including emission studies."

Researchers from the Food Protein Center combine cottonseed oil with ethanol to yield biodiesel and glycerin; Capareda tests the biodiesel in his laboratory.

"We also have other facilities for testing the quality of biodiesel following the American Society for Testing and Materials procedures (e.g., cloud and pour point, viscosity, sulfur, distillation), and this complemented well with their project," he says.

Because of research and researchers like these, the BioEnergy Alliance will result in bioenergy for the state, nation and world. ■