

Energy Cane Leadership
USDA-ARS Sugarcane Research Unit (SRU)
Houma, La

I. Mission Statement

To provide research-based solutions that enhance the viability of sugar cane as a sugar and/or biofuels feedstock through the development of improved varieties and environmentally friendly production strategies that will insure industry profitability, expand the cropping range, and combat a constantly evolving pest complex that includes diseases, insects, and weeds.

II. Research Accomplishments/Strengths:

- The SRU has been actively involved in a sugarcane varietal development program for the sugarcane industry since the late 1920's as part of a three-way agreement with the LSU Ag Center and the American Sugar Cane League (grower/miller organization).
- The major emphasis of the SRU's breeding program is the development of high yielding, disease and insect resistant, cold tolerant, good ratooning varieties that are adapted to low organic matter mineral soils. Cold tolerance comes from genes obtained from wild species of sugarcane (*Saccharum spontaneum*) and its related genera, *Miscanthus* and *Erianthus*. The SRU maintains an active collection of these parental clones through APHIS permits. This collection of wild species and related genera used to introgress desirable genes is unique, extensive, and continues to grow as a result of the SRU's non-funded cooperative agreements on varietal development with countries where these clones are native to the area.
- The SRU's sugarcane breeders use the early generation hybrids (F₁'s and BC₁'s) from these crosses as candidate energy canes because of their high biomass yields and tolerance to biotic and abiotic stresses (heterosis).
- Selection and testing procedures used by SRU scientists to identify superior sugar cane varieties can be easily adopted for energy cane as traits selected for in sugar cane e.g. yield, drought and cold tolerance, disease and insect resistance, and nutrient use efficiency would be similar for energy cane.
- The SRU's photoperiod/crossing facilities will be tripled in 2010 as a result of congressional appropriations.
- The SRU and its two Louisiana partners released three energy cane varieties in 2007 and will release another variety in 2010 with dry matter yields expected to be 10 to 20% higher.
- Six candidate energy cane varieties developed by the SRU are being tested by University Cooperators in Florida, North Carolina, Georgia, Alabama, Mississippi, Arkansas, Oklahoma, Louisiana, Texas, Hawaii, and California under the USDA-ARS Sun Grant Initiative as energy cane has been identified as a viable regional feedstock for the south-central and south-eastern U.S. To date, the energy cane clones have survived the winter months at all locations and plots for yield testing have been established. Data will be used in varietal releases of these clones.

- The SRU's breeders have at least 10 clones being advanced as possible energy cane varieties in yield trials to include alternate sites in Mississippi, North Louisiana, Arkansas, and Texas.
- The SRU has a multi-disciplinary team of scientists working under five CRIS Projects to address the SRU's mission. The scientists at the SRU are well-published in their disciplines, have an outstanding international reputation and are frequently requested to give invited presentations at state, regional, national, and international meetings and consult at foreign research institutions. Expertise of the scientific staff can be found in Section III below.
- The SRU's scientists are conducting research to identify complementary crops and sustainable management practices for these crops to enable their culture on an "energy plantation" to insure year-round deliveries of feedstock to biorefineries. Complimentary crops include: sweet and forage sorghums, tropical maize, Miscanthus, and tropical sugar beets.
- The SRU has a 300 acre research farm and all of the farm equipment needed to do research to include weigh wagons to determine plot yields. In addition, it has specific cooperative agreements in place with a number of sugarcane growers to establish replicated field experiments on their commercial farms (>100 additional acres for research) at no cost.

III. Multidisciplinary Scientific Staff

A. CRIS Research Projects

1. Genetic Improvement of Sugarcane by Conventional and Molecular Approaches (Breeding)

- a. **Dr. Anna Hale.** Research geneticist, Dr. Anna Hale, has been employed at the SRU since 2007. Dr. Hale leads the basic breeding and energy cane components of the breeding program. Her responsibilities include: (1) acquiring and maintaining germplasm from wild species of *Saccharum* and related genera; (2) characterizing parents and progeny for traits that will increase the adaptation of sugarcane to Louisiana's temperate climate to include: cold tolerance, stubbling ability, disease resistance, and sugarcane borer resistance; (3) utilizing conventional crossing and molecular marker techniques to produce interspecific and intergeneric hybrids containing new sources of disease and insect resistance and cold tolerance; (4) recombining progeny through backcrossing to develop parental material containing a concentration of desirable genes for the SRU's commercial breeding program; and (5) developing screening procedures to determine relative cold tolerance among clonal material in the basic breeding program. Materials out of the basic breeding program are currently being used in regional testing for bioenergy production. Dr. Hale is the current chair of the Sugarcane Crop Germplasm Committee. She has published on the variation in starch levels in a wide range of sugarcane germplasm and has articles in press on sugarcane red rot

resistance. Prior to her employment at the SRU, Dr. Hale worked on determining the antioxidant levels in potato germplasm and on a molecular mapping project to determine QTLs associated with glucoraphanin content in broccoli (*Brassica oleracea*).

- b. **Dr. Yong-Bao Pan.** Research molecular geneticist, Dr. Yong-Bao Pan, has been employed at the SRU since 1995 and is a member of both the breeding (75%) and pathology (25%) research projects. While employed at the SRU, he: (1) used 5S rRNA-ITS and SSR DNA markers on sugarcane and related species to develop markers to: fingerprint parental clones, assess the quality of crosses made at the SRU, and identify hybrids; (2) assessed genetic variability and phylogenetic relationships among sugarcane, *S. giganteum*, Old World *Erianthus*, and *S. spontaneum* using the 5S rDNA, random amplified polymorphic DNA (RAPD), and SSR DNA markers; (3) developed high-throughput (HT)-SSR genotyping technology and a local variety molecular identity database; (4) developed several lines of new germplasm that had *S. spontaneum* cytoplasm; (5) developed a PCR procedure for the detection and identification of *Xanthomonas albilineans* (*Xa*), the causal bacterium for the sugarcane leaf scald disease; and (6) developed a PCR protocol and a tissue-blot DNA Hybridization Assay for the detection and identification of *Leifsonia xyli* subsp. *xyli*, the causal bacterium of sugarcane ratoon stunting disease (RSD).

2. Disease Control Through the Enhancement of Resistant Sugarcane Germplasm (Pathology)

- a. **Dr. Michael Grisham.** Research Plant Pathologist, Dr. Michael Grisham, has been employed at the SRU since 1984 and currently serves as the project's lead scientist. The objectives of the project are 1) to identify and develop germplasm with resistance to major diseases affecting sugarcane in Louisiana including smut, rust, leaf scald, ratoon stunting disease, mosaic, and yellow leaf and 2) to identify genetic variability among sugarcane pathogens. Research in support of achieving these objectives includes the development and modification of immunoassay and nucleic acid-based diagnostic protocols for the detection of viral, bacterial, and fungal pathogens. Recent emphasis has been to develop diagnostic protocols that are more sensitive and quantitative including the application of real-time PCR for the detection of sugarcane pathogens in hosts and vectors. Research is being conducted on the effects of ratoon stunting disease, sugarcane yellow leaf disease, and mosaic on sugarcane yield and cane quality. Epidemiological and host resistance studies are being conducted on sugarcane yellow leaf virus (SCYLV), the causal agent of yellow leaf. An extensive study is being conducted on the genetic

variability within sugarcane mosaic virus (SCMV) and sorghum mosaic virus (SrMV) that cause mosaic in Louisiana sugarcane. Temporal and spatial distributions of viruses and strains within the Louisiana sugarcane industry are being examined. Other research includes determining the effects of cultural practices on the development and severity of sugarcane diseases, for example, the effect of soil nutrition on the incidence and severity of sugarcane brown rust.

- b. **Dr. Yong Bao Pan.** See III.B.1.c above.

3. Developing Integrated Weed and Insect Pest Management Systems for Efficient and Sustainable Sugarcane Production (Entomology and Weeds)

- a. **Dr. William White.** Research entomologist, Dr. William White has been employed at the SRU since 1982 and currently serves as the project's lead scientist. Through innovative behavioral studies of the sugarcane borer (SCB) larvae infestation process and insect development, Dr. White has redefined the yield-loss criteria for determining the economic threshold level of SCB damage used in pesticide application decisions. He has facilitated research on the inheritance of resistance to the SCB that has led to the development of appropriate breeding strategies. To date, 17 SCB-resistant clones have been registered and released for use by sugarcane breeders. He has also identified the ecological barriers preventing the permanent establishment in Louisiana of the borer parasitoid, *Cotesia flavipes*. He designed a field survey protocol and organized a team of national and international experts that led to the discovery of a new insect pest, *Blastobasis graminea*, previously unreported in the United States. He is also credited with the discovery of three other insect pests in Louisiana. Dr. White duties also include serving as a full-member of the commercial breeding team providing suggestions to the selection of parents for crossing, to the procedures for variety evaluation, and to the decision for variety release. He has participated in the release of five cultivars since joining the team. Dr. White currently serves as the International Society of Sugar Cane Technologist's Biology Commissioner and as Chairman of the Commission's Entomology Committee.
- b. **Dr. Caleb Dalley.** Agronomist, Dr. Caleb Dalley, has been employed at the SRU since 2004. His primary research emphasis is on the development of cultural and chemical strategies for the control of problematic weeds in sugarcane with particular emphasis on *Cynodon dactylon* and *Sorghum halepense*. Cultural practices include varietal competitiveness, frequency and type of cultivation, and the utilization of post-harvest residue blankets to suppress weed development while chemical strategies include the use of preemergence and postemergence applications of herbicides. He is also involved in evaluating herbicides

that could be used for weed control in sweet sorghum, and in evaluating the agronomic needs for the production of sugar beets in Louisiana. Dr. Dalley is responsible for the SRU's ripener research where herbicides, especially glyphosate, are applied to accelerate sucrose accumulation early in the harvest season.

4. New and Improved Cultural Practices for Sustainable Sugarcane Production and Environmental Protection (Cultural Practices)

- a. **Dr. Richard Johnson.** Research Agronomist, Dr. Richard Johnson, has been employed at the SRU since 2001 and currently serves as the project's Lead Scientist. Dr. Johnson's primary research focus is in the area of precision agriculture applications for sugarcane production systems that optimize production efficiency and insure profitability. This has included variable-rate application systems, remote sensing of field standing cane for biomass and sucrose estimations and documentation of the spatial variability in soil properties and cane yield. He has also worked to optimize sugarcane fertility and crop management systems for both sugar and energy cane. Recently he has been a member of a team that has developed a yield monitor that can be mounted on sugarcane harvesters.
- b. **Dr. Ryan Viator.** Research Agronomist, Dr. Ryan Viator, has been employed at the SRU since 2003. Specific objectives of his research are to: (1) assist the SRU's plant breeders in identifying and evaluating sugarcane germplasm with: the ability to emerge through post-harvest leaf litter in the late winter at the start of the subsequent growing season and also possess greater stalk to leaf ratios and leaf sheaths that are easily separated from the stalk by mechanical harvesters; (2) develop methods to manage the post-harvest litter generated during green cane harvesting to reduce its suppressive effects; (3) explore, as a member of an interdisciplinary team, the potential benefits of the litter on pest management (weeds, diseases, and insects) and possible interactions of other sources of stress such as ripener usage, waterlogged soils, and/or non-optimal harvest conditions with litter retention; (4) lead cooperative studies to find profitable alternate uses of the plant litter remaining on the field after harvest; and (5) develop cultural practices that insure sugarcane profitability such as: fall regrowth management, date of planting, starter fertilizer, date of harvest, conservation tillage, use of rotational crops in the summer fallow, harvesting effects on cane quality, and ripener management. He also actively screens germplasm in the early stages of the varietal development program for tolerance to post-harvest residue and periodic soil saturation.

5. Soil and Water Management

- a. **Dr. Paul White.** Research Soil Scientist, Dr. Paul White, joined the SRU in August, 2009. His work areas include developing management practices for sustainable sugar and energy cane production that maintain or restore soil health to maximize crop yield. The research aims to increase soil carbon levels, limit soil erosion, and improve agrichemical use efficiency. Dr. White's research also includes using by-products, such as biochar, mill mud, and fly ash generated during the processing of sugarcane to raw sugar as beneficial soil amendments for energy crops.