LSU AgCenter:
A Decade of Innovation

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The LSU AgCenter is at the forefront of developing valuable innovations in food technology, renewable natural resources and sweet potato, rice, wheat, sugarcane and oat breeding. This is a collection of articles from Louisiana Agriculture, the LSU AgCenter's quarterly magazine that chronicles the contributions the cooperative extension service and the university make to science, teaching and the people of Louisiana. These articles feature some of the major research fields, projects and people that have made this institution a leader in globally impactful innovation and commercialization over the past decade.

LOUISIANA Agriculture

Assuring Our Future Through Scientific Research and Education

CONTENTS

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LSU AgCenter research, extension boost sugarcane industry

Kenneth A. Gravois

As Louisiana begins its third century of sugar production, research continues to play a vital role that sustains both growers and processors. Many facets of the industry continue to change. Farm and factory sizes have increased. Input costs continue to climb. Labor is becoming an ever-increasing problem. Sugarcane rust disease has increased to a point of lowering yields. Sugarcane varieties once thought invincible have shown weakness, and new varieties have arrived. Unfortunately, one thing that has not changed much is price. Sugarcane farmers and processors face a host of challenges. The LSU AgCenter mission is to conduct research and extension programs that maximize production while minimizing the inputs needed for sustainable yields.

Varieties and diseases

As one reads through the history of sugarcane production in South Louisiana, the relationship between varieties and diseases is evident. In fact, much of the early sugarcane variety work was done by plant pathologists. Destructive diseases including mosaic, ratoon stunting disease and stalk rotting disease were found in Louisiana from the beginning of sugarcane cultivation. These diseases culminated their destructive effects in the 1920s by nearly decimating a once-thriving industry.

In the decades following, sugarcane varieties changed in lock step with the strain changes of mosaic. New diseases have arrived: Brown rust in the late 1970s, smut in the early 1980s, leaf scald in the early 1990s and yellow leaf in the late 1990s. Orange rust was found in Florida in 2007 and could present problems for the Louisiana sugar industry. Disease-resistant varieties have been the main line of defense against these diseases.

Photo by John Wozniak

Kenneth A. Gravois, plant breeder, is the Graugnard Brothers Professor and Resident Coordinator at the LSU AgCenter's Sugar Research Station in St. Gabriel.

Kenneth Gravois and Keith Bischoff lead the AgCenter sugarcane breeding efforts. With increasing levels of brown rust in the state's leading variety, LCP 85-384, new disease-resistant varieties are needed. Changing varieties in a perennial crop such as sugarcane is not an easy process, especially when the acreage peaks at 91 percent as was the case with LCP 85-384 in 2004. Since 2003, the LSU AgCenter, U.S. Department of Agriculture-Agricultural Research Service and the American Sugar Cane League have released seven new varieties to replace LCP 85-384. These varieties include HoCP 96-540, L 97-128, Ho 95-988, L 99-226, L 99-233, L 01-283 and HoCP 00-950. The work is ongoing as new experimental varieties continue to be developed in the breeding program. Many in the industry have said that the influx of new sugarcane varieties has kept them in business. Sugarcane varieties are truly the lifeblood of the industry.

Jeff Hoy has research responsibilities for sugarcane diseases. More recently, his efforts have included finding a fungicide to aid in the control of brown rust in Louisiana. Disease-resistant varieties have been the mainstay of control for brown rust, but other control strategies would be useful. His work has

Kenneth A. Gravois, Graugnard Brothers Professor and Resident Coordinator, Sugar Research Station, St. Gabriel, La.

shown yield losses up to 7 tons per acre because of brown rust. The use of fungicides has helped recoup these losses with timely applications. Hoy continues to manage the Sugarcane Disease Detection Laboratory as the Louisiana industry continues its fight against an old foe – ratoon stunting disease – and new diseases such as yellow leaf. Maximizing yields from billet-planted sugarcane is another research interest for Hoy. Many growers have switched to billet planting in an effort to circumvent labor shortages. Billet planting is also the only choice if seedcane has been lodged (fallen over), such as after hurricanes.

Old, new insect pests

The sugarcane borer has caused significant yield reductions in South Louisiana. In the early days of the industry, farmers did not have many options to combat the sugarcane borer. Beginning in the 1950s, insecticides became a popular control option. Many of the early insecticides were effective but harsh on the environment. Gene Reagan leads an AgCenter entomology research program combating the harmful effects of the sugarcane borer. Over the years, Reagan's research efforts have led to the use of pyrethroid insecticides, a new and safer chemistry. More recently, his research efforts have led to the registration of the insecticide Confirm, the most environmentally safe insecticide in use in sugarcane. Applications of Confirm specifically target the sugarcane borer while avoiding beneficial predators. Work is continuing with the insecticide Diamond, another environmentally safe insecticide. Full registration is possible for 2008.

A new insect pest is on the horizon – the Mexican rice borer. Reagan has led a multistate research effort determining the effect of this new stalk borer on Louisiana sugarcane varieties. He also has investigated the ecology of this new insect pest to determine the best means of its control. His research and monitoring efforts have tracked the eastward movement of the Mexican rice borer. Louisiana will be much better prepared when this new insect invades the rice and sugarcane growing regions of South Louisiana.

Weed control, cultural practices, environmental issues

Perennial weeds mean perennial problems. Jim Griffin leads AgCenter research and extension programs in sugarcane weed control. Weed control costs are high for sugarcane in Louisiana. Griffin's research constantly explores ways of reducing weed control costs while maintaining good weed control. Other research efforts include evaluating new herbicides, using alternative crops as a means of weed control and testing reduced tillage systems. Griffin's work has shown that Louisiana sugarcane farmers could reduce tillage without adverse effects on yield.

Ben Legendre conducts research on chemical ripeners, which increase the sucrose content in sugarcane. Louisiana has moved toward earlier harvests. Research has shown that chemical ripeners can increase the recoverable sugar per ton of cane by 50 to 70 pounds. His work also includes the search for alternative ripeners, such as Palisade. An alternative nonglyphosate-based ripener would be useful in the advent of herbicide-resistant crops such as Roundup Ready sugarcane.

With escalating fertilizer costs, determining cost effective fertilizer rates is the research area for Sonny Viator and Brenda Tubana. Their efforts have led to the changing of sugarcane fertilizer recommendations that include reduced nitrogen rates. Other research efforts include the fine-tuning of soil test results to match recommended rates of fertilizers.

Producing sugar with a minimal impact on the environment is another research objective within the LSU AgCenter. Magdi Selim, Richard Bengtson and Sonny Viator conduct research on improved water quality. To economically produce sugarcane in Louisiana, sugarcane growers must burn the leafy trash residue either before harvest or after harvest. If the leafy trash blanket is left on harvested fields, yield reductions of 3 to 5 tons per acre can occur in the subsequent crop. Results from this research have led to the development of BMPs (best management practices) for sugarcane production. It is important that the Louisiana sugar industry manage itself rather than being managed by federal and state environmental mandates.

Sonny Viator has also cooperated with USDA-ARS scientist Richard Johnson on research pertaining to precision agriculture. Applying nutrients and herbicides to areas only where they are needed can decrease production input costs, maximize yields and mitigate any harmful effects to the environment. Applying variable rates of lime to fallow sugarcane fields appears to be an excellent application of this new technology.

Economics

Sugarcane farmers and processors are in business to make money. Mike Salassi assists in these efforts by preparing an annual sugarcane budget that estimates sugarcane production costs based on inputs, equipment costs and yield potential. With urban encroachment increasing, Salassi provides information on land and crop values. Another of Salassi's current projects is to minimize transportation costs for sugar factories through hauling schedules. Mike Salassi has also been called upon by the U.S. Department of Agriculture to determine the feasibility of using sugarcane and it processing products and byproducts for ethanol production. His work has shown that the most economical sugarcane feedstock for ethanol production is molasses. Salassi works with many in the research and extension groups to apply economic analyses to their research and outreach efforts.

Sugar processing, new technologies

The Audubon Sugar Institute continues its long-standing mission of maximizing the production of raw sugar in Louisiana's sugar factories. Records kept by personnel at the Audubon Sugar Institute show an ever-increasing trend in Louisiana factory efficiency, even as factory size increases. As the sugar industry becomes more integrated with sugar refineries, research on producing a high level of sucrose in sugar (the pol level) with optimum color continues.

As the nation looks to the agricultural sector of the economy to meet some of its energy demands, work at the Audubon Sugar Institute focuses on ethanol conversion technologies. Funding, primarily through the Department of Energy, has focused research on converting sugarcane bagasse (a byproduct of raw sugar production) to ethanol. Although bagasse is used as a fuel for boiler operations within raw sugar factories, high fiber sugarcane varieties could become more common as the technology to convert cellulose to ethanol becomes more economical. The Audubon Sugar Institute is taking a lead role as the Louisiana sugar industry hopes to diversify through energy production.

Sugarcane has helped invigorate the South Louisiana economy for more than 200 years. Research and extension efforts of the LSU AgCenter have the goal of sustaining and diversifying an industry vital to the people and culture of south Louisiana. ■

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Breeding *High-yielding, Delicious* Sweet Potatoes

Don LaBonte

The development of high-yielding and delicious sweet potato varieties began right here in Louisiana more than 70 years ago. The late Julian C. Miller and others at the Louisiana Agricultural Experiment Station discovered how to induce flowering and seed set by trellising sweet potato vines onto fences. They found that this straightforward technique stressed the plant and caused it to flower. This opened a world of opportunity to develop new varieties for the industry by genetic recombination.

A fast-paced effort ensued to collect sweet potato varieties from throughout the world and to make as many crosses as possible. Many of the varieties resisted flowering, and just a handful of seed were produced. But ever so slowly new varieties were developed to replace the original varieties grown in Louisiana, which were from the Caribbean and had little or no disease resistance, poor and erratic yield, and a muted orange flesh.

Seventy years later the sweet potato breeding program continues. We still use the nursery started by Miller in the 1930s on the LSU campus in Baton Rouge. Though the technology has changed, the breeding program builds on a legacy of methodical progress toward developing the perfect sweet potato. Diseases that once were the scourge of the industry such as fusarium wilt and soil rot are forgotten as new varieties incorporating resistance to these diseases have replaced susceptible ones. But new threats to the industry invariably arise, and we adapt our breeding program to address these new issues.

Breeding programs take years of determined work to improve a trait, and we try to anticipate industry and regulatory changes. For instance, the federal government has pressed for years to reduce the number of pesticides used by growers, thereby delivering more pesticide-free crops to consumers and reducing pesticides in our environment. Consumers clearly prefer to have pesticide-free crops, and growers are anxious to reduce pesticide usage to save on production costs.

In the mid-1990s we set out to develop resistance to Rhizopus soft rot. This is a common disease that causes roots to break down after they are boxed and sent to market. A simple puncture wound and a few Rhizopus spores is all that it takes to drastically compromise the marketability of fresh market potatoes. A couple of roots infected with this disease are enough to get a load rejected at a distant shipping terminal. An effective fungicide (dicloran) is available, but we also had the foresight to realize its days were numbered. As recently as 2008, the European Union put a zero tolerance on this fungicide, and thus all sweet potatoes exported to the burgeoning EU market must be free of this fungicide.

Our efforts to breed for Rhizopus soft rot resistance are typical of the approach we use to improve all traits. We began with a group of genetically diverse individuals (parents or genotypes, as we term them) with good flowering attributes. We allow them to cross-pollinate in an open pollinated nursery. Because of

Photo by Tara P. Smith

Laid out along a lane at the Sweet Potato Research Station in Chase, La., is a row of more than 250 bags of different varieties of sweet potatoes being evaluated for their storage quality.

Don LaBonte, Professor, School of Plant, Environmental & Soil Sciences, LSU AgCenter, Baton Rouge, La.

the sweet potato's complicated genetic structure, an individual genotype cannot cross with itself but must cross with another genotype. Thus, we arrange a nursery with 15-30 unique parents, and let bees to do the pollination. We then harvest the seeds in the fall and plant upwards of 2,000-4,000 seeds at the Sweet Potato Research Station in January each year in a greenhouse. In May, we transfer the resulting seedlings (progeny) to the field and allow them to grow and produce storage roots. At harvest we visually select those that have an attractive shape and decent yield. Through the course of this process, we usually winnow these to just a few hundred. Next we screen all those selected for resistance to Rhizopus soft rot.

In the beginning of this project few selections had notable levels of resistance. But by using an approach called mass selection, we select the best 10 percent and use these as parents in the next cycle of breeding. The entire process takes two years to complete and return to the nursery. This process is repeated, each time selecting the best of the best to use as parents. As it stands now, most of the progeny are resistant, and we are focused on selecting for all important traits including yield, appearance, resistance to all the other diseases, and eating quality. Our efforts are paying off. We are now poised to incorporate this resistance into varieties that can be commercially grown by the industry.

The LSU AgCenter breeding program has a similar effort to enhance resistance to the sweetpotato weevil, the most damaging insect pest of sweet potatoes in the world. We are also initiating efforts to improve virus resistance and skinning resistance in sweet potato. We are particularly keen on developing a sweet potato variety with Rhizopus soft rot resistance and a more durable skin. This combination will push us toward a more mechanized harvest, requiring less labor and less cost in production.

Trait breeding represents just a fraction of our breeding efforts. The bulk of our crossing efforts are among elite genotypes to produce a new variety with ever higher yield, improved quality and ease of production. We may generate 10,000 to 14,000 seeds every year from these nurseries and have only 10-15 suitable progeny after three years of trials. It can take another three years to determine if any of these have value for the industry. In a given year we are looking at progeny at all stages of the six-year process.

The breeding program is both an art and a science. It involves intuition that a given progeny has the right look, all the while using scientific investigative techniques to ensure good yield, disease and insect resistance, and eating quality. Once we identify a superior variety, we also need to figure out how to grow it – all sweetpotato varieties seem to behave a little differently, and they often require tweaking in-field variables, such as fertility, to maximize production. The LSU AgCenter Breeding Program is multidisciplinary and taps into the expertise of many in the sweet potato research group. The team approach ensures that the LSU AgCenter will meet the ever-changing needs of producers and the industry. ■

A really SWEET sweet potato – that's *Evangeline*

Don LaBonte, Christopher Clark, Arthur Villordon and Tara P. Smith

Why do people eat sweet potatoes? Because they are sweet! A new variety, Evangeline, just released by the LSU AgCenter, will satisfy those who want a really sweet sweet potato.

What makes Evangeline so special is its sugar profile with twice as much sucrose as Beauregard, another widely grown LSU AgCenter-developed variety. Evangeline does, however, have less maltose, a sugar produced during cooking. But this is a great tradeoff. People perceive sucrose (table sugar) as being much sweeter than maltose. Not only is Evangeline sweeter out of the oven, it also makes a great microwaved sweet potato. AgCenter research has shown it has twice the sucrose content and similar levels of maltose as Beauregard when microwaved. Evangeline also has excellent processing qualities, and the deep orange flesh color has wide appeal.

Taste aside, this sweet potato variety also has much to offer Louisiana producers. Yield and overall quality of this variety have been comparable to Beauregard. Evangeline appears to produce fewer jumbos, or oversized roots, than Beauregard, so potentially, this could translate into a few more U.S. No.1 grade roots at harvest. If growers are delayed in their harvest operations, they may have more time to capture the high-value, premium U.S. No.1 grade, which is what you whole buy in the store.

In 2008, AgCenter researchers also discovered that Evangeline did not break down and rot in the soil when torrential rains associated with Hurricane Gustav ravaged Louisiana agriculture. Fields of Evangeline sweet potatoes remained harvestable while many planted in Beauregard suffered significant loss. A variety that can tolerate flooding is a tremendous asset, given the high cost of sweet potato production. In addition, stored roots from flooded fields held up well and remained flavorful following months of storage. This lagniappe information garnered in 2008 has swayed many producers to plant larger acreages of Evangeline in 2009.

Disease resistance of Evangeline is similar to Beauregard except that Evangeline has resistance to southern root knot nematode, a disease common in some production areas. The variety is not as good a plant producer as Beauregard. Farmers are being encouraged to presprout (warm up) roots before bedding them in the ground to increase earliness and quantity of plants. Sweet potatoes are not propagated like true potatoes – roots are not cut into pieces and planted, but rather bedded in the ground. The bedded roots generate sprouts, which are cut and transferred to production fields.

Louisiana is renowned for producing the best sweet potatoes, and the taste and appeal of the famous "Louisiana Yam" is known around the world. Evangeline builds on this strong tradition and is sure to impress the palates of all who try it. ■

Don LaBonte, Professor, School of Plant, Environmental & Soil Sciences, LSU AgCenter, Baton Rouge, La.; Christopher Clark, Professor, Department of Plant Pathology & Crop Physiology, LSU AgCenter, Baton Rouge, La.; Arthur Villordon, Associate Professor, and Tara P. Smith, Assistant Professor, Sweet Potato Research Station, Chase, La.

Jazzman competes well in aromatic rice market

If you drive by a field of Jazzman rice, its pleasant, nutty aroma is unmistakable. For farmers, the pleasant fragrance is the smell of money.

The LSU AgCenter Rice Research Station developed Jazzman rice varieties to compete with Thai Jasmine.

Of the 600,000 tons of rice imported into the United States annually, more than 60 percent is Thai Jasmine. The Far Eastern variety can only be grown in regions of the world with short day lengths, such as Thailand, something not found in Louisiana's growing season.

But breeding work by Xueyan Sha at the Rice Research Station has led to varieties of rice with taste and smell similar to Jasmine. Sha's work first produced Jazzman in 2009, then an improved version, Jazzman-2, came last year. Sha is now working on a Clearfield version of Jazzman.

Bobby Hanks, chief executive officer of Louisiana Rice Mill, said Jazzman-2 is proving to be a solid competitor to Thai Jasmine. "There's a real good chance the U.S. Jazzman could get a good share of that market."

Hanks said the 2011 Jazzman crop totals more than 11,000 acres in Louisiana, and farmers will get a premium for the aromatic rice. Louisiana Rice Mill contracted with farmers to grow Jazzman-2 for either a flat price or a price of $5 a barrel more than the price for regular long grain rice.

It is critical that this year's crop do well to produce enough rice to make it widely available, he said. "We need for them to do well this year yield-wise."

Louisiana Rice Mill supplies Jazzmen Rice LLC with its supply of Jazzman.

Andrew Wong of the Jazzmen Rice Company said U.S. Jazzman competes with Thai Jasmine in countries where importing U.S. rice is cheaper than importing Thai rice. The U.S. rice has been exported to Canada and France, he said.

Wong's company, which sells Jazzman rice under the Jazzmen brand, has widespread distribution on the U.S. West Coast. "We will be trying soon to get into the East Coast," he said. The company participates in culinary trade shows and has attracted the attention of top chefs, including John Besh, of New Orleans.

Jazzmen rice is sold in groceries, and institutional food distributors sell it to restaurants. The company has obtained rights to use the image of the late Louis Armstrong in its trademark. "We spend a lot of money on branding, promoting and marketing it," Wong said.

Falcon Rice Mill of Crowley also sells the Jazzman rice variety.

"We're excited about it," said Robert Trahan, of Falcon. "We've seen increased demand every year. I think we finally have a product that is close to the aromatics."

Last year the company increased its acreage by 20 percent, and this year the acreage will double. "We've sold everything we contract," Trahan said. "We probably could squeeze out more sales, but we only have so much room for storage."

To meet increased demand, Doug and Jerry Foreman, of Lafayette Parish, contracted to grow rice for Falcon this year. Farmer Jimmy Hoppe of Fenton has grown aromatic rice for Falcon for several years.

Hoppe said his sales of Jazzman have increased his rice sales dramatically. "Actually my sales have about doubled, and I've probably picked up a third more customers," he said.

Hoppe increased his acreage of the aromatic rice this year by a third to meet the demand. He also said his farm is now represented by a food service company that supplies specialty stores and groceries along the I-10 corridor.

Hoppe also sells directly to customers who visit his farm. "It becomes not only a sale, but actually an opportunity for me to share what goes on at the farm."

He said it didn't surprise him to hear from a returning customer that they prefer his rice to Thai Jasmine. Hoppe said he explained to the customer that Thai Jasmine is often blended with non-aromatic, long-grain rice.

Kurt Unkel, of Kinder, is a small grower. This year he has 25 acres of Jazzman, and he sells in niche markets, including farmers markets in New Orleans and Baton Rouge. His rice also is available in local food stores and on the Internet.

Last year, Unkel's field was infested with red rice, resulting in a mix of domestic rice and the unwanted plant. But he chose to sell the rice anyway, even pointing out the red rice on the packaging labels.

He said buyers of his rice liked the red rice, and they like the new Jazzman. "My customers like it. I work for them."

■ **Bruce Schultz**

Photo by Bruce Schultz

Clearfield technology changes the rice industry

Steve Linscombe

Clearfield rice is grown around the world under exclusive license to BASF. Since 2003, it has brought in more than $20 million to the LSU AgCenter.

Clearfield rice production technology, which was developed by LSU AgCenter scientists, has dramatically changed rice production. It was originally licensed to the American Cyanamid Corporation in 1998. The company was later purchased by BASF, which currently commercializes the technology in a number of rice-producing countries. The technology has returned significant royalty revenues to the AgCenter and should continue to do so for the foreseeable future.

To understand the significance of this technology, it is important to know a little bit about the rice industry. Rice production is an important part of the agricultural picture in the southern United States, especially in the major producing states of Arkansas, Louisiana, Mississippi, Missouri and Texas. The mechanized production of rice began in the 1880s in southwest Louisiana utilizing some of the new agricultural implements invented during this period.

From the beginning of this industry, production was plagued by a weedy relative of commercial rice called red rice, which came in the first seed used by the fledgling industry. Most red rice biotypes are characterized by a red bran layer. Thus, if the grain is harvested and makes it through the milling process, it can cause quality reductions in the milled white rice sample. However, much of the red rice produced in a commercial rice field will never make it through the combine because red rice plants have a propensity to shatter as the seed reaches maturity. In addition, red rice seed has a pronounced dormancy mechanism. Because of the shattering and dormancy traits, once a field is infested with red rice, the seed will remain viable and problematic for many years. Because rice and red rice are so closely related, it has been difficult to develop a conventional rice herbicide that will control red rice without causing significant injury to the commercial rice crop. However, research conducted at the Rice Research Station in Crowley eventually led to the development of Clearfield rice production technology, which has allowed for the control of red rice in commercial rice production.

Because it was not feasible to develop a rice herbicide to control red rice without harming the commercial rice, the idea was to develop a new type of rice plant that would be genetically resistant to a herbicide that would control red rice. This was accomplished by a process known as induced mutation breeding, where a large number of seed is subjected to an agent that causes a high level of mutations or changes to the genetic makeup of the seed. The agent used was a chemical called ethyl methane sulphonate (EMS). After treatment with EMS, the seed were planted, and the resulting plants were sprayed with imazethapyr, a BASF herbicide known to effectively control red rice as well as conventional rice.

After 12 years of repeating this process with billions of rice seed, success was finally achieved when a lone plant survived the imazethapyr treatment. This single plant, along with several more resistant plants developed in a similar manner a few years later, allowed for the development of the Clearfield rice technology. It was finally possible to kill red rice without destroying the commercial rice crop. This then allowed, through conventional rice breeding, the development of new varieties that would be high-yielding and have the superior traits needed by the rice industry, while at the same time being resistant to imazethapyr and to a related BASF herbicide called imazamox, which is also used with the technology.

After 12 years of repeating this process with billions of rice seed, success was finally achieved when a lone plant survived the imazethapyr treatment.

The technology was first used on a limited acreage in 2002. This acreage has steadily grown through the years, and in 2012, Clearfield rice was grown on more than 60 percent of the rice acreage in the southern United States. This includes varieties developed by the LSU AgCenter, the University of Arkansas and the Mississippi State University breeding programs, as well as hybrids developed by RiceTec, a private rice-breeding company. The AgCenter receives a royalty for the resistance gene regardless of which breeding program develops the variety or hybrid. However, if the variety has been developed by the AgCenter, the royalty rate increases.

The Clearfield technology has allowed a dramatic improvement in the rice producer's ability to control red rice. Imazethapyr and imazamox also provide excellent control of many other problematic weeds in rice production. In addition to weed control, the Clearfield technology has changed

Clearfield rice allows southwest Louisiana rice farmers to drill-seed their fields, which is a practice better for the environment and less costly than aerial seeding into flooded fields. Before the advent of Clearfield, farmers had to rely on a combination of water-seeding and water management to try to prevent the red rice weed from sprouting. Photo by Bruce Schultz

the production systems used in rice farming. Before Clearfield rice, the only approach to minimize red rice on severely infested fields was a combination of water seeding and water management that prevented red rice seed from germinating. Water in soil keeps oxygen away from the seed and prevents germination. A typical system involved flooding a rice field in the early spring and then working the field in the water to destroy any red rice seedlings present. After this operation, pre-germinated seed was flown over the field. Shortly after seeding, the field was drained briefly to encourage rice seed root penetration into the soil. The trick was to leave the field drained long enough for the root to anchor but not so long that the soil cracks and oxygen finds its way to the red rice seed below the soil surface. This system only suppressed red rice, and its success was dependent on weather conditions and pumping capabilities that would allow a field to be quickly reflooded. Another major problem with this system was when fields were drained after seeding, the water leaving the field contained a high sediment load from the water tillage operation. This led to soil erosion and water quality problems in receiving streams.

The advent of the Clearfield technology meant these fields would no longer have to be worked in the water and could now be dry-seeded, in many cases using no-till or minimum-till techniques. So, in addition to improving weed control, Clearfield technology has greatly reduced soil erosion and improved water quality and overall environmental stewardship.

This technology has been rapidly adopted across the southern United States and has led to high-yielding, higher-quality rice. The reduction of red rice has also greatly benefited the milling industry, as well as consumers and other end users. In addition, Clearfield rice is also being grown today in a number of other rice-producing countries. While this research has become a very important intellectual property for the AgCenter, it also has led to dramatic improvements in productivity and environmental stewardship in rice production.

Steve Linscombe is American Cyanamid Professor for Excellence in Plant Genetics/Breeding/Biotechnology and rice breeder at the Rice Research Station. He is also the director of the Southwest Region for the LSU AgCenter.

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Sabliov Looks at Nanotechnology to Create Healthier Foods

Liz Lebrón

While many of her colleagues work to discover the next big thing, Cristina Sabliov, an LSU AgCenter researcher and professor in the Department of Biological and Agricultural Engineering, likes to think in nano terms. Sabliov specializes in creating nanodelivery systems for bioactive substances that can improve people's health.

Sabliov and her colleagues get their inspiration from industries not immediately associated with food, such as medicine – industries that pioneered the use of nanotechnology through high-cost research and development projects. Now that nanotechnology is more commonplace, the food industry is taking advantage of its lower cost and wider availability to create pathways for improved consumer health.

The medical field has successfully used nanodelivery systems in the treatment of cancer, and Sabliov and her team hope similar conveyance mechanisms will enable them to improve vitamin uptake and bio-viability.

"We can actually target food to a specific segment of the population," Sabliov said. "Maybe if you are predisposed to cancer or cardiovascular disease, you will someday consume food that is designed for you specifically."

Supported by a grant from the U.S. Department of Agriculture's National Institute of Food and Agriculture, Sabliov and her team design nanoparticles that can be loaded with vitamins, antioxidants and other healthy bioactives. The particles, which measure just one hundred nanometers in size, provide improved stability of the bioactive material they carry. Improved stability leads to greater efficiency in delivering the compound and, in turn, greater benefit for the recipient. Moreover, scientists can engineer the particles with time-release technology to match their specific delivery needs.

Sabliov has been working on nanodelivery systems for natural food colorants that can replace artificial dyes in processed foods. They have had success with beta carotene, the orange color in carrots, which companies could potentially use to give macaroni and cheese its distinct color.

"Particle design is a function of its intended application," Sabliov said. "This will dictate what kinds of materials you will choose to make your particles and how you design them."

Consumers already encounter natural nanodelivery systems in products like vitamin D-enhanced milk, but use of engineered nanostructures in food science was not always a welcomed advance.

"When I joined LSU 10 years ago, the field of nanotechnology was quite new, especially in food," Sabliov said. "There wasn't a lot of interest in applying nanotech to food because of all the unknowns."

Unknowns continue to exist today. Concerns over nanotechnology use in food include questioning what happens to the particles once they have delivered the bioactive agent to the body.

To ensure the nanostructures she develops are safe for consumption, Sabliov works with a team of scientists, including toxicologists, to better understand how the particles' absorption, distribution, metabolizing and excretion affect the body.

"There's a big push to engage consumers and find out what they know about nanotechnology and what they perceive as

Cristina Sabliov is a researcher and professor in the Department of Biological and Agricultural Engineering. Photo by John Wozniak

Supported by a grant from the U.S. Department of Agriculture's National Institute of Food and Agriculture, Sabliov and her team design nanoparticles that can be loaded with vitamins, antioxidants and other healthy bioactives.

dangerous," she said. "Companies are pursuing this type of research behind closed doors, and industry is listening to academia as well. I'm convinced we will see more of this technology in the market within 10 years."

One promising avenue for the widespread use of nanotechnology in consumer goods is colorant nanoparticles for food. Many natural colors are unstable and not water soluble, which led food manufacturers to use artificial food colorants in their products. Under pressure from consumers to use more natural ingredients, companies like Kraft Foods, which recently announced it will discontinue use of two types of yellow food dye in its cartoon character-shaped macaroni and cheese, are seeking natural substitutes.

In collaboration with Carlos Astete, assistant research professor, Sabliov has been working on nanodelivery systems for natural food colorants that can replace artificial dyes in processed foods. They have had success with beta carotene, the orange color in carrots, which companies could potentially use to give macaroni and cheese its distinct color.

"If you put beta carotene in a particle covered by a surfactant," Sabliov said, "then those particles are very nicely suspended in water and it will provide the uniform orange color you're looking for, even though the compound inside is hydrophobic. We made that."

Seeing her work on dinner tables across the country would be one of Sabliov's greatest professional achievements. In her lab, she works to ensure the successful adoption of nanotechnology by the food industry through rigorous and comprehensive

Kurt Ristroph is an LSU undergraduate student studying with Prof. Sabliov. Photo by John Wozniak

research that addresses both consumer and industry concerns. She is currently designing food using patented particles she created.

"It would be very rewarding if at some point during my career I could see some of the products that we design available on the market," Sabliov said. "If we see the technology is well-regulated and embraced by both consumers and industry, that would make me feel like I made a significant contribution to the field."

Sabliov understands that the classroom is the gateway to the grocery store shelf, and she takes pride in training the future nanotechnology workforce. In addition to teaching a graduate class in nanotechnology, Sabliov also mentors young faculty both in the United States and abroad.

"This field will take off at some point," she said. "My contribution is training and mentoring scientists who can then train students at other universities around the world. If we want to see the field develop and safely applied to foods, then we have to collaborate."

Liz Lebrón is a communications graduate assistant with the LSU College of Engineering.

Sabliov and her research team design nanoparticles that can be loaded with vitamins, antioxidants and other healthy bioactives, with potential use in the food industry to improve people's health. Photo by John Wozniak

Vol. 59, No. 3, Summer 2016

Food Incubator

Celebrates Three Years of Success

Olivia McClure

When the idea for the LSU AgCenter's Food Incubator was first hatched in 2012, there was no facility in Louisiana where people who wanted to pursue the daunting journey of starting a food business could go for expert advice and production equipment.

In the past three years, the Food Incubator has filled that void, serving as a "one stop shop" for people looking to turn their recipes into profitable, successful businesses.

The incubator officially launched in July 2013 with just 10 tenants and now offers services to 35 tenants — with more on a waiting list — who make 67 different products in the incubator's facilities.

The incubator has become a vital resource for Louisiana food entrepreneurs who otherwise would have to go out of state to find technical expertise and kitchen facilities to make their products, said Gaye Sandoz, director of the incubator. It has helped people turn old family recipes and creative new ideas alike into viable businesses that have found receptive audiences around Louisiana.

"Buying local is trendy now," Sandoz said. "The customers feel it's healthier and safer because they know the source, and they want to support the community."

The impressive roster of products made by incubator tenants includes everything from salad dressings and barbecue sauces to candies and gelato. Many of the products are sold at local farmers markets and stores across Louisiana and the South. Some tenants have found an even bigger audience through online orders shipped around the country.

Success stories are abundant at the incubator, Sandoz said, noting that the initiative has helped create 30 full-time and 50 part-time jobs.

There's Richard Hanley, one of the incubator's first tenants whose salad dressings have made it onto store shelves in multiple states. There's Alvin Ray, who today has a full-time job making and selling his popular sweet and spicy Bayou Best pickles — something he once did just for friends and family after coming home from his old job as a maintenance man. And there's Mario Lozanov, a former organic chemist who now oversees a small empire of carts around Baton Rouge that sell his City Gelato, which is also available in several supermarkets.

Four tenants, including Hanley and Ray, have graduated to co-packers, which are facilities that entrepreneurs contract with to manufacture products on their behalf. Being accepted by a co-packer allows tenants to ramp up production and fulfill the ever-growing demand for their products.

LSU's Louisiana Business and Technology Center Business Incubator — which helps entrepreneurs, including LSU students, start small businesses — was instrumental in getting the Food Incubator off the ground in 2013, said Sandoz, who had worked at another food business incubator in Norco, Louisiana, that has since closed.

In the incubator's first year, its handful of inaugural tenants made 3.5 tons of products using a couple of small kettles, a bottler and a few other pieces of equipment in a renovated space in Clyde Ingram Hall on LSU's campus. In 2014, production jumped to 21 tons, then more than doubled to 44 tons in 2015.

Since opening, the incubator has expanded, adding more and larger equipment to accommodate the growing list of tenants and to help them satisfy increasing demand for their products. Incubator tenants can also take advantage of kitchen facilities in the new Animal and Food Sciences Laboratories Building, which opened in August 2014.

"I know we wouldn't be where we are today without the facilities and the personnel with the incubator," said Abigail Ricks, who makes Old Soul Pickles at the incubator.

"To take something from a homemade product and bring it to a bigger scale is something that if you don't have any experience and you're a home cook, you might not have any idea where to start," Ricks added. "But by using the food sci-

The LSU AgCenter Food Incubator team includes from left to right, front row, Pitchayapat Chonpracha and Valentina Rosasco, both graduate studenta. Second row, Matthew Ulmer, recent graduate in food sciencea; Gabriela Crespo, food scientist; and Marvin Moncada, food scientist. Back row, Luis Espinoza, food scientist; Ashley Gutierrez, food scientist; Gaye Sandoz, incubator director; and Adam Lofaso, undergraduate student. Photo by Olivia McClure

Lili Courtney, center, works with her son, Lloyd Courtney, left, to package bottles of her Delightful Palate salad dressing at the LSU AgCenter Food Incubator. Photo by Olivia McClure

The incubator has become a vital resource for Louisiana food entrepreneurs.

entists and Gaye Sandoz, who is a wealth of knowledge, we've been able to maintain the quality of our product and even improve it."

The incubator's staff includes four food scientists — Luis Espinoza, Marvin Moncada, Gabriela Crespo and Ashley Gutierrez — who help tenants adjust their recipes so they're shelf stable and safe. They also help both tenants and other food entrepreneurs reformulate recipes to create improved or entirely new products, like ones that use only natural products.

In the process, the tenants often learn more about the food industry and their own products, Sandoz said. They learn about the functions of certain ingredients and work with the scientists to find ways to cut production time and be more efficient.

It's important for tenants to know their products well so they can successfully market them, Sandoz said. She encourages tenants to do in-store demonstrations and sell their products at farmers markets where they can interact with customers and learn more about their preferences. Technologies like social media and email newsletters can help them keep in touch with customers to develop a loyal fan base.

"If you can't market, you shouldn't start a food business," Sandoz said. She often reminds tenants that they are most qualified to tell the story of their product — a strength they should leverage when talking to customers.

The incubator's four student workers and one graduate assistant are also available to help tenants throughout the production and marketing processes, which offers valuable real-world experience in many aspects of the food industry.

Trey Bacon, who makes Tres Bien Que barbecue sauce with his mother, said incubator equipment like heated kettles and a bottler have allowed him to make more sauce faster so he can meet growing demand for the product. The incubator staff has also helped him navigate health regulations and make sure his barbecue sauce is safe — tasks that can be difficult for newcomers to the industry, but are necessary to do retail sales.

"Our store presence alone exploded once we were able to say we were made in the LSU AgCenter Food Incubator," Bacon said. Before coming to the incubator, his sauce was sold in just a couple of stores. Now, it's available in 25 stores, he said.

Linda McAdams, of Truly Southern Pretzel Crunch, said the incubator has helped her family's product reach the shelves of about 80 stores in south Louisiana and a few other states in just a year and a half. She said that kind of success wouldn't be possible without the guidance she's received from Sandoz, the food scientists and other tenants.

"It's an unbelievable experience to have this right in our own backyard, and I think that so many other cities around the country would benefit from this," McAdams said. "I know not everybody knows about it, and we take the opportunity to let people know how fantastic a program it is and the amazing results we get. We cannot thank the staff enough because they always go above and beyond for us."

Olivia McClure is an assistant specialist with LSU AgCenter Communications.

Matthew Broha uses a kettle to make Ruth's Recipes hummus at the LSU AgCenter Food Incubator. Broha's mother, Kathy Broha, started Ruth's Recipes and is one of the original tenants of the incubator. Photo by Olivia McClure

In the incubator's first year, its handful of inaugural tenants made 3.5 tons of products . . . In 2014, production jumped to 21 tons, then more than doubled to 44 tons in 2015.

Vol. 59, No. 2, Spring 2016

Revealing the Hidden Half: Development of a Low-Cost Aeroponics Growth System as a Tool for Sweet Potato Root Research

Arthur Villordon

The sweet potato has a system of roots that allow it not only to obtain soil-based resources like water and nutrients but also store food reserves. This storage capacity is unique to the sweet potato and represents the most economically important biological activity of the crop. Lateral or branch roots, the main determinants of root architecture, enable plant root systems to perform these functions. The onset of this specialized function is referred to as storage root formation. Roots that fail to undergo storage root formation become lignified, or woody, and do not contribute to productivity. Hence, the knowledge of the intrinsic and environmental factors that favor storage root formation is important in developing and testing management practices that contribute to improved agricultural yields.

New research has uncovered a fundamental association between lateral root branching and the ability of sweet potatoes to form storage roots. In roots with restricted branching, swelling is delayed or reduced. Thus, understanding the factors that control root branching will lead to developing and testing methods that promote optimum use of soil resources and consistent productivity. However, the study of plant roots has traditionally lagged behind studying stems, leaves, flowers or fruits.

Traditional methods for measuring roots grown in soil, such as washing and root tracing, are destructive and time consuming. Alternative approaches such as the use of underground observation windows typically underestimate some root growth factors. Recent advances in imaging technologies have enabled the non-destructive measurement of root development but are currently cost prohibitive and generally inaccessible to the broader scientific community. Another method is the use of a technique called aeroponics, where plant roots are fully accessible through the growth cycle and can be fully recovered for harvesting. LSU AgCenter researchers are developing an inexpensive aeroponics growth system as a tool for sweet potato research.

Growth system requirements

The principle of aeroponics is to grow plants with their root systems exposed to a nutrient mist. Plants show optimal growth in aeroponics systems because of an unimpeded oxygen supply to the root system. Unlike roots that are 100 percent immersed in nutrient solutions, roots grown in aeroponics systems typically show optimum lateral root development, an important consideration for root architecture research.

At minimum, the system is composed of a root chamber in which the mist is intermittently sprayed. The nutrient mist can be produced by mechanical foggers, venturi-type sprayers, ultrasonic foggers or pressurized solutions delivered through nozzles. The duration of the spray interval has an important effect on the development of the root system and should be adjusted for each plant species. Infrequent spraying might cause water stress, whereas too frequent or continuous misting may lead to leaching essential nutrients from the root system.

The nutrient solution is typically collected at the base of the chamber or in an external container and recirculated. Regulating the nutrient solution temperature, composition, concentration and pH can be either automated or performed manually at specified time intervals.

Materials and methods

One of the principal goals of the work was to develop a low-tech system that simulates the timing of storage root formation by field-grown plants. Another requirement was simplicity in operation to avoid complex machinery. The use of off-the-shelf components helped ensure flexibility and adaptability in many environments, including resource-limited locations. Figure 1 shows the basic components of the growth system: a plastic container (A) was used as a misting chamber while an air pump (B) was used in conjunction with a venturi mister (C) to propel the nutrient spray to the root system. The nutrient solution is self-contained within the plastic container and refilled when necessary. Sweet potato cuttings were inserted through openings on the plastic lids and secured using commercially available foam collars. A commercially available timer was used to determine the spray intervals after initially evaluating different interval settings.

Results and discussion

The multiyear experiments were conducted at the Sweet Potato Research Station. The initial hypothesis was that manipulating nutrient availability over time contributed to storage root formation and enlargement. This was based on

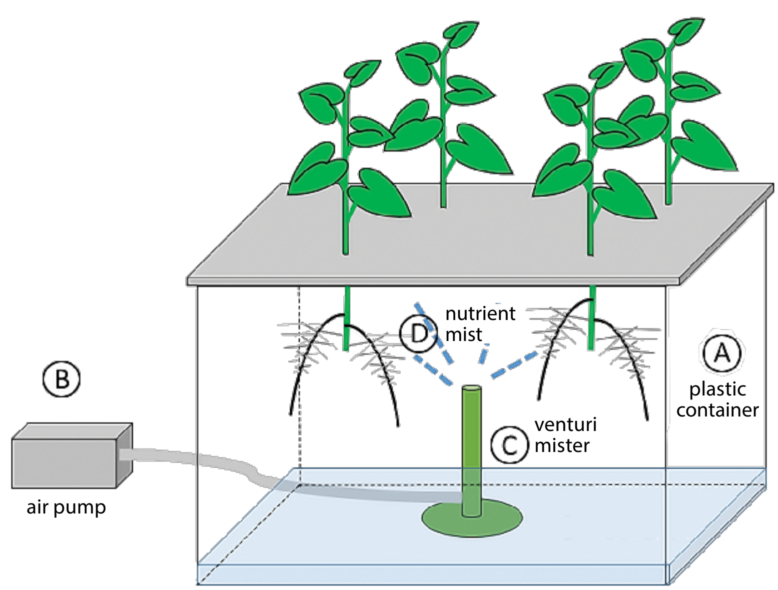


Figure 1. Diagrammatic cutaway view of the aeroponics growth system.

Figure 2. View looking into the aeroponics misting chamber, showing the developing root system of sweet potato plants at five days after planting.

measurements from earlier experiments that showed root swelling was accompanied by the reduction of nitrogen in the growth medium. In addition, studies were conducted in order to synchronize the timing of storage root formation in the aeroponics culture as close as possible with field conditions. Thus, the initial experiments consisted of an initial growth phase (Figure 2) using a nutrient solution with complete macronutrients and micronutrients followed by a storage root formation phase characterized by removing nitrogen from the nutrient solution.

It was determined that root swelling was more consistent when the initial phase was at least 20 days before the imposition of the nitrogen-deprivation treatment. One of the initial responses that were observed following the removal of nitrogen was the pigmentation of roots as early as three to four days. Around this time, the roots also increased in diameter by as much as 25 percent to 50 percent. These observations would not have been possible if the plants were grown on soil or in pots.

Swollen roots were clearly visible after 35 days, a time frame similar to field-grown roots (Figure 3). At the same time, shoots showed nutrient-deficiency symptoms, indicating that nutrients were diverted from the leaves to support enlarging the storage roots. On the other hand, plants grown in a continuous complete nutrient solution did not manifest root pigmentation, and root swelling was minimal. Long-term evaluation of the system showed that the timing of storage root formation also was influenced by variety and non-uniformity of nutrient availability in root systems during advanced stages of development. In particular, it was determined that the sweet potato variety Bayou Belle formed storage roots without the nutrient solution having been changed when the developing root system restricted the access of some roots to the nutrient mist.

Figure 3. View of swollen storage roots of sweet potato variety Bayou Belle grown in an aeroponics growing system at 57 days after planting.

These findings demonstrate the advantage of the aeroponics system in facilitating non-destructive, real-time observations of developing root systems compared with roots grown in soil or artificial growth media. In particular, the marked increase in root pigmentation in response to nutrient deprivation would have been easily missed in root systems grown in soil or an artificial growth substrate.

Aeroponics growth system in greenhouse.

Conclusions and prospects

It has been demonstrated that sweet potato plants can be manipulated to form storage roots in an aeroponics growth system developed from relatively inexpensive, off-the-shelf components. Results from ongoing work will increase the understanding of how nutritional cues influence sweet potato root system development and storage root formation. Such knowledge has potential direct agricultural applications through the identification and evaluation of management practices that optimize fertilizer recommendations.

Other potential research applications include mineral nutrition, disease research, temperature effects, screening for desirable root mutants and root exudates. Root exudates are compounds excreted by root systems in response to stress stimuli in the soil environment and represent an important knowledge gap in sweet potato research. The aeroponics system is a convenient method to study the effects of nutrient deficiency on storage root formation and associated physiological and molecular processes. The nutrient delivery system enables the targeted removal of a specific nutrient without interference from biotic and abiotic variables that are found in agricultural soils.

Arthur Villordon is a professor at the Sweet Potato Research Station at Chase.

Photos by Arthur Villordon

Vol. 60, No. 3, Summer 2017

LSU AgCenter 'Hot' **Intellectual Properties**

Dirk Benedict

LSU AgCenter scientists continue to bring scientific discoveries to the world marketplace through the Office of Intellectual Property. Since 2000, 12 new companies have been started based on licensing technology from the AgCenter. Royalties from these companies and from other licensing agreements have generated more than $70 million since 1999. Following are four of the current "hot" properties.

Bellevue Sweet Potato (LA 06-52)

Don La Bonte, sweet potato breeder, talks about new sweet potato varieties, including the Bellevue, at a field day for producers at the Sweet Potato Research Station, Chase, Louisiana. Photo by Olivia McClure

Bellevue Sweet Potato. Photo by John Wozniak

The Bellevue sweet potato (LA 06-52) was developed by Don La Bonte, professor and director of the LSU AgCenter School of Plant, Environmental and Soil Sciences. Bellevue was released in 2013 and has since become a commercial success across the world.

"Normally, varieties are very location-specific," La Bonte said. "We were able to modify the genetics through cross-breeding to create a variety that was very adaptable. This variety is unique in that it can grow in both sandy and heavy soils in various weather conditions with a stable output. Stability is a big thing for growers."

Australia in particular has seen an increased use in the variety. Nematodes, a type of plant parasite, are a major problem for the country because of its sandy soils. Previously, AgCenter varieties were grown there free of charge, but growers are now paying for the newer varieties, like Bellevue, because of their superior output. The variety is also being grown in several U.S. states, including Louisiana and California, and in several other countries including Canada and Honduras.

In addition to its resistance to nematodes like the southern root-knot nematode, the variety is also resistant to several major fungal diseases such as Fusarium wilt and Streptomyces soil rot. Plant production from bedded storage roots is not ideal, and research is underway to improve plant production.

Yield and disease resistance are not the only concerns for growers. They also want a plant that appeals to a wide variety of consumers. Bellevue is sweet with a moist texture. It has a bright orange flesh and a copper-colored skin with few indentations. Storage longevity is excellent. The sweet potato also has a consistent shape and quality from the field to the plate.

TigerBullets

Qinglin Wu, a professor in the LSU AgCenter School of Renewable Natural Resources, displays TigerBullets, a lost circulation material product that he developed. TigerBullets are made from recycled wood and plastic, and they fill cracks inside oil wells so drilling fluid levels can be maintained and the drill can run more smoothly. The material also helps keep drilling fluid from seeping out of cracks. Photo by Olivia McClure

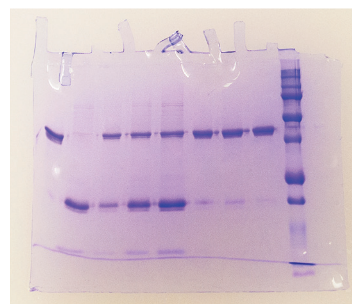
TigerBullets is a commercial product based off research by Qinglin Wu, professor in the LSU AgCenter School of Renewable Natural Resources. The invention is a new type of lost circulation material (LCM) based on recycled wood and plastic that fills earthen cracks inside of oil wells to maintain drilling fluid levels. TigerBullets is used as part of the drilling fluid and acts as a fluid loss control agent and lubricant to make the drill run more smoothly. The material also swells to fill cracks of various sizes on the sides of the drilling well and remains rigid to prevent seepage of drilling fluid through these cracks.

TigerBullets is made from natural, predominantly biodegradable, materials that would otherwise be thrown away as waste in combination with recycled water-bottle-grade plastics. One material that can also be used to make TigerBullets is the plastic from used motor oil containers. There are more than 3 billion quart-size HDPE (high-density polyethylene) motor oil containers being land-filled each year in the United States alone, containing over 150,000 tons of HDPE plastic.

TigerBullets is manufactured by Wallace Molding and Millwork Inc., of Columbia, Louisiana. The material is licensed and marketed by HolePluggers LLC, of New Iberia, Louisiana, and distributed by Alpine Specialty Chemicals. The material has been used by major oil companies including BP, Exxon, Chevron, XTO, Pioneer Natural Resources, OXY and others in more than 400 oil wells across the United States and in several other countries, including Australia, Brazil, Canada, Russia, Singapore, Thailand, Kazakhstan, Mexico and Saudi Arabia. Schlumberger, an oilfield services company, has used TigerBullets in deep-water drilling in Vietnam.

Drought Tolerance Gene SaADF2

LSU AgCenter molecular biologist Niranjan Baisakh holds a piece of gel that shows the expression of a protein from smooth cordgrass that can be used to confer drought tolerance to crops. Photo by Olivia McClure



Niranjan Baisakh, associate professor in the LSU AgCenter School of Plant, Environment and Soil Sciences, is working on conferring drought tolerance to new varieties of plants through a gene he has isolated called SaADF2. Drought is a condition where either there is not enough water available for plants to absorb or where soil conditions prevent water absorption. This particular gene was derived from smooth cordgrass because of its high tolerance to both drought and salinity. The ultimate goal is to develop new varieties of rice and corn that can survive harsh environmental conditions.

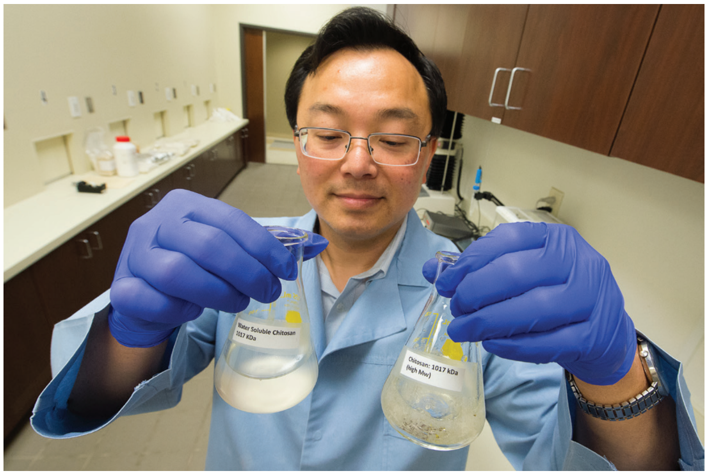
One method of granting resistance to new plants is transgenesis, where a gene that codes for a certain trait from one type of plant is moved into a different type of plant, giving the latter that trait. Data from research studies performed under controlled conditions showed survival of rice plants containing the SaADF2 transgene for prolonged periods with no water supply and higher water absorption under salt stress for plants. This work is patent pending and received a grant from the LSU Leverage Innovation for Technology (LIFT) fund to advance the work toward development of a drought-tolerant corn.

Because of concerns by some consumers about eating genetically modified food, Baisakh is taking a multipronged approach to plant breeding.

"We wanted to validate the gene not just at the transgenic level, in a controlled greenhouse, but also at the field level, through traditional crossbreeding, where it could be tested in natural conditions," Baisakh said.

The traditional breeding approach can help reduce these concerns. Baisakh has also been crossing drought-sensitive and drought-tolerant varieties of rice and testing the progeny under natural field conditions at the H. Rouse Caffey Rice Research Station with hopes of creating drought-tolerant rice varieties that would show similar results obtained with SaADF2. New varieties developed from either method could go a long way in stabilizing food supply in regions of the U.S. and abroad where good quality water available for irrigation is limited.

High Molecular Weight Chitosan



LSU AgCenter food scientist Witoon Prinyawiwatkul holds beakers containing solutions with water-soluble chitosan, left, and regular chitosan, right. Prinyawiwatkul developed the water-soluble, high molecular weight chitosan powder, which has antimicrobial properties and can be used as a coating or film for foods and packaging materials. Photo by Olivia McClure

A new method to produce high molecular weight (HMW), soluble chitosan powder was developed by Witoon Prinyawiwatkul, professor, and his research team in the LSU AgCenter School of Nutrition and Food Sciences. Chitosan has been reported as an antimicrobial that can be applied as a coating or film to foods and packaging materials. Chitosan also inhibits some pathogenic bacteria. Chitosan is derived from chitin, which is mainly produced from crustacean (such as crab and shrimp) shell wastes. A high molecular weight allows the chitosan to form a more viscous gel when mixed with water. High concentrations of HMW chitosan solution are difficult to obtain when mixed with water, but the new method makes it possible.

The developed technique provides a simple preparation procedure for dissolving the HMW chitosan without any chemical modifications. It also eliminates the pungent acidic odor of the solution, making it more desirable for use in food. Research has been performed on food preservative applications using the material's film-forming and coating properties to prevent spoilage at room temperature, which can be valuable in regions where refrigeration is limited.

The HMW chitosan's applications are not limited to food preservation; promising research has also been conducted into its use as a unique antimicrobial. Recent studies by Marlene Janes, professor, and her team at the LSU AgCenter School of Nutrition and Food Sciences, yielded positive results using the HMW chitosan against food-borne pathogenic bacteria in fish. Since oysters are consumed raw, strong antimicrobial properties are important to minimize the risk of food-borne illness. Further studies are being conducted into the types of bacteria affected, which may provide valuable results for potential seafood industry partners.

"We are very excited about these results," Prinyawiwatkul said. "Crab, shrimp and crawfish are consumed all the time here, and our work can make consumption safer."

Dirk Benedict is the marketing coordinator for the Office of Intellectual Property.

LSU AgCenter 'Hot' **Intellectual Properties**

Dirk C. Benedict

LSU AgCenter scientists continue to bring scientific discoveries to the world marketplace through the Office of Intellectual Property. Since the inception of the office, 18 new companies have been started based on licensing technology from the AgCenter. Royalties from these companies and from other licensing agreements have generated more than $70 million since 1999. Following are four of the current "hot" properties.

Dirk C. Benedict is the marketing coordinator for the LSU AgCenter Office of Intellectual Property.

Deer Prefer Buck Forage Oats

The first "Buck Forage Oats" from the LSU AgCenter, also known as LA604, was developed by Steve Harrison, wheat and oat breeder and professor in the School of Plant, Environmental, and Soil Sciences.

"Buck Forage Oats" was originally known as Coker 833, an oat line made by Harrison's father, Howard Harrison, at the Coker's Pedigreed Seed Company. All of Coker's oat lines were donated to the U.S. Department of Agriculture and distributed to university breeders across the region when the company's breeding program was discontinued in the 1990's. LA604 was created through cross pollination of various Coker oat lines made available through that distribution and licensed to Arkansas County Seed Company, Inc. in 1997. It was then sold through various distributors in the United States as "Buck Forage Oats" for over a decade.

In 2008, a new oat variety, LA99017 or "Buck", was released after nine years of development by Steve Harrison, Kelly Arceneaux, Katie McCarthy, and Lucas Bisset at the LSU AgCenter. Buck was derived from a 1999 cross pollination between LA604 and a Texas A&M University breeding line. It was selected for forage production, cold tolerance, and disease resistance. James Kroll, a wildlife biologist from Stephen F. Austin State University in Nacogdoches, Texas, conducted deer preference and grazing tolerance trials that led to the release of Buck. These studies showed that deer were more likely to eat the new Buck than other oat varieties.

This new variety was also licensed by Arkansas County Seed and is sold as the latest "Buck Forage Oats" brand.

"Dr. Harrison has certainly hit it out of the park every time we decide on a varietal trait we want in an oat," said Jake Butler, vice president of Arkansas County Seed, "His efforts, along with Dr. Kroll's, have left us with the only true oat variety that holds all of the specific traits we identified to most benefit and attract white-tailed deer."

Buck is a tall winter oat primarily used for wildlife food plots and as a forage for deer. Because of its tolerance to cold, it persists longer into the winter than most oat varieties. Hunters may plant small amounts to attract deer to a certain location for hunting, whereas other groups may plant many acres for herd feeding and nutrition.

"The continued support from and partnership with Arkansas County Seed has been incredibly valuable," Harrison said. "They sponsor part of the breeding program for new food plot varieties that allows us to make improvements."

Buck is more resistant to diseases like crown and stem rust with a higher grain yield. The oats also remain greener in cold temperatures for longer periods, which is important for attracting more deer to the plot location.

Working together, Arkansas County Seed and the LSU AgCenter have had almost 20 years of commercial success. "Working with Dr. Harrison, and the rest of the staff with the LSU AgCenter, for the past 20 plus years has been a great privilege and a tremendous help for our company," Butler said. "We are eager to continue these efforts, though breeding a better oat than Buck may be very difficult to accomplish."

Steve Harrison, wheat and oat breeder and professor in the School of Plant, Environmental, and Soil Sciences, in one of his research plots at the LSU AgCenter Macon Ridge Research Station in Winnsboro. Photo by Rick Bogren

Vol. 61, No. 1, Winter 2018

Frontière, High-protein Rice Cultivar

Ida Wenefrida and Herry Utomo

A non-GMO, high-protein rice (*Oryza sativa L.*) cultivar named Frontière was recently developed by the LSU AgCenter. It is the first high-protein rice cultivar developed for commercial applications anywhere in the world. Released in 2017, Frontière has a plant variety protection certificate issued by the U.S. Department of Agriculture. A patent has recently been issued for Frontière, USPTO No. 9888631. It has an averaged grain protein content of 10.6 percent. Frontière is adapted to the rice-growing areas in Louisiana and has shown consistently higher grain protein content throughout multi-location trials in Louisiana and other places, including the LSU AgCenter Puerto Rico winter nursery and production fields in Illinois.

CHARACTERISTICS

Frontière was derived from the Cypress cultivar, which is known for excellence in milling quality. It is a very early-maturing, lodging resistant, semi-dwarf cultivar with an average height of 36 inches and emerges to 50 percent heading in 85 days. It has a first-crop yield of 5,946 pounds per acre. Similar to Cypress, Frontière rates moderately susceptible-to-highly resistant to rice blast and is susceptible to sheath blight. Its grain quality and characteristics are similar to the rice cultivar Cypress, but its cook type is intermediate, differing from Cypress or Cocodrie, which both have a high cook type. Its distinctive cooking characteristic is probably due to increased protein content. Frontière meets the industrial standards for commercial applications and is expected to perform very well in Louisiana and surrounding regions.

NO NEED TO CHANGE PRODUCTION PRACTICES

No adjustment is needed to grow Frontière. Its management practices follow the recommendation previously set for Cypress. With a typical yield of 2.67 tons of rough rice, or 1.7 tons of milled rice, per acre, planting high-protein rice will result in about 331 pounds of additional protein produced with no extra cost. The additional amount of protein obtained is equivalent to the amount of protein obtained from 1,146 pounds of meat or 1,200 gallons of milk. With a total U.S. rice production area of 3.7 million acres, high-protein rice can produce an additional 0.23 million tons of protein. This is an incredible added value that can be generated without any additional cost or changing practices.

HIGH POTENTIAL AND NEW TO THE MARKET

High-protein rice was developed in anticipation of expanding U.S. and other markets for new food products that emphasize more nutritional value from major food crops, including rice. The availability of high-protein rice can directly support a number of nutritionally important rice-based products, such as rice milk, baby foods, cereals and crackers. High-protein rice can be tailored into functional foods for various purposes, or it can be used to meet the needs for individuals with specific genetic traits. High-protein rice can also be used to develop nutrition regimes or nutritionally dense food products for optimum fitness and health. Globally, more than 750 million people currently suffer from chronic malnutrition. About 520 million of them live in rice-eating countries. This is undoubtedly a complex problem, and high-protein rice can provide profitability that can be used to help solve the worldwide problem across social, cultural and economic issues.

Because Frontière is new to the market, marketing channels have to be established. In parallel, research for the next generations of high-protein rice lines is being carried out for improved appeal to the markets.

Ida Wenefrida is an assistant professor, and Herry Utomo has an F. Avalon Daggett Professorship in Rice Research and is an associate professor, both at the H. Rouse Caffey Rice Research Station, Crowley.

Ida Wenefrida prepares a buffering solution to use on rice plant tissue to determine if genetic markers show lines of rice with increased protein levels.

Photo by Bruce Schultz

Vol. 61, No. 2, Spring 2018

LSU AgCenter Innovations Flow **Beyond Louisiana Boundaries**

Alana Fernandez

Innovations created by LSU AgCenter scientists flow beyond the boundaries of Louisiana. As of April 2018, AgCenter innovations are licensed on six of the world's seven continents – all but Antarctica. Those licenses generate royalty revenue not only to help build the AgCenter's network across the world but also to further the AgCenter's mission of serving Louisiana through research and extension programs.

The AgCenter's farthest reaching and most financially successful inventions are rice varieties. The rice research program has generated over $60 million in royalty revenue, and LSU AgCenter rice varieties are known and grown across the world. A key factor in the rice varieties' success is the herbicide-tolerant trait being bred into the right varieties that have been tested and trialed through the AgCenter's expert guidance. The AgCenter has left its mark on the rice world over the past 20 years with its herbicide-tolerant rice varieties and commitment to excellence, and the researchers are constantly striving to increase the breadth and depth of the AgCenter's impact with new innovations such as hybrid rice varieties, embracing technological advances in genomics and breeding, and partnering with other institutions.

A new long-grain hybrid rice, LAH169, with high quality and competitive yield potential is being released by the LSU AgCenter. It was developed at the H. Rouse Caffey Rice Research Station during the past seven years. Rights to commercial development will be sold at a later date, according to Alana Fernandez of the LSU AgCenter Office of Intellectual Property. LSU AgCenter hybrid rice breeder Jim Oard, above, said LAH169 has 50 percent less chalk than the commercial hybrids currently available, along with a respectable yield. Photo by Bruce Schultz

In addition to rice, the LSU AgCenter has developed a reputation worldwide as the leader in sweet potato innovation, both breeding and development. Over the past 10 years, AgCenter scientists have released sweet potato varieties that have improved yield, taste, color and other desirable characteristics. Unlike rice, which is licensed to one entity, sweet potatoes are licensed to dozens of entities, and the royalty revenue numbers are far less concrete but, in fact, are in the millions. These varieties have allowed the Sweet Potato Research Station, in Chase, Louisiana, to flourish as a center for knowledge and insight for the growers of Louisiana and beyond. As the reputation of the sweet potato breeding program has grown, so has its footprint throughout the world. The AgCenter has sweet potato licensees and partners in Africa, Asia, Australia, Europe and South America. In addition, AgCenter sweet potatoes are grown across the United States and in Canada. The sweet potato program continues to expand with new varieties, innovative approaches to partnerships, and expanded markets to territories once considered unsuitable for sweet potato growth.

Beyond traditional crops, the AgCenter is the source of innovations in agricultural engineering, agricultural chemistry, renewable natural resources, and many other areas. It is in the School of Renewable Natural Resources where TigerBullets was invented. This unique material is used in drilling fluid to reduce lost circulation in oil-drilling wells. This technology created a new business and jobs in Louisiana, and the TigerBullets technology has been used by multinational corporations from Vietnam to the Gulf of Mexico, including BP, Chevron, Exxon and Schlumberger.

The LSU AgCenter strives to improve sustainability and search for more effective solutions to local and world problems while being good stewards of resources. Through the AgCenter's Global Network, the AgCenter Intellectual Property Office has had the privilege of working with the Visegrad University Association, a conglomerate of universities from Eastern Europe and surrounding areas devoted to advancement in agriculture. The AgCenter has orchestrated partnerships between AgCenter researchers and Visegrad University Association members to facilitate joint innovation, and those research efforts will bring AgCenter innovation to even more places across the globe.

From drilling fluids in Vietnam to sweet potato fields in South Africa to rice fields in Italy, the LSU AgCenter has extended its reach around the globe and will continue to live its mission of educating, innovating and improving lives at home and abroad.

Alana Fernandez is the associate director of the LSU AgCenter Office of Intellectual Property.

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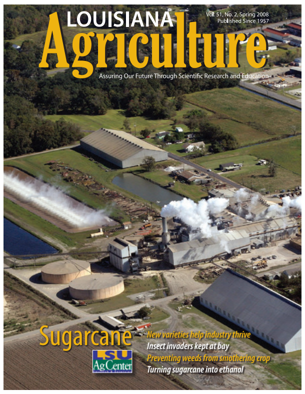

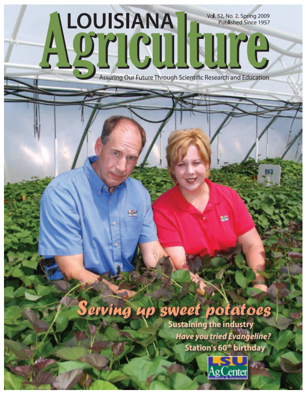

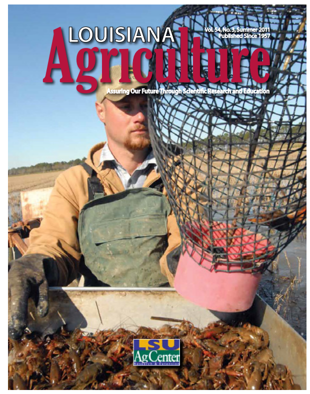

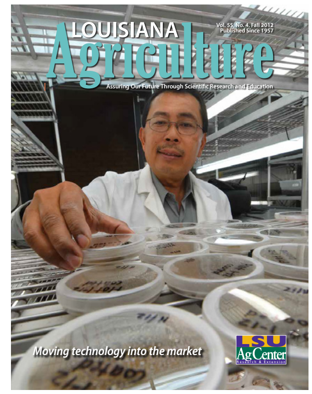

If you are interested in more information about commercially focused research at the LSU AgCenter, contact the Office of Intellectual Property.

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