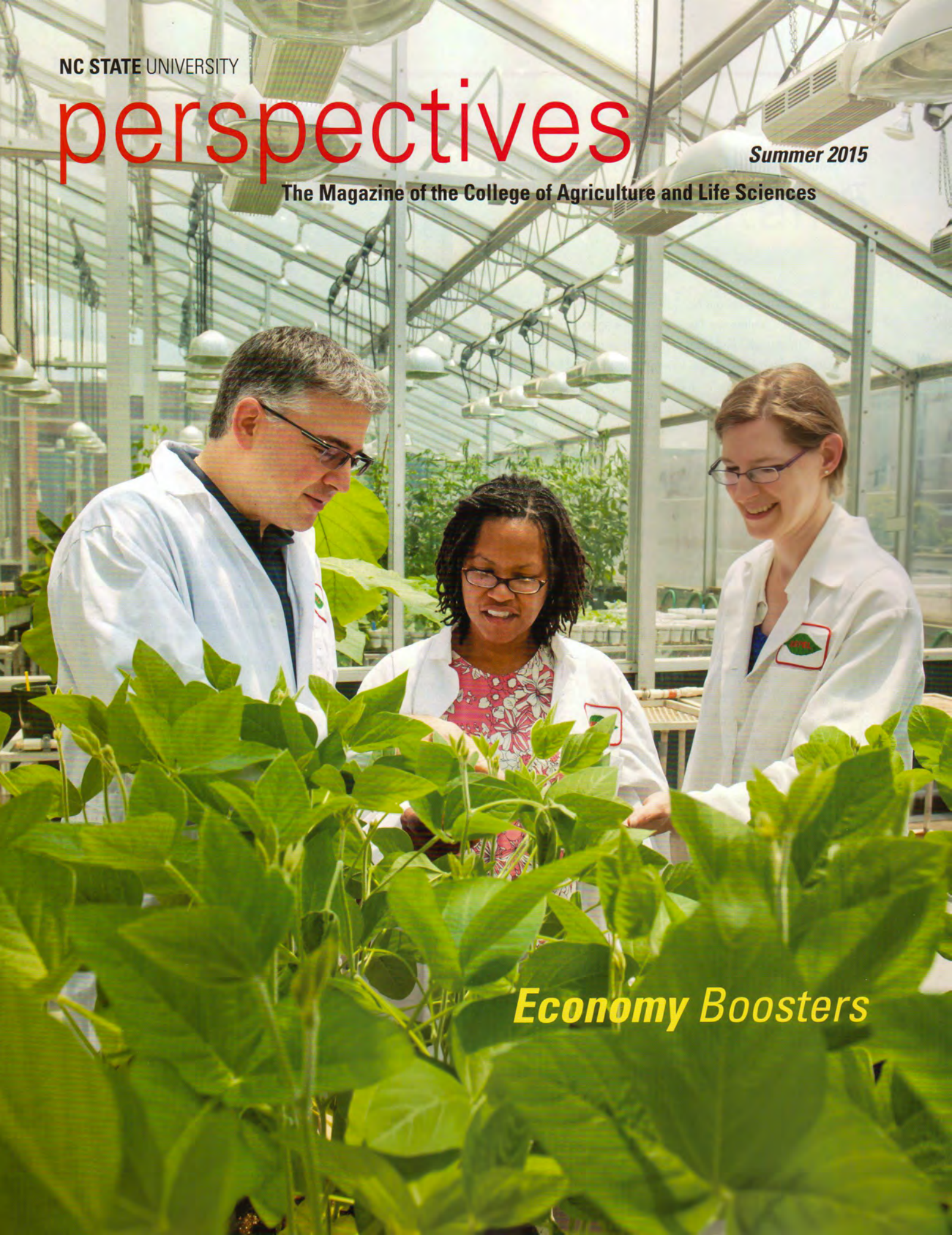


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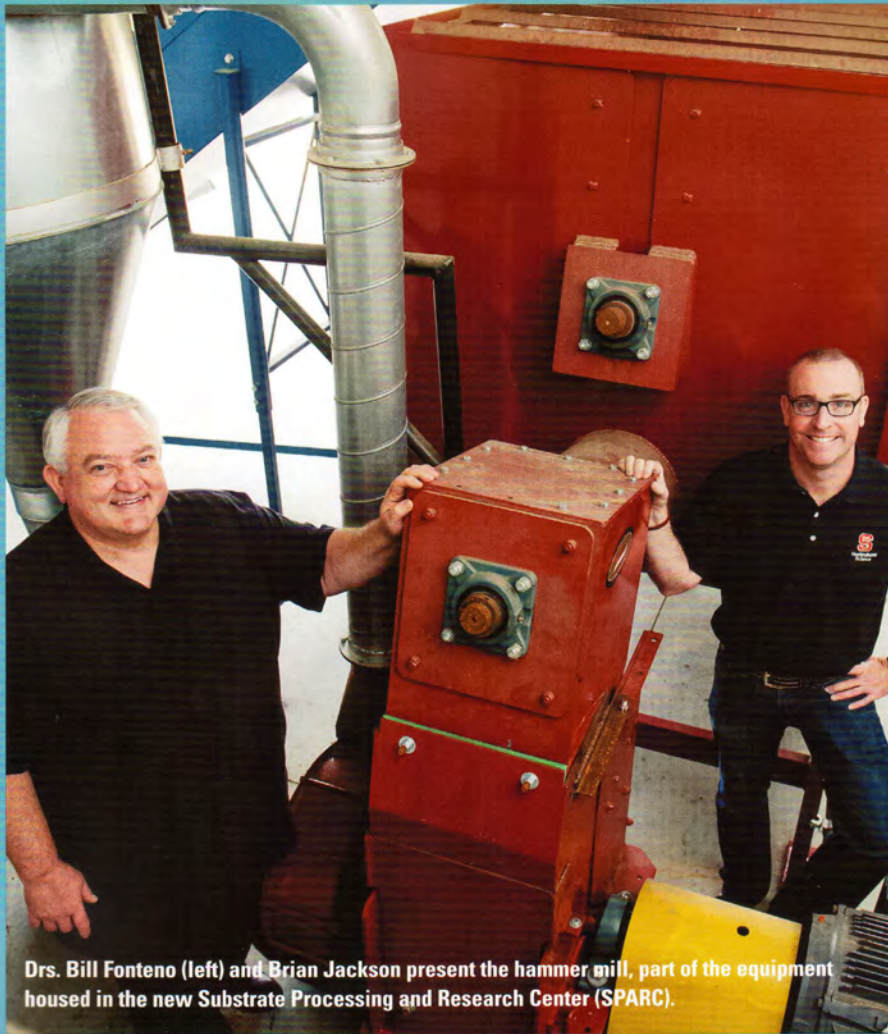
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*Economy Boosters*





Drs. Bill Fonteno (left) and Brian Jackson present the hammer mill, part of the equipment housed in the new Substrate Processing and Research Center (SPARC).

# Built for Use

*New and renovated flora and fauna research facilities will bolster college programs that support the state's economy.*

by Terri Leith

As the College of Agriculture and Life Sciences works to support the growth of agriculture as the state's foremost economic engine, among its top priorities is growing facilities to help expand its capacity for agricultural research. Developing new facilities and renovating existing ones helps meet students' needs and keeps CALS at the forefront of interdisciplinary innovation. Two prime examples, one renovated, one new, can be found on the NC State campus: the Aquatic Facility at Grinnells Animal Health Labs and the NCSU Substrate Processing and Research Center (SPARC) at JC Raulston Arboretum's Horticultural Field Lab. Here is a look at those facilities and the programs that they are enhancing.



Standing by tanks of fish in the new Aquatic Facility at Grinnells Animal Health Labs are John Davis (left), research technician, and Brad Ring, research operations manager.



## A SPARC of Ingenuity

According to the N.C. Department of Agriculture and Consumer Services, the North Carolina green industry – which includes greenhouse, nursery, floriculture, sod and Christmas tree producers and related industry trades – represents \$8.6 billion in economic impact in the state. Among the NC State University programs supporting that industry are those of the Horticulture Substrates Laboratory (HSL). And now the work of those substrate scientists has been significantly strengthened with a new state-of-engineering facility – the Substrate Processing and Research Center (SPARC).

At the SPARC, “researchers seek to stay on the cutting edge of developing and engineering new soils/substrates to meet the needs of the ever-changing world of agriculture and horticulture,” said Dr. Brian Jackson, associate professor in the College of Agriculture and Life Sciences (CALs) Department of Horticultural Science.

“Substrates” refers to the growth media or potting soils around a plant. Horticultural substrate research studies include plant/water/fertilizer issues related to the below-ground portion of a crop.

“To think of substrates and their role in horticulture, it is in many ways like Atlas holding the world. Substrates are to horticulture what Atlas is in that portrayal. . . .the foundation!” said Jackson, who specializes in horticultural substrates for greenhouse and nursery crop production and for retail consumer products (bagged soil and mulches in garden centers).



**The SPARC enables large-scale processing of organic materials – such as wood, bark, grasses, tobacco stalks – that can be used in developing the next generation of potting soils. The SPARC also facilitates lab activities and, with the creation of new products, can be an economic stimulus.**

“The growth of plants in containers is as important now as it ever has been and will continue to be in the future, as horticulture and all of agriculture continually improve in efficiency and effectiveness,” he said. “Even field grown horticultural plants and crops start their lives in substrates when they are in the seed/seedling or cutting propagation stage.”

Dr. Bill Fonteno is founder and lead developer of the CALs activities that make up the premier substrate science program in the United States. The Horticultural Science Department has had a long history of soils and substrates work. Along with Fonteno, Drs. Ted Bilderback, Stu Warren and Paul Nelson were ground-breakers in greenhouse, nursery and landscape substrates at NC State for more than 20 years but have all since retired. Today several others have research and extension areas in soils and substrates, including Dr. Helen Kraus in rain

gardens and nursery crops, Dr. Brian Whipker in greenhouse nutrition and Dr. Barbara Fair in landscape and urban soils. It is the largest collection of researchers in horticultural soils and substrates in the United States.

Fonteno explains that there are three tiers of function in his and Jackson’s combined program: 1) laboratory analysis and characterization of retail and professional substrates; 2) “rhizometrics,” the assessment of root growth of container-grown plants; and 3) with SPARC, the engineering and construction of traditional and alternative organic substrate components.

In the first, or diagnostic function, the CALs scientists analyze a substrate’s chemical properties, those concerned with plant nutrition, fertilization practices and nutrient retention in the container, and its physical properties, which dictate how rapidly the container will drain, how often watering is needed and, to a certain extent, how available nutrients will be to plants. They also analyze materials sent to them by growers and those who manufacture substrates.

“What we all did for more than 35 years was to analyze materials brought to us to answer the question, ‘Will this work?’” he said. “Now, adding Brian’s perspective, we are actually engineering components for substrates.”

So, for the last five years, Jackson said, “We’ve been working on engineering wood materials to be used in soil products – a process that makes several different products from the same original tree. We have added the engineering to the science of substrates to design them to meet the growers’ needs.”

While Fonteno and Jackson have worked with several less popular materials (tobacco



**At the Horticultural Substrates Laboratory in Kilgore Hall, Drs. Brian Jackson and Bill Fonteno show the various types and consistencies of substrates, the plant growth media designed to meet growers’ specific needs.**



stalks, cotton stalks, switch grasses, bamboo, and eucalyptus) for substrates, the two main materials they are engineering and constructing from are pine bark and pine wood – specifically from loblolly pine, which is native pine to the southeast United States and is the most abundant, most grown pine species.

“Substrates used to contain soil (field soil) until the 1960s, but today no field soil is used,” Jackson said. “Soil is heavy, may contain heavy metals, doesn’t have good air/water properties when put in a container, and it can contain weed seeds, herbicides, pathogens and diseases.”

Today, substrates are “soilless” in that they comprise organic and inorganic materials that are lightweight and have better physical (wettability, water holding, air space) and chemical (pH and soluble salts) properties. “We needed to figure out how to manufacture wood-based analogs of traditional components, so people can make and sell these products,” Jackson said.

Thus, he said, “The new SPARC facilitates not only the lab activities but new products and an economic stimulus.”

And more and more crops are and will be grown in containers and controlled environments in the future, he said. He lists as popular examples floriculture crops (poinsettia, mums, bedding plants, cut flowers), vegetables (lettuce, tomatoes, peppers, cucumbers), fruits (strawberries), herbs and a possible crop of the future, marijuana.

Said Fonteno, “Soils that plants grow in have to maintain high standards. Having better engineered substrates helps produce better plants.”

He points out the varieties of media they are processing from pine wood for the differing roles they play, including a cottony, water-holding medium that can substitute for peat; pellet-like wood particles that add drainage and substitute for white perlite (volcanic ore aggregate); and a small particled blend that holds water and improves drainage.

“As water quality and supply becomes more problematic for growers, efficiency of materials to capture and hold water must be greater,” Fonteno said. “For example, we have created a sustainable, renewable version of perlite at half the cost.”

There are also samples of biochar – black charred products made from materials such as rice hulls, wood shavings, peanut hulls and wood chips. This char technology that improves poor soils is actually hundreds of years old, Fonteno said. “It holds nutrients very well and is good for sandy eastern North Carolina soils.”

And while biochar can be a costly process, the gas that comes off in the charring of the materials could be collected as an energy byproduct to mitigate the costs. “We’re testing biochar to understand its properties,” Fonteno says. “Also, when we see the viability of its use, commercial power plants that currently use bark and wood as fuels could be a good source of char.”

The Fox Hall greenhouse complex is the site of greenhouse crops and plant nutrition teaching and research, along with a large area devoted to the non-destructive study of root growth – the key in growing a healthy plant, Jackson said.

And here is also where they use the mini-horhizotron, a three-sided, propeller-shaped

pot. Unlike a conventional pot, where you would have to remove the pot to see what’s happening with the roots, the mini-horhizotron’s three windowed sides offer multiple plant-friendly views of how roots are faring in the substrates.

In designing the mini-horhizotron as a new way of measuring roots, Jackson said, “We started with a larger horhizotron, developed at Virginia Tech. We wanted to make a smaller version to look at smaller greenhouse grown plants. We made this redesign with removable panels to look at all three sides at the root system.

“These are used for research collaboration and for teaching. This gives us the opportunity to test several soils and substrates, observe the plant’s response, and record the effects of water and fertilizer – all without disturbing or destroying the root systems.”

And lately they’ve modified it further, adding a non-glare glass through which to look and altering a side panel removal trajectory to protect the leaves of the plant when the panel is lifted off.

“This shows how fast they grow. The first three or four weeks are critical. This allows us to monitor growth and put numbers on it. There are now three times the surface area through which we can see the roots,” Fonteno says. “It’s almost like a plant version of an ant farm! It gets students excited to see what’s going on.”

The substrate lab is the largest university lab of its type in the world, Jackson said, adding, “Half the techniques used, Bill has developed himself.”

Yet, the two realized there was still a lack of knowledge in the area of engineering substrates. “We knew we needed to build a facil-



Becky Kirkland

**The mini-horhizotron (below) was designed to be a new way to measure roots in growth. At left, Jackson uses a larger version to observe how plants are responding to growth media.**



Becky Kirkland





Becky Kirkland

**Wood chips (right) fed into the hammer mill will be pulverized and rendered into desired particle sizes via chosen screens. This process yields the varieties of substrates (above) to suit potting purposes and geographic needs.**

ity to do state-of-the-art substrate work and on a big enough scale to do the work commercially," Jackson said. "We got \$180,000 from Golden LEAF to build SPARC. The SPARC building was conceived and designed to do commercial-sized testing."

And now, he says, "It is the only thing remotely like it at a university in the United States – possibly the world – to research substrates. The SPARC building is the next step to carry substrates work to the next level; it is the crown jewel in our program."

**T**he new space where the engineering of the substrate material takes place is by the Horticultural Field Lab, behind the JC Raulston Arboretum.

"It's a dream come true for us," said Jackson.

The SPARC is the home of a 50-horsepower hammer mill, 2-cubic-yard hopper with auger feed system, conveyor system, cyclone air handling system, substrate dryers and two different screening devices for separating substrate particle sizes.

A big red machine is the centerpiece. It includes the hammer mill, made by a company in Hickory. It's a pulverizer, where large hammers spin and bust materials into small particles.

"We look at all variables that go into particle size reduction," says Jackson, who describes how a fist-size or smaller chunk of wood goes up the blue conveyor, then falls into a hopper, where an auger at the bottom of the hopper conveys the chunks to the hammer mill, where they are pulverized.

Settings on the hammer mill determine the

consistency of the resulting material, such as shredded or chips or pellets. Particle size is adjusted by changing the screen inserted at the bottom of the hammer mill. As material falls through the hammers, they keep hitting it till it will fall through the chosen screen (there are different sizes of holes in each).

Then, air sucks up the product into the cyclone and sends it into a collection vessel. Big white bags above collect dust as air moves through.

"We also have a capability to run the material through more screening devices and shake, to sieve and fraction particles after they've been engineered," Jackson explained. "This allows the construction of substrates from these particles into specific products for specific purposes."

The SPARC has "tremendous potential for collaborative work among many, not just in horticulture," said Jackson.

"The unique thing about this facility is its specific capability to examine many processing variables associated with grinding/engineering/constructing substrate materials from organic materials. The capabilities of this facility could be of interest to colleagues in forestry, wood products, soil science and ag engineering, to name a few. We are partnering with faculty from most all these departments to build a team of specialists to advance substrate science in ways never before attempted."

There is not such a facility at any university that has the full capability as the SPARC, he said. It is because of this void in research



Brian Jackson

facilities that they wanted to invest in creating such a facility, he said. "From root boxes to soil diagnostics to this facility – one can't be done without the others to help 'Atlas' support all of horticulture!"

Jackson is also excited about what the new facility can do for the state's economy, as he foresees "jobs created by current soil/substrate manufacturers, who may be making and selling new products based in part on this research, and money generated from organic materials that may be the next popular materials used in horticultural substrates – pine trees, agricultural wastes, storm debris, biochar."

The premise behind the funding provided by Golden LEAF was the creation of new substrate materials/components made from local materials in North Carolina and around the region, Jackson said. "There are numerous companies and businesses in the state that make their living making and selling substrates. This state is the fourth largest producer of floriculture and nursery crops in the United States. And North Carolina has some of the largest pine bark substrate suppliers in the East."

"It is my dream to help continue the long tradition of NC State being the most recognized university program for substrate research in the United States and one of the best in the world," said Jackson. "The construction of the SPARC is testament to our commitment and desire to continue cutting edge research in substrate science." 🌸