VOL. 18, 2021

Re: search

A MAGAZINE OF THE AGRICULTURAL RESEARCH PROGRAM IN THE COLLEGE OF AGRICULTURE AND ENVIRONMENTAL SCIENCES AT NORTH CAROLINA AGRICULTURAL AND TECHNICAL STATE UNIVERSITY

New media promises sweet rewards

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NORTH CAROLINA AGRICULTURAL AND TECHNICAL STATE UNIVERSITY

AGRICULTURE AND ENVIRONMENTAL SCIENCES

A magazine of the Agricultural Research Program in the College of Agriculture and Environmental Sciences at North Carolina A&T State University

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On the cover: Salam Ibrahim, Ph.D., and research assistant Tahl Zimmerman are working to find a new medium for cultivating lactic acid bacteria, important for producing yogurt and other dairy foods.

3,000 copies of this public document were printed at a cost of $11,641, or about $3.88 per copy.

Some photos were taken before the COVID-19 pandemic and, therefore, show individuals not wearing masks or socially distancing.

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Re:search

North Carolina Agricultural and Technical State University is an 1890 land-grant, doctoral, high research activity university dedicated to learning, discovery and community engagement. The university provides a wide range of educational opportunities from bachelor's to doctoral degrees in both traditional and online environments. With an emphasis on preeminence in STEM and a commitment to excellence in all its educational, research and outreach programs, North Carolina A&T fosters a climate of economic competitiveness that prepares students for the global society.

Mission

The College of Agriculture and Environmental Sciences provides opportunities for individuals from diverse backgrounds to achieve excellence in the food, agricultural, family and environmental sciences through exemplary and integrative instruction, and through scholarly, creative and effective research and Extension programs.

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A magazine of the Agricultural Research Program in the College of Agriculture and Environmental Sciences at North Carolina Agricultural and Technical State University

Hymon-Parker

Growing Anew in Changing Times

Fall 2021 has been a season of reopening, both across our country and on our campus.

As researchers began to understand SARS-COV-2, the virus that causes the coronavirus COVID 19, and offer immunizations to protect against it – we have an ongoing vaccine clinic on our own campus – the university has begun to return to normal operations after more than a year of closed classrooms, residence halls and dining facilities.

As a public research institution, and a historically Black college and university (HBCU), we took an active role in scientific inquiry during the pandemic and in recovery from it, earning a record $27.5 million in externally funded research, an increase of 17% from 2020. Included in that amount is $1.1 million from the U.S. Department of Agriculture to support the 1890 Center of Excellence for Student Success and Workforce Development (SSWD), a multi-institutional consortium designed to improve the recruitment, retention and graduation of diverse students in the food, agriculture, natural resources and human (FANH) sciences. The CAES is leading that consortium, a top initiative among land-grant HBCUs, to produce the next generation of diverse leaders in key agricultural professions. You'll read about the SSWD Center in this issue.

The pandemic also brought on new challenges for the state's growers and those who work with them in the supply chain. We turned our attention to researching the economics of growing industrial hemp, one of North Carolina's budding cash crops, to provide better advice for growers seeking to understand the market for this new crop. We also experimented with ways to help industry provide healthier, lower-cost foods for the marketplace, including probiotic-rich yogurt and the use of nanoencapsulation technology to increase foods' nutritive qualities.

The doors to our research labs have also reopened and our field sites have begun to grow again. The ribbon-cutting ceremony for our $6 million, 17,000 square foot Extension and Research Farm Pavilion, held in September, literally opened the doors to the university's largest community engagement, research and teaching facility. In the years to come, we'll grow this facility and plan for other expansion at our 492-acre University Farm, including an amphitheater; a community and urban food complex with a creamery, research labs, classrooms; and a small business incubator, allowing us to reach more people, hold more workshops and engage more stakeholders.

As the largest 1890 land-grant college of agriculture in the nation, we are growing ideas and harvesting innovation. We invite you to explore the research topics in this magazine, and then, join us as we open new doors.

Sincerely,

Shirley Hymon-Parker

Re: information sjhymon@ncat.edu

CAES Extension and Research Farm Pavilion opens doors, ushers in new season of growth for farm

"A dream 20 years in the making" was realized at N.C. A&T's 492-acre farm on Sept. 21 as local, state and national dignitaries lined up to cut the ribbon and open its CAES Extension and Research Farm Pavilion.

The $6 million, 17,000 square foot facility, built with funds from USDA's National Institute of Food and Agriculture, will be used to conduct research and deliver educational programming to students, farmers and community members. It includes a 500-seat auditorium, classrooms, labs, a conference room and a kitchen.

"This is a big moment in the life of our university, because what we do here today, in opening this facility, is symbolic of our role as a land-grant university," said Chancellor Harold L. Martin Sr., Ph.D. "The farm has been a critical research and educational asset to the university since its inception in 1904. This is an expansion of that role."

Greensboro Mayor Nancy Vaughan, N.C. Agriculture Commissioner Steve Troxler and District 1 Councilwoman Sharon Hightower joined Martin; Mohamed Ahmedna,

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Ph.D., dean of the College of Agriculture and Environmental Sciences; Andy Perkins, associate vice chancellor for facilities; Leon Moses, farm superintendent; and animal sciences student Tahirah Jones, president of the university's chapter of the national association Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS), in opening the state-of-the-art Pavilion.

"This Pavilion makes this beautiful farm not only the university's largest classroom and largest laboratory, but also its largest community engagement space," Ahmedna said. "As the largest college of agriculture among 1890s universities, we take our commitment to research, teaching and Extension very seriously. This building demonstrates that commitment."

The Pavilion's opening also marks a major step in a building boom at the farm, Ahmedna said. In the next years, NIFA will provide financial support for additional projects planned for the space, including an amphitheater; a community and urban food complex with a dairy, research labs, classrooms; and a small business incubator. The dairy unit's planned expansion will allow it to create such A&T-branded products as "Aggie Ice Cream", milk and butter.

Already, the college has opened student and community gardens near the Pavilion as part of the planned expansion.

These projects will be important economic drivers for east Greensboro, said Vaughan.

"N.C. A&T and the city of Greensboro are intertwined," Vaughan said, "In a city challenged by food insecurity, to be able to have a land-grant institution like A&T right here with the innovations they're making, are

From left, University Farm superintendent Leon Moses; Greensboro Mayor Nancy Vaughan; N.C. Agriculture Commissioner Steve Troxler; A&T Chancellor Harold L. Martin Sr.; Dean Mohamed Ahmedna; Greensboro City Councilwoman Sharon Hightower; student representative Tahirah Jones; and Associate Vice Chancellor for Facilities Andy Perkins ready themselves for the CAES Extension and Research Farm Pavilion ribbon cutting ceremony in September, 2021 on the campus of North Carolina A&T State University.

all going to have a major impact on the city."

Originally opening in 1904 to be a source of food and milk for the campus cafeteria, the farm has "produced" ever since. It generates not only food for the community – last year, the farm donated a record 21,500 pounds of vegetables to four area food pantries - but also research on sustainable agriculture and natural resources conservation, such as swine waste research and soil conservation; animal science, such as research into food animals' likelihood of contracting SARS-CoV-2, the virus that causes the COVID-19 disease; and potential new crops, such as ginger, truffles and industrial hemp, that have the potential to improve farmers' bottom lines and boost the state's $95.9 billion agricultural impact.

And the farm helps to feed hungry minds. Most years, more than 1,000 school-age children tour the farm; it's also a source of internships and work-related research for university students.

"The college is to be commended on opening this building, which will be so important in helping to deliver programs to stakeholders across the state and the nation," said Jewel Bronaugh, Ph.D., USDA deputy secretary of agriculture, who praised the college in recorded remarks at the opening ceremony.

Steve Troxler, N.C commissioner of agriculture, thanked the college and the farm's staff for its excellence.

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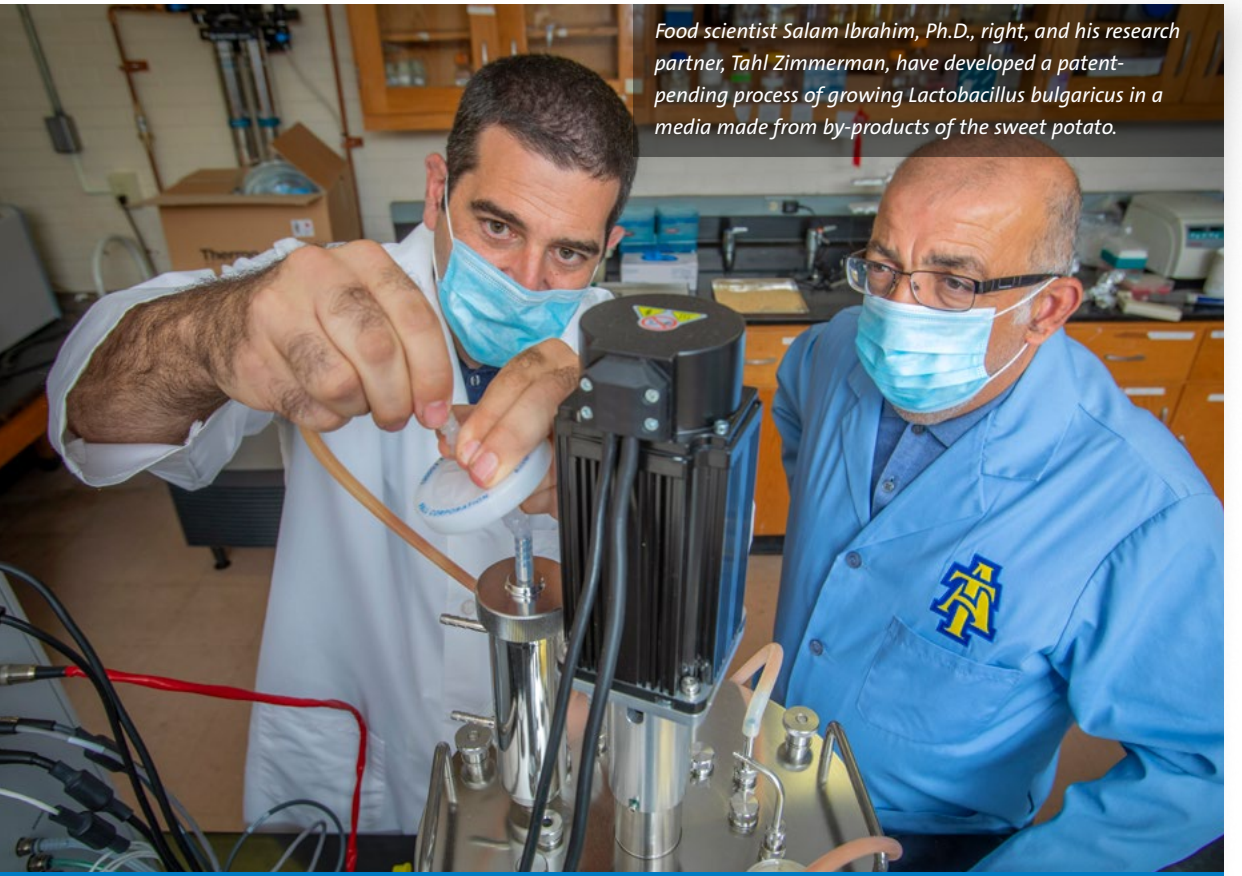
Steve Troxler, the N.C. commissioner of agriculture, acknowledges the accomplishments of the N.C. A&T University Farm during the ceremony. "I congratulate A&T for its work with small farms," he said.

"This farm is the best in North Carolina. I ought to know because the Department of Agriculture and Consumer Services runs 18 research farms," Troxler said. "When I came and toured the farm recently, I was blown away. I congratulate A&T for its work with small farms and for our work together."

The new building projects will be watched closely by Farm Superintendent Leon Moses, who started working at the farm when he was an undergraduate student. Earlier this year, he celebrated 45 years of engagement with the farm.

"This building is a dream 20 years in the making," said Moses. "When I think of how many people the farm has changed, and of all the people who have become great by first stepping foot on this land, it makes me proud. I'm proud of the entire university, but I'm the most proud of this place and the direction in which it's growing."

Greensboro Mayor Nancy Vaughan provides greetings during the ceremony. "The innovations A&T is making ... are going to have a major impact on the city," she said.



Food scientist Salam Ibrahim, Ph.D., right, and his research partner, Tahl Zimmerman, have developed a patent-pending process of growing Lactobacillus bulgaricus in a media made from by-products of the sweet potato.

FCS professor seeks to give yogurt production a sweet boost

FIVE TO 10 THOUSAND YEARS AGO, when the first cow, goat or sheep herders in Mesopotamia discovered that they could not only eat the fermented milk that their warm climate had produced, but that they could make it tasty, the culinary world gained an asset: yogurt was born.

This ancient food, thought to have been eaten as long as milk-producing animals have been domesticated, not only enabled milk to be preserved through fermentation, which turns it into yogurt or cheese. It also proved to have numerous health benefits as an excellent source of protein, calcium and probiotics.

By the 20th century, yogurt had hit the big time, having migrated to Europe with travelers from Arabia, Turkey, India and Russia in the Middle Ages, then gone around the world as both a creamy, fruity breakfast and snack essential and a nutritious cooking staple. The purpose of the fermentation process that creates yogurt had turned from simply preserving the milk product, to selling it.

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Food scientist Salam Ibrahim, Ph.D., in the Department of Family and Consumer Sciences, has researched yogurt and its benefits for the past 22 years, and has witnessed much of yogurt's progression from niche health food to dairy aisle powerhouse. Within this evolution, he has seen issues arise for the industry.

"Selling yogurt in commercial production calls for consistency," he said. "Consistency is the key to making a product acceptable to consumers. Modern yogurt production involves culturing milk with live bacteria, which produce lactic acid, which coagulates the milk proteins and makes the milk ferment. That cultured bacteria must be grown in the same way, every time."

That consistency starts with a reliable, nutritious, inexpensive media in which to grow Lactobacillus bulgaricus and other forms of lactic acid-producing bacteria that cause fermentation. A quality medium provides the consistency to give producers control of their final product. But therein lies the problem: although many media, including milk, whey and soy, have been used through the years, in the modern era, they are all either too expensive or too allergen-producing to be ideal for commercial production.

In the industry's conundrum, Ibrahim sees an opportunity to boost both the product's health benefits and North Carolina's economy. He and his departmental research partner, Tahl Zimmerman, have developed a patent-pending process of growing Lactobacillus bulgaricus, one of the bacteria that cause fermentation, in a media made from byproducts of the sweet potato.

"In industry, cultured bacteria has been grown in the same way for years: in a media that can be carefully controlled, called the "mother." For years, that media was milk, and as long as milk's cost was low, that was fine," Ibrahim said.

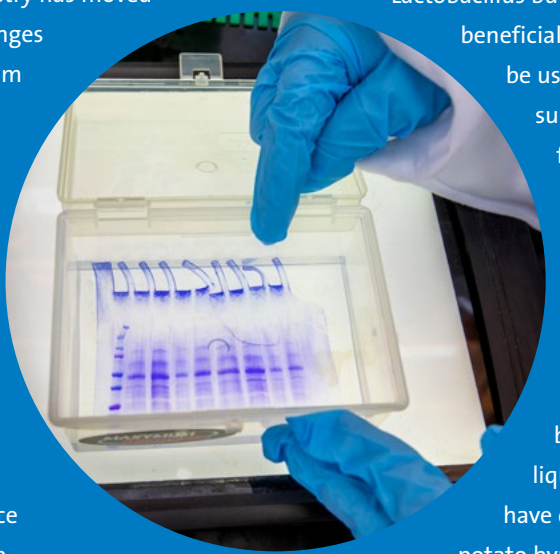
"In the 1980s, milk prices started to

RIGHT INSET: Tests results demonstrate beneficial compounds produced by good bacteria known as probiotics and found in yogurt.

BELOW: Salam Ibrahim, Ph.D., left, leads students Asia Edwards, Alaina Brock and Deja Carrington as they check the growth of good bacteria to ultimately produce healthier foods.

rise, and the industry started looking for alternatives. It settled on whey, a byproduct of milk. But by the 1990s, healthy bacteria called probiotics had become popular food additives, and so the industry no longer had to simply culture bacteria for cheese and yogurt. It needed to grow bacteria in such a way as to grow a high cell mass of viable cultures for the consumer to get the optimal health benefit. In addition, the cells had to have high enzymatic activity to stay alive a long time to get to market. All of these factors became challenges to maintaining good products."

Even as the industry has moved forward, many challenges have remained, Ibrahim said, and the 20-year quest for an alternative media has been his focus.



"In order to grow good bacteria, you have to have three nutrients: a nitrogen source, a carbon source and a buffer, such as a phosphate, to make sure they reach a high cell number," he said. "We worked with several things through the years. But then, I thought of the sweet potato."

High in nutrients, low in calories, this popular tuber is North Carolina's top crop and official vegetable. In 2019, N.C. grew nearly 2 billion pounds of sweet potatoes which brought nearly $375 million to the state economy, according the U.S. Department of Agriculture. In fact, the Tarheel state accounts for 50% of the national supply and grows more than 95,000 acres a year, nearly 30,000 more than the next closest growers, California and Mississippi.

"We have a lot of sweet potatoes – so many that 20% are left in the field as being damaged, irregular in shape, or too small," he said. "Also, when sweet potatoes are processed, byproducts are created, such as the peel or the ends. But these are all high in potassium, nitrogen, calcium, phosphorus and the micronutrients essential to bacteria growth. That caught my attention.

"I thought, what if we could extract nutrients from sweet potato byproducts and create a low-cost, water-based liquid that could be used as a medium for growing Lactobacillus bulgaricus and other beneficial bacteria that could be used as probiotics or supplements for other foods?"

Ibrahim and Zimmerman have been working with the food industry for several years, and the work has been successful. The liquid media that they have created from sweet potato byproducts has proved to not only grow high numbers of bacteria, but to grow faster-replicating, longer-surviving, better functioning bacteria that can be used as probiotics, they said.

"There are alternatives out there now, but they're not so good," Zimmerman said. "Past efforts to create such a media in a sustainable way have ultimately failed because they invariably rely on expensive chemical or enzymatic processes that require a high amount of energy from the grower. Our technology is a purely mechanical

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Asia Edwards prepares a sample under the direction of Salam Ibrahim, Ph.D. The probiotics industry uses bacteria as medicine, says Ibrahim, which requires better functioning bacteria.

process that requires few other inputs, and it supports more viable cells, better."

The rise of consumer demand for probiotics, or beneficial bacteria, as food supplements has produced its own challenges for the food industry. These high-functioning bacteria must not only grow well, but also have long shelf lives so that consumers get their full benefit.

"The probiotics industry uses bacteria as medicine," Ibrahim said. "One problem they've had is that an animal product-based media, such as whey, and the familiar vegan substitute soy, each have the potential to be an allergen. A sweet-potato media is plant-based and can be marketed as vegan, but doesn't have the allergenic potential."

Working with the Office of Intellectual Property Development at N.C. A&T, Ibrahim and Zimmerman have applied to patent their process, which can benefit both farmers and industry.

"Adopting this technology would mean that farmers could find another market for their discarded goods, food processors could use sweet potato byproducts that are now discarded, and the industry, which is searching for new technologies, could manufacture plant-based probiotics in a sustainable, affordable way," Zimmerman said.

Ibrahim and Zimmerman have obtained a two-year, $50,000 grant from the National Science Foundation to work with potential industry partners on their needs. Their collaborative efforts are beginning to pay off with interest from the industry, Ibrahim said.

"The yogurt industry has a problem. We think we have an answer for them," Ibrahim said. "The basic research is over; now we're designing the equipment and working with partners' particular needs. We're very excited. Anything is possible."

Truffle travails lead to triumph for CAES researcher, industry partners

The trouble with truffles – the pricey, edible soil fungus synonymous with nose-to-the-ground dogs and flavorful dinners in five-star restaurants – is that they're hard to grow. Soil and water conditions must be managed. The weather must be moderate. The tree host must be in good health. If it's too hot, too wet, too dry, too cool, or any of an assortment of more nebulous conditions that even experts can't always pinpoint, they won't grow.

With so much effort – and money – required to get into the truffle business, the whole proposition may seem like a waste of time; indeed, most attempts at establishing truffle orchards in the U.S. have failed, despite millions of dollars of investment. But the payoff for a successful truffle harvest can make it all worthwhile. According to the U.S. Department of Agriculture's 2021 National Retail Report for specialty crops, truffles can sell for hundreds of dollars a pound; the most celebrated varieties can sell for more than $1,000 per pound.

Omon Isikhuemhen, Ph.D., a mycologist In the Department of Natural Resources and Environmental Design in the College of Agriculture and Environmental Design, has devoted much of his career to the study of mushrooms and truffles. A respected specialist in shitake cultivation who has helped North Carolina farmers get into mushroom cultivation, Isikhuemhen now wants to do the same for truffles, helping the state's farmers take advantage of the demand for this high-value commodity.

He and his team have succeeded where others have failed thanks to their willingness to experiment with the type of truffle, the kind of tree and a secret inoculation mixture Isikhuemhen said came to him in a dream. With this mix, he was able to generate an estimated 200 pounds of truffles in 2019 for a grower in Warren County, catching the industry's attention worldwide.

Now, he and his team are working to build on that success. "It's our goal that North Carolina will become the largest truffle-producing state in the nation," Isikhuemhen said. "Right now, we have new

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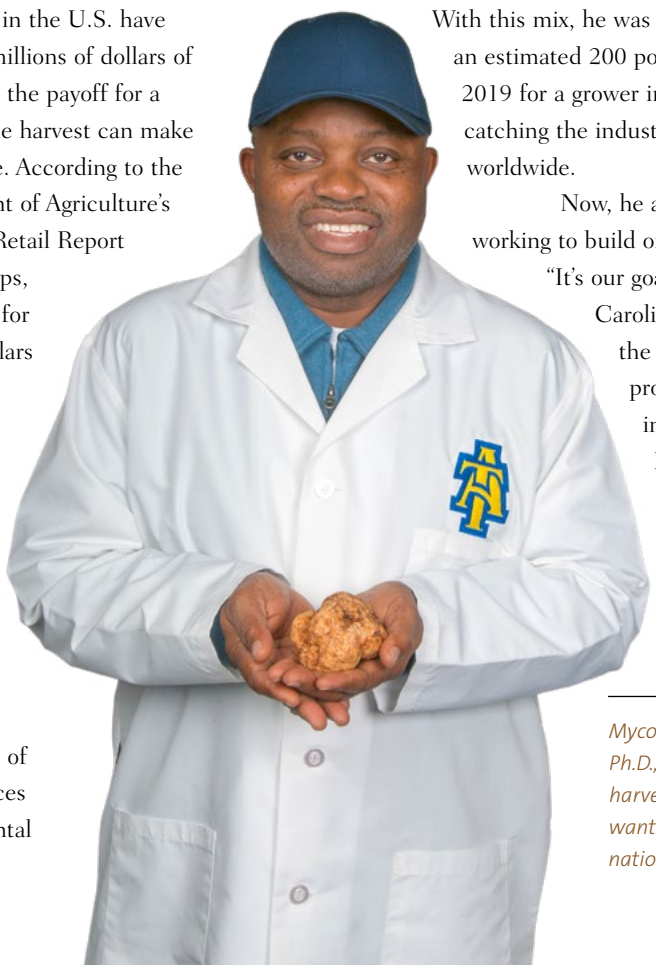

Mycologist Omon Isikhuemhen, Ph.D., holds a Bianchetto truffle harvested in North Carolina. He wants to make the state the nation's largest truffle-producer.

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Nancy Rosborough, CEO of Mycorrhiza Biotech, follows one of her truffle-sniffing dogs through a plot of pines. Rosborough's company, Mycorrhiza Biotech, is experiencing truffle-growing success after partnering with Isikhuemhen.

grant to try to expand the host range for the white truffle Tuber borchii. We are also trying to research and improve on various aspects of the technology to improve on yield from fields in different parts of the Southeast using various host trees. We want to learn which microclimates and soil dynamics are the most conducive."

Truffles are found underground near tree roots, similar to an underground mushroom. But unlike that biological cousin, it's not always apparent when, or if, they're present. Dogs, or in some countries, pigs, can sniff them out from the aroma they produce; described as "earthy, pungent, musky" thanks to pheromones and other compounds they make, it's the aroma that sells the truffle, even moreso than the taste.

And they need time. Often grown from trees whose roots have been intentionally inoculated with truffle spores, truffles can take five to nine years to start producing. According to experts, it can cost $25,000 an acre to set up a truffle orchard; even then, there's no guarantee of a successful harvest. Truffles only grow on certain species of tree; to grow significant numbers of them, farmers must grow both the tree and the fungus, and encourage them to work together symbiotically.

Truffle culturing was popular in centuries past, but revived worldwide in the 1970s when France and Italy hit the jackpot by finding the right conditions to grow black winter truffles and white truffles, two varieties for which those countries have become famous. Prospective growers in the U.S. tried to follow suit in the late 1990s, but despite millions of dollars in investment, most of those attempts failed for reasons that were unclear, according to experts.

Isikhuemhen became interested in truffles during this time, and watched as North Carolina put together a team of researchers to develop an industry for the black winter truffles called the Perigord, after the region of France where they are commonly grown.

Unimpressed by the high-value, but notoriously finicky and slow-growing Perigord truffles, he instead decided to try growing a variety of white truffle called the Bianchetto on the roots of loblolly pines, the standard timber tree in the Southeast, he used his own growth media to inoculate the roots of the pine seedlings with truffle spores before they are planted. A medium-sized player in the truffle world, the Bianchetto had been overlooked, according to Isikhuemhen, in the industry's rush to the pricer European varieties. But the

Bianchetto known as Tuber borchii, which sells for around $500 per pound, seems to tolerate conditions in the American Southeast and grow well on pine trees, two factors that drew Isikhuemhen's attention.

Isikhuemhen and his industry partner Nancy Rosborough, chief executive officer of Burlington company Mycorrhiza Biotech, announced a breakthrough truffle harvest in 2017 using his method of inoculation, and Mycorrhiza became the first grower in North America to produce Bianchetto truffles on loblolly pines.

"We did the research, then moved to the field, and now, we have truffles," Isikhuemhen said at the time.

Other growers and the culinary market were slow to warm up to the idea, however; the team was forced to wait to celebrate until two years later, when Isikhuemhen, Rosborough and their client Thomas Edward Powell III experienced spectacular success with Powell's truffle orchard at Burwell Farms in Warren County. Powell is the owner of LabCorp, the world's largest clinical diagnostics company; after joining forces with Rosborough and Isikhuemhen in 2010, he was rewarded with a 30-pound Bianchetto truffle harvest in 2019.

Expecting a few hundred truffles from his two-acre plot, Powell and his chief scientific officer, Richard Franks, reaped a few thousand instead using the microbial system devised by Isikhuemhen which, he said, grows truffles five times faster than any other.

That success was highlighted by author Rowan Jacobsen, whose article "Has the American truffle finally broken through?" appeared in Smithsonian magazine this year.

For an agricultural state like North Carolina, where growers are still recovering economically from the demise of the tobacco market, truffles can be a niche crop – particularly for small and limited-resource farmers, Rosborough said.

INSET: Bianchetto truffles have proven to be adaptable to N.C. climate changes and grow well on pine tree roots.

"You can make enough to save the family farm,' said Rosborough, whose company Mycorrhiza Biotech is named for the botanical term for the symbiotic relationship between the truffle – the fruiting body of the fungus – and the host plant. Rosborough knows family farms well; a native of Washington, D.C., she moved in 2005 to the farm her mother had grown up on in Gibsonville, and immediately noticed that the area's small farms were losing ground to suburbs.

Motivated by her desire to save the area's family farms, including her own, Rosborough found Isikhuemhen while searching for potential crops to grow, and the two have partnered ever since.

Now, with their truffle triumph secure, they are helping Burwell Farms expand its truffle orchard; Mycorrhiza Biotech has more customers; and Rosborough has planted some truffles on her own farm.

"We were never doing this just to make money," Rosborough told Smithsonian magazine. "The goal has always been to get this technology into the hands of small farmers. If, in a few years, there are 50 farmers in each of the Southeastern states growing truffles on small plots and using that money to hold onto their land, then we can say it worked."

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Beatrice Dingha, Ph.D., a researcher and professor in the Department of Natural Resources and Environmental Design, works with a team of students who are examining how hemp benefits from intercropping.

HEMP RESEARCH: *Helping farmers navigate a new field*

For some farmers, hemp sounds like the cash crop of their dreams. Since Congress made hemp farming legal in 2018, it has been the hot new topic in agriculture, bringing hope to North Carolina farmers still recovering financially from the decline of the tobacco industry. The fast-growing plant can yield seeds, flowers, fibers and oil, all of which can theoretically fetch high prices on the hemp market — enticing thousands to try growing it.

But there's one problem for current and future hemp farmers: it's a new field, with little long-term research to guide eager farmers on their journey.

Enter the College of Agriculture and Environmental Sciences, which is performing research that ultimately will educate farmers on commercial hemp production. Researchers are studying a variety of aspects of hemp farming — from pests and pollination to production and profits — to help growers maximize the crop's potential and minimize the risks associated with growing it.

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As they reach conclusions, the researchers will share their findings with farmers and agricultural Extension agents through symposia, seminars, pamphlets, websites and other means — all with the goal of painting a full picture of the realities of hemp production.

"The plant has a lot of potential, but people are jumping into something without considering what they need to do first," said Obed Quaicoe, Ph.D., an assistant professor in the Department of Agribusiness, Applied Economics and Agriscience Education. His team is using a $500,000 grant from the USDA's Agriculture and Food Research Initiative to examine the financial risks of growing hemp.

Hemp is one of the oldest cultivated plants in the world, once grown in fields owned by George Washington and Thomas Jefferson. But there's not a wide body of research on the best conditions for growing hemp, the pests it attracts or the economic ramifications for farmers growing it.

With good reason. For most of the last 100 years, it was illegal to grow hemp, which made it impossible to study the plant's biology or its potential as a crop. Hemp comes from cannabis, the same plant that produces marijuana. And though it's legal once again to grow hemp in North Carolina, marijuana is a different story. State officials regularly test hemp farmers' plants for tetrahydrocannabinol, or THC. If a cannabis plant contains more than .3 percent THC, then it's marijuana and must be destroyed.

That's just one of the risks of hemp farming. Others include pests, mold and market saturation, which is where Quaicoe's interests lie. Too many farmers are investing time and money into growing a crop they know little about, he said. As of August 2021, there are 1,500 hemp growers licensed through the state's Industrial Hemp Commission; however, according to Quaicoe, many of those farmers have been so excited about the potential that they failed to line up buyers, which has been financially devastating for some.

"You have all this output from farmers and literally not enough people to buy the flowers or the fiber from them to process," he said. "When that happens, it chokes the market. And if you don't get a good price, you get your head underwater."

Dingha and her students look for signs of pest activity in test plots at the University Farm.

Obed Quaicoe, Ph.D., assistant professor in the Department of Agribusiness, Applied Economics and Agriscience Education, is examining the financial risks of growing hemp. "Usually, we research a crop first, then educate farmers, then they grow. With hemp, it went backwards," he said.

The Benefits of Intercropping

Beatrice Dingha, Ph.D., often finds herself walking through rows of hemp at the N.C. A&T Farm, inspecting the plants, monitoring the soil, keeping an eye out for bees and bugs, her specialty.

Dingha, a research associate professor in the Department of Natural Resources and Environmental Design, is examining how hemp benefits from intercropping — growing two or more other crops so close together that they interact biologically. The research is being funded in part by a $230,000 grant from the Southern Sustainable Agriculture Research and Education, which promotes sustainable farming practices.

Dingha and her team are using three crops for this grant-funded research: hemp, cowpeas (better known as black-eyed peas) and either okra, squash or watermelon, which are dependent on bees for pollination.

The bees are an important part of Dingha's research, and not just because she's an entomologist. Bees seek out cowpeas for nectar. The more pollinators there are in the fields, the greater the cowpeas' yield. And that means more nitrogen in the soil, something needed to produce a healthy hemp crop. Dingha is experimenting with four varieties of cannabis plants to see which one reacts best.

"If we can have cowpeas that produce nitrogen, then we might be able to cut down on the amount of fertilizer that we use," she said. "That's a big impact, since farmers won't have to spend as much money on fertilizer."

Her team's research has another important implication for hemp farmers: it demonstrates the importance of farmers having a second or third crop to sell income if something happens to the hemp.

"They should not rely only on hemp, because we all know that hemp is a delicate crop," she said.

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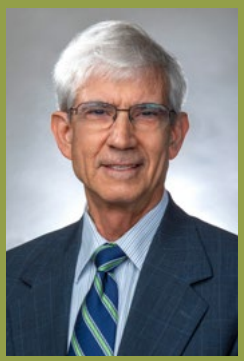
Perfecting Production

A delicate crop, indeed. It needs the right temperature, the appropriate amount of fertilizer, the correct irrigation, the proper protection from pests and weeds. Any variations, and the crop could fail, costing farmers their livelihoods until next season.

Ghasem Shahbazi, Ph.D., a professor in the Department of Natural Resources and Environmental Design, has spent the last four years investigating the optimal growing conditions for hemp — specifically what varieties produce the best CBD oil. The agricultural and biological engineer, who specializes in bioenergy research and product development, is a member of the N.C. A&T Industrial Hemp Team, which is now in the second phase of research funded in part by a grant from the USDA Evans-Allen Research Program.



Shahbazi

Like the other researchers in the college, Shahbazi's goal is helping farmers remove the guesswork from planting, cultivating and selling this often-misunderstood plant.

Bhowmik

"Some people by nature only look at the positive side," he said. "They only look at the price and potential and income and say, 'Wow. I need to jump in there with both feet.' But a lot of people couldn't sell their hemp in years past because of the lower quality, or because of a lack of connection with a buyer."

The first phase of the team's work began with Arnab Bhowmik, Ph.D., the assistant professor of soil science and soil microbiology who is responsible for the part of the research that takes place on the farm. He planted two varieties known for their production of buds that produce high quality CBD oil to assess what grows best under what circumstances.

With grown plants in hand, Shahbazi extracted and purified the CBD oil, running it again and again through the university's small-scale biorefinery machine. The second phase, which began in 2020, is focusing on how the quality of the soil impacts the quality of the CBD oil.

Results from both phases will help farmers choose their varieties more wisely — and temper their expectations.

"We tell them that they need to be careful," Shahbazi said. "Usually in these situations, there are people who have a lot of money that they can throw at risky things. Farmers don't have unlimited money to throw at risky things."

Generation NEXT

Hundreds of high school students have gained firsthand exposure to research from the Research Apprenticeship Program.

By knitting together grants, creative thinking, and new partnerships, as well as adapting existing programs, faculty and staff in the College of Agriculture and Environmental Sciences at N.C. A&T is grooming the next generation of agricultural leaders.

No one way will work, said Shirley Hymon-Parker, Ph.D., the college's associate dean for research.

"With all of the challenges we are facing now and those to come, our land-grant universities have to ensure they are doing those things needed to prepare students so they are ready with creative and research-based solutions," Hymon-Parker said. "This is still part of our mission to ensure that we are accessible, adaptable and preparing students for tomorrow."

Only half the number of students needed to fill the more than 60,000 food and agriculture-related jobs available annually graduate each year. As such, yeoman's efforts are required to fill that gap and ensure that the workforce is diverse and inclusive. While universities are working individually, they are also working collectively and collaboratively to ensure the U.S. of a globally competitive workforce.

One of A&T's centerpiece efforts was securing an additional grant from the United States Department of Agriculture to host the **1890 Center of Excellence for Student Success and Workforce Development**. The initial center funding came in 2020 for $1.6 million, with an additional $1.1 million netted last year.

The center is one of a maximum of six national centers launched in celebration of the Second Morrill Act of 1890. This thinktank, in partnership with Florida A&M, Fort Valley State, Lincoln, Tuskegee and Virginia State universities, the University of Arkansas at Pine Bluff and the University of Maryland Eastern Shore, will also serve the entire 1890 land-grant university system.

The center's overall objective will be to serve as a hub that will develop and test programs designed to attract, retain, graduate and place minority students in careers in the food, agriculture, natural resources and human sciences and related fields. The center will:

- Provide STEM and experiential learning opportunities to high school students.

Continues on next page

- Recruit, retain, mentor and graduate first-generation, underrepresented students at 1890 universities.
- Deliver workforce development experiences to enhance the pipeline from secondary to postsecondary to graduate programs to careers.
- Develop strategies to integrate emerging technology into the academic curriculum.

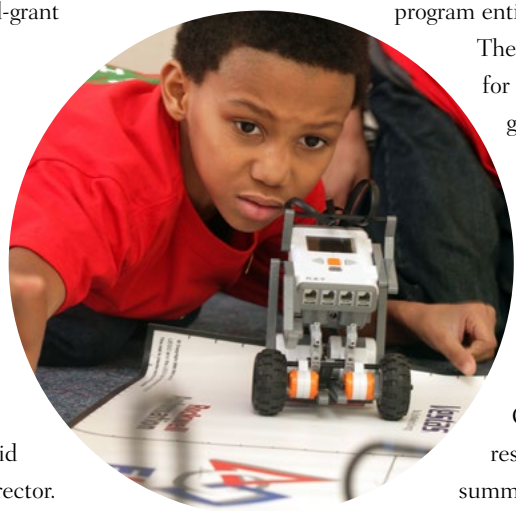
Cooperative Extension will play a vital role in the center's activities using its 4-H program as fertile ground to help young people connect to agriculture-based careers and opportunities.

To date, the center, initially known as the Center of Excellence to Motivate and Educate for Achievement (MEA), has assisted more than 1,400 students, introduced more than 65 technologies and hosted 86 training workshops.

With additional support from USDA's National Institute of Food and Agriculture, the college offered partial scholarships to 70 freshmen and transfer students seeking degrees in food and agriculture this summer. These one-year, $2,000 scholarships are part of a federal, 1890 land-grant scholarship program providing more than $19 million to the nation's 19 historically black land-grant universities.

This new **1890 Scholarship Program**, coupled with the existing 1890 Agricultural Scholars program, should increase the talent pipeline for the next generation of agricultural workforce leaders and scientists, said Carrie Castille, NIFA director.

"We need the brightest minds from across all areas and cultures in our society to be represented, Castille said, adding that the NIFA scholarship programs help that goal become attainable.



Recently A&T partnered with **N.C. Virtual Public Schools** to offer two agriculture-related classes to middle and high-school students statewide.

Virtually, students can take two courses from A&T: one in animal science and one in food and nutritional science. This is a critical gain for districts that don't offer these classes in person.

"Many agriculture courses were cut in a curriculum shift in the late 1980s, and individual schools districts don't have the funds to supply them on their own," said Brandon Simmons of N.C. VPS.

After two years of work and coordination, the classes were available early this summer. Almost 350 students, 192 in food and nutrition and 156 in animal science, have signed up for or are taking the classes. Funding to develop the programs and initial courses was available through a USDA Capacity Building Grant.

The project was part of a three-year $299,800 grant to create the classes for high school students and develop student ambassadors, a coordinated social media campaign, and implement a student retention program entitled Guaranteed 4.0.

The final centerpiece for building the next generation of agriculture professionals is the continuation of the **Research Apprenticeship Program** (RAP), which pairs high school students with CAES researchers for a residential, campus-based summer internship.

COVID-19 canceled the program in 2020, but RAP was switched to a virtual program for 2021. But the change did not halt the work nor dampen the enthusiasm of this cohort of students.

ABOVE: Kingsley Ekwemalor Ph.D., right, an assistant professor in the Department of Animal Sciences, guides a RAP student through an examination in the University Farm's Small Ruminant Unit.

LEFT INSET: An elementary school student enjoys a robotics class, part of the CAES's outreach to public schools.

From studying insects and biochars to cloning Mimi the brown mouse, RAP students worked individually and as a team with selected research faculty members.

A critical part of the program is getting students to understand the research process and see themselves as part of solving a real-life crisis, much like developing the COVID-19 vaccinations, said Hymon-Parker. Additionally, she added, they need to see research as fun and profitable.

"Research was an intimidating concept because of the misconception of having to do the studies alone or the pressure of always being correct," said Kayia Morrow, a RAP student from Greensboro, NC, during her final presentation. "This program has shown that there are teams that develop relationships for years and work together to make mistakes and develop solutions to worldwide programs."

Or added Tara Lepore, a rising high school senior from Hubert, NC. "… One of my favorite parts of this experience was learning how it's not just one department. Everything moves and develops together. The amount of real-life field research done is so exciting. In high school, we don't do much of any field work, so I'm excited to get to A&T and start real-life research."

In addition to these efforts, A&T has a **Multicultural Scholars** program and is enhancing and creating new doctoral programs focused on today's agricultural challenges.

No one program will be the magic elixir, said Hymon-Parker. Still, as the population swells, producers deal with climate changes, depletion of resources and political shifts and technologies emerge, colleges and universities must embrace the challenges and opportunities ahead.

"We can't watch agriculture change and not change how we are preparing the next generation of professionals," said Hymon-Parker. "The world is changing. The students are changing and we're making adjustments and adaptations, so we remain relevant and ready."

ADDING VALUE:

One professor is using nanoscience to combat foodborne listeria

Leonard Williams, Ph.D., director and professor of food safety and microbiology at CEPHT, experiments with embedding microbials into food packaging, or directly into food itself.

Ask any scientist who studies foodborne illnesses to name the bacteria, virus or parasite that causes them the most sleepless nights, and near the top of their list will be these two scary words: listeria monocytogenes.

Present in soil and water, the bacteria called listeria wreaks a kind of havoc that goes well beyond the garden-variety "I think I ate some bad potato salad" illness that all of us have experienced at one time or another. What starts as flu-like symptoms up to a month after ingesting it can progress to confusion, loss of balance and convulsions as the listeriosis infection spreads throughout the body. According to the Centers for Disease Control and Prevention, listeria is the third leading cause of food poisoning-related deaths in the U.S., killing about 260 of the roughly 1,600 people who ingest it. It's especially deadly for newborns, the elderly and people with compromised immune systems.

In 2020, for example, deli meat containing listeria infected a dozen people in Florida, Louisiana, Massachusetts and New York. All 12 were hospitalized, and one died.

Leonard Williams, Ph.D., from the College of Agriculture and Environmental Sciences doesn't want you or anyone else to get listeriosis. In fact, he and his colleagues are spending quite a bit of time figuring out ways to keep you safe from it.

Williams is director and professor of food safety and microbiology at N.C. A&T's Center for Excellence in Post-Harvest Technologies on the North Carolina Research Campus in Kannapolis. He and one of his doctoral students, Akbar Bahrami, are joining researchers in the U.S. and abroad to consider the impact that antimicrobial compounds could have on protecting consumers from listeria.

The work was funded in part by a grant from the U.S. Department of Agriculture's National Institute for Food and Agriculture.

The research, now in its early stages, eventually will explore how to achieve this through encapsulated technologies, which in this situation means embedding antimicrobials directly into the food or the packaging. The process makes use of nanoscience, the use of ultra-small particles to enhance properties.

Food companies have been using microencapsulation or nanoencapsulation for years to add flavor, aroma or even nutritional value to foods. And food scientists have tried various methods over the years to control the growth of listeria in food — including sterilization, which can change the way the food looks or tastes; and heat, which can't be used on fresh fruits and vegetables.

Using encapsulated technologies to combat listeria is something new. It also has the potential to save lives.

"This is a very, very long-term project, and there are so many avenues that we're going to explore," said Williams, a Greensboro native and graduate of Ben L. Smith High School. "Before we actually go deep into the nanoscience, we have to know how the actual strains (of listeria) respond to those antimicrobials."

Testing for pathogens

So first things first: Williams' team had to go grocery shopping.

By his count, his students and research

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Williams' various lab elements include a variety of prepared solutions, left; bacterial cultures, middle; and shelves of agar plates containing isolated bacteria. Aggressive food-borne bacteria can hospitalize — or kill — those who ingest it. Williams's lab is testing antimicrobials' effectiveness against them.

assistants brought into the lab more than 6,000 food samples — eggs, cheeses, milk, dried foods, leafy vegetables, ready-to-eat products and more — from grocery stores, farmers markets and roadside stands. "We're trying right now to get a profile of all the foods that are considered to be high risk for listeria and look at the prevalence and incidence of listeria in these products," he said.

Then they tested the samples for listeria monocytogenes, the most deadly form of listeria, but also looked for four other dangerous strains through a process called genotyping. The positivity rate was .9%, which is roughly the national average. But listeria is a zero-tolerance pathogen, which means none of the samples should contain the bacteria.

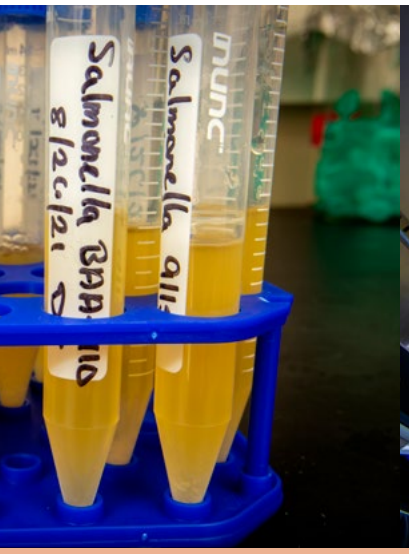
With those positive samples in hand — the gloved hands of heavily protected scientists, mind you — the team sets out to find how resistant the five different strains of listeria are to antimicrobials. "Research has shown that one strain of listeria does not respond the same way to treatments that another strain of listeria does," Williams said.

He and the other researchers conduct highly complex rounds of antibiotic testing on the listeria samples. Among the things they're considering: Are naturally occurring antimicrobials more effective than synthetic ones? What's the minimum concentration necessary to kill 50% of the listeria? To kill 90%? What other foods might interfere with the antimicrobial's impact? How long are time-released antimicrobials effective? How do these antimicrobials hold up under environmental stressors, such as thermal processing?

A bright future

The work already has led to nine different academic papers. For example, some early findings, published in Critical Reviews in Food Science and Nutrition, show that encapsulation strategies may be more effective against listeria than naturally occurring antimicrobials, which are scarcer, more expensive and less stable.

And the team isn't done; Williams emphasizes that this is slow, incremental work. But eventually, he said the research could lead to a patent for a new kind of encapsulated technology that adds listeria-fighting microbes into food or onto packaging by coating it with

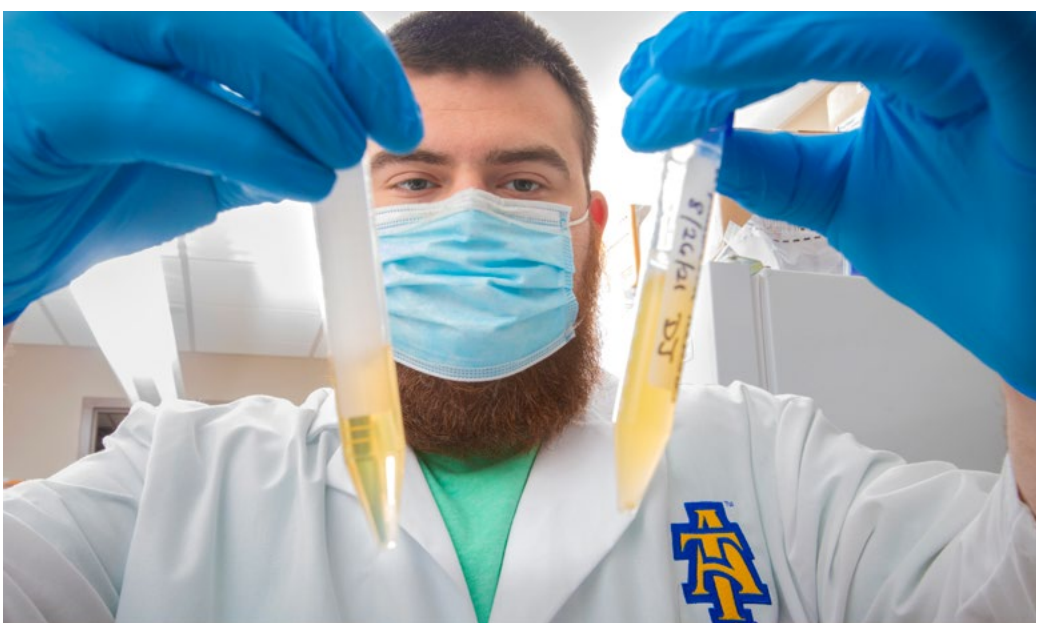


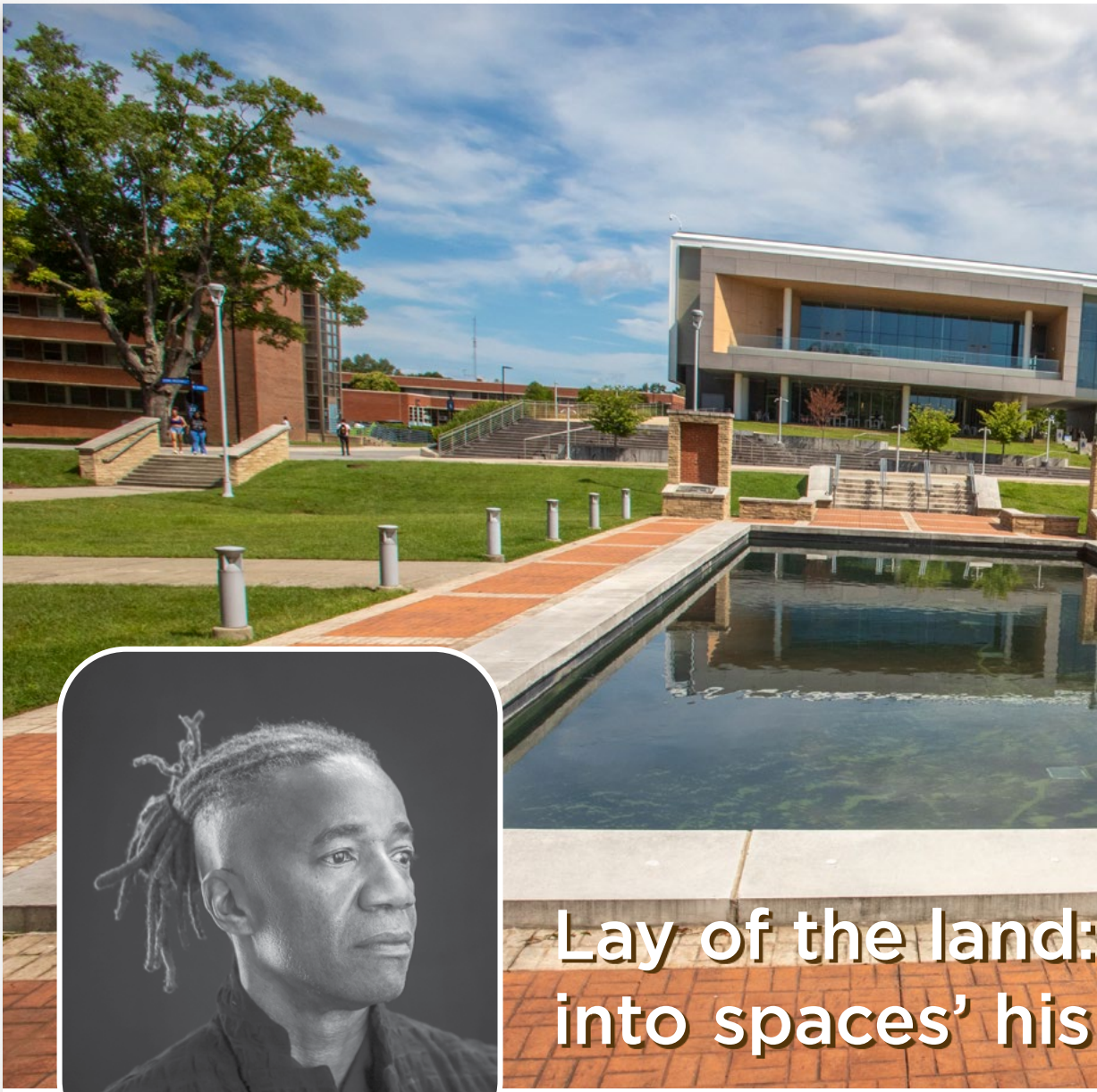
antimicrobial nanoparticles.

Across the world, other scientists are doing similar work on other types of foodborne pathogens, he said. The technology has great potential, according to Williams, particularly in a culture that values easily accessible packaged foods.

"There are researchers out there who are focusing a great deal of their attention and time on trying to develop rapid methods to detect and control pathogens in ready-to-eat food products," he said. "It takes time to develop these technologies. We still have a lot of work to do, but the future is extremely bright when it comes to developing new value-added products that are safe for consumption and can be readily consumed with very minimum heating."

Dustin Smith, Williams' lab assistant, runs through his daily observations as he collects research information.





Lay of the land: into spaces' his

MENTION "LANDSCAPE ARCHITECTURE" IN CONVERSATION, and the thoughts of many will turn to bright green lawns edged by manicured, blooming bushes and trees. But landscape architecture is more than "landscaping," the maintenance of a space. It's about its design and function, a mix of natural and built features that achieve a certain purpose.

For landscape designer, writer, artist, professor and community planner Walter Hood '81, that purpose lies in using research, and an understanding of an area, to connect its modern needs with its history and culture. He likens this philosophy to a 'palimpsest,' a term which literally refers to a manuscript that has been erased and written over, but with the original writing still visible. In Hood's practice, it means unearthing a place's past like an archaeologist, turning up events, names and physical remains of bygone eras to inform his designs.

"Architecture contains the detritus of civilization," Hood says. "A lot of places inhabited by people of color have literally been

A reflecting pool and four sections of brick wall from Scott Hall, where a historic clash between A&T students and the National Guard took place in 1969. The pool is a memorial to the event.

LEFT INSET: CAES graduate Walter Hood

Walter Hood '81 digs deep tory to revitalize their present

wiped away. We can resurrect those places and those contributions, pair them with a contemporary need, and as designers, we can begin to weave them together so that people today can see how we all contribute to the world."

Hood has spent a lifetime integrating people with public spaces, particularly urban ones, and particularly for populations in need of a voice. In doing so, he may have become one of N.C. A&T's most esteemed alumni.

In 2019, he became one of 26 honorees awarded a fellowship by the MacArthur Foundation, nicknamed the "Genius Grant," for "creating ecologically sustainable urban spaces that resonate with and enrich the lives of current residents while also honoring communal histories," according to the award's committee.

The same year, he was honored as a Knight Public Spaces Fellow by the John S. and James L. Knight Foundation, and also received the Dorothy and Lillian Gish Prize, named for the American actress-directors, for "making beauty in the world."

This year, he has been named a member of the American Academy of Arts and Letters, a

Continues on next page

Walter Hood – a landscape designer, writer, artist, professor and community planner — credits A&T with giving him the tools to realize his dreams. "A&T gave me courage I didn't know I needed," he said.

Senior Loeb Scholar at Harvard University and a United States Artists Fellow.

"Enough awards!" Hood says, laughing. "I need to get back to work."

Hood, who founded Hood Design Studio, Inc. in Oakland, CA in 1992, earned his undergraduate degree and got his start in the inaugural class of N.C. A&T's landscape architecture program. But according to Hood, the university gave him a great deal more than his first degree and a set of skills.

"A&T was highly touted as a place where a person of color could go and feel at home, and it gave me courage that I didn't know I was getting," he said. "A neighbor of mine growing up had played football at A&T, and that was a big reason for my going there – he was larger than life, and I was almost following in his footsteps. When you're young, it's very persuasive to see someone who came from your same context doing these things, and you want to do the same.

"It was amazing to be around so many kinds of people, a whole kaleidoscope of Blackness. At the time I didn't know it, but it was shaping my worldview."

In his freshman year in 1977, the landscape architecture program didn't exist. Hood was drawn to art, but as a first-generation college student, "art was not a realistic major," he said. So, he became an architectural engineering major.

"During that time, Dr. Charles Fountain was putting the landscape architecture program together and gave a series of talks about the curriculum, and I was drawn right away to the artistry of it. Architectural engineering was more about math and drafting, but landscape architecture had this other creativity that was much more intriguing to me."

Fountain became Hood's mentor, helping him with classes and giving him a summer job working on a landscape preserve that he was creating with an architect from Korea.

"He saw something in me that I didn't know I had," Hood said. "That summer, I planted a one-mile-long hedge of abelia grandiflora all by myself, and I took an art history course. Those two events changed me because one taught me rigor while the other showed me that I needed more liberal arts in my life, which informs my practice now. So that was the beginning.

"The year before my senior year, Dr. Fountain persuaded me to take a semester off and take a co-op job with the National Parks Service in Asheville. That also changed me, because even though I was probably the only person of color in the building in 1980, being able to hone my skills gave me a proficiency that I probably wouldn't have reached otherwise. Knowing that I had the skills gave me courage."

Hood's time on campus was marked by both fun and rigor.

"Campus social life was amazing. The music, sports and culture circulating at an HBCU were really heady. My freshman year, I

almost lost my scholarship, but people stepped in and saved it.

"By my junior year, I was working almost full time and the program itself was very rigorous," he said. "There were about 12 of us, and since we were the first class, we were the experimental guinea pigs for sure. We had a good time – we were a rowdy bunch. But we were also very aware that a standard was being set, so we worked all the time."

After graduation, however, Hood realized that his vision for landscape architecture required more.

"A&T gave me great skills, but as I worked my way up to the Northern cities, I saw I couldn't get by on skills alone. I needed a liberal arts education. I had a friend who had gone to the University of California at Berkeley, and that's where I decided to go to graduate school."

Hood received masters degrees in both architecture and landscape architecture from the University of California, Berkeley in 1989, where he has also been a faculty member for the past 28 years. In 2013, he received a master of fine arts degree with distinction from the School of the Art Institute of Chicago, focusing on sculpture and urbanism.

"When I started going up North, I started to see the environments that people like myself were living in, and the kinds of responses that we were given when we tried to make changes. Even when I came to grad school, I saw that no one was really thinking about the hard issues.

"For a while, I was perplexed by how I wanted to practice. During the '90s, when I started teaching, I used my research to ask questions about design and to document the world around me through writing. I turned them into fictitious landscapes that allowed me to break out of the normative thought processes. That writing became my first book, Urban Diaries.

"In that book, I was talking about issues like prostitution and homelessness. Now, 20 years later, it's as though people have woken up and become interested in these topics, too."

Hood's projects range in scale, from a landscape and memorial for the International African American Museum in Charleston, S.C. to the redesign of an under-used turn lane and strategic use of topography to create Splash Pad Park in Oakland, CA. Recently, he submitted designs for a park in Winston-Salem dedicated to Peter Oliver, a freedman who worked as the potter in Old Salem and lived with his family on land across Liberty Street from the historic village. Long used for industrial buildings, the land has recently been rezoned as park space. Evidence of the Oliver family's presence was found in the village's records dating to the 1700s; actual archeological evidence at the site has mostly been erased by years of development.

"A lot of our past has been literally scraped clean. One thing I can do is unearth these identities, these spaces, so that people can see how we all contribute together," said Hood, who addressed the issue of resurrecting "lost" people and their contributions in his 2020 book Black Landscapes Matter.

A piece of history that Hood misses on A&T's campus is historic, huge Scott Residence Hall. Once A&T's largest dorm, it was the scene of a clash between A&T students and the National Guard in May, 1969 that resulted in the death of one student. Other students were saved by a wall of Scott Hall which was scarred by 50 bullets when the National Guard fired at the dorm. A memorial stands on campus.

"Campus today has lots of new, shiny stuff – those buildings could be anywhere," said Hood, who has returned to campus and worked with the landscape architecture program several times through the years. "The connection of people to place is what's lost. If we lose the place, we lose the memory, and we don't even know it but we're erasing ourselves."

Building that sense of place and identity comes first, Hood said; from there, the work of reconciliation.

"The biggest thing is to build a foundation of reconciliation. Each generation will still be living a fiction if we don't reconcile the past," he said. "Landscape architecture can help with that. I may not live to see it, but it can."

PUBLICATIONS

A selection of recently published journal articles and book chapters from the faculty of the College of Agriculture and Environmental Sciences.

Department of Agribusiness, Applied Economics & Agriscience Education

Alston, A. J., Roberts, R., & English, C. W. (2019). Building a sustainable agricultural career pipeline: Effective recruitment and retention practices used by colleges of agriculture in the United States. Journal of Research in Technical Careers, 3(2), 1-23.

Alston, A. J., Roberts, R., & English, C. W. (2020). Toward a holistic agricultural student recruitment model: A national analysis of the factors affecting students' decision to pursue an agricultural related degree. Journal of Research in Technical Careers, 4(1), 1.

Ammons, S., Blacklin, S., Bloom, D., Brown, S., Cappellazzi, M., Creamer, N., Cruz, A., Hynson, J., Knight, G., Lauffer, L., Liang, K., Menius, L., Piner, A., Smallwood, A., Stout, R., Stover, C., Thraves, T., & Ukah, B. (2021). A collaborative approach to COVID-19 response: The Center for Environmental Farming Systems community-based food system initiatives. Journal of Agriculture, Food Systems, and Community Development, 10(2), 297–302.

Ashqer, Y. S., Liang, C. L., & Bikdash, M. (2020). Creating a multivariate-multifunctional database for weed control to support organic mix vegetable production. World Journal of Agriculture and Soil Science 4(5), ISSN: 2641-6379.

Baber, C. R., Faulkner, P. E., & Lyles, D. (2019). Relationships between cognitive engagement and self-efficacy for high school students who participate in service-learning. Journal of Research Initiatives, 5(1), 1.

Brown, S., & Liang, K. (2020). Telefarming. Journal of Agriculture, Food Systems, and Community Development, 9(3), 1-4.

Dhamankar, S. S., Hashemi-Beni, L., Kurkalova, L. A., Liang, C. L., Mulrooney, T., Jha, M., & Miao, H. (2020). Study of active farmland use to support agent-based modeling of food deserts. The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, 44, 9-13.

English, C. W., Simpson, C., & Alston, A. J. (2019). The perceived impact of life experiences and selected growth areas upon the employability preparation of land-grant college graduates. Journal of Southern Agricultural Education Research, 69(1), 125-137.

Faulkner, P. E., Begum, S., & English, C. W. (2019). How Bangladesh is increasing the employability of females with technical training programs. In Bala, S. & Singhai, P. (Eds.), Gender Issues in Technical and Vocational Education Programs, (pp. 158-182). IGI Global.

Kaya, A., Faulkner, P. E., Baber, C. R., & Rotich, J. P. (2021, March). Insights from immigrant and refugee youth on resilience through sport participation during adaptation to a new country. Journal of Immigrant & Refugee Studies, 1-34. DOI: 10.1080/15562948.2021.1890303

Liang, C. & Brown, A. (2019). Local food policy councils - Adopting social network theories to support food systems. Agricultural Research and Technology, 22(3): 556199. DOI: 10.19080/ARTOAJ.2019.22.556199.

Liang, C. L. K. (2020). A proposed logic model to examine innovation and entrepreneurship to support/enhance long-term resilience and social/economic mobility in rural communities. Agricultural Research & Technology: Open Access Journal, 23(5), 63-67.

Liang, C. L., Kurkalova, L., Beni, L. H., Mulrooney, T., Jha, M., Miao, H., & Monty, G. (2021). Introducing an innovative design to examine human-environment dynamics of food deserts responding to COVID-19. Journal of Agriculture, Food Systems, and Community Development, 10(2), 1-11.

Minus, K., Woods, J., Roberts, R., English, C., & Rodriguez, B. (2021). Empowering the caregiver network of farmers with a disability: A case study of the North Carolina AgrAbility project. Advancements in Agricultural Development, 2(1), 95-106.

Mulrooney, T., Foster, R., Jha, M., Beni, L. H., Kurkalova, L., Liang, C. L., ... & Monty, G. (2021). Using geospatial networking tools to optimize source locations as applied to the study of food availability: A study in Guilford County, North Carolina. Applied Geography, 128, 102415.

Quaicoe, O., Asiseh, F., & Isikhuemhen, O. S. (2020). The business of hemp in North Carolina: Where the rubber meets the road. Journal of Agricultural Hemp Research, 1(2), 1-24.

Roberts, R., English, C. W., & Alston, A. J. (2020). Fostering identity development in teacher preparation: Service-learning's role in empowering agricultural education majors to teach STEM concepts. Journal of Agricultural Education, 61(3), 214-232.

Stiopca, O., Cobb, R., & Faulkner, P. E. (2020). Challenges of online teaching during the pandemic COVID-19: Reports from Moldovan vocational education and training teachers. European Scientific Journal, 16(34), 195. https://doi.org/10.19044/esj.2020.v16n34p195

Sullivan, M., Ricketts, J. C., Faulkner, P. E., & Hall, J. (2019). 1890 land-grant institutions and school-based agricultural education preparation: past, present, and future insights from institutional opinion leaders. NACTA Journal, 63(2).

Sugri, I., Abubakari, M., Bidzakin, J. K., & Yeboah, O. A. (2019). Integrated post-harvest practices to reduce losses in maize storage for smallholders. Advances and Trends in Agricultural Sciences, 2, 54-62.

Thomas,T., Olofinsao, A., & Taylor, K. (2020). Determining the role of food-related values and food-related lifestyle in influencing food-related behavior of Guilford County residents. Journal of Biomedical Science and Research, 8(6),480-485.

Thomas, T., & Dorbu, F. (2020). Influence of food attributes on purchasing behavior of food desert residents in eastern Greensboro, NC: Multidimensional scaling approach. Journal of Biomedical Science and Research, 11(1).

Werner, S., Lemos, S. R., McLeod, A., Halstead, J. M., Gabe, T., Huang, J. C., Liang, C. L., ... & McConnon, J. (2019). Prospects for New England agriculture: farm to fork. Agricultural and Resource Economics Review, 48(3), 473-504.

Yeboah, O., & Shaik, S. (2021). The influence of climate change on the demand for ethanol. Renewable Energy, 1(64) 1559-1565.

Yu, J., Mikiashvili, N., & Liang, C. L. (2019). Deoxynivalenol and ochratoxin A in North Carolina grown organic wheat grains. Journal of Food Safety, 39(6), e12687.

Department of Animal Sciences

Adjei-Fremah, S., Worku, M., De Erive, M. O., He, F., Wang, T., & Chen, G. (2019). Effect of microfluidization on microstructure, protein profile and physicochemical properties of whole cowpea flours. Innovative Food Science & Emerging Technologies, 57, 102207.

Adjei-Fremah, S., & Worku, M. (2019). Cowpea polyphenol extract regulates galectin gene expression in bovine blood. Animal Biotechnology, 1-12.

Anele, U. Y., Anike, F. N., Davis-Mitchell, A., & Isikhuemhen, O. S. (2021). Solid-state fermentation with Pleurotus ostreatus improves the nutritive value of corn stover-kudzu biomass. Folia Microbiologica, 66(1), 41-48.

Asghari, M., Abdi-Benemar, H., Maheri-Sis, N., Salamatdoust-Nobar, R., Salem, A. Z., Zamanloo, M., & Anele, U. Y. (2021). Effects of emulsified essential oils blend on performance, blood metabolites, oxidative status and intestinal microflora of suckling calves. Animal Feed Science and Technology, 277, 114954.

Asiamah, E. K., Vailati-Riboni, M., Zhou, Z., Xu, T., Loor, J. J., Schimmel, K., & Worku, M. (2019). Rumen-protected methionine supplementation during the peripartal period alters the expression of galectin genes associated with inflammation in peripheral neutrophils and secretion in plasma of Holstein cows. The Journal of Dairy Research, 86(4), 394-398.

Asiamah, E. K., Ekwemalor, K., Adjei-Fremah, S., Osei, B., Newman, R., & Worku, M. (2019). Natural and synthetic pathogen associated molecular patterns modulate galectin expression in cow blood. Journal of Animal Science and Technology, 61(5), 245.

Ayivi, R. D., Gyawali, R., Krastanov, A., Aljaloud, S. O., Worku, M., Tahergorabi, R., ... & Ibrahim, S. A. (2020). Lactic acid bacteria: Food safety and human health applications. Dairy, 1(3), 202-232.

Donovan, B., Suarez-Trujillo, A., Casey, T., Aryal, U. K., Conklin, D., Williams, L. L., & Minor, R. C. (2021). Inclusion of oat and yeast culture in sow gestational and lactational diets alters immune and antimicrobial associated proteins in milk. Animals, 11(2), 497.

Ebeid, H. M., Kholif, A. E., Chrenkova, M., & Anele, U. Y. (2019). Ruminal fermentation kinetics of Moringa oleifera leaf and seed as protein feeds in dairy cow diets: In sacco degradability and protein and fiber fractions assessed by the CNCPS method. Agroforestry Systems, 94(3), 905-915.

Elaref, M. Y., Hamdon, H. A. M., Nayel, U. A., Salem, A. Z. M., & Anele, U. Y. (2020). Influence of dietary supplementation of yeast on milk composition and lactation curve behavior of Sohagi ewes, and the growth performance of their newborn lambs. Small Ruminant Research, 191, 106176.

El-Essawy, A. M., Anele, U. Y., Abdel-Wahed, A. M., Abdou, A. R., & Khattab, I. M. (2021). Effects of anise, clove and thyme essential oils supplementation on rumen fermentation, blood metabolites, milk yield and milk composition in lactating goats. Animal Feed Science and Technology, 271, 114760.

Elghandour, M. M., Khusro, A., Adegbeye, M. J., Tan, Z., Abu Hafsa, S. H., Greiner, R., ... & Salem, A. Z. M. (2020). Dynamic role of single-celled fungi in ruminal microbial ecology and activities. Journal of Applied Microbiology, 128(4), 950-965.

Fasina, Y. O., Obanla, T. O., Ferket, P. R., & Shah, D. H. (2021). Comparative efficacy of spray-dried plasma and bacitracin methylene disalicylate in reducing cecal colonization by Salmonella Enteritidis in broiler chickens. Poultry Science, 101134.

Hassan, A., Hafsa, S. A., Elghandour, M. M. Y., Reddy, P. R. K., Salem, M. Z. M., Anele, U. Y., ... & Salem, A. Z. M. (2020). Influence of Corymbia citriodora leaf extract on growth performance, ruminal fermentation, nutrient digestibility, plasma antioxidant activity and faecal bacteria in young calves. Animal Feed Science and Technology, 261, 114394.

Khattab, I. M., Abdel-Wahed, A. M., Khattab, A. S., Anele, U. Y., El-Keredy, A., & Zaher, M. (2020). Effect of dietary probiotics supplementation on intake and production performance of ewes fed Atriplex hay-based diet. Livestock Science, 237, 104065.

Koltes, J. E., Cole, J. B., Clemmens, R., Dilger, R. N., Kramer, L. M., Lunney, J. K., ... Worku, M., Zhang, H., & Reecy, J. M. (2019). A vision for development and utilization of high-throughput phenotyping and big data analytics in livestock. Frontiers in Genetics, 10, 1197.

Mensah-Bonsu, M., Dingha, B. N., Jackai, L. E., Adjei-Fremah, S., & Worku, M. (2020). Evaluation of preference of brown marmorated stink bug, Halyomorpha halys (Stal) for different colour bell peppers and the role of plant protein. Arthropod-Plant Interactions, 14(3), 363-372.

Rodríguez-Gaxiola, M. A., Domínguez-Vara, I. A., Barajas-Cruz, R., Contreras-Andrade, I., Morales-Almaráz, E., Bórquez-Gastelum, J. L., ... & Anele, U. Y. (2020). Effect of enriched-chromium yeast on growth performance, carcass characteristics and fatty acid profile in finishing Rambouillet lambs. Small Ruminant Research, 188, 106118.

Serrano, H. D. A., Mariezcurrena-Berasain, M. A., Castillo, A. D. C. G., Carranza, B. V., Pliego, A. B., Rojas, M. T., ... & Rivas-Caceres, R. R. (2020). Antimicrobial resistance of three common molecularly identified pathogenic bacteria to Allium aqueous extracts. Microbial Pathogenesis, 142, 104028.

Vorsah, R. V., Dingha, B. N., Gyawaly, S., Fremah, S. A., Sharma, H., Bhowmik, A., Worku, M., & Jackai, L. E. (2020). Organic mulch increases insect herbivory by the flea beetle species, Disonycha glabrata, on amaranthus spp. Insects, 11(3), 162.

Worku, M., Asiamah, E. K., Vailati-Riboni, M., Loor, J. J., & Kang, H. W. (2020). Supplemental methionine, choline, or taurine affect galectin gene expression in adult Holstein cow and neonatal Holstein calf neutrophils in vitro. Journal of Microbiology, Biotechnology and Food Sciences, 10(1), 87-92.

Cooperative Extension

Fernandez, G., Pattison, J., Perkins-Veazie, P., Ballington, J. R., Clevinger, E., Schiavone, R., ... & Chacón, J. G. (2020). 'Liz'and 'Rocco'strawberries. Horticultural Science, 55(4), 597-600. https://doi.org/10.21273/HORTSCI14516-19

Gu, S. & Rana, T.S. (2021). Growth, yield and fruit quality of organic day-neutral strawberry in field and low tunnel settings in the southeastern United States. Acta Horticulturae, 1309, 447-456. https://doi.org/10.17660/ActaHortic.2021.1309.64

Gu, S. & Ballard, A. (2021). Low tunnels increased early-season yield of organic June-bearing strawberries in southeastern United States. Acta Horticulturae 1309, 457-462. https://doi.org/10.17660/ActaHortic.2021.1309.65

Rana, T. S., Gu, S., & Yu, J. (2020). Effect of low tunnels and planting dates on the fruit quality of organic day-neutral strawberries in high tunnels in North Carolina. International Journal of Fruit Science, 20(2), S1036-S1053. https://doi.org/10.1080/15538362.2020.1774475

Rana, T. S., & Gu, S. (2020). Growth and yield of organic day-neutral strawberries in low tunnels inside high tunnel in North Carolina. Horticultural Science 55(3), 336–343. https://doi.org/10.21273/HORTSCI14491-19

Robinson, J. C., Yang, G., Gu, S., & Lu, Z. C. (2019). Plant growth response of black cohosh to shade levels in a high tunnel. Horticultural Science, 54(12), 2178-2181. https://doi.org/10.21273/HORTSCI14472-19

Robinson, J., Yang, G., Gu, S., Lu, Z. C., & Holmes, B. (2020). Nutrient uptake analysis of black cohosh (Actaea racemosa L.) grown under shade in greenhouse. Australian Journal of Crop Science, 14(10), 1630-1636. doi: 10.21475/ajcs.20.14.10.p2436

Department of Family & Consumer Sciences

Abu Hafsa, S. H., Ibrahim, S. A., Eid, Y. Z., & Hassan, A. A. (2020). Effect of dietary Moringa oleifera leaves on the performance, ileal microbiota and antioxidative status of broiler chickens. Journal of Animal Physiology and Animal Nutrition, 104(2), 529-538. doi: 10.1111/jpn.13281

Adegoke, S. C., Tahergorabi, R., Bhattacharjee, C., Nath, A., Cassano, A., & Chakraborty, S. (2021). Conventional macro-and micromolecules separation. In: Food Waste Recovery, 89-107. Academic Press.

Crucifer Production – hampered by the harlequin bug

Crucifer production is hampered by many pests, including the harlequin bugs seen on the collard leaf in this photograph. The damage this insect causes reduces leaf quality and makes the greens unmarketable. CAES researchers seek to prevent such damage and make crucifer production (e.g. collard or kale) more profitable to growers and safer for consumption. Their goal is to do so without recourse to highly toxic pesticides, for example using resistant varieties or trap crop technology.

Alexander, R., Estabrooks, P., Brock, D. J. P., Hill, J. L., Whitt-Glover, M. C., & Zoellner, J. (2021). Capacity development and evaluation of a parent advisory team engaged in childhood obesity research. Health Promotion Practice, 22(1), 102-111.

Al-Sahlany, S. T. G., Altemimi, A. B., Abd Al-Manhel, A. J., Niamah, A. K., Lakhssassi, N., & Ibrahim, S. A. (2020). Purification of bioactive peptide with antimicrobial properties produced by Saccharomyces cerevisiae. Foods, 9(3).

Altemimi, A. B., Mohammed, M. J., Yi-Chen, L., Watson, D. G., Lakhssassi, N., Cacciola, F., & Ibrahim, S. A. (2020). Optimization of ultrasonicated kaempferol extraction from ocimum basilicum using a Box–Behnken design and its densitometric validation. Foods, 9(10), 1379.

Ananey-Obiri, D., Matthews, L., & Tahergorabi, R. (2020). Chicken processing by-product: A source of protein for fat uptake reduction in deep-fried chicken. Food Hydrocolloids, 101, 105500.

Ayad, A. A., El-Rab, D. A. G., Ibrahim, S. A., & Williams, L. L. (2020). Nitrogen sources effect on Lactobacillus reuteri growth and performance cultivated in date palm (Phoenix dactylifera L.) by-products. Fermentation, 6(3), 64.

Ayad, A. A., Williams, L. L., Gad El-Rab, D. A., Ayivi, R., Colleran, H. L., Aljaloud, S., & Ibrahim, S. A. (2020). A review of the chemical

composition, nutritional and health benefits of dates for their potential use in energy nutrition bars for athletes. Cogent Food & Agriculture, 6(1), 1809309.

Ayivi, R. D., Gyawali, R., Krastanov, A., Aljaloud, S. O., Worku, M., Tahergorabi, R., da Silva, R. C. & Ibrahim, S. A. (2020). Lactic acid bacteria: Food safety and human health applications. Dairy, 1(3), 202-232.

Bonku, R., & Yu, J. (2020). Health aspects of peanuts as an outcome of its chemical composition. Food Science and Human Wellness, 9(1), 21-30.

Bonku, R., Mikiashvili, N., & Yu, J. (2020). Impacts of Pptease treatment on the contents of tocopherols and B vitamins in peanuts. Journal of Food Research, 9(6).

Boyaci-Gündüz, C. P., Ibrahim, S. A., Wei, O. C., & Galanakis, C. M. (2021). Transformation of the food sector: Security and resilience during the COVID-19 pandemic. Foods, 10(3), 497.

Brock, D. J. P., Estabrooks, P. A., Maurer, H. M., Hill, J. L., Barlow, M. L., Alexander, R. C., & Zoellner, J. M. (2019). Building and sustaining community capacity to address childhood obesity: A three-year med-methods case study of a community-academic advisory board. Family & Community Health, 42(1), 62.

Colleran, H. L., Hiatt, A., Wideman, L., & Lovelady, C. A. (2019). The effect of an exercise intervention during early lactation on bone mineral density during the first year postpartum. Journal of Physical Activity and Health, 16(3), 197-204.

da Silva, R. C., Colleran, H. L., & Ibrahim, S. A. (2021). Milk fat globule membrane in infant nutrition: A dairy industry perspective. Journal of Dairy Research, 1-12.

Dixon, D. L. (2019). Teaching apparel construction using a flipped classroom approach. Journal of Family and Consumer Sciences, 111(2), 58-60.

Dong, X. B., Huang, W., Bian, Y. B., Feng, X., Ibrahim, S. A., Shi, D. F., ... & Liu, Y. (2019). Remediation and mechanisms of cadmium biosorption by a cadmium-binding protein from Lentinula edodes. Journal of Agricultural and Food Chemistry, 67(41), 11373-11379.

Fidan, H., Stankov, S., Petkova, N., Petkova, Z., Iliev, A., Stoyanova, M., ... & Ercisli, S. (2020). Evaluation of chemical composition, antioxidant potential and functional properties of carob (Ceratonia siliqua L.) seeds. Journal of Food Science and Technology, 57(7), 2404-2413.

Galanakis, C. M., Aldawoud, T., Rizou, M., Rowan, N. J., & Ibrahim, S. A. (2020). Food ingredients and active compounds against the Coronavirus disease (COVID-19) pandemic: A comprehensive review. Foods, 9(11), 1701.

Georgiev, M. G., Goranov, B., Ilyazova, A., Ibrahim, S., & Krastanov, A. (2021). Solid-phase micro extraction coupled with GC–MS for determination of the metabolite profile of newly isolated strains of Lactobacillus delbrueckii ssp. bulgaricus. Food Science and Applied Biotechnology, 4(1), 38-47.

Gyawali, R., Zimmerman, T., Aljaloud, S. O., & Ibrahim, S. A. (2020). Bactericidal activity of copper-ascorbic acid mixture against Staphylococcus aureus spp. Food Control, 111, 107062.

Gyawali, R., Oyeniran, A., Zimmerman, T., Aljaloud, S. O., Krastanov, A., & Ibrahim, S. A. (2020). A comparative study of extraction techniques for maximum recovery of ß-galactosidase from the yogurt bacterium Lactobacillus delbrueckii ssp. bulgaricus. Journal of Dairy Research, 87(1), 123-126.

Hayek, S. A., Gyawali, R., Aljaloud, S. O., Krastanov, A., & Ibrahim, S. A. (2019). Cultivation media for lactic acid bacteria used in dairy products. Journal of Dairy Research, 86(4), 490-502.

Ibrahim, S. A., Ayad, A. A., Williams, L. L., Ayivi, R. D., Gyawali, R., Krastanov, A., & Aljaloud, S. O. (2021). Date fruit: A review of the chemical and nutritional compounds, functional effects and food application in nutrition bars for athletes. International Journal of Food Science & Technology, 56(4), 1503-1513.

Jaiswal, G., & Ha-Brookshire, J. (2019). Exploring suppliers' perceptions and approaches toward codes of conduct: behind the scenes at Indian apparel export firms. International Journal of Fashion Design, Technology and Education, 12(2), 158-166.

Jaiswal, G., & Ha-Brookshire, J. E. (2020). The effect of buyers' power on suppliers' motivations in managing their compliance mechanisms: A study of Indian apparel export firms. Journal of Fashion Marketing and Management: An International Journal, 24 (2), 153-173.

Kiprotich, S., Mendonca, A., Dickson, J., Shaw, A., Thomas-Popo, E., White, S., ... & Ibrahim, S. A. (2020). Thyme oil enhances the inactivation of Salmonella enterica on raw chicken breast meat during marination in lemon juice with added yucca schidigera extract. Frontiers in Nutrition, 7(2).

Lee, S. G., Brownmiller, C. R., Lee, S. O., & Kang, H. W. (2020). Anti-inflammatory and antioxidant effects of anthocyanins of Trifolium pratense (red clover) in lipopolysaccharide-stimulated RAW-267.4 macrophages. Nutrients, 12(4), 1089.

Lee, S. J., Kim, D., Parrott, K. R., Giddings, V. L., & Robinson, S. R. (2019). Financial and health challenges of low-income elderly homeowners aging in place. Journal of Family & Consumer Sciences, 111(2) 31-42.

Lee, S. J., Kim, D., Kim, S. K., Parrott, K. R., Giddings, V. L., & Robinson, S. R. (2019). Emerging themes on aging in place from low-income older renters. Housing and Society, 46(2), 110-127.

Liu, F., Liu, Y., Feng, X., Ibrahim, S. A., & Huang, W. (2021). Structure characterization and in vitro immunomodulatory activities of carboxymethyl pachymaran. International Journal of Biological Macromolecules, 178, 94-103.

Liu, Y., Hu, C. F., Feng, X., Cheng, L., Ibrahim, S. A., Wang, C. T., & Huang, W. (2020). Isolation, characterization and antioxidant of polysaccharides from Stropharia rugosoannulata. International Journal of Biological Macromolecules, 155, 883-889.

Maman, R., Chen, G. & Yu, J. (2019). Influence of particle size reduction on functionality, polyphenol extractability and In Vitro digestibility of grape pomace. EC Nutrition. 14(5), 425-433.

Maman, R., & Yu, J. (2019). Chemical composition and particle size of grape seed flour and their effects on the characteristics of cookies. Journal of Food Research, 8(4), 111- 12.

Moradi, M., Kousheh, S. A., Razavi, R., Rasouli, Y., Ghorbani, M., Divsalar, E., & Ibrahim, S. A. (2021). Review of microbiological methods for testing protein and carbohydrate-based antimicrobial food packaging. Trends in Food Science & Technology, 111(5), 595-609.

Newcomb Hopfer, E., & Lee, S. J. (2020). Trends in "Journal of Family & Consumer Sciences" submissions: 2009-2018. Journal of Family and Consumer Sciences, 112(2), 17-27.

Otieno, D., Lee, E. J., Lee, S. G., Richard, C., & Kang, H. W. (2020). Optimizing process of brewing onion peel tea using a response surface methodology. NFS Journal, 20, 22-27.

Oyeniran, A., Ibrahim, S. A., Gyawali, R., Tahergorabi, R., Zimmerman, T., & Krastanov, A. (2020). A modified reinforced clostridial medium for the isolation and enumeration of Lactobacillus delbrueckii ssp. bulgaricus in a mixed culture. Journal of Dairy Science, 103(6), 5030-5042.

Parrott, K. R., Lee, S. J., Kim, D., Robinson, S. R., & Giddings, V. L. (2020). The role of informal support systems in residential environments for low-income older renters: an exploratory study. Housing and Society, 1-14.

Pei, Y., Otieno, D., Gu, I., Lee, S. O., Parks, J. S., Schimmel, K., & Kang, H. W. (2021). Effect of quercetin on nonshivering thermogenesis of brown adipose tissue in high-fat diet-induced obese mice. The Journal of Nutritional Biochemistry, 88, 108532.

Rana, T. S., Gu, S., & Yu, J. (2020). Effect of low tunnels and planting dates on the fruit quality of organic day-neutral strawberries in high tunnels in North Carolina. International Journal of Fruit Science, 20(sup2), S1036-S1053.

Sharaf Eddin, A., Adegoke, S., Issa, A. T., Wilson, C., & Tahergorabi, R. (2020). Physicochemical changes of surimi gels with addition of different particle sizes of citrus peel fiber. Journal of Aquatic Food Product Technology, 29(10), 1029-1040.

Sharaf Eddin, A., Adegoke, S. C., Ibrahim, S. A., & Tahergorabi, R. (2021). Fortification of surimi gels with camel milk. Journal of Aquatic Food Product Technology, 1-14.

Tumbarski, Y., Petkova, N., Todorova, M., Ivanov, I., Deseva, I., Mihaylova, D., & Ibrahim, S. A. (2020). Effects of pectin-based edible coatings containing a bacteriocin of bacillus methylotrophicus bm47 on the quality and storage life of fresh blackberries. Italian Journal of Food Science, 32(2).

Yu, J., & Mikiashvili, N. (2020). Effectiveness of different proteases in reducing allergen content and IgE-binding of raw peanuts. Food chemistry, 307, 125565.

Yu, J., Mikiashvili, N., & Liang, C. L. (2019). Deoxynivalenol and Ochratoxin A in North Carolina grown organic wheat grains. Journal of Food Safety, 39(6), e12687.

Yu, J., Smith, I. N., & Mikiashvili, N. (2020). Reducing ochratoxin A content in grape pomace by different methods. Toxins, 12(7), 424.

Zimmerman, T., Goetz, T., & Ibrahim, S. A. (2020). Learning business economics and fermentation by developing a method for producing yogurt breadcrumb. Science Scope, 43(9).

Zimmerman, T., Ibrahim, M., Gyawali, R., & Ibrahim, S. A. (2019). Linking biochemistry concepts to food safety using yogurt as a model. Journal of Food Science Education, 18(1), 4-10.

Zimmerman, T., Gyawali, R., & Ibrahim, S. A. (2020). Introductory chapter: Overview of trends in dairy science and technology. In Ibrahim, S.A., Gyawalli, R. & Zimmerman, T. (Eds.), Current Issues and Challenges in the Dairy Industry, 3. InTechOpen.

Zimmerman, T., Chasten, V., Lacal, J. C., & Ibrahim, S. A. (2020). Identification and validation of novel and more effective choline kinase inhibitors against Streptococcus pneumoniae. Scientific Reports, 10(1), 1-10.

Zimmerman, T., Siddiqui, S. A., Bischoff, W., & Ibrahim, S. A. (2021). Tackling airborne virus threats in the food industry: A proactive approach. International Journal of Environmental Research and Public Health, 18(8), 4335.

Zoellner, J. M., You, W., Hill, J. L., Brock, D. J. P., Yuhas, M., Alexander, R. C., & Estabrooks, P. A. (2019). A comparative effectiveness trial

Abolghasem Shahbazi, Ph.D., professor in the Department of Natural Resources, joins his student Mehrab Valizadehderakhshan at their molecular distillation system where they biorefine CBD.

of two family-based childhood obesity treatment programs in a medically underserved region: Rationale, design & methods. Contemporary Clinical Trials, 84, 105801.

Department of Natural Resources and Environmental Design

Adesina, I., Bhowmik, A., Sharma, H., & Shahbazi, A. (2020). A review on the current state of knowledge of growing conditions, agronomic soil health practices and utilities of hemp in the United States. Agriculture, 10(4), 129.

Ahiablame, L., Sheshukov, A. Y., Mosase, E., & Hong, J. (2019). Modelling the impacts of grassland to cropland conversion on river flow regimes in Skunk Creek watershed, Upper Midwest United States. River Research and Applications, 35(9), 1454-1465.

Akinlabi, G., Erhabor, B., & Isikhuemhen, O. S. (2021). The royal king culinary-medicinal mushroom Pleurotus tuber-regium Sclerotium (Agaricomycetes): A potential source of drug for inter-ocular pressure management. International Journal of Medicinal Mushrooms, 23(6), 25–31.

Anele, U. Y., Anike, F. N., Davis-Mitchell, A., & Isikhuemhen, O. S. (2021). Solid-state fermentation with Pleurotus ostreatus improves the nutritive value of corn stover-kudzu biomass. Folia microbiologica, 66(1), 41-48.

Aryal, N., Deng, D., Jha, M. K., & Ofori-Boadu, A. (2019). Monitoring, sampling, and automated analysis. Water Environment Research, 91(10), 1288-1293.

Aryal, N., Wood, J., Rijal, I., Deng, D., Jha, M. K., & Ofori-Boadu, A. (2020). Fate of environmental pollutants: A review. Water Environment Research, 92(10), 1587-1594.

Baffaut, C., Lohani, S., Thompson, A. L., Davis, A. R., Aryal, N., Bjorneberg, D. L., ... & Yasarer, L. M. W. (2020). Evaluation of the soil vulnerability index for artificially drained cropland across eight conservation effects assessment project watersheds. Journal of Soil and Water Conservation, 75(1), 28-41.

Bandura, I., Isikhuemhen, O. S., Kulik, A., Serdiuk, M., Sucharenko, O., Jukova, V., Koliadenko, V., & Gaprindashvili, N. (2021). Specific subject area: Agriculture science (agronomy and horticulture) Effect of perforation size and substrate bag fruiting position on the morphology of fruiting bodies and clusters in Pleurotus ostreatus (Jacq.) P. Kumm. Journal of Applied Biology & Biotechnology 9(3), 35-40.

Bhowmik, A., Kukal, S. S., Saha, D., Sharma, H., Kalia, A., & Sharma, S. (2019). Potential indicators of soil health degradation in different land use-based ecosystems in the Shiwaliks of Northwestern India. Sustainability, 11(14), 3908.

Bonanno, A., Di Grigoli, A., Vitale, F., Di Miceli, G., Todaro, M., Alabiso, M., ... & Isikhuemhen, O. S. (2019). Effects of diets supplemented with medicinal mushroom myceliated grains on some production, health, and oxidation traits of

dairy ewes. International Journal of Medicinal Mushrooms, 21(1).

Cloutier, M. L., Bhowmik, A., Bell, T. H., & Bruns, M. A. (2019). Innovative technologies can improve understanding of microbial nitrogen dynamics in agricultural soils. Agricultural & Environmental Letters, 4(1), 190032.

Deng, D., Lamssali, M., Aryal, N., Ofori-Boadu, A., Jha, M. K., & Samuel, R. E. (2020). Textiles wastewater treatment technology: A review. Water Environment Research, 92(10), 1805-1810.

Dingha, B. N., Nyaupane, S., & Jackai, L. E. (2020). Laboratory assessment of host plant selection of the brown marmorated stink gug (Halyomorpha halys). American Journal of Entomology, 4(2), 26-34.

Dingha, B. N., Jackai, L. E., Amoah, B. A., & Akotsen-Mensah, C. (2021). Pollinators on cowpea Vigna unguiculata: Implications for intercropping to enhance biodiversity. Insects, 12(1), 54.

Eid, A.M., Fouda, A., Abdel-Rahman, M.A., Salem, S.S., Elsaied, A., Oelmüller, R., Hijri, M., Bhowmik, A., Elkelish, A., & Hassan, S.E.D. (2021). Harnessing bacterial endophytes for promotion of plant growth and biotechnological applications: An overview. Plants, 10(5), 935.

Ewunkem, A. J., Sintim, H. O., Dingha, B. N., Gyawaly, S., & Jackai, L. E. (2020). Nutritional ecology of the southern green stink bug Nezara viridula (Hemiptera: Pentatomidae) on selected varieties of cowpea and tomato. American Journal of Entomology, 4(1), 1-9.

Gargano, M. L., Zervakis, G. I., Isikhuemhen, O. S., Venturella, G., Calvo, R., Giammanco, A., ... & Ferraro, V. (2020). Ecology, phylogeny, and potential nutritional and medicinal value of a rare white "maitake" collected in a Mediterranean forest. Diversity, 12(6), 230.

Gbewonyo, S., Xiu, S., Shahbazi, A., & Zhang, L. (2020). Low thermal conductivity carbon material from electrospinning and subsequent chemical activation. Carbon Letters, 30(3), 289-296.

Gerald, C. L., McClendon, C. J., Ranabhat, R. S., Waterman, J. T., Kloc, L. L., Conklin, D. R., & Williams, L. L. (2019). Sorrel extract reduces oxidant production in airway epithelial cells exposed to swine barn dust extract in vitro. Mediators of Inflammation, 2019, 420468.

Hashemisohi, A., Wang, L., & Shahbazi, A. (2019). Dense discrete phase model coupled with kinetic theory of granular flow to improve predictions of bubbling fluidized bed hydrodynamics. KONA Powder and Particle Journal, 36, 215-223.

Joseph, G., Zhang, B., Mahzabin Rahman, Q., Wang, L., & Shahbazi, A. (2019). Two-stage thermophilic anaerobic co-digestion of corn stover and cattle manure to enhance biomethane production. Journal of Environmental Science and Health, Part A, 54(5), 452-460.

Joseph, G., Zhang, B., Harrison, S. H., Graves Jr., J. L., Thomas, M. D., Panchagavi, R., ... & Wang, L. (2020). Microbial community dynamics during anaerobic co-digestion of corn stover and swine manure at different solid content, carbon to nitrogen ratio and effluent volumetric percentages. Journal of Environmental Science and Health, Part A, 55(9), 1111-1124.

Khajeh, A., Wang, L., & Shahbazi, A. (2020). Conversion of carbon dioxide into liquid hydrocarbons using cobalt-bearing catalysts. In Conversion of Carbon Dioxide into Hydrocarbons Vol. 1 Catalysis (pp. 1-23). Springer, Cham.

Li, X., Wang, L., Zhang, B., Khajeh, A., & Shahbazi, A. (2020). Iron oxide supported on silicalite-1 as a multifunctional material for biomass chemical looping gasification and syngas upgrading. Chemical Engineering Journal, 401, 125943.

Lohani, S., Baffaut, C., Thompson, A. L., Aryal, N., Bingner, R. L., Bjorneberg, D. L., ... & Yasarer, L. M. W. (2020). Performance of the soil vulnerability index with respect to slope, digital elevation model resolution, and hydrologic soil group. Journal of Soil and Water Conservation, 75(1), 12-27.

Mandal, N., Datta, S. C., Dwivedi, B. S., Manjaiah, K. M., Meena, M. C., & Bhowmik, A. (2021). Zincated nanoclay polymer composite (ZNCPC): Effect on DTPA-Zn, Olsen-P and soil enzymatic activities in rice rhizosphere. Communications in Soil Science and Plant Analysis, 1-13.

Mandal, N., Bhowmik, A., Ganguly, P., & Datta, S. C. (2020). Approach to study clay-organic complexes. In Soil Analysis: Recent Trends and Applications (pp. 119-141). Springer, Singapore.

McCumber, A. W., Kim, Y. J., Isikhuemhen, O. S., Tighe, R. M., & Gunsch, C. K. (2021). The environment shapes swine lung bacterial communities. Science of The Total Environment, 758, 143623.

Mensah-Bonsu, M., Dingha, B. N., Jackai, L. E., Adjei-Fremah, S., & Worku, M. (2020). Evaluation of preference of brown marmorated stink bug, Halyomorpha halys (Stal) for different colour bell peppers and the role of plant protein. Arthropod-Plant Interactions, 14(3), 363-372.

Messer, T. L., Moore, T. L., Nelson, N., Ahiablame, L., Bean, E. Z., Boles, C., ... & Schlea, D. (2020). Constructed wetlands for water quality improvement: A synthesis on nutrient reduction from agricultural effluents. Transactions of the ASABE, 64(2), 625-639.

Mosase, E., Ahiablame, L., Park, S., & Bailey, R. (2019). Modelling potential groundwater recharge in the Limpopo River basin with SWAT-

MODFLOW. Groundwater for Sustainable Development, 9, 100260.

Mosase, E., Ahiablame, L., Light, F., & Dwomoh, F. (2019). A case study of rainfall and temperature trends in San Diego region, 1985-2017. Hydrology, 6(4), 87.

Muriungi, B., Wang, L., & Shahbazi, A. (2020). Comparison of bimetallic Fe-Cu and Fe-Ca oxygen carriers for biomass gasification. Energies, 13(8), 2019.

Quaicoe, O., Asiseh, F., & Isikhuemhen, O. S. (2020). The business of hemp in North Carolina: Where the rubber meets the road. Journal of Agricultural Hemp Research, 1(2), 3.

Rahman, Q. M., Zhang, B., Wang, L., Joseph, G., & Shahbazi, A. (2019). A combined fermentation and ethanol-assisted liquefaction process to produce biofuel from Nannochloropsis sp. Fuel, 238, 159-165.

Rahman, Q. M., Zhang, B., Wang, L., & Shahbazi, A. (2019). A combined pretreatment, fermentation and ethanol-assisted liquefaction process for production of biofuel from Chlorella sp. Fuel, 257, 116026.

Reba, M. L., Aryal, N., Teague, T. G., & Massey, J. H. (2020). Initial findings from agricultural water quality monitoring at the edge-of-field in Arkansas. Journal of Soil and Water Conservation, 75(3), 291-303.

Robinson, J. R., Isikhuemhen, O. S., & Anike, F. N. (2021). Fungal-metal interactions: A review of toxicity and homeostasis. Journal of Fungi, 7(3), 225.

Robinson, J. C., Yang, G., Gu, S., & Lu, Z. C. (2019). Plant growth response of black cohosh to shade levels in a high tunnel. Horticultural Science, 54(12), 2178-2181.

Robinson, J., Yang, G., Gu, S., Lu, Z. C., & Holmes, B. (2020). Nutrient uptake analysis of black cohosh (Actaea racemosa L.) grown under shade in greenhouse. Australian Journal of Crop Science, 14(10), 1630-1636.

Sutton, K., Xiu, S., & Shahbazi, A. (2021). Development of fluorine-intercalated biochar material for radiation shielding. Journal of Analytical and Applied Pyrolysis, 155, 105038.

Valizadehderakhshan, M., Shahbazi, A., Kazem-Rostami, M., Todd, M. S., Bhowmik, A., & Wang, L. (2021). Extraction of cannabinoids from Cannabis sativa L. (hemp). Agriculture, 11(5), 384.

Vorsah, R. V., Dingha, B. N., Gyawaly, S., Fremah, S. A., Sharma, H., Bhowmik, A., ... & Jackai, L. E. (2020). Organic mulch increases insect herbivory by the flea beetle species, Disonycha glabrata, on Amaranthus spp. Insects, 11(3), 162.

Zhang, B., Wang, L., & Li, R. (2019). Bioconversion and chemical conversion of biogas for fuel production. In Hosseinini, M. (Ed.) Advanced Bioprocessing for Alternative Fuels, Biobased Chemicals, and Bioproducts, (pp. 187-205). Elsevier.

Zhang, B., Joseph, G., Wang, L., Li, X., & Shahbazi, A. (2020). Thermophilic anaerobic digestion of cattail and hydrothermal carbonization of the digestate for co-production of biomethane and hydrochar. Journal of environmental science and health, part A, 55(3), 230-238.

Center for Excellence in Post-Harvest Technologies

Adjei-Fremah, S., Worku, M., De Erive, M. O., He, F., Wang, T., & Chen, G. (2019). Effect of microfluidization on microstructure, protein profile and physicochemical properties of whole cowpea flours. Innovative Food Science & Emerging Technologies, 57, 102207.

Adongbede, E. Jaiswal, Y., Davis, S., Randolph, P., & Williams, L.L. (2020). Antioxidant and antibacterial activity of the wild polypore-trametes polyzona (Pers.) justo., Journal of Food Science & Biotechnology, 29, 27-33.

Appell, M., Biswas, A., Chang, S., Chen, W., Cheng, H.N., Daily, J., Fan, X., Granvogl, M., Guo, M., Ito, Y., Jin, T., Kobori, M., Leland, J.V., Liu, L., Luo, Y., MacMahon, S., Mahattanatawee, K.; Nam, S., Osorio, C., Park, B., Ren, D., Sang, S., Shahidi, F., Tunick, M.H., Udenigwe, C.C., Wang, Q., Yokoyama, W., Y, L., Zhang, Y., Zhu, Y., & Zhu, Y. (2020). Changing the landscape: An introduction to the agricultural and good chemistry technical program at the 258th American Chemical Society national meeting in San Diego. Journal of Agricultural and Food Chemistry, 68, 12769-12772.

Ayad, A. A., El-Rab, D. A. G., Ibrahim, S. A., & Williams, L. L. (2020). Nitrogen sources effect on Lactobacillus reuteri growth and performance cultivated in date palm (Phoenix dactylifera L.) by-products. Fermentation, 6(3), 64.

Ayad, A. A., Williams, L. L., Gad El-Rab, D. A., Ayivi, R., Colleran, H. L., Aljaloud, S., & Ibrahim, S. A. (2020). A review of the chemical composition, nutritional and health benefits of dates for their potential use in energy nutrition bars for athletes. Cogent Food & Agriculture, 6(1), 1809309.

Baboli, Z. M., Williams, L., & Chen, G. (2020). Design of a batch ultrasonic reactor for rapid pasteurization of juices. Journal of Food Engineering, 268, 109736.

Baboli, Z. M., Williams, L., & Chen, G. (2020). Rapid pasteurization of apple juice using a new ultrasonic reactor. Foods, 9(6), 801.

Bahrami, A., Delshadi, R., Jafari, S. M., & Williams, L. (2019). Nanoencapsulated nisin:

An engineered natural antimicrobial system for the food industry. Trends in Food Science & Technology, 94, 20-31.

Bahrami, A., Baboli, Z. M., Schimmel, K., Jafari, S. M., & Williams, L. (2020). Efficiency of novel processing technologies for the control of Listeria monocytogenes in food products. Trends in Food Science & Technology, 96, 61-78.

Bahrami, A., Delshadi, R., Assadpour, E., Jafari, S. M., & Williams, L. (2020). Antimicrobial-loaded nanocarriers for food packaging applications. Advances in Colloid and Interface Science, 278, 102140.

Bahrami, A., Davis, S., Mousavi Khaneghah, A., & Williams, L. (2020). The efficiency of technologies used for epidemiological characterization of Listeria monocytogenes isolates: An update. Critical Reviews in Food Science and Nutrition, Oct. 23, 1-13.

Bansode, R. R., Randolph, P. D., Plundrich, N. J., Lila, M. A., & Williams, L. L. (2019). Peanut protein-polyphenol aggregate complexation suppresses allergic sensitization to peanut by reducing peanut-specific IgE in C3H/HeJ mice. Food Chemistry, 299, 125025.

Chen, R., Huang, J., Jaiswal, Y., Wei, J., Huo, L., Xia, X., ... & Liang, Y. (2020). Molecular design, synthesis and docking study of alkyl and benzyl derivatives of robustic acid as topoisomerase I inhibitors. Chemistry & Biodiversity, 17(3), e1900556.

Chen, R., Yuan, C., Jaiswal, Y., Huo, L., Li, D., Williams, L., ... & Liang, Y. (2020). Synthesis and biological evaluation of some 1, 8-naphthalimide-acridinyl hybrids. Journal of Chemistry, 2020, 7989852.

Chen, R., Huo, L., Jaiswal, Y., Wei, J., Li, D., Zhong, J., Williams, L.L., Xia, X. & Liang, Y. (2019). Synthesis and evaluation of anti-cancer activity of new 4-acyloxy derivatives of robustic acid. International Journal of Molecular Sciences, 20(21), 5336.

de Erive, M. O., Wang, T., He, F., & Chen, G. (2020). Development of high-fiber wheat bread using microfluidized corn bran. Food Chemistry, 310, 125921.

de Erive, M. O., He, F., Wang, T., & Chen, G. (2020). Development of ß-glucan enriched wheat bread using soluble oat fiber. Journal of Cereal Science, 95, 103051.

Delshadi, R., Bahrami, A., Tafti, A. G., Barba, F. J., & Williams, L. L. (2020). Micro and nano-encapsulation of vegetable and essential oils to develop functional food products with improved nutritional profiles. Trends in Food Science & Technology, 104, 72-84.

Delshadi, R., Bahrami, A., Mcclements, D. J., Moore, M. D., & Williams, L. (2021). Development of nanoparticle-delivery systems for antiviral agents: A review. Journal of Controlled Release, 331, 30-44.

Delshadi, R., Bahrami, A., Assadpour, E., Williams, L., & Jafari, S. M. (2021). Nano/microencapsulated natural antimicrobials to control the spoilage microorganisms and pathogens in different food products. Food Control, 61, 1241-1259.

Desam, G. P., Li, J., Chen, G., Campanella, O., & Narsimhan, G. (2020). Swelling kinetics of rice and potato starch suspensions. Journal of Food Process Engineering, 43(4), e13353.

Donovan, B., Suarez-Trujillo, A., Casey, T., Aryal, U. K., Conklin, D., Williams, L. L., & Minor, R. C. (2021). Inclusion of oat and yeast culture in sow gestational and lactational diets alters immune and antimicrobial associated proteins in milk. Animals, 11(2), 497.

Hemmati, F., Bahrami, A., Esfanjani, A. F., Hosseini, H., McClements, D. J., & Williams, L. (2021). Electrospun antimicrobial materials: Advanced packaging materials for food applications. Trends in Food Science & Technology,111:520-533.

Hu, C., Tang, Y., Zhao, Y., & Sang, S. (2019). Quantitative analysis and anti-inflammatory activity evaluation of the A-type avenanthramides in commercial sprouted oat products. Journal of Agricultural and Food Chemistry, 68(46), 13068-13075.

Hu, C., & Sang, S. (2020). Triterpenoid saponins in oat bran and their levels in commercial oat products. Journal of Agricultural and Food Chemistry, 68(23), 6381-6389.

Huang, Q., Zhu, Y., Lv, L., & Sang, S. (2020). Translating in vitro acrolein-trapping capacities of tea polyphenol and soy genistein to in vivo situation is mediated by the bioavailability and biotransformation of individual polyphenols. Molecular Nutrition & Food Research, 64(1), 1900274.

Ibrahim, S. A., Ayad, A. A., Williams, L. L., Ayivi, R. D., Gyawali, R., Krastanov, A., & Aljaloud, S. O. (2021). Date fruit: A review of the chemical and nutritional compounds, functional effects and food application in nutrition bars for athletes. International Journal of Food Science & Technology, 56(4), 1503-1513.

Idehen, E., Wang, W., & Sang, S. (2020). Health benefits of barley for diabetes. Journal of Food Bioactives, 12, 76-86.

Jaiswal, Y. S., & Williams, L. L. (2020). Spatio-temporal imaging and high-resolution mass spectrometry analysis: New avenues in herbal drug discovery and plant metabolomics. In Herbal Medicine in India (pp. 249-261). Springer, Singapore.

Publications

Jaiswal, Y., Xue, Y., Xiao, T., & Williams, L.L. (2020). Application of Microcomputed Tomography and Image Processing Tools in Study of Plants. In Herbal Medicine in India: Indigenous Knowledge, Practice, Innovation and its Value. Springer Nature Publishing. ISBN: 978-981-13-7248-3.

Jaiswal, Y., Shaikh, M., Wang, I., Yong, Y., Lin Lin Lee, V., & Williams, L. (2020). Evaluation of anti-convulsive properties of aqueous kava extract on zebrafish using the PTZ-induced seizure model. Brain Sciences, 10(8), 541.

Jaiswal, Y. S., Yerke, A. M., Bagley, M. C., Ekelöf, M., Weber, D., Haddad, D., ... & Williams, L. L. (2020). 3D Imaging and metabolomic profiling reveal higher neuroactive kavalactone contents in lateral roots and crown root peels of Piper methysticum (kava). GigaScience, 9(9), giaa096.

Maruvada, P., Lampe, J.W., Wishart, D.S., Barupal, D., Chester, D.N., Dodd, D., Dorrestein, P.C., Dragsted, L.O., Draper, J., Duffy, L.C., Dwyer, J.T., Emenaker, N.J., Fiehn, O., Feunang, Y.D., Gerszten, R.E., Hu, F., Karp, R.W., Klurfeld, D.M., Laughlin, M.R., Lynch, C.J., Little, R. Moore, S.C., Nicastro, H.L., O'Brien, D.M., Ordovas, J.M., Osganian, S.K., Playdon, M., Prentice, R., Raftery, D., Reisdorph, N., Roche, H.M., Ross, S.A., Scalbert, A., Sang, S., Srinivas, P.R., & Zeisel, S. H. (2020). Perspective: dietary biomarkers of intake and exposure – exploration with omics approaches. Advances in Nutrition, 11(2), 200-215.

Student researchers gain experience and the opportunity to work alongside faculty in the college's research labs.

Sang, S., Idehen, E., Zhao, Y., & Chu, Y. (2020). Emerging science on whole grain intake and inflammation. Nutrition Reviews, 78(Supplement 1), 21-28.

Sang, S., Snook, H. D., Tareq, F. S., & Fasina, Y. (2020). Precision research on ginger: The type of ginger matters. Journal of Agricultural and Food Chemistry, 68(32), 8517-8523.

Tang, Y., Hu, C., & Sang, S. (2020). Characterization of reaction products and mechanisms between serotonin and methylglyoxal in model reactions and mice. Journal of Agricultural and Food Chemistry, 68(8), 2437-2444.

Tang, Y., Zhu, Y., & Sang, S. (2020). A novel LC-MS based targeted metabolomic approach to study the biomarkers of food intake. Molecular Nutrition & Food Research, 64(22), 2000615.

Tang, Y., Zhao, Y., Wang, P., & Sang, S. (2021). Simultaneous determination of multiple reactive carbonyl species in high fat diet-induced metabolic disordered mice and the inhibitory effects of rosemary on carbonyl stress. Journal of Agricultural and Food Chemistry, 69(3), 1123-1131.

Wang, W., Snooks, H. D., & Sang, S. (2020). The chemistry and health benefits of dietary phenolamides. Journal of Agricultural and Food Chemistry, 68(23), 6248-6267.

Wang, J., Lu, Y., Zheng, T., Sang, S., & Lv, L. (2019). Scavenging of acrolein by food-grade antioxidant propyl gallate in a model reaction system and cakes. Journal of Agricultural and Food Chemistry, 67(31), 8520-8526.

Wang, P., Zhang, S., Yerke, A., Ohland, C. L., Gharaibeh, R. Z., Fouladi, F., ... & Sang, S. (2021). Avenanthramide metabotype from whole-grain oat intake is influenced by faecalibacterium prausnitzii in healthy adults. The Journal of Nutrition, 151(6), 1426-1435.

Youn, K., Yoon, J. H., Lee, N., Lim, G., Lee, J., Sang, S., ... & Jun, M. (2020). Discovery of sulforaphane as a potent BACE1 inhibitor based on kinetics and computational studies. Nutrients, 12(10), 3026.

Zhang, S., Wang, R., Zhao, Y., Tareq, F. S., & Sang, S. (2020). Metabolic interaction between ammonia and baicalein. Chemical Research in Toxicology, 33(8), 2181-2188.

Zhang, S., Xiao, L., Lv, L., & Sang, S. (2020). Trapping methylglyoxal by myricetin and its metabolites in mice. Journal of Agricultural and Food Chemistry, 68(35), 9408-9414.

Zhang, D., Jiang, X., Xiao, L., Lu, Y., Sang, S., Lv, L., & Dong, W. (2020). Mechanistic studies of inhibition on acrolein by myricetin. Food Chemistry, 323, 126788.

Zhang, H., Wang, T., He, F., & Chen, G. (2021). Fabrication of pea protein-curcumin nanocomplexes via microfluidization for improved solubility, nano-dispersibility and heat stability of curcumin: Insight on interaction mechanisms. International Journal of Biological Macromolecules, 168, 686-694.

Zhang, D., Jiang, X., Xiao, L., Lu, Y., Sang, S., Lv, L., & Dong, W. (2020). Mechanistic studies of inhibition on acrolein by myricetin. Food Chemistry, 323, 126788.

Zhang, H., He, F., Wang, T., & Chen, G. (2021). Thermal, pasting, and rheological properties of potato starch dual-treated with CaCl2 and dry heat. LWT, 111467.

Zhang, S., Wang, R., Zhao, Y., Tareq, F., & Sang, S. (2019) Biotransformation of myricetin: A novel metabolic pathway to produce aminated products in mice. Molecular Nutrition & Food Research, 63, 1900203.

Zhang, S., Ohland, C., Jobin, C., & Sang, S. (2020). Black tea theaflavin detoxifies metabolic toxins in the intestinal tract of mice. Molecular Nutrition & Food Research, 2000887.

Zhao, Y., Zhu, Y., Wang, P., & Sang, S. (2020). Dietary genistein reduces methylglyoxal and advanced glycation end product accumulation in obese mice treated with high-fat diet. Journal of Agricultural and Food Chemistry, 68(28), 7416-7424.

Zhao, Y., Shi, L., Hu, C., & Sang, S. (2019). Wheat bran for colon cancer prevention: the synergy between phytochemical alkylresorcinol C21 and intestinal microbial metabolite butyrate. Journal of Agricultural and Food Chemistry, 67(46), 12761-12769.

Zhu, S., Campanella, O., & Chen, G. (2021). Estimation of parameters in the Weibull model from microbial survival data obtained under constant conditions with come-up times. Journal of Food Engineering, 292, 110364.

Zhu, S., Li, B., & Chen, G. (2021). A modified Weibull model for design of oscillated high hydrostatic pressure processes. LWT, 143, 111118.

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North Carolina A&T State University Chancellor Harold L. Martin Sr., left, greets, Alton Thompson, Ph.D., the executive director for the Association of 1890 Research, at the start of the reception for the CAES Extension and Research Farm Pavilion ribbon cutting ceremony in September 2021. Behind them, CAES Dean Mohamed Ahmedna, Ph.D., and Richard Bonanno, Ph.D., director of N.C. State Extension, also greet each other.