

South Carolina (Clemson University, South Carolina State University Combined) Annual Report - FY2021

Report Status: Approved as of 07/13/2022

Contributing Organizations

Clemson University
South Carolina State University

Executive Summary

Overview

South Carolina State University and Clemson University work to provide non-biased, science-based information to our citizens. Both institutions focus on working relationships between Research and Extension that produces relevant and timely information to solve issues at the community, county, and state levels. Agriculture remains South Carolina's largest industry, accounting for almost 247,000 jobs and \$4.62 billion in annual economic impact. However, health and wellness continue to be an issue across the state. The CDC estimates that SC has between a 35-40% prevalence of obesity among adults. This is further exacerbated by the fact that SC has an almost 14% poverty level. Considering the most pressing issues in the state, Clemson University and SC State University concentrate on 5 broad Critical Issues which are: 1) agribusiness and community development, 2) agrisystems productivity and profitability, 3) environmental and natural resources conservation, 4) family and youth development, and 5) food safety, security, and nutrition.

[Clemson Cooperative Extension Service](#) works in each of the 5 Critical Issues areas to meet the needs of South Carolinians. Clemson Extension served 214,194 citizens (direct contacts) during 7,386 workshops and events, many of which were held in-person following CDC guidelines to further prevent the spread of COVID. Program participants that completed evaluations indicated that they gained new knowledge and were utilizing practices learned. Clemson Extension continues to support multistate positions that provide expertise in the areas of apples, peaches, and orchard floor management. Clemson Extension is continuing to find ways to serve stakeholders using online platforms and is pilot testing a "Virtual Agent" position that focuses solely on delivering programming to address each of the 5 Critical Issues online, both synchronously and asynchronously. Furthermore, Clemson Extension logged over 22 million indirect contacts due to a surge in visits to the [Clemson Cooperative Extension Service Home and Garden Information Center](#) (HGIC) website. [Land-Grant Press by Clemson Extension](#) continues to also provide on-demand information for professionals in South Carolina and around the world. There were 70,124 unique pageviews across 113 available publications in [Land-Grant Press](#) for FY 2021.

Clemson University Research Experiment Station

The Experiment Station continues to work collaboratively to support research and outreach across South Carolina. Not only is research being conducted on the University campus, but at (6) Research and Education Centers (RECs) located across South Carolina. They are strategically located to conduct agricultural research in representative conditions of South Carolina's distinct soil and climate regions, benefiting a variety of producers in those locations. These RECs, collectively known as the Clemson Experiment Station, are part of a nationwide system of scientists working to improve quality of life. The Experiment Station continues to provide comprehensive support and is committed to excellence in research with the goal of preparing agricultural professionals and individuals with research information. We will continue providing resources and solutions to production, environmental, and economic issues for the citizens of South Carolina and beyond through research activities conducted at the Clemson Agricultural Experiment Station.

The Clemson Experiment Station is highlighting a subset of accomplishments from 58 projects for this reporting period.

In addition to the research and outreach efforts conducted by SC State Research and Extension, a few significant events that occurred at SC State during FY 2021 was the "Next Wave of Hemp". It expressed how South Carolina builds an industrial supply chain and infrastructure for a green future. It measured the standards of the multi-billion-dollar agribusiness industry. The event impact caused an increase in knowledge, expanded partnerships, and explored markets covering hemp. Another exciting experience was the opening of a new research and demonstration farm in Olar, SC. The farm operations will identify challenges impacting South Carolina's agriculture

industry. It will also study the emerging hemp crop and research vegetable production using conventional and organic practices; explore agroforestry; and expand community gardening. In addition, a ribbon-cutting ceremony for the opening of the Camp Harry E. Daniels Leadership Center in Elloree, SC was held. The Center will be utilized to enhance leadership skills and implement a learn by doing principle. It will expose opportunities to increase knowledge in STEM, nutrition education, literacy, and arts. The Center will serve as a community resource for business and industry, non-profits, organizations; etc. It will also increase facility usage in the community.

SC State Extension served 32,253 people through direct contacts and 97,401 indirect contacts were logged. A total of 671 workshops were held throughout the reporting period that encompassed the 5 Critical Issues within the 7 Regional Areas. There were 71 YouTube videos produced with over 12,000 views. Facebook reached 362,096 people; Instagram served 251,806 constituents and Twitter reached 75,301 individuals. Other media outlets such as Webinars (1,166) and Mailchimp (45,953) were used. Nearly a million people in South Carolina and around the country received, viewed, read about, and benefited from the funds provided for programs, activities and events.

The SC State Research Program is the catalyst that has kept the University at the forefront of agricultural and rural research problems and issues confronting South Carolina. The researchers are emerging leaders in their fields and they are working to combat obesity among youth, enhancing bioremediation technology, improving food safety and security, developing optimization models that will aid in decreasing logistics costs for biofuel and identifying techniques to increase academic performance of students in public schools. SC State Researchers and Extension professionals are training undergraduate and graduate students to become the nation's next generation of biologists, engineers, environmental scientists and educators.

A total of 26 research projects were funded for the reporting period. Five research projects ended during the yearly report period. Four research project administrators requested and received extensions because of mitigating circumstances they were unable to meet their original completion date, due mainly to the COVID-19 crisis. Four final bulletins were written and/or submitted for publication. Five new projects were able to come aboard for the present reporting period.

Critical Issue: Agribusiness and Community Development

The [Clemson Extension Agribusiness](#) program team served 48,243 citizens (direct contacts) during 689 programs. With COVID on the decline, many in-person activities were allowed to restart, following CDC guidelines. A highlight for FY 2021 was the establishment of the SC Governor's School for Agriculture Education. It is a residential high school located on 1,310 acres and provides an opportunity for youth to continue their education through an agricultural lens. The Ag + Art Tour returned in FY 2021 with over 45,000 visitors since its inception. This popular agribusiness program engages citizens in learning about farming, where food comes from, and exposes them to local farms for obtaining fresh food. It also engages local artists to expand their potential audience base and provides an enhanced experience at the farm. To help increase the reach of farmers, a publication released through Land-Press by Clemson Extension provides ideas and tips for improving a farm's social media presence ([10 Tips for Farm Social Media](#)). In only 11 days from the publication date, there were 93 unique pageviews, providing evidence of Clemson Extension's focus on serving farmers. The Agribusiness program team also continues to provide health and wellness information to farmers by partnering with the SC Farm Bureau to help connect farmers with trained mental health counselors.

Clemson Experiment Station

The overarching goals of this reporting period were to create awareness and interest at the middle and high school levels for careers in the agricultural sciences, to prepare students for academic success and professional pursuits, leading to a sustainable supply of well-educated agricultural scientists, and to prepare and empower agricultural educators to effectively teach rigorous STEM content within the school-based agricultural education curriculum. These goals directly align with our research agenda to prepare students for the 21st century employability skills required for success in modern agriculture and STEM fields. The STEM it Up (SIU) program provided high-quality professional development programs for agriscience teachers nationwide. Specifically, our goal is to continue the focus on the education component by promoting exposure to horticulture/floriculture through development of curricular resources. Laboratory investigations, lesson plans and materials were developed to focus on the STEM concepts that naturally occur in the field of plant science. The curricular materials are utilized to train secondary agriscience teachers in school-based agricultural education (SBAE) programs to effectively deliver inquiry-based instruction on concepts and better understand career opportunities related to the horticulture/floriculture industry.

SC State is in the process of restructuring its Critical Issue: Agribusiness and Community Development. Effective implementation of the program will enhance the economic and community development of South Carolina through traditional and cutting-edge technology, innovation, and best practices. The intent is to deliver continuous and coordinated efforts to create the economic, environmental, and social conditions that allow communities to thrive.

Critical Issue: Agrisystems Productivity and Profitability

The Clemson Extension program teams of [Agronomic Crops](#), [Horticulture](#), and [Livestock and Forages](#) work within the Critical Issue of Agrisystems Productivity and Profitability. There were 48,243 direct contacts across 689 programs and events in FY 2021. Programmatic events focused on crops that can be grown in South Carolina such as corn, cotton, peanuts, soybeans, tobacco, peppers, tomatoes, strawberries, and small grains, to name a few. Other important topics covered included pest identification, pest management, pasture management, [bull testing](#), water management, etc. Clemson Extension also helps farmers improve productivity and profitability through the [Precision Agriculture](#) team. The Clemson Agronomic Crops team continues to participate in [irrigation research](#) that focuses on on-farm agricultural water management. Clemson Extension also serves the [turfgrass industry](#) that includes golf courses, sod production, sports field management, and professional lawn care. Clemson Extension continued to support multi-state positions related to fruit production and management. Highlights include work on San Jose scale, pollinators, and flower thrips in peaches. Apple work included [spray timing](#), [Fuji apple tree rootstock](#), and [apple fruit abscission mechanisms](#).

Clemson Experiment Station

Recent research has examined the recapture and reuse of rendered animal materials for use as fertilizer. Crop yield, nutrient loss, long term biological health of the soil, and soil sustainability was examined in this project. A series of field and lab studies examining various formulations of rendered materials were conducted to time nutrient release rate with plant demand. This approach reduced nutrient leaching losses seven-fold, reduced farm operations by one-third, reduced chemical fertilizer use by one third and improved soil and microbial health two to five-fold all while maintaining similar crop yields as the commercial fertilizer system. Other Agrisystems Productivity and Profitability research has focused on biological control of arthropod pests and weeds in vegetable and ornamental plants. The use of beneficial predatory mites and a predatory beetle was examined on a commercial tomato line for consumption of spider mite eggs. A search for natural predators for the muhly grass mealybug, a relatively new pest of muhly grass that is becoming common throughout the coastal region of South Carolina is also underway. Through integration of effective biological control, conventional pesticide applications can be reduced and associated environmental, pest management and socioeconomic consequences can be decreased or avoided. These studies are important steps to understanding foraging behavior of predators and parasitoids on pest resistant crops and will help to improve the overall profitability of agronomic, vegetable, and ornamental crops in the region.

For SC State Extension, small scale commercial vegetable producers, farmers, gardeners, and livestock producers face increasingly high production costs with their enterprises. The Critical Issue of Agrisystems Productivity and Profitability accumulated 3,798 direct contact hours through the operation of 3 programs (Small Scale Animal Production, Sustainable Agriculture Production and Risk Management Education). The overall goals are to promote retention of small-scale family farms; reduce off-farm input and integrate natural processes such as nutrient cycling, nitrogen fixation, and pest-predator relationships into the agricultural production process. Many of SC State's Extension participants sought ways to keep their businesses afloat. Some of the small-scale producers saw their profit margin decline. Unless the producers could get a handle on production cost, they could very well fail with their individual operations. Workshops, seminars and trainings were held to assist the small-scale producers and limited resource farmers in increasing their profits and maintaining the land.

The SC State research component addressed the Critical Issue of Agrisystems Productivity and Profitability with one researcher who designed a mobile hearing van with a sound treated booth and waiting area to assist farmers with hearing and loss. A hearing conservation program was developed to educate farmers on the importance of wearing hearing protection during continuous exposure to loud noises. A survey assessed farmers' usage of hearing protection devices and exposure to loud noise. Recruitment participation was received from the Farmer Associations and Young Farmers of Orangeburg and Clarendon counties.

Critical Issue: Environmental and Natural Resources Conservation

The Critical Issue of Environmental and Natural Resources Conservation is addressed by Clemson Extension program teams in the areas of [Forestry and Wildlife Resources](#), [Horticulture](#), [Livestock and Forages](#), and [Water Resources](#). For FY 2021, 55,687 direct contacts were recorded across 2,193 programs. Many of the participants reported a gain in knowledge (11,659) and 8,296 reported using practices learned during programs. Clemson Extension Water Resources Agents work tirelessly to protect the freshwater supply in South Carolina and educate citizens on how they can contribute to water protection and conservation. They also provide training in areas such as [stormwater pond management](#), [dam ownership](#), [stream improvement](#), and [septic tank management](#). Clemson Extension Livestock and Forages agents provide training in [Confined Animal Manure Management \(Camm\)](#) to address various areas of manure management, including water quality protection and odor management. Clemson Extension Forestry and Wildlife Resources Agents continued working to educate landowners in timber management. The SC Women Owning Woodlands program remains a popular program and offers

trainings such as chainsaw safety and basic forest management. The [SC Master Naturalist](#) program is expanding its reach by offering online programs to supplement the basic and advanced in-person courses. In FY 2021 the SC Master Naturalist had 224 graduates and reported almost 13,000 volunteer hours. The popular [Master Tree Farmer](#) was revised and launched that is a hybrid course.

Clemson Experiment Station

Active forest management impacts environmental variables such as fuel accumulation, vegetation, water quality, and erosion. In the past year, our research has resulted in the development of a decision support tool for environmentally friendly timber harvesting in mountainous terrain. This tool, when implemented, will help forest managers identify where selected silvicultural practices (timber harvesting, fire, thinning) can be implemented without adversely impacting soil and water quality. Landowners, state and federal agencies, scientists and non-profits have benefited from the dissemination of our research findings via extension papers, and presentations to landowner groups and at scientific meetings. We have strengthened our relationships with these partners in ways that will no doubt lead to future opportunities for collaboration. This research has benefited the broader public in that by providing sound scientific information regarding the sustainable management of forest ecosystems. While the project is still in its early stages, land managers are already using our findings to make long-term decisions about forest management.

The SC State Critical Issue of Environmental and Natural Resources Conservation is incorporated in the Agrisystems Productivity and Profitability Critical Issue. It is a combination of Sustainable Agriculture, Natural Resources, and Environment. Therefore, SC State Extension would not be reporting their progress under this particular issue.

However, SC State Research does have several research projects that fall within the Critical Issue: Environmental and Natural Resources Conservation. Scientists have focused on accumulation of post-consumer waste plastics; saving energy by recovering resin, and reutilizing post-consumer plastics(PCPs). Research was conducted on susceptibility of stored product insects to gaseous ozone focusing on flow characteristics and penetration of of ozone through various materials.

Critical Issue: Family and Youth Development

Clemson Extension programs teams of [4-H Youth Development](#) and [Agricultural Education](#) focus much of their efforts to address critical issues related to Family and Youth Development. The 4-H Youth Development program team engaged 48,858 youth across South Carolina. This number is down significantly from previous years due to COVID restrictions on in-person activities and continued COVID variants that emerge. However, the [4-H Pinckney Leadership Program](#) continues to thrive and serve South Carolina, despite COVID restrictions. The FY 2021 program was held virtually and in conjunction with 3 other Clemson programs that have similar missions and reached over 600 underrepresented youth. The Agricultural Education program also continued to engage citizen through 1,952 programs offered engaging over 13,000 youth and adults. Clemson Extension Agricultural Education Coordinators continue to work throughout the state to supervise Agricultural Education programs in middle and high schools. The [SC FFA](#) remains committed to preparing students to serve and lead in agriculture and served over 7,100 youth in FY 2021.

The **Clemson Experiment Station** does not conduct research in this critical area.

SC State Extension recorded 21,794 direct contacts involving youth across the state in the 4-H Youth and Family Development programs, which include citizenship, healthy lifestyles, financial management and STREAM (Science, Technology, Reading, Engineering, Agriculture/Art, Math). Youth are projected to experience productive adulthood when they participate in experiences that provide opportunities for youth to develop competencies, values, and social skills. The SC State Critical Issue of Family and Youth Development worked with 1471 youth in the citizenship. The goal of the SC State Citizenship Project was to engage participants in projects and activities that promoted social balance and focused on positive character traits and helped to develop basic life skills. The projects and activities focused on character education and career preparation with 8 youth groups. Five hundred thirty-nine (539) youth were served in a combination of 33 presentation and workshops. As a result of the activities, 55% of the participants reported knowledge gained. Fifty-nine percent (59%) of the participants developed better communication skills. Through participation in workshops and field trips, a high school participant was afforded the opportunity to gain employment upon graduating from high school. The participant credits his guidance in the program as the reason for identifying his career path and pursuing his goals. The participant was hired with the local school district as an auto-mechanic assistant.

In addition, a STEMBIZNESS Camp was held in Florence, SC. A 3 phase program was incorporated to introduce students to basic STEM concepts; the engineering design process; and taught entrepreneurial concepts. Youth were exposed to STEM opportunities and entrepreneurship; and an introduction to different career paths. The youth were provided the motivation to achieve; research new learning objectives; develop their own engineering design process; and prepare a STEM SHARK TANK presentation.

The STREAM (Science, Technology, Reading, Engineering, Agriculture/Arts and Math) Project focused on increasing youth participation in activities that fostered efforts to develop a qualified local labor force. School enrichment projects, summer camps, afterschool services, and community youth projects were coordinated and focused on urban farming, computer coding, technology, gardening, and reading. Two hundred seventy nine (279) youth participated in a combination of 54 educational workshops. Fifty-five youth participated in the urban farming and gardening activities, 62 participated in computer coding and technology activities and 162 participated in reading activities. In regard to urban farming, 50% of the participants indicated it was their first time planting seeds, preparing soil, and using a garden tool. Sixty nine percent of the farming and technology participants indicated knowledge gained and intended to adopt practices introduced in the project. Seventy-seven percent of the reading participants were provided resource materials to sustain their development in reading skills.

Critical Issue: Food Safety, Security and Nutrition

Food safety, security, and nutrition impacts everyone. The Clemson Extension [Rural Health, Expanded Food and Nutrition Education Program](#), and [Food Systems and Safety](#) program teams strive to improve the lives of South Carolinians in this critical issue area. The teams served 40,647 people across 2,373 programs and events. Clemson Extension Food Systems and Safety Agents conduct programs such as the [Food2Market](#) that is designed to help food entrepreneurs navigate the many steps of food regulation that are necessary to prepare foods for safe sale. This group of agents also conducts a training program for fruit and vegetable growers to teach them how to navigate the Food Safety and Modernization Act (FSMA) regulations. The Rural Health team supports science-based initiatives and programs that help prevent and self-manage chronic diseases, such as diabetes and hypertension. The Expanded Food and Nutrition Education Program (EFNEP) provides practical and hands-on nutrition information to families with limited financial resources.

Clemson Experiment Station

Multiple genetics and breeding research projects have investigated methods to improve the adaptability of crops to a changing climate and a more stressful growing environment. We are currently breeding Phaseolus beans for improved heat tolerance during reproductive stages. Improving reproductive efficiency of snap beans in higher temperatures can lengthen the growing season, expand the production area, and increase resilience to more variable climate conditions. We are currently screening a wide variety of the USDA snap bean accessions under heat stress to select the most heat tolerant cultivars. These selections will be utilized in breeding programs with the goal of developing and releasing more resilient snap bean varieties. We are also improving soft red winter wheat tolerance. Specifically, we are attempting to incorporate host plant resistance to Fusarium head blight and various Puccinia rusts. Over 500 new winter wheat populations have been developed to utilize in future cultivar development which should ultimately improve the production and profitability of winter wheat production in the southeastern U.S. Breeding efforts are also underway in grain sorghum to identify ideal plant characteristics and develop an underlying breeding strategy for organic grain production. We are also developing a new sorghum genetic mapping population to identify underlying genetic controls that regulate carbon partitioning. These controls could be used to accelerate selection and breeding for grain, sweet sorghum and bioenergy sorghums.

According to SC State Extension, the family is one of society's oldest and most resilient institutions. Therefore, we have to maintain the health and wellness of the family. The Critical Issue of Food Safety, Security and Nutrition had 6,661 direct contacts. A total of 6 areas (Building Family Strengths, Household and Family Financial Management; Children, Youth and Families at Risk; Expanded Food and Nutrition Education Program (EFNEP); Food Safety and Wellness and Diet, Nutrition, and Health) encompass the Critical Issue of Food Safety, Security and Nutrition. EFNEP Educators fulfilled the requirements of many of the critical components for healthy eating through the Eat Smart and Move More, Kids in the Kitchen, and Smart from the Start curriculums. They were able to get participants to eat healthier and exercise more. Limited resource youth and families with children learned how to eat healthier meals and snacks, stretch their food dollars and reduce the risk of food-borne illnesses. Participants received monthly healthy tips dealing with indoor exercises, healthy recipes, and guidelines for improving overall health. Physical activity demonstrations were introduced through exercise strategies that were easy to do and did not require equipment or additional resources.

The SC State Extension Healthy Lifestyles Project emphasized healthy food alternatives and provided opportunities for participants to increase daily physical exercise, activities that improved heart rate and increase water intake. The activities consisted of small group activities, lectures, PowerPoint presentations, and food-tasting demonstrations. SC State Extension conducted healthy lifestyle educational workshops with 7 different youth groups across 3 counties. The total number of participants were 193 with 39 outreach activities conducted. Activities conducted engaged youth from kindergarten to eighth grade and many consisted of physical activity demonstrations and healthy eating combined.

The SC State Research explored the Critical Issue: Food Safety, Security and Nutrition through 4 different research projects. Research focused on the impact of international trade policy changes on global food security and South Carolina agriculture; susceptibility of insects to gaseous ozone: flow characteristics and penetration of ozone through various materials; you are what you eat: investigating

nutrition as a key prophylaxis against chronic inflammation and other co-morbidities in South Carolina families and an analysis of phytochemicals isolated from sweet potatoes grown on South Carolina farms and antibacterial effects of sweet potatoes phenolic extracts on foodborne pathogens.

Merit and Scientific Peer Review Processes

Updates

None for Clemson Extension.

Slight modification of Clemson University Experiment Station Merit and Scientific Peer Review Process

An internal review panel meets to review all research outputs and outcomes in preparing to initiate new research projects. The review panel consists of the Experiment Station Assistant Director, the Department Chair of the principal investigator, the Research and Education Center (REC) Director, and other subject matter experts as needed. The panel is appointed by the Experiment Station Director in consultation with other administration, faculty and staff. The panel reviews all proposals submitted for new projects in addition to (1) internal and (2) external reviewers' comments to ascertain the merit of the project and to assure that it fits the overall goals and objectives of the Experiment Station and the College. A project termination discussion is held at the conclusion of the project to discuss the project and determine the next steps for a new project. In addition, all research projects go through a review process as outlined under Hatch regulations. This serves as the Expert Peer Review process, as each project is sent for external review, comments and suggestions, which are examined and incorporated into the new project proposal, as appropriate.

No updates for SC State Research and Extension.

Stakeholder Input

Actions to seek stakeholder input that encouraged their participation with a brief explanation

There was a comment on the last Plan of Work that Clemson did not have an advisory council. As a point of clarification, the [SC State Extension Advancement Council](#) serves both SC State University and Clemson University. This is a joint council that provides guidance for both institutions.

Methods to identify individuals and groups and brief explanation

None for Clemson Extension.

SC State Extension did not vary much from their methods of identifying individuals and groups. However, when the schools, agencies and communities were still in COVID mode, the best methods to identify other participants was to utilize the organizations we were already collaborating with to initiate and spread the word of the projects we had to offer to different agencies in their circle of work.

Methods for collecting stakeholder input and brief explanation

None for Clemson Extension.

Normally, SC State Extension would have conducted face-to-face interviews to collect data. However, stakeholder data was collected through digital surveys and questionnaires as well as Zoom or Teams Meetings, due to COVID. Focus group questions were received through the mail. We were still able to collect valuable information from the participants through evaluations and comments on program operations and implementation.

A statement of how the input will be considered and brief explanation of what you learned from your stakeholders

Information provided by the [SC State Extension Advancement Council](#) was used to guide Clemson Extension programming efforts across the state. Clemson Extension also sought the advice of County Extension Advisory Councils. Some of the Clemson County Extension Advisory Councils met virtually due to COVID restrictions but continued to engage in prioritizing programming efforts. A formal needs assessment was conducted with all County Extension Advisory Councils and data is still being analyzed so that results can be

disseminated to Clemson Extension Agents and Associates. However, much of the information collected from the SC State Extension Advancement Council and County Extension Advisory Councils confirms that Clemson Extension needs to continue to work within the 5 broad Critical Issues identified for South Carolina.

For SC State Extension, the Advisory Councils were very beneficial. Participants provided valuable information regarding the implementation of the virtual and hybrid delivery models. Comments on video and audio quality, virtual program navigation, program times, and communication will be used to improve future program delivery. Comments on program timing, communication and marketing, relevance of content, and age appropriation will be considered in future project planning and implementation.

Highlighted Results by Project or Program

Critical Issue

Agribusiness and Community Development

[A framework for secondary schools agriscience education programs that emphasizes the STEM content in agriculture](#)

Project Director

Catherine DiBenedetto

Organization

Clemson University

Accession Number

1014706



[**2021 Annual Report -A Framework for Secondary Schools Agriscience Education Programs that Emphasizes the STEM Content in Agriculture**](#)

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Problem or need: Although many colleges of agriculture have experienced an increase in student enrollment over the past decade, fewer students maintain their agricultural focus through successful placement in an agriculturally based scientific position upon graduation (Dyer et al., 1996; NRC, 2009). The focus of this multistate research project is to revitalize an interest in agriculture as a career path and ensure secondary school students enrolled in school-based agricultural education programs throughout the nation have the requisite competencies to succeed in college and careers. The end result will be an abundant supply of well-educated workers in Science, Technology, Engineering and Mathematics (STEM) careers that are prepared with current agricultural knowledge, and the technical and 21st century employability skills needed for them to enter, advance and be successful candidates in agriculture and STEM-based fields of study.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Non-Technical Summary: The issues of recruitment and preparation for careers in agricultural sciences overlap. Thus, the overarching goals of this multistate project are: 1) to create awareness and interest at the middle and high school levels for careers in the agricultural sciences, 2) to prepare students for academic success and professional pursuits, leading to a sustainable supply of well-educated agricultural scientists, 3) to prepare and empower agricultural educators to effectively teach rigorous STEM content within the school-based agricultural education curriculum. These goals directly align with my research agenda to prepare students with the 21st century employability skills required for success in the 21st century agriculture and STEM fields. Specifically aligned with the goals of the Multistate research project. My work on objective three to develop an innovation configuration for implementing an agriscience program, focused on identifying effective methods of instruction used by exemplary secondary agriscience teachers. Innovation Configurations (IC) clarify what full implementation should look like. Levels of use chart individual's' behaviors in regard to the change. Stages of Concerns (SoC) measure people's feelings and perceptions of change. Innovation Configurations (IC) describe what the change should look like when it is properly implemented (Hall & Hord, 2006). An Innovation Configuration map was created by a subset of multistate research team members to develop a common understanding of what is expected and to measure how an innovation has been implemented. Plans for dissemination and utilization of the IC map are currently underway. With regard to objective two, to identify teaching methods, resources (facilities, equipment, materials, etc.), and techniques currently utilized by exemplary teachers. My STEM it Up (SIU) program sponsored by an educational grant from the American Floral Endowment (AFE), which provides high-quality professional development programs for agriscience teachers nationwide,

aligns with the essence of objective two. Specifically, our goal is to focus on the education component of the AFE mission by promoting exposure to horticulture/floriculture through development of curricular resources. Laboratory investigations, lesson plans and materials are developed to focus on the STEM concepts that naturally occur in the field of plant science. The curricular materials are utilized to train secondary agriscience teachers in school-based agricultural education (SBAE) programs to effectively deliver inquiry-based instruction on concepts and better understand career opportunities related to the horticulture/floriculture industry. In 2020 the Global Pandemic obviously caused a great deal of uncertainty and stress for all. Teachers especially were tasked with how to engage their students virtually with curricula and concepts that are best delivered through a hands-on/experiential method. The SIU 3.0 program engaged 23 teachers from 13 states around the nation and not only provided programming to enhance the STEM concepts in the floriculture and horticulture courses those teachers taught, but also provided a very important support system during the most difficult time of the participants careers. An undergraduate student in the agricultural education program in CAFLS also engaged in the research conducted during the SIU 3.0 program in the summer of 2021. Research conducted by the STEM it Up program directly aligns with the multistate project's goals objectives and has addressed the following questions:

Student Focused – perceptions

What are students' perceptions of STEM in horticulture/floriculture industries?

What are students' perceptions of STEM careers in horticulture/floriculture industries?

Teacher Focused - perceptions

What are teachers' perceptions of STEM in horticulture/floriculture industries?

What are teachers' perceptions of STEM careers in horticulture/floriculture industries?

Student focused - Content

What is the level of student knowledge of STEM concepts in horticulture/floriculture industries?

What is the level of student knowledge of STEM careers in horticulture/floriculture industries?

Briefly describe how your target audience benefited from your project's activities.

Target Audience:

The target audience of the multistate research project is secondary agriscience teachers and their students enrolled in school-based agricultural education programs throughout the nation. Both collaborative work among our multistate team of researchers and each members' individual areas of expertise in their respective areas has provided the foundation for many agricultural education programs to highlight and improve how their curriculum meets science, technology, engineering, and mathematics (STEM) learning outcomes, increasing the rigor and relevance of agricultural education nationwide.

Briefly describe how the broader public benefited from your project's activities.

Broader Audience:

As we look to future work, providing continual, research-based, high-quality professional development will empower agricultural educators with an increased awareness of the practices, cross-cutting concepts, and disciplinary core ideas included in the agriscience program. This increased awareness will be accompanied by modified curricula to guide secondary agriscience teachers in highlighting STEM concepts and ideas in the lessons they teach; ultimately positively impacting student learning outcomes. Additional stakeholders such as state agricultural education leaders, secondary school administrators, and business and industry leaders will be introduced to and benefit from the outcomes of the programs designed for secondary agriscience teachers and the dissemination of research findings and professional briefs.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Comments:

The leadership team of this multistate research project (2019—2022, 3-year term) consisted of:

Chair: Catherine DiBenedetto, Clemson University

Vice-Chair: Aaron McKim, Michigan State University

Objective 1 Coordinator: Brian Myers, University of Florida

Objective 2 Coordinator: Kasee Smith, University of Idaho

Objective 3 Coordinator: Kevin Curry, Penn State University

I have served a Chair of the S1071 Multistate Research Project over the past three years. I planned and led annual meetings and subcommittee meetings during this time. At the May 25 (virtual) meeting held from 4:00-6:00 pm EST, Greetings from Administrative Advisor, Lesley Oliver (representing Southern Region Experiment Directors) were brought to the group and discussion occurred with a unanimous vote to proceed with a proposal for a replacement project for the 2022-2027 cycle. With the assistance of Natalie Ferand, (previous graduate student at University of Florida, now currently an assistant professor at Virginia Tech) and Co-chair Aaron McKim, assistant professor at Michigan State University, I led the development of the statement of issues and justification for the replacement proposal and submitted the replacement request in July of 2021. The project was temporarily approved in December of 2021 by the Multistate Research Committee for the Southern Region. In March 2022, I contacted all members listed in the NIMSS reporting system under the S1071 project and other individuals who attended the May meeting or contacted me showing interest in joining the project to assist with the full proposal next three-year cycle of this multi-state research effort. Of the 21 individuals contacted, a total of six individuals representing South Carolina, Virginia, Mississippi, Louisiana, Michigan, and Georgia attended the virtual meeting on March 3, 2022, and have assisted with sections of the full proposal. Members representing South Dakota, Idaho, Pennsylvania, Utah, and Kansas communicated interest, but were unable to attend the meeting. After the meeting, I communicated with Lesley Oliver for additional guidance, and I will submit the final replacement project proposal to her by the March 15, 2022, deadline. For the next reporting period, the objectives of the replacement project are Objective 1: Curriculum- Facilitate the adoption of an agriscience curriculum framework that is grounded in the concepts and approaches of the Next Generation Science Standards. Objective 2: Teaching Methods and Techniques-Identify teaching methods, resources (facilities, equipment, materials, etc.), and techniques currently utilized by agriscience teachers during exemplary Agricultural STEM instruction; Objective 3: Professional Development-Design and evaluate professional development as it relates to Agricultural STEM Education.

Dissemination to Stakeholders - Related Research Publications and Presentations:

1. Ferand, N. K., **DiBenedetto, C. A.**, Myers, B.E., Barry, D. M. (In review). Implications of science illumination on student motivation to learn science in agriculture. *Journal of Agricultural Education*. Submitted – Aug 2021, Revised and Resubmitted Feb 2022
2. Ferand, N. K., **DiBenedetto, C. A.**, Myers, B.E., Barry, D. M. (In review). Implications of science illumination on student content knowledge of technical floriculture and core scientific ideas. *Journal of Agricultural Education*. Submitted- Aug 2021
3. Wearing, E., **DiBenedetto, C. A.**, & Ferand, N. K. (2022). Investigating Agriscience Teachers' Knowledge and Comfort of IBI and STEM Integration [Poster presentation]. American Association for Agricultural Education (AAAE) Southern Research Conference, New Orleans, Louisiana.
4. Ferand, N. K., **DiBenedetto, C. A.**, Wearing, E. & Myers, B. E. (2021). *Evaluation of a virtual plant science program for agriscience teachers* [Poster presentation]. American Association for Agricultural Education (AAAE) Research Conference, virtual conference.
5. Ferand, N. K., **DiBenedetto, C. A.**, Wearing, E. & Myers, B. E. (2021). *COVID showers bring virtual flowers: Getting floriculture curriculum to bloom online* [Poster presentation]. American Association for Agricultural Education (AAAE) Research Conference, virtual conference.

7. Ferand, N. K., **DiBenedetto, C. A.**, & Myers, B. E. (2021). *Evaluation of a virtual plant science program for agriscience teachers* [Poster presentation]. American Association for Agricultural Education (AAAE) Southern Research Conference, virtual conference.
8. Ferand, N. K., **DiBenedetto, C. A.**, & Myers, B. E. (2021). *COVID showers bring virtual flowers: Getting floriculture curriculum to bloom online* [Poster presentation]. American Association for Agricultural Education (AAAE) Southern Research Conference, virtual conference. ***Outstanding Poster award.**

[Agriculture and Natural Resources Education and Development for Adults and Youth](#)

Project Director

Susan Guynn

Organization

Clemson University

Accession Number

7000046



Colleton County AG+Art Tour

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Many people now reside in cities and municipalities, outside of rural farming areas. Because of this trend, people may not understand or appreciate the agricultural industry and where their foods come from every day. The SC AG+ART Tour provides an opportunity for farmers in SC to showcase their farm, sell products directly on-farm, and increase their market for products. At the same time, it allows for families and groups to tour local farms to better understand the agricultural industry in this state and have a better connection to their food source in a fun and entertaining setting.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Since the inception of the SC AG+Art Tour in 2012, over 45,000 visitors have participated in the program. In 2021, Colleton County was added as another county that participated in the SC AG+ART Tour. Expanding the program into a new county provides better access for some families and individuals to experience rural lifestyles and the life of a farmer. This type of activity promotes appreciation for the farmers efforts to provide a sustainable food source while protecting the environment. At the same time, it allows farmers an opportunity to market products directly to consumers on farm, thus eliminating some shipping and handling expenses and increasing profits.

Briefly describe how your target audience benefited from your project's activities.

The SC AG+ART Tour benefits farmers by providing them exposure to local and community residents that they may not have reached otherwise. It provides a marketing tool for the farmers to increase farm traffic and increase sales. Furthermore, it allows the farmers to demonstrate their support of other local artists and be supportive community members. The SC AG+ART Tour is the largest free farm and art tour in the nation. And in 2021, Colleton County was added to the growing list of counties that participate in the program.

For Colleton County residents specifically, it may draw new tourism to the county. Colleton County is rural with a population of a little over 38,000 residents and is classified as a “Most Distressed” community according to the CDC Distressed Communities Index. Adding a potential revenue source for residents of Colleton County could help improve the quality of life for some farmers and provide more financial farm stability while providing educational opportunities for farm visitors.

Briefly describe how the broader public benefited from your project's activities.

The SC AG+ART Tour benefits the broader public by providing a local educational forum for exploring how food is produced and distributed in the world. It creates a better appreciation of farmers and their challenges to survive and thrive in global markets while serving their local communities. It also an outlet for other local artist to access an untapped market by displaying their works at the local farms.



Establishment of the SC Governor's School for Agriculture Education

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Agriculture is the number one industry in South Carolina. However, fewer youth are growing up on a farm and entering the agricultural profession. Agricultural programs in middle and high schools are key to introducing students to the agriculture industry and providing training.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The SC Governor's School for Agriculture (SCGSA) was opened for the 2021-2022 school year. The SCGSA's mission is provide a place where high school students can learn about and experience agriculture hands-on. Students also take core classes, such as English and math, but are taught through the lens of how it relates to agriculture. All core classes at taught at the honors level and students can seek dual enrollment for both college credit and obtain certifications in the field.

Briefly describe how your target audience benefited from your project's activities.

The SC Governor's School for Agriculture is the only residential high school for agriculture education in the nation. As such, it provides opportunities for youth to learn skills necessary to enter SC's largest industry, agriculture. The school is located on a gated, 1,310-acre campus in McCormick, SC and provides opportunities for high school students to continue their education through the agriculture lens. Students benefit by learning skills and obtaining certifications (such as chainsaw safety and artificial insemination) while also completing core classes that are taught through the lens of agriculture. All core classes are taught at the honors level and students can seek dual enrollment for college credit and certifications. Students are provided a safe learning environment while exploring careers in the agricultural field.

Briefly describe how the broader public benefited from your project's activities.

The SC Governor's School for Agriculture serves the general public by preparing youth to enter the agricultural workforce. With fewer youth growing up on farms and seeking to further their education in the agricultural field, the SC Governor's School for Agriculture helps students focus their education in an agricultural context. Youth that enter the agricultural industry workforce helps to fill gaps in the workforce that supplies and supports the world's food system.

Critical Issue

Agrisystems Productivity and Profitability

Innovative Industrial Hemp Production Investigation as a Viable New Emerging Crop for Small and Minority Farmers

Project Director

Florence Anoruo

Organization

South Carolina State University

Accession Number

7000543



In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Industrial Hemp is a non-psychoactive variety of *Cannabis sativa* L. 1890 industrial hemp research project focused on regional genetic trials and data collection on CBD and fiber/grain cultivars, that will undoubtedly provide enhanced knowledge, help bridge hemp farming disparity, and reduce the barriers facing black farmers in the hemp industry. The research initiative is designed to educate, innovate, and elevate interest and knowledge for students, farmers, and community at large in industrial hemp production via a tri-factor platform of research, education, and extension.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Completed first round of multi-cultivar indoor and outdoor research trials at two demonstration research sites in Orangeburg County and Charleston, with two minority collaborating partners.

Determination of best industrial hemp cultivars for indoor vs field cultivation from 3 cultivars cultivated.

-Identification of industrial cultivars (oil, fiber, and fiber/grain) best suited for SC soil and environmental conditions.

-Analysis and assessment of results collected from our indoor and outdoor research sites.

- Publication of best management practices in industrial hemp production via State and 1890 sponsored events.

- Presentation of evidence-based research methods and current trends in hemp production, for farmers, policy and decision-makers, via meeting, seminars, workshops, and webinars.

-Trained and research-informed students and extension staff (two undergraduates participated in the research

-Exposed and knowledgeable limited resource socially disadvantaged farmers in industrial hemp production who are poised to be successful and competitive in hemp industry

-Positioned SCSU 1890 as a premier leader in industrial hemp and emerging crop research.

- New industrial production knowledge applied

-New methods and skills developed in sustainable production of hemp.

-New research directions for industrial hemp production

Recommendation on soil type, growing and crop management best practices, and cultivar selection, regarding industrial hemp production to minority small scale and socially disadvantaged farmers

-Adopt and use new methods and/or improved BMP in hemp production.

-Development of well-informed hemp farmers and processors

-Creation of interest in agriculture/industrial hemp related industry and employment opportunities

-More economic-competitiveness for rural and limited resource and socially disadvantaged farmers.

- Conducted four regional webinars series. Topics covered include hemp basics, licensing, State and Federal regulations, land acquisition and registration for hemp cultivation, selection of genetics, row cropping information, sustainable cultivation techniques, nutrient requirement, irrigation systems, pest/weed control, sampling and testing for CBD/THC, harvesting, marketing, transportation, and handling of hemp biomass, and importance and use of cover crops in industrial hemp production, harvesting, storage, and processing.

-Partnered with the following agencies and entities for the webinar series – USDA, SCDA, FSA, HempGrid, Clemson University, NRCS, thereby broadening participation, networking opportunities, access to resources and career opportunities for our students, farmers, and other professionals.

-Presented SC State 1890 industrial research initiative at the Black Cowboy Rodeo- July 30th and 31st, 2021 Rembert SC. August 27, 2021.

Presented industrial cultivation information to attendees from across the state at the Low Country Agribusiness Tour. August 2021- St Helena Island, SC.

-Presented seminar/workshop to SC small scale farmers. Title: Use of Cover Crops as a IPM Tool for Fall Greens. Oct. 25, 2021. Bowman. SC.

-Developed a industrial flip chart/handbook for farmers and extension agents and other professional around SC and beyond.

- Two abstracts accepted for oral presentation at the ARD conference in 2022.

Abstract #1:Evaluation of Effects of Planting Date on Seedling Mortality Industrial Hemp Cultivar- Spectrum

Abstract #2: Comparative Analysis of Suitability of Three Cannabis sativa L. Cultivars for Field and Indoor Cultivation in South Carolina

- Forged collaborative hemp research partnerships with over 6 institutions including: North Carolina A&T, NC State University, Clemson University, University of South Carolina, Shaw University, Florida State University, Alabama State University.

- Currently working on forging partnerships with hemp-based industries (Ford Motors, BMW, Volvo) and end product producers and consumers for student training others and employment opportunities.

Briefly describe how your target audience benefited from your project's activities.

Target Audience: Students, farmers, scientists, extension agents, community members, and other professionals.

The project provided multiple opportunities for training and professional development via face-to-face group meetings/discussions, seminars, and webinars to students, extension agents, farmers, and other professionals.

Two minority farmers recruited for our demonstration research initiative have acquired adequate knowing through experiential learning to successful grow hemp on their farmers.

Additionally, undergraduate interns involved in the research had opportunities to acquire knowledge in agricultural research and technology via experiential learning and participation in field and indoor industrial hemp research.

Developed an industrial hemp flip chart/handbook for farmers and extension agents and other professional around SC and beyond.

Briefly describe how the broader public benefited from your project's activities.

Two abstracts accepted for oral presentation at the ARD conference April 2022.

Abstract #1:Evaluation of Effects of Planting Date on Seedling Mortality Industrial Hemp Cultivar- Spectrum

Abstract #2: Comparative Analysis of Suitability of Three Cannabis sativa L. Cultivars for Field and Indoor Cultivation in South Carolina

Conducted four regional webinars series.

Topics covered include hemp basics, licensing, State and Federal regulations, land acquisition and registration for hemp cultivation, selection of genetics, row cropping information, sustainable cultivation techniques, nutrient requirement, irrigation systems, pest/weed control, sampling and testing for CBD/THC, harvesting, marketing, transportation, and handling of hemp biomass, and importance and use of cover crops in industrial hemp production, harvesting, storage, and processing.

-Partnered with the following agencies and entities in the delivery of the webinar series – USDA, SCDA, FSA, HempGrid, Clemson University, NRCS.

Webinar #1: Getting Started in Hemp Production.

Presenters: Dr. Florence Anoruo, SC State 1890 Industrial Hemp Researcher

Vanessa Elsalah, South Carolina Hemp Program Coordinator, SC Dept of Agriculture

Jody Carter, Orangeburg County Executive Director. Farm Service Agency (FSA)

Webinar #2: Industrial Hemp Production and Industry Basics Unearthed Session II

Presenters: Dr. Florence Anoruo, SC State 1890 Industrial Hemp Researcher

Jason Eargle, HempGrid Management Team

Webinar #3: Industrial Hemp Production and Industry Basics Unearthed Session IIe

Presenters: Dr. Florence Anoruo, SC State 1890 Industrial Hemp Researcher

Jason Eargle, HempGrid Management Team

Webinar # 4: Industrial Hemp Production and Industry Basics Unearthed, Session IV

Presenters: Dr. Florence Anoruo, SC State 1890 Industrial Hemp Researcher

Jason Eargle, HempGrid Management Team

Results and information have been disseminated via social media- Youtube, University website, presentation at SC State 1890 and other SCDA hosted events, seminars and webinars, professional meetings, and conference.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Continue work on phase 2 of our indoor/outdoor genetics hemp trials, with addition of third demonstration site and expanding our cultivars for CBD oil, fiber, and grain selection from 3 to 9.

- Complete development of our hemp and industrial hemp curriculum content for formal education of students in the School of Agriculture, farmers, and other interested parties.
- Expand our field demonstration research sites from 2 to 3 (Charleston and Branchville), and the third at SC State 1890 research demonstration farm, Olar SC.
- Add an additional small scale and socially disadvantaged farmer to our cohort of farmer collaborators.
- Recruit a graduate student and research assistant
- Establish field research plots at the SC State 1890 demonstration farm in Olar, SC for CBD and fiber genetics trials.

Sustainable Agriculture, Natural Resources and Environment

Project Director

Edoe Agbodjan

Organization

South Carolina State University

Accession Number

7002111



Small Farmers Make Commercial Vegetable Production Better

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Commercial vegetable production is an important source of income to many small farmers in South Carolina. Many of the farmers may not utilize the latest, improved production practices, or research-based information generated by the Extension System. The farmers have negative challenges affecting vegetable production, such as, drought, pollination and market access adversely affecting yield.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The major activities helped to achieve or make significant progress toward the goals and objectives described in the non-technical summary by conducting on farm demonstrations, receiving instruction on proper applications, and assisting the farmers in providing value addition to their products, including packaging their products to the standards of the regional food hubs. Some of the activities included projects conducted under the Integrated Pest Management (IPM) Program. Several of the agents used the silver, metallic plastic mulch, and the IPM Fall Greens Project. The metallic, silver plastic mulch allowed key participants to evaluate their use on their farms. It was used to help with weed control, as well as an insect management tool. Participation in the IPM Fall Greens Project exposed some farmers to the use of improved vegetable varieties, and updated production methods.

The pandemic made food access more difficult and hampered the agents in providing outreach efforts. The agents had to be creative and innovative, to work with the farmers. The agents used a hybrid delivery method to solve many problems and assist the farmers.

Briefly describe how your target audience benefited from your project's activities.

Many citizens that live in communities located within the urban and rural communities in South Carolina regions do not have easy access to grocery stores. Communities also face supply chain issues that hamper the availability of food on shelves for sale. Since COVID-19, there has been an increased interest in local food production. The opportunity has presented itself for small-medium sized vegetable farms who are interested in selling direct to customers to do so. Because of the training and knowledge provided to the farmers, some were able to earn 2 hours re-credit toward their pesticide license.

Briefly describe how the broader public benefited from your project's activities.

The broader public benefited from the project's activities because citizens were provided easier access to purchasing food or fresh vegetables through farmers markets, roadside stands, on-farm sale techniques, etc. One hundred and ninety-eight (198) small scale farmers received educational training in vegetable production and marketing. One farmer was able to market some of his fall vegetable crops to a local food hub. Three farmers reported profitability gains. Three hundred acres of land were affected by the integrated crop management practice. Thirty acres were involved in conservation tillage. Participants adopted new improved skills and used applied knowledge in commercial vegetable production, which made crops better for the public and yield a better and sustainable family farm that is strong and economically sound for farming communities.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

The COVID-19 pandemic focused the agents to change the way they conducted business. They had to be innovative in their delivery to the farmers as well as the constituents. Because of the training and professional development provided, the farmers were able to increase their profits and provide more quality products. The results have been disseminated through social media (podcasts, YouTube, etc.) and local publications.

[Economic Impact and Management of Important Foliar Pathogens of Vegetable Crops in South Carolina](#)

Project Director

Anthony Keinath

Organization

Clemson University

Accession Number

1024597



In 2-3 sentences, briefly describe the issue or problem that your project addresses.

This project facilitates a new cross-disciplinary collaboration across plant pathology, agricultural economics, and agricultural engineering to address persistent disease problems in the southern region with a new approach and focus. We will examine disease management from plant pathology, economic, and engineering perspectives, seeking to provide growers with new pest management practices that will improve yields and increase profitability. This project focuses on three representative vegetable crops grown in South Carolina: slicing cucumber (*Cucumis sativus*, Cucurbitaceae family), kale (*Brassica oleracea* var. *acephala*, Brassicaceae), and eggplant (*Solanum melongena*, Solanaceae). Key diseases on these crops include downy mildew on cucumber and other cucurbits caused by the oomycete *Pseudoperonospora cubensis*, Alternaria leaf spot on kale and other vegetable brassicas caused by the fungi *Alternaria brassica* and *A. japonica*, and Phomopsis blight on eggplant caused by the fungus *Phomopsis vexans*.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Objective 1. Activity: Conducted fungicide sensitivity bioassay on cucumber and butternut squash with 6 concentrations of oxathiapiprolin in October 2021. Outcome: Reduced sensitivity to oxathiapiprolin in *Pseudoperonospora cubensis* Clade 2 on cucumber was found at 0.5x, 0.25x, and 0.13x of the field rate, while sensitivity was reduced in Clade 1 on butternut squash only at 0.13x rate. Activity: Downy mildew was assessed and fruit were harvested from cucumber seed on March 24, April 15, and May 12, 2021 and sprayed or not sprayed with fluopicolide alternated with chlorothalonil. Outcomes: Yields of cucumber were similar with and without fungicides at the early planting date, but at the late planting date, yields were increased by 350% with fungicide applications. Early planting managed downy mildew without fungicide applications.

Objective 2. During Spring of 2021, an initial assessment of the GPS and data collection platforms was completed as part of a graduate level special topics course. Data was collected over multiple days in a simulated field with known reference locations to evaluate how well the collected data could be localized to an individual plant using different GPS correction types. Additionally, preliminary field testing was conducted in along with a kale field trial. The location, cultivar, pathogen type, disease severity, and photos of the inoculated plants were collected along with unmanned aerial vehicle (UAV) imagery of the field.

Objective 3. Activity. Using data collected on downy mildew severity, we estimated the disease diffusion curve and reverse engineered the potential yield without disease. Outcome: We found that the most expensive fungicide, three times more expensive than the least expensive, has net returns 22% higher than the least expensive, and 81% higher than the no fungicide treatment. Our results indicate that no fungicide is a viable option only under an extremely low probability of disease.

Briefly describe how your target audience benefited from your project's activities.

Early seeding of slicing cucumber in March in Charleston, SC, doubled profits compared to April seeding, even with a cost of \$168/acre for replacing 28% of the seedlings that were killed by frost after they emerged. Early seeding resulted in a profit of \$21,600/acre, while late seeding (2 weeks before downy mildew appeared) resulted in a net profit of only \$25/acre. Early seeding eliminated the need for fungicide applications to manage downy mildew. Fungicide applications at the late seeding date produced yields and profits similar to nonsprayed cucumbers at the middle seeding date but lower than the nonsprayed cucumbers at the early seeding date. Late-seeded cucumbers require regular fungicide applications to be profitable. More expensive fungicides do not necessarily increase yields compared less expensive fungicides. This result can help growers to reduce their fungicide costs by up to \$80/acre.

Briefly describe how the broader public benefited from your project's activities.

Early planting of cucumbers can be used to increase the supply of organic cucumbers, increasing the supply of locally produced organic cucumbers while reducing transportation costs and the associated carbon outputs.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to

communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Training in detection and identification of cucurbit downy mildew was provided for 1 PhD student, and training in GPS and UAV use was provided to 2 MS students and 1 PhD student.

Results were disseminated to vegetable growers, agribusiness personnel, and Extension agents via six virtual meetings on Jan. 20, 2021 (North Carolina Cabbage Meeting), Feb. 4, 2021 (Clemson Hort Team Virtual Cucurbit Meeting), Feb. 11, 2021 (Clemson Hort Team Virtual Brassica Meeting), Feb. 2021 (Southern Agricultural Economics Association conference, Online), April 8, 2021 (Canadian Reduced-Risk Strategy for Cucumber Downy Mildew Annual Meeting), and four presentations on downy mildew of cucumber at the Clemson Coastal REC Field Day on June 17, 2021.

Peer-reviewed publication: Keinath, A. P., Toporek, S. M., DuBose, V. B., Zardus, S. H., and Ballew, J. B. 2021. First report of *Alternaria japonica*, a causal agent of black spot, on kale in South Carolina, United States. Plant Dis. 105(7):2016. <https://doi.org/10.1094/PDIS-01-21-0085-PDN>

Increasing Long-Term Profitability and Sustainability of Advanced Techniques in Prunus Agriculture in South Carolina

Project Director

Jeffrey Adelberg

Organization

Clemson University

Accession Number

1024860



Increasing Long-Term Profitability and Sustainability of Advanced Techniques in Prunus Agriculture in South Carolina

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

We address many of the key problems affecting peach production in the Southeastern U.S.

Major replant problems that endanger peach production in the U.S include Peach Tree Short Life (PTSL) and Armillaria Root Rot (ARR). PTSL is a complex syndrome that includes susceptibility of rootstocks to ring nematode (*Mesocriconema xenoplax*) and scions to bacterial canker (*Pseudomonas syringae*) infection. ARR in the SE is caused by the soil-borne fungus *Desarmillaria tabescens* that infects the root(s) and colonizes at the soil-trunk interface, killing the tree by girdling. Conventional rootstock breeding cycles can take up to 40 years for release. Thus, there is a need to understand genetic resistance mechanisms and establish a platform for biotechnology enhancement of existing rootstocks through genomics, genetics, and in vitro methodology.

Carbon pools in soils are critical for maintaining the productivity and sustainability of agroecosystems. Orchards with soils with a low organic C level are more susceptible to diseases and have reduced resilience to climatic variability. Thus, there is a need for improving peach orchard sustainability through the amelioration of soil health.

Safeguarding southeastern peach production from viruses and other graft-transmissible pathogens is also a critical part of our mission.

Furthermore, the peach root-knot nematode (*Meloidogyne floridensis*) was first found in South Carolina in 2019. Because current distribution of *M. floridensis* in South Carolina is currently unknown, statewide survey is necessary. Additionally, management options for this nematode are limited as the most widely used Guardian® rootstock is susceptible to *M. floridensis*. Research is needed to determine alternative nematode management methods such as nematicides and cover crops.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Several experiments have been conducted that are aimed to understand the genetic architecture of host resistance to ARR. Our results have revealed several candidate genes that are induced and highly expressed upon ARR infection. Experiments have also been performed that are aimed to improve in vitro plant growth and disease challenge conditions. These results

have led to an improved system to assess host resistance to ARR using a carefully controlled system which has led to the identification of new plum germplasm with possible ARR resistance mechanisms. Additional experiments have also tested various explant sources and conditions that are conducive to plant regeneration through somatic embryogenesis. Our results have led to a system that is amenable to genetic transformation and whole plant regeneration.

Two experiments on improving soil health through the application of soil organic amendments are being carried out at our experimental orchards. Our results in 2021 showed how hardwood mulch applied at planting (mixed in the soil) increased tree growth within a year of application, whereas mulch or mulch and poultry litter surface-applied to mature (6-year-old) trees partly or completely replaced the need for synthetic fertilization within two years. Mulch as well as compost additions improved soil water holding capacity, which can be critical during a dry spell.

We tested over 6,500 trees for Prunus necrotic ringspot virus, prune dwarf virus, and plum pox virus. This sampling effort consisted of trees in commercial orchards for cultivars of interest for propagation, orchard blocks for production of rootstock seed, and breeder blocks. Providing these results to the growers and nurseries enabled them to avoid propagating budwood/seed from the virus-infected trees, thus reducing the risk of large-scale spread of economically important viruses. Additionally, we initiated a project to test the efficiency of bacteria (*Xylella fastidiosa*) transmission through two major methods of grafting- T-budding and chip budding. Ultimately this project will enable nurseries to make data-driven decisions on their methods of tree propagation.

We conducted a survey to determine the distribution of *M. floridensis* in South Carolina was limited to a few orchards in Upstate in 2021 and the survey will continue in 2022. Because *M. floridensis* has not been detected in the samples surveyed so far, an isolate of *M. frloidensis* from Florida is being used to establish the inoculum for cover crops evaluation. Experiments have been established for winter cover crops in a greenhouse. Additionally, to determine the efficacy of non-fumigant nematicides against nematodes associated with peach, on-farm studies were conducted in 2021.

Armillaria Root Rot (ARR) is a substantial problem that many peach growers have to deal with, especially over the last few years. Despite the severity of the disease, currently, we do not have accurate estimates about the economic impact of ARR for peach growers. To be able to learn more about the extent of the problem, as well the ways producers utilize to tackle the issue, a survey instrument was developed. The purpose of this questionnaire is to estimate the impact of Armillaria Root Rot on peach production in the United States. This is the first study to evaluate the cost of this disease to United State producers.

Briefly describe how your target audience benefited from your project's activities.

Target audience is commercial peach growers, Extension agents, private consultants, the fruit-tree nursery industry, researchers and Extension agents.

Presentation of relevant results were delivered to 2021 American Society for Horticultural Science, Southeastern Regional Fruit and Vegetable Conference, Society for in Vitro Biology National Meeting (virtual) Great Lakes Fruit and Vegetable Expo, National Clean Plant Network Virtual Meeting, Clemson University Board of Visitors tour of our experimental farm, Titan Farm Board of Directors (largest peach producer in Southeastern U.S.), and Plant and Environmental Sciences Seminar Series.

Briefly describe how the broader public benefited from your project's activities.

The broader public benefits from this project because management of ARR leads to the sustainability of peach farms, which contributes to the economy of the state and the region. Soil health and improvement of the orchard as an eco-system promotes long-term profitability and sustainability of peach farms, which contributes to the economy of the state and the region. Our virus-testing program contributes to the long-term viability of orchards. Management of nematodes leads to the sustainability of peach farms, which contributes to the economy of the state and the region.

A website for the clean plant program was also developed and shared with stakeholders (cleanplant.clemson.edu).

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Two postdoctoral scientists were mentored in research designs, data collection and interpretation, manuscript preparation, and in supervising undergraduate and graduate students. In addition, multiple undergraduate, graduate, and technical staff were trained in genomic analysis, genetics, in vitro biology, design of experiments, and genetic transformation. We will

continue collecting data for the activities detailed in the project, with a focus on improving somatic regeneration and understanding the genetic mechanisms of host resistance to ARR derived from plum progenitor species and disseminate any relevant piece of information to the target audience.

Undergraduate and graduate students were trained in physiological and horticultural measurements (such as gas exchange, tree water relations, and growth parameters), and tissue analysis techniques. We will continue collecting data for the activities detailed in the project, with an emphasis on tree and soil nutritional and water status, gas exchange, growth, and tree health, and disseminate any relevant piece of information to the target audience.

In the virology program, two staff members were hired on this project and gained experience in stakeholder engagement, field study management, and virus diagnostics. Staff working on this project gained experience in website design (cleanplant.clemson.edu). We will conduct the annual virus survey in spring 2022, with plans to test an estimated 7,000 trees for PDV, PNRSV, and PPV using ELISA. Additionally, we will conduct a pilot experiment to improve diagnostic methods, in which a subset of orchard blocks will be tested by both ELISA and qRT-PCR (a more sensitive method) in order to determine if qRT-PCR detects lower-titer virus infections earlier than ELISA. Depending on these results, we will adjust our diagnostic methods accordingly. We will also begin to develop virus elimination capabilities by combining heat therapy and meristem tip tissue culture.

A graduate student has been trained on survey of nematode samples, nematode identification, and greenhouse evaluation. The nematode survey will continue to reach as many peach orchards in South Carolina as possible. Greenhouse study on summer cover crops will be conducted. Data analysis and manuscript preparation will be conducted for the greenhouse and on-farm experiments.

A graduate student has been hired, worked on an economic survey instrument, and is learning about the statistical techniques needed for this analysis.

There was a peer reviewed publication:

Adelberg J, Naylor-Adelberg J, Miller S, Gasic K, Schnabel G, Bryson P, Saski C, Parris S, Reighard G. 2021. In vitro co-culture system for *Prunus* spp. and *Armillaria mellea* in phenolic foam rooting matrix. *In Vitro Cellular & Developmental Biology - Plant*. 57(3):387-397. doi: 10.1007/s11627-020-10136-2.

Management of Arthropod Pests and Soilborne Pathogens on Ornamental Plants, Trees, and Turfgrasses in the Southeast

Project Director

Steven Jeffers

Organization

Clemson University

Accession Number

1024864



Management of arthropod pests and soilborne pathogens on ornamental plants, trees, and turfgrasses in the Southeast

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

The production and use of ornamental plants and turfgrass has become an increasingly important part of the economy in South Carolina, the southeastern region, and the United States. However, plant diseases and arthropod pests can pose major limitations and challenges to sustainable production and consistent profitability in the ornamental plant and turfgrass industries—particularly in the warm, humid climate of the southeastern USA where pathogens and pests, as well as plants, flourish. Therefore, we are conducting research on diseases and arthropod pests in turfgrass and ornamental plant systems that impact the southeastern region of the USA so that we can we develop extension and outreach resources to improve the diagnosis and management of these pest and disease problems.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Major activities by the Jeffers Lab Group. We have an ongoing research project studying *Phytophthora* root and crown rot (PRCR) on lavender plants in the USA and routinely receive plant and soil samples from lavender growers around the country. To date, we have identified ten species of *Phytophthora* involved in PRCR. *P. nicotianae* is the most frequently isolated species with *P. citrophthora* and *P. palmivora* isolated less frequently. Seven other species have been isolated occasionally including *P. cactorum*, *P. cinnamomi*, *P. cryptogea*, *P. drechsleri*, *P. megasperma*, *P. sansomeana*, and *P. tropicalis*. We currently are developing a non-destructive procedure for sampling and detecting *Phytophthora* spp. on young, nursery-grown plants before plants are planted in the field. This will prevent introducing these pathogens into lavender fields on contaminated plants where *Phytophthora* spp. can become established and persist for years. We summarized results from two experiments evaluating the efficacy of 12 oomycete-specific fungicides to manage this disease in the greenhouse and confirmed that phosphonate products were most effective. We also summarized results from previous experiments to determine if a quaternary ammonia product containing the active ingredient didecyltrimethylammonium chloride could be used to remediate *P. nicotianae* populations in lavender field soil. Although there was a significant reduction in pathogen activity, the treatments were not effective enough to be used for disease management by growers.

We collaborated again with Syngenta Flowers, Inc. to evaluate 32 annual vinca (*Catharanthus roseus*) genotypes for resistance to 16 isolates of *P. nicotianae*. Annual vinca is one of the most popular bedding plants planted in the southeastern USA. Data from our annual resistance evaluations helps develop more resistant cultivars of annual vinca that will survive better in southeastern landscapes. We identified *P. cinnamomi* as a pathogen of three native tree species for the first time in the USA: Northern red oak (*Quercus rubra*), water oak (*Q. nigra*), and loblolly bay (*Gordonia lasianthus*). We determined that root systems on these tree species had to be flooded periodically for plants to show foliage symptoms and succumb to disease; therefore, flooding was shown to be a predisposing factor that enhanced disease development.

Major activities by the Chong Lab Group. In 2020-2021, data and results generated by this project formed the basis for three peer-reviewed papers, three chapters in ornamental plant and turf pest management guidebooks, four scientific paper presentations, 28 popular press articles (i.e., extension bulletins, newsletters, and trade journal articles), and 21 extension educational presentations or programs to state, regional, national, and international stakeholders. The newsletter *PestTalks* reaches nearly 27,000 subscribers biweekly. A total of 1,636 contacts were made through educational programs, specimen identification, management recommendations, and site visits. Studies conducted during this period generated efficacy data for several new insecticides and provided stakeholders with scientific data for selecting the most effective pest management products.

To address Objective 1 under the goal of developing management programs for arthropod pests of ornamental plants and turfgrasses, sampling of wood boring insect diversity and seasonal abundance has been conducted at various nurseries in South Carolina and North Carolina; 48 species of bark and ambrosia beetles have been collected using ethanol-baited soda-bottle traps. The main activity period for these beetles was March to June, suggesting that management efforts should focus on this time period. Low numbers of individuals, however, were collected throughout the year. Attempts to develop a degree-day model and to identify plant phenological indicators so far have not been fruitful. Attempts to correlate insect abundance with locations and habitat types also failed.

A study was developed to determine if the addition of ethanol or benzaldehyde to sticky purple panel traps may increase the effectiveness of the sticky traps in collecting flatheaded borers, particularly the flatheaded appletree borer, which is a major pest of ornamental trees in nurseries. Only a small number of borers were collected; therefore, we were not able to evaluate whether the volatile lures can improve trapping efficacy. However, with additional trapping, we determined that *Chrysobothris veridiceps*, instead of *C. femorata* (the flatheaded appletree borer), is the major species in nurseries of both North and South Carolina. The current management approach for flatheaded borers in ornamental tree nurseries was based on previous research that the major species was *C. femorata*. Discovery from this study suggests that the current management approach may need to be modified to address a different flatheaded borer species, *C. veridiceps*, which is likely to have a different life cycle and differ in susceptibility to management tools than *C. femorata*.

An effort to address Objective 2 has yielded significant results. A study on how fertilization, irrigation, and mowing can impact the severity of bermudagrass mite infestation suggests that increased fertilization, reduce irrigation, and greater mowing heights increased the severity of infestation. Investigations of the efficacy of various insecticides and miticides also identified spirotetramat as a potent miticide in reducing the abundance and damage from bermudagrass mites. Based on the results from this project, a request was submitted by Bayer Environmental Science to regulatory agencies in Florida, Georgia, South Carolina, Mississippi, and Texas to allow for a 24(c) Special Local Needs Registration of the insecticide Kontos against bermudagrass mite on golf course turf.

Major activities by the Roberts Lab Group. Throughout the reporting period, our lab diagnosed 162 turfgrass samples with 90 diagnoses (56%) were pathogens impacting the roots. Of these samples, 15 diagnoses (9%) were take-all root rot (TARR, *Gaeumannomyces* spp.), one (0.6%) was spring dead spot (*Ophiosphaerella* spp.), one was fairy ring (unidentified), one was

Pythium root rot (*Pythium* spp.), and 72 diagnoses (44%) were pathogenic nematodes (multiple species).

Soilborne pathogens impacting turfgrasses were isolated so individual species could be identified using molecular tools. Recent literature has shown six different fungus species can cause TARR—including *Gaeumannomyces* sp., *G. graminicola*, *G. graminis*, *G. nanograminis*, *Candidacolonium cynodontis*, and *Magnaportheopsis cynodontis*. Isolations from turf samples in South Carolina, based on sequencing of the DNA internal transcribed spacer region, has positively identified *G. nanograminis* as a pathogen causing TARR in the coastal areas of South Carolina. Isolations from turfgrass samples will continue in coming years to examine potential variation in the causal agents of TARR in additional areas throughout the southeast. Similarly, nematode pests have been positively identified to genus using established morphological features. Over the past year, pathogenic nematode species have included *Belonolaimus* sp., *Helicotylenchus* sp., *Hoplolaimu* spp., *Meloidogyne* spp., *Mesocriconema* sp., and several others. Of these, *Belonolaimus longicaudatus* has been observed to cause significant damage even at low population densities, which is consistent with previous reports in the literature.

Briefly describe how your target audience benefited from your project's activities.

The target audience of this project includes greenhouse and nursery personnel, other ornamental plant producers, sod producers, golf course superintendents and managers, athletic field managers, landscape and lawn care professionals, arborists, municipal and private grounds managers, Extension personnel, Master Gardeners, pest management product manufacturers and dealers, and researchers.

Activities conducted by the Jeffers lab group is having a significant impact on the Phytophthora root and crown rot problem affecting the lavender industry in the USA. Their research has identified the primary pathogens and determined that the main source of inoculum is coming from the nurseries and greenhouses growing lavender plants. Therefore, they are working on a project to identify contaminated plants before they are planted in the field, which should help prevent contaminating field sites. They also have identified the most effective types of fungicides for managing the disease. The lab group is working with industry partners to develop cultivars of annual vinca cultivars resistant to *P. nicotianae*, so plants will survive better in southeastern landscapes. They have identified new diseases that threaten some of the tree species native to the Southeast and the environmental conditions that promote disease development.

By focusing on the prevalence of soilborne issues occurring in turfgrass areas, the Roberts lab group identified some of the key pathogens causing these problems. They provided several educational opportunities for managers in South Carolina and the surrounding region. Educational opportunities highlighted two field trials evaluating chemical control application methods in 2020 in addition to current knowledge surrounding the topic. The program had three joint (with NC State University) online sessions offering turfgrass managers the opportunity to sign-on and ask questions. Moreover, our program has provided seven presentations at online and in-person meetings across the reporting period.

Activities conducted by the Chong lab group allowed stakeholders to better understand the biology and more accurately schedule insecticide applications against scale insects, wood boring insects, whiteflies, thrips, spider mites, redheaded flea beetle, and other arthropod pests. Recommendations for better application methods, timing, and product selection benefitted six ornamental plant nurseries, eight greenhouses, five professional landscape care operations, and six golf courses throughout the country by reducing crop losses and pest management expenses.

Briefly describe how the broader public benefited from your project's activities.

The broader public benefits from our project activities because our target audience is becoming better educated and more knowledgeable about the pest and disease problems affecting turfgrass, ornamental plants, and trees in the southeastern USA. This translates into healthier plants being produced and grown, healthier landscapes, parks, and sports fields across the region, and an overall reduction in pesticide use. Likewise, this will result in increased utilization of home lawns, sports fields, parks, and golf courses in the region at a time when the general public increasingly wants to enjoy outdoor activities.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

To date, there have been no major changes or problems on this project. We are making good progress on our objectives and will continue moving forward as outlined in the proposal.

Training opportunities: Four PhD students (Daniel Dlugos, Matthew Brown, Dawn Sikora, Cory Tanner) and four MS students (Annie Borlik, Caitlin Silva, Ray Adcock, Malone Thomason) worked to help accomplish the objectives set forth in the project proposal. These students were trained in scientific methodology, scientific and extension writing, and oral and written communication skills. In addition, three undergraduate students worked in the Jeffers lab and learned basic lab and greenhouse procedures and skills for conducting research. Eleven full-time and part-time employees worked on various aspects of this project and were trained on proper procedures for collecting, sorting, and preparing samples. In addition, several virtual training sessions and workshops were held for stakeholders because in-person activities were limited by COVID restrictions.

Dissemination of results: The results of this project were disseminated primarily through presentations at scientific and extension workshops and meetings, as well as publications in peer-reviewed journals, trade journals, and newsletters at the state, regional, national, and international levels. Most of the dissemination of project results during the current time period was done virtually due to COVID restrictions and limitations.

Plan for the next reporting period: Studies outlined in this project will be continued, and several manuscripts reporting on completed studies will be published in the next reporting period. Two MS and two PhD projects are nearing completion. At the completion of these graduate student projects, theses, dissertations, peer-reviewed publications, and scientific and extension presentations will be produced.

Peer-reviewed Publications

Brown, M. S., C. K. Blubaugh, and J. H. Chong. 2021. Biology and management of eriophyid mites in turfgrass. *Journal of Integrated Pest Management* 12: 25. doi: 10.1093/jipm/pmab020

Joseph, S. V., R. Wolverton, and J. H. Chong. 2021. Efficacy of selected insecticides in reducing rhodesgrass mealybug (Hemiptera: Pseudococcidae) density on golf course putting greens. *Journal of Agricultural and Urban Entomology* 37: 10-21.

Joseph, S. V., J. H. Chong, B. Campbell, B. Kunkel, D. Lauderdale, S. Jones, S. Gill, Y. Chen, P. Schultz, D. Held, F. Hale, A. Dale, E. Vafaie, W. Hudson, D. Gilrein, and A. Del Pozo-Valdivia. 2021. Current pest status and management practices for *Systema frontalis* (Coleoptera: Chrysomelidae) in ornamental plants in the eastern United States: An online survey. *Journal of Integrated Pest Management* 12: 17. doi:10.1093/jipm/pmab012

Kheirodin, A., A. M. Simmons, J. C. Legaspi, E. E. Grabarczyk, M. D. Toews, P. M. Roberts, J.-H. Chong, W. E. Snyder, and J. M. Schmidt. 2020. Can generalist predators control *Bemisia tabaci*? *Insects* 11: 823. doi:10.3390/insects11110823

Brown, M., and J. H. Chong. 2021. Biology and management of bermudagrass mite. LGP 1112. Land-Grant Press by Clemson Cooperative Extension, Clemson, SC. <https://lgpress.clemson.edu/publication/biology-and-management-of-bermudagrass-mite/>

Jeffers, A.H., and J. H. Chong. 2021. Biological control strategies in integrated pest management (IPM) programs. LGP 1111. Land-Grant Press by Clemson Cooperative Extension, Clemson, SC. <https://lgpress.clemson.edu/publication/biological-control-strategies-in-integrated-pest-management-ipm-programs/>

(Please reapprove; no changes were made) Water Management and Quality for Specialty Crop Production and Health

Project Director

Sarah White

Organization

Clemson University

Accession Number

1023841



2021-22

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Water quality and optimized application of water are critical components of successful crop production. Yet only water pH and EC are commonly monitored in specialty crop production facilities, with only 38% of operations reporting in a recent national survey. Only 53% of respondents measured water usage, of those that measured water use - only 30% measured water

volume applied with a flow meter, an accurate, low-labor means to measure water use. Many operations do not know how much water they use or how much water leaves their production areas after an irrigation event. Lack of accurate information regarding water volumes applied or in irrigation return flow reduces information accuracy for planning for drought scenarios or expansion of production acreage.

Increased levels of nutrients in surface waters can lead to eutrophication, algal blooms, and impairment of water bodies. Operations growing specialty crops in containers use intensive production practices that can release relatively large quantities of nutrients into surface and groundwater. Plants require more nitrogen and potassium than phosphorus (P), although they are typically applied at a similar ratio (i.e., 20-20-20), which can lead to relatively large amounts of P leaching from a container into surface waters. Moderately lower P uptake rates in plants also make it more difficult to remove P from natural aquatic systems. Capturing P before it leaves an operation is beneficial for the environment and may also prove beneficial for the grower if a process could be developed to recycle P within an operation. This project took steps toward “closing the loop” for P recycling in specialty crop operations by evaluating the use of substrates to sorb P from operational water and the potential for use of P-saturated substrates as a supplemental P source that enables the production of container plants with less P supplied as fertilizer while protecting the environment from excess P additions.

Multiple water quality and quantity issues exist at the interface of agricultural, urban, and ecological landscapes. These issues (e.g., harmful algal blooms, runoff quality, operational water quality, and flooding) impact the sustainability and security of all three systems. Sustainable water resource issues can be addressed by utilizing various digital technologies such as sensors, databases, automation, analytics and computer modeling. The tools, technologies, and techniques developed could help answer various intriguing water quantity and quality questions related to the behavior of urban and agricultural micro watersheds, watershed management, runoff management, crop management, stormwater, stream restoration science, harmful algal blooms and many more.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Researchers from Clemson University and USDA-ARS Wooster finished characterizing operational and stormwater quality dynamics for two production watersheds in SC in fall 2021. Water samples were collected over time from operational water entering both a small (area = 0.95 acres) and large (area = 7.69 acres) reservoir. These data were used to begin estimation and visualization of storm event runoff volumes, reservoir refill rates, irrigation return flow, and water quality (e.g., suspended sediments, nutrients, pH, electrical conductivity, dissolved oxygen). Data (both volume and quality-based) will be integrated to characterize the movement of contaminants within water during storm and irrigation events. Growers can use this data to better inform reservoir management and refill strategies (whether storm event runoff will be adequate for irrigation needs or if groundwater pumping will also be needed).

Plant growth trials were completed with four plant species over an 8-month period to determine if iron-oxide (saturated with phosphorus filtered from operational water) could serve as a slowly available phosphorus source. We performed 162 serial extractions of the potting substrates to determine the fractionation and relative availability of P across chemical fractions and quantified plant growth responses. We determined which species responded similarly to control release fertilizers or iron oxide / calcined clay as a supplemental phosphorus source. *Panicum virgatum* and *Rosa* spp. responded similarly to phosphorus supplied from a controlled-release fertilizer or that which desorbed from a phosphorus saturated substrate.

Research and development of various monitoring systems for the Hunnicutt Creek watershed in the Piedmont Ecoregions of SC have helped us understand the issues with digital technologies. As urban stormwater is an objective of the project, data-driven technologies that can help understand urban stormwater and runoff in an intelligent way – can also be adapted to enable the prediction of water dynamics in agricultural systems. An understanding of different data-driven tools will also aid in better runoff and nutrient management in multiple settings. They will also help in better understanding water quality issues such as algal blooms in aquatic systems impacted by varied land uses.

Focus group meetings were organized to better understand the issues with algal blooms in livestock ponds. Farmers, Clemson Extension agents, and employees from NRCS, EPA, and SCDHEC participated in the focus group meetings. The discussions from the focus group meetings will help in creating various educational tools and reference documents for the participants to address harmful algal blooms when they get a call or see it first-hand.

Briefly describe how your target audience benefited from your project's activities.

Growers of nursery and greenhouse crops now have slightly better information on potential reservoir refill rates and also information on how production practices (irrigation style) influence operational water volumes returning to reservoirs. We also have begun development of a filtration technology that can remove phosphorus from operational water or runoff before

it leaves an operation, helping to better protect downstream ecosystems.

Better digital technologies and tool availability benefit growers, municipalities, engineers, Municipal Separate Storm Sewer (MS4) communities, water quality managers, extension agents, farmers, and regulators.

Briefly describe how the broader public benefited from your project's activities.

Results from water quality and volume monitoring and assessment will enhance knowledge related to water storage by production system, flow timing and dynamics, peak loading times during irrigation events, dilution volumes (how much water needs to be captured before it can be released offsite with minimal potential for negative environmental impacts), and reservoir sizing to capture irrigation return flow for water recycling.

One grower indicated an interest in developing phosphorus filtration technologies for their operation. We are working to broaden the applicability of results and determine the capacity of the varied substrate to serve in a similar manner to iron oxide substrates.

The outcomes of the research on digital technologies helped stakeholders to visualize the impact of watershed disturbances, runoff quality, and storm events. The outcomes from the focus group meetings will help develop reference materials on harmful algal blooms that would help the first responders during an algal bloom in livestock ponds.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

- Issues with instrumentation are always challenging. Field maintenance is a key component in the application of digital technologies to water and the environment. Data management is crucial for big data collection.

- One co-PI (Majsztrik) moved to an alternate position, so the research suggested by him will no longer be completed (SC will test irrigation system efficiency for a number of impact, micro-irrigation, and drip irrigation systems. Distribution uniformity, wear over time, and the influence of wind and other parameters will be tested.)

- Training materials for the stakeholders (extension agents and farmers) on harmful algal blooms are being developed.

- Research results were disseminated using conference and seminar presentations, journal articles, webinars, and Land-Grant Press by Clemson Extension articles.

Peer-referred publications of 2021-22:

- Scaroni, A., D. Sahoo and C. G. Wallover. 2021. Stormwater Ponds in South Carolina. Land Grant Press Extension Article, Clemson University. August 29, 2021.

- White, S., L. E. Beecher, R.H. Davis, H.B. Nix, D. Sahoo, A. E. Scaroni, and C. G. Wallover. 2021. Ponds in South Carolina. Land Grant Press Extension Article, Clemson University. July 2, 2021.

- Sahoo D, Yazdi MN, Owen, Jr. JS, White SA. The Basics of Irrigation Reservoirs for Agriculture. Clemson (SC): Clemson Cooperative Extension, Land-Grant Press by Clemson Extension; 2021 Oct. LGP 1121.
<https://lgpress.clemson.edu/publication/the-basics-of-irrigation-reservoirs-for-agriculture/>.
<https://doi.org/10.34068/LGP.R.01>

- o Garcia Chance, LM, CR Hall, SA White. 2022. Viability assessment for the use of floating treatment wetlands as alternative production and remediation systems for nursery and greenhouse operations. *Journal of Environmental Management*. 305:114398. <https://doi.org/10.1016/j.jenvman.2021.114398>
- o Yazdi, MN, JS Owen, SW Lyon, SA White. 2021. A Critical Review of Irrigation Retention Reservoir Performance and Design Considerations to Enhance Water Security for Specialty Crops. *Journal of Cleaner Production*. 321:128925. <https://doi.org/10.1016/j.jclepro.2021.128925>
- o Bell, NL, SN Jeffers, SA White. 2021. Potential susceptibility of six aquatic plant species to infection by five species of *Phytophthora*. *Plant Disease*. 105(12):4074-4083. <https://doi.org/10.1094/PDIS-10-20-2190-RE>

Closing Out (end date 09/07/2023)

Biological Control of Arthropod Pests and Weeds

Project Director

Juang-Horng Chong

Organization

Clemson University

Accession Number

1017633



Biological control of arthropod pests and weeds in South Carolina

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Vegetables and ornamental plants grown in fields, greenhouses, and nurseries, as well as ornamental plants and grasses maintained in urban landscapes, are highly valuable to the economy and wellbeing of our citizens. But, these valuable plants are often attacked by a myriad of insect and mite pests. These endemic and invasive pests have traditionally been managed through the frequent applications of insecticides, which resulted in reduced efficacy, pesticide resistance, and human and environmental risks. By integrating biological control within the larger framework of vegetable and ornamental plant management, we will be able to reduce pesticide application and the associated environmental, pest management, and socioeconomic consequences. Research and extension activities conducted under this project result directly in achieving pest management goals while alleviating the associated problems.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

As part of a collaboration among members of this group (Chong, Mutschler-Chu and Schmidt), Chong and a PhD student (Matthew Brown) had investigated the foraging behavior and efficacy of three predatory mite species (*Phytoseiulus persimilis*, *Neoseiulus californicus* and *Amblyseius andersoni*) and a predatory beetle (*Stethorus punctillum*) on a commercial tomato cultivar (Amelia) and an acylsugar-producing experimental tomato line (CU07). Results suggested that *S. punctillum* foraged on both tomato lines equally, whereas the predatory mites foraged on CU07 at a much lower frequency than on Amelia. Consumption of spider mite eggs by the predatory mites were also significantly lower on CU07.

In another study, Chong and Brown also investigated the potential for bifenthrin medium incorporation to impact predatory mite efficacy. As part of the red imported fire ant quarantine requirements, ornamental plant nurseries in the quarantined areas are required to treat the artificial medium used to grow the plants with selected insecticides (bifenthrin being the most commonly used). The team released *P. persimilis* on medium treated with bifenthrin at different times (thus different residual ages) and documented the numbers of predatory mites and the numbers of surviving spider mite eggs on lima bean plants where the predatory mites moved to after crawling across the treated medium. Results suggested that even bifenthrin residue of 7 days had no observable impacts on the survival of the predatory mites and their consumption of spider mite eggs.

A study to document natural enemy diversity of the muhly grass mealybug, *Stemmatomerinx acircula*, in urban landscape of South Carolina is on-going. The invasive mealybug species was first detected in 2018 and is now known in the coastal counties throughout the southeastern US and other states further in-land. An egg predatory wasp in the family Pteromalidae have been collected in 2020 but its identity has not been confirmed. Common lady beetle species, such as *Harmonia axyridis* and *Coleomegilla maculata*, do not appear to be attracted to the mealybugs.

Briefly describe how your target audience benefited from your project's activities.

The target audience includes ornamental plant and vegetable producers, landscape care professionals, crop consultants, Extension personnel, and fellow scientists.

Briefly describe how the broader public benefited from your project's activities.

The multi-state survey of natural enemies of thrips, whiteflies, and spider mites will inform organic vegetable growers in the southern US on the diversity of natural enemies occurring in their fields, as well as the impacts of these natural enemies. Muhly grass is prized as an ornamental plant, as well as of cultural and economic significance as the raw materials for sweetgrass baskets. Understanding the natural enemy complex of the muhly grass mealybug will allow researchers to develop integrated management plan for the invasive mealybug species in order to protect the valuable muhly grass from this new pest. The study on the compatibility of Group 9 insecticides will allow growers to better develop an effective pest management plan that integrates chemical and biological control. Understanding the foraging behavior of predators and parasitoids on pest resistant crop varieties or their compatibility with pest quarantine treatments, are also important in determining the potential of integrating biological control and host plant resistance. Through better understanding of the ecological relationship between pests and their natural enemies, and better utility of compatible insecticides and pest resistant varieties, we will be able to develop integrated pest management programs that reduce pest damage, improve economic returns, and alleviate negative consequences of pest management activities.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Continue moving research forward to meet the defined objectives.

[Sustainable Agriculture Production Systems for Animals](#)

Project Director

Susan Guynn

Organization

Clemson University

Accession Number

7000047



Beef Cattle Feeder Sale

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Helping farmers to maintain economically sustainable markets for their cattle is crucial to maintaining the livestock industry in SC. Small farmers/producers for cattle may not have the same market advantages as larger operations when selling cattle. Therefore, organizing beef cattle feeder sales for smaller operations helps to increase market value of the cattle. Thus, smaller farmers/producers can increase their profits and remain financially solvent.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The Beef Cattle Feeder program helped small farmers/producers of cattle to market their cattle by organizing a sale off-farm, which yields higher prices for the cattle. Organizing the smaller farmers/producers across multiple counties helps many smaller farmers/producers increase profitability, and thus, retain their farming operations.

Briefly describe how your target audience benefited from your project's activities.

There were nine local farmers/producers across three counties (Chester, Fairfield, and York) that participated in the Beef Cattle Feeder sale. A total of 632 head of feeder calves (8 loads and 2 partial loads) were marketed. Marketing feeder calves off-farm resulted in \$0.18 per pound higher prices when compared to traditional auction markets. This resulted in \$126 dollars per head of additional revenue to farmers. Marketing feeder calves using this alternative marketing strategy generated an increase of \$79,630 in revenue, which averages out to an additional \$8,848 of revenue per farm.

Briefly describe how the broader public benefited from your project's activities.

Since smaller farmers/producers can increase revenue, more farms are able to remain in production. This not only impacts a sustainable food supply, but it also impacts local communities that depend on the small farms for their livelihood. Small farms support the farm owners but may also employ other community members. They contribute to the local communities through wages but also through taxes. These types of activities help to maintain smaller farms/producers but also contribute locally to maintain a healthy community.



Confined Animal Manure Management

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Confined animals can create environmental problems while supplying a sustainable food source. South Carolina Regulation R.61-43 provides requirements for confined animal facilities and the utilization of animal manure from those facilities. One of the requirements in the regulation is for managers of confined animal facilities to obtain and maintain a manure management certification, called Confined Animal Manure Management (Camm). This certification cover manure management to protect the environment, such as water and air quality, nutrient management, and alternative waste handling practices.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The Camm certification ensures that farmers/producers who have confined animals properly manage and dispose of the manure. There are guidelines in the certification program that specify how animal manure is managed and brokered in South Carolina. Camm certification is intended to protect the environment, including water quality and odor management.

Briefly describe how your target audience benefited from your project's activities.

Farmers/producers benefited from the training by obtaining or being recertified for the Confined Animal Manure Management (Camm) program. There were 662 farmers/producers that participated in 32 online trainings. The farmers/producers will be able to continue their farming operations in an environmentally and economically sustainable manner. The certification allows farmers/producers to learn new manure management techniques and practices to improve their overall farming operations.

Briefly describe how the broader public benefited from your project's activities.

The Camm certification protects environmental quality, which has a direct impact on the quality of life of the community near the facilities. Camm certification directly impacts the broader public by helping farmers/producers learn how to properly manage odors and vectors, protect water quality, manage nutrient runoff, cite facilities, and learn about alternative waste handling practices.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Due to COVID, all Camm certifications were conducted virtually.

Project Director

Susan Guynn

Organization

Clemson University

Accession Number

7000022



Crop production

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

US agriculture is a \$1 trillion-per-year industry and the number one industry in South Carolina with a \$46.2 billion annual economic impact. To help sustain the agricultural industry in South Carolina, Clemson Extension agents work to increase farmer's knowledge and implementation of economically and sustainable agronomic production systems. Crop production meetings help provide up-to-date information on various aspects of crop production. Furthermore, trials on varieties that increase yield and are resistant to disease are also important to maintain crop profitability and economic sustainability for farmers. Finally, tobacco farmers are provided GAP training so that they can continue to raise and meet contractual obligations.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Crop production meetings provide up-to-date information on various aspects of crop production. Due to COVID, Clemson Extension agents were forced to conduct crop production meetings virtually. Furthermore, soybean producers requested information on the best soybean varieties available for their areas based on environmental factors. Planting the most suitable soybean variety increases production and profitability.

Tobacco growers also received required Good Agriculture Practices (GAP) training. This training allowed tobacco growers to maintain their productivity and retain valuable tobacco contracts.

Briefly describe how your target audience benefited from your project's activities.

Over 174 row crop farmers attended cotton and peanut production programs. These production programs provided farmers with the latest information on various aspects of crop production. Learning new techniques to help sustain and improve crop production and increase yield increases helps farmers maintain economic viability and sustains crop production available for public consumption.

Also, soybean producers will benefit from the field trials so they can match the soybean varieties to local environmental and soil conditions for their farms. This may lead to increased production and yields, which in turn provides economic stability and agricultural production sustainability.

Tobacco growers are required to be GAP certified in order to keep their tobacco contracts and sell their tobacco. This certification requires the tobacco growers attend yearly meetings to obtain continuing education credits for certification. The Clemson Extension agents worked with other land-grant researchers and agents across the Southeast to provide virtual GAP Connections training.

Briefly describe how the broader public benefited from your project's activities.

The broader public benefits from these activities by having a sustainable flow of soybean, cotton, tobacco, and peanut production. Farmers that follow sustainable production agricultural practices, and are educated on how to protect the environment, such as water quality, contributes to the health and well-being of the broader public. Farmers can reduce herbicide runoff, thus helping to improve water quality. They can also focus on sustainable practices to help maintain soil health, thus increasing crop yields and providing a sustainable food supply.



In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Palmer amaranth, also known as pig weed, is a common weed that invades cotton and soybean fields. Over time, pig weed has developed a resistance to many of the common herbicides labeled as safe to use for soybean and cotton crops. An herbicide called Dicamba was approved in 2017 for use on pig weed in cotton and soybean crops. However, a farmer must have training on the use and application of Dicamba before they are allowed to purchase it.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Clemson Cooperative Extension Service conducted Dicamba training for farmers growing cotton and soybeans that have pig weed infestations. The training certified farmers so they could purchase Dicamba to use on their crops. This allowed for normal yields of cotton and soybean so farmers could maintain crop profitability while applying an herbicide in an environmentally safe and sustainable manner.

Briefly describe how your target audience benefited from your project's activities.

Farmers benefited from the Dicamba training because they were certified to purchase and apply Dicamba to their cotton and soybean crops. Without the Dicamba certification training provided by Clemson Cooperative Extension Service, farmers could potentially suffer economic loss of cotton and soybean crops due to pig weed. Furthermore, farmers are educated on the proper use and application, so the herbicide does not cause damage to non-target crops or harms the environment.

Almost 700 farmers attended the Dicamba training during the spring of 2021.

Briefly describe how the broader public benefited from your project's activities.

The general public benefits indirectly from this training because farmers are able to provide a sustainable and consistent yield of cotton and soybeans. Soybeans are used to meet a variety of needs such as food, biodiesel, engine oil, and other non-food products. Cotton is used for not only clothing but also for non-clothing products such as bedding and cottonseed oil production.

The environment will also benefit, which in turn is beneficial to the broader public, through reduced runoff into the water supply. Furthermore, because the farmers attended formal training on the proper handling, use, and application of Dicamba, there is less of a chance that non-target species will be impacted.

Critical Issue

Environmental and Natural Resources Conservation

ATMOSPHERIC WATER GENERATORS FORM MODIFIED POSTCONSUMER PLASTIC

Project Director

Nasrollah Hamidi

Organization

South Carolina State University

Accession Number

1026706



ATMOSPHERIC WATER GENERATORS FORM MODIFIED POSTCONSUMER PLASTIC

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

This research impacts two of our daily needs: freshwater and a clean environment. An unexpected challenge emergent in recent history is obtaining clean fresh water, the daily source of life which was available in the surface streams and underground rivers., these common natural sources of clean drinkable water continue to be depleted by overuses and are being polluted by agricultural, civil, industrial, and defense activities. Atmospheric water generation (AWG) proposed by this

research is not only feasible but preferred, besides, the resources required to construct such systems can be extracted from post-consumer plastics (PCP) which their accumulations generated many environmental problems, and the rate of their growth yearly rate estimated to be over 3%.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

This research impacts two of our daily needs: freshwater and a clean environment. An unexpected challenge emergent in recent history is to obtain clean freshwater, the daily source of life which traditionally it was available in the surface and underground streams and rivers. These common natural sources of clean drinkable water continue to be depleted by being polluted by agricultural, civil, industrial, and defense activities and over usages. Therefore, the regular source of freshwater soon could become an exhausting nonrenewable resource. In stark contrast to our constantly shrinking potable sources, the estimated amount of water vapor in the Earth's atmosphere is comparable with the freshwater sources on earth and is renewable. Therefore, atmospheric water generation (AWG) proposed by this research is not only feasible but preferred. Besides, the resources required to construct such systems can be extracted from post-consumer plastics (PCP) whose accumulations generated many environmental problems, and the rate of their growth yearly rate estimated to be over 3%. Thus, PCPs can be treated similarly to renewable resources and could be used to construct AWGs.

The goals are: (1) reducing the amount of PCP pollutants by reusing them to build AWGs, and (2) providing potable water where needed by developing proper AWGs. Currently, large amounts of energy are consumed to discard PCPs. To remedy this, the project intends to repurpose the energy required to collect, transport, and discard PCPs to manufacture fibers, yarns, films, rods, and frames for AWGs. A simple passive AWG uses natural processes to harvest water from fog and dew; its main body holds a condenser of various shapes such as a flat surface, inverse pyramids, a panel frame holding a net, or a harp shape panel. The main body could be made of PCPs, wood, or metal, or a combination of such. The condenser must be a combination of hydrophilic substances to attract and condense moisture, and hydrophobic materials to move water away from

the production sites to the collectors. The shape of the condenser depends on the moisture availability and geo-climatic conditions; it could be a hydrophobic flat surface such a metal or plastic, a net or a fiber with or without hydrophilic microsities,

or an elaborated large house with desiccants and condensers. In the case that the direct use of PCPs is unattainable, resins will be extracted from PCPs and used. Blending PCPs with smart materials also is another venue to fabricate AWGs absorbents, which will be addressed in this project. The active AWG devices have higher yields and are more elaborate. However, this comes at the cost of the use of large amounts of energy. The condenser is cooled by a refrigerant system and the fans move the compressed air into the condenser. In humid regions such as SC, moisture could be condensed directly; in the arid regions, the moisture is collected by a desiccant, and then water is collected by distillation. Three types of AWGs will be built in this project and tested in lab and field conditions. The fieldwork will take place in suitable locations within the SCSU

campus and/or the 1890-Research farm with the aid of the extension agents.

Major activities completed / experiments conducted; Data collected; Summary statistics and discussion of results and Key outcomes or other accomplishments realized:

Ordering instruments and set-up the labs for new research

Hire a lab assistant or Lab associate to work in the project

We were able to revise, rewrite, and resubmit about six manuscripts for to be published in various peer-reviewed journals.

Briefly describe how your target audience benefited from your project's activities.

Here are the peer-reviewed and open access journals publications:

1. Nasrollah Hamidi, Mehrdad Yazdani-Pedram and Nurannah Abdussalam, Upcycling poly(ethylene terephthalate) wastes by solvent extraction: Thermal stability and kinetics studies of the recovered PET, *J. Appl. Polym. Sci.* 2022, (14), 51950, e51905. <https://doi.org/10.1002/app.51905>
2. Nasrollah Hamidi, Nurannah Abdussalam, and Mehrdad Yazdani-Pedram, Upcycling Poly(Ethylene Terephthalate): Identification of the Recovered Poly(Ethylene Terephthalate) by Thermogravimetry Analysis, *J. Macromol. Sci. Part B* 2021, AHEAD-OF-PRINT, 1-19, <https://doi.org/10.1080/00222348.2021.1996908>
3. Nasrollah Hamidi and Mitra Ganewatta, Influence of the rosin pendent group on the solution properties of a high molecular weight hydrogenated poly(norbornene), *Polymer*, 2021, 232, 124167, ISSN 0032-3861, <https://doi.org/10.1016/j.polymer.2021.124167>. (<https://www.sciencedirect.com/science/article/pii/S0032386121007904>)

4. Nasrollah Hamidi and Nurannahar Abdussalam, Kinetics study of the thermal decomposition of post-consumer water bottle made of poly(ethylene terephthalate) in a nitrogen atmosphere, Acta Scientific Applied Chemistry, 2021, 1(1), 6-21
<https://actascientific.com/ASAC-Article-Inpress.php>

5. Nasrollah Hamidi and Allison Sarvis, Kinetics study of the combustion of post-consumer food container made of poly(propylene) International Journal of Research in Engineering and Science (IJRES). ISSN (Online): 2320-9364, ISSN (Print): 2320-9356 www.ijres.org Volume 9 Issue 8 ? 2021 ? PP. 01-13, URL: www.ijres.org. <http://www.ijres.org/papers/Volume-9/Issue-8/Series-3/A09080113.pdf>

6. Nasrollah Hamidi, Upcycling postconsumer high-density polyethylene (PC-HDPE): Thermal stability and kinetics study of the filaments extruded from PC-HDPE, Journal of Macromolecular Science, Part B. 2022, 61(1), 37-60.
<http://dx.doi.org/10.1080/00222348.2021.1962571>,

Briefly describe how the broader public benefited from your project's activities.

SCSU researchers have designed and launched a comprehensive program encompassing reusing, recycling and solvent extraction of the resins, the main building block of the post-consumer plastics. These are vital results for removing the postconsumer plastics from environment into the recycling and reusing system. As a result of these activities, we will have a healthier, cleaner, and safer environment. In addition, we save energy.

These results strengthened the capabilities of SCSU to address the increasing problem of postconsumer plastics accumulation in open and deep landfills and warehouses.

Also, these studies help to established working collaborations between the academic and students who are next generation of work force in the nation and 1890-Research and Extension, engineering and sciences.

The project created a solution to solve the problem of postconsumer plastics by reusing and extraction of the resins. This improves the effectiveness of SCSU in addressing the needs of local, State, Nation and world.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Among all media, the most effective and time-consuming are the peer-reviewed open access journals. We used peerreviewed journals and open access journals as the main venue to disseminate our results. We were able to revise, rewrite, and resubmit about six manuscripts that were accepted for to be published in various peer-reviewed and open access journals.

Urban Horticulture Education

Project Director

Susan Guynn

Organization

Clemson University

Accession Number

7000066



Urban Horticulture Webinar Series

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Home gardening is gaining in popularity since the COVID crisis started in 2020. However, many home gardeners are either new or novice and do not have the educational background to successfully garden. Furthermore, gardens may fail due to lack this lack of knowledge or inappropriate gardening techniques that are either not sustainable or are detrimental to the plants. Increasing general knowledge of urban horticulture practices will improve home gardens and decrease potential issues with herbicide applications.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The Urban Horticulture webinar series aimed to increase general knowledge of gardening topics. The topics included things such as integrated pest management, specific crop information, and cultural practices like vertical gardening, interplanting, and crop rotations. These topics are important for beginning and continuing home gardeners to meet their gardening objectives.

Briefly describe how your target audience benefited from your project's activities.

Home gardeners benefitted from the series by gaining valuable knowledge about sustainable home gardening practices. Home gardeners now have the knowledge to identify disease and pest issues, cultivar selection, crop rotation, and cultural gardening practices. Eighty-nine people attended the webinar, and 39 participants completed the post webinar survey. Almost 85% of respondents stated that they learned new information during the webinar and 74% of respondents planned on implementing new practices in the garden.

Briefly describe how the broader public benefited from your project's activities.

Home gardeners help reduce the carbon footprint of humans across the world. By being less dependent on food that is shipped across the country or world, carbon emissions are decreased. Furthermore, home gardeners that grow a surplus of food can share their bounty with others in need. This helps to increase the fresh food supply, albeit on a microscale. Finally, home gardens help supply households with fresh, healthy food, which lead to healthier lifestyles.

[Exploring Linkages Between Forest Management, Disturbance Ecology, and Environmental Quality](#)

Project Director

Donald Hagan

Organization

Clemson University

Accession Number

1024645



Exploring Linkages Between Forest Management, Disturbance Ecology, and Environmental Quality

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

This project investigates how active forest management impacts environmental variables such as fuel accumulation, vegetation, water quality, and erosion to help forest managers better implement policies and best management practices. Additionally, it addresses how fire - alone or in combination with other management practices - may alter the storage, reactivity, and mobility of mercury (Hg).

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

During the reporting period, we collected field data (including vegetation, fuels, soil and water) at high elevation sites in the southern Appalachians, mid-elevation sites along the Blue Ridge Escarpment, and low elevation sites in the Piedmont and Coastal Plain. Data analysis and statistical modeling are ongoing. Several papers were published and several more are in various stages of preparation. One notable paper outlines the development of a decision support tool for environmentally friendly timber harvesting in mountainous terrain. This tool, when implemented, will help forest managers identify where silvicultural practices (timber harvesting, fire, thinning) can be implemented without adversely impacting soil and water quality. Other papers associated with this project assess how fire and forest management influence the cycling of mercury in aquatic food webs, and how these same activities can influence the development of "disinfection byproducts" in municipal drinking water supplies. Project activities have facilitated networking with various external collaborators (other researchers, agency personnel, landowners, non-profits) -- and these relationships will enable us to add additional study sites to the project in forthcoming years.

Briefly describe how your target audience benefited from your project's activities.

Our target audience includes landowners, state and federal agencies, scientists and non-profits. These audiences have benefitted from the dissemination of our research findings via extension papers, and presentations to landowner groups and at scientific meetings. Additionally, papers we published in the last year - focusing on topics ranging from fire seasonality, timber harvest optimization, and water quality inform the management of public and private lands within our study region. These benefits are reciprocal -- in that by providing these deliverables, we have strengthened our relationships with partners in ways that will no doubt lead to future opportunities for collaboration.

Briefly describe how the broader public benefited from your project's activities.

As demand for forest products increases, the potential for ecological degradation follows. This study has benefited the broader public in that it provides sound scientific information to inform the sustainable management of forest ecosystems. While the project is still in its early stages, land managers are already using our findings to make long-term decisions about forest management. We expect this to continue as the project moves into year 2 and beyond. Since the majority of the land base in our study area is under private ownership, the dissemination of our study findings to landowners will enhance their ability to make sound forest management decisions. The broader public will be the ultimate beneficiary, since clean water and healthy soil are two of the most important ecosystem services that forests provide.

Since many in-person meetings were shifted to an online format during the COVID-19 pandemic, this allowed us to reach a much broader audience than we might have otherwise. Regional meetings, for example, were often attended virtually by interested parties from around the world. While we much prefer the in-person interaction that traditional meetings offer, the opportunity to disseminate our study findings to people outside the study region no doubt increases the potential for broader impacts.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

COVID-19 presented some logistical challenges during the reporting period, particularly with respect to fieldwork. But we were nonetheless able to stay on schedule with our data collection activities. Thus far, preliminary results have been disseminated to communities of interest in the form of conference presentations (mostly online), landowner meetings, peer-reviewed publications, and extension fact sheets. During the next reporting period, we plan to continue data collection, develop and refine our statistical models, present our findings at relevant meetings, and publish. We are also exploring opportunities to expand the project through new partnerships with landowners, agencies and other scientists.

Closing Out (end date 09/07/2023)

Wildlife and Natural Resources

Project Director

Susan Guynn

Organization

Clemson University

Accession Number

7000064



Northern Bobwhite Quail Restoration Video

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

In 2020, hunting contributed approximately \$1.1 billion to South Carolina's economy through direct, indirect, and induced sales. Furthermore, conservation efforts are funded in part by hunting license sales as well as firearm and archery sales. The Northern Bobwhite Quail (*Colinus virginianus*), one of the most popular grassland game bird species, has shown significant declines in population over the past 30 years primarily due to habitat loss. The loss of populations of quail can result in lower hunting license sales, thus impacting other conservation projects across the state.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Clemson Extension partnered with South Carolina Department of Natural Resources and the Bobwhite Quail Initiative to create a video to educate landowners on the important habitat characteristics of the Northern Bobwhite Quail. The 30-minute video covered the vital food sources for quail, the importance of ground cover needed for protection from predators, and many other essential land management practices needed to restore and supply the much-needed habitat for Northern Bobwhite Quail.

Briefly describe how your target audience benefited from your project's activities.

Landowners learned how to manage habitat to favor the Northern Bobwhite Quail through the video. The habitat requirements for Northern Bobwhite Quail include things such as ground cover to protect from avian predators, areas rich in insects to provide protein for chicks, and shrubby/brushy cover for nesting. Northern Bobwhite Quail tend to avoid mature forests and instead favor more disturbed sites, which is an important point for landowners to understand that want to manage for quail. Furthermore, landowners learned how to use other management tools to create favorable habitat, such as prescribed fire. The video was posted on the Clemson Extension Forestry and Natural Resources Team YouTube channel and was over 230 times.

Briefly describe how the broader public benefited from your project's activities.

Many conservation projects are funded through hunting and fishing license sales, firearm and archery sales, and fishing equipment sales. Increasing quail populations helps to maintain interest in hunting, and thus, hunting license sales, and the general enjoyment of seeing and hearing wild quail. Furthermore, landowners can meet their management objectives and maintain their timberlands, instead of selling the land to development. This provides the benefits of the forest to the surrounding community, such as carbon sequestration, forest aesthetics, and forest products, among other things.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Due to COVID, educational videos were utilized since in-person programming was not allowed due to CDC guidelines.



Wild Hog Management in SC

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

South Carolina has experienced dramatic increases in the distribution and abundance of wild hogs over recent decades, leading to an increase in damage these animals cause to natural, agricultural, and developed landscapes. Wild hogs are in every county in the state and the population is estimated to be more than 100,000. Yearly crop and non-crop damage combined with the expenses of controlling these animals is estimated to be in the hundreds of millions of dollars. Considering the impacts that wild hogs have on the natural landscape and native species and to the threat wild hogs pose to the state's livestock industry through the spread of zoonotic diseases, the economic impacts of wild hogs could likely be much higher. Expanding populations are causing economic and environmental damage that warrants control.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The Wild Hog Management Workshop educated landowners, wildlife biologists, and land managers on basic hog biology, which informs management and control options. Controlling wild hog populations on a property is an ongoing management activity and must be continuously maintained. Much of the expansion of the wild hog population is due to their birth flow breeding strategies, low mortality rates, and the fact that they can breed at 6 months of age, which means populations can increase quadratically.

Briefly describe how your target audience benefited from your project's activities.

Providing landowners with the knowledge of the life cycle of hogs helps them to understand the importance of year-round population control. Furthermore, understanding the disease implications of having wild hogs present on a property also helps to make landowners/managers aware of the importance of control. For example, it was recently found that wild hogs can be carriers of chronic wasting disease, but it does not seem to impact them, thus, they are intermediate hosts. This knowledge helps farmers that are adjacent to forest lands understand the importance of control measures as well. The webinar had 330 participants from the Southeast region. Following the webinar several land managers scheduled site visits to determine their best course of action for their specific situations. Additionally, following this webinar legislation was passed restricting the transportation of wild hogs in SC, allowing for fines of up to \$1,000 per wild hog.

Briefly describe how the broader public benefited from your project's activities.

Wild hogs can cause millions of dollars in damage to agricultural and natural resources. Furthermore, wild hogs can carry a wide number of zoonotic diseases, thus potentially creating a human health concern. Controlling wild hog populations decreases the threat of disease spread, decreases crop damage, and therefore increases crop yield for a sustainable food supply, and protects natural resources from their destructive rooting nature. In many cases, wild hogs will outcompete native fauna for resources, and thus, create potential declines in wildlife population health and populations.

Closing Out (end date 09/07/2023)

Sustainable Forest Management and Environmental Enhancement

Project Director

Susan Guynn

Organization

Clemson University

Accession Number

7000041



Flora and fauna of the longleaf pine ecosystem

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

The longleaf pine ecosystem is in decline and efforts to restore this ecosystem are dependent upon private landowners for cooperation. Many landowners have interests in restoring the longleaf pine ecosystem and motivations are varied, including creating habitat for pollinators, preserving the cultural heritage that evolved around longleaf, bringing back the northern bobwhite, and an appreciation for the aesthetics of a longleaf pine stand.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The 2-day workshop on longleaf pine ecosystems provided information on cost-share and technical assistance programs offered through the USDA, other government agencies, and non-profit groups. It also addressed the plants and animals that are found within the longleaf pine ecosystem along with tools to help landowners gauge the success of their restoration efforts. Other restoration tools were also discussed such as prescribed fire and herbicide use, that are integral to the restoration process.

Briefly describe how your target audience benefited from your project's activities.

The 2-day workshop hosted 132 virtual participants that gained valuable information on tools and metrics for gauging success when restoring longleaf pine ecosystems. Of the participants that completed the post-program survey, 84% stated that they had increased their knowledge of the longleaf pine ecosystem. Additionally, 81% stated they would seek out more educational opportunities about longleaf pine ecosystem restoration while 93% stated that they had increased their comfort level as a landowner/manager seeking to restore the longleaf pine ecosystem.

Briefly describe how the broader public benefited from your project's activities.

The longleaf pine ecosystem can help provide clean air and water sources, protects against wildfires, and can withstand some hurricanes since it is adapted to the sandy soils and conditions of a coastal system. The longleaf pine ecosystem also provides a breadth of plant species, estimating that as many as 900 plant species are only found in longleaf pine ecosystems. The ecosystem services and benefits of longleaf pine from a timber production standpoint are extensive and important services to humans.



Silvopasture Production Workshop Series

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Landowners are increasingly looking for alternative income opportunities so they can retain their land. Since timber production is not an annual income source, alternative income sources may be necessary for some landowners. Also, with increases in land rates and costs of operating farms, it has become vital that farmers and ranchers are given unique opportunities for raising livestock to remain profitable. Finding ways to help forest landowners and farmers remain solvent is critical to protecting SC's forests and agriculture industry.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The Silvopasture Production workshop series addressed topics to educate landowners, farmers, and ranchers on various aspects of silvopasture as a supplemental/alternative income opportunity. This workshop series worked toward the long-term goal of educating landowners, farmers, and ranchers so they can maintain an economically sustainable timber and farming operation.

Briefly describe how your target audience benefited from your project's activities.

The Silvopasture Production workshop series benefited farmers and timber landowners that are seeking additional revenue streams. It allowed timber landowners the opportunity to understand the implications of grazing livestock within a managed timber stand that has the primary management objective of timber production. Furthermore, farmers/producers that seek additional grazing locations for their livestock may have other options available if they understand the circumstances surrounding silvopasture production. This workshop increased knowledge for both timber landowners and farmers/producers looking for additional revenue sources or grazing options for livestock.

Topics in the workshop included timber management for forage production, forage selection and establishment, grazing systems and strategies, pesticide use, soil fertility, fencing options, livestock selection, and livestock nutritional needs.

Briefly describe how the broader public benefited from your project's activities.

Silvopasture has wide sweeping benefits to the broader public. Forest products and fiber production are critical to society. Products such as paper are important but also pulp fluff, construction materials, and other non-traditional forest products are also crucial to society. Livestock production is also important to provide a sustainable food supply to society. By combining grazing and timber production, benefits from forests and sustainable food supply) are realized on less lands.

Closing Out (end date 09/07/2023)

[Water Resources, Ponds, Wetlands, and Aquaculture Education](#)

Project Director

Susan Guynn

Organization

Clemson University

Accession Number

7000040



Low Impact Development Design in SC: Challenging Sites workshop

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Growth among the coastal counties of South Carolina is some of the fastest in the nation. One-on-one conversations with community members that represent both residential and professional audiences show an increased interest in finding ways to encourage development that reduces impact on flooding and ecological integrity of an area. Resources developed to encourage sustainable design, like the Low Impact Development in Coastal South Carolina: A Planning and Design Guide, are not well used and perceptions exist that site constraints, like shallow water table and poorly drainage soils, make incorporation of suggested practices difficult.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Low impact development (LID) helps to manage stormwater close to the source and mimic natural hydrologic regimes. The result of LID reduces the volume of runoff and diverts stormwater flows away from a common collection point. However, adoption of LID practices is lacking due to misconceptions about implementation barriers, like shallow water tables and poorly drained soils. The Low Impact Development Design in SC: Challenging Sites workshop helped to overcome common misconceptions about LID and increase adoption of practices.

Briefly describe how your target audience benefited from your project's activities.

The Low Impact Development Design in SC: Challenging Sites workshop targeted design engineers, landscape architects, and city and county stormwater and planning review staff. The workshop included lectures to assist with design decision-making on project sites, how to use the [Low Impact Development in Coastal South Carolina: A Planning and Design Guide](#) tools, and case studies from professionals working in the design field.

Over 90 participants engaged in the virtual lecture series. Of the 45 participants that took a post-program evaluation, more than 50% represented private firms, thus showing an interest in non-government stakeholders in applying LID principles. Over 60% of participants said they would incorporate information learned into site designs, indicating an increase in adoption of practices.

Briefly describe how the broader public benefited from your project's activities.

By designing and redesigning developments in the coastal communities of SC, stormwater runoff and pollutants are less likely to enter sensitive water sources, thus helping to protect water quality. Furthermore, developments (e.g., residential communities) can reduce stormwater runoff and maintain stormwater management areas with reduced aid and financial expenses of a professional consultant.

By maintaining water quality, it also helps to protect fragile coastal ecosystems and maintain biodiversity. Biodiversity provides opportunities for the general public to experience nature and its intrinsic values.



Stream Bank Repair at Brushy Creek

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Water, its quality and quantity, is a natural resource that is impacted by almost every land use management decision, from private homeowners to large corporate landowners to municipalities. Yet, many of the people making these land management decisions are ignorant of the consequences. The Tyger River Watershed is found in an urban area of upstate of South Carolina and is impaired for bacteria and sediment. These impairments impact both water quality and recreational opportunities.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The program achieved helping to improve water quality for municipalities that manage riparian areas along creeks, streams, and rivers within their jurisdiction. The educational and hands-on experiences reinforced the educational materials presented that can be applied to future riparian area projects. Improved riparian area management can increase water quality, decrease water treatment costs, and improve overall stream health for recreational and wildlife uses.

Briefly describe how your target audience benefited from your project's activities.

Clemson Extension agents designed a stream bank repair project for Brushy Creek. This involved a background presentation for municipal staff that explained the benefits of healthy riparian buffers along waterways. Clemson Extension also held a day long field session to implement methods learned during the presentation.

A total of 3 live fascines, 256 livestakes, and 500 ft2 of erosion control matting were installed. Twenty-seven municipal staff learned about impairments and best management practices used to repair stream banks. They also had a chance to help with repairing ~400 ft2 of stream bank along Brushy Creek. A post-workshop survey indicated 83% of participants planned to use the information learned during the workshop. Additionally, 100% reported learning new information and 67% said they feel better able to address stream issues.

Briefly describe how the broader public benefited from your project's activities.

The stream, Brushy Creek, is maintained by municipal staff who do not have knowledge of stream bank issues. Grant funding was provided by Upstate Forever through a 319 Grant from DHEC, to repair a stream bank and riparian area in Greer, SC that was contributing pollution to the watershed. This project improved water quality in the stream as well as improvements to protect the watershed. Clean drinking water is necessary for everyone, and this project contributed to providing it. Furthermore, it educated managers that make land use decisions that could potentially impact water quality, thus, potentially reducing future decisions that degrade water quality.

Critical Issue

Family and Youth Development

Closing Out (end date 09/07/2023)

Healthy Lifestyles for Youth Audiences

Project Director

Susan Guynn

Organization

Clemson University

Accession Number

7000068



Nutrition, Wellness, and Exercise

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Healthy lifestyles are important for youth, both physically and mentally. Physical health is imperative for proper development and into adulthood. Mental health helps provide youth with the self-confidence necessary to be happy, engaged, and caring citizens. Clemson Extension 4-H programming empowers youth to be healthy- body and mind – with the skills to make healthy decisions and lead healthy lifestyles. We will highlight two of our programs related to healthy lifestyles.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Programming across SC provided opportunities for youth to have hands-on experiences in learning about healthy lifestyles and the potential long-term impacts on them. The hands-on experience allowed youth to explore ways to make better food and drink choices that benefited their body and minds. Students were also provided with virtual programming to continue learning about healthy choices and lifestyle. Most programs combined healthy lifestyles with nutritional information as well as the benefits of regular exercise. Post-program evaluations showed a trend that students learned how to make healthier decisions as that they were applying what they learned. With youth being more cognizant of healthy choices, this may also influence other family members (youth and adult) to improve their nutritional and exercise choices.

Briefly describe how your target audience benefited from your project's activities.

Hampton County has an obesity rate that exceeds 40%. To help combat obesity and teach youth healthy choices, a Kids in the Kitchen program was developed and attended by 12 youth that allowed youth a hands-on opportunity to see how healthier choices in food and exercise impacts their overall health and well-being. The program taught the impacts of food on the body through the Kitchen Chemistry program. Students learned how gluten, fats, oils, whole grains, and water impact the human body and organs. Students were also taught how to read labels to determine which foods were better choices for their meals and snacks. Post-program evaluations of parents indicated that their child(ren) was reading food labels and selecting food and drink based on the nutritional content rather than taste, label, or advertising.

Colleton County is one of the least healthy counties in South Carolina. Nearly 40% of adults are characterized as obese and 36% of reporting adults are inactive. To combat this trend in youth, Colleton County 4-H Extension Agents participated in the Colleton County School Wellness Checklist program, which was initiated by the Boeing/MUSC Children's Wellness Center. A program to target specific issues recognized by school nurses that are grade-specific was created featuring nutrition, healthy food choices, and the importance of physical activity. Clemson 4-H Extension Agents also provided support of school gardens in 5 elementary schools that are utilized in the program. Due to COVID, some school gardens could not be maintained but virtual programs were still delivered for Pre-K to 5th grade. A total of 587 students participated in the Colleton County School Wellness Checklist program, gaining knowledge of healthy lifestyle choices.

The Healthy Lifestyles activities had a total of 11,358 youth and was broken down as follows:

- Foods and Nutrition: 9,366
- Health: 1,418
- Personal Safety: 574

Briefly describe how the broader public benefited from your project's activities.

It is estimated that obesity costs Americans an average of \$1,900 per year. Teaching youth how to make healthy lifestyle choices decreases their chances of chronic illness, such as diabetes and heart disease. Reducing the obesity rate of adults through learned healthy behavior as a youth can reduce the financial burden and increase mental wellness as adults. This also helps the youth serve as active and productive community members as adults.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

COVID impacted the ability of 4-H Agents to provide in-person programming. Therefore, some programs were not available, such as school gardening and food preparation.

Closing Out (end date 09/07/2023)

Science, Engineering, and Technology for Youth Audiences

Project Director

Susan Guynn

Organization

Clemson University

Accession Number

7000044



4-H STEM Advancements

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Positive youth development is critical for developing life skills and personal development. Positive youth development experiences enhance and increase knowledge in STEM-related areas, natural resources, horses, livestock, and agriculture. Programs conducted in 4-H covered topics such as embryology, school gardening programs, computational thinking skills, plant sciences, natural resources, and others. While it is not possible to report on every 4-H project in the state, we have highlighted our most impactful programs for this reporting cycle.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

South Carolina served 57,537 students in STEM-focused programs alone. One of the programs, called Journey to Mars, disseminated 700 kits to county Extension offices that included 8 lessons and activities for youth to complete. There was also an at-home version that contained 5 lessons and activities. This project developed skills such as tinkering (experimenting and playing), creating (designing and making), debugging (finding and fixing errors), persevering (keeping going), and collaborating (working together).

Clemson Cooperative Extension Service was also chosen to lead the development of the Galactic Quest 4-H STEM Challenge. This program is developing a hands-on challenge activity that touches on important STEM topics such as physics, engineering, computer science, and space agriculture. The curriculum will be shared nationally so youth across the country can benefit from it.

The 4-H Embryology program allows youth the opportunity to care for and hatch out eggs. This program provides lessons in responsibility as well as basic biology, and animal adaptations. Another program was the Wildlife Food Plot Project that exposed youth to environmental issues using research-based science.

Briefly describe how your target audience benefited from your project's activities.

Youth in SC benefited from the activities through increased self-confidence, knowledge, and skills in the STEM areas. In South Carolina, 57,573 youth participated in STEM-focused activities. Below is a list of areas and number of youth participants

- Consumer and Family Science: 671

- Biological Sciences: 168

- Technology and Engineering: 12,803

- Environmental Education/ Earth Sciences: 11,924

- Animals: 18,807

- Plant Sciences: 13,200

The Galactic Quest 4-H STEM Challenge will provide youth with the opportunity to explore physics, engineering, computer science, and space agriculture. Through hands-on opportunities, youth will be allowed to learn about these STEM-based careers and explore options for career development.

The Wildlife Food Plot Project hosted over 120 youth with 100 plots across 31 counties. Youth learned applied wildlife conservation, plant identification, and habitat management. This project connected youth to the science behind real-world issues.

The 4-H Embryology taught basic biology and life sciences to students. The project also taught responsibility as the students are required to oversee the incubation and hatching process. There were over 4,400 students in SC that participated in the 4-H Embryology program.

Briefly describe how the broader public benefited from your project's activities.

Youth are the future and their education in STEM fields is critical. 4-H Youth Development programs are intended to prepare youth to pursue careers in the STEM fields. These fields include the traditional technology focused programs, such as the Journey to Mars program, but also includes agricultural-focused careers, which is an area struggling to develop and maintain a workforce. Activities such as the Youth Academy Livestock and Learning (YALL) program helped engaged youth in areas such as dairy, livestock, and poultry sciences.

With rapid urbanization and an increasing disconnect between people and their food sources, training youth in technology and the ag sciences is even more critical to maintain farms and agribusinesses into the future for a sustainable food source.

Influences of Music Instruction on Reading and Music Achievement: Increasing Agricultural Literacy and Awareness in Grades

PreK-5

Project Director

Rosetta Dingle

Organization

South Carolina State University

Accession Number

1014004



Influences of Music Instruction on Reading and Music Achievement: Increasing Agricultural Literacy and Awareness in Grades PreK-5

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

The purpose of the research project entitled *Influences of Music Instruction on Reading and Music Achievement: Increasing Agricultural Literacy and Awareness in Grades PreK-5* was to examine the effects of a music approach on the reading achievement and music achievement of elementary students while increasing their agriculture awareness. Additionally, specific instructional practices were implemented per the music classroom and the reading or literacy classroom. The principal investigator of this project, a general music specialist, communicated and collaborated with reading teachers of the aforementioned grade levels to accommodate the synchronization of similar content topics taught and learned in general music and reading, linked, via common components.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

By way of this project, six elementary reading teachers have been introduced to a method whereby they may collaborate with the elementary general music teacher in their schools, students have experienced hands-on developmentally-appropriate learning activities that are related to standards-based music lessons and standards-based reading or literacy lessons, students and teachers have been exposed to agriculture content in a meaningful practical way.

Based on this project's outcomes, some scientific proof exists for generating synergy learning (improved music and reading skills) among students when linking music and reading using an agriculture theme. At the elementary level, synergy learning is more enhanced when gender becomes a factor. This appears to be more prominent at the lower elementary grade levels. Specific music experiences appear to aid students' developmental aptitude for music learning. Specific reading activities appear to aid students' reading and writing skills.

Briefly describe how your target audience benefited from your project's activities.

Music teachers, reading teachers, reading coaches, principals, and the State Department of Education are provided with an additional methodology and curriculum framework for improving elementary students' music aptitudes and reading achievement while focusing on an agriculture theme. With this curriculum framework, teachers link two different disciplines via a common theme and other salient components that contribute to the instructional practice and learning within the classroom space for an appointed time as students assume the executive role of their learning activities.

Briefly describe how the broader public benefited from your project's activities.

- Dr. Rosetta Dingle, PI; Jamieon Jamison-Gilmore, Student Research Assistant, and Dr. George E. Hicks, Reading Specialist presented, Influences of Music Instruction on Reading and Music Achievement: Increasing Agricultural Literacy and Awareness in Grade Pre-K, at the virtual National Association of African-Americans Studies and Affiliates (NAAAS) Conference.
- Dr. Rosetta Dingle, PI; Jamieon Jamison-Gilmore, Kataya Parson, Student Research Assistants; and Dr. George E. Hicks, Reading Specialist's proposal, Linking Music, Literacy, Agricultural Literacy and Awareness at Grade Levels PreK-5, was accepted for the May 2021 in-person Stem/Steam Hawaii University International Conference (HUIC). Due to the university's continued restrictions on travel at that time, the research team did not attend the conference.
- Nia Smith, Dach'na Pierre, Jamieon Jamison-Gilmore, Tyrall Kinard, Student Research Assistants; and Dr. Rosetta Dingle, PI developed newsletters for parents and students comprising good healthy tips and relevant, original melodies. Among others, newsletter titles included Breakfast, Lunch, Food and Health. Examples of melodies included Breakfast by Jamieon J. Gilmore; The Imperfect Garden by Gilmore and Dingle, and Tacos by Gilmore.
- Dr. Rosetta Dingle, PI, Dr. George E. Hicks, reading specialist, and students have been asked to provide a music-reading working shop comprising movement activities for preschool children at the Calhoun County Library. The PI is currently communicating with the librarian regarding a January 2022 date. Due to rising virus cases in South Carolina, the workshop may be virtual.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Greater Faith Baptist Daycare Center - July 8, 2021

Grades: K - 2 participation

Music Outcomes: (GM.P.NH. 3.1) I can sing or move using a steady beat.

(GM.R. NL.71) I can listen and respond to music (continuous flow and continuous flow with pulsation)

Ag Literacy Outcome: Identify healthy foods

Book - We Pick Apples read aloud

Chante Two Red fruits chanted and responded to via movement

Songe Peas sung and responded to via movement

[Engaging Youth and Families in S.T.R.E.A/A.M. \(Science, Technology, Reading, Engineering, Agriculture/Arts and Mathematics\)](#)

Project Director

Sharon Wade-Byrd

Organization

South Carolina State University

Accession Number

7000466



Bridging the Digital Divide through Education in South Carolina

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

In 2018 under new standards proposed by the State Department of Education, all South Carolina public school students in kindergarten through eight grade were required to learn computer science. Every child will not be a computer scientist but, knowledge and understanding of computer science will help ease the digital divide between students in poverty and their

wealthier counterparts. Lack of computer education coupled with poverty and limited to lack of internet access, the youth in the Pee Dee Region needed assistance and support in the area of Science, Technology, Engineering and Mathematics (STEM) education to enhance learning and excel in the area of computer science.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Originally, the Pee Dee Region partnered with two (2) local elementary/middle schools to host the 2019 National 4-H Youth Development's National Youth Science Day's (NYSD) "Game Changers" Challenge, which taught young people coding skills through three engaging hands-on activities. The program gave access and opportunity for youth within the region to take an interest in STEM education and activities. In 2021, youth were given an opportunity for hands-on learning. They had a chance to make mistakes in their learning, learn from their peers, and develop important life skills to help them to be able to problem solve, have patience and be able to do teamwork. First, a total of seventy-five (75) K-7 grade Pee Dee Region youth participated. Wallace Elementary/Middle (WEMS) After School Program in Marlboro County had fifty-six (56) 3rd - 7th graders and Florence 1 Theodore Lester Elementary School's Extended Day Academy in Florence County had nineteen (19) K - 6th graders participate. The youth learned about automation, optimal efficiency, and programming, through the "Hack Your Harvest Challenge", and learned how to develop and invent playground games through concepts like pattern recognition and abstraction, in the "Program Your Playground Challenge". Secondly, three activities were facilitated to 32 students. The lesson taught was "Landing Zone Surveyor". As an unplugged activity, the students attempted to land on Mars and discovered the features important for setting up a base camp. In Red Planet Odysseys, the activity was where the students used their engineering skills to build a vehicle that explored the surface of Mars and the last unplugged activity was "Crop Curiosity" where the students learned about biology, environmental science, and agriculture to grow nutritionally efficient food on Mars. The activities introduced the youth to a whole new world of STEM. It allowed the youth to experience STEM in a fun, yet learning environment.

Briefly describe how your target audience benefited from your project's activities.

The target audience benefited from the project's activities because the youth learned online activities that allowed them to create an animation advocating for a cause or issue they cared about using "First and Scratch". Pre and Post-test were administered to each participant. In the first group of youth, forty-four percent (44%) of the thirty-six (36) participants who completed the entire program, reported knowledge gained. In the second set of activities administered, pre and post-test assessments were conducted. Twenty-six of the 32 youth showed an increase in knowledge in the "Mars Base Stem Challenge".

Briefly describe how the broader public benefited from your project's activities.

The broader public benefited from the project's activities when the youth obtained exposure to the computer and the various activities youth were able to perform. The broader public could benefit from the use of technology and the wide range of information available. By educating the youth, the public also gained knowledge. The youth could take the lessons learned and inform the broader public of how valuable and beneficial STEM could be to the community.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

One major change would be to order more supplies and expand the program activities within the communities. No problems were encountered regarding the approach. The program plans to expand its activities across the Pee Dee Region to provide training and professional development on a larger scale. More schools will be asked to partner with 1890 Research and Extension to continue bridging the digital divide. A possibility would be to incorporate adult basic computer training into the curriculums. The results were published in various reports and disseminated across the state. For the communities with special interest, the information was distributed in several forms of social media, such as local newspapers, facebook, videos, etc.



In 2-3 sentences, briefly describe the issue or problem that your project addresses.

At-risk youth in rural communities represent a high percentage of high school dropouts, underemployed individuals, and those that lack basic skills to enhance optimal academic performance and job seeking abilities. The Juvenile Offenders and Victims Report indicates the top characteristics of dangerously at-risk youth are living in poverty, limited connectedness to school or work, and limited basic life skills. The Citizenship Project efforts engaged participants in activities that assist with a strategic plan for developing career paths, provided opportunities to develop essential life skills, and included school enrichment activities that promoted academic performance and positive behavior.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The major activities helped achieve or make significant progress toward the goals and objectives described in the non-technical summary by expanding the participants awareness of career opportunities and enriching their social well-being of the schools and communities the participant reside in. The project provided a safe place for youth to go while their parents worked to receive quality educational and recreational services necessary to keep them healthy. The youth enhanced outcomes in multiple ways: motivation and attendance improved, standardized test scores went up, and the dropout rate went down. The youth received a better understanding of the real-world and interdisciplinary applications. Character education was taught through the six pillars of character: trustworthiness, respect, responsibility, fairness, caring, and citizenship. A team approach was utilized with the incorporation of other character education best-practices.

Briefly describe how your target audience benefited from your project's activities.

The target audience benefited from the project activities because they gained knowledge in career preparation and development skills that assisted with social development. They were afforded opportunities to explore career options and experience creative measures to sustaining basic life skills. The basic life skills development was reached through practical engagement in demonstrations that focused on decision-making, interest assessments, and college and career planning. Increasing awareness of community issues was also a focus of the project activities. The youth learned through service learning to identify the source of rights and responsibilities at each level of citizenship in the community.

Briefly describe how the broader public benefited from your project's activities.

The broader public benefited from the project's activities as a learning process that enabled students in the community to understand, care about and act on core ethical values, such as respect, justice, civic virtue and citizenship, and responsibility for self and others. The project an opportunity to develop community service projects. Community non-profit agencies were identified that share the mission of Extension in providing youth development opportunities. Through a successful partnership with a local civic/social organization, the group donated gardening tools/equipment totaling \$1,000.00 for the project's use. As an activity, the youth created raised bed gardens, learned about social responsibility through sustainable living, physical fitness, agriculture careers, and a means to develop a close-knit community.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

There were no major changes or problems encountered in the approach the agents took to reach the youth. They were very attentive and receptive to the information being provided. Because of the success of the project and how well received it was, the organization may be able to branch out into other communities and increase participation. The results have been disseminated through the actions of the 1890 social media unit, known as Marketing and Communication (MARCOM). The unit does interviews, media releases, Facebook posts and other forms of distribution, especially in the local newspapers. In the next year, the project plans to increase the number of youth served, educational workshops and Memorandum of Agreements (MOA) for external community outreach activities by at least 10%.

Closing Out (end date 09/07/2023)

[Civic Engagement for Youth Audiences](#)

Project Director
Susan Guynn



4-H Pinckney Leadership Program

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

It is important that youth be mentored to serve as active community members and leaders not only as adults, but as youth. The Pinckney Leadership Program is designed for middle and high school students who are looking to develop their leadership abilities and awareness in civic engagement. The goal of the program is to empower students to serve with compassion, lead with humility, and inspire others through integrity.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The Pinckney Leadership Program helped students develop as leaders in their schools and communities, prepared them for college and career fields through exploration and academic enrichment activities, developed an understanding of social justice and how to be advocates, allies, or activist, and exposed students to the majors and opportunities available to them at Clemson University.

Briefly describe how your target audience benefited from your project's activities.

Students are required to apply to participate in the 4-H Pinckney Leadership Program but is open to all rising 7th and 8th grade students as well as rising 10th and 11th grade students. The program has now expanded and high school seniors that plan to continue their education post-high school that were previous 4-H Pinckney Leadership program participants now have the opportunity to apply for a scholarship. The scholarship is for \$1,500 per year and can be kept for 4 years of schooling upon reapplication.

The Pinckney Leadership Program allows middle and high school students the opportunity to develop critical leadership and civic engagement skills to better prepare them for life and post-high school educational opportunities. It also can help students achieve an increased level of self-confidence that can be carried throughout their lifetime. The scholarship program aids seniors to help overcome a financial barrier to post-high education. While the scholarship will not cover the cost of all higher education expenses, it may provide the students the extra financial incentive necessary to continue their education.

Due to COVID, the 2021 4-H Pinckney Leadership Program teamed up with three other Clemson University programs focused on serving underrepresented student through SC to achieve obtaining a higher education. The other three partners included the Emerging Scholars, Tiger Alliance, and Clemson Career Workshop. Through virtual programming, over 600 students were able to attend events. While the excitement and benefit of attending in-person programs was lost due to COVID, the virtual platform allowed the program to accommodate more students, resulting in an impact on a greater number of students.

Briefly describe how the broader public benefited from your project's activities.

Our youth will, in the near future, be the voices for social justice, community activism, and advocacy for citizens in SC and beyond. Providing opportunities, such as the 4-H Pinckney Leadership Program, helps youth develop leadership skills, increase self-confidence, and volunteer in safe environments. These skills will eventually benefit the public through the youth being more aware of and engaged in societal issues and social injustices.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

COVID forced the 4-H Pinckney Leadership Program to be held virtually for a second year in a row.



In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Many youth are unfamiliar with proper manners and professional behavior. Many youth do not know basic rules of table etiquette, professional dress, professional writing, or how to write a resume. Furthermore, COVID has impacted youth's ability to learn and practice proper manners and professionalism. Lacking a proper manner and professionalism skill set can hurt a youth's ability to function and thrive in a community or professional environment.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Youth in three counties in SC (Newberry, Lexington, and Richland) participated in a 6-week virtual training program to increase manners and professionalism. The lessons created a cultural educational opportunity for youth in a virtual environment. While these programs may prove more beneficial in-person so students can have the opportunity to practice new skills in a safe environment, the virtual lessons still exposed students to the skill set.

Briefly describe how your target audience benefited from your project's activities.

The virtual manners program included general manners, table manners, phone etiquette, American flag etiquette, professional dress, interviews, professional writing, resumes, thank you notes, and sportsmanship. Over 75% of respondents reported that they had an increase in knowledge in the areas taught. Furthermore, 75% of participants reported that they are more likely to use table manners than they would have prior to the program. Also, 100% of the participants agree that they are more likely to send a hand-written thank you note, are more confident in displaying the American flag, and are less likely to display unsportsmanlike conduct on a sporting field or in an arena.

Without this project, youth may not have been exposed to how to act and serve as community members. They learned new skills and intend to apply those skills in their lives in the future.

Briefly describe how the broader public benefited from your project's activities.

Youth that are confident and educated in proper manners and professionalism can act as community members in a positive manner. These youth have the self-confidence to serve as leaders and engage in community activities as they get older.

Critical Issue

Food Safety, Security and Nutrition

Family, Nutrition, and Health

Project Director

Edoe Agbodjan

Organization

South Carolina State University

Accession Number

7002210



Healthy Lifestyles Do the Body Good

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

To help promote healthy lifestyles for families with school age children, they need to be made aware of information that can change or improve their lives. Eating healthy and participating in physical activities can increase the overall outlook in life and decrease health problems. Obesity is a complex, serious, and costly public health issue that affects two out of three South Caroling adults and one out of three South Carolina children.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The major activities helped achieve or make significant progress toward the goals and objectives described in the non-technical summary by helping youth and adult participants to improve their quality of life through educating them on the importance of eating a healthy balanced diet and being physically active. The adults learned more about stretching their food dollars and how to cook quick healthy meals. With the information provided families and youth, they were empowered to make healthy food decisions, understand food insecurity, and understand how to prevent diseases such as diabetes, high blood pressure, and obesity. Workshops were administered to the participants. A pre and post-test was provided at the beginning and end of each workshop. The pre-test allowed agents to measure the participants' knowledge of health and nutrition. The post-test was administered at the end to see if knowledge was gain from the information provided. Adult participants were given information on how to create a grocery list from items left in the kitchen, prior to going shopping and creating a monthly grocery shopping budget. The action allowed parents to stretch their food dollars. Adults were encouraged to eat more fruits and vegetables to lower the risk of common diseases related to nutrition and how active a person may be. The youth participants were encouraged to eat foods from the five food groups, drink more water and less sugary drinks, and a discussion took place on where most foods come from. The goal was to give youth the knowledge to make better decisions when it related to nutrition and health and for them to improve their quality of life and avoid falling ill from a poor diet.

During the Expanded Food and Nutrition Education Program (EFNEP) sessions, two hundred twenty-eight participants were involved in tasting different fruits or vegetables in season. After following up with the participants, they continued to try different fruits and veggies. This allowed the participants to increase their fruit and veggie intake. The post-test results showed ninety-nine percent of the youth participants improved their abilities to choose healthier foods and gained knowledge. The adult participants showed a one-hundred percent improvement in their diet quality.

Briefly describe how your target audience benefited from your project's activities.

The target audience benefited from the project's activities because the knowledge gained regarding the understanding of the importance of eating healthy foods was beneficial to the entire family. Exercising and watching what a person eats helped to control obesity as well as other diseases. Trying different types of fruits and vegetables broadens the knowledge and introduces the taste pallet to a whole new world of varieties. The participants got an opportunity to get hands-on experiences. Healthy recipes were provided for individuals to do, or they could do as a family, which would help to strengthen the family bond. The sessions provided training on safe handling of foods, which reduced the chances of getting or preparing contaminated food for consumption. The overall benefit will translate into healthy families and communities.

Briefly describe how the broader public benefited from your project's activities.

The broader public benefited from the project's activities because the participants were able express what was learned to their extended family and demonstrate the power of what was learned. The broader public was able to see the SC State @ Home Series of videos produced by the participants and agents across the regions. The @ Home Series produced grocery shopping tips, how to make delicious and healthy snacks and meals. The exposure to the project and what it had to offer constituents increased the visibility of the 1890 Research and Extension Program.

Breeding Phaseolus Beans for Resilience, Sustainable Production, and Enhanced Nutritional Value

Project Director

Sandra Branham

Organization

Clemson University

Accession Number

1024825



FY 2021 Results

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Heat stress during the reproductive stages of snap bean development can have a negative impact on production reducing yield and quality of pods. Breeding heat tolerant snap bean cultivars could extend the growing season, expand production areas, and increase resilience to fluctuating temperatures but is limited by a lack of genetic knowledge and large-scale germplasm screenings. As part of this Hatch project, we have screened a large diversity panel of USDA snap bean accessions under heat stress conditions in a summer field trial and will use the most heat tolerant germplasm to initiate a plant breeding program to develop new snap bean cultivars resilient to temperature fluctuations.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The genetic diversity of snapbeans was assessed through DNA sequencing of 384 accessions from the USDA National Plant Germplasm System. The genetic data generated will be used in future years of the project for genetic mapping of economically important traits for improvement of snapbeans. The snapbean accessions and current commercial cultivars were evaluated for pod production under optimal and heat-stressed conditions in replicated field trials in Charleston, SC in spring 2021. The trial will be repeated in Spring 2022. The most heat tolerant accessions will be used to initiate a breeding program with the ultimate goal of releasing heat tolerant snapbean varieties.

Briefly describe how your target audience benefited from your project's activities.

The target audiences reached during this reporting period include growers, processors, and extensions agents that were able to see the pod production variation under variable growing conditions during a field day at the station. Snapbean researchers will benefit from release of the genotyping data of the snapbean accessions (manuscript in preparation). Lab technicians gained experience growing snapbeans during the field trial.

Briefly describe how the broader public benefited from your project's activities.

The broader public indirectly benefitted from these activities through the potential to increase the sustainability and stability of snapbean production through fluctuating climatic conditions. The research generated through this project will guide breeding efforts for future variety releases that may be commercially available to the public.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

A graduate student was recruited for this project and will run the Spring 2022 field trials to gain training and experience for a career in agriculture. Students were hired for the summer season to assist with the field trials and were able to gain valuable hands-on experience in an agricultural setting. Results were disseminated to the growers and processors through a field day at the Clemson Coastal REC in Charleston, SC. Genetic data was shared with other researchers through oral presentations at the Crop Science Society annual meeting and at invited seminars at Michigan State University and Cornell University. During the next reporting period, the project will (1) publish the genetic diversity of snapbeans in a peer-reviewed publication, (2) complete a second set of replicated field trials in Charleston, SC, (3) start making crosses of the most heat-tolerant accessions, and (4) complete a genome-wide association study of heat tolerance in the snapbean panel.

[You Are What You Eat: Investigating nutrition as a key prophylaxis against chronic inflammation and other co-morbidities in South Carolina families](#)

Project Director

Shanora Brown

Organization

South Carolina State University

Accession Number

1022524



You Are What You Eat: Investigating nutrition as a key prophylaxis against chronic inflammation and other co-morbidities in South Carolina families

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Safe, high quality, and nutritious foods are essential for human health and well-being. Growing evidence indicates that nutrition plays a significant role not only in human health but also in the prevention of disease which includes long-term intervention strategies that involve lifestyle changes and adaptations. Nutrition is a single and significant environmental modifier that every living organism is exposed during their lifetime; and provides a great window of opportunity to prevent or change the pathogenic course of disease progression.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The South Carolina State University researchers have begun engaging Orangeburg Community stakeholders and the underserved community population to address proper nutrition, healthy eating, and aid in the dissemination of knowledge about the You Are What You Eat research project.

The accomplishments of this project thus far include:

- Preparation of a lab safety handbook for working in the lab during Covid.
- Successfully training three underrepresented minority female undergraduate students working in the lab during the academic year and summer.
- Hosted a Community Health Session on Nutrition and Covid

Briefly describe how your target audience benefited from your project's activities.

COVID-19 & Nutrition Panel discussion presented by Cancer Lab 204 and 1890 Research & Extension. As the world is going backward and COVID-19 is taking a toll on our community even harder, we weighed in on the impact of nutrition, both advantages and disadvantages, on this virus. As researchers, it was our duty to educate everyone in effort to get REAL about this serious life-threatening virus and to take our health more serious with the many health disparities that impact our community. We also had dynamic panelists from the nutrition/family consumer sciences department on campus.

Briefly describe how the broader public benefited from your project's activities.

We have successfully hosted a Community Health Series entitled: Nutrition and Covid-19: Weighing the Impact of Diet Quality & Advantages and Risks on Susceptibility and Severity of Disease. The session addressed the role nutrition plays in the proper functioning of the immune system, varying dietary patterns and their benefits, nutritional tips for college students living on campus and the lessons learned about diet and Covid-19 risk during the pandemic. This research project will lead to greater awareness of healthful selection of foods by African American families who participate and ultimately reduce the burden of chronic diseases.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Conference Presentations:

1. You Are What You Eat: Investigating Nutrition as a Key Prophylaxis Against Chronic Inflammation and Other Co-morbidities in South Carolina Families. S.G. Brown*, A.E. Knowell*, 1890 Research and The Department of Biological and Physical Sciences, South Carolina State University, Orangeburg, SC 29117. Submitted to ARD Research Symposium, April 2-5, 2022, Atlanta, Georgia.
2. Evaluating the Expression of Known Pro-Inflammatory, Obesity, and Cancer Markers in South Carolinian Children. V. Burgess*, S. Brown, A. Knowell, 1890 Research and Department of Biological and Physical Sciences, South Carolina State University, Orangeburg, SC 29117. Submitted to ARD Research Symposium, April 2-5, 2022, Atlanta, Georgia.

3. Investigating Childhood Obesity and Chronic Inflammation in South Carolinian Children: Data Analysis from Orangeburg County. K. Stokes*, S. Brown, A. Knowell, 1890 Research, South Carolina State University, Orangeburg, SC 29117. Submitted to ARD Research Symposium, April 2-5, 2022, Atlanta, Georgia.

4. Understanding Best Research Dissemination Methods for the YAWYE Project Among South Carolinians Amid a Global Pandemic. A. Miller*, S. Brown, A. Knowell, 1890 Research and Department of Biological and Physical Sciences, South Carolina State University, Orangeburg, SC 29117. Submitted to ARD Research Symposium, April 2-5, 2022, Atlanta, Georgia.

Susceptibility of Insects to Gaseous Ozone: Flow Characteristics and Penetration of Ozone through Various Materials

Project Director

Rizana Mahroof

Organization

South Carolina State University

Accession Number

1019346



Susceptibility of Insects to Gaseous Ozone: Flow Characteristics and Penetration of Ozone through Various Materials

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Stored product insects cause millions of dollars of losses annually to stored durable commodities such as grain, grain-based products, legumes, dried fruits, nuts and spices. This research proposes to evaluate the susceptibility of various life stages of economically important stored product insects to different doses and exposure time to ozone, to establish a dose-time-mortality relationship. Further to characterize flow through various construction surfaces to evaluate the efficacy of ozone treatment for various storage structures.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Short Term: Generating knowledge and skills on ozonation techniques, testing the pilot technology for building and construction surface materials, and generalizing outcomes to wider geographical areas.

Intermediate Term: Building-upon the capacity of food security and food safety research in South Carolina State University, training undergraduate and graduate students, and dissemination of knowledge among professionals *via* refereed publications, conference proceedings and presentations.

Long Term: Minority students obtain jobs and research positions in food science and agricultural sciences; to strengthen the institutional research capacity in food and agricultural sciences; optimizing ozonation as a method of stored product insect control; changing behavior and practice of pest management among target audience; wider reach of scientific community through refereed publications; and reducing use of pesticide in the consumer chain.

Briefly describe how your target audience benefited from your project's activities.

Invited talks:

Mahroof, R. M. (2021). Stored-Product Pest Management in a Changing World: Challenges and Accomplishments. Invited seminar, Department of Entomology, Rutgers, The State University of New Jersey, November 19th, 2021, Webinar.

Mahroof, R. M. (2021). Engaging for a Good Cause: Bugs, an HBCU and a Woman of Color in Entomology. Symposium on Diversity and Inclusion, Annual meeting of the Southeastern Branch of the Entomological Society of America, March 29-31st, 2021, Virtual Meeting.

Mahroof, R. M. (2021). World of Insects. Trends in Biology Seminar Series, Department of Agricultural Biology, Faculty of Agriculture, University of Peradeniya, Sri Lanka. February 12th, 2021, Webinar.

Other oral presentations:

Mahroof, R. M. (2021). Effects of delayed mating on the mating performance of *Lasioderma serricornis* (F.). Annual meeting of the Entomological Society of America, Oct 30-Nov 3rd, 2021.

Mahroof, R. M. and Paudel S. (2021). Dose-response of selected stored product insects to ozone treated on various surface materials, 11th International Conference on Controlled Atmosphere and Fumigation in Stored Products, Manitoba, WI, Canada (Virtual), Aug 23-27th, 2021.

Mahroof, R. M. (2021). Stored Products Research and Teaching in Sri Lanka: My Fulbright Experiences. Annual meeting of the Southeastern Branch of the Entomological Society of America, March 29-31st, 2021, Virtual Meeting.

Briefly describe how the broader public benefited from your project's activities.

- The major outcome of the research is scientific knowledge generated to optimize ozone as a fumigation technique and how flow characteristics of this gas varies in various building surfaces and add information to the literature base.
- Local, national and international presentations and outreach activities were done. Some of the information are published in peer-reviewed articles and conference proceedings.
- Research program provided cutting-edge training to South Carolina State University students, to train and prepare research fellows for academic career and to educate farmers, industry representatives and pest control operators in stored products industry.
- The work disseminated information *via* scientific publications, extension bulletins and internet sources. South Carolina State University (SCSU) is a public university, located in an area that has a traditional, rural, agricultural economy, thus such disseminations are vital for the community to benefit from the university research
- Being located in an agricultural economy and fulfilling its land grant mission, success in 1890 agricultural research programs is crucial to SCSU. My research program complements the achievement of institutional land grant mission by training students in entomology, thus, SCSU can produce highly skilled, competent, and socially aware graduates to enable them to work and live productively in a dynamic, global society.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

This project has provided job opportunities for a number of people including a postdoctoral research associate and undergraduate assistants. Students have been employed to be a part of this project and many other students have volunteered to gain some research experience and training to equip them in their future endeavors. It has also provided opportunities for people working on the project to develop their networking and public-speaking skills through attending professional meetings, contributing to publications and becoming a members of professional societies.

Closing Out (end date 09/07/2023)

Plant Genetic Resources Conservation and Utilization

Project Director

Stephen Kresovich

Organization

Clemson University

Accession Number

1016646

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Result 1: Characterization of peanut genotypes with reduced content of immunogenic proteins to develop reduced immunogenicity peanut lines.

Problem:

Peanut allergy prevalence has risen from 0.4% to 1.9% of the US population in the last two decades. Sixteen peanut proteins are known to cause allergy. Four of them, namely Ara h1, Ara h2, Ara h3, and Ara h6, were identified as major allergens. Among other food allergies, peanut allergies are most prevalent and are not confined to the world's primary peanut production areas. The only effective therapy so far is an abstinent diet. A vaccine known as PALFORZIA™ was approved recently, but it could only prevent an immune reaction to accidental peanut exposure. Avoiding peanuts is not straightforward due to their ubiquitous presence and unintended contamination of the products with peanuts. An alternative solution to this problem is developing reduced immunogenicity peanuts to minimize the chances of severe consequences of accidental peanut exposures.

Result 2: Traits and underlying genetics for low-input organic sorghum production

Problem:

Sorghum is a hardy cereal crop with potential for organic production that could help meet the increased demand for organic food products and feed grains. However, no efforts have been made to determine the proper sorghum ideotype, or ideal plant characteristics, and underlying breeding strategy for this cropping system.

Result 3: Improving wheat productivity and resiliency to biotic stressors.

Problem:

Soft red winter wheat is a major crop for the southeastern USA, with over two million acres grown annually in the region. However, progress towards increasing wheat yields in the region have not been successful enough to meet the predicted demand needed in future years. Breeding for host plant resistance is often challenging as a result of quantitative inheritance and genotype-by-environment (G×E) interactions. Utilizing genomic prediction to boost yield potential and reducing the threat of disease with the development of resistant cultivars are methods that could certainly help meet the future demand for cereal grains.

Result 4: Development and characterization of a new sorghum genetic mapping population.

Problem:

Because of its genetic diversity, sorghum can be effectively used for food, feed, fiber, and fuel. Sorghum has the ability to allocate and store assimilates (i.e, carbon) in various plant tissues. This results in differentiation of major sorghum types: (1) grain sorghum — C stored as starch in the grain, (2) sweet sorghum — C stored as simple sugars in the stem parenchyma, and (3) bioenergy sorghum — C stored as structural carbohydrates such as lignin and cellulose. Although plant breeders have used conventional methods to develop these sorghum types, the underlying genetic controls that regulate carbon partitioning are largely unknown for the crop, which hinders the ability to accelerate crop improvement.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Activities:

To achieve this objective, we screen the peanut germplasm for the content and composition of immunogenic peanut seed storage proteins.

1] We screened the USDA mini-core collection of 108 genotypes plus a few other exotic or wild peanut genotypes identified as sources of useful alleles for biotic and abiotic stress resistance for genotypes with reduced content of immunogenic proteins. The mini-core collection of 108 genotypes represents the US peanut germplasm collection of about 10,000 accessions. This screen led to the identification of a wild peanut *Arachis diogeni* accession GKP 10602 with extremely reduced content of the allergenic proteins and 27 other genotypes completely lacking or reduced content of specific major allergens. The germplasm collection was evaluated using methods like electrophoresis and chromatography. Both procedures confirmed the reduced content of immunogenic proteins in these genotypes.

2] Like the USDA mini-core collection, total seed storage proteins from 93 of the 184 accessions of an international ICRISAT mini-core collection, which represent 14,310 peanut genotypes derived from 92 countries, were extracted, quantified, and resolved on the SDS polyacrylamide gels. Sixteen of these samples showed reduced content of allergenic proteins, especially in the atomic mass range of the major allergenic proteins. Additionally, we screened a set of 16 selected peanut genotypes from South Asia. Several of these genotypes showed extensively reduced content of allergenic proteins. These peanut genotypes identified through the germplasm screens will serve as an excellent source to breed reduced immunogenicity peanut genotypes.

3] Fortunately, for the *A. diogeni* accession GKP 10602 identified in the screen, we had an introgression line (IL) population at PDREC. Dr. Shyam Tallury (USDA-ARS) generated this material during his time at Clemson University. In addition, a similar but larger population existed at NC State University, which we have access to through collaboration. This population segregates for many morphological traits, such as seed size, leaflet shape and size, and resistance to pests and pathogens. This IL population consists of a total of 139 lines. Out of 139 ILs, 84 are well characterized, and the remaining 55 lines are relatively uncharacterized. We extracted total seed proteins from all of these lines and are profiling them using polyacrylamide gels and HPLC. The PAGE gel analysis revealed this population to exhibit great variation in the Ara h1, Ara h3, and iso-Ara h3 content from nil to reduced accumulation. We will utilize this data to map the protein quantity loci (PQLs) - the regulators of the observed variation in specific proteins - using the protein data as phenotype and the genotypic data recorded for these lines.

4] More detailed profiling of the seed storage proteins of these genotypes using high-performance liquid chromatography is underway. For this analysis, pure Ara h1, h2, h3, and h6 proteins are used as standards to determine relative quantities of these proteins. LC-MS analysis of the proteins derived from selected lines will also be performed via scanning the proteins of these lines for specific epitopes to determine absolute quantities of the major allergens in these lines. In addition, we will be using ELISA to determine quantities of specific proteins in these lines using antibodies specific to Ara h1, Ara h2, Ara h3, and Ara h6.

5] Fortunately, through our collaboration with NCSU, we have access to another population of 176 recombinant inbred lines (RILs). It is derived from a genetic cross between genotype NC25 and 'Georgia Green,' which stemmed from our germplasm screen for reduced-immunogenicity lines. Interestingly, two earlier studies identified 'Georgia Green' to accumulate reduced Ara h3 and iso-Ara h3. Screening of the RILs for their protein profiles exhibited segregation for Ara h3 and iso-Ara h3 proteins. The genotypic data is currently being generated for these RILs to map this protein trait and other phenotypic traits for which the prenatal genotypes differ.

Activities:

The problem was addressed by evaluating yield performance, agronomic traits, and biotic stress resistance under certified organic practices for 185 different grain sorghum entries, which included pure lines and hybrids, as well as 10 sweet sorghum cultivars and four commercial maize hybrids. Data from multiple years and locations concluded that sorghum can be effectively produced organically with reduced inputs, but hybrid or cultivar selection is extremely important for success, with grain yield for different entries ranging from near zero up to almost 6000 kg ha⁻¹. Top sorghum entries yielded similar to maize hybrids and were particularly competitive in a marginal, low-input production environment. Overall, hybrids outperformed inbred lines as heterosis, or hybrid vigor, positively impacted influential agronomic traits. Sugarcane aphid tolerance, increased canopy closure, and grain mold resistance were positively correlated with grain yield and should be considered target traits for breeding sorghum for organic use.

Activities:

Incorporating host plant resistance to diseases such as *Fusarium* head blight (FHB) and various rusts (leaf, stripe and stem) caused by *Puccinia spp.* is the most economical and sustainable approach. To develop new wheat cultivars for regional growers with increased FHB resistance and yield, targeted breeding and evaluation trials within these environments is necessary. The earlier generation stage that breeders can accurately screen for resistance (genetically or phenotypically) has major implications on selection intensity and genetic improvement. Increasing throughput and accuracy of field screening along with the incorporation of genomic selection can accelerate development of resistant cultivars dramatically. The Clemson Cereal Grains Breeding & Genetics (CGBG) program successfully developed over 500 new winter wheat populations over the past year to incorporate new productivity and resistance genes and make recurrent selections to improve the genetics within future cultivars for release, licensing, and commercialization. Utilizing new sources of genetic diversity from the NPGS Small Grains Collection has been instrumental for this effort.

Activities:

A carbon partitioning nested associated mapping (CP-NAM) population was developed as a genetic resource to enable evaluation of how sorghum effectively allocates C throughout the plant. The CP-NAM consists of 11 recombinant inbred families that were created using 11 diverse founder lines with variable plant architecture that were crossed to the single recurrent parent, 'Grassl'. Between 200-274 recombinant inbred lines (RILs) were made available within each family for a total of ~2,500 F6 RILs comprising the CP-NAM. Individuals were genotyped using genotyping-by-sequencing to generate nearly 145,000 SNPs after filtering. Joint linkage mapping was then performed to identify existing and novel QTL to validate the genetic resource and discover potential sources of valuable genetic variation, respectively.

Briefly describe how your target audience benefited from your project's activities.

Target audience benefit:

Based on reports from the United Sorghum Checkoff Program, farmers and private industry stakeholders have expressed interest in producing sorghum under certified organic production practices. Further, the scientific community needs information on what target traits and genetic material are important for sorghum improvement to develop cultivars and hybrids for commercial use. As mentioned above, this study determined the priority traits— sugarcane aphid tolerance, increased canopy closure, and grain mold resistance— that should be improved for sorghum to become more productive and higher quality for organic producers and end-users. Because organic food and feed is a premium market, farmers can potentially increase their profitability with this value-added commodity.

Target audience benefit:

Wheat is a global crop that is used for major purposes including a plethora of food products as well as a staple ingredient in animal feed rations. Improving soft red winter wheat production and resilience against various stressors such as heat or disease helps regional farmers to increase on-farm yields, helps national millers and integrators by providing higher quality (and thus healthier) grain, and consumers that desire healthier grain options. This research provides a potential to all agricultural stakeholders that depend on wheat production, handling, and utilization.

Target audience benefit:

The CP-NAM population was released along with corresponding genomic data for use in genetic, genomic, and agronomic studies with a focus on carbon-partitioning regimes. Seed will be publicly available upon request from the National Plant Germplasm System through the Germplasm Resources Information Network (GRIN). The scientific community will have the ability to utilize this resource for myriad genetic and physiology studies to better understand plant genetic function as it relates to assimilation, allocation, and utilization of C and other nutrients throughout the life cycle of sorghum, cereal crops, and potentially other distantly related plant species.

Briefly describe how the broader public benefited from your project's activities.

Consumers are becoming more and more health conscious and demand for organic food products has risen sharply in the past decade. It is a challenge for crop and animal producers to meet this demand for organic products because of ongoing production challenges and the lack of tools and technologies that are optimized for this sector. This study identified the challenges of production for organic sorghum as well as germplasm that is already suited for organic cropping systems. As such, this allows farmers to more easily meet consumer demand, which should make organic cereal grain and meat products (that must be fed with organic grains) more accessible and affordable.

Increasing local and regional wheat yield and quality improves the livelihoods of many, especially those within the region that have ties to agriculture. More quality wheat produced in the region makes a very big impact on profitability of agricultural stakeholders and can dramatically impact the availability and affordability of staple food products that are offered to consumers on the grocery store shelves, in restaurants, or fresh at the farmer's markets.

Providing additional genetic resources for a commodity and value-added crop like sorghum offer the potential to accelerate genetic gain for improved productivity and quality, which ultimately equates to better seed products available on the market to producers. Equipping farmers with more appropriate seed technology for their intended production use and environment will increase chances of successful production of sorghum for food, feed, fiber, and fuel. All of these uses are imperative to either combat food and energy security and environmental sustainability.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to

communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

Refereed journal article and book chapters

1. **Rustgi S***, Alam T, Jones ZT, Brar AK, Kashyap S (2022) Reduced-immunogenicity wheat and peanut lines for people with foodborne disorders. Chemistry Proceedings (accepted).
2. **Rustgi S***, Kakati JP, Jones ZT, Zoong Lwe ZS, Narayanan S (2021) Heat tolerance as a function of membrane lipid remodeling in the major US oilseed crops (soybean and peanut) Journal of Plant Biochemistry and Biotechnology 30:652–667 [IF 1.175]
3. Alam T, Anco D, **Rustgi S*** (2021) Reconditioning and disposition of aflatoxin-contaminated peanut: A guide for the United States peanut producers. Clemson University Land-Grant Press LGP 1116.
<https://lgpress.clemson.edu/publication/reconditioning-and-disposition-of-aflatoxin-contaminated-peanut-a-guide-for-us-peanut-producers/>.
4. Windham J, Sharma S, Kashyap MK, **Rustgi S*** (2021) CRISPR/Cas12a (Cpf1) and its role in plant genome editing. In: G. Tang, S. Teotia, X. Tang, D. Singh (Eds.), RNA-based technologies for functional genomics in plants. Springer Nature, Cham, Switzerland. pp 15-42.

Other scholarly publications (abstracts, invited reviews, etc)

1. Jayapuram A, Grant A, Eddy J, Gause A, **Rustgi S**, Jones Z, Begum H (2022) In silico enzymatic digestion of peanut seed proteins and epitope mapping to determine the level of immunogenicity. 2022 SC INBRE Science Symposium, BI-07.
2. Blanks J, Gamble N, Moody M, **Rustgi S**, Jones Z, Begum H (2022) The effect of heat treatment on peanut pollen viability. 2022 SC INBRE Science Symposium, BI-08.
3. Hannah N, Maynard S, Thomas L, **Rustgi S**, Alam T, Begum H (2022) Screening of peanut germplasm for reduced-immunogenicity lines. 2022 SC INBRE Science Symposium, BI-09.
4. **Rustgi S**, Alam T, Jones Z, Naveed S, (2021) Breeding peanuts for reduced immunogenicity. 2021 Pee Dee Research and Education Center Field Day Abstract book.
5. **Rustgi S** (2021) Reduced immunogenicity wheat and peanut research help on its way for sensitive individuals. Proceedings of the International Conference on the “Infectious Diseases in an Era of Vaccines,” (October 18-19, 2021).

Oral/poster presentations

1. **Rustgi S** (2022) “Developing non-immunogenic, safe, and surplus crops to feed the growing world population;” The (Clemson Health Advancement Talks) CHAT (January 20, 2022).
2. **Rustgi S** (2022) “Reduced-immunogenicity wheat and peanut lines for people with foodborne disorders” 1st International Online Conference on Agriculture - Advances in Agricultural Science and Technology, virtual, (February 10-25, 2022).

3. **Rustgi S** (2021) "Next-generation plant breeding and management strategies to develop healthy, safe & surplus crops;" Joint PES & ENT Seminars, Department of Plant and Environmental Sciences, Clemson University, Clemson SC (November 19, 2021).

4. **Rustgi S** (2021) "Germplasm screening and allele recycling to breed crops with novel traits." S-009 Committee Meeting, virtual (August 10, 2021).

5. Alam T, *Brar A*, *Kerr R*, *Jones Z*, Naveed S, and **Rustgi S** (2021) Crafting reduced-immunogenicity peanut genotypes for peanut-allergic individuals. 2021 ASHS Annual Conference, Denver, CO (August 5-9, 2021).

6. *Floyd K*, *Anders K*, Alam T, **Rustgi S** (2021) Protein profiling of unique peanut genotypes to produce reduced immunogenicity lines. Summer Program for Research Interns Virtual Poster Forum (July 16, 2021).

Note: Asterix = corresponding author, underline = graduate student, italics = advisee.

[The Impact of International Trade Policy Changes on Global Food Security and South Carolina Agriculture](#)

Project Director

David Karemera

Organization

South Carolina State University

Accession Number

1016748



The Impact of International Trade Policy Changes on Global Food Security and South Carolina Agriculture

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

The Impact of International Trade Policy Changes on Global Food Security are important for local farmers and producers. The project has focused on the study of food security at county, state and national levels and addressed the impact of United States-Mexico-Canada (USMCA) and other regional free trade agreements on Dairy, Poultry, and turkey trade flows from South Carolina.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Student Training in International Trade Research

- ***We trained students*** in international trade and food security research. Two graduate and one undergraduate student were engaged in project activities.
- These students produced research materials that supported project execution. The materials included USDA data on food availability, USDA food security briefs, and state website data. More assignment included collecting data to estimate trade models, review of literature and compiling references to the project.
- The graduate students produced tables that are needed in regression modeling and performed graphical representations of certain data such as graphing data on food availability by county using US Census data.

- The undergraduate student was productive. She generated needed online data relevant to the analysis of factors affecting food availability and helped in data tabulation during production of the final Bulletin.

Food Availability study in South Carolina Counties

- The study has identified factors affecting food availability in South Carolina.
- Using US Census data available every five years for 2002, 2007, 2012, and 2017, we designed cross section models for each year and used the models to analyze and evaluate factors affecting food availability in South Carolina's forty-six counties.
- In the study, we addressed factors affecting food availability and the number of food-insecure persons in South Carolina. A county's harvested acres are an indication of the capacity and ability to supply agricultural foods in the county. The empirical analysis shows that an increase in harvested acres or a decrease in a county's unemployment rates will significantly increase food availability. The results suggest that counties located further north tend to have less food availability. This implies that improving food accessibility and shortening the distance between farms and food markets would increase food availability. This behavior is consistent in all four years of study. Other factors such as prevalence of greenhouses and profits from corn sales enhance food availability but the effect does vary by Census year and model specifications.
- The data for food insecure persons were available for 2012 and 2017. The agency "Feeding America" provided us the data that included the number of food insecure persons by county. The county of Richland had the highest number of food insecure persons including adults and children in 2012 and in 2017. The county of Greenville had highest number of food insecure children in 2012 and 2017 census years. The county of Greenville registered the largest decline in number of food insecure persons, including children from 2012 to 2017 while the county of Jasper shows least decrease in the number during this period. Similarly, the county of Greenville registered the largest decline in number of food insecure children from 2012 to 2017 while the county of Marion shows no decrease in the number of food insecure children during this period.
- A comparative description reveals that in the year 2012, seventeen of the twenty-three northern counties had the number of food-insecure persons, including adults and children be below the state average. Six of the twenty-three northern counties had the number of food-insecure persons be above the state average. Ten of twenty-three southern counties had the number of food-insecure be above the state average. Thirteen of the southern counties had the number of food-insecure persons be below the state average. The above ratios remained unchanged in 2017.
- A description of food insecure children shows differences at county level. In the year 2012, seventeen of the twenty-three northern counties had the number of food-insecure children below the state average. Six of the twenty-three northern counties had the number of food-insecure children above the average while nine of the southern counties had the number of food-insecure children be above the state average. Fourteen of the southern counties had the number of food-insecure children be below the average. During the year 2017, eighteen of the twenty-three northern counties had the number of food-insecure children be below the average while five of the twenty-three northern counties had the number of food-insecure children be above the state average. Ten of the twenty-three southern counties had the number of food-insecure children be above the average. Thirteen of the twenty-three southern counties had the number of food-insecure children be below the average.
- The study sought to identify factors affecting food security indicators, notably per capita calorie supply. Using data from 1961 to 2017, dynamic panel gravity models are used to address the factors affecting food security within the United States. We looked at the impact of The North American Free Trade Agreement (NAFTA) on food and per capita calorie supply. The results show that the lagged dependent variable, and independent variables that include gross domestic product, productivity, farm income, trade openness and NAFTA are major factors affecting food security indicators. In most cases, no significant effect is found for population, and life expectancy.

- However, we find evidence of a positive and significant impact of NAFTA on food security in terms of food supply. Including the interaction term between NAFTA and productivity, the study reveals that NAFTA did not lead to a shift in productivity to enhance food supply. NAFTA effects on food and calorie supply seems to have declined over time.
- Models for food availability, and capita calories supply were evaluated. We examined the impact of agricultural productivity on the level of the food security indicators. Agricultural productivity is proxied by agricultural value added per hectare and cereal production per ton.
- The findings show that agricultural productivity proxied by cereal production does enhance the level of food security. However, productivity proxied by agricultural value-added per hectare indicated reduced food security in the study area. This finding suggests that the lack of sustained agricultural productivity significantly contributes to reduced food availability and calories supply. This finding suggests that there is need to promote agricultural productivity to obtain higher level of food security. The results also suggest that trade openness did not lead to significant increase in food security. The gross domestic product, farm income, and arable land remain significant factors affecting food security indicators.
- **International Trade and the Impact of USMCA on agricultural trade flows.**
- Advanced dynamic gravity and probit models of international trade were used to evaluate impact of free trade agreements. The analysis focused on the United States, Mexico, and Canada Agreement (USMCA) and its impact on dairy, poultry, and turkey exports from South Carolina. The estimates show that USMCA increased dairy trade flows from South Carolina by \$2.620 million yearly, solely as a result of complete tariff cuts on S.C. exports to Mexico and Canada. Results for the poultry and turkey trade were not significant.
- The findings reveal that the EU, ASEAN, and MERCOSUR increase trade flows of dairy with insignificant effects on poultry and turkey trade.
- The limitation of this result is that the USMCA is a new agreement and its trade potentials have not yet realized. Simulation models were used to predict potential trade increased from the USMCA without regards to whether the Agreement is trade creating or diverting.

Collaboration with Michigan State University

- The subagreement with Michigan State University where Dr. Titus Awokuse is an outside Project Collaborator is being implemented. Dr. Awokuse indicated that data collection and analysis have been completed and the final subagreement report is forthcoming.

Briefly describe how your target audience benefited from your project's activities.

1. SCSU faculty and Students participated in the discussion and execution of the project activities.
2. Collaboration with USDA agents on food availability data. The research team had multiple conversations and entertained discussions with outside agencies. The research team received support from USDA agents and State Department of Agriculture agent.
3. Academic audience and others with interests in international trade and food safety and food security are reached through publication of research materials such the refeed journal article and working papers series.

4. General audience and the public at large with interest in trade and food safety and food security are also reached through publication of research materials such the refereed journal article and working papers series.

Briefly describe how the broader public benefited from your project's activities.

1. Publication and production of Working Papers series are venues of dissemination:

Publication:

The paper entitled "Assessing Trade Benefits of a TTIP and the Role of Regional Free Trade Blocks on South Carolina Agricultural Exports: A Static and Dynamic Approach" is published in the - International Journal of Food and Agricultural Economics"; Vol 9. N0 4, pp. 245-261, 2021.

Working papers are available:

a. An Empirical Assessment of Factors Affecting Regional and Local Food Security.

b. Determinants of Local Food Security:

c. The Potential Impact of USMCA and other Regional Free Trade Agreements

2. Farmers and rural community survey participants were reached and were made aware of the issued of trade on food security.

3. Survey participants are aware of benefits and challenges of international trade on farm production, exports, and trade

4. Students' participation in survey administration is also opportunity for training and experiential learning.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

1. An undergraduate and two graduate students were trained in international trade and food security research. The students are essential and integral part of the project research team. The undergraduate and graduate students were engaged in multiple activities. Their assignment included collecting needed data to estimate trade models, review of literature and reading

references to the project. They conducted library searches and data collection; and retrieved online abstracts of reference papers. The students are asked to reach basic trade papers and retrieved related abstracts.

2. Students were required to review international trade literature and participate at every stage of project activities including production and review of quarterly and yearly reports; and NIFA reports.

3. The project has provided research opportunities to a post doctorate research associate. The research associate has gained experience in international trade research and had opportunity to published research in international trade.

4. Under supervision of the project director, the research associate designed and implemented advanced econometric models to identify food security determinants. The results are used to draft manuscript for possible presentations and subsequent publication. Thus, the project has given the research associate opportunity to build a professional resume.

5. The data programmer and the project director had opportunity to design and created a new variable called "a county location index" that was used to assess the impact of location on food availability.

Food Systems and Safety

Project Director

Susan Guynn

Organization

Clemson University

Accession Number

7000042



Food Safety Review Jam Session

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

More than 250 foodborne diseases pose a serious threat to public health. Foodborne diseases affect an estimated 48 million people in the United States per year, resulting in 128,000 hospitalizations, and 3,000 deaths (2017). The State of South Carolina requires a person (certificated in food safety) in charge (PIC) to be present for each shift at a licensed food service establishment from an approved food safety course to help combat foodborne diseases.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Providing education and keeping a certification current for food service workers regarding food safety is essential in preventing foodborne illness through current and updated information. Teaching safe food handling practices helps prevent foodborne diseases. Also, reducing foodborne illnesses in restaurants helps to lower liability claims against restaurants which increases profit margins.

Briefly describe how your target audience benefited from your project's activities.

Food service managers need to recertify for the Food Protection Manager Certification Exam every 5 years and may prefer studying information in a group. Initially, retaking the 6-hour course was the only option to prepare for recertification within a group setting. Food service managers needing to review and recertify for the Food Protection Manager Certification Exam can review for the test with Clemson Extension food safety agents without sitting for the 6-hour course. The Food Safety Review Jam Session is a 3-hour webinar which highlights and reviews key concepts of food safety and is designed to assess the knowledge of food managers preparing to recertify for the nationally approved Food Protection Manager Certification Exam. Through the online virtual trainings, 100% of participants were extremely satisfied when reporting that the information was useful and plan to take actions for change based on their participation.

Briefly describe how the broader public benefited from your project's activities.

Foodborne illnesses are preventable through knowing and applying safe food handling practices. Certifying workers in safe food handling practices ensures that restaurants meet guidelines in preparation and service of the food. The public has a decreased chance of contracting a foodborne illness and can enjoy dining out. Reducing foodborne illnesses also reduces the financial burden on restaurants by having lower insurance premiums, and thus, increased profit margins. Many restaurants are vital to workers that depend on them for their livelihoods.



Local Products and Goods Licensing and Labeling

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

Foodborne illnesses are always a significant concern for the public. According to public health and food safety experts, approximately 48 million individuals become sick each year from the consumption of contaminated food. Furthermore, local farmers and producers may not know what is needed to safely sell their honey products, baked goods, or shelled eggs in South Carolina.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

Clemson Extension agents provided a statewide virtual class that provided information on the SC Food & Cosmetic Law and the SC Egg Law. This class helps new food entrepreneurs and local farmers wishing to sell their products learn food safety and food product labeling requirements, thus reducing the likelihood of foodborne illnesses.

Briefly describe how your target audience benefited from your project's activities.

A total of 73 participants increased their knowledge of sanitizing, packaging, and labeling their shelled eggs for sale to the public. Furthermore, 23 participants increased their food safety knowledge to prevent foodborne illnesses and state requirements for selling their honey products and baked goods.

The training on licensing and food safety requirements allowed local farmers and food entrepreneurs to safely sell their products to the general public. Direct marketing of local specialty and food items may provide an important revenue stream for local farmers and food entrepreneurs.

Briefly describe how the broader public benefited from your project's activities.

Proper food handling, safety, and labeling is important to protect humans from foodborne illnesses. The training for local farmers and food entrepreneurs provides a level of protection for the public so they can buy and consume local goods and products while at the same time reducing their carbon footprint. Furthermore, the local goods and products purchased provides a community investment in the citizens and surrounding counties so they can continue to thrive and support the agricultural industry.

Describe and explain any major changes or problems encountered in approach. Additionally, note opportunities for training and professional development provided, how results have been disseminated to communities of interest, and any new details regarding what the project or program plans to do during the next reporting period to accomplish the goals.

These programs were conducted virtually due to COVID restrictions.

Health and Nutrition

Project Director

Susan Guynn

Organization

Clemson University

Accession Number

7000043



Green Space and Wellness

In 2-3 sentences, briefly describe the issue or problem that your project addresses.

According to the Robert Wood Johnson Foundation county health rankings, Lee County, SC, has reached obesity levels of over 40%, while their physical inactivity levels have risen to over 36%. These county health rankings provide a snapshot of the community health within the places where we live, work, play, and worship and become a starting point for community change. Understanding that health is not just chronic illness or disease but also dramatically impacts social and mental wellbeing is critical to improving community health.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

The Clemson Extension Rural Health and Nutrition agent worked to identify ways to create opportunities for physical activity that was free, easily accessible, and safe. The Lee County Library had an annex that was an old used car lot with an abundance of beautiful green space that could be developed to fill the need of the community for increased opportunity for physical activity, and thus potentially leading to reduced obesity rates in the county.

Briefly describe how your target audience benefited from your project's activities.

Creating a sense of community through public outdoor spaces can help foster a sense of social belonging within the community. At the same time, quality parks and green spaces can improve physical health by increasing physical activity levels which could reduce obesity rates and chronic diseases. After receiving permission from county group members, Friends of the Lee Library, it was decided that along with a coalition of community residents, Clemson Extension would help to create an outdoor destination space. The new outdoor greenspace benefited mental health by lessening social isolation, improved cognitive functions, and enhanced community connections through building a community sense of pride and belonging. These benefits are provided to the community members in a free, easily accessible, and safe location. Furthermore, it connects the community with other government services, such as access to the library.

Briefly describe how the broader public benefited from your project's activities.

Obesity can create a chronic health condition that may carry a public financial burden. Furthermore, communities that have higher than average obesity rates may also have an increased rate of physical inactivity, which can lead to social isolation. The physical conditions can lead to reduced mental wellness, which can also carry a financial burden to manage. Healthier communities are more active, socially engaged, and advocate on their own behalf for improved social equity and justice.



In 2-3 sentences, briefly describe the issue or problem that your project addresses.

One in seven adults, approximately 500,000 people, has diabetes in South Carolina, which increases a person’s risk for cardiovascular complications. Approximately 10,000 South Carolinians died from heart disease in 2017, making it the second leading cause of death for the state. Therefore, chronic conditions like diabetes and heart disease are a persistent issue in both urban and rural communities of South Carolina.

Briefly describe in non-technical terms how your major activities helped you achieve, or make significant progress toward, the goals and objectives described in your non-technical summary.

In response to these health issues affecting urban and rural communities, the Clemson Extension Rural Health and Nutrition Team delivered a series of webinars titled Know Diabetes by Heart (KDBH) in collaboration with the American Heart Association and the American Diabetes Association. The purpose of the virtual webinars was to raise awareness and understanding of the link between diabetes and cardiovascular disease. Through these webinars, Clemson Extension positively empowered people across the state of South Carolina to better manage their risk for cardiovascular disease, heart attacks, and strokes.

Briefly describe how your target audience benefited from your project's activities.

Individuals with diabetes are at an increased risk for developing future cardiovascular complications. In fact, adults with diabetes are two times more likely to have heart disease than adults without diabetes. The Know Diabetes by Heart programs focused on diabetes and its relationship to heart disease. It provided the audience information on what diabetes is, symptoms of diabetes, its relation to heart disease, and when to talk to a healthcare provider about symptoms. Participants also learned about other Clemson Extension health and wellness programs that can also reduce the risk of developing diabetes and cardiovascular disease.

Briefly describe how the broader public benefited from your project's activities.

Reducing diabetes and related heart disease creates healthier families and communities. Many times, family members are burdened with caring for individuals with chronic health conditions later in life. By reducing the risk of diabetes, and subsequent heart disease, families have less stress, reduced financial burden related to a chronic medical condition, and improved quality of life. Furthermore, community members that take a personal interest in improving their health can inspire other family or community members to do the same.

Type

Projects / Programs without a Critical Issue

Not Provided

Projects/ Programs

0