

# South Carolina State University and Clemson University Combined Research and Extension Plan of Work 2022-2026

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## **I. Plan Overview**

### **1. Executive Summary**

South Carolina is blessed with a diversity of ecoregions and open land, providing opportunities for SC residents to earn a living from the land. It also provides an opportunity for tourism. The warm climate and diversity across the landscape also attracts residents to live in SC and work at the numerous industries located within the state. The primary industry in SC is agriculture, with 25,000 farms across 4.7 million acres that contributes over \$46 billion to the state's annual economy and provides over 247,000 jobs. Forestry is also an important economic driver in SC, contributing over \$21.2 billion annually. With such diverse natural resources across the state, tourism is also a major economic force, accounting for expenditures of \$24.4 billion in 2019. The 5.1 million people living in SC are crucial to maintaining the quality of life and conservation of the natural beauty in SC, particularly youth, since they are our future stewards of the state. The livelihood and quality of life for SC residents is what drives the programming and research focuses for Clemson and South Carolina State (SC State).

The Plan of Work reflects Research and Extension activities planned by Clemson and South Carolina State (SC State) Universities to benefit agribusiness, communities, and citizens of South Carolina from 2022 through 2026. Clemson and SC State Research are based on the discovery and delivery of new knowledge through science-based, relevant research leading to discoveries specific to South Carolina's needs. Focus areas include advancing the competitiveness of the agriculture and forestry industry, enhancing the economic potential of rural communities, safeguarding the food supply, preserving natural resources and preparing the younger generations to become productive citizens. There is continued emphasis on evaluating all Research and Extension activities and providing quality performance information to stakeholders through Extension and outreach activities.

The mission of the Clemson Cooperative Extension Service (Clemson Extension) is to provide science-based, non-biased information to the citizens of South Carolina. To do that, we recognize that South Carolina is a diverse state in terms of geography and demographics. There are some areas of SC that are rural and the primary industry is agriculture or forestry. However, there are urban centers that continue to grow in population where agriculture is not the primary industry but struggle with other issues that still require the support of Clemson Extension. To address these wide-ranging issues, Clemson Extension will focus on the areas of agrisystems productivity and profitability, agribusiness and community development, environmental and natural resources conservation, food safety and nutrition, and youth and family development. We will deliver science-based information in conjunction with the Clemson Experiment Station and others throughout the country to improve the lives of all South Carolinians.

As part of the land-grant mission, the objective of the SC State Program is to raise the educational consciousness and awareness of national issues that impact South Carolinians, with special emphasis on limited resource clientele, in order to improve their quality of life. It is an organized research and extension system that addresses quality of life opportunities for residents. The program provides effective stakeholder outreach programs and services in the area of agriculture/natural resources, family life, health and nutrition, youth development, agribusiness, community economic development, education and technology. The research and Extension components will focus on the areas of agrisystems productivity and profitability, agribusiness and community development, environmental and natural resources conservation, food safety, security and nutrition, and youth and family development.

SC State values the integration of research, teaching and outreach. The research provides adequate funding to faculty, staff and students to become engaged in organized research efforts/opportunities to address problems and issues of concern. In conjunction with the SC State Research, the Extension unit delivers research-based programs/activities designed to help stakeholders/clientele enhance their quality of life, in order to respond to environmental changes. Both units work cohesively for the betterment of the citizens of South Carolina.

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.

Agrisystems productivity and profitability:

Clemson University Research continues with the Advanced Plant Technology program at the Pee Dee Research and Education Center in Florence, SC. This research will provide a bridge to 21st-century agriculture using traditional plant breeding and molecular genetics to develop new crops and crop-based products. The goal of the program is to foster continued development of the agricultural economy in the Pee Dee Region and throughout South Carolina. Specific objectives are to increase the per-acre value of crops; improve drought, insect and disease resistance; improve crop yields, and introduce new crops and crop-based products that can expand the market for South Carolina farm products; and attract private agribusiness investment in research, development, and application of new technologies and the creation of new crop varieties. The current crops of interest are corn, cotton, peaches, peanuts, sorghum, soybean, and wheat. Studies also include research on crop pests, plant diseases, invasive weeds, and best-management practices for cultivation. This program is currently improving agriculture in South Carolina one field at a time.

New research by Clemson University Experiment Station will be underway in the following areas: the use of Intelligent Agritronic Devices (IAD) and methodology for site-specific management of crop inputs (irrigation, nutrients, pesticides, etc.), for cattle production to enhance farm profits and environmental sustainability of South Carolina's agriculture, the reduction of costs while providing a robust mechanism to manage weeds in agronomic crops in South Carolina, and the improvement to irrigation water management in South Carolina by using real-time soil and weather inputs to automate irrigation scheduling of a center pivot equipped with variable-rate irrigation (VRI) technology. Researchers will look to mitigate yield and quality degradation in peanut production from biotic and abiotic stresses and sustainably grow the crop and utilize the information gained from the dynamics of the plant metabolites to predict the mechanism of glyphosate resistance in Palmer amaranth, and for the restoration of sites invaded by exotic plant species.

In terms of new research efforts, SC State is concerned with three specific areas of agriculture; controlled environment agriculture, urban agriculture and organic agriculture. Controlled environment agriculture (CEA) is an advanced and intensive form of hydroponically based agriculture where plants grow within a controlled environment to optimize horticultural practices. Urban agriculture includes production (beyond that which is strictly for home consumption or educational purposes), distribution and marketing of food and other products within the cores of metropolitan areas and at their edges. Examples include community, school, backyard, and rooftop gardens with a purpose extending beyond home consumption and education, urban market gardens, innovative food-production methods maximize production in a small area, community supported agriculture based in urban areas, and family farms located in metropolitan greenbelts. Organic agriculture is organic farming that makes healthy foods, healthy soils, healthy plants, and healthy environments a priority, along with crop productivity. Organic farmers use biological fertilizer inputs and management practices such as cover cropping and crop rotation to improve soil quality and build organic soil matter. By increasing the amount of organic matter in the soil, organic farmers enhance the soil's ability to absorb water, reducing the impacts of drought and flooding. Improving soil organic matter also helps it to absorb and store carbon and other nutrients needed to grow healthy crops, which, in turn, are better able to resist insects and diseases.

Furthermore, SC State is interested in innovative research pertaining to the development of Smart Farms. Smart Farms are a means of incorporating information and communication technologies into agriculture. Sensors are installed in fields to collect data about soil and plants. The data would be beneficial in helping to prevent diseases and make agriculture efficient and sustainable. Smart Farming is the future of agriculture. Therefore, research will be conducted to secure and optimize internet-of-things deployed for Smart Farming. It makes the farm process automated and smarter, enabling the farmer in reducing the cost and effort. The administration has identified and is in the process of acquiring property to establish the foundation for Smart Farming.

Research at SC State will investigate mathematical frameworks and design novel algorithms to achieve an optimized and

secure Internet-of-Things (IoT) deployment for the Smart Farming system. The project aims to increase the agricultural yield, reduce the input cost and improve the decision-making in agriculture by developing an IoT based smart farming system. The Smart Farming system will be built using cloud computing and fog computing technology, the components such as IoT gateways and the IoT applications must be placed in a way that minimizes the operational cost of the cloud-fog infrastructure and satisfies the Quality-of-Service (QoS) requirement of the IoT applications.

SC State Research will broaden its focus on assessing the hearing loss and high blood pressure of farmers and agricultural workers in three counties in South Carolina. The study will educate farmers in the state of the risk factors of how noise-induced hearing loss could affect other areas of their health. The research seeks to produce an inclusive environment for students who major in speech-language pathology and audiology or farm careers by enhancing their knowledge as well as changing practices and attitudes of farmers/farm workers.

SC State Research will look at the ultrasound of a noninvasive method of a wide application in the medical field, which can be combined with Artificial Intelligence (AI) to see a lot of direct applications across sectors. It can bring a paradigm shift in how farming is seen today. The proposed research is an AI based Advanced Ag-Drone system for local farmers in South Carolina.

Clemson Extension will continue work to increase the adoption of practices that reduce nuisance and environmental impacts through the educational process. The topics addressed could include: control of odors and vectors, protection of water quality, nutrient management, citing of facilities, and alternative waste handling practices. Emphasis will be on confined animal production facilities. However, development and demonstration of grazing systems to protect water quality are also of interest.

Crops in the southeastern United States are generally produced in fields known to have a high degree of variability in soil type, topography, soil moisture and other major factors that affect crop production. Emerging tools and practices to increase crop production, decrease operating costs and reduce environmental impacts for specific conditions will be taught by Clemson Extension to farmers across the state. South Carolina is unique in that we have an environment that allows for growing a diversity of fruits, vegetables, herbs and nuts. As our state grows in population it is imperative that Clemson Extension educates food producers on the best management practices for both farm profitability and environmental sustainability.

There are many areas in South Carolina that have a large concentration of poverty due to low incomes received by minority farmers. In many instances, the farmers lack the skills required to apply agricultural technology in their operations, including both production and marketing. Opportunities are extremely limited to many of the operators for off-farm income. Improving their farm income is, in many instances, their only hope. Therefore, the SC State outreach efforts will address landowners, limited resource socially disadvantaged farmers, and ranchers' needs with various educational activities and projects. One of the underlining objectives will be to equip all farmers with sound management practices, which is a must for the success and sustainability of farming enterprises. The clientele are businessmen and women. Therefore, their operations should be considered an integral part of their county and regional rural economic development.

The Small Farm Program will be implemented within six basic SC State Extension Regional areas and serve at least 25 counties across the state. The six regions will include the Piedmont Region (Abbeville, Edgefield, Greenwood, McCormick and Saluda Counties); Low Country Region (Allendale, Colleton, Hampton, Beaufort and Jasper Counties); Pee Dee Region (Chesterfield, Dillon, Marlboro and Marion Counties); Midlands Region (Bamberg, Calhoun, Dorchester and Orangeburg Counties), Santee-Wateree Region (Clarendon, Sumter, Georgetown and Williamsburg Counties) and Coastal Region (Charleston, Dorchester and Berkeley Counties). SC State plans to implement the Small Farm Program in the Coastal Region as a new initiative. Each region will explore animal production systems, vegetable production systems, sustainable agriculture production, Integrated Pest Management (IPM) practices and risk management education and natural resource development.

Agribusiness and community development:

Clemson research will continue to focus on the development, analysis and application of next-generation materials, hardware, software, and network systems required to implement new technology that will represent emerging sustainable agriculture and will transform the way we monitor and manage small family farms to large industrial farms. Clemson University researchers will collect data on agricultural and meteorological events, aggregate data into functional

databases, and transform the data into information to be used for site-specific management of water, nutrients, herbicides, and pesticides within individual fields.

Research at Clemson University will continue to examine hydrologic, biogeochemical and forest productivity processes along a hydroperiod and salinity gradient in the Hobcaw Barony on the upper coast of South Carolina. The study will not only provide critical information regarding ecosystem processes in a region sensitive to climate change, but also establish a foundation for an environmental sensor network using technological innovation.

SC State Researchers continue to explore improving agritourism marketing in South Carolina. They will examine the marketing capabilities of small farmers who engage in agritourism activities as a supplemental or primary means of earnings and seek to provide research-based measures to improve the marketing viability of such farms.

South Carolina continues to lag behind in national and regional averages that measure economic well-being such as poverty rate and per capita income. SC State research will seek factors that contribute to the economic well-being of the state. There will be an empirical investigation of South Carolina's growth, employment, and economic development.

Due to today's globalized complex supply chain systems and highly-uncertain business environment, supply chains have become susceptible to disruptions. A design of resilient and efficient supply chain logistics network (SCLNs) system to mitigate the impact of disruptions in South Carolina is being investigated by SC State. A framework for designing the SCLNs is in process.

Meaningful differentiation and close customer ties are essential to the success of any business, but especially for the survival of small producers and sellers. The agribusiness sector consists of many small-scale producers whose primary market remains regional in scope. Social media platforms have emerged as valuable channels for small businesses to connect with their customers, promote their offerings, increase visibility and build brand reputations in the community. SC State research will continue on social media use among value-added agricultural enterprises: goals, challenges and return on investments.

While research continues to advance agricultural techniques, government regulations and the economic environment have increased the risks of farming in South Carolina. Agricultural firms today (both large scale and small and limited resource firms) are forced to consider the greater market, financial, production, and environmental risks than in the past. These risks require a significant change in agribusiness management philosophy and also provide a challenge to develop risk-oriented educational programs. Clemson and SC State Extension will provide educational programs directed at teaching management skills that ensure long-term profitability and sustainability for the farm business. The programs will include business planning, creative problem solving, assessing alternate enterprise combinations and technologies for profitability while managing market and financial risks and maintaining the integrity of the environment.

In addition, research studies have shown that financial literacy significantly impacts business performance, while little attention has been paid to how financial literacy affects the farm's performance in the agricultural context. SC State will conduct research to improve farm performance through financial literacy education among farmers in South Carolina. The research will develop various training programs conduct workshops, and offer counseling services for farmers. The outreach activities will benefit farmers and assist in collecting data and obtaining feedback.

A major threat to the agricultural industry is a lack of future leaders and employees in agriculture. Clemson and SC State Extension programs will focus on providing educational opportunities that address current issues and industry trends in agriculture in the high schools and middle schools across the state. Creating successful high school and middle school agricultural programs is vital to the long term success of the agricultural industry. With fewer students growing up on farms, agricultural programs in schools are key to introducing students to the agricultural industry as well as providing the training that was once learned at home on the farm. In addition to providing learning opportunities for high school and middle school students, Clemson and SC State Extension programs will continue to be offered to communities to assist farmers and other agriculturalists to remain on the cutting edge of technology and business skills.

Environmental and natural resources conservation:

Research by Clemson scientists is underway on remote data collection and data management on forests. Data, including temperature, turbidity, and dissolved oxygen, are collected in a database that can be viewed via the internet. Research is

also continuing in the areas of silviculture, harvesting operations, forest management, and forest health. The data collected for forests will be valuable for landowners. The application of this technology to forest production has been requested by landowners in the state. Techniques to enhance forest growth and quality are critical to growers in the state.

SC State Research continues to examine the removal and/or stabilization of non-radioactive Uranium (U) and heavy metals utilizing a unique combination of specific microbial activities from novel bacteria isolated from U-contaminated soils and sediments. Natural attenuation of U-contaminated groundwater, soils and sediments will be evaluated.

SC State researchers will continue reusing post-consumer plastics (PCPs) for solvent extraction of resins and other reprocessing. The recovering resins from PCPs for reuse are very energy efficient, environment friendly and economically advantageous compared to making new resins from petrochemicals.

An investigation by SC State will focus on applying instrumental neutron activation analysis (INAA) to the study of heavy metals in Spanish moss (*tillandsia usneoides*) for bio-monitoring air pollution in the low country of South Carolina. Spanish moss is an epiphyte that grows on large trees in tropical and subtropical climates. A sample of the moss with INAA will be studied. The research will give a better understanding of the environmental impact of human activities on air pollution toxicology.

Also, soil and water are major natural life-supporting resources and play an essential role in the natural ecosystem and in most landscapes of the earth. SC State will research the climatic impacts and predictability of soil erosivity and precipitation over the Southeastern United States.

Water quality is persistently a major priority statewide in South Carolina. Water, its quality and quantity, is a natural resource that is impacted by almost every land use management decision, from the private homeowner to large corporate landowners to municipalities. Clemson Extension educational programming will continue to address the impacts of land use, and to promote Best Management Practices (BMP's) at all levels of land ownership. Educational programs on factors affecting water quality and quantity are also needed for municipal and local governments, as well as to inform and better organize volunteer groups. Another issue to be addressed by Clemson Extension is equine traffic in South Carolina, which is estimated at 750,000 horses across the state. The most fundamental management problems for equine management are controlling erosion and the prevention of stream sedimentation and fecal contamination of surface waters. Increased knowledge about wetland ecosystems, mankind's impact on water quality and what can be done to ensure proper water quality are important topics offered in Clemson Extension programming.

South Carolina has an abundance of wildlife and forest resources that enhance the quality of lives, provide families with outdoor recreational opportunities, and drive the economy by providing revenue to the state economy and local communities. Wildlife and wildlife-related activities contribute more than \$1.5 billion dollars annually to the state's economy. In addition, revenue generated from wildlife recreation (e.g. hunting) in rural communities generates an estimated \$6 million dollars a year to individual counties. Over 81% of all land in the eastern United States is in private ownership and forested land in SC accounts for 12.9 million acres and has an economic impact of \$21 billion annually. Managing our forest for sustainability is important, not only from an economic standpoint but also from an environmental perspective and Clemson Extension will provide programming in these areas to sustain our forests and waterways. Water impoundments, ponds and managed wetlands also impact the quality of life in SC. They provide water for irrigation, livestock, and fire suppression, and can provide a sustainable source of fish protein for consumption and bait. Water impoundments also provide habitat for wildlife and recreational opportunities for residents. The functional condition and appearance of each pond or managed wetland affects the value of the property overall, and poor management may impede its intended uses and affect property values. Because South Carolina is among the fastest growing states in the nation, this growth has put unprecedented pressure on wildlife, wildlife habitat and forest resources, including urban trees and wildlife. Since most of the land-base in the state is privately owned, private landowners have a tremendous opportunity to impact wildlife and forest conservation in South Carolina. Clemson Extension programs aimed at providing landowners and natural resource managers with the tools, information and economic incentives to maintain and enhance lands for wildlife and forestry are paramount.

The environmental horticulture (or "green") industry complex includes production firms (nursery, greenhouse, and sod producers), horticultural service firms (landscape, lawn, and tree care professionals), urban foresters and arborists, private and public grounds workers, landscape pest management professionals, and retail garden centers. As a whole this industry has an annual economic impact of \$281 million dollars in South Carolina. The non-commercial, or consumer, side

of environmental horticulture includes home gardeners, hobbyist nursery and greenhouse enthusiasts, various non-profit organizations, and school and community gardeners. Collectively, these two groups represent the spectrum of urban horticulture and their actions/practices have an incredible effect on the economy and ecology of South Carolina and social condition of its residents. Clemson Extension seeks to address the economic, environmental and social aspects of horticulture and will develop and implement targeted programming in which Extension clientele increase their knowledge and adoption of practices in various areas of environmental horticulture.

#### Food safety, security, and nutrition:

Clemson Research continues in the area of food safety and nutrition. Researchers are working to prevent disease outbreaks in the animal livestock industry which could have serious consequences to the food animal industry, food processing industries and the consumer. It is imperative that the industry has conclusive evidence on the effectiveness of rendering and post-process storage conditions to destroy and/or prevent the growth of animal disease pathogens. Thorough understanding of bacterial transfer from surfaces is at the heart of food safety and rapid detection methods for bacterial contamination are crucially needed in all aspects of food safety research and quality control. Maintaining food safety is an on-going commitment to food animal production. There are many aspects still unknown, and food safety research to ensure foodborne outbreak prevention is timely and needed. Protecting the public from foodborne illnesses is of paramount importance. This research will attract and retain food industries in the region to improve the economic status of South Carolinians. Maintaining safe food production systems beginning at the farm level is essential to the continued economic viability of agricultural producing regions in the state as well as the entire country.

Clemson researchers continue to address improvements in packaging that can help improve food safety but also food quality in terms of improving shelf life thus reducing food waste. Antimicrobial food packaging could help extend shelf life and provide an extra level of assurance for companies regarding the quality of their products meeting code date requirements. Another significant area of loss is during distribution and retail sale of which fresh produce make up the largest category. The proposed work will include fresh produce which could impact the local, rural grower in assisting them in getting their products through the distribution cycle to market without serious loss of quality and overall shelf life.

According to public health and food safety experts, approximately 48 million individuals, or one out of six people, become sick each year from the consumption of contaminated food. Moreover, the Food and Drug Administration estimates that 2-3% of all foodborne illnesses lead to secondary long-term illnesses. Food Marketing Institute research shows that consumers know that food safety is important and know that they personally should observe sound food-handling practices. However, it also shows that either they do not fully comprehend some of the most important messages or they fail to use food safety measures. The need to constantly communicate food safety messages is underlined by continued changes in food safety recommendations for both consumers and the food service industry, such as the Food Safety Modernization Act (FSMA). Five of the seven FSMA key elements are federal regulations that require formalized training and certifications to meet the requirements. Clemson Extension will continue to offer FSMA certifications on the following: FSMA Preventive Controls for Human Food; FSMA Preventive Controls for Animal Food; FSMA Produce Safety Rule and FSMA Foreign Supplier Verification Programs. In addition to food safety programs, retail food safety is critical for the state of SC. Travel and tourism and the related retail food service industry are South Carolina's largest economic drivers. Training retail managers and employees in safe food handling practices are key to maintaining a healthy tourism experience and to repeat visitors.

At the individual citizen level, an individual's health status is heavily determined by factors other than health care. Lifestyle, genetics, socioeconomic factors, access to community resources, and the physical environment play significant roles, especially as health trends increasingly shift from infectious and acute diseases to chronic conditions. New approaches that coordinate resources and aid community members in navigating health systems are needed by Clemson Extension as well as SC State to foster a culture of health (Robert Wood Johnson Foundation, 2016) in the places where people live, work, learn, and play. Clemson and SC State Universities have the community presence, local credibility, and partnership network to effectively coordinate health resources, influencing the social, economic, and environmental determinants of health (Braun et al., 2014). South Carolina's health ranking in 2015, compared with all other states, was 44 (United Health Foundation, 2017). Two factors contributing to poor health outcomes in South Carolina are a large number of rural communities and their associated poverty (Wong & Regan, 2009). Over half of the state's 46 counties are at least 50% rural (University of Wisconsin Population Health Institute, 2016), a designation associated with limited access to primary health care providers due to supply and distance (Rural Health Foundation, 2016). Thirty-four counties in South Carolina are designated as primary care health professional shortage areas (Health Resources and Services Administration,

2016). In one rural county in South Carolina, this designation equates to a ratio of one primary care provider to every 9,000 residents. Poverty is a persistent issue in rural counties (Andress & Fitch, 2016), and in South Carolina, rural communities have high rates of unemployment, children living in poverty, and food insecurity (University of Wisconsin Population Health Institute, 2016). Resulting health outcomes include higher than national and state averages for premature death, poor overall health status, and high rates of obesity, physical inactivity, and chronic health conditions (University of Wisconsin Population Health Institute, 2016). Clemson Extension and SC State Extension are well-positioned to address the problem, leveraging partnerships with Public Health Sciences researchers and health delivery systems.

SC State is committed to reducing childhood obesity, improving the health and nutrition of residents and having a more sustainable and secure food supply. The researchers are instrumental in focusing on foodborne pathogens that affect the food supply, which causes illnesses to millions of Americans annually. Training and education to farmers would be provided to enhance food safety, through outreach programs/ activities and demonstrations.

SC State will conduct research to investigate South Carolina crops for the prevalence of mold and the reduction of aflatoxins by ozone. Also, a new initiative dealing with susceptibility of insects to gaseous ozone: flow characteristics and penetration of ozone through various materials will be examined. In addition, research will continue on targeted and untargeted multi-residue pesticide analysis in food using chromatography-mass spectrometry (MS) techniques and multi-variable statistical tools to investigate multi-residue pesticides in foods, specifically selected fruits, and vegetables.

Safe, high quality and nutritious foods are essential for human health and well-being. The SC State researchers will enhance the thought of you are what you eat. They will examine the link between different nutritional dietary patterns and the risk of disease by determining unique inflammatory profiles among South Carolinian families.

Attention to food safety has increased over the past fifteen to twenty years in many areas of the agricultural industry. SC State looks at low income/small scale South Carolina food supplier perceptions of technology-based food safety approaches. The approaches center around traceability technology as a means of providing heightened visibility and accountability within the food supply chain of farmers.

Proper nutrition and exercise are steps to help prevent obesity. Childhood obesity is a serious medical condition in the United States. In South Carolina, children age 2-17 are classified as overweight (14.9%) and 16.7% as obese. SC State is researching achievement motivation for child obesity prevention. Appetite is controlled by a hypothalamus, which is an unconscious part of the brain. The study will attempt to influence appetite control.

Children from households that do not have access to healthy, nutritious foods are significantly more likely to obese earlier in life than other children. SC State will continue analyzing the role of high pro-inflammatory diets and childhood obesity in the risk of adult carcinogenesis in South Carolina children.

Nationally, there are more than 42 million households dealing with food insecurity. The social work program at SC State is examining a school-based program to address the food insecurity of public school students in rural areas. The focus is on the relationship of school-based programs and their effect on nutrition and behavior, as well as developing initiatives that will enhance participation in food programs and access to food to address food insecurity.

In addition, research is underway to show the impact of international trade policy changes on global food security and South Carolina agriculture. Limitations in farming technology, arable land and limited water for farming will cause food production to grow much slower than food demand (Koo and Taylor, 2015). The imbalance may cause a sharp increase in food prices and malnutrition, both globally and locally. SC State looks at the extent of carbohydrate and fat derived AGEs (Advanced Glycation End-products), measuring amounts of carborymethyllysine (CML) and carboxyethyllysine (CEL) from obese (BMI>30) and breast cancer-noncancerous tissue samples from similar age groups and known BMI values. The results may lead to better management and development of new drugs for obesity-related conditions and breast cancer treatment.

Youth and family development:

Society has undergone dramatic social, demographic and economic changes that have deeply affected individuals and families in this country. Clemson and SC State Extension Programs will focus on strengthening individuals and families

while addressing current issues facing children, youth and families across the lifecycle. South Carolina families at all income levels need educational information that improves human relationships and helps them manage their resources more effectively. Family resource management programs will focus on increasing the knowledge, attitudes, skills, and confidence to apply effective and successful financial management and wise consumer strategies thus increasing the financial stability and security of families across the life cycle. Creating caring families and communities through collaborative efforts is a must if we are to meet the challenges today and beyond. This approach demands a team approach to programming that focuses on the needs of the total family. Strong families provide children with a sense of belonging and identity and create hope for the future. Youth development is also a concern in SC. Therefore, the SC 4-H Youth Development Program will use a learn-by-doing approach, the involvement of caring adults, and the knowledge and resources of Clemson, SC State and the land grant university system to empower youth to become healthy, productive, and contributing members of society. Moreover, with the passage of the 2018 Farm Bill, SC State has a minimum of \$500,000 to invest in students who major in Food and Agricultural Sciences to increase the amount of minorities in the profession.

There is a major dilemma regarding the mental health state among the youth of today. Many are dealing with personal and home life challenges which result in feelings of hopelessness and despair. Consequently, individuals who are faced with the mentioned challenges often exhibit problems such as poor school attendance, behavioral issues and low academic performance, which may, in turn, potentially lead to school dropout, violence, and suicide. Research at SC State will look at the effects of horticulture therapy on at-risk youth living in rural communities. The research intent is to combat identified problems by developing an afterschool horticulture therapy program.

Based on the South Carolina test results of 2015-2016, most test-takers (graders 3-8) did not meet state-established reading expectations in Orangeburg County Schools. Less than half of the students met or exceeded established reading required scores, according to the SC State Department of Education. SC State research will focus on the influences of music instruction on reading and music achievement to increase agricultural literacy and awareness in grades PreK-5.

#### Multistate Activities

Multi-state research activities and programs will continue to be emphasized as researchers participate in establishing multi-state projects with their colleagues in other states in the region and across the country. Multi-state research programs are the result of extended collaboration and consultation between faculty members in their respective states. The decision to move forward with a regional program is based on the appropriateness of the program to address critical issues, the ability of faculty to develop, implement and evaluate the program and on the potential for the program to be effective in meeting the identified needs of the citizens and industries in the state. Clemson's multi-state programs include the Southern Region Fruit Consortium, a collaboration between North Carolina State University, Clemson University and institutions in Georgia, Virginia, Tennessee, and Arkansas. Continuing initiatives will include tobacco, apple and strawberry work with the University of Georgia and NC State. Research faculty will continue to be encouraged and supported in their efforts to obtain outside funding to leverage their federal and state funding base. The Regional Peach Initiative is a partnership between South Carolina and Georgia. The Orchard Floor Management program was listed as a co-recipient of an SCRI grant coordinated by Virginia Tech to determine the impact ground cover manipulation can have on wine grape vigor. The Regional Apple Initiative is a partnership between South Carolina, Georgia, and North Carolina. The apple specialist is located at the Western NC Research Center. The Initiative will increase coordination and expansion of efforts in conducting educational programs throughout the region.

## 2. FTE Estimates

Year	1862 Extension	1890 Extension	1862 Research	1890 Research
2022	178.0	56.0	94.0	17.0
2023	180.0	68.0	98.0	19.0
2024	182.0	72.0	102.0	22.0
2025	184.0	75.0	104.0	32.0

2026	186.0	75.0	106.0	32.0
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## II. Merit / Peer Review Process

Extension (Clemson and SC State): The South Carolina State Extension Advancement Council provides input at a state level for both Clemson Extension and SC State Extension programs. At Clemson University, each county also has a local county advisory board that reviews programs and makes suggestions for improvements. The Clemson Extension County Advisory Boards meet to review program history and provide input for future programming needs. Clemson also launched Land-Grant Press (LGP) by Clemson Extension, which is a peer-reviewed system for all Clemson Extension publications. Each article submitted is assigned 2 internal reviewers and 1 external reviewer for accuracy and readability of the article. Reviewers are considered experts in their field and they have the option to accept the article, accept it with revisions, or reject the article. Once the article is deemed acceptable for publication, a final review is conducted by the Managing Editor and a Contributing Editor. This peer-review process ensures that all publications generated by Clemson Extension are up-to-date, factual, and accurate. SC State University has advisory boards by county regions to review their programs and recommend improvements. Programs are also reviewed by the Extension Program Team leaders and administration. Projects and programs are reviewed based on organizational capacity, relevance and impact. In 2018 a survey was administered to external stakeholders to receive feedback on the strengths and weaknesses of Clemson Extension programming.

Research (Clemson and SC State): For Clemson University Experiment Station, an internal review panel meets to review all research outputs and outcomes with faculty members in preparing to initiate new research projects. The review panel consists of the Experiment Station Director, which is the Associate Dean for Research and Graduate Studies, the Department Chair of the principal investigator, a member of media services, 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 with (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 meeting 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, as appropriate.

SC State does their reviews quarterly. A project termination meeting 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 or Evans- Allen regulations. This serves as the Expert Peer Review process, as each project is sent for external review and comments and suggestions are examined and incorporated into the new project, as appropriate.

## III. Stakeholder Input

### 1. Actions to Seek

- Use of media to announce public meetings and listening sessions
- Targeted invitation to traditional stakeholder groups
- Targeted invitation to non-traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals
- Targeted invitation to non-traditional stakeholder individuals (i.e. under-served groups such as those in rural areas that have limited access to community resources)
- Targeted invitation to selected individuals from the general public (solicited feedback regarding the STEM program)
- Survey of traditional stakeholder groups
- Survey of traditional stakeholder individuals
- Survey specifically with non-traditional groups.

### 2. Methods to Identify

- Use of Advisory Committees
- Use internal focus groups
- Use external focus groups
- Open listening sessions

Needs assessments  
Use surveys

### **3. Methods to Collect**

Meeting with traditional stakeholder groups. (i.e. Cattleman's Association, County Forest Landowners Associations, County Advisory Boards, County Administrators)  
Survey of traditional stakeholder groups  
Meeting with traditional stakeholder individuals  
Survey of traditional stakeholder individuals  
Meeting with general public (open meeting advertised to all)  
Meeting specifically with non-traditional groups (i.e. under-served groups such as those in rural areas that have limited access to community resources)  
Survey specifically with non-traditional groups  
Meeting specifically with non-traditional individuals  
Meeting with invited selected individuals from the general public (solicited feedback regarding the STEM program)

### **4. How Considered**

Budget planning and allocation process  
Identification of emerging issues to be addressed  
Redirect Extension programs  
Redirect Research programs  
Consideration of needs in staff hiring process  
Action plans  
Setting of priorities for planning cycle

## **IV. Critical Issues**

### **1 Agrisystems Productivity and Profitability**

#### **Description:**

Clemson Extension & Research (CER) as well as SC State will help develop niche markets for livestock producers, diversify farming operations, and make local products available. CER and SC State will develop and implement sustainable and environmentally sound animal production systems, and provide training for increases in animal health, profitability, and productivity. Researchers will investigate production, management and diseases of agronomic crops and ornamental plants. Please refer to more detailed information in the Executive Summary.

**Term:** Long

#### **Science Emphasis Areas**

Bioeconomy, Bioenergy, and Bioproducts  
Environmental Systems  
Sustainable Agricultural Production Systems

### **2 Agribusiness and Community Development**

#### **Description:**

Clemson and SC State Extension & Research will help develop local and regional food systems, promote agribusiness development, and enhance community resiliency and economic capacity. Clemson and SC State will provide training and support with an emphasis on agribusiness and natural resources, industry cluster development and economic impact analysis as well as community enhancement that is linked to community

image, sustainable economic development, and improved quality of life. Clemson and SC State Extension will provide agricultural educational opportunities in grades K-12 that address current issues and industry trends to increase the agriculture workforce. Please refer to the Executive Summary for more detailed information.

**Term:** Long

**Science Emphasis Areas**

Education and Multicultural Alliances  
Sustainable Agricultural Production Systems

**3 Environmental and Natural Resources Conservation**

**Description:**

Clemson and SC State Extension and Research will focus on expanding and enhancing forestry and the forest industry, balancing the demands of water supply and water quality, and wildlife conservation. Research will examine loblolly and longleaf pine management and the effects of severity and frequency of prescribed burns on the production and exports of pollutants and nutrients in forested watersheds. SC State research will focus on removal and/or stabilization of non-radioactive Uranium and heavy metals, toxic trace elements of cotton seeds and reusing post-consumed (PSCs) for solvent extraction of resins and other reprocessing. Clemson and SC State Extension will focus on landowner education to increase management practices and land stewardship. Work will also focus on environmental horticultural education and efforts to reduce the impact of animal agriculture on the environment. Please refer to the Executive Summary for more detailed information.

**Term:** Long

**Science Emphasis Areas**

Agroclimate Science  
Environmental Systems

**4 Food Safety, Security and Nutrition**

**Description:**

Clemson Research will investigate food safety implications related to organic vs. conventional systems for egg laying, on-farm composting, natural antimicrobials, antimicrobial and modified atmosphere packaging, and the study and development of bioactive compounds from peach by-products. Clemson and SC State Extension will communicate changes in food safety recommendations for consumers and the food service industry as identified by Clemson and SC State Researchers and other agencies. Clemson Research will work to increase food safety through improved processing and packaging, and developing new diagnostic procedures for animal pathogens. SC State will focus on reducing childhood obesity, improving the health and nutrition of residents and provide a more sustainable and secure food supply. Please refer to the Executive Summary for more detailed information.

**Term:** Long

**Science Emphasis Areas**

Family & Consumer Sciences  
Food Safety  
Human Nutrition  
Youth Development

**5 Family and Youth Development**

**Description:**

Clemson and SC State Extension will provide families at all income levels with educational information that improves human relationships and helps them manage their resources more effectively. Creating caring families and communities through collaborative efforts is a must if we are to meet the challenges of today and beyond.

Youth development is a concern and Clemson and SC State Extension will help mentor youth in order to become healthy, productive and contributing members of society. Providing a safe environment to learn and grow as individuals is critical for the success of mentoring youth in today's society. Research at SC State will focus on the effects of horticulture therapy on at-risk youth living in rural communities. Please refer to the Executive Summary for more detailed information.

**Term:** Long

**Science Emphasis Areas**

Education and Multicultural Alliances

Environmental Systems

Family & Consumer Sciences

Human Nutrition

Youth Development