2018 South Carolina State University and Clemson University Combined Research and Extension Annual Report of Accomplishments and Results

Status: Accepted

Date Accepted: 08/22/2019

I. Report Overview

1. Executive Summary

The Annual Report of Accomplishments and Results reflects activities performed by both institutions' (Clemson University and South Carolina State University) individual and collective functions of research, teaching and extension/outreach. The working relationship between Research and Extension is based on the discovery and delivery of new knowledge specific to South Carolina's needs and are delivered through Extension programs in the National Institute of Food and Agriculture (NIFA) Priority Areas. The major 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 young people to become productive citizens.

There is continued emphasis on evaluating all Research and Extension activities and providing quality performance information to stakeholders. The accomplishments and results gathered during the FY 2017 - 2018 reporting period were through pre/post-tests, stakeholder input, programs, activities, evaluations, research project implementation and other sources of data collection to access the needs of the citizens of South Carolina. The report addresses the following Planned Programs: Sustainable Animal Production Systems, Sustainable Agriculture Production for (non-food) Horticultural Crops, Natural Resource Management, Food Safety, Agribusiness and Community Development, 4-H Youth Development and Families, Nutrition and Childhood Obesity, Sustainable Energy, Climate Change and Global Food Security and Hunger.

SC State Research and Extension raised the educational consciousness and awareness of national issues that impacted the residents of South Carolina. It invested in faculty whose proposed studies aligned with targeted research areas, which showed promise in providing solutions to various complex challenges that impacted communities in the state and nation, which advanced the overall research capacity of the University. During the 2017- 2018 reporting period, the research efforts of faculty members remained constant at 21. The number of professional presentations was 55. There were twenty-five (25) faculty presentations and thirty (30) student presentations. The presentations were made throughout the United States, informing people of the research going on at SC State University. There were forty-eight (48) articulation agreements with external agencies established. A total of nineteen articles were published. Of that number, seven were peer reviewed for publication. The SC State researchers worked to combat obesity among youth, examined the nutritional value of food, studied food safety issues, conducted leadership and economic development problems, worked with 4-H youth development and families, and examined global food security and hunger issues.

SC State Extension implemented educational programs in targeted county clusters across the state. Life-long learning opportunities were provided to help rural and urban participants improve their quality of living. The Extension Program served 8,158 individuals in outreach activities. One thousand three hundred twenty-six (1,326) different outreach activities were sponsored by Extension. A total of 543 educational workshops were conducted and 4,873 attendees completed the workshops.

There is a new administrative structure for Public Service and Agriculture (PSA) at Clemson

University. Dr. George R. Askew serves as the Vice President for PSA and Dr. Keith L. Belli serves as the new chief academic and administrative officer and Associate Vice President for Clemson PSA and as the new College of Agriculture, Forestry and Life Sciences (CAFLS) Dean, where he collaborates with Askew to advance the interests of both complimentary units. Dr. Paula Agudelo is the new Clemson Experiment Station Director and Dr. Thomas R. Dobbins continues as the Cooperative Extension Service Director.

The Experiment Station works collaboratively with the CAFLS to support research and outreach across South Carolina. Not only is research being conducted on the University campus, but at Research and Education Centers (RECs) located across South Carolina. These RECs 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.

Clemson Extension has conducted 11,297 programs that served 132,319 people. The Clemson Experiment Station is reporting on a total of 45 projects. Climate Change was removed as a program, years ago, but significant work is currently underway and it has been added back as an Experiment Station program. Summaries reflecting both institution's planned program areas are listed below.

Sustainable Animal Production Systems
Clemson Extension agents conducted 153 programs focused on animal production systems across the state. Ninety-nine percent of attendees at livestock and forage programs reported a gain in knowledge as a result of workshops. In addition to educational programs, agents also helped diagnose issues in forages such as Bermuda Grass Stem Maggots, increased forage production, soil fertility issues, pasture establishment, and animal nutrition.

The Confined Animal Manure Managers (CAMM) program is headed by the Livestock and Forages team to reduce the impacts of animal facilities on aesthetics (odors) and natural resources, particularly water. This program is in response to Regulation R.61-43, Standards for the Permitting of Agricultural Animal Facilities and trained 1,216 individuals in FY 2017-18 in 70 programs held across the state. The Livestock and Forages team is also instrumental in educating farmers on improved breeding and foraging strategies.

With over an estimated 750,000 horses in the state of South Carolina, there is a critical need for equine and pasture management. To fill this gap in knowledge, Clemson Extension agents provided workshops on soil fertility, pastures grasses, weeds, manure management and pasture quality. Agents also assisted landowners with the collection, submission and interpretation of soil and hay samples. These activities are critical in maintaining proper nutritional value in hay supplies and to ensure they are not above toxic nitrate levels. Healthy soils also improves the quality of forages, thereby creating healthier pasture and foraging areas.

The SC State Small Farm Assistance and Outreach Program continues to inform producers about land loss and retention, land use, herd health management, forestry management and risk management.

The Experiment Station has been involved with raising replacement heifers which represent a significant investment for producers in time and resources. Research was conducted with newborn calves through gravid pre-fresh heifers, much of which is utilized by producers and stakeholders to improve performance of growing dairy cattle. Guidelines and recommendations were delivered to farms relative to improving heifer performance through alternative feeds and feed additives. Adoption of these practices contributed to reduced costs of raising replacement heifers and improved nutrient utilization, health, and well-being of dairy calves and heifers. Research has ranged from improvements in forage management and quality, alternative protein and energy sources, to increased understanding of laboratory methods to evaluate nutrient utilization. It represents advancements in the nutritional management of lactating cows in both organic and conventional dairy farming systems from different regions of the country. As lactating cows represent the largest sector of the dairy industry and feed cost is a large part of the overall farm budget,

this research is also critical to the future success of dairy producers.

Clemson research has raised awareness with beef cattle producers of potential improved genetic selection. Researchers have focused on the design and development of a fine needle aspirate biopsy (FNAB) device that is semi-automated and allows for tactile ease of use and consistent sampling in animal models. They are currently working to redesign the current FNAB system. Developments over the past year include improvement of design by observing biopsy procedures utilizing the old biopsy needle design, utilizing CAD to re-design and create multiple iterations of 3D prototypes via a 3D printer. These prototypes were assessed for functionality and ergonomics via the development of verification tests and end-user questionnaires. Testing included making sure the components of the system fit together and could deploy a biopsy needle with the force required to take a tissue sample in cattle. In terms of ergonomic testing, the team designed the system to prevent slippage of the device which could be common in beef cattle operations outdoor facilities due to weather and animals moving during sampling. The Animal & Veterinary Sciences (AVS) students have assisted with the completion of data collection from one life cycle of calves. This has included FNAB collection, blood collection, life cycle data collection of birth weight, weaning weight, carcass weight, end product evaluation and carcass traits. The AVS students are compiling genomic expression data for the development of databases to be shared with cattle industry breeders. The second set of data from the next generation of calves has started with FNAB, blood collection and birth weights.

Experiment Station Researchers are working with South Carolina livestock producers to determine how to effectively incorporate alfalfa into forage crops, such as bermudagrass. Alfalfa is an excellent forage that can be successfully used in many types of livestock feeding programs. It is a versatile crop that can be used for pasture or as hay, silage or green chop. Alfalfa also can play an important role in crop rotations because it fixes and supplies substantial amounts of organic nitrogen to subsequent crops and has numerous other positive effects on soil fertility, soil structure and soil health. The Experiment Station is working with South Carolina producers to bring alfalfa back to the top of the forages list. Alfalfa does have a lot of promise for growing high-quality forage and reducing producer costs, especially for purchased protein supplements and nitrogen fertilizer. Alfalfa has a high nutrient value, making it an ideal legume hay. Current demonstration plots have proven that it can be successfully grown.

Sustainable Agriculture Production for (non-food) Horticultural Crops
The environmental horticulture (or "green") industry has an annual economic impact of $281 million in South Carolina, making it an important focus in Extension programming efforts. Clemson's Home and Garden Information Center (HGIC) provided gardening information to 11,601 individuals by telephone or email. In addition, the HGIC website recorded 2,774,557 hits last year, which underscores the importance of this service to the citizens of South Carolina and surrounding states. The Master Gardener program is vital to extending Clemson Extension's reach to audiences across SC. As such, Master Gardeners contributed valuable service time and program support. A new volunteer reporting system was also established for Master Gardeners to report hours and miles traveled. While reporting to the system is not required of volunteers, the new system will help ease the burden of reporting.

At SC State, one researcher conducted extensive research to educate rural farmers and agricultural workers in two South Carolina counties (Orangeburg and Calhoun) on the risks associated with loud noises on their farms. The study strives to promote the use of hearing protection, in order to make agricultural work more conducive to a healthy lifestyle. The research is expected to illustrate a strong correlation between high noise levels farmers may be exposed to, the hearing loss that occurs as a result of their actions and other related issues that are linked to hearing loss, specifically an increase in heart rate.

Previous studies have implied that high noise levels increase stress, which can lead to an increase in heart rate and blood pressure. Uncontrolled high blood pressure can cause damage to arteries and lead to

stroke or cardiovascular disease. The farms were located anywhere from 10 to 50 miles from the University, so the researcher was able to attain measurements on-site. During visits to the farm, the Principal Investigator (PI) utilized the audiological equipment, sound level meter, and blood pressure monitor equipped on the vehicle to measure the noise levels of the machinery, measure blood pressure and assess their hearing acuity.

The Experiment Station is conducting research to better understand diseases of ornamental plants and trees caused by Phytophthora spp. so that more effective and sustainable disease management strategies can be developed. This is accomplished by developing improved methods for detecting propagules of these pathogens in plants, soil, and water, by documenting the etiology of these diseases, and by evaluating current and studying novel disease management practices. In 2018, research was concluded on the annual screening of hybrid seedlings at a field location in SC. Several major accomplishments came from this project. (1) Discovery that hybrid chestnut families selected for resistance to Cryphonectria parasitica, the chestnut blight pathogen also are resistant to P. cinnamomi. (2) In collaboration with several other research groups, it identified specific gene loci associated with resistance to P. cinnamomi,, and (3) Continued to accept soil and plant samples from chestnut collaborators to diagnose Phytophthora root rot on symptomatic plants and detect Phytophthora spp. in soils where chestnut trees are growing or might be planted.

Data and results generated by Clemson research has helped producers and homeowners 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 method, timing and product, had saved three ornamental plant nurseries and greenhouses in SC in crop losses and cost of control, and two turf and golf courses in cost of pest management.

Additional Clemson research identifying the most common scale insect species submitted for diagnosis by plant pest diagnosis services or laboratories throughout the U.S. and in four southeastern states (GA, NC, SC and TN) has been completed. Lists of 20 most commonly submitted armored scale species, 20 soft scale species and five other scale insect species have been compiled.

Clemson researchers continue to collect and screen various biotypes of Ipomoea lacunosa (pitted morning glory) from various parts of southeastern United States. Overall results confirm with previous year's findings that the abundance of transport sugars in the ipomoea tissue correlates with the ability of the plant to withstand glyphosate application rates.

Palmer amaranth (Amaranthus palmeri) is one of the most economically damaging glyphosate-resistant weed, mainly in row production systems, in the country. Previous studies have shown that the glyphosate-resistant biotype (R-biotype) do sustain metabolic perturbation immediately (8hr) after the herbicide treatment, but recovers by 36-72 hrs after treatment, possibly due to the abundance of antioxidant machinery that complements EPSPS amplification. Spectral quality of light had a dominant influence on the cellular physiology of A. palmeri, with artificial lighting, irrespective of the overall light intensity, resulting in poor metabolic response. More than 32,000 unique mass features, which were curated to 1503 metabolites, showed significant response across the treatments. In the absence of drought stress, the cellular physiology, and the metabolite pools of A. palmeri were biotype dependent.

Natural Resource Management
Forestry is a $21 billion annual industry in South Carolina and therefore, is it is important to protect this resource. Over 80% of all forest lands are in private ownership, which makes it crucial to provide information to landowners, foresters and land managers about proper management techniques for timber growth and yield as well as to sustain healthy forests. To accomplish this, Clemson Extension agents provided 1,244 programs for over 12,500 landowners, land managers, foresters and other concerned

citizens. Programs included topics such as forest health, invasive species, logging cost analysis, white-tailed deer management, silvicultural practices, forest pest identification, water quality, pond management, stormwater runoff reduction and a variety of other topics.

Stormwater runoff is considered by many to be the leading threat to water quality. To combat this issue, Clemson Extension agents provide training and workshops on stormwater runoff prevention. One tool to combat stormwater runoff is the installation of rain barrels. Over 400 rain barrels were installed by private citizens as a result of Clemson Extension efforts. Over 350 of those rain barrels were sold at annual festivals and events hosted by local cities and counties around the state. At the Charleston County Lonnie Hamilton Public Administration Building in North Charleston, a 400 square foot buffer was installed as part of the 2017 Fall Shorescaping workshop. A floating wetland is designed to decrease pollutants that enter waterways. These wetlands absorb the pollutant and are taken up by plants, which are not impacted by the pollutants and eventually cleans the water prior to entering a watershed. A 72 square foot floating wetland was installed along with almost 400 square feet of shoreline plantings. In addition, there are over 22,000 ponds in South Carolina in only eight coastal counties in South Carolina (as of 2013). Therefore, pond management workshops are crucial to maintaining these ponds to function as designed.

In an effort to increase awareness and conservation of water resources in South Carolina, the Journal of South Carolina Water Resources is published annually (https://tigerprints.clemson.edu/jscwr/about.html). The Journal of South Carolina Water Resources (JSCWR) is an annual peer-reviewed journal dedicated to scientific research and policy on all aspects of water management to prepare for and meet the growing challenge of providing water resources for the sustainable growth of South Carolina's economy, while preserving its natural resources. The aim of the JSCWR is to provide a forum for peer-reviewed articles focused on South Carolina's water resources, with the goals of influencing science-based management decisions and heightening awareness.

Natural and microbial attenuation of Uranium (U) contaminated groundwater, soils and sediments are being researched at SC State University. Uranium contamination of groundwater, soil and sediments is a global problem. It is largely due to the effects U has on human health as the internalization of U can adversely affect kidneys, bones and blood pressure. The study examines how effectively the strains reduce the level of U from contaminated soil taken from the Mixed Waste Management Facility (MWMF) at Savannah River Site (SRS) in Aiken, SC. Soil from MWMF served as a source of non-radioactive U. The treatment's effectiveness was quantitatively measured by changes in U mobility prior to and after treatment. The research examined the effect of amendments on microbial activity and how it impacted U sequestering under anaerobic conditions. The study provided an opportunity to quantitatively determine the extent of the novel P.pituda Biotype B SRS and A.piechandii SRS strains to reduce the level of U from MWMF contaminated soil under aerobic and anaerobic conditions, and to examine the genes encoding biosurfactants, which enhance the U reducing abilities of the strains.

Additional research, at SC State, included applying instrumental neutron activation analysis (INAA) to the study of toxic trace elements in cotton seeds. Research focused on the environmental impact of superfund sites on the local cotton plantations. Cotton has been an important cash crop in the Palmetto State, since revolutionary times to the current day. Its seeds are about 15% of the value of the crop and used widely in making oil and feeding animals. Cotton seeds can serve as an indicator of heavy metal contamination of local soil. South Carolina, like other states, is subject to the environmental impact of human behaviors. Dozens of heavily polluted superfund sites are scattered in the state and most of them are on the National Priority List (NPL) of EPA. Some NPL sites are close to local cotton plantations. It is conceivable the cotton may be under a contamination impact of the sites through groundwater movement or other migration paths.

Clemson researchers have observed that frequent prescribed fires in southeastern forests can help prevent wildfires like those that have impacted much of Northern California. Researchers are studying the

role of fire in the Appalachian Mountains and is part of a team bringing prescribed burning back to the region. Prescribed burning involves using fire to control pest insects and diseases, provide forage, improve habitats for wildlife and put nutrients back into the soil, as well as promote the growth of trees, wildflowers and other plants. It also reduces hazardous fuel accumulations, which helps reduce the risk of future catastrophic wildfires. Fire is important for healthy forests.

Clemson researchers are working to protect the state's water resources by focusing on irrigation water and helping monitor the diminishing water quality in South Carolina's rivers and streams.

Food Safety
Agents in EFNEP conducted programs across the state for ServSafe(R) certification. Of the 325 people attending the program, 236 passed the exam for a pass rate of 73%. These ServSafe programs represented 178 restaurants in SC. The National Restaurant Association estimates that a conservative cost of a food-borne illness outbreak costs $6,333. Therefore, the economic value of training to prevent food-borne illness outbreaks represents a potential savings of $1,127,274.

The Clemson Extension Food2Market program is designed to assist food entrepreneurs in meeting state and federal food safety requirements in order to produce and sell foods. A new online Food2Market program was launched in February.

SC State has two research projects providing investigations under the Food Safety program area. One researcher focused on ozone treatment as an alternative for conventional fumigation to manage stored products of insects. The study maintains stored products of insect colonies of various species. Data was generated on susceptibility of oryzaephilus mercator life stages to ozone gas. Testing took place on the susceptibility of various stages to ozone, exposed with or without food to be compared to control with and without food. There was testing of different life stages including, but not limited to, eggs, larvae, pupae and adults. The effect of ozone on germinating seeds was also evaluated.

Research ended on the United States (US), European Union (EU) Transatlantic Trade, and Investment Partnership (TTIP) and their potential impacts on food safety and South Carolina agricultural production, exports and trade. Coastal states with large bases of farm production contribute most to the cross-Atlantic trade. Specifically, California's agri-food exports to the European market, leading all other states. The high value of California exports is most likely attributable to the high value specialty crops and animal products. Louisiana turned out to be the second largest exporter. It was found that large exporting states tended to benefit more from the potential trade liberalization. Inland states with less dependency on agriculture were expected to make modest gains from a TTIP agreement that address regulatory differences in food safety.

Clemson researchers are working to develop packages that would use communication between cells to detect food that's beginning to spoil. This "intelligent" packaging would use sensors to detect biological processes - specifically, the signals cells send to each other when they start to break down. This cell-to-cell communication, called quorum sensing, uses signaling molecules called autoinducers. Researchers are designing sensors that would identify autoinducers present in packaged foods. The idea behind the quorum sensing is that it makes use of a normal microorganism biological process. Researchers take what the microorganisms do naturally, combined with their being able to sense that they are starting to create a food spoilage situation and build that in to a sensor. Current methods to detect food spoilage with packaging, use labels or materials that change color when they detect such volatiles as ammonia or sulfur from the breakdown of proteins in meat. Using labels or materials that change colors are limited in use, are not a direct indicator of spoilage and usually signal when it is too late to be useful. By the time the color change occurs, the human nose can just as easily detect the aroma of the volatiles. Results from this research will serve as a foundation for biosensors and ultimately intelligent packaging to effectively monitor changes in food and, in turn, improve food quality and safety.

Clemson researchers have focused on developing smart packages that can harvest their own power. The demand for and application of smart packaging devices used during the transport and storage of products continues to increase. Development of an energy harvesting device that can harvest power from forces naturally occurring in the distribution environment while possibly mitigating those forces experienced by the product would benefit producers and consumers. Researchers will build on previous work with modeling the vibration response of complex foam materials to determine how to create a means to reduce the vibration transmitted to products while still generating adequate power. Researchers have spent several decades designing mechanisms that offer innovative, flexible and cost-effective means to replace or augment batteries and power devices by converting mechanical motion into electricity. This research has far-reaching implications in powering devices in the hyper-connected world known as the 'internet of things'.

Agribusiness and Community Development
A program titled "Steps to Becoming a Successful Entrepreneur" was developed and held around the state to promote small farms and other successful agri-focused businesses. Newsletters were also created and distributed to help promote agrotourism (http://freshwatercoastfoundation.org/about/feasibility-studies-2). Agents also served families with limited access and resources for fresh foods through the Mobile Farmers Market and African American CSA markets programs. Agents and Associates also served on crop councils (i.e. SC Peach Council) as advisors and to provide guidance on issues facing the industry.

In an effort to recruit more people into the agricultural workforce, a regional teachers meeting was organized along with a workshop for QRM evaluations. Regional meetings were also held around the state where topics such as curriculum, extended day funding, FFA, adult education, SCAAE, Perkins and EIA guidelines were discussed. The SCAAE conference for Sumter County was held at Lakewood High School and had 13 planned workshops. The SCAAE Summer Conference was held in Clemson, SC with a total of 102 teachers attending. Thirty-nine workshops were conducted throughout the year focused on agriculture, food and natural resources education (AFNRE) with 107 in attendance throughout the year. The programs include local and state meetings related to AFNRE.

In FY 2017-18 a total of 683 new students enrolled in high school and middle school Agricultural Education programs throughout the state. These programs include a combination of Future Farmers of American (FFA) and supervised Agricultural Experiences. The Agricultural Education program conducted a total of 134 programs focused on high school and middle school students. Some 125 Young Farmer (YF) programs were conducted. Participants in the YF and Agribusiness Association reported a 100% gain knowledge from programs offered throughout the state. This gain in knowledge indicates that there is a clear need for information aimed at young farmers and agribusiness owners in order to advance agriculture and the agricultural work force in SC.

Under the Agribusiness and Community Development area, SC State has six research projects. However, five of the projects concluded during the reporting period. The one on-going research project focused on improving agritourism marketing in South Carolina. It examined the marketing capabilities of small farmers who engage in agritourism activities as a supplemental or primary means of earning and seeking to provide research based measures to improve the marketing viability of the farms. The research activities lead to the identification of current and potential small farm agritourism practioners and the marketing challenges faced in developing and communicating agritourism experiences and resources. The identification of the "gaps" in agritourism marketing among small farmers provided an opportunity for farmers to develop marketing strategies and resources in procuring the financial support or technical expertise needed to further develop their agritourism enterprises. A set of "best practices" in agritourism marketing will be identified. The best practices will be formulated as a training resource to be delivered through workshops, web-based curricula and outreach training for agritourism practitioners.

As the research of dynamic linkages among capital investment, export, agribusiness, education, business climate and quality of life variables and economic development of South Carolina comes to completion, South Carolina continues to lag behind in national and regional averages that measure economic and social well-being. The researcher identified quality of life and business climate variables that influenced economic developments. The impact of macroeconomic factors on gross state products (GSP) was examined. A needs assessment of agribusiness and non-agribusinesses were surveyed in the counties of Orangeburg, Calhoun and Bamberg. The researcher used time-series data to assist in data collection. The research provided the opportunity for five refereed journal articles to be published and twelve professional papers to be written and presented. In addition, a final research bulletin will be published and findings disseminated.

Another SC State research project looked at data envelopment analysis (DEA) based integrated logistics network system designed to improve supply chain efficiency in South Carolina. The major goal of the research was to develop an innovative framework for designing an integrated logistics network, as it is an important strategic decision that significantly affects the overall performance of supply chain management activities. An important impact for the project was the development, presentation and demonstration used of the goal programming (GP) model and Data Envelopment Analysis framework to the supply chain design problem to help decision-makers who were responsible for supply chain planning and management activities.

A study exploring can U. S. export credit programs enhance exporting opportunities and increase income for small agribusinesses and small farmers in South Carolina concluded during the 2017 - 2018 reporting period. It addressed the problem of how jobs can be created to stimulate economic development and growth by establishing international markets and using the U. S. export credit programs (ECPs) to mitigate non-payment risks associated with international markets. Its relevancy was how the current U. S. unemployment rate can be reduced further and how the U. S. labor participation rate can be boosted up. The economic impact analysis showed in 2015, SC agricultural exports were $800 million. Its economic impact on the SC economy was $1.26 billion. Through agricultural exports, SC created jobs and stimulated growth.

Another research project under the Planned Program area ended during the report cycle, which dealt with accelerating the usage of digital communication technologies by small agribusiness firms in South Carolina. Agribusiness is the leading industry in South Carolina and is an engine of rural development and growth. But, in this changing technologically advanced business climate, SC agribusinesses are lagging behind other states in their adoption of technological tools for business communication. This has resulted in lower visibility, consumer trust and loss of new leads of local agri-brands. Today's consumers start their search online, read reviews and make purchase decisions. Lack of a digital presence contributes to a loss of business reputation and thus sales. Additionally, just being on digital platforms was not enough, the tools required a strategic approach towards audience selection, content creation and content marketing. Due to the absence of resources and training, small businesses were unable to harness the power of cyber marketing, which was a lower cost channel than other forms of traditional avenues. The project sought to increase the digital footprint of small agribusiness firms in the state by understanding the challenges undermining their digital efforts and by softening the barriers through the provision of tangible resources in the form of training programs, assistance with content creation and dissemination through various digital platforms. By improving digital visibility, local agri-brands would be able to realize improved customer engagement, customer trust and customer traffic.

To conclude the SC State research projects under the Agribusiness and Community Development Planned Program, the final project focused on reduction of transient instability related power blackouts to lessen the crops and livestock losses by U. S. farms and the spoilage of refrigerated agricultural products. Electricity is essential for the proper operation of U. S. agriculture farms (crop and livestock production systems). Electricity is needed for the different farming processes. For example, electricity is needed for

the operation of irrigation pumps in crop production, greenhouse heating in specialty crop production and heating and cooling in livestock production.

Transient instability of an electrical power system may lead to system to widespread power blackout. Transient instability does not occur frequently, but when it does, it has disastrous effects in terms of losses of crops and livestock by U. S. farms, and spoilage of refrigerated agricultural products. Therefore, real-time control (or improvement) of transient stability is very crucial for the secured operation of power systems. To overcome the serious drawbacks of the real-time local control strategies suggested in the literature, the researcher introduced a completely new method of transient stability solely for the purpose of real-time local control of transient stability. The proposed work was the implementation of the new method for the real-time local control of transient stability. In the proposed technique, transient stability of the power system was controlled (i.e. the power system was stabilized) from the site of each individual generator.

Clemson researchers participated in a multi-state USDA AFRI proposal to develop a Local Foods Vitality Index that involves primary data collection from both producers and consumers; allowing for more informed local decision making regarding food systems investments. Researchers are assessing the viability of a food hub or similar produce aggregation project in the Midlands of South Carolina.

4-H Youth Development and Families
The 4-H program in South Carolina focuses on youth development in the areas of STEM, citizenship and healthy lifestyles. These programs are designed to increase youth knowledge, invoke healthy lifestyle choices and prepare them as the future leaders. Skills taught in the 4-H programs across the state also help to improve self-confidence, reduce stress and anxiety levels, and stimulate brain development. In order to promote these benefits, 4-H agents across the state conducted 4,743 programs which resulted in attendance records of 104,562 participants.

The 4-H Leadership programs attracted 22,970 participants, which accounts for 22% of all 4-H participation. The STEM program had 103,428 youth involved for a 98.9% participation rate and the Healthy Lifestyles programs saw 20,211 youth participate for a 19% participation rate.

Twelve students from three different high schools have joined forces and organized service projects to benefit three local charitable organizations. A program in Sumter County prepared students with life skills related to developing a resume, professional networking techniques such as self-introductions, and proper attire for interviews. A 4-H club was created in Walterboro that consists primarily of economically disadvantaged and limited resource students. While participation in this group is limited, it is consistently serving a core group that has adopted the Veterans Victory House as a service project where they make wheelchair pillows and blankets for the veterans at the facility.

Without volunteers, Clemson Extension would not be able to reach and serve as many adults and youth throughout the state. A total of 8,979 volunteers in Master Naturalist, Master Gardener, and 4-H programs, provided almost 57,900 service hours to Clemson Extension. This is a value of approximately $1.3 million in program support to Extension. These volunteers served as resources for citizens, served on boards and committees, conducted programs and expanded the reach of Clemson Extension.

SC State has three research projects under the heading of 4-H Youth Development and Families. Two of the projects are on-going and one ended during the reporting cycle. Research concluded dealing with challenging and encouraging African American males to be successful in mathematics. South Carolina is one of the lowest ranking states for graduating black males. Reportedly, black males scored the lowest on standardized test, especially in mathematics. One of the key predictors of success in high school and college admissions is eighth grade mathematics achievement. The research focused on an after school tutoring/mentoring program, Saturday academies and summer mathematics enrichment.

Three successful academic school years of after school tutoring and summer mathematics enrichment programs were held. During the academic school year, at least two undergraduate research assistants reported to each targeted school three times a week to mentor and tutor the participants in mathematics for two hours after school. On the first Saturday of each month for the academic school year, the participants and their parents met on campus (SC State) to attend a three hour Saturday mathematics workshop. A pre-test was given on the first day of the program each summer. The participants were assigned an iPad Mini for instructional purposes during instruction time. The participants showed improvement on their post-test results. The average increase for the group was about 15 points. A bulletin will be published documenting the overall findings of the study.

Additional research looked at financially literate entrepreneurship. The researcher's goal was to improve rural youth and families' economic and employment situations by providing and supporting quality education in entrepreneurship and financial literacy. The research provided entrepreneurship and financial literacy training sessions to approximately 50 high school students. Four guest speakers were identified to conduct workshops related to entrepreneurship and financial literacy. A pre-test and post-test was disseminated to the 50 students and their parents/guardians. An Advisory Board was coordinated and presentations were conducted at local and national conferences.

Moreover, research was conducted on the influences of music instruction on reading and music achievement. Based on the South Carolina test results of the 2015 - 2016 academic year, most test takers (grades 3 - 8) did not meet state established reading expectations in Orangeburg County Schools. Less than half of the students who were tested in each public Orangeburg County School District met or exceeded established reading required scores. Furthermore, neither one of the school districts' reading results came close to the number of students who met or exceeded state requirements for reading. The SC State Department of Education reported that beginning in the 2017 - 2018 school year, third graders who do not meet the established reading requirements would be retained. Those overarching facts present a need that requires effective intervention methods that might be started at the early childhood and elementary grade levels.

With purposes of achieving students' overall reading and music skills, the project aimed to test the influence of two discrete courses linked by agricultural literacy outcomes involving food, health and lifestyle. Using Pre-K through 5th grade subjects, the investigator tested the effects of reading instruction and music instruction on the subjects' reading achievement and music achievement. Per grade level (Pre-K - 5), two intact classes would serve as a convenient sample. Subjects of all intact classes would complete a developmentally appropriate test of reading and music at the onset of the one-group pre-test and post-test experiment design. After a 12 week instructional period, subjects' pre-test and post-test scores would be compared to determine if significant changes occurred regarding subjects' reading skills and music skills. The investigator examined the effects of grade, gender, socio-economic levels and race among subjects. Positive, significant findings may be used to suggest a method for the improvement of reading skills and music skills. It is a known fact that students who learn to read at a high proficiency level, read to learn. Such students are more prone to become independent thinkers and successful citizens who make positive contributions to their communities. Many times, such contributions are directly related to the economy of the communities in which the citizens live.

Nutrition and Childhood Obesity
The Expanded Food and Nutrition Education Programs (EFNEP) were conducted for 245 limited resource families, incorporating 880 individuals, to improve nutrition practices, food safety, and food resource management practices such as planning meals, comparing prices, and using grocery lists.
Under the Nutrition and Childhood Obesity Planned Program, SC State has four research projects. One research project, which ended during the report cycle, dealt with the reduction of cancer risks caused by obesity and metabolic syndrome: inhibition of Insulin-like Growth Factor 1 Receptor (IGF-1R)

signaling. Obesity is among the top five preventable causes of many common cancers. Current research on the subject supports a strong link between obesity, type-2 diabetes, metabolic syndrome and cancer related mortality. It has been estimated that, overall, overweight and obesity causes 20% of all cancer cases. A 14 year follow-up study of a population of 33,230 men has shown that the metabolic syndrome conferred a 56% increased risk of cancer mortality. The factor that links diabetes, obesity and metabolic syndrome with cancer is believed to be hyperinsulinemia. Increased insulin levels in the blood leads to increased synthesis of the growth hormone IGF-1 and reduced secretion of IGF-1 binding proteins (IGF-BP), which keep IGF-1 levels under control. Whereby, resulting in higher levels of free bioactive IGF-1. IGF-1 is associated with an increased risk of many types of cancers. It exerts its effects through signaling from its receptor, IGF-1R and plays a major role in cell proliferation, survival and inhibition of programmed cell death of irregular cells (apoptosis). The study seeks to test the concurrent targeting of multi-components of the signaling pathway initiated by IGF-1, in order to inhibit cell proliferation and restore apoptosis to test the feasibility of the strategy to inhibit cancer cell growth.

Using growth assays, it was established that in pancreatic, lung and breast cancer cells, using combination treatment of drugs significantly inhibits the cell growth. The IC 50 values showed a range of concentrations. Consequently, Western analysis experiments showed apoptotic proteins were being expressed in all cell lines tested. Several intermediates of the signaling pathway protein kinase pathway (pAKT), cleaved caspase and cleaved poly (adp-ribose) polymerase (PARP) have been verified. In order to further provide proof of apoptotic activity, enzyme-linked immunosorbent assays (ELISA) were conducted successfully. The results will be peer-reviewed and published in a bulletin for dissemination.

An investigation on food derived AGEs (Advanced Glycation End-products) in relation to obesity and breast cancer was studied. Experiments using gas chromatography-mass spectrometry (GC/MS) spectroscopy procedure and SIM methodology to detect small amounts of the AGEs carboxymethyllysine (CML) and carboxyethyllysine (CEL) from female non-formalin fixed non-hispanic white subjects of different age (56 - 85) years; BMI 15.235 - 26.814) and obesity (57 - 63 years; BMI 21.35 - 51.88) ranges. Control experiments using non-cancerous paired match samples from the same subjects were also analyzed using GC/MS and selected ions for CML, CEL and lysine trifluoroacetyl methyl ester derivatives. Each cancerous and non-cancerous ductal carinoma samples were homogenized using hand held homogenizers, de-lipidated, the precipitates collected by centrifugation and the samples were hydrolyzed using 6M HCI and heating at 95˚ C, 18h. The residues were esterified using methanolic-HCI at 65˚ (0.5 hour), evaporated using nitrogen blow drying process and converted into trifluoroactyl derivative usingtrifluoracetic anhydride (TFAA) as the reagent for the process.

Experiments, thus far, indicate the AGE CML and LY components in the samples examined were easily detected by selective ion monitoring (SIM) GC/MS, but CEL components are present in lower amounts and are not easily detected in the samples analyzed. Further experiments are in progress.

Another SC State researcher is examining achievement motivation for child obesity prevention. According to the SC Department of Health and Environmental Control (DHEC) 2013, children ages 2 - 17 were classified 14.9% as overweight and 16.7% as obese. Children's obesity is a serious medical condition in the United States. In many cases of childhood obesity, there is a lack of motivation toward a behavior for obesity prevention. Obese children usually do not have motivation to apply needed diet and exercise to avoid obesity. A need for developing and boosting achievement motivation goes beyond obesity prevention. It is a more general problem and expands to a need of motivation to achieve other goals in life as well. So a need is evident that achievement motivation should be researched, in relation to obesity prevention, with consequences to the other goals of life.

Physiologically, there is no way of counseling somebody "do not have appetite" because appetite is controlled by a hypothalamus, which is an unconscious part of the brain. So, a procedure was used that boosts achievement motivation in the cortex (conscious part of the brain), which activates the reward

circuits in the hypothalamus, which in turn can influence appetite control. An achievement motivation boosting procedure has been designed for the cortex, which takes advantage of the possibility of a subject to use brain signals to control movement of a physical device. The method is known in science as a brain-computer interface. It is a non-invasive method and often considered as a computer+robot game of interest for children. The procedure consists of a subject hooking on a robotic arm and controlling its movement with the power of his/her brain signals.

Research participants were recruited through collaboration with Felton Laboratory Charter School (FLCS). An educational infrastructure for attracting research motivated students in the project and building a research infrastructure by increasing awareness of the neurobiology of obesity and achievement motivation was established. Lectures on appetite control achievement motivation and obesity prevention in the B490 Brain Science and B405 Medical Physiology courses were given. After enrollment, the Initial Measurements were provided, such as anthropological measurements: weight, height, Body Mass Index (BMI), waist and hip circumference and blood pressure; initial Electroencephalogram (EEG), recording the brain activities and initial biofeedback measurement during relaxation and arousal; initial measurements were taken as baseline against, which observed the progress of the training. After basic parameters were taken, students were instructed how to perform the achievement motivation training (controlling the movement of the robot arm using brain signals). The anthropological measurements and biofeedback training were provided regularly with the achievement motivation training. As an incentive for the first group of research participants, wireless head phones were purchased and given to the students.

In a study analyzing the role of high pro-inflammatory diets and childhood obesity in the risk of adult carcinogenesis in South Carolinian children, the research focuses on the growing crisis of childhood obesity. In the United States, one third of all children ages 2 - 19 are considered overweight or obese. Children from households that do not have access to healthy, nutritious foods were significantly more likely to be obese earlier in life than other children. Areas of South Carolina, such as the I-95 Corridor, have been under-developed for a long period of time and contributed to numerous problems to include obesity, poverty and increasing health problems due to lagging health care. Obesity in children can lead to numerous health complications like diabetes, high blood pressure, high cholesterol, chronic inflammation, endothelial dysfunction and cancer. Therefore, eliminating or reducing preventable risk factors such as unhealthy nutrition and childhood obesity may have important implications for reducing clinical manifestations of adult cancer outcomes. The study enrolled South Carolinian children from Chesterfield, Newberry and Richland Counties to determine if obesity and/or high-fat pro-inflammatory diets contributed to increased levels of pro-inflammatory markers, raising the possibility that long-term chronic inflammation may contribute to and increase the risk of adult cancers.

The results suggested an increased expression of pro-inflammatory markers were directly correlated to diet irrespective of weight class (normal, overweight, obese). Survey analysis indicated many of the participants ate a variety of foods, both healthy and processed foods. Preliminarily, the results suggested the intake of high-fat diets (pro-inflammatory/fast foods) present with increased expression of the pro-inflammatory markers seen were irrespective of weight class (normal, overweight, obese). Data analysis is on-going.

Sustainable Energy
Results from research dealing with reusing post-consumed plastics for solvent extraction of resins and other reprocessing was conducted during the report period at SC State. The project centers on saving energy by recovering resin and reutilizing post-consumed plastics (PCPs) increases yearly by over 2% and it is slightly higher than the rate of resins production. Recovering resins from PCPs for reuse is very energy efficient, environmental friendly and economically advantageous compared to making new resins from petrochemicals.

The research consisted of reducing the amounts of post-consumed plastics in four major ways, which were

extracting the resins from post-consumer (PC) plastic products. Varieties of PC materials were dissolved in solvents and mixtures of the solvents, resins were extracted, thermally characterized; using post-consumer plastics to produce other useful materials. Expanded PC polystyrene was used to replace gravels to produce cement blocks useful as construction materials; using post-consumed plastic in construction materials. PC polyethylene was converted to roads useful for 3-D printing and hot glue and types of the post-consumed plastics were collected, washed and cut to small sizes, then air dried to further uses. A set-up to melt and recast post-consumed plastics to rod and filaments was designed. The instrument was built and tested successfully. A mold was made to produce insulated cement blocks for construction. Ten samples of the gravels were replaced with PC-EPS, then prepared and tested for mechanical strength and thermal conductivity.

At Clemson University, switchgrass research results showed that harvesting twice per year every other year (compared to twice per year every year), reduced but did not stop the yield decline associated with multiple harvests in a single growing season. Research also showed that the older switchgrass variety was still the most productive for the South Carolina region. After about five years of production, switchgrass grown under higher intensity management will experience some yield decline and shift back to a clump type of growth habit. Biomass sorghum was shown to have great yield potential for production in South Carolina and to yield more than switchgrass. Limitations to biomass sorghum production include the need to replant each year and the recent appearance of the sugarcane aphid.

Clemson Researchers investigated and developed sustainable technologies to convert biomass resources into chemicals, energy, materials and other value added products with the goal of carbon drawdown, and established new efficient ways for the production of biodiesel from cottonseed oils was accomplished using enzyme technology in partnership with Novozyme, Inc.

Researchers also developed a modeling and systems approach to support development of sustainable biomass production and conversion to bioenergy and bioproducts. Modeling techniques using Superpro Designer for process development of cottonseed biodiesel was accomplished during this year. Further modeling of hempseed oils are currently being pursued.

Global Food Security and Hunger
Agronomic crop production is another important programmatic focus, resulting in wide-ranging statewide impacts on South Carolina citizens. Agronomic crops agents conducted 302 programs statewide with a total of 7,253 people attending these programs. Information from variety trials for corn, soybeans, grain sorghum, peanuts, sweet potato, cotton and others were disseminated. Agents provided information on each crop such as yields, growing condition requirements, varieties and other pertinent information so that farmers may make an informed decision about which crops to plant. Information and training on pest identification as well as pest control is also commonly discussed in workshops along with pesticide applicator training.

In an effort to increase agronomic crops, a Clarendon County, a farmer is working to re-establish a pickle grading station to help sustain the pickle industry. As a result of these efforts, approximately 1,500 acres of cucumbers and peppers are now being produced in SC, totaling around $4.5 million in sales. This effort has not only increased an agriculture commodity in SC, it has helped boost local economies through increased job opportunities and income.

To help farmers save time and money, a mobile app has also been developed and is gaining use by farmers. The app provides up-to-date information on the latest Integrated Pest Management (IPM) recommendations and spray guides. Over a two-year time period, there has been a 70% increase in the use of the app by farmers, leading to potential increased savings in pesticide application programs.

Under the Global Food Security and Hunger Planned Program, SC State has two research projects. The

first project conducts an investigation of alternative sources of vegetable oil from non-edible plant seeds for biodiesel production, while the other research deals with a social worker's role in improving food insecurity to promote healthy student development through school-based services.

Project one investigated alternative oil sources for the production of biodiesel based on non-edible, non-staple seed sources indigenous to South Carolina. The project characterized seed plants that were native to the state of South Carolina or seed plants that could be transplanted to the state. The seed plants were selected based on pre-determined criteria. The requirements included the seed plants were non-edible or non-staple, had short maturation period, di-cots and plants that could be easily and inexpensively cultivated. Oils extracted from acceptable samples were compared to the yield, chemical and physical characteristics of the soybean oil as a standard.

Six of the oils (lavender, California dreaming, blue flax, black-eyes Susan; wild sunflower and bachelor button cornflower) extracted were used to produce biodiesel, experimentally, in the laboratory. The study found there were non-edible/non-staple seeds indigenous to South Carolina or the southeastern United States that can produce oil. Based on the initial analyses on the oil yields from the seeds, it was found most of the seeds evaluated had yields comparable to the yield for the soybean oil. Out of the total 14 seeds evaluated, 12 had yields comparable or better than the soybean oil (7%). Nine of the 12 seed oils were found to be suitable for production of biodiesel. The seed oils were from wild sunflower, black-eyed Susan, shasta daisy, pecan, bachelor button cornflower and lavender. The others were blue flax, California dreaming and impatiens. The complete results will be published and disseminated in a bulletin.

Secondly, food insecurity has become a national, yet social problem. Nationally, there are more than 42 million households dealing with food insecurity, of which 13 million are children. The research at SC State is proposing a school-based program to address food insecurity of public school students that reside in rural areas (Orangeburg and Calhoun Counties).

Clemson Experiment station scientists are evaluating nitrogen management strategies to optimize cotton yields on non-irrigated fields across different soil types and cropping systems in the state. It is anticipated that research will provide cotton farmers with information related to the amount of nitrogen needed to produce more profitable crops, while preserving the environment and saving money.

A patent was received for a new fertilizer. The goal is to get the fertilizer commercialized so that producers would be able to fertilize organic crops and have the yield comparable to conventional produce without the lag time of existing organic produce.

Climate Change
Climate change models predict threatening heat and drought stress conditions in crop-growing regions of the country. Farmers lack drought and heat tolerant crop varieties, creating the need for developing such varieties for improving productivity. Previous research, along with that of others suggest that lipid remodeling is important for plants to cope with abiotic stresses. Clemson researchers investigated the regulation of lipid composition in response to heat stress in order to identify lipid biomarkers with direct breeding utility. This research is an important step in developing drought- and heat-tolerant crop varieties.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	135.0	41.0	86.0	13.0
Actual	144.0	0.0	142.0	0.0

II. Merit Review Process

1. The Merit Review Process that was Employed for this year

- Internal University Panel
- External Non-University Panel
- Expert Peer Review
- Other (Research Results Reviewed by selected growers and commodity groups and associations)

2. Brief Explanation

The South Carolina State Extension Advancement Council (SEAC) reviews and comments on new programs initiated by Clemson University and South Carolina State University. The Council meets face-to-face 2 times per year and uses electronic communications throughout the remainder of the year. The Clemson Extension Service Program Development and Delivery sub-committee serves as an external non-university panel to provide input into statewide programming efforts and endeavors. The committee members have participated in Extension programs, are knowledgeable of South Carolina's social and economic demographics, and are sensitive to the needs of underserved and underrepresented populations. The overall SEAC committee is comprised of a variety of members that include occupations such as bankers, foresters, small farm owners, county and city officials, wildlife biologists, educators, lawyers, small business owners, physicians, real estate professionals, public utility professionals, etc. In 2018, Clemson Extension conducted a stakeholder survey to gauge how well Clemson Extension is serving its citizens. The results from this survey are being utilized to revise the Clemson Extension strategic 5-year plan. An internal review system is also in place to serve Clemson Extension. Clemson Extension State Program Team Leaders also review statewide programmatic efforts for relevance and value to stakeholders. Each Program Team Leader reviews the Annual Plan of Work in their respective areas and provides updates as necessary.

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 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 or Evans-Allen 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.

III. Stakeholder Input

1. Actions taken to seek stakeholder input that encouraged their participation

- 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
- Targeted invitation to selected individuals from general public
- Survey of traditional stakeholder groups
- Survey of traditional stakeholder individuals
- Survey specifically with non-traditional groups

Brief explanation.

Clemson Extension and SC State Extension seek input by identifying stakeholders and seeking feedback on existing and future programming efforts. This is typically an informal process through the use of traditional media outlets as well as utilization of social media to solicit input on various Extension activities. In 2018, Clemson Extension conducted an external stakeholder survey that sought input into Clemson Extension activities to determine if the services provided were meeting the needs of citizens throughout South Carolina.

SC State constantly requests feedback from their constituents through face-to-face meetings as well as surveys and evaluations. Annual Cooperative meetings are held seeking input on programs and activities. Open dialogue is requested of what is being done and what could be done better or deleted/revised. The input is shared with faculty and staff through information sessions, in order that they may develop and submit proposals under the Planned Program Areas.

Clemson Research as well as SC State Research seeks to gather input from stakeholders via various social media avenues: Clemson websites, radio/TV, press releases, workshops, fairs and field days, and through the Impact Magazine that is published quarterly.

2(A). A brief statement of the process that was used by the recipient institution to identify individuals and groups stakeholders and to collect input from them

1. Method to identify individuals and groups

- Use Advisory Committees
- Use Internal Focus Groups
- Use External Focus Groups
- Open Listening Sessions
- Needs Assessments
- Use Surveys

Brief explanation.

Clemson Extension and SC State Extension partners with agencies and organizations to engage all stakeholders such as commodity groups, community leaders, advisory board members, business and industry representatives, non-governmental/non-profits organizations, human services providers, etc. Furthermore, both programs partner with agencies and organizations to identify underrepresented and underserved groups to participate in Extension reviews and programming activities. Previous participants in Clemson Extension and SC State programs are also encouraged to become involved and are invited to attend county and regional advisory meetings to provide input. Internally, Clemson Extension administrators, Extension agents, specialists and faculty, department chairs and deans serve in providing input. Also, results from SC State's Annual Cooperative meetings provide a wealth of information for the staff to consider and implement. In addition, Clemson Research works with Extension and meets with producers and other stakeholders at field days and during campus visits.

2(B). A brief statement of the process that was used by the recipient institution to identify individuals and groups who are stakeholders and to collect input from them

1. Methods for collecting Stakeholder Input

- Meeting with traditional Stakeholder groups
- Survey of traditional Stakeholder groups
- Meeting with traditional Stakeholder individuals
- Survey of traditional Stakeholder individuals
- Meeting with the general public (open meeting advertised to all)
- Survey of the general public
- Meeting specifically with non-traditional groups
- Survey specifically with non-traditional groups
- Meeting specifically with non-traditional individuals
- Meeting with invited selected individuals from the general public

Brief explanation.

In 2018, an external stakeholder survey was administered throughout the state that sought input on Clemson Extension's progress toward gauging program quality, information delivery and services. The State Extension Advancement Council, regional and county advisory boards also provide input into programmatic needs and delivery. Commodity groups, state agencies and federal agencies (i.e. SC Department of Natural Resources, SC Department of Agriculture, NRCS, US Forest Service), farmers, and other interested individuals are engaged in dialogue throughout the year that provides input into programs and services. In addition, statewide programs in each of the program areas are surveyed to estimate program impacts. This survey is administered through Qualtrics ® and results are disseminated to appropriate Clemson Extension personnel for utilization.

Stakeholders do not hesitate to inform and provide input when they see an opportunity to make a change or enhance something. They will attend meetings, make telephone calls, write letters, etc. At SC State's Project Community meetings, stakeholders identify community needs, discuss the community needs, and prioritize the needs. Extension seeks to implement based on capacity and mission.

3. A statement of how the input will be considered

- In the Budget Process
- To Identify Emerging Issues
- Redirect Extension Programs
- Redirect Research Programs
- In the Staff Hiring Process
- In the Action Plans
- To Set Priorities

Brief explanation.

Data gathered on Clemson Extension and SC State programs at the state, county and local levels are aggregated to adjust programming focus and efforts to meet the needs of the stakeholders. The 2018 external stakeholder survey results are being considered as the Clemson Extension Strategic Plan is being revised for the next 5-year cycle. All statewide program impact surveys are also utilized and shared with administrators, State Extension Advancement Council members and other Clemson Extension personnel to ensure positive impact of programming efforts.

Data are used to assist in writing reports, developing programs and making recommendations on the local, state and national levels.

Brief Explanation of what you learned from your Stakeholders

Input from stakeholders and surveys indicated that Clemson Extension and SC State are achieving their mission to provide science-based information to all citizens of South Carolina throughout for all program focus areas. Information provided from the stakeholders allowed the institutions to learn that research and extension are valuable assets to the state, community and individuals.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
{No Data Entered}	{No Data Entered}	{No Data Entered}	{No Data Entered}

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	5242446	1870988	4805102	2288764
Actual Matching	5242446	1870988	5188542	2288764
Actual All Other	0	0	10744394	0
Total Actual Expended	10484892	3741976	20738038	4577528

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	5454236	0	4769490	0

V. Planned Program Table of Content

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Sustainable Animal Production Systems

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
301	Reproductive Performance of Animals	15%	15%	40%	0%
302	Nutrient Utilization in Animals	20%	15%	60%	0%
303	Genetic Improvement of Animals	15%	15%	0%	0%
307	Animal Management Systems	15%	15%	0%	0%
308	Improved Animal Products (Before Harvest)	10%	10%	0%	0%
311	Animal Diseases	10%	5%	0%	0%
315	Animal Welfare/Well-Being and Protection	10%	15%	0%	0%
723	Hazards to Human Health and Safety	5%	10%	0%	0%
	Total	100%	100%	100%	0%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	11.0	8.0	7.0	1.0
Actual Paid	16.2	7.0	6.2	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
607501	294927	355577	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
607501	294927	238672	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	193399	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Clemson Extension conducted workshops on a variety of topics such as forage management, soil fertility management, forage variety selection, weed, pest and disease identification and control, herd health, improved breeding systems, proper fencing techniques and options, replacement heifer sales, on-farm cattle scales, sprayer calibration and other topics. Extension agents throughout the state also in assisted in emergency preparedness operations in conjunction with local, county and state officials. These emergency plans included resources for the care of mass farm animals as well as pets and service dogs.

The SC State Small Farm Assistance and Outreach Program continued to improve management operation skills of farmers by conducting workshops and allowing them to participate in conferences to gain knowledge and increase skills in land loss and retention, land use, herd health management, forestry management and risk management. The farmers will become efficient in livestock production management through better decision making and minimizing their overall production costs.

Work is underway with a livestock nutritionist at Clemson to develop a hay mix of bermudagrass, alfalfa and barley. Alfalfa can be a very productive crop with high levels of biomass accumulation. The potential for alfalfa acreage expansion in the South is great.

2. Brief description of the target audience

The target audience included producers, limited-resource farmers and agency personnel, etc.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	15660	113957	1058	87519

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	1	6	7

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Disclosures

Year	Actual
2018	0

Output #2

Output Measure

- Licenses

Year	Actual
2018	0

Output #3

Output Measure

- Number of people completing educational workshops.

Year	Actual

2018	6696

Output #4

Output Measure

- Number of educational workshops conducted.

Year	Actual
2018	277

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of people reporting increased knowledge and indicating adoption of animal production practices.
2	Number increased percentage of forage fed beef production in the State and Region
3	Increased income due to producers and growers improved production efficiency of confined animal systems.

Outcome #1

1. Outcome Measures

Number of people reporting increased knowledge and indicating adoption of animal production practices.

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	1139

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Small scale swine producers were encouraged to raise swine in a ground environment. The Hampton County Cluster was interested in raising the old fashioned pastured raised swine. Sustainable practices were employed to reduce off-farm input and maximize on-farm input. There was a demand for pastured raised swine.

What has been done
A search was done to identify the breed of swine compatible for pastured raised swine. A series of workshops were held with the small scale swine producers to increase their knowledge of old fashioned pastured raised swine. Two small scale on-farm demonstration pasture raised swine herds were established to satisfy an increase in local consumers demand for free range swine. Both enterprise operators were local third generation family farm swine producers' youth.

Results
Of the individuals participating in the workshop training sessions, all adopted the practices and have seen improved production in their herds. Plans are underway to increase the herds. A marketing plan for local buyers and Bar-B-Q vendors is being developed.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
307	Animal Management Systems

308	Improved Animal Products (Before Harvest)
315	Animal Welfare/Well-Being and Protection

Outcome #2

1. Outcome Measures

Number increased percentage of forage fed beef production in the State and Region

2. Associated Institution Types

- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	30

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The Greenwood Cluster livestock producers were interested in implementing summer annual grasses to reduce their supplemental feed costs, increase animal performance and provide a palatable food source for their livestock. The predominant grass in the Cluster, fescue, slows production in the months of June through August causing a reduction of forage for livestock.

What has been done
A workshop was held to inform producers of the different varieties of summer annual forages available for planting dates, planting methods and the best uses for each forage. Forty-seven producers attended the workshop.

Results
Fifteen producers planted sudangrass, pearl millet, legume sudangrass mixtures, and brassica millet mixtures. As a result of planting the forages, all producers reported not purchasing any additional nutritional supplements. Three producers reported they produced enough excess forage to make two cuttings of hay.

4. Associated Knowledge Areas

KA Code	Knowledge Area
302	Nutrient Utilization in Animals
307	Animal Management Systems

Outcome #3

1. Outcome Measures

Increased income due to producers and growers improved production efficiency of confined animal systems.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	250000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Various changes were made to the 2018 Farm Bill in regards to the Margin Protection Program for dairy. These changes greatly improved the program and made it beneficial to sign up for the program if proper procedures were followed.

What has been done
The Extension Specialist made individual visits and phone calls to dairymen across the state to explain the changes and to offer assistance in determining the most economically beneficial option for producers for the sign-up process. Producers were taught how to use a decision tool and were able to use their personal farm numbers for more accuracy. The specialists also assisted Farm Service Agents to help them better understand the program and the decision tool.

Results
To date, 50% of dairy operations across the state are signed up for the MPP-Dairy program which could result in payments of close to $250,000 to the states dairy operations. Many are still considering their options and will be able to make informed decisions on their participation in this program as a result of Extension's help. Adoption of best practices contributed to reduced costs of raising replacement heifers and improved nutrient utilization, health, and well-being of dairy calves and heifers.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals

307 Animal Management Systems

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The Livestock and Forages team is instrumental in educating farmers on improved breeding and foraging strategies. For example, 318 farmers utilized Expected Prodigy Differences (EPD) in sire selection/proper breed complementation and/or improved health and reproduction methods. These improved techniques as presented by Clemson Extension will help sustain long-term production in farms across the state.

In the low country of SC, most beef cattle herds are cow-calf operations consisting of 25 head of brood cows or less. To assist cattle growers to maximize profits, workshops were held that covered forage management, soil fertility management, forage variety management, weed, insect and disease identification, herd health and farm safety. Ninety-eight percent of participants indicated that they gained knowledge from information introduced at these meetings. Additionally, 50% of the participants intended to utilize the information provided.

The communities within the Hampton Cluster were requesting the old fashioned pastured raised swine. Therefore, Extension agents worked to provide training and give the consumers what they wanted. As a result, demand increased and more herds are being formed. A marketing plan for local buyers and Bar-B-Q vendors is being developed.

A workshop was held to inform producers of the different varieties of summer annual forages available. After receiving training and planting the suggested forages, all of the producers reported not purchasing any additional nutritional supplements. Three producers reported they produced enough excess forage to make two cuttings of hay.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Sustainable Agriculture Production for (non-food) Horticultural Crops

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
111	Conservation and Efficient Use of Water	10%	0%	50%	0%
201	Plant Genome, Genetics, and Genetic Mechanisms	0%	0%	10%	0%
204	Plant Product Quality and Utility (Preharvest)	5%	0%	0%	0%
205	Plant Management Systems	20%	0%	0%	0%
211	Insects, Mites, and Other Arthropods Affecting Plants	20%	0%	10%	0%
212	Pathogens and Nematodes Affecting Plants	20%	0%	10%	0%
215	Biological Control of Pests Affecting Plants	5%	0%	0%	0%
216	Integrated Pest Management Systems	20%	0%	20%	50%
601	Economics of Agricultural Production and Farm Management	0%	0%	0%	50%
	Total	100%	0%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	15.0	0.0	8.5	0.0
Actual Paid	17.2	0.0	5.4	0.5
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
626667	0	744790	84160
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
626667	0	534419	84160
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	2589398	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The Home and Garden Information Center (HGIC) provided gardening information to 11,601 individuals by telephone or email. In addition, the HGIC website recorded 2,774,557 hits last year, which underscores the importance of this service to the citizens of South Carolina and surrounding states. The HGIC staff also updated 115 fact sheets and created 34 new fact sheets. Horticulture agents provided training and assistance for senior citizens creating raised gardening beds as well as insects, soils fertilizer, plant nutrition, plant physiology, botany, turfgrass, vegetable gardens, urban forest and other horticulture education for youth and adults.

The Master Gardener program is vital to extending Clemson Extension's reach to audiences across SC. One example of a community serviced by Master Gardeners is work with Habitat For Humanity in Beaufort County. A new volunteer reporting system was also established for Master Gardeners to report hours and miles traveled. While reporting to the system is not required of volunteers, the new system will help ease the burden of reporting. .

Studies conducted by Clemson's Experiment Station during this period generated efficacy data for several new insecticides, and provided stakeholders scientific data in selecting the most effective pest management product.

An SC State researcher was looking to determine the percentage of farmers and agricultural workers in rural South Carolina who were directly affected by hearing loss due to loud farm equipment and the ones who took proactive measures to protect their hearing from noise exposure. The baseline data collected was Systolic Blood Pressure (SBP bilaterally), Diastolic Blood Pressure (DBP bilaterally), Pulse (bilaterally), Baseline Audiograms and Sound Levels of farm equipment, as well as documentation of the minimum and maximum number of hours within each work day the farmers stated they operated the equipment. On average, the participants operated farming equipment an average minimum of 4 hours and a maximum of 7. 5 hours a day. The average sound level the participants were exposed to during the time frame was 99.225 dB (min: 88.7 dB, max: 104.8 dB, o: 7.20), which is well above the maximum safe time without usage of hearing protection devices. Data was collected to measure the levels of noise exposure to compare with OSHA noise standards. Blood pressure levels were measured and surveys distributed to assess the use of hearing protection devices.

2. Brief description of the target audience

The audience included producers, small farmers and Extension personnel, horticulture professionals, residents in counties with Master Gardener programs, Master Gardeners, and consumers.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	21191	16874665	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2018

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	14	14

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Disclosures

Year	Actual
2018	1

Output #2

Output Measure

- Licenses

Year	Actual

2018	0

Output #3

Output Measure

- Number of people completing horticultural educational workshops

Year	Actual
2018	13377

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of participants gaining knowledge and applying skills learned in environmental horticulture education.

Outcome #1

1. Outcome Measures

Number of participants gaining knowledge and applying skills learned in environmental horticulture education.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	19970

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The Clemson Extension horticultural crops team 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.

What has been done
In FY 2017-18, Clemson Extension personnel conducted over 3,000 programs focused on horticultural education. Topics covered included environmentally sensitive landscape management, proper pesticide application, weed, pest and disease identification, UV light application for fungicides, community gardens, soil protection for new nurseries, and more. Extension agents assisted farmers with building a UV light that combats fungicides that are resistant to chemical treatment, assisted with school and community gardens, and trained pesticide applicators on best management practices. Master Gardeners were trained and rendered service in the community.

Results
Research data results has helped producers and homeowners with insecticide applications against scale insects, wood boring insects, whiteflies, thrips, spider mites, redheaded flea beetle and other arthropod pests. Recommendations for better application method, timing and product, had saved three ornamental plant nurseries and greenhouses in SC in crop losses and cost of control, and two turf and golf courses in cost of pest management. Master Gardeners contributed 32,140 hours of service representing over $714,000 in program support. This translates to each volunteer (3,026) recording 10.6 hours each of service. There were also 138 people certified for the first time as Master Gardeners.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
216	Integrated Pest Management Systems

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

The request for vehicle tags and registration was delayed, therefore, the research on Preventing the Effects of Noise Induced Hearing Loss and High Blood Pressure Among South Carolina Farmers and Agricultural Workers was not able to begin as planned. Due to the delay, an extension of the project was requested and granted.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Over 90% of the 10,745 participants in environmental horticulture programs reported a gain in knowledge. Assistance was provided to over 11,000 residents via email, telephone or social media, indicating the importance of accurate and applied solutions to horticultural problems in South Carolina.

Nine participants were surveyed and asked if they used hearing protective devices and only 44% of the sample admitted to usage of hearing protective devices; but not on a consistent basis while operating farm machinery. The goal is to get at least 30 farmers to participate in the research. When asked if they were provided protective devices free of charge by SC State Extension would they consider usage, an astounding 78% of the participants answered "yes" they would use the device. Only 33% surveyed answered "yes" to receiving any form of prior education on the benefits of using hearing protection devices, hearing health, operation time standards and OSHA guidelines. Many of the participants were operating their farm equipment on average 4 to 7.5 hours a day at an average decibel level of 99.22 dB; which was well above the maximum safe time without usage of hearing protection devices. Preliminary baseline data indicated participants were not only exhibiting mild to moderate hearing loss in the high frequency range of 2000Hz - 8000Hz, but they also were

presenting abnormal blood pressures spanning from elevated to Hypertension Stage 2 blood pressure. This indicated to the researcher there seemed to be a true correlation between hours of noise exposure without hearing protection, blood pressure and high frequency hearing loss.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

Natural Resource Management

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
111	Conservation and Efficient Use of Water	20%	0%	0%	25%
112	Watershed Protection and Management	20%	0%	25%	5%
122	Management and Control of Forest and Range Fires	3%	0%	25%	0%
123	Management and Sustainability of Forest Resources	20%	0%	50%	10%
124	Urban Forestry	1%	0%	0%	0%
131	Alternative Uses of Land	0%	0%	0%	15%
133	Pollution Prevention and Mitigation	30%	0%	0%	15%
135	Aquatic and Terrestrial Wildlife	6%	0%	0%	0%
201	Plant Genome, Genetics, and Genetic Mechanisms	0%	0%	0%	30%
	Total	100%	0%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	18.0	0.0	17.5	1.0
Actual Paid	21.1	0.0	11.7	2.0
Actual Volunteer	12.3	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
681723	0	355577	354813
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
681723	0	1089593	354813
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	1826546	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Clemson University Extension personnel focused on water resources education, sustainable forest management practices, wildlife management, and pond management. Annual trainings were offered in Certified Erosion Prevention & Sediment Control Inspector Program (CEPSCI), Certified Stormwater Plan Reviewer (CSPR), Master Pond Manager, QDMA Deer Steward I, Wood Supplier System, Logging Cost Analysis, Master Naturalist, Healthy pond Series, Master Pond Manager, rain barrel construction, Adopt-A-Stream, and Woodland Management Series. A conference was organized in the Lowcountry that addressed pond owners as well as HOAs responsible for stormwater runoff ponds. Topics included weed management, shoreline stabilization, and wildlife management.

Adaptive Clemson Extension programs included pesticide spraying and calibration, Managing Your Upstate Forest, urban tree care, forest economics, prescribed fire, ground cover in longleaf pine systems, invasive species, feral hogs, bobwhite quail, and other related topics. The Timber Market Trends in SC quarterly bulletin is prepared and distributed throughout the state.

A Clemson research project will provide an overview of South Carolina's sustainable forest resources. It focuses on all forest resources (wildlife, timber, recreation, water, aesthetics, etc.) and specifically addresses long-term timber supply related to the state's future use and development of these resources.

Other research also being continued are projects to evaluate the contribution of bacterial contaminants and sediments to streams that result from recreational trails and trail user types, to understand the cellular and molecular mechanisms that govern virulence of the food-borne pathogen, Entamoeba histolytica,and to study how climate change related disturbances, such as hurricanes, sea level rise, salinity intrusion, and drought, insect break out, fire and management, etc, affect the coastal forests, and how coastal forests react to these disturbances.

Researchers are working on developing sustainable remediation technologies to encourage use of alternative water resources, especially recycled irrigation runoff, to decrease dependence on potable water and enhance long-term economic viability.

Under the Natural Resource Management program, SC State has two research projects. Project one focuses on natural attenuation of Uranium (U) contaminated groundwater, soils and sediments. Several techniques were utilized to produce tranconjugantsof A.piechaudii and P.pituda in an attempt to produce random mutations in genes involved in biosurfactant production. Cultures were taken. Wire loops were then used to transfer bacteria from the cultures and produce adjacent line streaks. The streaks were allowed to grow for 1 day and mixed with a steel spreader. The mixed cultures were allowed to conjugate

overnight. The results demonstrated the line streak conjuation method was most efficient at producing transconjugants. Specifically, 1800 transconjugants were produced, while electroporation and chemical transformation each generated 0 transconjugants. However, dot conjugation produced only 37.

SC State project two dealt with applying instrumental neutron activation analysis (INAA) to the study of toxic trace elements in cotton seeds. Cotton seeds were collected and whole cotton plant samples were harvested in Orangeburg, Richland, Lexington, Aiken, Sumter and Dorchester counties. A new group of samples were irradiated by Pulstar nuclear reactor at NCSU. All the spectra of short-lived isotopes and medium-lived isotopes were measured. The cotton seeds are being studied along with corresponding local soil with a radioanalytical method Instrumental Neutron Activation Analysis (INAA). By analyzing cotton seeds and the corresponding local soil with INAA, it is possible to determine the level of elements with high accuracy and extreme sensitivity, as well as establish a relationship between the amount of toxic trace elements in cotton seeds and the level of heavy metal contamination in the local soil. A new group of students with INAA theories and radiation safety were trained. A new software for instrumental neutron activation analysis was designed and implemented at http://naas.scsu.edu.

2. Brief description of the target audience

The target audience included farm and forest landowners, Extension agents, and administrators, natural resource professionals, land management agency personnel and user groups, nature-based tourism operators/industry, South Carolina citizens, tourists, children in school, after-school, summer and 4-H programs, agents and volunteers, urban, suburban and rural residents, farmers, ranchers, poultry and swine producers, foresters, urban agents, agency personnel, urban planners and land owners/managers, municipal officials, and local community groups statewide, managers, government officials and recreation and tourism operators.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	15035	3278177	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	48	48

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Disclosures

Year	Actual
2018	0

Output #2

Output Measure

- Licenses

Year	Actual
2018	0

Output #3

Output Measure

- Number of people completing educational workshops.

Year	Actual
2018	12521

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of people gaining knowledge and using practices to improve water quality and quantity.
2	Number of people applying wildlife habitat improvement practices.
3	Number of acres affected by sustainable forestry practices.

Outcome #1

1. Outcome Measures

Number of people gaining knowledge and using practices to improve water quality and quantity.

2. Associated Institution Types

- 1862 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	13443

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The Environmental Protection Agency has identified storm-water runoff as the number one threat to water quality in the surface waters of the United States. In addition, other non point source pollution also contributes to degraded water quality. There are economic costs of degraded water quality through water filtration and treatments systems to the local governments. Detention ponds, without proper maintenance, can become another source of pollution.

What has been done
Extension Agents delivered programs and conferences, conducted television campaigns, created and distributed print media and utilized online resources in an attempt to educate and entice behavioral changes amongst the citizens of South Carolina. Topics covered were how to control stormwater runoff and other non-point source pollutants. Techniques included the use of bio-retention ponds and designs for low impact development. The construction of downspout planter boxes, rain barrels and rain gardens were demonstrated. The use of shoreline buffers to minimize erosion was presented. The SC Adopt-A-Stream program continued. Individuals were trained in monitoring protocols for biological, chemical and bacterial stream issues.

Results
This program extends the water quality effort of local and state agencies by increasing the water sampling effort throughout the state. The outreach efforts of the agents combined with ad campaigns and printed, readily available information on management had the potential to impact tens of thousands of retention ponds covering thousands of acres throughout the state of South Carolina.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
131	Alternative Uses of Land
133	Pollution Prevention and Mitigation

Outcome #2

1. Outcome Measures

Number of people applying wildlife habitat improvement practices.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	568

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
All wildlife has value, intrinsic or extrinsic, and as such, wildlife conservation is important in the light of increased populations and land fragmentation. Some wildlife species can be assigned an economic value, such as white-tailed deer or turkey, but other species such as neo-tropical migratory birds and herpetofauna, only have intrinsic value. All wildlife has a function in the ecosystem and provides some ecosystem service that is of benefit to humans.

What has been done
Workshops, traditional and online, were offered that covered topics from habitat management, species management, and people management within natural systems. These programs considered biology and physiology, soils, plant selection, hunter management, trail management, prescribed fire and variety of other topics. Basic wildlife management was taught through the Master Wildlifer program. A new online version of the Deer Steward I program, in conjunction with the Quality Deer Management Association was launched and covered topics such as herd management, herd monitoring, habitat management and hunter management.

Results
Homeowners and visitors to the Pee Dee Research and Education Center learned how to select plants favorable to pollinators through demonstration sites and home visits. The Master Wildlifer program is an international program that has potentially affected hundreds of thousands of acres

across North America. Volunteers have contributed over 25,699 hours of service, which represented over $571,000 of program support.

4. Associated Knowledge Areas

KA Code	Knowledge Area
131	Alternative Uses of Land
135	Aquatic and Terrestrial Wildlife

Outcome #3

1. Outcome Measures

Number of acres affected by sustainable forestry practices.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	151314

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
One of the primary tools for forest management is the use of prescribed fire. While prescribed fire has numerous ecological, environmental benefits, and economic benefits, the biggest barrier to the use of it is smoke management. Smoke created by prescribed fire creates a liability for a landowner, especially if used near busy roads, large urban centers and other heavily populated areas. As such, many landowners tend to shy away from prescribed fire, thus leading to unhealthy forests.

What has been done
Efforts to maintain healthy forests included workshops on prescribed fire, wood identification, pest and disease identification and control, wood supplier systems and logging cost analysis, and other topics. Urban forestry was also a program focus area that covered scouting for signs of declining health, insects and diseases, etc.

Results
Programs offered related to forest economics helped landowners, foresters and land managers to better manage forests to maximize economic returns. The Timber Market Trends in SC bulletin

was published that provides an analysis of the previous quarters lumber prices. This helps forestry professionals gauge harvesting operations financial expectations. The prescribed fire workshop will help to increase the importance and utilization of prescribed fire in the future. Overall, forestry programs potentially impacted at least 150,000 acres statewide.

4. Associated Knowledge Areas

KA Code	Knowledge Area
122	Management and Control of Forest and Range Fires
123	Management and Sustainability of Forest Resources
124	Urban Forestry

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Clemson Extension agents provided 1,244 programs for over 12,500 landowners, land managers, foresters and other concerned citizens. As a result of this effort, over 99% of those attending the programs reported a gain in knowledge. Volunteers such as Master Naturalists contributed 25,699 hours, which represented over $571,000 of program support. The total acres affected by Master Naturalist volunteers was over 73,319.

Results from the SC State Project One demonstrated the line streak conjugation method was most efficient at producing transconjugants. Specifically, 1800 transconjugants were produced, while electroporation and chemical transformation each generated 0 transconjugants. However, dot conjugation produced only 37.

With SC State Project Two cotton seeds were collected and whole cotton plant samples were harvested in Orangeburg, Richland, Lexington, Aiken, Sumter and Dorchester counties. A new group of samples were irradiated by Pulstar nuclear reactor at NCSU. All the spectra of short-lived isotopes and medium-lived isotopes were measured. A new group of students with INAA theories and radiation safety were trained. A new software for instrumental neutron activation analysis was designed and implemented at http://naas.scsu.edu.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 4

1. Name of the Planned Program

Food Safety

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
502	New and Improved Food Products	5%	0%	0%	0%
503	Quality Maintenance in Storing and Marketing Food Products	20%	20%	0%	10%
703	Nutrition Education and Behavior	10%	30%	0%	25%
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	40%	15%	25%	25%
723	Hazards to Human Health and Safety	25%	15%	75%	20%
724	Healthy Lifestyle	0%	20%	0%	20%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	5.0	3.5	4.0	2.0
Actual Paid	3.0	6.5	5.3	1.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
98857	260400	283350	250482
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
98857	260400	176410	250482
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	107443	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Clemson Extension agents taught safe handling of food to personnel in the food service industry and the general public. Commercial food processors were targeted in an effort to improve commercial food processing efficiencies and effectiveness/develop new markets/improve commercial handling, processing, preservation and packaging to provide safe and high quality foods. Attention was given to providing consumers with scientifically based, reasonable nutrition and food safety information via the media. Food-borne illnesses were identified and conditions discussed that lead to the growth of harmful bacteria. Most common food-borne pathogens, additives, preservatives and basic kitchen safety techniques were taught. Food industry personnel were certified in safe food handling techniques. Extension Specialists assisted entrepreneurs in meeting state and federal food safety requirements in order to produce and sell foods.

SC State assessed the susceptibility and biological responses of selected external feeders of grain to ozone gas. Data was generated on susceptibility of oryzaephilus mercator life stages to ozone gas. Testing took place on the susceptibility of various stages to ozone, exposed with or without food to be compared to control with and without food. There was testing of different life stages including, but not limited to, eggs, larvae, pupae and adults. The effect of ozone on germinating seeds was, also, evaluated.

The research on United States (US) European Union (EU) transatlantic trade and investment partnership (TTIP) was in its final year. The researchers tested for aflatoxins associated with peanuts and corn of SC farmers. One hundred ninety farmers were surveyed. A brochure was developed and distributed to the farmers. A questionnaire dealing with knowledge of aflatoxins was developed. A new protocol testing the effects of ozone on peanuts was conducted.

Clemson's Experiment Station Researchers are working on smart packaging to develop packaging so smart it can energize itself. Triboelectric energy harvesters convert mechanical energy to electrical energy, which is collected and used to charge rechargeable energy cells to power small electronic devices. The work will provide the foundation for technology for smart packaging and powering sensors to monitor products while they are transported.

2. Brief description of the target audience

The target audience included community leaders, agencies, policy makers, general public, limited resource families, food service managers, supervisors, food handlers, producers, commercial food handlers, processing and packaging industry, entrepreneurs seeking to start food businesses or improve existing food business, media and other marketing contacts, and publication outlets - doctors' offices and grocers.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	961	9402	1577	40859

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	2	2

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Licenses

Year	Actual
2018	0

Output #2

Output Measure

- Disclosures

Year	Actual
2018	0

Output #3

Output Measure

- Number of people completing educational workshops.

Year	Actual
2018	2297

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of participants reporting increased knowledge in safe food handling and applying practices learned.
2	Number of managers/supervisors/food handlers completing educational program and receiving a course certificate
3	Number of new or improved food products entering the market as a result of adopting recommended practices
4	Number of people reached through media outlets that utilize Extension food safety resources.

Outcome #1

1. Outcome Measures

Number of participants reporting increased knowledge in safe food handling and applying practices learned.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	1046

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Food is essential to life. However, food-borne illnesses can cause acute and chronic health problems. There is a need to improve food safety and food handling knowledge to decrease the likelihood of contracting a food-borne illness.

What has been done
Clemson Extension personnel conducted 88 workshops that related to safe food handling practices. Proper canning techniques were also taught throughout the state to homeowners.

Results
Of the 1,046 persons participating in workshops, 98% indicated a gain in knowledge.

4. Associated Knowledge Areas

KA Code	Knowledge Area
503	Quality Maintenance in Storing and Marketing Food Products
703	Nutrition Education and Behavior
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
723	Hazards to Human Health and Safety
724	Healthy Lifestyle

Outcome #2

1. Outcome Measures

Number of managers/supervisors/food handlers completing educational program and receiving a course certificate

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	325

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
According to public health and food safety experts, approximately 48 million individuals become sick each year from the consumption of contaminated foods. Research shows that consumers are aware of safe handling practices (i.e. 85% know they should wash their hands) but they don't follow recommended guidelines (i.e. only 65% of people do wash their hands). The needs to constantly communicate food safety messages is underlined by continued changes in food safety.

What has been done
Clemson Extension personnel conducted 31 ServSafe programs with 325 people in attendance representing 178 food establishments. The ServSafe program was administered across the state for food industry personnel.

Results
A total of 236 food service employees passed the ServSafe exam and earned a course completion certificate, representing a pass rate of 73%. The National Restaurant Association estimates that a food-borne illness outbreak costs $6,333. Therefore, the economic value of training to prevent food-borne illness outbreaks represents a potential savings of $1,127,274.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
723	Hazards to Human Health and Safety

Outcome #3

1. Outcome Measures

Number of new or improved food products entering the market as a result of adopting recommended practices

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	9

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Food entrepreneurs need knowledge on safety and wholesomeness of their products before they may sell them to the public. Their product must be in compliance with all local, state, and federal regulations. Moreover, food industry personnel who manufacture, process, package or distribute food are required by the FDA and SC Department of Agriculture to be certified in either HACCP (Juice, Seafood, Poultry or Meat) or HARPC (all other human food not covered by HACCP and apart of the Food Safety Modernization Act).

What has been done
The Food2Market program that assists food entrepreneurs in meeting the state and federal regulations and safety requirements necessary to produce and sell foods is ongoing. Food2Market personnel worked with the SC Department of Agriculture, SC Department of Health and Environmental Control and Clemson's Livestock Poultry Health Department to deliver regulatory information and requirements for foods produced and sold in state. A new 8-week online Food2Market program was launched. The program covered not only state and federal regulations but food safety planning, product testing, nutrition labeling, food processing, record keeping, traceability and recall as well as resources for business owners.

Results
Of the 33 people that registered for the Food2Market program, 27% went on to have their food product tested for sell on the market. Twenty three persons attended the in-person training. Evaluation results are being analyzed.

4. Associated Knowledge Areas

KA Code	Knowledge Area

502	New and Improved Food Products
503	Quality Maintenance in Storing and Marketing Food Products
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
723	Hazards to Human Health and Safety

Outcome #4

1. **Outcome Measures**

Number of people reached through media outlets that utilize Extension food safety resources.

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The Food2Market program was developed as a hybrid course. There is an 8-week online course followed by a one day in-person workshop. The program covered state and federal regulations as well as food safety planning, product testing, nutrition labeling, food processing, record keeping, traceability and recall. Twenty-seven percent of the participants had their food product tested in preparation to sell on the market.

Statistical analyses done on the rice weevil data obtained indicated a significant difference in the ozone effect on insect stages between any two depths. Complete adult mortality was recorded at the 5 cm depth immediately after ozone exposure. Mortality at 15 cm depth was about 70% and at the 25 cm depth, about 30% mortality was recorded 2 DAT. Fewer eggs at the 5 cm depth hatched compared to the corresponding control or eggs at the 15 cm or 25 cm depth. This was an indication of the need for longer exposure duration and/or ozone concentration for insects at deeper depths to be affected.

The results suggest TTIP would increase SC farm exports by $21.91 million per year as a result of complete tariff cut alone on SC agricultural exports to EU countries or by $49,983.94 on trade flows (exports + imports). It was found that the Netherlands,

Indonesia and Colombia were the top three destinations of SC agricultural exports. NAFTA has increased agricultural trade flows by $17.13 million in trade creation and $21.28 million in trade diversion. Taiwan and Hong Kong were among the top five destinations of SC farm products. The five countries account for over 53% of all SC agricultural exports to the world.

Also, the researchers conducted testing for aflatoxins associated with peanuts and corn of SC farmers. The results showed peanut samples 4p and 6p exhibited aflatoxin levels greater than 25 ppb as recommended by the USDA. Similarly, corn samples 2C, 11C and 14C, displayed levels greater than 25 ppb, thereby posing a health threat. Of the 190 farmers surveyed about their knowledge of aflatoxins, 58% reported they never heard of it, 26% indicated they somewhat knew about it, while only 16% definitely knew about it. The results indicated there needs to be more education regarding information about aflatoxins. A new protocol was developed testing the effects of ozone on peanuts. The protocol sought to explore the efficacy of using ozone as a deterrent for aflatoxin contamination of the crops. A one-page brochure was developed and provided to the farmers about aflatoxins. A research bulletin will be published and disseminated throughout the state.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Agribusiness and Community Development

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
601	Economics of Agricultural Production and Farm Management	5%	15%	0%	10%
602	Business Management, Finance, and Taxation	35%	10%	0%	10%
603	Market Economics	5%	15%	0%	10%
608	Community Resource Planning and Development	45%	10%	0%	20%
610	Domestic Policy Analysis	10%	5%	0%	0%
801	Individual and Family Resource Management	0%	10%	0%	10%
802	Human Development and Family Well-Being	0%	10%	0%	15%
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	0%	5%	0%	10%
806	Youth Development	0%	0%	0%	5%
903	Communication, Education, and Information Delivery	0%	20%	100%	10%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	10.0	7.0	7.5	5.0
Actual Paid	7.4	6.0	7.8	3.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
443863	381090	230644	559431
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
443863	381090	88205	559431
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	214887	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Clemson Extension Agribusiness and the Catawba Farm and Food Coalition developed a partnership with the Microsoft Corporate Campus in Charlotte, NC to pilot a wholesale buying program that serves an urban market while at the same time allowing rural farmers to expand into the wholesale industry. Agents also delivered the Steps to Becoming a Successful Entrepreneur Workshop which integrates business innovation and entrepreneurial learning for mid-career entrepreneurs and local leaders.

Annie's Project, a nationwide program, was delivered in SC to attract women into the farming and ranching business. The Colleton County Mobile Farmers Market was started to promote an increase in the consumption of fruits and vegetables among under-served communities, identify ways in which the Mobile Farmers Market can be sustained for future success, and increase sales of the local farmers. Agribusiness agents continued to serve existing farmer markets and to assist in the development of new markets.

The Experiment Station is becoming increasingly focused on local and regional food systems development as a marketing strategy for small-scale producers.

The 1890 research activities lead to the identification of current and potential small farm agritourism practitioners and the marketing challenges faced in developing and communicating agritourism experiences and resources. Marketing strategies and resources in procuring the financial support or technical expertise to further develop agritourism enterprises was identified.

The impact of macroeconomic factors on gross state products (GSP) was examined. A needs assessment of agribusiness and non-agribusinesses were surveyed in the counties of Orangeburg, Calhoun and Bamberg. The researcher used time-series data to assist in data collection. A research bulletin was prepared and submitted for publication.

The data envelopment analysis (DEA) research developed, presented and demonstrated the use of the goal programming (GP) model and data envelopment analysis framework to the supply chain design problem to help decision-makers who are responsible for supply chain planning and management activities. A case study was developed and demonstrated. A detailed bulletin of the project findings was submitted for publication.

A SC State researcher used an import demand model to examine whether an export credit, such as the U. S. general service management (GSM-102) program constitutes additionality in terms of cost savings to importing countries. The findings were published in a bulletin and submitted for publication.

Digital footprint data of 1500 small agribusinesses in South Carolina was conducted. An analysis of digital usage by different categories of agribusiness was examined. The research findings were documented in a bulletin for publication and distribution. Since the development of the Digital Lab in 2016, 10 businesses have been able to receive assistance through the lab and adopted digital platforms for connecting with their customers.

Real-time control or improvement of transient stability is very crucial for the secured operation of power systems. To overcome the serious drawbacks of the real-time local control strategies, the researcher introduced a completely new method of transient stability solely for the purpose of real-time local control of transient stability. Transient stability of the power system was controlled from the site of each individual generator. For a full analysis, the findings were published in a bulletin for dissemination.

2. Brief description of the target audience

The target audience included students, child care providers, limited-resource persons, community leaders, board/council members, nonprofit organization boards and groups, adults, youth, business and workforce preparation agencies and disadvantaged citizens and communities, state, federal, and local agency personnel, association members, citizens faced with public issues, and citizens engaged in economic and tourism development.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	4059	66476	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of publications and business plans.

Year	Actual
2018	18

Output #2

Output Measure

- Total number of people completing educational workshops.

Year	Actual
2018	5198

Output #3

Output Measure

- Number of business owners increased knowledge.
  Not reporting on this Output for this Annual Report

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Total number of people reporting increased knowledge in community improvement and development as a result of participation in CLED activities.
2	Number of participants engaged in agribusiness and community promotion projects

Outcome #1

1. Outcome Measures

Total number of people reporting increased knowledge in community improvement and development as a result of participation in CLED activities.

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Number of participants engaged in agribusiness and community promotion projects

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	2136

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Small farmers within the Catawba Region of South Carolina have historically lacked access to wholesale marketing channels. This lack of access stems from limited interaction with wholesale buyers coupled with a lack of education on the wholesale selling process (pricing, packaging, etc.). Without this access, farmers are missing out on a potential revenue stream for their farm business.

What has been done
Clemson Extension Agribusiness and the Catawba Farm and Food Coalition developed a partnership with the Microsoft Corporate Campus in Charlotte, NC to pilot a wholesale buying program. Farmers provide a volunteer wholesale program manager a list of products available for wholesale each week and the Microsoft Chef orders what is needed. Farmers bring each other's sold products to the campus on a rotational basis. While delivering the product, farmers are able to have a 'Farmer Table' to showcase their farm and sell products directly to Microsoft campus employees.

Results

Products produced in rural areas of South Carolina are being utilized in an urban corporate campus. New dollars are being infused not only to participating farmers but in their communities as well. Future plans are to reach other corporate campuses within the greater Charlotte, NC area.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
806	Youth Development
903	Communication, Education, and Information Delivery

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Public Policy changes
- Competing Public priorities
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Workshop surveys in the Feeding Innovation - Catawba program showed that participants increased their knowledge of how to increase exposure and reach of their farm business. Participants in the agribusiness programs in FY 2017-2018 reported a gain in knowledge (99.9%) and 57% states that they are utilizing the practices learned in programs.

A set of "best practices" in agritourism marketing was identified. These best practices were used as a training resource.

The research results implied that capital investment, export and education played a pivotal role in propelling South Carolina's economic growth both in the short and long term. Many farmers were not satisfied with their profits. With sales revenue being very small, many small farmers depended on off-farm jobs to supplement their income. Other issues the small farmers expressed included low market prices for their commodities, lack of storage facilities, lack of market access, high cost of labor, inadequate machinery and equipment, insufficient computer technology, lack of support by government and lack of knowledge in financial record keeping. The majority of non-farm businesses indicated that the top three critical success factors were knowledge of how businesses operate, skills in communication and good marketing strategies. Interpersonal skills ranked fourth. The research provided

the opportunity for five refereed journal articles to be published and twelve professional papers to be written and presented. In addition, a final research bulletin will be published and disseminated of the findings.

Capital investment, export and education played a pivotal role in propelling South Carolina's economic growth both in the short and long term. Non-farm businesses indicated the top three critical success factors were knowledge of how businesses operate, skills in communication and good marketing strategies. Five refereed journal articles were published and twelve professional papers were prepared.

A case study was developed and the researcher demonstrated the applicability of the innovative approach of combining the goal programming (GP) model into data envelopment analysis (DEA) method for biomass to biofuel supply chain (BBSC) design problem. The approach can help decision-makers evaluate various BBSC options and develop efficient and robust design schemes. The combined GP-DEA approach performs well and provides insight to academicians as well as practitioners and researchers. A bulletin will be produced for publication and distribution.

The researcher used an import demand model to examine whether an export credit, such as the U. S. general service management 102 (GSM-102) program constituted additionality in terms of cost savings to importing countries. The results indicated there were significant benefits in terms of cost savings to the importing countries as a result of the U. S. GSM-102 program. The results implied GSM-102 export credits increased the quantity exported, due to the shifting of the import demand curve to the right. It implied as the importing countries' budget constraints were relaxed through cost savings, they were likely to increase their imports. A more detailed report of the findings was submitted for publication and distribution.

The digital footprint data of the 1500 small agribusinesses in South Carolina presented some interesting results. Overall, only 33% of businesses were presently using a website for marketing their products and services. Furthermore, businesses situated in the I-26 corridor were more likely to have a website than the other areas. Since I-26 connects larger urban areas in SC, such as Charleston, Columbia and Greenville; businesses situated in the vicinity of the cities were more likely to be using digital marketing than businesses primarily located in dominantly rural counties. An analysis for digital usage by different categories of agribusiness revealed manufacturers of value-added items (bakery products, beauty products, condiments, etc.) used websites more often than farms operating agri-tourism or pick your fresh produce, dairies, meat and poultry, etc. Data analysis also revealed a difference in the digital self-proficiency of business owners that had websites and social media pages for their businesses and the ones that did not. Overall, businesses with no website evaluated themselves as less proficient, while dealing with technology than the ones that implemented technology in their day to day business operations. While, generally, older businesses tended to have more websites, older agribusinesses were still catching up with digital technologies. Based on the findings, fifty-eight percent of small agribusinesses that had been in the market for more than ten years had introduced a website only in the past one year. The number of times a website had been redesigned was dependent upon when the website was first introduced. The websites that had been introduced in the past five years had undergone no more than one redesign; whereas, websites more than five years old or more had undergone redesign or extensive updates averaging two or more. A more in-depth report of the research findings will be published in a project bulletin for distribution.

Electricity is essential for the proper operation of U. S. agriculture farms (crop and livestock production systems). Electricity is needed for the different farming processes. The research introduced a new method of transient stability solely for the purpose of real-time control of transient stability. With the proposed technique, transient stability of the power system was controlled (i.e. the power system was stabilized) from the site of each individual generator.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

4-H Youth Development and Families

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
801	Individual and Family Resource Management	5%	10%	0%	25%
802	Human Development and Family Well-Being	5%	10%	0%	15%
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	5%	10%	0%	20%
806	Youth Development	85%	70%	0%	40%
	Total	100%	100%	0%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	22.0	11.5	0.0	1.0
Actual Paid	31.2	9.0	0.0	1.0
Actual Volunteer	12.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
1016729	430821	0	325440
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1016729	430821	0	325440
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The 4-H youth development educational program is committed to assisting youth and adults in acquiring knowledge, life skill and attitudes that will enable them to become self-directing, contributing and productive members of society. The Clemson Extension 4-H program in South Carolina focuses on youth development in the areas of STEM, pets care, public speaking, leadership development, poultry genetics, shooting sports, service projects, citizenship, school gardening projects, nutrition, livestock rearing and showing, robotics, forestry, team building, and many others topics. These programs are designed to increase youth knowledge, invoke healthy lifestyle choices and prepare them as the future leaders. Skills taught in the 4-H programs across the state also help to improve self-confidence, reduce stress and anxiety levels, and stimulate brain development. Youth are provided skills needed to become well-rounded students. Training such as leadership, conflict resolution, stress management, financial management, social skills and diversity were conducted. Basic computer skills were taught.

County programs provided a wide variety of experiential educational opportunities and curricula through a number of different delivery modes such as clubs, short-term interest programs, camps, etc. dependent upon their personnel and budgets. Emphasis was on volunteer-led educational programming that provided productive youth/adult partnerships. In addition, statewide curriculum training for volunteers, staff and youth was provided for replication at the club and county levels.

At SC State, a committee that includes university departments, 4-H agents and industry is continuing to develop curriculum for the Stemulator activity which will include robotics, GSP/GIS, Aerospace, ATVs, biofuel programming, the power of wind and global food web. The 1890 program at SC State will continue to use the two 4-H Science Trailers throughout the state to reach additional youth in the area of science and technology. Each county is challenged to established new clubs to explore various aspects of science. These youth will attend the Clemson Student Investigators program.

At SC State, research was conducted challenging and encouraging African American males to be successful in mathematics. An after school tutoring/mentoring program, Saturday academies and summer mathematics enrichment were held. Workshops were held focusing on ACT and SAT preparation. Specific problem areas, such as word problems were addressed. A pre-test was given the first day of the program each summer. Real world applications and problem-solving was an essential portion of each lesson. A post-test was, also, administered.

Financially literate entrepreneurship was researched. Entrepreneurship and financial literacy training sessions were provided to approximately 50 high school students. A pre and post test were administered to the students as well as their parents/guardians.

The students of the research dealing with influences of music instruction on reading and music achievement were given a pre and post test. Comparisons were made on reading achievement and music achievement, based on grade levels.

2. Brief description of the target audience

The 4-H program will targeted all youth between the ages of five and eight, all youth between the ages of

nine and nineteen, parents and other adults interested in the development of South Carolina youth, parents and young adults ages 30-44, mature volunteers ages 45-64, grandparent and senior Volunteers ages 65+, adult learners (college students), and teachers.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	3770	1401533	100155	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	1	1

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of people participating in educational workshops conducted

Year	Actual
2018	79701

Output #2

Output Measure

- Total number of adult volunteers (including non-Extension staff) trained in club, school

enrichment, and special interest program delivery and management in all 4-H project areas.

Year	Actual
2018	3770

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of trained adult volunteers and staff, (including non-Extension staff) who teach subject matter and life skills to youth
2	Number of youth who gain knowledge in leadership and citizenship project areas
3	Number of youth participating in service learning projects for the community and to improve themselves, and help others.
4	Number of youth who gain knowledge and skills about plants, livestock and/or pets.
5	Number of youth who develop knowledge and skills in science, engineering, and technology (including electricity, computers, pontoon classroom, etc.).
6	Number of youth who gain knowledge in natural resources and shooting sports.
7	Number of youth who develop and improve communication skills through speaking and debating.
8	Number of youth increased knowledge in financial management.

Outcome #1

1. Outcome Measures

Number of trained adult volunteers and staff, (including non-Extension staff) who teach subject matter and life skills to youth

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	3770

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The 4-H Youth Development provides structured programs that engage youth in hands-on learning experiences while also providing development of essential elements of belonging, independence, mastery and generosity. However, this youth development program could not exist without caring adult volunteers. Therefore, there is a need for an effective system to develop volunteer trainers in 4-H Youth Development.

What has been done
Clemson hosts a statewide Volunteer Leader Symposium each year to help adults passionate about 4-H network with each other, gain valuable insights about programs and working with youth, as well as share updates about the 4-H program in South Carolina. In addition, leaders are trained on the local level. In FY 2017-2018, 3,770 volunteers were trained in the 4-H program.

Results
These volunteers make positive impacts on youth by providing them a caring learning environment. 4-H volunteers contributed an estimated 22,260 hours of volunteer service, representing around $502,616 in program support.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #2

1. Outcome Measures

Number of youth who gain knowledge in leadership and citizenship project areas

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	19181

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Youth have basic needs that include developing a sense that they are valuable, contributing members of their family and community. To meet this need, 4-H provides a structured program for teaching and developing leadership and citizenship skills. 4-H helps youth learn to serve more effectively in leadership roles at the club, county, state and regional levels.

What has been done
Clemson 4-H Youth Development provide opportunities for youth to participate in programs that develop and instill lifelong skills that will advance their knowledge in leadership and citizenship. Youth participated in 4-H State Congress, Ambassador Training, National 4-H Council and the 4-H Pinckney Leadership. The Pinckney Leadership Program, a premier youth development program in SC, hosted 72 sophomores and juniors in two week-long sessions that were held on the Clemson University campus. Additionally, four participants from a previous conference were selected to return and serve as group leaders from the new attendees. The SC 4-H Legislative Day offers youth an opportunity to tell their stories of the benefit of 4-H to state legislators.

Results
The Pinckney Leadership program provides youth with leadership experience and empowers them to become leaders in their own communities and to pursue higher education. The program also hosted a leadership camp that was held for 50 middle school students that introduce youth to the concepts of leadership in conjunction with a summer camp experience.

4. Associated Knowledge Areas

KA Code	Knowledge Area
803	Sociological and Technological Change Affecting Individuals, Families, and

	Communities
806	Youth Development

Outcome #3

1. Outcome Measures

Number of youth participating in service learning projects for the community and to improve themselves, and help others.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	4967

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Community service and self enrichment are important in youth development. Recent studies have shown that youth participating in 4-H program are four times more likely to contribute to their communities than youth outside of a 4-H program.

What has been done
In response to this need for structured learning and development, 4-H provided students with opportunities to plan, lead and participate in service learning projects. Students were engaged in Veterans Day blanket project and Christmas decoration projects. Youth gave over 3,132 hours of service making and distributing Christmas ornaments at local food shelters, volunteering at the Help4Kids Food Pantry, helping at the Florence Disabilities Board Thrift Store, providing supplies to the needy and elderly and preparing cards for veterans through Operation Gratitude.

Results
The service learning projects supported by donations help youth develop socially, mentally and civically. Youth were able to learn about cultural diversity, gratitude for military service and sacrifice, issues within their communities and leadership. Youth are more likely to be engaged in community programs, service and leadership as a result of their service learning projects. A total of $6,100 of in-kind donations were made to youth-focused service learning or community development projects. Youth service hours were valued at over $69,600.

4. Associated Knowledge Areas

KA Code	Knowledge Area

801	Individual and Family Resource Management
802	Human Development and Family Well-Being
806	Youth Development

Outcome #4

1. Outcome Measures

Number of youth who gain knowledge and skills about plants, livestock and/or pets.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	66476

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Research reveals that when children have hands-on experiences with nature, the results can lead to fewer incidents of anxiety and depression, improved self-esteem, enhanced brain development, and a sense of connectedness to the community and the environment. The biophilia hypothesis, as coined by E.O. Wilson, states humans have a need to feel sense of belonging in the natural world. Students participating in projects related to plants and animals can fulfill these innate needs.

What has been done
Youth were provided a wide array of program topics such as pet care and adoption, poultry genetics, county and state livestock shows, embryology development, and community/school gardening projects. Students competed in the Junior Beef Roundup program, the SC 4-H Small Garden Project, Junior Master Naturalists and Junior Master Gardeners programs. Partnerships were formed with non-governmental organizations, and local school and communities for establishing gardens. The School Gardening for South Carolina Educators program was present in 21 counties, at 106 schools, with 318 educators. Some 4,284 plants were distributed for the school gardens.

Results
Youth learned skills such as gardening, animal husbandry, livestock judging, and stewardship of livestock. Through the 4-H Pet Pals Clubs youth learned valuable care-taking skills. They learned how animals are feeling based on their behavior. They learned about basic physiological needs

(i.e. worming, fleas, etc.) of pets.

4. Associated Knowledge Areas

KA Code	Knowledge Area
802	Human Development and Family Well-Being
806	Youth Development

Outcome #5

1. Outcome Measures

Number of youth who develop knowledge and skills in science, engineering, and technology (including electricity, computers, pontoon classroom, etc.).

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	35534

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
4-H Science and Engineering programs encourage youth to pursue related fields as a career choice. Science and engineering affects not only technology such as computers, but it also impacts agricultural development, energy needs, community development and every other aspect associated with living. The 4-H program in South Carolina offers youth the opportunity to develop knowledge and skills in science, engineering and technology.

What has been done
4-H has been involved in the 4-H Engineering Challenge, Science on the Move, STEM Literacy Programs, ScienceFest and other curriculums designed to engage youth in science and engineering. A computer science grant through Google allowed 4-Hers to develop their computer science skills.

Results
The Google grant provided 30 Google Chromebooks, 20 Google Expedition sets and numerous STEM-based activity kits that teach programming, engineering, soldering and other computer related skills. Other 4-H activities also increased a youth's ability to problem solve, increase

critical thinking skills, practice deductive reasoning, and encourage creativity. 4-H youth are two times more likely to engage in science, technology and math during out-of-school times.

4. Associated Knowledge Areas

KA Code	Knowledge Area
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
806	Youth Development

Outcome #6

1. Outcome Measures

Number of youth who gain knowledge in natural resources and shooting sports.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	7004

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
As more and more youth are raised in urban environments, opportunities for exposure to natural resources conservation and the shooting sports is limited. Youth also have reduced opportunities for exploring nature. Research has demonstrated that children who are allowed to play outside are more likely to be future leaders, have decreased social anxiety and increased productivity in school.

What has been done
Youth have participated in shooting sports events as well as natural resources events. 4-H shooting sports programs were offered that covered firearm safety, hunter safety, Wildlife Food Plot projects, H2O camps, 4-H Forestry clinic, National 4-H Forestry Contest, recycling programs, 4H Training Project WET, Jr Naturalist Programs, shotgun teams, archery teams, Connecting Youth to Nature school programs, bee keeping, and other related topics.

Results
4-H partnered with non-governmental organizations, local, state and federal agencies to provide opportunities for youth to develop interest and skills in natural resources and the shooting sports. One student in the shooting sports program is now training for tryouts for the US Olympic Shotgun

Team in 2020. Youth have increased self-confidence, team player skills, greater understanding of soil, plant and wildlife interactions, and an increased appreciate for forests, forestry and forest wildlife.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #7

1. Outcome Measures

Number of youth who develop and improve communication skills through speaking and debating.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	474

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Youth need opportunities to develop assets such as good communication skills, organizational abilities, reasoning skills, and self-confidence. They have opportunities for such development through their participation in the 4-H Communication and Expressive Arts projects.

What has been done
Thirteen programs were conducted reaching 474 (ES-237) youth. Youth gave presentations and demonstrations during club and county level contests and gave speeches at community organizations promoting 4-H.

Results
Youth successfully prepared and gave presentations. They demonstrated good communication skills, organizational abilities, reasoning skills and self-confidence. Youth researched various topics and presented information.

4. Associated Knowledge Areas

KA Code	Knowledge Area

802	Human Development and Family Well-Being
806	Youth Development

Outcome #8

1. Outcome Measures

Number of youth increased knowledge in financial management.

2. Associated Institution Types

- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	702

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A 2017 study by the Program for International Student Assessment (PISA) showed that one in five (22%) of U. S. students lack basic financial literacy skills. Families, youth and children should be interested in making sound financial decisions to avoid fraud and mismanaging funds.

What has been done
Money Smart classes were delivered to students grades K - 12. The curriculum taught students the difference between needs and wants, short term goals versus long term goals and how to make a personal budget.

Results
As a result of the training, one hundred percent reported they gained knowledge and learned a new concept from attending the program. From the pre and post-test, 48% indicated they now understood the importance of credit. The students learned that rates are based on one's credit score. One participant realized he needed to open a bank account, in order to save money. He asked his mother to take him to the Credit Union to open an account.

4. Associated Knowledge Areas

KA Code	Knowledge Area
801	Individual and Family Resource Management
802	Human Development and Family Well-Being
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

806 Youth Development

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Economy
- Appropriations changes
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Almost 76% of youth in 4-H programs reported using practices learned. Clemson 4-H volunteers contributed over $502,000 in value, extending the reach of 4-H throughout the state. 4-H youth were engaged in programs that will build life skills and contributed to their communities through service learning projects. Many of these youth may go to college, choose a STEM career and make healthier lifestyle choices.

In the 1890 research study on African American males, the participants showed improvement on their post-test results. The average increase for the group was about 15 points. From the research, participants were able to identify various careers that were mathematics related, apply knowledge gained in mathematics related learning activities and make informed choices about high school and college paths regarding mathematics related fields. A research bulletin will be published and disseminated with the findings.

With the financially literate entrepreneurship project, 50 students and their parents/guardians gained knowledge and skill sets to improve their entrepreneurship and financial literacy potential.

The research on influences of music instruction on reading and music achievement showed Pre-K males performed better on the Brigance reading 4 year old pre-test than the 5 year old Brigance reading post-test. Males and females in the first grade did not differ significantly on any of the post-test reading achievement scores. The normality test was performed on MAP reading composite scores and the Iowa Tests of Music Literacy (ITML) rhythm standard scores of pre and post-tests. Data on both test were approximately normally distributed. A t-test revealed no significant difference for the rhythm test or the reading test.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 7

1. Name of the Planned Program

Nutrition and Childhood Obesity

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
701	Nutrient Composition of Food	0%	5%	0%	10%
702	Requirements and Function of Nutrients and Other Food Components	0%	5%	0%	15%
703	Nutrition Education and Behavior	50%	35%	0%	30%
723	Hazards to Human Health and Safety	0%	30%	0%	20%
724	Healthy Lifestyle	50%	25%	0%	25%
	Total	100%	100%	0%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	21.0	5.0	0.0	2.0
Actual Paid	12.4	2.5	0.0	1.5
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
389927	208823	0	431351
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
389927	208823	0	431351
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Clemson Extension and SC State conducted programs aimed at increasing nutritional awareness, physical activity and proper food preparation techniques by youth and adults. As school cafeterias move more toward "scratch-made" food in order to increase nutrition and improve diets, programs to teach these techniques are needed to train school cafeteria workers. The "Culinary Boot Camp" program is designed to increase awareness of nutritional requirements and teaches food preparation techniques, MyPlate, Dietary Guidelines and six basic nutrients. Clemson Agents also provided learning opportunities for senior citizens through programs that utilized a Nutrition Bingo game. Adult and youth audiences were taught basic nutrition, how to read nutrition labels, healthy lifestyles, food preparation for healthy cooking and healthy snacking. Cooking classes were offered for adults and youth across the state to promote increased nutritional intake and healthy choices. Classes such as Cooking Around the World, Senior Healthy Lifestyles, Cooking Matters, Nutrition Bingo, Kids in the Kitchen and others were utilized to help adults and youth increase their nutritional intake, physical activity and promote healthy lifestyles.

SC State had four research projects operating under the Nutrition and Childhood Obesity Planned Program. The study dealing with the reduction of cancer risk caused by obesity and metabolic syndrome used growth assays to establish that in pancreatic, lung and breast cancer cells, using combination treatment of drugs significantly inhibits cell growth. Basic experimental procedures (cell growth assays and Western analysis) outlined in the project were used. In order to obtain further proof, additional experimental procedures enzyme-linked immunosorbent assay (ELISA) were developed.

The investigation on food derived AGEs in relation to obesity and breast cancer demonstrated experiments were carried out using GC/MS spectroscopy procedure and SIM methodology to detect small amounts of the AGEs CML and CEL from female non-formalin fixed non-Hispanic white subjects of different age (56 - 85 years: BMI 15.235 - 26.814) and obesity (57 - 63 years: BMI 21.35 - 51.88) ranges. Control experiments using non-cancerous paired match samples from the same subjects were also analyzed using GC/MS and selected ions for CML, CEL and lysine trifluoroacetyl methyl ester derivatives. Each cancerous and non-cancerous ductal carcinoma samples were homogenized using hand held homogenizers, de-lipidated, the precipitates collected by centrifugation and the samples were hydrolyzed using 6M HCl and heating at 95˚C, 18h. The residues were esterified using methanolic-HCl at 65˚ (0.5 hour), evaporated using nitrogen blow drying process and converted into trifluoroactylderivative using TFAA as the reagent for the process.

The achievement motivation for child obesity prevention recruited students to participate in the research. The necessary consent forms and questionnaires were completed. Initial measurements were take, such as BMI (Body Mass Index), blood pressure, electroencephalogram (EKG), etc. The anthropological measurements and biofeedback training were provided regularly with the achievement motivation training. As an incentive, wireless head phones were purchased and given to participants. A new brain-computer interface was activated.

The research analyzing the role of high pro-inflammatory diets and childhood obesity collected preliminary data comparing the expression of the inflammation markers in non-cancer vs. prostate cancer DNA. Children were recruited to determine if obesity and/or high fat pro-inflammatory diets contribute to increased levels of pro-inflammatory markers and obesity related genes. One-on-one and group lab meetings were held.

2. Brief description of the target audience

The target audience included agencies that serve all income levels, including limited resource families and youth and general youth and adult audiences.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	8215	3589180	15203	40859

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	1	1

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of children and youth reached in healthy eating programs.

Year	Actual
2018	19763

Output #2

Output Measure

- Number of youth completing educational workshops.

Year	Actual
2018	19168

Output #3

Output Measure

- Number of youth gained knowledge in nutrition and fitness.

Year	Actual
2018	18417

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of people gaining knowledge as a result of participating in educational workshops.
2	Number of children and youth gaining knowledge in eating healthy foods.
3	Number participants reporting increase knowledge in safe food handling and nutrition.

Outcome #1

1. Outcome Measures

Number of people gaining knowledge as a result of participating in educational workshops.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	22731

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
South Carolina ranks 13th in the nation for rates of adult obesity and 2nd in the nation for the rates of obesity in children ages 10-17. These rates have increased dramatically in the last 30 years and are resulting in a higher prevalence of chronic problems and diseases related to obesity. For children, unhealthy weight, insufficient exercise, and chronic poor nutrition increases a child's risk of physical, mental, behavioral, learning and emotional problems in their childhood and lifetime. The total economic impact of obesity and associated chronic diseases has been estimated at $1.2 billion in South Carolina.

What has been done
Clemson Extension Agents taught 1,244 programs such as Cooking Around the World, Senior Healthy Lifestyles, Cooking Matter, Nutrition Bingo, Kids in the Kitchen, Culinary Boot Camp, and others were utilized to help adults and youth increase their nutritional intake, physical activity and promote healthy lifestyle. South Carolina took first place in the Great American Seafood Cook-Off:4-H Edition in New Orleans.

Results
Over 85% of participants stated that they gained knowledge by participating in the programs. With increased knowledge of nutrition and the importance of physical activity, long-term impacts will not be realized for a while but it is expected to lead to decreases in the occurrence of obesity in adults and youth and a decreased prevalence of Type 2 Diabetes.

4. Associated Knowledge Areas

KA Code	Knowledge Area
701	Nutrient Composition of Food
703	Nutrition Education and Behavior
723	Hazards to Human Health and Safety
724	Healthy Lifestyle

Outcome #2

1. Outcome Measures

Number of children and youth gaining knowledge in eating healthy foods.

2. Associated Institution Types

- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	802

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The State of Obesity reports have documented how over the past fifteen years, significant progress was made preventing obesity and stabilizing obesity rates, especially among children. By promoting better nutrition and increased physical activity in workshops and classes, the staff can see a decline in childhood obesity and an upswing in overall health.

What has been done
One hundred nineteen workshops/classes were taught stressing the importance of proper nutrition and regular physical activities. The five basic food groups, the six essential nutrients in everyone's diet, food safety and the importance of moving more and being active were implemented.

Results
The pre- and post-test were administered to the participants. There was an overall increase in knowledge of 43.9% of the participants. Of the 802 students in the workshops/classes, 352 students showed an increase of knowledge.

4. Associated Knowledge Areas

KA Code	Knowledge Area

703	Nutrition Education and Behavior
723	Hazards to Human Health and Safety
724	Healthy Lifestyle

Outcome #3

1. Outcome Measures

Number participants reporting increase knowledge in safe food handling and nutrition.

2. Associated Institution Types

- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	1577

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Foodborne illnesses are a very intense issue. Scientific research has found that there are currently over 250 different cases of foodborne illnesses. Some of the causes are bacteria, viruses, and parasites. It is estimated that 48 million people get ill from a foodborne illness each year. Out of the 48 million people, 3,000 will die. Between the years of 1998-2008, researchers found a total of 271,974 illnesses reported were related to foodborne illnesses. Children are not often exposed to proper food preparation techniques because of their caretaker's lack of knowledge of food safety and foodborne illnesses.

What has been done
SC State Extension provided its Healthy Lifestyles Program to families throughout South Carolina through a partnership with various community partners working with low-income families. A total of 1577 participants were reached. Wellness classes focused on teaching participants the importance of healthy food preparation and eating healthy. The eight-lesson series focused on teaching youth the importance of washing their hands before eating, handling food and how this can help reduce foodborne illness. Youth also participated in food preparation/tasting and exercise demonstrations to reinforce the information discussed in classroom lectures.

Results
To measure the student's retention of the topics covered, each student completed a pre and posttest assessment. The test evaluated the youth's knowledge of food safety and healthy food preparation. Eight hundred and two (802) youth reported knowledge gained from the review of the pre and post test, which was 50%. Six hundred and sixty-three (663) of participants indicated they

intended to implement skills learned during the workshops; 42%. Four hundred and nine (409) reported they had adopted the handwashing practices taught during the workshops; 26%. The results showed that the youth had gained an increased understanding of food safety nutrition and physical activity.

4. Associated Knowledge Areas

KA Code	Knowledge Area
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
723	Hazards to Human Health and Safety
724	Healthy Lifestyle

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Public Policy changes
- Competing Public priorities
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

In EFNEP, 92% of the participants improved in one or more nutrition practices. More than 77% improved in one or more food safety practices; 78% improved in one or more food resource management practices; 81% of participants increased the amount of physical activity; 97% of participants improved their diet; 46% increased fruit consumption; 48% increased vegetable consumption; and 47% increased consumption of calcium-rich foods. Through a series of lessons, 5,272 4-H EFNEP participants learned basic nutrition, the importance of daily physical activity, how to make healthy food choices and food safety in preparation and storage. Evaluation data show that at completion of the program 86% of the youth reported eating a variety of foods; and 59% improved practices in food preparation and safety.

The research on reduction of cancer risk caused by obesity and metabolic syndrome show that cancer cell lines used (two pancreatic carcinomas, small cell lung cancer and breast cancer) a spectrum of dependence on IGF-1 for tumorigenic activity, as evidenced by their sensitivity to the inhibitors used. The experimental procedures of the project allowed multiple undergraduate students to be exposed to experimental procedures in the biomedical technology field. The knowledge gained in the classroom and laboratory was used in identifying research targets in cancer drug therapy. A research bulletin was prepared for publication and distribution.

The project aimed at investigating the effects of obesity and age on the development and progression of breast cancer used experiments to define concrete answers. The experiments performed indicated the AGE CML and Ly components in the samples examined were easily detected by SIM GA/MS, but CEL components were present in lower amounts and were not easily detected in the samples so far analyzed. Further experiments are being studied. Analysis on ductal carcinoma breast cancer and non-cancer tissue samples were procured from the Bioserve supplier. The samples were processed and analyzed.

The SC State research staff on achievement motivation for child obesity prevention obtained NIH certification for working with human subjects. Head phones were given to the participants as an incentive to participate in the research.

In analyzing the role of high pro-inflammatory diets and childhood obesity, the researchers found there was a marked increase expression in the inflammation markers, Serum amyloid A and C-Reactive Proteins (SAA1 and CRP). The pro-inflammatory markers seen were directly correlated to diet irrespective of weight class (normal, overweight, obese). Survey analysis indicated many of the participants ate a variety of foods, both healthy and processed foods.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 8

1. Name of the Planned Program

Climate Change

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
132	Weather and Climate	0%	0%	50%	0%
205	Plant Management Systems	0%	0%	50%	0%
	Total	0%	0%	100%	0%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	5.5	0.0
Actual Paid	0.0	0.0	0.1	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
0	0	33790	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Mass spectrometry was used to quantify lipids of crops under stressed and non-stressed conditions. The identified lipid metabolic traits associated with stress tolerance will advance knowledge on physiological

basis of tolerance, and will prove useful to plant breeders and scientific communities in plant industry and other public and private sector institutes to develop stress tolerant varieties as they continue to adapt to the ever threatening heat and drought conditions.

2. Brief description of the target audience

The target audience include regulatory agencies, plant breeders and scientific communities in plant industry and other public and private sector institutes.

3. How was eXtension used?

eXtension was not used in this program.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Disclosures

Year	Actual
2018	0

Output #2

Output Measure

- Licenses

Year	Actual
2018	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Provide knowledge to policy makers to assist in coping with the effects of climate change, particularly in the coastal region.

Outcome #1

1. **Outcome Measures**

Provide knowledge to policy makers to assist in coping with the effects of climate change, particularly in the coastal region.

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Public Policy changes
- Competing Public priorities
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Each research project, and its respective program, sets a series of objectives to be accomplished. The situation is presented at the time the research begins and changes are reported during the conduction of the research and at its conclusion. An internal review committee meets with researchers and teams of researchers on research projects and research programs within the planned program areas. The intent of the research effort is identified, as are the anticipated outputs and outcomes. Measures would include new knowledge developed, disclosures, patent applications, patent awards, license agreements, publications and other selected measures, as appropriate.

Key Items of Evaluation

V(A). Planned Program (Summary)

Program # 9

1. Name of the Planned Program

Sustainable Energy

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
123	Management and Sustainability of Forest Resources	100%	0%	30%	0%
402	Engineering Systems and Equipment	0%	0%	50%	25%
403	Waste Disposal, Recycling, and Reuse	0%	0%	0%	50%
511	New and Improved Non-Food Products and Processes	0%	0%	20%	25%
	Total	100%	0%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	4.0	0.0	2.5	0.0
Actual Paid	1.0	0.0	2.3	1.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
36450	0	62466	118273
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
36450	0	51885	118273
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	10749	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Clemson Extension conducted programs in the areas of urban tree care and production. Urban trees help to reduce air pollution, assist with storm-water control, provide carbon storage, improve water quality and reduce energy consumption.

Clemson researchers investigated and developed sustainable technologies to convert biomass resources into chemicals, energy, materials and other value added products with the goal of carbon drawdown, and established new efficient ways for the production of biodiesel from cottonseed oils was accomplished using enzyme technology.

An SC State researcher looked at reusing post-consumed (PC) plastics for solvent extraction of resins and other reprocessing. The resin was recovered by precipitation in methanol and the solvents were recovered by fractional distillations. The recovered resin was dissolved and precipitated again for maximum purity. The resins were dried under vacuum for a week and cauterized by thermogravimetry, differential scanning calorimetry. PC polyethylene was converted to rods useful for 3-D printing and hot-glue. PCPs were collected, washed and cut into small sizes, then air dried for further uses.

2. Brief description of the target audience

All consumers in the state will benefit from research and education programs related to lower cost energy options.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	261	14833	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	2	2	4

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Disclosures

Year	Actual
2018	0

Output #2

Output Measure

- License agreements

Year	Actual
2018	0

Output #3

Output Measure

- Number of people completing educational workshops

Year	Actual
2018	90

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of people reporting knowledge gained in sustainable energy and land management and diversification strategies.

Outcome #1

1. Outcome Measures

Number of people reporting knowledge gained in sustainable energy and land management and diversification strategies.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	75

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Biodiversity is the foundation of healthy ecosystems and is essential to human and environmental well-being. Healthy ecosystems in urban environments are equally important as in more natural areas. One important component of urban environments is urban trees and the ecosystem services they provide.

What has been done
An Arbor Day celebration was hosted by an Extension Specialists to highlight the importance of urban trees. Topics discussed at this program included proper tree selection, planting, and maintenance along with the ecosystem services provided by urban trees. Clemson Extension agents also provided on-site assessment and guidance for private citizens, local communities, cities and government offices. Local newspaper and other media outlets were utilized to increase awareness, value and proper care of urban trees.

Results
Urban trees if properly maintained have the capacity to reduce air-pollution, provide storm-water control, store carbon, improve water quality in urban watersheds and reduce energy consumption. Urban trees may have a cooling effect, thereby reducing energy consumption requirements by homeowners and business owners. Carbon emissions may also be absorbed and stored permanently in the trees, even after death, thereby helping to reduce emissions. Finally, urban trees also have a social benefit by providing aesthetic beauty and reducing the look of an urban community as being a concrete oasis.

4. Associated Knowledge Areas

KA Code	Knowledge Area

123	Management and Sustainability of Forest Resources
402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Public Policy changes
- Competing Public priorities
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Two peer-reviewed publications were submitted and accepted on tree characteristics favorable to urban environments and one ornamental trees that become invasive. An Arbor Day Celebration was hosted that highlighted the importance of urban trees and their value to communities, sustainable energy and their contributions to a healthy urban environment.

In the SC State resins research, a setup to melt and recast post consumed plastics to rods and filaments was designed. The instrument was built and tested successfully. A mold was made to produce insulated cement block for construction. Ten samples of gravels were replaced with PC-EPS (expanded polystyrene). It was prepared and tested for mechanical strength and thermal conductivity. A peer-reviewed journal was accepted for publication.

Key Items of Evaluation

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V(A). Planned Program (Summary)

Program # 10

1. Name of the Planned Program

Global Food Security and Hunger

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	10%	10%	15%	10%
204	Plant Product Quality and Utility (Preharvest)	10%	20%	15%	15%
205	Plant Management Systems	15%	20%	0%	20%
211	Insects, Mites, and Other Arthropods Affecting Plants	0%	0%	20%	0%
212	Pathogens and Nematodes Affecting Plants	25%	0%	15%	0%
213	Weeds Affecting Plants	10%	0%	0%	10%
216	Integrated Pest Management Systems	20%	20%	35%	15%
601	Economics of Agricultural Production and Farm Management	5%	30%	0%	10%
701	Nutrient Composition of Food	5%	0%	0%	20%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	30.0	8.0	33.5	1.0
Actual Paid	35.0	7.0	34.6	1.0
Actual Volunteer	15.5	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
1340729	294927	2738908	164814
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1340729	294927	3009358	164814
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	5801972	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Clemson Extension agents assisted farmers, landowners, and other stakeholders in the areas of food security and hunger. There were seven counties throughout the state that met to discuss natural disaster preparedness and procedures for agriculture disasters. Topics were discussed that covered livestock as well as pet shelters during natural disasters. Clemson Extension specialists also presented information at the SC Emergency Management Annual Conference in Myrtle Beach, SC. Discussions included the SC Veterinary Reserves and on SC ESF17, which is the South Carolina Emergency Operations Plan for Animals and Agriculture in SC. Agents attended meetings with County Emergency Response Teams (CERT) to plan how they could assist County Area Response Teams (CART) during times of natural disaster as related to livestock and animal health. A program was held to educate producers and the industry about the Mid Atlantic Secure Milk Supply (SMS) program which was developed to protect and minimize the operational and economic effects of diary operators in SC in the event of a Hoof and Mouth Disease outbreak. As a results of this program, 13 dairy farms in the process of developing biosecurity plans.

Agronomic crops agent conducted 302 programs statewide with a total of 7,253 people attending these programs. As a result of the workshop, 94% reported an increase in knowledge. Information on various crops such as corn, soybeans, grain sorghum, peanuts, sweet potato, cotton and others was discussed during this workshop. Agents provide information on each crop such as yields, growing condition requirements, varieties and other pertinent information so that farmers may make an informed decision about which crops to plant. Information and training on pest identification as well as pest control is also commonly discussed in workshops along with pesticide applicator training. Variety trials were conducted through the Official Variety Testing (OVT) program. All major row crops (except peanuts and tobacco) were tested at locations throughout the state. Extension agents assist with on-farm locations for some of the crops based on location.

Clemson Extension also provided training for pesticide applicators. The pass rate for the pesticide applicator exam was 89%. Topics discussed during the pesticide training was pesticide record keeping, personal protective equipment for safe pesticide application, calibration of liquid and dry pesticide equipment, and pesticide use in field crops common to the area.

An investigation of alternative sources of vegetable oil from non-edible plant seeds for biodiesel production was conducted at SC State. The identified seeds: peanut, soybean, morning glory, purple cornflower, pecan, black-eyed susan, bachelor-button-cornflower and wild sunflower. Others seeds included: lavender, shasta daisy, blue flax, California dreaming, impatiens, four o'clock, butterfly milkwood bird's foot trefoil and zinnia. The physical and chemical properties of the seeds including: yields, densities,

iodine numbers, viscosities and their flow properties were determined. A new mathematical model for fitting viscosity data was developed, since the existing models produced large inaccuracies in the region of interest (lower temperatures).

The research on a Social Worker's role in improving food insecurity to promote healthy student development through school-based services collected canned goods and non-perishable food items. Parents and students were administered surveys. A Pantry Pals Culinary Camp was developed. The students were taught how the garden provides produce for food demonstrations and meals. Hands-on demonstrations were held. The participants used "chromebooks" to research where different food comes from. A partnership was established with a local dentistry to demonstrate the importance of good oral health and hygiene.

As Experiment Station research continues on peach trees, we determined that different ripening seasons had different nutrient allocation patterns, and the amount of nutrients removed through each event differed among peach trees of different ripening seasons. Overall, early-season peach trees are capable of accumulating and mobilizing more nutrients back to the branches, trunks and roots during the period between postharvest and leaf senescence, meaning early-season peach trees might need less fertilization than what is often applied.

2. Brief description of the target audience

Research in this program has the potential to benefit growers, state, federal and international agencies dealing with food production and distribution and with end users in countries around the world. The target audience includes producers, Limited-Resource farmers and Extension personnel, agency personnel, producers, master gardeners, and growers.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	69266	1176505	9	12

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year:	2018
Actual:	2

Patents listed
Plant Propagation System and Method
Electro-Mechanical Controller for Adjusting Pump Stroke On The Go

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	25	25

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Disclosures

Year	Actual
2018	0

Output #2

Output Measure

- Licenses

Year	Actual
2018	0

Output #3

Output Measure

- Number of people completing educational workshops

Year	Actual
2018	16126

Output #4

Output Measure

- New Variety Releases

Year	Actual
2018	0

Output #5

Output Measure

- Number of youth participating in 4-H food systems programs

Year	Actual
2018	141

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of people reporting increased knowledge in agronomic practices that are environmentally sensitive and economically efficient.
2	Number of youth gaining knowledge of food systems
3	Number of producers indicating adoption of recommended agronomic crop production practices
4	Number of Master Gardeners applying skills learned and reporting activities.

Outcome #1

1. Outcome Measures

Number of people reporting increased knowledge in agronomic practices that are environmentally sensitive and economically efficient.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	15246

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Crop pests, which includes insects, weeds and diseases, can cost producers considerable expense, which decreases profitability. One way to lower chemical application costs is to scout for pests and apply herbicides only when the pests are at an economic threshold. Integrated pest management can be a beneficial management technique but many farmers may not be aware of how to implement a program.

What has been done
Clemson Extension conducted classes on the establishment and use of integrated pest management strategies. Topics covered included type of environment (greenhouses, farms, etc.), how to properly use biological controls and their place in programs, as well as, using scouting and monitoring properly. Classes were also held on scouting for pests in fields and how to determine economic thresholds for chemical application. Dicamba training, which is a chemical that can be used in conjunction with glyphostae to combat resistant weeds, was also conducted to teach proper application techniques to save money, for personal protection, and for environmental protection.

Results
Farmers that participated in Clemson Extension programs reported an increase in knowledge following the programs. Of those reporting a gain in knowledge, over 62% reported implementing the practices learned as a result of Clemson Extension programs. Implementation of new practices should lead to increased yields and decreased production costs for producers.

4. Associated Knowledge Areas

KA Code	Knowledge Area

203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
216	Integrated Pest Management Systems
601	Economics of Agricultural Production and Farm Management
701	Nutrient Composition of Food

Outcome #2

1. Outcome Measures

Number of youth gaining knowledge of food systems

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	141

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Nutrition is important for growth and development in youth. However, many youth aren't always exposed to environments where healthy food choices are encouraged. Proper nutrition can influence long-term health and reduce chronic diseases. In addition, youth do not always make the connection between food supply chain and healthy food choices.

What has been done
The School Gardening for SC Educators program provides opportunities to allow youth to become involved in growing a garden and then harvesting the food for consumption. To date over 850 educators have been trained on school gardens principles and practices with over 157 school gardens implemented in 22 counties throughout the state of SC.

Results

Clemson Extension and Clemson 4-H partnered with MUSC Children's Health Center, the College of Charleston and Boeing to continue to expand the School Gardening for SC Educators program. In recent studies, children that participated in 4-H programs were two times more likely to make healthier choices. By reaching students through this in-school program, the potential audience of children should be in the long-term a cohort of students making healthier choices. This program also shows students how they can create their own gardens at home, thereby helping to fill the need for fresh food in traditional food deserts.

4. Associated Knowledge Areas

KA Code	Knowledge Area
701	Nutrient Composition of Food

Outcome #3

1. Outcome Measures

Number of producers indicating adoption of recommended agronomic crop production practices

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	9490

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Increased production is an important consideration when planting varieties of crops. However, early pest detection and treatment/control are also important for expected yields in crop production.

What has been done
Variety trials were conducted and presented at various locations throughout the state. These workshops presented information on planting, expected yield and other considerations in crop production. Workshops were also conducted that discussed disease detection as well how to handle herbicide resistant weeds.

Results
Farm visits by Clemson Extension agents to collect leaf samples at two different times of the year identified an outbreak of rootknot nematodes. The Clemson Extension agent determined that it was likely due to planting a nonresistant soybean variety. Because of the flooding in 2015, there

was a shortage of resistant varieties and therefore, only nonresistant varieties were available. This lead the Extension agent to conduct training with other soybean producers on proper equipment cleaning techniques between fields to decrease the likelihood of contamination between fields. Clemson Extension Agents also conducted workshops to educate producers on Dicamba, which is a herbicide formulation that can be combined with glyphosate and glufosinate to combat herbicide resistant weeds. However, farmers who utilize Dicamba must follow very strict guidelines. The workshops offered by Clemson Extension help farmers to understand and apply this information on Dicamba application. These workshops should lead to increased yields and better plant growth through control of diseases and weeds.

4. Associated Knowledge Areas

KA Code	Knowledge Area
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
216	Integrated Pest Management Systems
601	Economics of Agricultural Production and Farm Management

Outcome #4

1. Outcome Measures

Number of Master Gardeners applying skills learned and reporting activities.

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

As a result of efforts by Clemson Extension personnel, of the producers that reported a gain in knowledge, 62% of producers reported implementing the practices they learned. This implementation of practices may lead to reduced costs for producers and increased yield. The economic gains may lead to a reduction in stress and anxiety in producers, thereby increasing their quality of life. While the economic gain and social impacts are important, if producers are able to reduce the amount of pesticides applied, it will also reduce negative impacts of the environment. With a reduction in chemicals, there is a lower threat to water quality, a reduced negative impact on non-target species, and less leaching of chemicals into the soil. Of the 302 total agronomic crops programs conducted statewide, 94% of the participants reported an increase in knowledge.

The research investigation of alternative sources of vegetable oil from non-edible plant seeds produced biodiesel from a few of the seed oils. Six of the oils extracted were used to produce biodiesel, experimentally, in the laboratory. The oils were lavender, California dreaming, blue flax, black-eyed-susan, wild sunflower and bachelor button-cornflower. The research findings will be published in a research bulletin.

Research dealing with a Social Worker's role in improving food insecurity received donations from community and SC State partners to provide food back packs to a total of 167 students. Three project sites established school gardens. A "Farm to Table" (farmer's market) was completed. All the produce that was grown in the project sites school gardens were collected and sold to the parents and SC State faculty and staff.

For FY18, the Clemson Experiment Station received a total of $5,000 in royalty money from Amadas for technologies 2014-103 and 2016-049 which resulted in a net balance minus fees of $4,207.84.

Key Items of Evaluation

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
17389	Number of children and youth who reported eating more of healthy foods.
Climate Change (Outcome 1, Indicator 4)	
0	Number of new crop varieties, animal breeds, and genotypes whit climate adaptive traits.
Global Food Security and Hunger (Outcome 1, Indicator 4.a)	
10384	Number of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources.
Global Food Security and Hunger (Outcome 2, Indicator 1)	
0	Number of new or improved innovations developed for food enterprises.
Food Safety (Outcome 1, Indicator 1)	
1	Number of viable technologies developed or modified for the detection and
Sustainable Energy (Outcome 3, Indicator 2)	
0	Number of farmers who adopted a dedicated bioenergy crop
Sustainable Energy (Outcome 3, Indicator 4)	
0	Tons of feedstocks delivered.