2018 North Carolina A&T State University and North Carolina State University Combined Research and Extension Annual Report of Accomplishments and Results

Status: Submitted

Date Submitted: 04/01/2019

I. Report Overview

1. Executive Summary

NC State and North Carolina A&T State universities make discoveries, improve them, teach them and pass them on so North Carolina succeeds. We put science and technology into action at field labs, research stations and Extension centers across the state. We improve N.C.'s top crops and their production methods to fuel N.C.'s economy. We also conduct research and extension work that improves our state's environment, enhances health and enriches people's lives. The work outlined here represents the research and extension accomplishments achieved in 2018 by the two land-grant institutions. The report emphasizes high-priority areas that affect the lives and livelihoods of agricultural and life sciences businesses, farms, adult and youth citizens, families and communities.

RESEARCH

The North Carolina Agricultural Research Service (NCARS) is the research arm of NC State's College of Agriculture and Life Sciences, and the Agricultural Research Program serves that role for NCA&T's College of Agriculture and Environmental Sciences. Both serve interests in agriculture as well as environmental, biological and life sciences while also providing the scientific base for academic and extension programs.

NC A&T's Agricultural Research Program

Fiscal Year 2018 was another highly productive year for CAES researchers. The work summarized here represents accomplishments from projects involving 25 research scientists.

Global Food Security - Plant Production Systems and Health

Research focused on advancing the emergent hemp industry by looking at best production practices to share with NC growers; developing a local cultivation protocol involving micropropagation for producing ginger plants (which grow tropically outside the continental U.S.); extending the growing season for organic strawberries using high and low tunnel production systems; reducing pest damage to organically grown apples and vegetables using natural (non-synthetic) pesticides and certain agronomic treatments; and applying commodity pricing analysis for assisting in policy planning to help guide direction of agricultural enterprise and production.

Global Food Security - Animals and Their Systems, Production and Health

The research for this NIFA focus area addressed development of a protein marker approach to identifying the immune system's response to disease pathogens in ruminants; isolating segmented filamentous bacteria from healthy weaned piglets that can be populated in the intestinal track to reduce post-weaning diarrhea -- a frequently fatal condition in newborn pigs; incorporation of spray-dried plasma supplementation to boost the immunocompetence in broiler chicks; and the contribution of value-added dairy production enterprises (such as cheese production) to supplement incomes of NC goat herd dairy farmers.

Sustainable Energy and Biotechnology

Research addressed development of an environmentally positive system (reducing CO_2 emissions) for

creating biochar-based functional materials from biomass. The researchers produced biochar from biomass sources that they converted into a raw material for low-cost high-performance materials for production of supercapacitors. Research is also underway to develop an efficient recovery system of energy, nutrients and water from agricultural and food wastes for sustainable agricultural production. The system in development will cover the processes involved with conversion of biogas to syngas, production of biochar from AD digestates, and conversion of biochar into fertilizers. To date, the researchers have a prototype anaerobic digestion process that uses a two-stage thermophilic anaerobic co-digestion process that extracts biogas/methane from corn stover.

Childhood Obesity
This focus area was addressed through nutrition education workshops to help residents living in underserved food desert communities adopt healthier eating habits. The workshops have focused on adoption of healthier food preparation and food selections, such as including more fresh produce in their diet and restricting the use of sugar and salt as well as increasing knowledge about the role of macro food nutrients in the diet. Another project examined the potential of faith-based settings as a connection portal for health promotion among older African American adults. Researchers observed changes in participants' recognition in the importance of healthy food (gardening, shopping, preparing, eating), physical activities, and the relationship between spirituality and healthy eating. In addition, ministers/clergy also adjusted/adopted a more health-centered approach in their sermons and daily teachings. A third project is exploring development of a new edible fried food coating process that could have substantial impact on individuals' choice of lower fat healthier food alternatives. The researchers are focusing on developing a coating that will retain less oil from the frying process and provide a healthier coating batter (sweet potato starch vs. corn starch).

Food Safety
In this NIFA focus area one group of NC A&T researchers are exploring local strains of L. bulgaricus as new sources for yogurts preferred by American consumers and as a financial benefit to the dairy industry. Another project is exploring the potential of using an oral immunotherapeutic approach to hypersensitivity to peanuts. To date there is no medically approved treatment for peanut allergy; this project has the potential for developing an approach that could increase the threshold of sensitivity allowing safer exposure to peanuts.

Human and Community Development
One project in this area addressed what senior renters need to age in place. Many elderly renters face challenges relating to their health and financial conditions and obstacles to independent living. Researchers found that these factors include unaffordable housing, unsupportive home environments, and a lack of support resources that limit housing options for older renters who wish to remain and age in place.

NC State's N.C. Agricultural Research Service
NCARS' mission is to develop knowledge and technology needed to improve productivity, profitability and sustainability of industries in agriculture and the life sciences; conserve and improve the state's natural resources and environment; improve the health, well-being and quality of life of North Carolina's citizens; and provide the science base for academic and extension programs. To overcome grand challenges in agriculture and life sciences, scientists frequently work with cross-disciplinary partners in academia, government and industry. Interdisciplinary research is among our hallmarks. Scientists and engineers in 12 CALS departments collaborate with partners in five NC State colleges and with NC A&T's College of Agriculture and Environmental Sciences. At the North Carolina Research Campus in Kannapolis, NCARS scientists with the Plants for Human Health Institute work among colleagues from UNC-CH, UNC-G, UNC-C, NCCU, NCA&T, ASU, Rowan-Cabarrus Community College and Duke University.

NC State scientists also have access to 10 field laboratories with extensive animal and crop research

capabilities, as well as facilities for agricultural and municipal waste management research. Eighteen research stations located strategically throughout the state support more than 1,200 acres of plot research, as well as field days and other events that host over 22,000 people a year. CALS also has research and extension centers with resident faculty and staff members at Plymouth, in the eastern part of the state, and Mills River, in the west. Another key off-campus site is the Center for Environmental Farming Systems in Goldsboro, a partnership of NC State, NCA&T and the state agriculture department, CEFS specializes in sustainable agricultural research and extension.

On-campus facilities include highly specialized laboratories for molecular imaging, soil analysis, and X-ray crystallography); greenhouses; the Phytotron controlled environment facility; the Pesticide Residue Laboratories; the Animal and Poultry Waste Management Center; the Feed Mill; the Structural Pest Training Center; the Genomic Sciences Laboratory; the Plant Transformation Laboratory; the Bioinformatics Research Center; the Food Rheology Lab; the Nuclear Magnetic Resonance Facility; the Structural Biochemistry Resource; the Plant Disease and Insect Clinic, and Food Processing Pilot Plants. Program highlights, by area, include the following:

Global Food Security - Plant Production Systems and Health
Through the North Carolina Plant Sciences Initiative, NC State is making major strides building on its strength in plant sciences. Construction of a research building has begun, and teams of scientists, engineers, economists and other scholars from across campus are competing for $650,000 that the university will award over the next 3.5 years for three project teams. It's envisioned that one award will be made in each of the initiative's research platform areas: plant improvement, data-driven agricultural biosciences and resilient agriculture and food systems. Other 2018 research related to plant production systems and health yielded these and many other accomplishments:
Identification of a lineage of the fungus A. flavus that could be key to developing successful biocontrol methods to reduce cancer-causing aflatoxin levels in crops.
Generation of new knowledge about alternative crops, such as hemp, stevia and miscanthus, and their potential for N.C. growers.
Analysis of using banding fertilizer on both sides of corn rows in a 2x2x2 configuration to increase yields. Corn growers embraced this approach, resulting in an $11 million income increase in 2018.
Dissemination of a calculator that helps growers select best-performing cotton varieties for their growing conditions.

Global Food Security - Animal Production Systems and Health
Food animal production accounts for 60 percent of NC's agricultural industry. To better serve the animal agriculture sector and meet growing global demand for protein-rich foods, CALS has joined with the College of Veterinary Medicine in a Food Animal Initiative. The goal: establishing North Carolina as the world leader in food animal biosciences. In 2018, CALS made significant strides in food animal research. Researchers are, for example, using genomic, proteomic and bioinformatic technology to discover the disease mechanisms of two infectious viruses posing a significant threat to the poultry and pork industries. Once the researchers identify host and viral genes associated with pathogenesis, they can be used to develop safer vaccines and more effective control strategies and to breed resistant or tolerant animals. Meanwhile, working with the North Carolina Pork Council and the National Pork Board, NC State is developing management strategies for improving sow longevity and creating a proactive physiological test for sow longevity. Sow retention rates have doubled in the past four years on farms that have adopted neonatal management strategies for replacement gilts.

Climate Change
In the face of climate change, weather variability, and the continuous decline of agricultural land and water resources, effective agricultural water management is critical to feeding a growing world population. NC State is developing innovative and transformative water management techniques to increase crop resilience and reduce the transport of nutrients and sediment from agricultural lands to receiving surface

waters. Accomplishments in this area are as follows:
An NC State research team has designed and demonstrated a new generation of smart water control structures that minimize the time and cost of drainage water management. The team continues to investigate the effects of water management on crop yield and nutrient export to surface waters. Supplemental irrigation during dry periods in the growing season could increase corn yields by more than 20%, and sub-irrigation during dry periods could increase soybean yields by more than 30%.
Scientists have developed a high-volume, low-pressure irrigation system to protect blueberry blooms and berries from spring freezes. Although these systems are expensive, most growers have realized that such systems can pay for themselves in a single night of freeze protection. Over 85% of NC blueberry fields are now protected by overhead irrigation, which has decreased the impact of spring freezes on blueberry crops and also increased yields.

Sustainable Energy, Including Biotechnology
NC State scientists are investigating the production of bio-based products--such as enzymes, biochemicals, and biofuels--from agro-industrial residues and dedicated biomass crops. Among the 2018 results:
Demonstration of value-added products from the sweet sorghum crop through ensilage and feedout studies at NC State field labs.
Evaluation of a variety of bale storage methods for compositional changes, with results showing promise for storage solutions for biomass feedstocks in the Southeast.
Elucidation of cultural management and crop development needs for camelina crop production as a fuel feedstock and winter cover in NC.
Progress in developing a synthetic carbon dioxide fixation cycle for camelina and algal bioreactor systems to enable conversion of microalgal fatty acids and lipids into fuel.
Demonstration that lignocellulose-degrading microorganisms isolated from the guts of wood-eating insects can potentially be a cost-effective means of converting agricultural residues and paper pulping waste into feedstock for fuel and commodity chemical production.

Food Safety
The U.S. Department of Agriculture estimates that foodborne illnesses lead to 3,000 deaths and cost the economy more than $15.6 billion each year. At the same time, food allergies are estimated to cost $25 million per year in the US. Research at NC State worked to reduce these illnesses and their associated costs. Food safety is also a key research area for the university's food manufacturing and processing initiative. A North Carolina Food Innovation Laboratory at the NC Research Campus in Kannapolis is under construction, with completion expected in the summer of 2019, with plans for a grand opening in October. The lab grew out of an ongoing partnership of the university, the North Carolina Department of Agriculture and Consumer Services and the North Carolina Department of Commerce/Economic Development Partnership of North Carolina. It is designed to support food processing and manufacturing of North Carolina commodities within our state.

Human Health, Nutrition, and Well-Being
Through its Plants for Human Health Institute and other programs, NC State is working to enhance human health through the production of nutritious food crops and healthy animals. Here are three examples from 2018:
Stevia is one of few crops that can serve as a natural healthier alternative to cane sugar, but over half of the population does not like the taste of the standard varieties. NC State has released a total of 31 improved varieties that not only provide a new taste profile for consumers but also exhibit high yields, rapid growth, and adaptation to NC's climate.
Amid mounting public concern, the federal government has enacted regulations to significantly reduce the use of antibiotics for growth promotion in poultry, and most antibiotics of concern will be managed in feed milling operations by veterinary feed directives. NC State researchers have identified several substances and feed formulations with a demonstrated ability to improve resistance to pathogens that

threaten human and animal health. All of the large integrated poultry production companies, as well as a few independent poultry producers in NC, have replaced antibiotics with alternative feed additives and production strategies.
Cancer, diabetes, autoimmune diseases, and many other common human illnesses are associated with the dysregulation of protein kinases. NC State scientists are elucidating the mechanisms of interaction between kinases and their substrates and regulators. Several important interactions have been identified, and pure forms of protein complexes have been isolated and reproduced in the lab. The knowledge gained could pave the way to effective clinical and pharmacological tools for disease diagnosis and treatment.

EXTENSION
The knowledge and technology developed through NCARS and ARP are delivered directly to North Carolina farmers, families and citizens through Extension programs emanating from NCA&T and NC State. The mission of N.C. Cooperative Extension -- a strategic partnership of the two university Extension units, along with federal, state and local governments - is to help people put research-based knowledge and technology to work to foster economic prosperity, environmental stewardship, and improved quality of life. To achieve this mission, Extension professionals at the state's two land-grant universities work with field faculty stationed in all 100 North Carolina counties and with the Eastern Band of Cherokee Indians. To maintain relevance and value in its programs, Extension benefits from the input of a well-established statewide system of lay advisers, who represent the state's diverse population. Each county periodically conducts an environmental scan to determine emerging needs and appropriate educational responses. These scans give residents, advisers, commodity group representatives, volunteers, and other clients an opportunity to ensure that local programs meet local needs and priorities.

NC State Extension
In 2018, NC State Extension continued strategic efforts to improve access to services, especially in its core program areas: agriculture, food and nutrition, and 4-H youth development. The organization focuses its resources where Extension is most needed, is best equipped to provide solutions, and can make the greatest impact. Each core area includes multiple programs, and volunteer-driven efforts--such as NC State Extension Master Gardener^{SM}--continue to be an integral part of Extension. NC State Extension programs translate the research-based knowledge generated by researchers and faculty members into everyday solutions that help keep North Carolina's $87 billion agriculture and agribusiness industry growing and sustainable. In 2018, NC State Extension provided educational programs to address public health issues, improve economic well-being, and help people make healthier, better-informed decisions. Programs range from breeding more profitable crops to creating local food markets that support healthier communities. Extension's 4-H programs encourage young people to learn by doing. In 2018, NC 4-H programs and camps reached 263,000 young people, helping them become active, contributing citizens. Extension partners with local governments, businesses and families in communities across the state. More than 200,000 volunteer hours enhanced Extension's capacity to focus on local needs and opportunities. With programs ranging from school gardens and farmers markets to Master Gardener groups and natural resources leadership, NC State Extension has continued its role in building and sustaining North Carolina communities.

NC A&T Cooperative Extension Program
Cooperative Extension at NC A&T delivers educational programs and technology that enrich the lives, land and the economy. Our mission is to provide educational programs to inspire North Carolina's underserved farmers, families, individuals, youth, and communities to make decisions to improve their lives. We use a continuous long-range planning and evaluation process designed to allow the organization to adapt programs rapidly in response to emerging needs and issues. The work of Cooperative Extension is driven by our strategic plan, Mission Possible, which is built upon nine priority program areas: Small-Scale Minority Farm Development, Natural Resource Management and Environmental Protection, Food Security, Chronic Disease Prevention, Youth Development, Family Well-Being, Leadership Development, Financial Management, Emergency Preparedness for Minority Audiences. In 2018, Cooperative Extension engaged

in innovative programs across the state and focused on areas such as STEM, ginseng production, community gardens, and helping small farmers discover new markets. These areas have not only been identified as critical to improving the quality of life in some of North Carolina's most economically stressed communities but are also embedded within Mission Possible.

Combined North Carolina Extension Accomplishment Highlights

Global Food Security - Plant Production Systems and Health
In the area of plant production systems, Extension at NC State and NC A&T had a significant impact in 2018. Highlights include:

Connecting farmers and others in government and industry with research-based solutions to multifaceted crop problems, NC State Extension plays an important role in the North Carolina Plant Sciences Initiative.
Operation and promotion of a regional farmers market that gives small and medium scale farmers the chance to sell products directly to consumers. The market had about 8,600 customer visits in 2018, an increase of almost 8% over the past year.
Continuation of the NC Farm School to help growers improve the economic health of their operations and to aid entrepreneurs in launching new ventures. Statewide, 399 people have participated since 2012. Graduates have developed 46 new farms and 140 continuing farms.
Clinics that helped growers in peanut-producing counties determine the right time to harvest their crop.
Development and delivery of grower education programs and improved practices for rootstock selection and cultural management of peach and apple orchards.
The wrap-up of a 12-year program that led to one of NC's first grassroots food hubs. Over the project's life, more than 100 farmers generated over $2 million.
Support of sustainable agriculture, community-based food systems and the development of NC's local food economy through the Center for Environmental Farming Systems (CEFS). The center - a joint effort of NC State, NCA&T and the state agriculture department -- helped 1,490 farmers through workshops, trainings, and demonstrations to drive adoption of best practices and reduce farm-level food loss.
Enhancement of NC A&T Plasticulture Equipment Rental Program for the state's small and limited-resource farmers. Plasticulture has been proven to increase yield, improve weed control and watering efficiency, and reduce fertilizer costs. Small farmers across the state have been able to try plasticulture by renting mulch layers and lifters at low cost.
Continuation of NC A&T Agrishops, a series of specialized regional workshops for small, limited-resources and socially disadvantaged farmers which focus on production and the business aspect of farming. A total of 70 farmers attended the workshops on topics such as mushroom production, silvopasture, high tunnels and wildlife agritourism.

Global Food Security - Animal Production Systems and Health
Extension agents and specialists -- the link between research and the industry - reported these and other accomplishments for 2018:

Food Animal Initiative: As CALS embarks with the College of Veterinary Medicine on a Food Animal Initiative, ongoing Extension outreach to food animal producers will be essential.
Value-Added Marketing: In Duplin County, Extension partnered with the Southeast Livestock Exchange and Zoetis to manage and advise producers that participate in the Coastal Carolina Cattle Alliance value-added marketing program. The program offers year-round educational activities and provides producers with the opportunity to market their calves. Participating producers saw an average increase in profit of $70 per head, or approximately $123,550 total over 1,765 calves sold.
Niche Meats: A niche meat working group delivered poultry processing resources to eight counties, and its programming reached a total of 158 Extension and farmer attendees. Resources and business templates have been shared across various workshops, and a free educational program for on-farm poultry processors has been launched. A meat marketing seminar sold out at 100 attendees, 95% of

whom indicated that they increased their knowledge of profitable meat marketing.
Litter Management: Area specialized poultry agents offered all-day seminars in five locations statewide to educate growers on litter management to reduce nitrogen and phosphorus runoff, building litter storage sheds, composting systems for mortality disposal, and other crucial issues. Evaluations completed by 44 growers indicated that farmers saved or profited $500 to $1,000 by attending the program and using the knowledge gained.
Controlled Environment Animal Protection: To address the need of the animal agricultural industries to attract a diverse, knowledgeable and skilled workforce to overcome obstacles to their vitality and sustainability, NC State released 19 educational modules of an eLearning curricula on Controlled Environment Animal Production (eCEAP) for the industries' future workforce, today's undergraduate and graduate students. The modules tap into faculty research experiences and expertise in sustainable energy, climate change, food security and safety and advanced digital learning technologies.

Climate Change
In the face of climate change and other factors, water and waste management training is critical to protecting the environment on farms, in rural areas and in cities and towns:

Animal Waste Certification: Statewide, farmers gained or maintained 2,479 animal waste management certifications they need to continue food animal production, and Extension-recommended waste analysis was used for proper land application on over 1 million acres.
Erosion & Sediment Control: NC State's Soil Science Department offered short courses and conferences for erosion and sediment control professionals, municipal and industrial wastewater operators, environmental health specialists, septic system installers and operators, professional engineers, soil scientists, well contractors, water quality specialists, government agency employees, and elected officials. More than 4,238 participants received technical training for license renewal or professional development.
Streambank Stabilization: Extension helped troubleshoot problem stream areas, build awareness, and provide hands-on training in streambank stabilization. Fifteen streambank repair workshops and one conference were held statewide, repairing 1,800 linear feet of streambanks, with surveys indicating an additional 1,500 feet repaired.
Storm Water Management: Four Extension workshops and a conference in Wake and Franklin counties trained local decision-makers and officials, property owners and managers, engineers, professional landscapers, educators, and other local stakeholders to better manage storm water. Certified practitioners reported designing or maintaining an additional 65 raingardens, bringing the total number of raingardens installed by participants to 374. Raingardens installed to date will prevent $54,073 worth of nitrogen and phosphorus from entering NC waters and infiltrate and clean an estimated $952,214 worth of additional future drinking water.

Childhood Obesity
Through multiple programs for children and adults, Extension addresses high rates of nutrition-related chronic diseases and conditions such as heart disease, high blood pressure and diabetes.

Expanded Food and Nutrition Education Program (EFNEP) helps food-insecure families learn how to provide nutritious, safe meals for their families on limited budgets. Statewide, 11,486 adults increased their fruit and vegetable consumption as a result of Extension programs from both North Carolina State and North Carolina A&T, including classes on how to grow, purchase, and cook healthy fruits and vegetables.
4-H EFNEP program at both institutions reached 17,209 school-aged youth with programs to address food resource management, nutrition practices, food safety, and changes in physical activity. 95% of participants improved dietary intake, 85% now practice daily physical activity, 89% practice better food resource management, and 86% have improved their food safety habits.
Steps to Health at North Carolina State and **Try Healthy** at A&T promotes positive, long-term behavioral changes related to nutrition and physical activity through programs targeting pre-school and elementary

school students, adults, older adults, and Latino and Hispanic families. Steps to Health reached 10,629 participants (9,281 children and 1,384 adults) and made 71,447 educational contacts within 61 counties across NC. More than 85% of participating preschoolers are more willing to try fruits and vegetables, while 73% of participating elementary school children are eating more fruits. Nearly 90% are more active. Try Healthy reached 13,008 participants (11,643 youth and 1,365 adults).
Eat Smart, Move More, Prevent Diabetes curriculum provides NC residents with accurate educational materials for diabetes prevention. This curriculum is offered both online and on site. Statewide, 962 adults participating in Extension education programs improved their blood glucose (A1c) levels.
Speedway to Healthy created and managed by Cooperative Extension at N.C. A&T, is a giant interactive exhibit incorporating experiential education that combats childhood obesity. At 1,200 square feet, the walk-through teaching tool replicates parts of the human body. It continues to be one of Extension's most popular programs and in 2018, over 6,000 students toured the Speedway to learn how different food choices and behaviors affect their bodies. Participants have the potential to save $155,520 in future medical costs and pave the way for a brighter, healthier and more active future for youth.

Food Safety
The Centers for Disease Control and Prevention estimate that roughly 1 in 6 Americans (or 48 million people) contract a foodborne illness each year, resulting in 128,000 hospitalizations and 3,000 deaths. Food safety education provided by Extension to consumers, growers, and food-service employees and managers helps prevent foodborne illness outbreaks.

ServSafe: 638 food service employees received ServSafe certification, 617 implemented ServSafe standards, and 1,233 food handlers received food safety training and education in safe food handling practices.
SafePlates: 457 food protection managers received Safe Plates training (415 were certified), and 342 food safety managers received ServSafe training (273 were certified). Over 60 Safe Plates for Food Managers classes were conducted with over 800 total participants.
Food Safety Plans: At the University of North Carolina at Pembroke, Extension helped introduce local produce into campus menus by teaching farmers to develop food safety plans required by FreshPoint, a food distributor for UNCP.
School Farm: Extension helped Yancey County's Future Farmers of America (FFA) chapter re-establish a school farm that produces and sells vegetables to a local food hub. Thanks to Extension training in good agricultural practices, the chapter met all food safety requirements needed to sell to the school cafeteria, giving students access to fresh, nutritious local food.

Human and Community Development
Cooperative Extension in North Carolina delivered human and community development programs addressing a range of community needs in 2018.

4-H Clubs: 18,295 youth participated in 4-H clubs. 4-H clubs build a healthier NC by improving the lives of young people and empowering them to make a difference in their communities. A 4-H horse club in Pasquotank County, for example, secured and delivered over $10,000 worth of donated livestock food and supplies to people and animals in need following Hurricane Florence. 4-H in Wilson County partnered with Darden Middle School to create a robotics club consisting of 15 girls ages 11 to 12. In Wayne County, the 4-H Roto Raptures Club went through an extensive build season in which they created and added features to a new robot, advancing through two district competitions and one state contest to represent Wayne County and 4-H for the second time at a world competition. 4-H clubs also address Healthy eating, food safety, exercise, and choices about relationships, drugs, and alcohol.
4-H Camps: At 4-H camps and conference centers across the state, youth can participate in programs that range from traditional camping activities (such as swimming and horseback riding) to environmental education, cooking, and building life skills. Tailored for youth ages 5-17, camps attracted 7,697 young people to learn about cooking and healthy eating, explore outdoor activities, prepare for careers, build

community volunteerism, develop life skills, and achieve academic and educational success. With fund provided by Cooperative Extension at North Carolina A&T, 4-H youth in Gates, Bertie, Wilson, and Bladen counties attended NASA's Space Camp which provided opportunities and experiences to minority and low-income youth that will shape and transform their thinking of the world and themselves.
4-H School Enrichment Programs bring learning to life. From embryology to healthy eating, 140,161 NC youth participated in 4-H school enrichment programs in 2018. Extension at NCA&T and its partners developed Get STEMed UP, a four-day teacher professional development program designed to build skills in math, science, literacy, agri-science, and digital learning for more than 60 NC teachers in Title 1 schools. Seventy five percent of respondents said they can apply knowledge gained at the institute in their work, and 96% said they would recommend it to others.
4-H Special Interest Programs: In 2018, 87,168 youth participated in 4-H special interest programs, including programs related to science, technology, engineering and math. Twenty-eight first generation 4-H youth participated in 4-H Youth Leadership Training. The students spent four days at North Carolina A&T and received training to prepare them for civic engagement in their communities, including leadership roles and responsibilities. They also learned about getting started in agriculture careers, starting a new 4-H club and using social medias as a marketing tool. In 2018, NCA&T launched Innovation Station, the 40 foot-foot-long mobile learning experience. The vehicle holds up to 15 students and provides cutting-edge technology as well as exterior programming capabilities. It will travel to counties throughout North Carolina, providing introductory and advanced STEM curriculum for children in grades K-12.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	691.0	66.0	397.0	46.0
Actual	672.0	65.5	352.0	105.6

II. Merit Review Process

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

- Internal University Panel
- External University Panel
- Combined External and Internal University Panel
- Combined External and Internal University External Non-University Panel
- Expert Peer Review

2. Brief Explanation

Merit review at NC State is conducted by senior administrators, program leaders, department heads, and department extension leaders. A thorough scientific and merit review of each proposed HATCH project is conducted at the departmental level before submission to the North Carolina Agricultural Research Service (NCARS). This departmental review consists of an informal review (PI's responsibility) and a formal review (Department Head's responsibility). HATCH projects must be aligned with one of the eight Planned Programs from the Plan of Work. Extension programs are determined based on a formal statewide needs assessment process used to determine emerging needs and appropriate education responses. These assessments give residents, governmental officials, advisers, commodity group representatives,

volunteers and other clients the opportunity to ensure that programs meet local needs and priorities. State program leaders, specialists, district directors, and selected county faculty conduct a rigorous review of economic, social, and environmental data. Collectively, these individuals provide an internal merit review of programming needs. They provide the broad areas and scope for Extension to focus its work. Program teams develop specific objectives, program descriptions, measures of progress, and impact indicators. This procedure results in the development of a state long range plan and provides the basic requirements for allocation of Smith-Lever funds. Specialists develop curriculum, training and technical assistance to assist county faculty address the needs that have been identified in the assessment.

Evans-Allen projects are supported through the Office of Agricultural Research in NC A&T State University's College of Agriculture and Environmental Sciences (CAES). The research director in conjunction with the leadership team, faculty and staff determines the need, priority, and scientific feasibility of proposed Evans- Allen projects and the development and implementation procedure for project documentation, merit review, and selection. This process assures that research proposals are scientifically sound, relevant to society's food and agricultural needs, and no duplication of efforts undertaken elsewhere. Prior to proposal development, alignment of the research topic with the needs of the state and the direction of the eight program initiatives of CAES is determined. Upon agreement by the department chair, the associate dean for research, the research director, and the principal investigator, a proposal on the topic for submission through the Evans- Allen program is prepared. A merit review process is conducted that includes a review by five peer reviewers from both within and outside the University who are knowledgeable of or familiar with the area of research. Proposals are then reviewed by the associate dean for research, who determines if additional review and substantive revision is necessary. Upon acceptance by the associate dean for research and research director, proposals are transmitted to NIFA/USDA for approval. Upon NIFA approval, proposals are submitted to the Office of Agricultural Research for budgetary review.

III. Stakeholder Input

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

- 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 of the general public

Brief explanation.

NC State College of Agriculture and Life Sciences is committed to seeking, receiving and using input from all stakeholder groups, including under-represented groups and the general public. NC State has made a concerted effort to involve and inform college partners and other stakeholders in planning efforts. The college holds an annual partnership meeting that brings together more than 100 representatives of 50+ commodity organizations, biotechnology companies, service organizations and societies, agricultural advocacy groups and others to encourage their input and support. NC State Extension routinely reaches out to stakeholder groups including residents, governmental officials, advisory leaders, commodity group representatives, volunteers and other clients. County extension personnel interact daily with stakeholders in such a way that input is effectively gathered and communicated to administration and faculty. An advisory leadership system

is functional in each of North Carolina's 100 counties and the Eastern Band of the Cherokee. Our advisory council represents geographic, cultural and economic diversity within the communities we serve. Extension county educators serve on local boards and committees which encourages stakeholder input.

The CAES Advisory Board provides advice and counsel on matters related to the College's strategic direction, priorities, and external relations, as well as advice on staying relevant and addressing the needs of its stakeholders. The Board is comprised of industry/commodity group leaders, alumni, students, partner agencies and small farmers. It provides eyes and ears into the communities served by NC A&T and provides a forum for CAES to hear from constituents and communicates information relating to research and outreach. The Strategic Planning Council (SPC) is the advisory leadership group for Cooperative Extension at NC A&T. The SPC membership is comprised of 24 influential volunteers representing the broad diversity of NC's population. Because of their knowledge as it relates to the local perspectives, council members assist with identifying, analyzing and prioritizing issues which impact limited- resource individuals, families and communities. Council members help Extension reach more clientele, ensure the relevancy of programs, delivery of Extension education and interpret the value of Extension to stakeholders. The SPC meets three times per year, one of which is a joint meeting with NC State's State Advisory Council. Networking and collaboration between both councils are facilitated by two members who serve on both councils. With these organized groups emphasizing and providing significant stakeholder input into program direction, a planned and proactive process is operational that assures that programs are reviewed and overall needs assessed on a continuous basis, but no less than once every two years, with greater frequency encouraged.

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.

NC State is committed to identifying and giving stakeholders the opportunity to provide feedback and ensure that local programs meet local needs and priorities. Stakeholders are identified through commodity groups, community partners, the Advisory Leadership System, volunteers, staff participation and attendance at community events, other clients, public outreach efforts, and the needs assessment process. Stakeholder are also identified through outreach efforts using mass media, social media, and the Extension website. The Advisory Leadership System, functional in each of North Carolina's 100 counties and among the Eastern Band of the Cherokee is also used to identify groups and individuals from whom we collect input. The Advisory Council represents geographic, cultural and economic diversity within the communities we serve. The system provides a means to engage a comprehensive stakeholder group. This system is monitored administratively to assure that a diverse group of stakeholders are engaged.

As noted previously, the CAES Advisory Board provides representation of a broad spectrum of interests that is vital to the progress and responsiveness of the College's ability to fulfill its mission of

service to the citizens of North Carolina. A major role of the Advisory Board is to provide input on the strategic direction for the College. The CAES recently updated its Strategic Plan in which, stakeholders identified by academic units, including the College and unit advisory boards, provided significant feedback into the research priorities established. In 2018, Dr. Mohamed Ahmedna, Dean of CAES charged a committee with developing a refresh of the college's strategic plan, Destination Excellence. The aim of the refreshed plan was to not only align with the university's strategic plan, A&T Preeminence: Taking the Momentum to 2023,but also to represent to the greatest degree possible, a collective vision of the CAES community (faculty, staff, students, alumni, and internal and external stakeholders). Feedback was gathered from a variety of sources including from CAES faculty, staff, and students, as well as external stakeholders. In addition, findings were gathered from a recent SWOT (strengths, weaknesses, opportunities, and threats) analysis of CAES. Based on feedback, there were seven core values that were identified to underpin the work of the college: responsibilities, excellence, integrity, inclusiveness, learning, and collaboration. While the mission and vision from the original plan remained the same, there was a "refresh" of the goals of CAES, enabling us to realign our plan more closely with A&T Preeminence. Cooperative Extension has its own 5 year strategic plan, Mission Possible. In 2018, Mission Possible in Motion, was developed to keep stakeholders abreast of progress made towards work on Extension's strategic plan.

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
- Survey of the general public
- Meeting specifically with non-traditional groups
- Meeting specifically with non-traditional individuals
- Meeting with invited selected individuals from the general public
- Survey of selected individuals from the general public

Brief explanation.

One source of stakeholder input comes from direct interactions between NC State research scientists and county-based extension educators with producers, industry and other agribusiness representatives. NC State maintains close ties with 90 state agricultural industry associations, of which 24 provide funding to various research projects annually, usually on a competitive basis. In these cases, the association boards give information on high-priority research areas to be used in requests for proposals, and boards decide which proposals to fund. This is the most targeted type of stakeholder input, having a direct effect on research activities. NC State Extension conducts a formal needs assessment which includes collection of stakeholder input. Extension uses mailed surveys, electronic/web surveys, one-on-one interviews, and focus groups to collect stakeholder input for the needs assessment and program prioritization process. Stakeholder input is also collected from the advisory leadership councils in each county. Strategic planning efforts in Extension and for the entire college benefit from concentrated efforts by college leadership to engage stakeholders through listening sessions, focus groups, and state-wide conferences and workshops. Many of the departments within the College of Agriculture and Life Sciences have formal advisory groups with stakeholder members that meet on a regular basis providing input and direction for research and Extension programs.

Each year, the SPC at North Carolina A&T hosts its annual Grassroots Leadership Conference (GLC), a forum which brings together a diverse group of local stakeholders throughout the three regions of North Carolina (Mountains, Piedmont and Costal Plains). Their input helps to determine the theme, program structure/content, and location. The purpose of bringing this group together is to discuss real issues impacting the lives of the residents of those regions of the state. The goal of the conference is to provide attendees with an opportunity to engage in a purposeful dialogue about a specific identified issue which leads to exploring and identifying real strategies and solutions that will help to improve the quality of life for North Carolina residents, especially limited resource populations. Responses on the survey at the GLC provides feedback regarding topics of interest for future conferences. In 2018, the theme of the conference was Access Granted: Healthy Outcomes for Our Communities and centered on addressing disparities in health outcomes as well as the barriers to care other than just access. In addition to Advisory Board, CAES uses mail surveys, electronic/web surveys, focus groups, and community forums to collect stakeholder inputs for the needs assessment and program prioritization process. CAES works with its College and departmental advisory boards to identify stakeholders. These boards are comprised of industry, commodity and organizational groups, as well as small farmers and alumni, who help the College identify stakeholders and assist with obtaining input into CAES' strategic direction and priorities.

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.

Because research and extension activities are directed toward the development and implementation phase of new knowledge and technology, faculty members are constantly relating industry needs and suggestions to other researchers, whose emphasis is more in the discovery phase. Stakeholder input is used in determining research directions as well as for gaining program support and advocacy for research initiatives. For example, the commodity association boards provide information on high-priority research areas to be used in requests for proposals, and boards then decide which proposals to fund. This is the most targeted type of stakeholder input, having a direct effect on research activities. The environmental scanning process entails obtaining both primary and secondary data on key issues of concern, needs and assets in the community and translating these needs into science based programs and services. These combined data and input are used to prioritize and target issues, needs and assets and serve to focus, guide and direct extension programming. Stakeholder input during strategic planning processes has provided useful direction to enable Extension and the college focus on those programs that are consistent with the college's mission and vision. In addition, relationships developed during these processes are providing stakeholder support for major legislative initiatives, financial development opportunities, student recruiting and positive stakeholder involvement in the future.

Brief Explanation of what you learned from your Stakeholders

Many issues identified as key concerns by North Carolina citizens are addressed by Cooperative Extension programs. Farmland preservation, farm profitability, diversification of production, aging

farm population, emergency preparedness, nutrition and health, and opioid drug uses were identified as key issues. Increasing economic opportunity, business development, and developing community leaders were other key issues. Environmental stewardship and natural resource management were identified across the state as well. A continued emphasis and concern about building strong families and developing responsible youth as well as educational and job skills opportunities were all labeled key issues facing North Carolina.

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	10578444	1101868	9279005	3413672
Actual Matching	10578444	1815334	9279005	2618006
Actual All Other	12967164	727335	54133248	884802
Total Actual Expended	34124052	3644537	72691258	6916480

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	1057844	0	6349321	648110

V. Planned Program Table of Content

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Global Food Security - Plant Production Systems and Health

☑ 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
201	Plant Genome, Genetics, and Genetic Mechanisms	10%	0%	15%	0%
202	Plant Genetic Resources	10%	10%	5%	10%
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%	0%	6%	0%
204	Plant Product Quality and Utility (Preharvest)	5%	10%	1%	20%
205	Plant Management Systems	18%	30%	8%	40%
206	Basic Plant Biology	5%	10%	7%	0%
211	Insects, Mites, and Other Arthropods Affecting Plants	10%	0%	11%	10%
212	Pathogens and Nematodes Affecting Plants	10%	0%	18%	0%
213	Weeds Affecting Plants	12%	0%	8%	0%
215	Biological Control of Pests Affecting Plants	0%	0%	3%	0%
216	Integrated Pest Management Systems	5%	15%	6%	10%
601	Economics of Agricultural Production and Farm Management	4%	10%	9%	10%
602	Business Management, Finance, and Taxation	5%	5%	0%	0%
603	Market Economics	0%	0%	3%	0%
604	Marketing and Distribution Practices	6%	10%	0%	0%
	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	139.0	20.0	146.0	7.0
Actual Paid	44.1	17.0	137.4	26.1

Actual Volunteer	117.0	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**
4548731	302447	4268343	836180
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
4548731	647787	4268343	516922
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
2593433	43358	24901295	453997

V(D). Planned Program (Activity)

1. Brief description of the Activity

Work in this program area included conducting discovery research on plants and plant systems using approaches including genomics, metabolomics and proteomics. Research was also conducted to develop improved crop varieties using traditional and genomic approaches. Researchers worked to introduce/discover new plants for food use and the green industry and to develop systems for production of plants for biofuels. Work in this area focused on methods to seek new uses for plants and plant byproducts. In addition, researchers focused on the development of production systems for organic farmers. Another area of research included the development of diagnostic techniques for indigenous and introduced pathogens. Work in these areas was facilitated through partnerships with industry. Sustainable production systems for both large scale and limited resource farmers was an important part of work conducted. In addition, research and extension focused efforts to enhance IPM programs through new techniques and strategies. Researchers and extension personnel also worked together to set up applied research/demonstration plots. Information was shared with grower and homeowner audiences through prepared publications and developed web portals. Focused educational programs for farmers, commodity groups, and industry were presented. Focused educational activities were provided to crop producers by Extension personnel on adopting best management practices, including those practices related to nutrient management, conservation, production, cultivars, pest management (weeds, diseases, insects), business management, and marketing. Extension presented focused educational programs on gardening and landscape practices including plant selection and placement, turfgrass management, soil management, growing food, water conservation and water quality preservation, storm water and erosion management, green waste management, pest and wildlife management. Examples of certification training provided by Extension personnel include: Certified Crop Advisor, Certified Turfgrass Professional, Licensed Landscape Contractor, and Pesticide Applicator.

2. Brief description of the target audience

The target audience is agriculture, agribusiness, commercial and limited resource farmers, new and part-time farmers, and agricultural chemical companies in North Carolina. The target audience also includes homeowners and the general public interested in horticulture, gardening, and landscaping. The audience includes personnel in regulatory agencies, the scientific community, consultants, news media, non-governmental organizations, and other public agency staff.

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	440602	1321806	110000	82706

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

Patent Applications Submitted

Year:	2018
Actual:	43

Patents listed

Methods and Compositions for Enhanced BioMass Production and Increased Abiotic Stress Tolerance 15/875,272
Synthetic Pathway for Biological Carbon Dioxide Sequestration15/875,313
Methods and Compositions for Delivery of CRISPR Based Antimicrobials16/063,409
Pyrus Hybrid Flowering Pear 'NCPX2' 15/932,716
Genome Engineering with Type I-B CRISPER-CAS Systems from Listeria Monocytogenes62/671,413
Compositions and Methods for Increasing Phytochemical Bioavailability and Bioactivity62/536,209
Use of Tebucozole for Annual Bluegrass (Poa annua) Control in Warm-Season Turfgrasses62/595,363
Beta-Hexosyl-Transferases and Uses Thereof15/702,438
Autonomous Aquatic Herbicide Application15/763,144
Systems and Methods of Carbon Fixation Using Solventogenic Clostridium Beijerinckii PCT/US2017/045571
Multi-Sample Chamber for Extended Term Microscope ImagingPCT/US2017/061424
Insect Barrier Textile Liner System62/649,007
3D Spacer Textiles for Crop Protection and Insect Control62/622,442
Nanotechnology System for Agricultural Applications 15/826,163
Transgenic Expression of Archaea Superoxide Reductase 15/836,465
Methods for Screening Bacteria, Archaea, Algae, and Yeast Using CRISPR Nucleic Acids 2016270649
Methods for Screening Bacteria, Archaea, Algae, and Yeast Using CRISPR Nucleic Acids 201680030913.5
Methods for Screening Bacteria, Archaea, Algae, and Yeast Using CRISPR Nucleic Acids 201792663
Methods for Screening Bacteria, Archaea, Algae, and Yeast Using CRISPR Nucleic Acids 2017-7037797
Methods and Compositions for Modification of Plastid GenomesPCT/US2017/049913
Methods for Diagnosis of Pseudoperonospora Cubensis Infection and Selection of Plant Resistance Genes to the SamePCT/US2017/050059
Altering Guide RNAs for Modulating Cas9 Activity and Methods of UsePCT/US2018/034322
Re-Engineering of Mycorrhizal Symbiosis in PlantsPCT/US2018/038173
crRNA:tracrRNA-based Binary Logic Gate Design as a Tool for Synthetic Biology62/559,112
System and Method for Continuous Microwave-Assisted Extraction of Bioactive Agents from Biomass PCT/US2017/063257
RNA-Guided Nucleases and Active Fragments and Variants Thereof and Methods of Use62/686,901
RNA-Guided Nucleases and Active Fragments and Variants Thereof and Methods of Use62/680,863
RNA-Guided Nucleases and Active Fragments and Variants Thereof and Methods of Use62/680,845
RNA-Guided Nucleases and Active Fragments and Variants Thereof and Methods of Use62/680,862
RNA-Guided Nucleases and Active Fragments and Variants Thereof and Methods of Use62/680,846
RNA-Guided Nucleases and Active Fragments and Variants Thereof and Methods of Use62/680,853
RNA-Guided Nucleases and Active Fragments and Variants Thereof and Methods of Use62/680,859
Smokebush 'NCCO1'15/731,653
Cotinus H2006-064-008 (Cotinus coggygria)17-9295
Chaenomeles NCCS4 15/731,654
Hyd arb H2011-234-012 White TT (Hydrangea arborescens)17-9271
Hyd arb H2011-234-014 Purple ZZ (Hydrangea arborescens)17-9272
Hyd H2011-234-009 WhtGreen FF (Hydrangea arborescens)17-9273
Spiraea 'NCSX2'15/932,521
Method for Modulating Plant Root Architecture15/805,044
Methods and Composition for Killing of Insect Pest Eggs17837595.2
Methods and Compositions for Killing of Insect Pest EggsPCT/US2017/045064
Micropropagation of Alexandrian laurel US 10028505

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	128	533	661

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Studies conducted to identify new germplasm and develop new and improved varieties of crops and ornamentals

Year	Actual
2018	115

Output #2

Output Measure

- Educate growers and other clientele through highly focused non-degree credit workshops and other formalized group educational sessions (no. of participants)

Year	Actual
2018	90200

Output #3

Output Measure

- Number of non-degree credit workshops and other formalized group educational sessions.

Year	Actual
2018	2921

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Increased Income as a Result of Production of New or Alternative Crops/Enterprises
2	Increased profit through the adoption of improved nutrient management practices
3	Number of releases of germplasm and varieties with improved yield potential and other qualities
4	New techniques and products developed and released that can be commercialized
5	Increased profit through the adoption of new production practices
6	More informed growers through highly focused non-degree credit workshops and other formalized group educational sessions.
7	Increased acreage of organic crops and specialty crops.
8	Number of discoveries of mechanisms that regulate the productivity of plants and the microorganisms that interact with them
9	Increased profit through the adoption of new production practices and marketing locally
10	New organic, farmers and agritourism markets established by individual entrepreneurs
11	Growers Adopting Improved Business Management Practices
12	Integrated high tunnel and agroforestry technologies for vegetable production on small farms
13	Improved national capacity to meet growing food demands

Outcome #1

1. Outcome Measures

Increased Income as a Result of Production of New or Alternative Crops/Enterprises

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Industrial hemp production was legalized in NC in 2016 as part of a pilot research program prompted by intense grower interest in this alternative crop. In order to grow industrial hemp, growers must apply for a license and participate in a research program. Because the crop is so new, very little is known about its production, processing, and marketing. About 100 growers produced hemp for the first time in 2017, and many more are eager to learn more about this crop.

What has been done
Cooperative Extension in Moore, Yadkin, Chatham, and Granville counties coordinated and provided hemp production training and information sessions that reached 522 participants. In addition, NC State researchers deployed a large number of grain, fiber, and floral hemp trials across the state in 2018, examining production methods and potential fertility issues affecting grain and fiber hemp. In the summer of 2018, NC A&T hosted Small Farms Field Day, its annual event that showcases research and demonstration projects that help small and limited-resource farmers increase their profits.

Results
To date, NC is home to 502 licensed industrial hemp growers, 2,876,914 licensed square feet of greenhouse, 6,381.88 licensed acres, and 337 registered processors. As a result of many combined efforts, growers and Extension personnel are better prepared to grow hemp across the state. Over 200 participants attended the Small Farms Field Day, which included a demonstration titled Industrial Hemp: Fertilization and Harvestable Yield Research into CBD Varieties.

4. Associated Knowledge Areas

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

Outcome #2

1. Outcome Measures

Increased profit through the adoption of improved nutrient management practices

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	31555319

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
National Corn Yield Contest winners report that banding fertilizer on both sides of the corn row in a 2x2x2 configuration has significantly improved their yields. However, this practice requires investment in new equipment, and many growers were reluctant to make this investment without clear evidence of yield increase. In addition, many growers were unsure how much fertilizer to use when applying this technique.

What has been done
NC State researchers began evaluating 2x2x2 starter placement in several locations across NC from 2016 to 2018. Seven out of the 10 studies conducted showed impressive yield increases ranging from 8.9 to 22.5 bushels per acre. The results also indicated that use of starter fertilizer rates currently applied based on the P content of the soil are appropriate for use in a 2x2x2 band.

Results
Extension meetings held across NC in 2017 and 2018 and an Extension agent training session held in June of 2018 educated growers on this new application method. Corn growers enthusiastically embraced this approach, resulting in an $11 million increase in income from corn production in 2018.

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
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices

Outcome #3

1. Outcome Measures

Number of releases of germplasm and varieties with improved yield potential and other qualities

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	25

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
As the world?s population grows, so does the demand for sustainable, affordable alternatives to the limited supply of fossil fuels. New high-yielding varieties of a perennial grass known as miscanthus could help meet this demand while providing a promising new crop for farmers in the Southeastern US.

What has been done
The US Department of Energy has awarded NC State $4.6 million over the next five years to evaluate hybrids. NC State scientists from four College of Agriculture and Life Sciences departments are participating in the project, as well as experts from Oak Ridge National Laboratory, Novozymes North America, and Iogen Corp.

Results
Researchers are currently evaluating the field performance of numerous varieties?15 of which were developed through a 10-year NC State breeding program?in different areas of the state. They are also examining how miscanthus production will influence the plant-soil microbiome, nutrient use, and water movement, and they are seeking optimized strategies for harvest, postharvest, and conversion of miscanthus. In addition to furthering the quest for renewable energy sources, these efforts will potentially increase the value, productivity, and ecological security of NC farmlands.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
206	Basic Plant Biology

Outcome #4

1. Outcome Measures

New techniques and products developed and released that can be commercialized

2. Associated Institution Types

- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	80

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Disease management practices have traditionally focused on breeding crops for resistance to pathogens and pests. Little attention has been given to biological control or biocontrol: the use of natural enemy microbes to keep pests in check and reduce toxin contamination. Aspergillus flavus is a fungus that contaminates valuable oil seed crops worldwide with carcinogenic toxins.

Current EPA approved biological control strategies used to combat the production of these toxins require reapplication every growing season and perform poorly in the face of constantly developing genetic variations of Aspergillus flavus.

What has been done

NC State researchers examined Aspergillus flavus to shed light on its genetic structure and biodiversity. They conducted studies on Aspergillus flavus samples to identify differences between and relationships among Aspergillus lineages and discover potentially promising lineages for biocontrol applications.

Results

The researchers identified a particular lineage of Aspergillus flavus that could significantly reduce aflatoxin levels over several years after introduction into native populations. This lineage could provide the foundation for a new aflatoxin control method that overcomes the shortcomings of previous techniques by exploiting population genetics to reduce mycotoxin production within fungal populations. This work has significant implications for mitigating aflatoxin crop contamination and may be applicable to the biocontrol of other toxin-producing fungi. This approach has been recognized by the Office of Research Commercialization at NC State, and a provisional patent has been granted.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
206	Basic Plant Biology
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems
604	Marketing and Distribution Practices

Outcome #5

1. Outcome Measures

Increased profit through the adoption of new production practices

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	31555319

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Cotton variety selection is one of the most important decisions a grower can make. Modern varieties enter the marketplace with little public testing, and they usually leave the marketplace rather quickly. In order to effectively evaluate variety performance across a broad range of environments or to determine the type of environment in which a particular variety should be positioned, growers need efficient, accessible tools and information sources.

What has been done
Agricultural and IT researchers at NC State have partnered to develop the NC Cotton Variety Performance Calculator, which was successfully launched in 2016 and has already proven to be an extremely valuable tool for making variety comparisons customized across a broad range of selection criteria. Other states have shown significant interest in this variety calculator, as have Cooperative Extension faculty working on other row crops.

Results
As of November 2018, the online NC Cotton Variety Performance Calculator has attracted 6,872 pageviews. The NC On-Farm Cotton Variety Evaluation program illustrated that improper variety selection could cost producers an average of $118 to $261 per acre in 2018, which is greater than the cost of most other single agronomic decisions a grower could make. Depending on the degree of error in variety selection when choosing among only the best-performing varieties from each seed company, this program demonstrated an average statewide potential impact of $47,200,000 to $104,400,000 based on NC?s cotton acreage of 400,000 in 2018. For every dollar invested from all organizations that provided support, this program returned $291 to $644 dollars to NC cotton producers, assuming acreage remains stable from 2018 to 2019. Additionally, if acreage remains at 400,000, this program will pay for itself if it influences variety selection on as few as 621 acres (0.2% of total acreage) and up to 1,373 acres (0.3% of total acreage).

4. Associated Knowledge Areas

KA Code	Knowledge Area
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
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems

Outcome #6

1. Outcome Measures

More informed growers through highly focused non-degree credit workshops and other formalized group educational sessions.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	49862

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
For growers to optimize peanut yield, they must understand how to evaluate optimum peanut maturity in light of field and weather conditions. Digging peanuts at the wrong time can cause significant reductions in quality and profit for growers. In 2018, peanuts matured quickly due to wet soil conditions, further complicating the logistics of harvesting.

What has been done
Extension agents in Duplin and Sampson counties partnered with the Duplin Ag Technician to hold five Peanut Pod Blasting clinics at two locations. Participants were able to bring their field samples to the clinics and have them evaluated for optimum maturity. Forty-one samples were evaluated, and the clinics allowed growers to view side-by-side comparisons of their samples.

Results
Over 10,221 acres of peanuts were planted in Sampson and Duplin counties, yielding an average of 22,997 tons of peanuts and an economic value of over $9,198,800. Digging at optimum

maturity and weather conditions can increase revenue by $14 per acre.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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
215	Biological Control of Pests Affecting Plants
216	Integrated Pest Management Systems
601	Economics of Agricultural Production and Farm Management
602	Business Management, Finance, and Taxation
603	Market Economics
604	Marketing and Distribution Practices

Outcome #7

1. Outcome Measures

Increased acreage of organic crops and specialty crops.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

In NC, many peach and apple orchards have suffered from historically poor performance in productivity, life and profitability. In addition, poor performing rootstocks have negatively impacted the performance of these specialty crops. Some of the most commonly used commercial apple rootstocks in NC have been repeatedly identified as among the poorest performers by NC State research trials.

What has been done
NC State research has led to the development of grower education programs and improved practices for rootstock selection and cultural management. This research has fueled a transformation in pre-planting and planting strategies that maximize orchard value and vigor.

Results
Many new successful plantings of apples and peaches have taken place statewide, especially as new growers begin planting orchards to keep up with increasing demand for local food. Research results demonstrate potential gross sales exceeding $8,000 per acre for apple and peach plantings, with small growers projecting gross sales of $40,000 to $60,000. If orchard productivity and survival are increased by 10% to 15% for a $45 million-dollar industry, annual benefits in the $3 million to $4 million range are realistic.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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

Outcome #8

1. Outcome Measures

Number of discoveries of mechanisms that regulate the productivity of plants and the microorganisms that interact with them

2. Associated Institution Types

- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	8

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The effects of climate change on agriculture and the global increasing demand for food drive the exploration of plant-microbial interactions that can improve plant nutrition and resilience. A deeper

understanding of microbial and plant secretions (exudates) in the rhizosphere and their biological roles will shed light on methods for sustainably increasing crop yields and nutrition.

What has been done

An NC State researcher has set up a new lab and trained a research team to begin investigations into how plants and microbes secrete small molecules to exchange nutrients and signals and engage in active competition within the rhizosphere. This research has yielded a method for extracting an important class of bacterial secreted metabolites from the soil and investigated bacterial activity in the context of soil chemistry, biofilm growth, and root exudate interactions. In addition, collaborations have been established at the local, national, and international levels to expand this interdisciplinary research program.

Results

Findings have been presented at a national soil sciences conference. Insights gained from studying the biological chemistry of the rhizosphere will help researchers learn how to leverage the activity of natural micro-organisms to increase plant yield and nutrition in an environmentally sustainable manner. These discoveries can be translated into new products and practices, including the development of biomarkers for important activities and the creation of environmentally friendly pathogen suppression methods.

4. Associated Knowledge Areas

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

Outcome #9

1. Outcome Measures

Increased profit through the adoption of new production practices and marketing locally

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual

2018 10518440

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The fall of burley tobacco in Madison County left over 1,000 tobacco farmers looking for alternative revenue sources. Cooperative Extension partnered with a handful of local farmers to begin developing one of the first grassroots food hubs in NC, aimed at providing former tobacco farmers with the resources to process, package, distribute, and market non-tobacco commodities.

What has been done
Extension partnered with eight individual grantors, receiving a total of $551,000 over the course of 12 years. This funded the purchase and build-out of a regional food hub complete with loading docks, coolers, freezers, a vegetable wash line, and a commercial kitchen. Cooperative Extension used this food hub to house a non-profit program delivering hands-on training in GAP certification, product grading, labeling, packaging, post-harvest handling, and marketing, among other vital production and distribution practices. Several public and corporate sector partners contributed to the success of this program.

Results
The program was closed in 2018. All recorded activities of the program reveal that over 100 farmers benefitted by diversifying their operations and generating over $2 million in income.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
601	Economics of Agricultural Production and Farm Management
602	Business Management, Finance, and Taxation
604	Marketing and Distribution Practices

Outcome #10

1. Outcome Measures

New organic, farmers and agritourism markets established by individual entrepreneurs

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	1315

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
According to the USDA Census of Agriculture, the average age of farmers is near 60, and the amount of farms and farmland have declined in the last decade. Meanwhile the number of small farmers, such as those selling directly to consumers, has increased, whereas the sales volume of fruits and vegetables has fallen dramatically. If these trends are to be reversed and small farmers are to be successful, they must have profitable markets available.

What has been done
The Vance County Regional Farmers Market provides an excellent venue for small and medium scale farmers to sell their products directly to consumers. NC Cooperative Extension operates the market under the auspices of the Vance County government. Cooperative Extension implements a comprehensive marketing strategy to promote the market on behalf of farmer vendors.

Results
The Vance County Regional Farmers Market received approximately 8,600 customer visits in 2018, an increase of almost 8% over the previous year. Various studies suggest that customers spend $25 to $30 during each visit to a farmers market. Using an estimate of $27.50, the total gross sales for 40 vendors was $236,500, or an average of approximately $5,900 per vendor. In addition, through the Donation Station program, an additional $3,500 worth of produce was purchased for donation to area charities. Vendors donated an additional $650 worth of produce, for a total donation value of $4,200.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
601	Economics of Agricultural Production and Farm Management
602	Business Management, Finance, and Taxation
604	Marketing and Distribution Practices

Outcome #11

1. Outcome Measures

Growers Adopting Improved Business Management Practices

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	3737

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Current growers need help improving the economic health of their farm operations, and entrepreneurs need guidance in launching new ventures. Increasing the business management knowledge of current and potential growers is vital to strengthening regional food systems and improving access to food.

What has been done
Extension agents from six counties hosted the NC Farm School Down East in 2018. A total of 19 agricultural entrepreneurs from eight counties completed the educational series, and 69% of those surveyed completed a written business plan.

Results
Participants in the NC Farm School Down East program estimated that they saved a total of $62,000 in business mistakes and start-up costs. They projected that the knowledge they gained through the program would increase their farm income by a total of $98,500. Statewide, 399 people have participated in Farm School since 2012. Graduates have developed 46 new farms and 140 continuing farms. In 2018, 88% of graduating students found a new market, 80% completed a business plan, and 73% have started agricultural development on previously unused land.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
602	Business Management, Finance, and Taxation
604	Marketing and Distribution Practices

Outcome #12

1. Outcome Measures

Integrated high tunnel and agroforestry technologies for vegetable production on small farms

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
High tunnels are protected growing structures that play a vital role in sustainable vegetable production, particularly on small to medium farms. The USDA Natural Resources Conservation Service provides cost sharing to help growers build high tunnels, but many growers lack the knowledge to plan and build an appropriate high tunnel set-up.

What has been done
Cooperative Extension in Vance County responded to this need by conducting consultations with high tunnel vegetable growers. A high tunnel vegetable production meeting was conducted with five producers from Kittrell, Bearpond, Middleburg,and Henderson communities. The extension agent partnered with WIZS radio to conduct radio programs on high tunnel crop production as well.

Results
Post meeting evaluations showed that all 5 producers had increased their knowledge of high tunnel crop production and intended to adopt Cooperative Extension?s recommendations. Four producers interviewed in November 2018 stated that they are successfully growing vegetables in high tunnels because of their adoption of the recommendations. Three farmers stated that they have been able to increase their profits by extending their growing season through the use of the high tunnels. They also want Cooperative Extension to conduct more high tunnel trainings in the upcoming year.

4. Associated Knowledge Areas

KA Code	Knowledge Area
204	Plant Product Quality and Utility (Preharvest)

205 Plant Management Systems

Outcome #13

1. Outcome Measures

Improved national capacity to meet growing food demands

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
With the emerging impacts of climate change, it is critical to create sustainable local food systems that can serve the 50 million food insecure individuals in the US while combatting food-related illnesses and preparing for the effects of an aging farm population. The Center for Environmental Farming Systems (CEFS) is a joint effort among NC State, NC A&T, and NCDA&CS aimed at developing and promoting a just and equitable food and farming system that conserves natural resources, strengthens communities, improves health outcomes, and provides economic opportunities in NC and beyond.

What has been done
CEFS integrates research, extension, and education to support sustainable agriculture, community-based food systems, and the development of NC's local food economy. CEFS efforts currently span over a dozen programs and initiatives, unifying hundreds of public and private sector partners statewide.

Results
In 2018, CEFS Food System Initiative Events reached 1,871 people to spread awareness about building food system networks, local and regional food business development, local foods, sustainable agricultural production, and other critical topics. CEFS empowered 1,490 farmers by providing workshops, trainings, and demonstrations to drive adoption of best practices and reduce farm-level food loss. In addition, CEFS raised $2 million in funding for a new crop breeding project and $500,000 in funding for a new greenhouse gas emissions project in the Farming System Research Unit.

4. Associated Knowledge Areas

KA Code	Knowledge Area
603	Market Economics
604	Marketing and Distribution Practices

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

Brief Explanation

Rapidly changing environmental and economic conditions, particularly the current over-supply of farm commodities and low prices, influence producers' abilities to adapt to change while ensuring sustainable production systems. NC legalized growing of industrial hemp and is working with farmers on regulations surrounding this crop. Continued effects of the economy on federal, state and local support for research and extension programs continue to challenge our research and extension enterprises. Likewise, regulatory and other governmental policies and rules influence the educational and research capacities of our programs and present challenges to producers, processors and marketers to comply with new and often expensive regulations. Revisions to federal Worker Protection Standard rules included annual training requirements. And in an environment of reduced funding, the program competition for existing funds becomes a greater challenge to manage. Nevertheless, emphasis is placed on those research and extension opportunities that have the greatest effect on sustainability of farms, families and businesses, i.e., economic, environmental, social and quality of life benefits. In 2018 North Carolina was hit by Hurricane Florence with 32 counties designated primary natural disaster areas by the USDA. The state's agriculture industry was then impacted by Tropical Storm Michael. Farm losses in North Carolina are estimated at $1.1 billion as a result of these two storms.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Outcomes and impacts determined from our research and extension programs support the principle that our programs engage a wide array of users across the state, help support enterprise and marketing change, involve integration of research and extension efforts, and create significant economic value to the state in terms of added value from innovations in agricultural production, costs saved and enhanced marketing approaches. Retrospective post evaluation surveys are used to identify knowledge gain, adoption of practices and economic or environmental impacts. Results indicate that producers are learning, and adopting practices, and in turn the changes are producing economic or environmental benefit. 18,685 plant systems producers adopted best management practices, including

those practices related to nutrient management, conservation, production, cultivars, pest management (weeds, diseases, insects), business management, and marketing resulting in a net income gain of $105,184,397.

Key Items of Evaluation

We are continually working to keep evaluation principles and tools aligned with plans of work, goals and objectives of our programs, and current best practices in program evaluation so that we can effectively report the results of our efforts.

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Global Food Security - Animals and Their Systems, Production and Health

☑ 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%	10%	9%	0%
302	Nutrient Utilization in Animals	15%	10%	15%	20%
303	Genetic Improvement of Animals	0%	20%	8%	20%
304	Animal Genome	0%	0%	7%	0%
305	Animal Physiological Processes	0%	0%	12%	30%
306	Environmental Stress in Animals	10%	0%	1%	0%
307	Animal Management Systems	10%	20%	26%	0%
311	Animal Diseases	10%	0%	12%	20%
312	External Parasites and Pests of Animals	5%	0%	5%	0%
313	Internal Parasites in Animals	5%	20%	0%	0%
315	Animal Welfare/Well-Being and Protection	5%	5%	0%	0%
511	New and Improved Non-Food Products and Processes	5%	0%	2%	0%
512	Quality Maintenance in Storing and Marketing Non-Food Products	5%	0%	0%	0%
601	Economics of Agricultural Production and Farm Management	5%	5%	3%	0%
602	Business Management, Finance, and Taxation	5%	5%	0%	0%
604	Marketing and Distribution Practices	5%	5%	0%	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	80.0	5.0	98.0	8.0
Actual Paid	20.7	5.5	88.0	21.0
Actual Volunteer	11.0	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**
1904120	87091	1948591	837089
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1904120	148658	1948591	604779
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
2593433	0	11367982	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The North Carolina Agricultural Research Service scientists conducted research projects to study methods to improve the efficiency of animal production. Research focused on methods to improve reproductive performance, nutrient utilization, and genetic influence on growth and reproduction. Scientists worked to improve animal management systems and environments, decrease the incidence of animal diseases and parasites (external and internal), improve the management of animal and agricultural pests, and find strategies to minimize the impacts of animal wastes in the environment. Species and commodity groups included in research are also very broad and include poultry such as turkeys, broiler chickens, and table-egg chickens. The research also includes swine, fish such as flounder, and cattle such as beef and dairy, and numerous pests such as house flies. Research included many phases of commodity production such as meat and dairy goats, chicken breeders (both broiler and table egg birds), commercial broilers (commercial refers to those animals produced for meat), breeder turkeys, commercial turkeys, swine breeders, commercial swine, all phases of aquaculture and beef and dairy production. Disciplines that were involved include nutrition, physiology, reproductive physiology, genetics, virology, bacteriology, microbiology, mycology, entomology, and many animal management systems such as grazing and forage management programs, hatchery management, feeding and drinking water systems, litter and bedding management, manure utilization, lighting programs, and breeder selection and management. A very important part of this work was to transfer technology and knowledge to our stake-holders and clientele. Therefore, an extensive outreach effort through Cooperative Extension was conducted by field and campus based faculty who are based on-site as well as being located across the state and based in local communities. Stakeholders and clientele are directly engaged in many ways including workshops, conferences, discussion groups, one-on-one teaching, demonstrations, field days, short-courses, continuing education classes, and scientific meetings. Indirect methods to reach stake-holders and clientele include long-distance education, newsletters, web sites, newspaper releases, television and radio programs, trade journals, scientific journals, and popular press articles. Focused educational programs conducted by Extension were provided to animal producers on adopting extension-recommended best management practices, including those practices related to husbandry, improved planning, marketing, and financial practices. Focused educational programs were also provided on Extension-recommended best management practices for animal waste management. NC State's Waste Processing Facility is used for waste management demonstrations. The Beef Cattle Genetics program in Extension is responsible for the North Carolina Beef Cattle Improvement Program at NC State; a cooperative herd improvement program in connection with the North Carolina Cattlemen's Association. Amazing Grazing is a pasture-based livestock educational initiative that began at CEFS' Field Research and Outreach Facility at Cherry Farm in Goldsboro and has developed into a statewide program delivered by NC State Extension. Special

educational programs focused on limited resource farmers continued to be a priority for NCA&T focused Extension efforts in pasture based production systems, aquaculture and alternative breeds.

2. Brief description of the target audience

The target audience is aquaculture, poultry, livestock producers, small-scale limited resource, beginning and underserved growers and agribusiness personnel in North Carolina. However, since North Carolina producers are some of the best in the world, ultimately, producers and agribusiness personnel across the country and around the world are the primary audience. The audience includes personnel in other state and federal agencies, local, state and federal politicians, and other stakeholders including the general public.

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	171485	430264	120604	86145

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

Patent Applications Submitted

Year:	2018
Actual:	1

Patents listed

Encapsulation of Nutritional and/or Compounds for Controlled Release and Enhancing their Bioavailability by Limiting Chemical or Microbial ExposurePCT/US2017/060667

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	23	173	196

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Participants in non-degree credit group training activities

Year	Actual
2018	28287

Output #2

Output Measure

- Relevant and impacts focused research projects to be conducted

Year	Actual
2018	95

Output #3

Output Measure

- Number of non-degree credit workshops and other formalized group educational sessions.

Year	Actual
2018	837

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Additional income gained by animal producers improved planning, marketing, and financial practices
2	Net income increased by producers improving animal husbandry practices
3	Number of animal producers adopting improved animal husbandry practices
4	Number Livestock Producers Adopting and Applying Improved Planning and Financial Management Practices
5	Number of new technologies developed to prevent/treat animal diseases
6	New organic, farmers and agritourism markets established by individual entrepreneurs

Outcome #1

1. Outcome Measures

Additional income gained by animal producers improved planning, marketing, and financial practices

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	3142426

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Very little training is provided to Cooperative Extension agents on niche meat production, making it difficult to provide training and technical assistance on niche meat production to Extension clientele. In fact, according to a recent survey of Cooperative Extension agents, 78% reported an interest in receiving training in pasture-based meats. In addition, the only independent poultry processing facility that serviced pastured poultry producers in NC closed in 2017, leaving many farmers without options for the 2018 season.

What has been done
NC State's Niche Meat Working Group coordinated a statewide improvement in poultry processing by purchasing a mobile processing trailer for Harnett County and neighboring counties to facilitate on-farm poultry processing demonstrations, opening an application for any county to apply for poultry processing supplies, and leveraging funds to advertise and support county-based poultry processing workshops statewide. NC State?s NC Choices Program also partnered with Cooperative Extension in Forsyth County to put on a meat marketing seminar.

Results
The Niche Meat Working Group delivered poultry processing resources to eight counties, and its programming reached a total of 158 Extension and farmer attendees. Resources and business templates have been shared across various workshops, and a free educational program for on-farm poultry processors has been launched. The meat marketing seminar sold out at 100 attendees, 95% of whom indicated that they increased their knowledge of profitable meat marketing.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
602	Business Management, Finance, and Taxation
604	Marketing and Distribution Practices

Outcome #2

1. Outcome Measures

Net income increased by producers improving animal husbandry practices

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	9427278

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The length of time that sows remain in production is directly related to their lifetime productivity. The current annual replacement rate for sows in the US is around 60%. This creates a situation in which most sow farms must replace their sows before they have recovered the cost of producing them and before they reach their most productive parities.

What has been done
NC State researchers have worked with the North Carolina Pork Council and the National Pork Board to develop management strategies for improving sow longevity and to create a proactive physiological test for sow longevity.

Results
Published research indicates that sow retention rates have doubled in the past four years on farms that have adopted these neonatal management strategies for replacement gilts. This has reduced the annual culling rate for sows from about 60% to 30%. This translates into each sow producing about 25 more pigs over her lifetime. Based on current market prices, this translates to

an increase of about $5,000 in gross income generated per sow. These results have also caused the National Pork Board to commit an additional $1.2 million over the next three years to further study factors affecting sow longevity.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
304	Animal Genome
305	Animal Physiological Processes
306	Environmental Stress in Animals
307	Animal Management Systems
311	Animal Diseases
312	External Parasites and Pests of Animals
313	Internal Parasites in Animals
315	Animal Welfare/Well-Being and Protection

Outcome #3

1. Outcome Measures

Number of animal producers adopting improved animal husbandry practices

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	7850

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Commercial poultry growers need support in mortality management and environmental stewardship to improve the performance of their poultry populations and drive short- and long-term profitability. Poultry growers especially need guidance in improving air, soil, and water quality to preserve the health of their animals, remain in compliance with regulations, and reduce their overall environmental footprint.

What has been done

Operating under the leadership of four area specialized agents, Cooperative Extension developed a program deployed across five locations statewide from January to April of 2018. This all-day seminar empowered growers with research on litter management to reduce nitrogen and phosphorus runoff, building litter storage sheds, composting systems for mortality disposal, and other crucial issues. Partners included the Prestage Poultry Science Department at NC State, other NC State specialists, USDA Natural Resources Conservation Service personnel, the NCDA&CS Vet division, and private industry partners.

Results

This program directly impacted 155 growers and indirectly impacted 900 poultry growers. Evaluations completed by 44 growers indicated that farmers saved or profited $500 to $1,000 by attending the program and using the knowledge gained to improve management of their poultry.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
304	Animal Genome
305	Animal Physiological Processes
306	Environmental Stress in Animals
307	Animal Management Systems
311	Animal Diseases
312	External Parasites and Pests of Animals
313	Internal Parasites in Animals
315	Animal Welfare/Well-Being and Protection

Outcome #4

1. Outcome Measures

Number Livestock Producers Adopting and Applying Improved Planning and Financial Management Practices

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	2617

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The cattle market reached all-time highs in 2014, and it has tapered off in the past three years, finally finding a bottom in 2016, but there are still ways to add value to calves through more advanced marketing programs. Calves that are sold in truck load lots consistently sell for $10?$30 per hundredweight higher than calves that are sold individually. Vaccinating and preconditioning these calves also increases their value to the feedlots that are purchasing them.

What has been done
Cooperative Extension in Duplin County partnered with the Southeast Livestock Exchange and Zoetis to manage and advise a group of producers that participate in the Coastal Carolina Cattle Alliance marketing program. Producers are provided with educational opportunities throughout the year and are given the opportunity to market their calves through this value-added program. In 2018, 20 producers from Duplin and surrounding counties sold their calves at three different sales with the CCCA.

Results
In 2018, 22 loads of value added calves were sold through the Coastal Carolina Cattle Alliance. The producers saw an average increase in profit of $70 per head, or approximately $123,550 total over 1,765 calves sold.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
602	Business Management, Finance, and Taxation
604	Marketing and Distribution Practices

Outcome #5

1. Outcome Measures

Number of new technologies developed to prevent/treat animal diseases

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Poultry and pork are important commodities for domestic consumption in the US and global exportation. Thus, disease outbreaks in these industries can adversely impact not only domestic production but also export revenue. Outbreaks can also harm the trade reputation of the US and result in bans on US meat products.

What has been done
A nationally and internationally recognized research program at NC state is exploiting the most recent developments in genomic, proteomic, and bioinformatic technology to discover the disease mechanisms of two infectious viruses that pose a significant threat to the US poultry and pork industries (Marek's disease virus and porcine reproductive and respiratory syndrome virus).

Results
Once the host and viral genes associated with the pathogenesis of these viruses are identified, they can be used to develop safer vaccines and more effective control strategies. These genes could also be used in breeding and selection efforts to produce resistant or tolerant animals. Such tools would not only decrease the economic impact of livestock losses but also shield people from contracting illnesses from diseased animals.

4. Associated Knowledge Areas

KA Code	Knowledge Area
306	Environmental Stress in Animals
311	Animal Diseases
312	External Parasites and Pests of Animals
313	Internal Parasites in Animals

315 Animal Welfare/Well-Being and Protection

Outcome #6

1. Outcome Measures

New organic, farmers and agritourism markets established by individual entrepreneurs

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	1315

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Support is needed for rural farms, specifically in the area of agritourism, to promote and protect local food systems and to provide visitors with unique experiences to learn about local farms. Agritourism also provides communities with the potential to increase their local tax bases and provide new employment opportunities.

What has been done
A collaborative effort between Cooperative Extension in Swain County?s Livestock and FCS/CRD agent, a certified yoga instructor, and owners of Darnell Farms offered a unique and stand-alone opportunity for tourists and locals to participate in goat yoga. Through the hands-on-experience obtained by participating in goat yoga, the participants were introduced to caring for and raising livestock, including animal health and animal nutrition. The livestock agents discussed the benefits derived from raising livestock. Participants also engaged in physical activity and experienced first-hand the benefits of doing yoga. The participants were able to tour Darnell Farms and were encouraged to purchase fresh fruits and vegetables from the farm. Seventeen people participated, with many curious onlookers who chose to observe the session.

Results
The participants described a very positive experience on the farm. Several tourists reported that it was their first visit to the farm and that they came especially for goat yoga. They also inquired about other opportunities and events that are held at Darnell Farms. Questions were answered about local 4-H opportunities and about other classes offered through the Extension office. Many participants stated that they would recommend Darnell Farms and goat yoga.

4. Associated Knowledge Areas

KA Code	Knowledge Area
511	New and Improved Non-Food Products and Processes
512	Quality Maintenance in Storing and Marketing Non-Food Products
601	Economics of Agricultural Production and Farm Management
602	Business Management, Finance, and Taxation
604	Marketing and Distribution Practices

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

Constantly changing environmental and economic conditions (weather, economic climate, feed prices, regulatory climate) influence producers' abilities to accommodate change and innovation, while ensuring the sustainability of their enterprises. Economic pressures continue to influence federal, state and local support for research and extension activities. Regulatory and other governmental policies influence the educational and research capacities of our programs and present challenges to producers, processors, and marketers of animal products to comply with emerging and often expensive regulations. And in an environment of reduced appropriated funding, the program competition for existing funds becomes greater. Nevertheless, emphasis is placed on those research and extension opportunities which will have enduring benefits to farmers, their families, businesses, communities and their industries, in terms of economic, environmental, social and quality of life considerations. Particular emphasis has been directed toward increasing the production of feed grains for the livestock and poultry industries in the state, generating revenue for grain farmers and greatly reducing costs to the livestock and poultry industries to import grain for their enterprises. In 2018 North Carolina was hit by Hurricane Florence with 32 counties designated primary natural disaster areas by the USDA. The state's agriculture industry was then impacted by Tropical Storm Michael. Farm losses in North Carolina are estimated at $1.1 billion as a result of these two storms. North Carolina's poultry sector suffered the loss of at least 3.4 million chickens and turkeys as a result of impacts from Hurricane Florence and the state's swine losses are estimated to be 5,500 hogs.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Evaluation of faculty activity reports, intellectual property creation (invention disclosures), peer reviewed journal articles, and data from our Extension Reporting System shows that our research and extension efforts in this planned program area are successful in engaging a wide array of animal agriculture producers, processors and marketers. The data indicate that delivery of relevant research information and research backed production best management practices are associated with significant improvement in profitability of livestock and poultry operations. Faculty are successful in influencing individual producers as well as production companies that our research findings can generate additional profitability in their operations, sometimes with added environmental benefit. Results indicate that producers are learning, and adopting practices, and in turn the changes are producing economic or environmental benefit.13,196 animal producers adopted best management practices, including those practices related to husbandry, animal waste management, use of livestock organic by-products, improved planning, marketing, and financial practices resulting in a net income gain of $24,540,007.

Key Items of Evaluation

We are continually working to keep evaluation principles and tools aligned with plans of work, goals and objectives of our programs, and current best practices in program evaluation so that we can effectively report the results of our efforts.

V(A). Planned Program (Summary)

Program # 3

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
102	Soil, Plant, Water, Nutrient Relationships	20%	40%	46%	35%
111	Conservation and Efficient Use of Water	10%	20%	5%	5%
112	Watershed Protection and Management	20%	20%	10%	10%
133	Pollution Prevention and Mitigation	5%	10%	13%	10%
141	Air Resource Protection and Management	5%	10%	0%	5%
401	Structures, Facilities, and General Purpose Farm Supplies	5%	0%	0%	0%
402	Engineering Systems and Equipment	10%	0%	6%	5%
403	Waste Disposal, Recycling, and Reuse	10%	0%	1%	0%
404	Instrumentation and Control Systems	10%	0%	1%	5%
405	Drainage and Irrigation Systems and Facilities	5%	0%	2%	5%
605	Natural Resource and Environmental Economics	0%	0%	16%	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	72.0	2.5	23.0	6.0
Actual Paid	9.4	2.0	21.1	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**
1163629	68439	2041381	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1163629	51559	2041381	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	8860	11909315	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research focused on creating new knowledge and solutions from basic research (e.g., nutshell-based activated carbons), to agricultural production systems research, to natural resource pollution prevention strategies, to examining people's attitudes and concerns about environmental issues and policies, including economic considerations. With this research information in hand, improved management, technological solutions and policies to environmental and natural resource utilization problems are proposed and evaluated with farmers, businesses, stakeholders and communities. Technology transfer occurs through demonstrations, workshops, and various media from Cooperative Extension in concert with researchers. NC State Extension provides focused educational programs on animal waste management systems. NC State Extension provides focused educational programs on Stormwater BMP Inspection and Maintenance.

2. Brief description of the target audience

Agricultural producers, agriculturally related businesses, environmental and governmental agencies, news media, general public, limited resource audiences, rural appraisers, commodity associations

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	41624	50020	84482	46165

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	7	57	64

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Waste Management Certification Programs

Year	Actual
2018	59

Output #2

Output Measure

- Number research project completed on environmental/natural resource issues

Year	Actual
2018	75

Output #3

Output Measure

- Enrollees for Natural Resources Leadership Institutes training

Year	Actual
2018	0

Output #4

Output Measure

- Number of non-degree credit workshops and other formalized group educational sessions.

Year	Actual
2018	445

Output #5

Output Measure

- Number of participants in non-degree credit activities

Year	Actual
2018	14958

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of farms utilizing precision application technologies
2	Number farms implementing best management practices for animal waste management
3	Number urban households/small farms with low-literacy individuals implementing or adopting best management practices to enhance water quality
4	Number waste management certifications gained or maintained
5	Number acres where proper waste analysis was used for proper land application
6	Number growers implementing stream protection practices
7	Number storm water systems installing BMPs
8	Number farms adopting use of biofuels
9	Number growers implementing improved irrigation and drainage systems

Outcome #1

1. Outcome Measures

Number of farms utilizing precision application technologies

2. Associated Institution Types

- 1862 Extension
- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Effective agricultural water management is critical to feeding a growing world population in the face of the continuous decline in agricultural land and water resources. Innovative and transformative water management techniques are needed to increase the resilience of crop production to climate change and variability and reduce the transport of nutrients and sediment from agricultural lands to receiving surface waters.

What has been done
An NC State research team is conducting experimental and modeling research on agricultural water management with the aim of increasing crop productivity and resiliency while reducing the negative environmental impacts of crop production systems on artificially drained land. A new generation of drainage water control structures has been designed to minimize the time and cost of drainage water management. These structures can be adjusted to automatically open and close according to a pre-set schedule, and a smart water management system has been designed to manage the outlets of the drainage systems in light of soil water conditions in the field.

Results
The new water management structures are being demonstrated at two sites, and the NC State research team continues to investigate the effects of water management on crop yield and nutrient export to surface waters. This research addresses local, national, and global needs to adapt crop production to a changing environment. Thus far, the research has shown that supplemental irrigation during dry periods in the growing season could increase corn yields by more than 20%, and subirrigation during dry periods could increase soybean yields by more than 30%. The development of a smart agricultural water management system will also lead to the

revitalization of controlled drainage in NC, driving increased crop production, reduced production costs, water conservation, and enhancement of water surface quality.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
404	Instrumentation and Control Systems

Outcome #2

1. Outcome Measures

Number farms implementing best management practices for animal waste management

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	2730

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
According to the NC Department of Agriculture and Consumer Services 2012 Agricultural Statistics report, swine production contributed a gross income of $2,509,280,000 to NC's economy. The farmers that operate swine farms must maintain an Animal Waste license to ensure that they are up to date on training to operate the effluent systems on their farm. In order to maintain this license, farmers must earn a minimum of six hours of credit every three years. Swine production generates waste that must be managed properly in order to ensure that our environment and natural resources are not damaged.

What has been done
In partnership with the NC Pork Council, NC Division of Water Quality, US Department of Agriculture, the NC Division of Soil and Water Conservation, and Murphy Brown, the NC Cooperative Extension Service in Northeast NC provided over 156 credit hours of waste management training to licensed animal waste operators at the 2018 Northeast Pork Conference. Trainings like these serve to keep animal waste system operators up to date on techniques and management practices they can use to optimize production while ensuring that they are doing everything they should to protect our natural resources.

Results
Producers were asked what the value of this training was worth to their farming operation for the 2018 farming season, and a total value of $7,850.00 was recorded. By attending the conference, the producers were able to maintain their licenses and continue using their waste systems. Statewide, 2,479 animal waste management certifications were gained or maintained, and Extension-recommended waste analysis was used for proper land application on 1,082,302 acres.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
133	Pollution Prevention and Mitigation
141	Air Resource Protection and Management
403	Waste Disposal, Recycling, and Reuse

Outcome #3

1. Outcome Measures

Number urban households/small farms with low-literacy individuals implementing or adopting best management practices to enhance water quality

2. Associated Institution Types

- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Knowledge of best practices is critical to empowering individuals to produce their own food and create beautiful landscapes in a sustainable, cost-effective manner. Failure to use best practices for horticultural production can lead to poor plant health, wasted costs, frustration, and abandonment of growing efforts.

What has been done
To strengthen the ability of individual households to apply best management practices in horticultural production, Cooperative Extension in Chowan, Gates, and Perquimans Counties offered the Gardening in Albemarle program, a six-week course tailored to the needs of new

gardeners and new residents. Fifty participants registered for the program and provided their feedback on the program's effectiveness.

Results
All of the participants indicated that they improved their knowledge, skills, and goals surrounding gardening and landscaping practices, and 73% indicated they would implement Extension-recommended practices to conserve water use and protect water quality. Total cost savings from the use of Extension-recommended practices to conserve water use and protect water quality exceeded $2,300.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management

Outcome #4

1. Outcome Measures

Number waste management certifications gained or maintained

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	2479

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Due to legislation, increased public awareness, and an increasingly sophisticated population of professionals in environmental fields, there is a growing need for training programs in NC on waste management, nutrient management, and watershed protection.

What has been done
NC State's Soil Science Department offered 63 short courses and conferences in 2018 for erosion and sediment control professionals, municipal and industrial wastewater operators, environmental health specialists, septic system installers and operators, professional engineers, soil scientists, well contractors, water quality specialists, government agency employees, and

elected officials.

Results

In 2018, 4,238 participants received technical training for license renewal and/or professional development. Statewide, 2,479 animal waste management certifications were gained or maintained, and Extension-recommended waste analysis was used for proper land application on 1,082,302 acres.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
133	Pollution Prevention and Mitigation
141	Air Resource Protection and Management
403	Waste Disposal, Recycling, and Reuse

Outcome #5

1. Outcome Measures

Number acres where proper waste analysis was used for proper land application

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	1082302

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Animal producers must comply with diverse rules and regulations to protect the environment and remain in compliance with the Division of Water Resources (DWR) standards. Producers must conduct annual sludge surveys of lagoons and submit plans of action to re-establish compliance if the sludge content of the lagoons is too high. If a producer is out of compliance, they may receive fines from the DWR ranging from $500 per incident to $25,000 per day in violation.

What has been done

In 2018, Extension agents in Sampson and Bladen counties provided waste management assistance to swine and poultry producers. Agents worked with producers to conduct sludge surveys for 73 lagoons. After completing the surveys, the farmers were provided with the completed sludge reports to aid in their annual inspection from the DWR. The agents assisted five producers in calibrating six equipment systems.

Results

Farmers doing their own sludge surveys and calibrations saved the producers over $11,000. An NC State Extension agent completed plans of action for high freeboard for 73 lagoons to help them stay in compliance. After Hurricane Florence, 33 waste utilization plans were updated with temporary amendments, and Extension wrote two sludge plans and 17 amendments on 550 acres, resulting in 54,660 extra pounds of plant available nitrogen (PAN) being applied to these fields.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
133	Pollution Prevention and Mitigation
141	Air Resource Protection and Management
403	Waste Disposal, Recycling, and Reuse

Outcome #6

1. Outcome Measures

Number growers implementing stream protection practices

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

As the ninth most populous state and the 10th fastest growing, NC is facing increasing pressure

on water resources. In addition, increasing storm water flows in the state are causing stream impairment, sedimentation, and property loss that affects growers, landowners, and local government. These groups are seeking cost-effective solutions to control eroding stream banks and preserve water quality.

What has been done

Cooperative Extension partners with state Extension specialists, local governments, environmental groups, engineers, private industry, and landowners to troubleshoot problem stream areas, gather data, build awareness, and provide hands-on training in streambank stabilization. For the past 10 years, these efforts have steadily expanded education efforts, increased the number of practices installed, and reduced streambank erosion and nutrient runoff into local streams. In addition, NC State researchers have partnered with the NC DOT to assess the impact of stream restoration on water quality by studying water quality before, during, and after restoration of a stream reach in Goldsboro, NC.

Results

In 2018, 15 streambank repair workshops and one conference were held statewide, reaching over 920 participants. During the workshops themselves, 1,800 linear feet of streambanks were repaired, with surveys indicating an additional 1,500 feet repaired. These efforts will reduce soil loss by 121 tons per year, and the value of nutrients removed from the water is estimated at $1,037,000. In addition, observations made at the 2 km-long research stream reach in Goldsboro, NC have shown that it is possible to measure water quality on a near continuous basis and that the stream restoration had a large beneficial effect on water quality within months of completion.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
402	Engineering Systems and Equipment
405	Drainage and Irrigation Systems and Facilities

Outcome #7

1. Outcome Measures

Number storm water systems installing BMPs

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
As NC's population continues to grow at an estimated rate of more than 250 residents per day, local government water quality officials must focus on pollution control in urban areas that are especially vulnerable to stormwater runoff. Pollution from such runoff damages streams and compromises drinking water supplies.

What has been done
For the past 12 years, Cooperative Extension agents in Franklin and Wake Counties have been leveraging Extension and community resources to deliver hands-on educational workshops on stormwater control. These workshops target local decision-makers, property owners and managers, engineers, professional landscapers, local officials, educators, and other local stakeholders.

Results
In 2018, four stormwater control workshops were delivered, and an additional 23 practitioners received certification, bringing the total number certified statewide to 449. Certified practitioners reported designing or maintaining an additional 65 raingardens in 2018, bringing the total number of raingardens installed by participants to 374. Raingardens installed to date will prevent $54,073 worth of nitrogen and phosphorus from entering NC waters and infiltrate and clean an estimated $952,214 worth of additional future drinking water.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
402	Engineering Systems and Equipment
404	Instrumentation and Control Systems
405	Drainage and Irrigation Systems and Facilities

Outcome #8

1. Outcome Measures

Number farms adopting use of biofuels

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Growing energy costs and dependence on foreign oil have led to an increase in research to discover alternative and renewable fuels. Agro-industrial residues and biomass crops contain complex carbohydrates that can be converted into biofuels. NC is uniquely situated within a climate zone that is friendly to multiple crops suitable for bioenergy synthesis. Investigating the production and conversion of biomass to renewable energy in NC can provide renewable domestic energy sources and bring new jobs to the region.

What has been done
NC State researchers have begun establishing production and processing practices for growing and converting biomass feedstocks into renewable energy sources. This work includes field testing of new bioenergy crops, continued testing of established bioenergy crops, and investigation of novel biomass conversion processes.

Results
Camelina crop production efforts at NC State are revealing cultural management and crop development requirements to effectively produce this oilseed as a fuel feedstock and winter cover in NC. Improved storage solutions for biomass feedstocks in NC's climate are also being created to support developing biomass conversion processes. In addition, near infrared spectroscopy models have been developed to estimate the composition of biomass materials, reducing the labor and time demands associated with routine biomass processing measurements. NC State researchers are also currently evaluating the field performance of numerous high-yielding varieties of a promising perennial energy grass known as miscanthus?15 of which were developed through a 10-year NC State breeding program?in different areas of the state.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
133	Pollution Prevention and Mitigation
605	Natural Resource and Environmental Economics

Outcome #9

1. Outcome Measures

Number growers implementing improved irrigation and drainage systems

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Numerous production problems plague the blueberry industry, including crop loss due to spring freezes. Late spring freezes can destroy flowers and easily wipe out an entire year?s blueberry crop. Overhead irrigation can provide protection against such freezes, but only with a carefully designed irrigation system.

What has been done
Researchers at NC State have designed a high-volume, low-pressure irrigation system to protect blueberry blooms and berries. Although these systems are expensive, most growers have realized that such systems can pay for themselves in a single night of freeze protection.

Results
Over 85% of blueberry fields in NC are now protected by overhead irrigation. The advent of irrigation for freeze protection has not only decreased the impact of spring freezes on blueberry crops but also increased yields.

4. Associated Knowledge Areas

KA Code	Knowledge Area
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
402	Engineering Systems and Equipment

404 Instrumentation and Control Systems

405 Drainage and Irrigation Systems and Facilities

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

Brief Explanation

Rapidly changing economic and environmental conditions influence producers' and communities' capacities to adapt to change and at the same time, sustain their operations. Water supplies for irrigation, high cost of fuels, and harsh weather systems present significant challenges all too often. Changing federal, state local funding commitments for research and extension programs are challenged regularly. And regulatory and other governmental policies challenge the entire community, which our research and extension programs serve. Nevertheless, we are committed to ensuring that programs that endure are those that will have significant economic, environmental, social and quality of life benefits to our stakeholders.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Examination of the outcomes and impacts in this program area indicate significant benefits in the areas of waste management, nutrient capture and utilization, and water quality protection, along with some of the economic benefits that accrue to those outcomes. Evaluation results show, in NC there were 1,082,302 acres where Extension-recommended waste analysis was used for proper land application. 2,157 farm operators attended certification training for Animal Waste Land Applicators. In addition, 114,249 acres are under recommended climate adaption strategies for production agriculture or natural resource management, including for invasive species, pest management, pollutant loads, and wetlands and 35,237 acres are under recommended climate mitigation practices such as water-use efficiency, livestock production feeding practices, carbon sequestration, reducing carbon or energy footprint.

Key Items of Evaluation

We are continually working to keep evaluation principles and tools aligned with plans of work, goals and objectives of our programs, and current best practices in program evaluation so that we can effectively report the results of our efforts.

V(A). Planned Program (Summary)

Program # 4

1. Name of the Planned Program

Sustainable Energy including Biotechnology

☑ 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
101	Appraisal of Soil Resources	0%	0%	6%	0%
102	Soil, Plant, Water, Nutrient Relationships	0%	0%	12%	0%
111	Conservation and Efficient Use of Water	0%	0%	3%	0%
133	Pollution Prevention and Mitigation	0%	0%	4%	0%
136	Conservation of Biological Diversity	0%	0%	6%	0%
201	Plant Genome, Genetics, and Genetic Mechanisms	0%	0%	16%	0%
202	Plant Genetic Resources	0%	0%	2%	0%
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	0%	0%	18%	0%
205	Plant Management Systems	0%	0%	0%	20%
213	Weeds Affecting Plants	0%	0%	1%	0%
401	Structures, Facilities, and General Purpose Farm Supplies	34%	0%	0%	0%
402	Engineering Systems and Equipment	33%	100%	6%	10%
403	Waste Disposal, Recycling, and Reuse	0%	0%	1%	30%
511	New and Improved Non-Food Products and Processes	0%	0%	7%	40%
601	Economics of Agricultural Production and Farm Management	0%	0%	12%	0%
605	Natural Resource and Environmental Economics	33%	0%	6%	0%
	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	8.0	0.0	8.0	5.0
Actual Paid	0.5	0.0	7.0	9.9

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**
105784	0	92790	265365
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
105784	0	92790	268970
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	541332	22473

V(D). Planned Program (Activity)

1. Brief description of the Activity

Work in this planned program areas included developing productive efficient systems to profitably produce a variety of crop and forestry based substrates for biofuels production, developing engineering solutions and systems to efficiently convert raw materials into useable fuels, exploiting bioprocessing systems to produce a variety of compounds that might have utility in processing and manufacturing processes, and advancing or knowledge of energy use and conservation in human, agricultural, animal and processing environments. Solutions and systems were communicated to users through extension education and demonstration activities.

2. Brief description of the target audience

Scientists, commercial and limited resource farmers, regulatory entities, homeowners, general public, agribusinesses

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	9	70	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	1	29	30

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Studies on producing agricultural and forestry substrates for biofuel production

Year	Actual
2018	5

Output #2

Output Measure

- Studies on engineering conversion processes for biofuels and other components

Year	Actual
2018	4

Output #3

Output Measure

- Educating homeowners, growers and processors through workshops and other group educational approaches on sustainable energy topics (no. of participants)

Year	Actual
2018	298

Output #4

Output Measure

- Number of non-degree credit workshops and other formalized group educational sessions.

Year	Actual

2018 7

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	New crops or other biofuels substrates identified
2	New bioprocessing technologies developed
3	New bioproducts identified
4	Number of households improving energy conservation measures
5	Installation of energy saving strategies on animal and crop production facilities
6	Enhanced large scale oilseed biofuel production among small scale producers

Outcome #1

1. Outcome Measures

New crops or other biofuels substrates identified

2. Associated Institution Types

- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
America needs new sustainable energy sources. Panicum virgatum, commonly known as switchgrass, is a warm season grass native to North America that offers promise as a biofuel species due to its high biomass production, ability to thrive within a broad geographic range, and perennial nature. Recent research has shown that switchgrass contains fungal symbionts that play an important role in the physiology of the host species.

What has been done
NC State researchers are currently investigating switchgrass as a biofuel species by analyzing the fungal communities that impact the tissues of this species and exploring potential avenues for manipulating microbial communities to increase the plant?s biomass output.

Results
Isolation of the fungi that share a symbiotic relationship with switchgrass has the potential to make this plant species? biofuel potential into a reality.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
133	Pollution Prevention and Mitigation
136	Conservation of Biological Diversity

201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
213	Weeds Affecting Plants
403	Waste Disposal, Recycling, and Reuse

Outcome #2

1. Outcome Measures

New bioprocessing technologies developed

2. Associated Institution Types

- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Dwindling petroleum reserves and the environmental impact of exhaust gases from petroleum diesel have resulted in an increased demand for biofuels. Although this alternative fuel burns clean, biofuel derived from unimproved oil crops cannot realistically compete with fossil fuels due to production costs and the limited availability of cultivable land for fuel crops. However, there are several emerging areas of biotechnology that can be exploited to improve biofuel production.

What has been done
NC State researchers have undertaken a project to improve the biofuel production potential of the oilseed plant Camelina sativa by developing a new synthetic carbon dioxide fixation cycle. In addition, they are developing scalable algal bioreactor systems to enable conversion of microalgal fatty acids and lipids into fuel. NC State researchers have also demonstrated that lignocellulose degrading microorganisms isolated from the guts of wood-eating insects can potentially serve as a means of cost-effectively converting agricultural residues and paper pulping waste to feedstock for fuel and commodity chemical production.

Results

A patent has been submitted for the synthetic carbon fixation enzymes discovered by NC State researchers, and the efficacy of these enzymes has been demonstrated. NC State researchers have also identified and characterized microbial genes that can improve oil production in microalgae, and a patent has been filed describing the genetic modification of the marine microalgae Dunaliella salina. In addition, an invention disclosure has been submitted to OTT describing the technology that NC State researchers have developed to isolate lignocellulose degrading microbes from the guts of wood-eating insects.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
213	Weeds Affecting Plants
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse

Outcome #3

1. Outcome Measures

New bioproducts identified

2. Associated Institution Types

- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Agricultural and food wastes threaten environmental health and create economic burdens. The creation of a waste-based biorefinery would enable the production of energy, fertilizers, and clean

water from agricultural and food wastes. The introduction of a well-designed waste-based biorefinery in the agricultural industry could increase the efficiency of local resource usage, reduce the import of energy and fertilizers, and improve the environmental sustainability and economics of agricultural production.

What has been done

NC A&T researchers have treated various agricultural (cattle manure and swine wastewater) and food wastes (corn stover) to enhance anaerobic digestion and investigate the interaction of systems that can facilitate biogas and methane production.

Results

The findings to date will help lay a foundation for a complete system for removing useful byproducts and clean water from animal wastewater. It will also support the production of environmentally friendly biofuels and fertilizers.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
133	Pollution Prevention and Mitigation
136	Conservation of Biological Diversity
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
213	Weeds Affecting Plants
403	Waste Disposal, Recycling, and Reuse

Outcome #4

1. Outcome Measures

Number of households improving energy conservation measures

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Installation of energy saving strategies on animal and crop production facilities

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Animal farms are evolving toward larger and more concentrated operations and facing significant challenges that affect their viability and sustainability. Climate change concerns, increasing energy costs, and animal welfare issues increase the challenges. The animal industry needs a trained workforce with the knowledge and technological competency to transform these industry challenges into opportunities to drive sustainable animal production.

What has been done
NC State is developing eLearning curricula on Controlled Environment Animal Production (eCEAP). These curricula are designed to tap into complementary faculty research experiences and expertise in sustainable energy, climate change, food security and safety, and advanced digital learning technologies to encourage the interests of minority students in the fields of food, agricultural science, and engineering.

Results
In 2018, 19 educational modules were released spanning animal environmental control, air quality, production economics, food safety, welfare, and species specific production systems. These modules increased the number and diversity of undergraduate and graduate students and enhanced the workforce skills and knowledge surrounding the adaptation of farm operations to sustainable energy, climate change challenges, and food safety and security. In the long term, this project will directly contribute to the adoption of renewable energy systems on farms, sustainable animal feeding operations, improved air quality, adaptation to climate change, improved animal welfare and productivity, and decreased food safety concerns.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
605	Natural Resource and Environmental Economics

Outcome #6

1. Outcome Measures

Enhanced large scale oilseed biofuel production among small scale producers

2. Associated Institution Types

- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The development of engineering techniques to exploit plant-based biomass and enhance the economic security of the US has been defined as a major research priority by federal, industrial, and academic groups. Agro-industrial residues and dedicated biomass crops contain complex carbohydrates that can be converted to high-value products (e.g., food products, pharmaceuticals, biochemicals, biopolymers, and biofuels). The development of biologically-based methods for converting and processing raw materials into higher-value, cost-effective products will increase the feasibility of using plant-based resources as additional feedstocks for consumer goods.

What has been done
NC State researchers are investigating the production of bio-based products?such as enzymes, biochemicals, and biofuels?from agro-industrial residues and dedicated biomass crops. Several areas make up the research program designed to address the diversity of renewable resources and processing methods that can be applied to generate products and enhance value. These include research into semi-solid fermentation technology, enzymatic conversion methods and fermentation for development of effective biomass conversion processes, hybrid application of thermal and microbial conversion technologies for biofuel production from lignocellulosic biomass, and integrated processing systems linking crop production and storage practices to the development of conversion technologies.

Results
Additional value-added products from the sweet sorghum crop have been demonstrated through ensilage and feed-out studies at NC State Field Labs. Fermentation studies with adapted C. beijerinckii strain SA1 for butanol production and C. thermocellum using carbon derived from sweet sorghum and perennial grasses are providing key information for the next phase of ?

advanced? biofuels. Near infrared (NIR) spectroscopy models have been developed to estimate the composition of biomass materials, reducing the labor and time investment required for routine processing measurements. In addition, compositional changes measured in a variety of bale storage methods show promise for these methods as storage solutions for biomass feedstocks in the Southeast climate. Ensiled bioenergy crops offer unique storage options for biomass feedstocks used in the developing conversion processes. Perennial grasses and sorghums grown on sprayfields have also shown promising establishment, as well as dry matter yields, and they have the potential to add value above the common Bermudagrass options. In addition, Camelina crop production efforts are elucidating cultural management and crop development needs to effectively produce this oilseed as a fuel feedstock and winter cover in NC.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
133	Pollution Prevention and Mitigation
136	Conservation of Biological Diversity
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants
205	Plant Management Systems
213	Weeds Affecting Plants
401	Structures, Facilities, and General Purpose Farm Supplies
402	Engineering Systems and Equipment

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

Brief Explanation

Economic and environmental considerations related to energy use, sources and conservation continue to present challenges to both producers and users of energy. North Carolina's bioenergy research efforts have focused on developing biomass sources and processes suitable for capturing biofuels from those materials. That has been a slow process, even though plant breeders and agronomists continue to work toward prolific and productive plants to produce biomass. Energy conservation in homes and business continues to get some emphasis, especially as it relates to solar energy. And some of our

research and engineering efforts have targeted energy use in both cooling and heating livestock and poultry buildings, with some success with solar approaches for heat and geothermal processes for cooling. Considerable opportunities may exist for continued impact in these areas.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Our research support base is modest, but nevertheless, our scientists and extension workers in this area have demonstrated the capacity to acquire external grants, publish their work in peer reviewed journals, and generate new processes and products. Plant breeders and agronomists have been successful in developing new cultivars of biomass producing grasses for potential biofuels production. Process engineers have made progress in solving some of the challenges to producing cellulosic ethanol. Evaluation results found that 161 producers who adopted a dedicated bioenergy crop and 29,677 acres were planted to a dedicated bioenergy crop in 2018.

Key Items of Evaluation

We are continually working to keep evaluation principles and tools aligned with plans of work, goals and objectives of our programs, and current best practices in program evaluation so that we can effectively report the results of our efforts.

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

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
703	Nutrition Education and Behavior	50%	50%	50%	50%
724	Healthy Lifestyle	50%	50%	50%	50%
	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	48.0	15.0	8.0	3.0
Actual Paid	5.0	17.3	3.5	2.3
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**
317353	220466	0	59064
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
317353	103387	0	109198
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
3241791	489844	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The Childhood Obesity Planned Program provides science-based educational and experiential learning opportunities that focus on both children and adults. Programs developed and provided by NC

Cooperative Extension in the area of healthy weight for children and adults is part of the larger initiative Eat Smart, Move More North Carolina. Important program activities include: EFNEP, the Expanded Food and Nutrition Education Program, is a federally funded educational program administered in North Carolina through NC State University and N.C. A&T State University. The Supplemental Nutrition Assistance Program-Education (SNAP-Ed) serves limited resource families across North Carolina to assist those eligible for food assistance to eat smart and move more. SNAP-Ed works to help participants make healthy choices within a limited budget and choose physically active lifestyles.

2. Brief description of the target audience

Intended audiences include children of all ages, youth, their adult family members, child-care providers, Head Start workers, food banks, food stamp and WIC recipients and community coalitions.

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	291372	874116	132870	99902

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

- Number of non-degree credit group activities conducted Healthy Eating, Physical Activity and

Chronic Disease Reduction

Year	Actual
2018	3248

Output #2

Output Measure

- Targeted audiences participate in workshops on Food, Nutrition and Childhood Obesity

Year	Actual
2018	61153

Output #3

Output Measure

- Relevant and impact focused research projects conducted

Year	Actual
2018	1

Output #4

Output Measure

- Number of participants in non-degree programs and activities

Year	Actual
2018	96029

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Program participants (adults) increase fruit and vegetable consumption
2	Program participants (youth) increase their fruit and vegetable consumption
3	Program participants increase their physical activity
4	Program participant reduce their BMI
5	Program participants (adults) decrease blood pressure
6	Program participants (adults) improve their blood glucose (A1c.) level
7	Program participants (adults) reduce their cholesterol
8	Program participants consume less sodium in their diet
9	Families, children, and youth have access to healthy food

Outcome #1

1. Outcome Measures

Program participants (adults) increase fruit and vegetable consumption

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	11486

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Eating the recommended amount of fruits, vegetables, and beans is critical to maintaining a healthy diet and reducing the risk of many chronic diseases, including heart disease, high blood pressure, and diabetes. Limited-resource families are at a greater risk of chronic diseases associated with poor nutrition, including obesity. In NC, about 66% of adults are overweight or obese, and 27% of US health care costs are related to obesity.

What has been done
North Carolina Cooperative Extension's Expanded Food and Nutrition Education Program (EFNEP) helps food-insecure families learn how to provide nutritious, safe meals for their families on limited budgets. EFNEP targets key behaviors, including low consumption of fruits and vegetables, to reduce the risk of overweight and obesity.

Results
Statewide, 11,486 adults increased their fruit and vegetable consumption as a result of Extension programs, including classes on how to grow, purchase, and cook healthy fruits and vegetables. In 2018, EFNEP enrolled 2,728 families, and 17,209 school-aged youth participated in 4-H EFNEP programs to address food resource management, nutrition practices, food safety, and changes in physical activity. According to the EFNEP Web-based Nutrition Education Evaluation and Reporting System annual report, 95% of participants improved dietary intake, 85% now practice daily physical activity, 89% practice better food resource management, and 86% have improved their food safety habits.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
724	Healthy Lifestyle

Outcome #2

1. Outcome Measures

Program participants (youth) increase their fruit and vegetable consumption

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	26642

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
NC struggles with high rates of chronic disease such as obesity, type 2 diabetes, heart disease, and stroke. These are the consequences of poor eating habits and lack of physical activity. Nearly two-thirds of adults are overweight or obese, and only 25% of children consume the daily recommended amount of fruits and vegetables. Additionally, almost half of NC children spend more than two hours per day watching television, playing video games, or using tablets or phones.

What has been done
The Family and Consumer Science Agent in Montgomery County partnered with the after-school Director at Star Elementary School to provide 8 weeks of education utilizing the Speedway to Healthy curriculum, developed by Cooperative Extension at North Carolina A&T. Specific instruction focused on MyPlate, physical activity and parts of the body including the brain, heart, lungs, and kidneys. Although participation varied from 10-16 students, a core group of 12 students remained consistent in the program from start to finish. In addition to interactive educational activities, students were able to prepare and sample healthy snacks throughout the program.

Results
At the end of the program, all participants reported being physically active on most days of the week, eating breakfast more often and
wanting healthier snacks. Eighty three percent of participants reported eating more fruits, and 75% reported eating more vegetables after this program. Almost three-quarters of parents reported their children asking for healthy snacks more often. Parents perception of children eating fruits and vegetables, eating breakfast and being active increased at the end of the program as well.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
724	Healthy Lifestyle

Outcome #3

1. Outcome Measures

Program participants increase their physical activity

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	23771

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
According to CDC guidelines, adults should do at least 150 minutes a week of moderate intensity aerobic physical activity, and adolescents should be physically active at least 60 minutes per day. Participation in physical activity is important to maintaining a healthy weight and reducing the risk of many chronic diseases, including heart disease, high blood pressure, and diabetes. In NC, about 66% of adults are overweight or obese, and 27% of US health care costs are associated with obesity.

What has been done

North Carolina Cooperative Extension's Expanded Food and Nutrition Education Program (EFNEP) targets key behaviors, such as increasing physical activity, to reduce the risk of overweight and obesity. The Eat Smart, Move More program motivates participants to change their physical activity patterns. In addition, the Swain County Cooperative Extension FCS agent partnered with the Swain County Health Department and Know It! Control It! Volunteers to offer an eight-session blood pressure control program over four months at the Swain County Senior Center.

Results

Statewide, 23,771 individuals increased their physical activity through Extension programs. In 2018, EFNEP enrolled 2,728 families, and 17,209 school-aged youth participated in 4-H EFNEP programs to address food resource management, nutrition practices, food safety, and changes in physical activity. According to the EFNEP Web-based Nutrition Education Evaluation and Reporting System annual report, 85% of participants increased physical activity. Seventeen participants completed the Know It! Control It! curriculum, and one participant indicated that the program played a key role in helping her identify and treat her stage 1 hypertension.

4. Associated Knowledge Areas

KA Code	Knowledge Area
724	Healthy Lifestyle

Outcome #4

1. Outcome Measures

Program participant reduce their BMI

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	2610

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

NC currently has an adult obesity rate of 32.1%, which is the 20th highest adult obesity rate in the nation. According to the CDC, participation in a lifestyle change program with the goal of 5% to 7% percent weight loss and 150 minutes per week of physical activity can lower one?s risk for developing type 2 diabetes by up to 58%.

What has been done
Created by a team of professionals with expertise in nutrition, physical activity, and behavioral change, the 15-week Eat Smart, Move More, Prevent Diabetes curriculum addresses NC?s need for accurate educational materials for diabetes prevention. This curriculum has been developed in an online, real-time format to increase the reach of diabetes prevention programs to those without access to an onsite program. The curriculum is now also offered via an in-person, onsite format using the same curriculum as the online format.

Results
Statewide, 2,610 individuals reduced their BMI through Extension programs. As of December 2018, 18 Eat Smart, Move More, Prevent Diabetes online classes have been offered to members of the NC State Health Plan. Total enrollment in these classes was 436. Results show that participants improved their body-mass index scores, with 5% in the healthy BMI range of less than 25 at the start of the program and 11.7% in that range at the program?s end.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
724	Healthy Lifestyle

Outcome #5

1. Outcome Measures

Program participants (adults) decrease blood pressure

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	924

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
According to the CDC, unhealthy eating habits have contributed to the obesity epidemic in the United States. A poor diet is associated with heart disease, high blood pressure, diabetes, and some cancers. Heart disease is the second leading cause of death in NC. In 2017, heart disease caused 18,840 deaths statewide. In NC, 34.7% of adults reported being told by a health

professional that they had high blood pressure.

What has been done

Created by a team of professionals with expertise in nutrition, physical activity, and behavioral change, the 15-week Eat Smart, Move More, Prevent Diabetes curriculum addresses NC?s need for accurate educational materials for diabetes prevention. This curriculum has been developed in an online, real-time format to increase the reach of diabetes prevention programs to those without access to an onsite program The curriculum is now also offered via an in-person, onsite format using the same curriculum as the online format.

Results

Statewide, 924 adults reduced their blood pressure through Extension programs. As of December 2018, 13 Eat Smart, Move More, Prevent Diabetes online classes have been offered to members of the NC State Health Plan. Total enrollment in these classes was 436. Results show that participants improved their blood pressure, with 26.4% in the healthy blood pressure range at the start of the program and 33.6% in that range at the program?s end.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
724	Healthy Lifestyle

Outcome #6

1. Outcome Measures

Program participants (adults) improve their blood glucose (A1c.) level

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	962

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Approximately 1,077,000 people in NC, or 12.9% of the adult population, have diabetes. Of these, an estimated 247,000 have diabetes but don?t know it. Medical costs associated with patients

who have diabetes are 2.3 times higher than medical costs for patients without diabetes. In 2017, the total direct medical expenses for diagnosed diabetes in NC were estimated at $7.7 billion, and another $2.9 billion were spent on indirect costs from lost productivity due to diabetes. The total estimated cost of diagnosed diabetes in the US in 2017 was $327 billion.

What has been done

Created by a team of professionals with expertise in nutrition, physical activity, and behavioral change, the 15-week Eat Smart, Move More, Prevent Diabetes curriculum addresses NC?s need for accurate educational materials for diabetes prevention. This curriculum has been developed in an online, real-time format to increase the reach of diabetes prevention programs to those without access to an onsite program. The curriculum is now also offered via an in-person, onsite format using the same curriculum as the online format.

Results

Statewide, 962 adults improved their blood glucose (A1c) levels through Extension programs. As of December 2018, 13 Eat Smart, Move More, Prevent Diabetes online classes have been offered to members of the NC State Health Plan. Total enrollment in these classes was 436. Results show that participants improved their A1c levels, with 13% showing normal A1c levels at the start of the program and 32% showing normal levels at the program?s end.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
724	Healthy Lifestyle

Outcome #7

1. Outcome Measures

Program participants (adults) reduce their cholesterol

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	962

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

People with high cholesterol have about twice the risk of heart disease, the leading cause of death in the United States, as people with lower levels. In NC, 35.5% of adults report having been told their cholesterol level is too high. High cholesterol usually does not present with any symptoms. As a result, many people do not know that their cholesterol levels are too high. In NC, 14.1% of adults have not had their cholesterol checked in the past five years. Of those who have had their cholesterol checked, nearly 80% had it checked within the past 12 months. In 2017, Winston-Salem NC ranked fourth nationwide for the highest percentage of adults with high cholesterol.

What has been done

The EFNEP program assistant at NC A&T partnered with community leaders in Winston-Salem NC to implement Eat Smart, Move More, a program that empowers youth, adults, and families with strategies for healthy eating and increasing physical activity. Through this program, participants learned to plan and prepare healthier meals.

Results

In 2018, EFNEP enrolled 2,728 families, and 17,209 school-aged youth participated in 4-H EFNEP programs, including a small group from Winston-Salem. Statewide, 962 adults reduced their total cholesterol through Extension programs.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
724	Healthy Lifestyle

Outcome #8

1. Outcome Measures

Program participants consume less sodium in their diet

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	4850

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Heart disease is a leading cause of death in North Carolina. High blood pressure makes the heart work harder and can lead to heart disease, stroke, heart failure, and kidney disease. According to the US Food and Drug Administration, in some people, a high sodium diet contributes to high blood pressure.

What has been done
Cooperative Extension in Currituck County held a series of hands-on cooking classes, including Mediterranean Cooking, Gardening and Cooking with Herbs, and Gardening and Cooking with Root Vegetables. These classes allowed a total of 113 participants to sharpen their cooking skills and try new, delicious, healthy recipes that they can prepare at home. In addition, Cooperative Extension in Cleveland County delivered Steps to Health - Take Control?a six-week evidence-based chronic disease prevention and management program?to 58 participants and made 265 educational contacts across three sites.

Results
Statewide, 4,850 adults reduced sodium intake through Extension programs. Currituck County Extension?s cooking classes encouraged 51% of participants to decrease the use of sodium in their diet, 58% to increase their fruit and vegetable intake, and 84% to prepare more meals at home. Steps to Health - Take Control helped 33% of participants select foods with less sodium, 47% eat more fruits and vegetables, and 30% become more physically active.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
724	Healthy Lifestyle

Outcome #9

1. Outcome Measures

Families, children, and youth have access to healthy food

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual

2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Many limited-resource families struggle with food resource management, food security, meeting the nutritional needs of their families, and keeping food safe and nutritionally sound. In addition, many food insecure families avoid hunger by limiting the types of food they buy and by participating in public and/or private food assistance programs. This reduces their access to healthy meals and exacerbates problems caused by unhealthy body weight. Limited resource families have an elevated risk of overweight and obesity. Food deserts in rural areas further threaten families? abilities to access healthy food.

What has been done

The Expanded Food and Nutrition Education Program (EFNEP) is a unique program designed to empower food insecure families with the knowledge, skills, and attitudes needed to efficiently manage food resources and provide nutritionally sound diets to their families on limited budgets. EFNEP enrolls youth (ages 5?19) and families with children ages 0?19 and provides supplemental nutrition education via social media, including Facebook, YouTube, and the EFNEP blog. In 2018, EFNEP enrolled 2,728 families, and 17,209 school-aged youth participated in 4-H EFNEP programs. In addition, Cooperative Extension in Warren County introduced a local small country store owner to the Healthy Small Food Retailer Program offered by the NC Department of Agriculture.

Results

Because of EFNEP educators' efforts, 89% of graduating adult participants showed improvements in food resource management practices, and 95% showed improvement in one or more diet quality practices, such as eating more fruits and vegetables, consuming fewer sugary drinks, and cooking food at home. In addition, 88% of graduated youth participants demonstrated an improved ability to choose healthy foods. The local country store owner was selected to receive a retail refrigeration unit, which has increased the store?s ability to provide healthy food to a rural area in the middle of a major food desert.

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
724	Healthy Lifestyle

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

Many factors affect individuals' decisions and abilities to practice positive behaviors with respect to healthy eating and physical activity. These factors include the physical and social environment of families, communities, and organizations; the policies, practices and norms within the social and work settings; and access to reliable information. Lasting changes in healthy behaviors require physical environments and social systems that support positive lifestyle habits. In order for individuals (adults and children) to make positive lifestyle changes with respect to healthy eating and physical activity, changes need to be made in the surrounding organizational, community, social and physical environments. Without these changes, successful health behavior change is difficult to achieve and sustain. Confidence in adopting and maintaining a behavior may be strengthened when the physical and social environment supports the new behavior. Policy and environmental interventions can improve the health of all people, not just small groups of motivated or high-risk individuals. NC Cooperative Extension continues to work using the multilevel model or socioecological model for behavior change. It is within that context that we provide education to participants while working at the county and state levels to make systems, policy, and environmental changes. These changes are systemic and societal, thus do not happen quickly. Slow changes in policy and environments that support healthy eating and physical activity continue to challenge our ability to make improvements in eating and physical activity patterns.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Adults and youth alike made incremental changes in a number of health enhancing eating behaviors as well as physical activity (detailed in the state defined outcomes above). The educational programs supporting these changes are continuing, as additional opportunities exist for further advances in these lifestyle changes. The program will continue to stress that those individuals who make healthy food choices and are physically active are more likely to achieve and maintain a healthy weight and reduce incidence of chronic disease. Ultimately, this will lead to a reduction in health care costs, increased longevity, greater productivity and improved quality of life. 11,486 adults and 26,642 youth increased their fruit and vegetables consumption and 23,771 participants increased their physical activity. Of our EFNEP participants, 95% improved dietary intake and 85% practice daily physical activity.

Key Items of Evaluation

We are continually working to keep evaluation principles and tools aligned with plans of work, goals and objectives of our programs, and current best practices in program evaluation so that we can effectively report the results of our efforts.

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Food Safety - Food Production Systems: Development, Processing and Quality

☑ 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
501	New and Improved Food Processing Technologies	0%	0%	15%	30%
502	New and Improved Food Products	0%	0%	10%	50%
503	Quality Maintenance in Storing and Marketing Food Products	15%	15%	10%	10%
504	Home and Commercial Food Service	50%	20%	5%	0%
701	Nutrient Composition of Food	0%	0%	15%	0%
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources	10%	25%	5%	0%
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	25%	40%	40%	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	74.0	5.0	53.0	6.0
Actual Paid	4.8	2.0	45.8	3.3
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**
423138	17020	278370	113603
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
423138	93429	278370	59747
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
1296716	0	1623997	55363

V(D). Planned Program (Activity)

1. Brief description of the Activity

Multiple research and educational outreach programs have been conducted under the umbrella of improving the quality, safety, security, and nutrition of food products produced in North Carolina. A very important aspect of this food safety activity is to transfer technology and knowledge to our stakeholders and clientele, including efforts of the Plants for Human Health Institute's NC Market Ready and NC Fresh Produce Safety Task Force. Focused educational programs are provided by NC State Extension to ensure the safety of products sold at farmers markets. NC State Extension provides focused educational programs on Good Agricultural Practices (GAPs) producers in North Carolina. Other focused educational programs provided by Extension include HACCP training for school food service managers and servers. Focused food safety programming is provided to producers by Extension before, during, and after natural disasters. Extension provides food safety training to food service workers and managers through the NC Safe Plates and ServSafe certification programs. Extension also provides focused programs to consumers on home food preservation including canning, pickling, and fermenting.

2. Brief description of the target audience

Primary food producers, food processors, foodservice operators, county extension agents, state and federal regulatory agencies, commodity associations, news media and consumers. The primary audience will be in North Carolina but will also extend to audiences in other states (state and federal agencies, local, state and federal politicians and other stakeholders).

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	25452	76357	5294	3980

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

Patent Applications Submitted

Year:	2018
Actual:	2

Patents listed

Methods for the Production of Fermented Beverages and other Fermentation Products15/573,652
Polyphenol-Protein Compositions and Methods of MakingPCT/US2017/067877

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	4	67	71

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of highly focused non-degree credit group training activities to be conducted

Year	Actual
2018	370

Output #2

Output Measure

- Relevant and impacts focused research projects to be conducted

Year	Actual
2018	32

Output #3

Output Measure

- Number of firms adopting quality and safety strategies

Year	Actual
2018	0

Output #4

Output Measure

- Program participants trained in home food preservation

Year	Actual
2018	1947

Output #5

Output Measure

- Program participants trained in good farmer's market practices

Year	Actual
2018	53

Output #6

Output Measure

- Number of participants in non-degree credit activities and programs

Year	Actual
2018	5797

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of program participants who successfully pass the food safety certification examination
2	Number of participants completing National Seafood HACCP Alliance Education and other food safety HACCP workshops
3	Number of companies adopting new technologies
4	Number of new companies in food manufacturing
5	Number of food industry companies undergoing equipment and food safety audits
6	Number of new food products that industry can manufacture to improve health
7	Program participants certified in Good Agricultural Practices (GAPs) or Good Handling Practices (GHPs)

Outcome #1

1. Outcome Measures

Number of program participants who successfully pass the food safety certification examination

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	638

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The Centers for Disease Control and Prevention estimate that roughly one in six Americans (or 48 million people) contract a foodborne illness each year, resulting in 128,000 hospitalizations and 3,000 deaths. Food safety education is believed to play an integral role in preventing foodborne illness outbreaks. The US Department of Agriculture (USDA) estimates that foodborne illnesses cost more than $15.6 billion each year.

What has been done
NC State Extension agents provide ServSafe and NC Safe Plates food safety training and certification programs for food service managers and food handlers. Safe Plates for Food Handlers was released in November 2018. These training programs provide instruction and an American National Standards Institute (ANSI) accredited CFPM examination for the Person in Charge (PIC) of a food establishment as specified in Paragraphs 2-102.12(A) and Section 2-102.20 of the NC Food Code Manual. In 2018, five new agents were trained in Safe Plates for Food Managers, bringing the total of trained agents to 47.

Results
Statewide, 638 food service employees received ServSafe certification, 617 participants implemented ServSafe standards, and 1,233 food handlers received food safety training and education in safe food handling practices. In addition, 457 food protection managers received Safe Plates training (415 were certified), and 342 food safety managers received ServSafe training (273 were certified). Over 60 Safe Plates for Food Managers classes were conducted with over 800 total participants. North Carolina Department of Public Instruction Career and Technical Education used Safe Plates for Food Managers in the public high school Foods and Nutrition 1 curriculum, reaching approximately 9,000 students.

4. Associated Knowledge Areas

KA Code	Knowledge Area
504	Home and Commercial Food Service
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources

Outcome #2

1. Outcome Measures

Number of participants completing National Seafood HACCP Alliance Education and other food safety HACCP workshops

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	276

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In NC, retail food establishments continue to produce new, creative foods using specialized processes. According to the FDA Model Food Code, specialized processes require variances and hazard analysis critical control points (HACCP) plans to ensure food safety. However, most HACCP training programs available are for manufacturing settings, which are very different from retail settings.

What has been done
NC State has developed a Validation and Verification of Retail HACCP Plans course to support environmental health inspectors? and regulators? understanding of retail HACCP. In 2018, partnerships were created with other state environmental health and extension programs to meet their training needs in this area.

Results
Statewide, 276 participants were trained in school HACCP principles. In Raleigh, 40 NC environmental health professionals were trained, and the HACCP course was launched to reach 50 trainees in Rhode Island with a cohort of trained instructors. Connections have been made to deliver the course to other states in 2019, and it will eventually reach an estimated 400 environmental health officers nationally through 10 participant workshops.

4. Associated Knowledge Areas

KA Code	Knowledge Area
504	Home and Commercial Food Service
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources

Outcome #3

1. Outcome Measures

Number of companies adopting new technologies

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Small unmanned aircraft vehicles (UAVs) and related technologies are maturing into a ubiquitous solution for spatial data acquisition. Agriculture has been identified as a major consumer of this technology, with projected revenues greater than $80 billion by 2020. In order to realize these benefits in agriculture, a firm understating of the technology, applications, and opportunities must be acquired.

What has been done
Over the past five years, a research and extension program focused on the use and application of unmanned aircraft has been developed. The program has secured funds and equipment necessary to investigate, research, and share information regarding the use of small unmanned aircraft vehicles in agriculture. Cooperative Extension in Orange and Alamance counties has recently procured drones for use in birds-eye crop health monitoring and plant disease diagnosis.

Results
NC State has developed a program to advance the use and application of unmanned aircraft systems in agriculture. As a result, stakeholders can find up-to-date, reliable, and vetted information on a technology that is widely discussed and marketed toward agricultural businesses. The impact for new and improved agricultural practices is significant. Cooperative

Extension in Orange and Alamance counties has achieved promising results via drone use and is investigating possibilities for expanding the application of this technology for specialty and field crops.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
503	Quality Maintenance in Storing and Marketing Food Products
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #4

1. Outcome Measures

Number of new companies in food manufacturing

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Up to 40% of crops produced never make it onto retail shelves, and threats to agricultural production and the increasing food and nutrition demands of a rapidly-growing population demand increasingly more efficient means to convert raw agricultural products into excellent sources of nutrition. The development of improved food manufacturing techniques can help offset limitations in agricultural production and optimize the value of agricultural products.

What has been done
In 2017, two NC State alumni started Glean, a new food production company, with one product: a sweet potato flour. The science behind their newest products?protein-rich food gummies?has roots in the research of NC State scientists with CALS? Plants for Human Health Institute and the

Department of Food, Bioprocessing and Nutrition Sciences, who have delivered breakthroughs that make it possible for food manufacturers like Glean to quickly extract nutrients from fruits and vegetables and add them to a protein source.

Results
Glean received the American Farm Bureau Federation?s People?s Choice Award as part of the 2019 Ag Innovations Challenge, which honors new entrepreneurs and innovations from rural areas. In addition, Glean has expanded to distribute several products across 1,200 retail stores in the Southeast. In a recent interview, Glean?s founders indicated that NC State?s hands-on courses played a key role in inspiring and empowering their entrepreneurial efforts, and CALS research was vital to their production of new healthy products.

4. Associated Knowledge Areas

KA Code	Knowledge Area
501	New and Improved Food Processing Technologies
502	New and Improved Food Products

Outcome #5

1. Outcome Measures

Number of food industry companies undergoing equipment and food safety audits

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	314

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Robeson County is home to the University of NC at Pembroke (UNCP) and a population of about 7,000 students who are increasingly concerned about where there food comes from, how it is grown, and whether it is safe to consume. Cooperative Extension has collaborated with the Center for Environmental Farming?s 10% NC campaign and UNCP?s personnel to introduce local food into the campus menu.

What has been done
To be considered for campus meals, produce had to be from a GAP certified farm. Cooperative Extension offered a 2.5 day workshop to assist farmers in writing a food safety plan to prepare for

a GAP audit. Twelve growers attended the workshop from Charlotte to Columbus counties, and three growers represented farms in Robeson County.

Results
Statewide, 314 participants developed food safety plans, and 1,036 were certified in GAP. Two Robeson County farmers completed the program, became GAP certified, and now sell produce to FreshPoint, a produce distributor for UNCP. In addition, 100% of the participants indicated that they were satisfied with the workshop, and 60% intended to pursue GAP certification.

4. Associated Knowledge Areas

KA Code	Knowledge Area
504	Home and Commercial Food Service
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

Outcome #6

1. Outcome Measures

Number of new food products that industry can manufacture to improve health

2. Associated Institution Types

- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Peanut allergy is among the most severe food allergies and is estimated to affect 1% of the American population. There are currently no medically approved cures or intervention strategies for reducing hypersensitivity to peanuts. Those with a peanut allergy must typically completely avoid peanuts and products containing peanuts in order to avoid potentially severe or even fatal allergic reactions. Oral therapy, which increases the threshold of peanut sensitivity in allergic individuals, may be a promising approach to reduce the severity of peanut allergies.

What has been done
Researchers at NC A&T have investigated allergic responses to a product that combines peanut flour, peanut protein, and components extracted from blueberries via in vitro and in vivo models, gaining insights into key protein pathways and immune cell behaviors.

Results
The findings thus far suggest that extracts from peanut skin can be combined with peanut flour to reduce immune cell response. Together, these components could create an effective immunotherapy for reducing hypersensitivity to peanuts.

4. Associated Knowledge Areas

KA Code	Knowledge Area
502	New and Improved Food Products

Outcome #7

1. Outcome Measures

Program participants certified in Good Agricultural Practices (GAPs) or Good Handling Practices (GHPs)

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	1036

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Cooperative Extension in Yancey County helped the local Future Farmers of America (FFA) chapter re-establish a school farm in 2015. For the past three years, Extension has guided the FFA chapter in planning, producing, harvesting, and selling vegetables to the local food hub (TRACTOR). In 2018, they wanted to sell their product and see it served in the Yancey County school system?s cafeterias because the school was not sourcing any items locally.

What has been done
Cooperative Extension in Yancey County partnered with the school system and the FFA to get the students? produce into the cafeterias. Extension assisted in crop planning, planting time, variety selection, and production issues; trained the FFA in good agricultural practices (GAP); and

helped them meet all food safety requirements to sell to the schools.

Results

The students? farm passed a GAP audit with Extension?s assistance. They also produced, harvested, and delivered a sweet potato crop to TRACTOR for washing, grading, and boxing, and the local high school cafeteria was able to serve them. The FFA was only the second school program to sell produce to a local school in the state.

4. Associated Knowledge Areas

KA Code	Knowledge Area
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins

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

Rapidly changing environmental and economic conditions influence producers' and food businesses' abilities to adapt to change while ensuring sustainable production systems and environments. Continued effects of the economy on federal, state and local support for research and extension programs challenge our research and extension enterprises. Likewise, regulatory and other governmental policies and rules influence the educational and research capacities of our programs and present challenges to producers, processors and marketers to comply with new and often expensive regulations. And in an environment of reduced funding, the program competition for existing funds became a greater challenge. Nevertheless, emphasis is placed on those research and extension opportunities that have the greatest effect on sustainability of farms, families and businesses

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The evidence of outcomes and impacts of this program area reported herein are derived from our Extension Reporting System, faculty activity reports and impact statements, and Office of Technology Transfer. The data indicate that our research and extension programs continue to reach significant segments of our audience with relevant research and extension information that benefits their businesses. Based on the impact statements,

publication records, intellectual property created, and effective outreach, especially with various food safety training and certification programs, including 2,353 participants trained in safe home food handling, preservation, or preparation practices, 1,233 food handlers receiving food safety training and education, 1,857 persons certified in Good Agricultural Practices (GAPs), and 122 trained in the Food Safety Modernization Act (FSMA).

Key Items of Evaluation

We are continually working to keep evaluation principles and tools aligned with plans of work, goals and objectives of our programs, and current best practices in program evaluation so that we can effectively report the results of our efforts.

V(A). Planned Program (Summary)

Program # 7

1. Name of the Planned Program

Human and Community Development- 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
607	Consumer Economics	0%	5%	30%	25%
608	Community Resource Planning and Development	15%	0%	40%	0%
609	Economic Theory and Methods	0%	0%	15%	0%
801	Individual and Family Resource Management	5%	20%	5%	5%
802	Human Development and Family Well-Being	5%	10%	10%	25%
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	5%	15%	0%	0%
804	Human Environmental Issues Concerning Apparel, Textiles, and Residential and Commercial Structures	5%	0%	0%	15%
805	Community Institutions, Health, and Social Services	5%	20%	0%	30%
806	Youth Development	60%	30%	0%	0%
	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	103.0	20.0	8.0	5.0
Actual Paid	29.3	22.0	7.0	19.6
Actual Volunteer	196.0	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**
2115689	406405	92790	558199
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2115689	770514	92790	491512
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
3241791	185273	541332	215184

V(D). Planned Program (Activity)

1. Brief description of the Activity

Youth impact is achieved by developing and testing an educational curriculum designed to help youth develop characteristics associated with positive youth development. This is achieved through a collaborative process of teams of campus/field based youth development educators, 4-H and other community professionals and volunteers, and youth. The family-focused goals of this program are addressed primarily through a series of workshops that focus on developing family resource management, investment in healthy housing practices, and effective parenting. State specialists at North Carolina A & T provide leadership for family resource management. The H-Plan is a tool developed by N.C. A&T specialists to assist families with diagnosing their financial status. Participants use the tool to record: "how much" money they have to spend each month as well as their monthly expenses; "how well" they are doing with maintaining a low income to debt ratio; and "how to" recover financially or move ahead in their savings. Parenting Matters is a curriculum developed by Cooperative Extension at N.C. A&T to help parents who need to improve their parenting skills and strengthen their relationships with their children

2. Brief description of the target audience

The target audience for the activities of this program includes youth and families including limited resource families. Other audiences include volunteers, stakeholders and youth development professionals "to create helping relationships, to enable youths to become responsible, productive citizens." Stakeholders for this program include advocates of underserved populations, representatives of rural communities, policy makers, community based organizations, and the scientific community.

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	899629	2574347	85732	63505

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	21	40	61

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of educational workshops related to energy efficiency and conservation.

Year	Actual
2018	7

Output #2

Output Measure

- Number of educational workshops for family financial management skills.

Year	Actual
2018	321

Output #3

Output Measure

- Program participants (youth) assuming new/expanded leadership roles in the community

Year	Actual
2018	10037

Output #4

Output Measure

- Number of educational workshops for consumers related to parenting and caregiving skills.

Year	Actual
2018	93

Output #5

Output Measure

- Program participants (adult volunteers) serving in new or expanded roles within Extension and beyond Extension, including community boards and task forces

Year	Actual
2018	1229

Output #6

Output Measure

- Program participants (youth volunteers) serving in new or expanded roles with Extension, and beyond Extension, including community boards and task forces

Year	Actual
2018	503

Output #7

Output Measure

- Program participants (youth students) gaining career / employability skills

Year	Actual
2018	42040

Output #8

Output Measure

- Program participants (youth students) gaining knowledge in STEM (Science, Technology, Engineering, Math)

Year	Actual
2018	127329

Output #9

Output Measure

- Relevant and impact focused research projects conducted

Year	Actual
2018	8

Output #10

Output Measure

- Total number of participants in non-degree credit educational programs and activities

Year	Actual
2018	18704

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Participants implementing basic financial management strategies (developing budget, keeping records, etc.)
2	Program participants actively managing their financial accounts and financial identity (such as; obtaining credit reports, choosing credit products, implementing identify theft safeguards, opening or selecting bank accounts, etc)
3	Program participants accessing programs and implementing strategies to support family economic well being.
4	Individuals, businesses, industries and governments engaging in best management practices related to energy use/conservation
5	Professionals using learned best practices with children/youth/adults, older adults
6	Program participants adopting positive parenting practices.
7	Youth Involved: Day Camps
8	Youth Involved: 4-H Clubs
9	Youth Involved: School Enrichment
10	Youth Involved: Special Interest
11	Youth Involved: Resident Camps
12	Increase adoption of healthy eating habits to improve diet and health of residents.
13	Increased teen mothers? abilities to provide positive parenting to their children.
14	Improve the accessibility of homes of older limited resource homeowners for living post retirement.
15	Identify the factors associated with successful entrepreneurship in rural communities.

Outcome #1

1. Outcome Measures

Participants implementing basic financial management strategies (developing budget, keeping records, etc.)

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	2019

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Partnership Village is a housing community in Guildford County, NC that offers support services to men, women, and families getting resettled after experiencing homelessness. This program provides case management and other services to help residents work toward independence and self-sufficiency. Partnership Village wanted to help its clients better manage their money by educating them on financial basics such as saving, budgeting, and understanding credit.

What has been done
The director of Partnership Village contacted the Guildford family and consumer sciences agent to request financial literacy classes for the clientele of Partnership Village. The agent created a rotational educational schedule for Partnership Village. During the four-week financial literacy class, participants learned strategies for budgeting for grocery bills and saving for emergencies. There was a follow-up session scheduled for participants two months later.

Results
A participant in the financial literacy classes offered at Partnership Village reported that she has saved $700 and started meal planning based on the education she received.

4. Associated Knowledge Areas

KA Code	Knowledge Area
801	Individual and Family Resource Management

Outcome #2

1. Outcome Measures

Program participants actively managing their financial accounts and financial identity (such as; obtaining credit reports, choosing credit products, implementing identify theft safeguards, opening or selecting bank accounts, etc)

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	988

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The US Census reports that 21.4% of people in Montgomery County live in poverty compared to the NC state average of 15.4%. The per capita income for Montgomery is over $6,700 less than that for the state as a whole, and the median annual income is $14,000 lower. Family and consumer science courses are no longer offered in Montgomery County high schools, making it harder for youth to learn skills that could save them money.

What has been done
The FCS Agent in Montgomery County partnered with the 4-H agent to hold an ?Adulting 101? program as part of the Summer Adventures series. During this two-day workshop, 15 youth learned the importance of saving, how to develop and monitor a personal budget, and how to choose and use credit wisely. Youth also learned money-saving life skills like clothing repair and car maintenance, and they learned basic interviewing skills and college financial aid strategies.

Results
In post-workshop evaluations, all the participants reported increased confidence in their ability to use credit wisely, develop and maintain a personal budget, and effectively manage household resources. In addition, each of the participants reported intention to save money, prepare and use a monthly budget, and prepare more meals at home.

4. Associated Knowledge Areas

KA Code	Knowledge Area
801	Individual and Family Resource Management

Outcome #3

1. Outcome Measures

Program participants accessing programs and implementing strategies to support family economic well being.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	394

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Women in agriculture encounter barriers to securing working capital, developing knowledge of tools and operational processes, and plugging into a network of other women farmers. Twenty-two percent of farms in Forsyth County are operated by women. Extension has expertise in facilitating the development of farmer-to-farmer networks and takes pride in helping ensure that the next generation of women are educated, encouraged, and empowered to take on the challenges of meeting the world?s growing food, fuel, and fiber needs.

What has been done
An initial gathering of women interested in developing a women?s farmer network was convened with support from NCA&T, NC State, the Center for Environmental Farming Systems, Blue Ridge Women in Agriculture, and the Natural Capital Investment Fund. Fifty participants from across the Piedmont attended workshop sessions on setting up and using small plot vegetable enterprise budgets, farm protection through conservation and transition plans, farm planning, seed saving, food hubs, network building, and resource development.

Results
At the end of the conference, 38 participants were surveyed and indicated that they had gained significant knowledge in all the agricultural and business resource management areas covered. In addition, a new peer-to-peer network is now in its early stages, beginning with a follow-up on-farm gathering held in April of 2018. Participants have connected through a social media platform for further networking and information sharing. As a result, 20 women farmers who were previously unfamiliar with Extension services are now connected to resources that are strengthening their farm operations so that they can improve their economic well-being and better care for their families.

4. Associated Knowledge Areas

KA Code	Knowledge Area
801	Individual and Family Resource Management

Outcome #4

1. Outcome Measures

Individuals, businesses, industries and governments engaging in best management practices related to energy use/conservation

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	298

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development
802	Human Development and Family Well-Being
804	Human Environmental Issues Concerning Apparel, Textiles, and Residential and Commercial Structures
805	Community Institutions, Health, and Social Services

Outcome #5

1. Outcome Measures

Professionals using learned best practices with children/youth/adults, older adults

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	151

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Science, technology, engineering, and mathematics (STEM) education plays a critical role in preparing our youth for the future. Through STEM, youth engage in experiences that encourage them to connect with other people and think critically, innovatively, and creatively. As we continue to work to meet the demands of a technology-driven society, STEM is essential to our everyday lives and to the advancement of the US economy. To successfully engage students in STEM activities, teachers must receive professional development and training in these areas.

What has been done
In 2018, Cooperative Extension, the College of Education, and the Math Department in the College of Science and Technology at NCA&T sponsored the Get STEMed UP: Aggie Educator Institute, a four-day teacher professional development program designed to build skills in math, science, literacy, agri-science, and digital learning for more than 60 NC teachers in Title 1 schools. Workshops included Technology in the Classroom, Rapid Response Systems for Active Learning in Science, Literacy and Arts Integration, and Engaging Students with Science.

Results
Participant evaluations were overwhelmingly positive. The majority of respondents rated the workshops as ?totally useful? or ?very useful,? and 75% of respondents believe they can apply knowledge gained at the institute in their work. Ninety-six percent of respondents said they would like to have the institute repeated in the future and would recommend it to others.

4. Associated Knowledge Areas

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

Outcome #6

1. Outcome Measures

Program participants adopting positive parenting practices.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	343

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The 2018 Cooperative Extension community needs assessment identified opioid misuse and helping youth and families make healthy decisions as a priority areas of focus. The NC 4-H Empowering Youth and Families Program (EYFP) focuses on opioid prevention education for youth ages 10?14 and their caregivers in rural NC. The program has four goals: to reduce youth substance use in rural NC, to improve parenting skills for caregivers of youth so that they can assist youth in making healthy choices, to improve family relationships of youth ages 10?14 and parents or caregivers, and to empower families to lead community change, thereby leveraging support for healthier lifestyles within those communities.

What has been done
Three counties began programming with Strengthening Families Program 10?14 (SFP 10?14), and the pilot program Powerful Communities. Montgomery and Yancey County have completed four cohorts at this time. In October 2018, the grant was expanded to seven additional counties by an award from SAMHSA. Ten counties are currently enrolled in the program and are scheduled to begin spring cohorts in February?March 2019.

Results
To date, a total of 23 youth participants and their parents completed the 12-week SFP 10?14 and Powerful Communities Curricula. In one county, 100% of parents improved parenting skills in at least one domain (communication, effective discipline, establishing/enforcing house rules, appropriate monitoring of youth), 75% of youth improved skills in goal-setting and achievement and stress management, 63% of youth described improvement in their parents' ability to stay calm when disciplining the youth, 63% of youth indicated improvement in family communication (having family meetings), and 50% of youth indicated improvement in the family's ability to sit down and work out solutions to family problems without people getting mad or yelling. One parent

reported increasing her ability to listen to her child's cues, stating that prior to the program she was "listening, but not LISTENING." Additionally, families reported success in implementing the techniques taught during the program and in their youth's reaction to the techniques utilized.

4. Associated Knowledge Areas

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

Outcome #7

1. Outcome Measures

Youth Involved: Day Camps

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	12297

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
NC offers its youth and families a number of unique opportunities to discover the world through 4-H camp and educational programs, to serve their communities, to learn employment skills, and to learn how to be citizen leaders.

What has been done
In 4-H day camps spread throughout the state, youth can participate in programs that range from traditional camping activities (such as swimming and horseback riding) to environmental education, cooking, and building life skills. Camps are tailored for youth ages 5?17.

Results
In 2018, 12,297 youths attended county based 4-H day camping programs. The focus of the various activities included cooking, nutrition, and healthy eating; career preparation, building community volunteerism, developing life and leadership skills, civic engagement, and achieving academic and educational success.
NC is constantly hit with weather disasters from hurricanes to major flooding events. The NC My PI summer day camp program provided an opportunity for 115 youth to better understand different disasters and how to prepare for them. Teens learned to be safe before and during a

disaster and how to help families and communities after a disaster. They learned about CPR and AED, watched a disaster simulation, learned about emergency management careers, learned to use HAM and NOAA Weather Radio, and gained knowledge of fire safety and how to be weather aware. The NC My PI program allowed teens to realize their potential by positively impacting the lives of those around them when they need assistance. One hundred percent of participants passed and are now Community Emergency Response Team (CERT) certified. Now, these youth can be called into volunteer action in the next emergency to assist their local community.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #8

1. Outcome Measures

Youth Involved: 4-H Clubs

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	18295

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
NC 4-H is a youth organization committed to building citizen leaders with marketable skills to succeed in today's global society. By participating in 4-H clubs, youth are empowered to reach their full potential by working and learning in partnership with caring adults.

What has been done
4-H clubs are helping build a healthier NC by improving the lives of youth, as well as empowering them to step up and make a difference in their communities. Healthy eating, food safety, exercise, and positive choices about relationships, drugs, and alcohol are all important factors addressed through 4-H programming. In addition, a 4-H horse club in Pasquotank County started a supply and food drive to provide aid to horses and pets affected by the catastrophic damage and record flooding inflicted by Hurricane Florence.

Results

In 2018, 18,295 youth participated in 4-H clubs. The 4-H horse club in Pasquotank secured and delivered over $10,000 worth of donated livestock food and supplies to people and animals in need. What was planned as a one-weekend event turned into a month-long project for these youth. For their disaster relief efforts, the club was presented with a letter of appreciation from the Craven County Commissioners and awarded the 2018 Outstanding Equine Community Service Award.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #9

1. Outcome Measures

Youth Involved: School Enrichment

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	140161

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Science teachers need opportunities to keep up with advances in their field, including disciplinary content and science teaching pedagogy. Likewise, students in NC and SC struggle with learning science, especially in communities where youth are faced with limited social and economic access. One in four children in the Carolina's is growing up in poverty, and the heavily structured school day does not offer opportunities to address many of their challenges. Coupled with the national standards calling to introduce science content to all students beginning in the early grades, many youth with limited access to resources are falling further and further behind.

What has been done
The NC&SC 4-H STEM program focuses on providing STEM professional development for educators and provides all materials needed to provide STEM instruction to youth in four schools located within designated "persistent poverty (strike-force) communities." Two trainings were held in 2018, during which 27 2nd, 3rd, and 4th grades were trained to deliver 4-H STEM-focused curricula, including Soil Solutions, Embryology, Bees and Pollinators, and Robotics.

Results
To date, 193 students have completed the Soil Solutions Curriculum. Youth who completed the Soil Solutions Curriculum gained knowledge about plant life cycles, the importance and composition of soils, parts of plants, and what plants need to grow. To date, 190 students have completed the Embryology Curriculum, and 193 students have completed the Soil Solutions Curriculum. Youth who completed the Embryology Curriculum gained knowledge about the parts of an egg, the importance of washing hands after handling an animal, the physical needs of chicks, and the life cycle of the chicken. Youth who participated in the Embryology Curriculum were statistically significantly more likely to be interested in a job in science when they grow up and to believe that they are good at science. Youth were statistically less likely to report that they did not like science after participation in the Embryology Curriculum.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #10

1. Outcome Measures

Youth Involved: Special Interest

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	87168

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
One of the main tools used by UNC System schools to determine admission status is standardized test scores, such as the ACT and SAT. On average, the top ten livestock and crop producing counties (a total of 15 counties within NC) had a deficit of 328 points on the SAT and a deficit of 10.8 points on the ACT. Unfortunately, this spread can mean the difference between getting into the college of one?s choice and settling for another pathway. Rural high school students with an interest in pursuing careers in NC agriculture are often not successful in gaining admissions to four-year institutions offering agricultural degrees.

What has been done

ASPIRE (ACT Supplemental Preparation in Rural Education) is designed to bridge deficits in rural high school students? performance on the ACT College Entrance Examination in order to increase the number of students pursuing higher education. As a high school student, preparing for a college entrance examination like the ACT can be pretty difficult. ASPIRE is a cooperative initiative through North Carolina Cooperative Extension Agents, public high school teachers, and the Princeton Review in rural counties to prepare sophomores and juniors for the ACT College Entrance Examination. The program is a 30-hour, ten-week course with four practice tests designed to help the students increase their scores on the ACT test.

Results

Research has demonstrated that participation in the ASPIRE program can increase the number of students admitted to higher education. In 2018, 70 students participated in ASPIRE. In one county, the seven students who completed the class increased their English composite score by an average of 3.69 points. Students reported an increase in confidence when taking the ACT and its components. In another county, nine students enrolled, and the class average increased 2.4 points to a final average of 22.8 out of a total of 36 points. Families also saved $935 per student by participating in ASPIRE and not taking the class directly from Princeton Review. Another student needed a minimum composite score of 16 for admittance to the two colleges he desired to attend, but his first ACT test score was a 14. He completed ASPIRE and received one-on-one assistance from the 4-H Agent. The 4-H Agent corresponded with the admission?s department of two colleges on the youth?s behalf. On Christmas Eve, the youth received an acceptance letter from his desired school, and he was awarded a $44,000 academic scholarship and a place on the golf team. The school also recognized his need for academic support and has already established a tutoring plan.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #11

1. Outcome Measures

Youth Involved: Resident Camps

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual

2018	907

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

For more than 80 years, NC 4-H camping has taught youth life skills through centers located from the mountains to the sand hills to the coast. NC offers youth and families a number of unique opportunities to discover the world through 4-H camp and educational programs, to serve their communities, to learn employment skills, and to develop as citizen leaders.

What has been done

All North Carolina 4-H Camps are managed and operated by NC State Extension. At 4-H camps and conference centers across the state, youth can participate in programs that range from traditional camping activities (such as swimming and horseback riding) to environmental education, cooking, and building life skills. Camps are tailored for youth ages 5?17. All North Carolina 4-H camps are accredited by the American Camp Association. In addition, Chatham County 4-H recruited and secured 52 youth to attend a week-long 4-H Residential Camp administered at BJP 4-H Educational Center. In partnership with Triangle Community Foundation and Communities in Schools - Chatham County, Chatham 4-H was able to sponsor and introduce under-served youth from the Siler City community to a variety of physical activities, healthy eating options, and positive life skill development opportunities during the course of the week-long camp.

Results

In 2018, 2,427 youth attended camping programs at one of three 4-H camps across the state. Of these youth, 907 were overnight campers who attended camp with their county 4-H program. The focus of the various activities included cooking and healthy eating, exploring outdoor activities, career preparation, building community volunteerism, developing life skills, and achieving academic and educational success. Seventy-six percent of families whose children participated in the week-long camp for under-served youth reported that their children were currently eating more fruits and vegetables than prior to their camping experience. In addition, 84% of those respondents also noted that their children were now more physically active. Residential camp may be used as an effective vehicle for disseminating nutritional and physical activity knowledge to youth.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #12

1. Outcome Measures

Increase adoption of healthy eating habits to improve diet and health of residents.

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Two-thirds of NC adults are overweight or obese, and NC ranks 13th in the nation for obesity, 9th for adult-onset diabetes, and 17th for hypertension. In addition, only one in four children eat the recommended amounts of fruits and vegetables, and almost half spend more than two hours a day watching television. The prevalence of food insecurity in NC is also higher than the national average, with one in four children in NC living in households that lack access to adequate food and three in ten children relying on the Supplemental Nutrition Assistance Program (SNAP).

What has been done
The Try Healthy Nutrition Program Assistant and FCS Extension Agent partnered with the School System and local daycare centers to provide nutrition education to 189 youth.

Results
Results from the post program Jeopardy game showed that all students increased their knowledge of MyPlate, brain health, heart health, mouth health, and overall nutrition knowledge. Verbal feedback from the
teachers indicated that the students "loved the program" and the students were able to try foods that they had never had before. In addition, the teachers remarked that the children were always excited to participate in the program and looked forward to the lessons. Cooperative Extension in Stanly County plans to expand their outreach of Try Healthy programming in 2019.

4. Associated Knowledge Areas

KA Code	Knowledge Area
607	Consumer Economics
802	Human Development and Family Well-Being

Outcome #13

1. Outcome Measures

Increased teen mothers? abilities to provide positive parenting to their children.

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
According to the CDC, 683,000 victims of child abuse and neglect were reported to CPS in 2015. According to the Hoke County Department of Social Services, there were 55 children in foster care in 2017. Research shows that child abuse and neglect can be prevented through parent education programs that focus on decreasing negative parenting behaviors and practices.

What has been done
The family and consumer sciences agent with Extension in Hoke County partnered with the Hoke County Department of Social Services to offer parenting classes to 13 parents utilizing the Parenting Matters curriculum which was developed by extension specialists at North Carolina A&T. Topics presented included Parenting Challenges, You?re a Role Model, Taking Care of Yourself: To Better Take Care of Your Child, and Understanding Your Child?s Behavior. One of the participants was a teen mom, and several of the mothers were in their early 20s.

Results
The teen mother participant reported increased knowledge of positive parenting skills. One of the participating couple?s two children had been removed from their home due to reports of neglect, but after the parents completed the classes, the case was dismissed, and the two children were returned to their parents, resulting in an estimated yearly savings of $13,944 for the county.

4. Associated Knowledge Areas

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

Outcome #14

1. Outcome Measures

Improve the accessibility of homes of older limited resource homeowners for living post retirement.

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
NC has a growing population of elderly residents. Many elderly renters want to ?age in place? and continue living safety, comfortably, and independently in their own homes and communities. Aging in place can yield cost savings for families, governments, and health systems. The median monthly payment for a nursing home was $5,243 in 2013, whereas the median monthly payment for non-institutional long-term care (such as living at home using an in-home care service) was $928. Aging in place also benefits the emotional health of elderly individuals and benefits the community, which gains their economic contributions and stability.

What has been done
NCA&T researchers assessed aging renters? residential (home, neighborhood, and town) environments, health, financial conditions, and formal and informal resources by conducting 25 onsite interviews with urban aging renters, 51 surveys with rural aging renters, and 23 home design assessments in a central urban city.

Results
The findings reveal numerous obstacles to aging in place, including unaffordable housing, unsupportive home environments, and lack of support resources. The participants expressed the need for several modifications in kitchens and restrooms. Major modifications include grab bar; insulation; ramp; toilet; door; and floor, plumbing, roof, and sink modifications. Home modification can be a cost-saving strategy that allows the elderly population to age in place and avoid using specialized senior housing such as nursing homes.

4. Associated Knowledge Areas

KA Code	Knowledge Area

802	Human Development and Family Well-Being
804	Human Environmental Issues Concerning Apparel, Textiles, and Residential and Commercial Structures

Outcome #15

1. Outcome Measures

Identify the factors associated with successful entrepreneurship in rural communities.

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Entrepreneurship offers a potential path to improved financial well-being. Most aspiring entrepreneurs find that their current job does not pay enough, and they express interest in starting a side job to supplement (and perhaps eventually replace) their main source of income. Food entrepreneurs play a vital role in revitalizing local food economies, but like other entrepreneurs, they often struggle to locate the resources to produce and market their products effectively.

What has been done
Cooperative Extension in Harnett County provided one-on-one business development meet-ups for two budding entrepreneurs who wanted to make additional income to support their families. These individuals engaged in business planning, business development, and business structuring activities. Cooperative Extension in Madison County offers an NCDA&CS inspected, value-added kitchen that entrepreneurs can access after completing food safety and policy procedure training.

Results
With Extension?s help, the Harnett County entrepreneurs have started their businesses; one is a truck hauler, and the other is a small home-based business selling t-shirts and vinyl products. Both entrepreneurs have increased their household income, resulting in additional funds to support their families. Fermenti, a family-owned fermenting company, started from scratch at the Madison County kitchen and has since expanded to produce 1,000 jars of product a month for distribution at 35 food venues. Fermenti has also received coverage in one national and several local magazines and has spearheaded an annual fermenting festival held at Extension in Madison County.

4. Associated Knowledge Areas

KA Code	Knowledge Area
607	Consumer Economics
608	Community Resource Planning and Development
803	Sociological and Technological Change Affecting Individuals, Families, and Communities

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 Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

The national budget crisis and its trickle down impact on the state of North Carolina have affected some of the program efforts, impacts and outcomes. Until the economy rebounds more robustly, communities and families stay closer to home and are less inclined to participate in educational programs. Despite Extension's footing in communities, when parents struggle with family finances and employment, their youth are impacted.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Evaluation of Extension Reporting System data indicate that significant numbers of youth as well as adults engage with educational activities in this program area. Nevertheless, it is clear that over a quarter million youth are documented, and likely more, as being engaged with the youth programs and receiving quality education and mentoring from their involvement. In NC 4-H program has helped 144,722 youth increase knowledge in STEM (Science, Technology, Engineering, Math), 42,040 youth gain career skills, and 15,073 youth gain entrepreneurship skills.

Key Items of Evaluation

We are continually working to keep evaluation principles and tools aligned with plans of work, goals and objectives of our programs, and current best practices in program evaluation so that we can effectively report the results of our efforts. North Carolina implemented 4-H online in 2018 which will aid in data collection and reporting.

V(A). Planned Program (Summary)

Program # 8

1. Name of the Planned Program

Human Health, Nutrition and Well-being

☑ 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
206	Basic Plant Biology	0%	0%	17%	0%
501	New and Improved Food Processing Technologies	0%	0%	2%	0%
502	New and Improved Food Products	0%	0%	8%	40%
503	Quality Maintenance in Storing and Marketing Food Products	0%	0%	7%	0%
701	Nutrient Composition of Food	0%	0%	16%	25%
702	Requirements and Function of Nutrients and Other Food Components	0%	0%	9%	25%
704	Nutrition and Hunger in the Population	0%	0%	14%	0%
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	0%	0%	18%	0%
722	Zoonotic Diseases and Parasites Affecting Humans	0%	0%	9%	0%
724	Healthy Lifestyle	0%	0%	0%	10%
	Total	0%	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	46.0	6.0
Actual Paid	0.0	0.0	42.2	23.4
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	556740	744172
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	556740	566878
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	3247995	137785

V(D). Planned Program (Activity)

1. Brief description of the Activity

Human nutrition, health and well-being research and outreach programs will include, but not be limited to, the concepts listed below: The Plants for Human Health Institute at Kannapolis, NC aims to enhance the nutritional value of fruits and vegetables and related compounds to improve human health and prevent disease. One of their first major accomplishments, collaborating with the David H. Murdock Research Institute and a nationwide consortium, is the sequencing of the blueberry genome, a major fruit when fresh fruit consumption and antioxidants for health are considered. Associated with the Institute, the NC Market Ready outreach program will provide information to growers and marketers for business management, marketing, safety and production management to facilitate the introduction and production of new crops evolving from the Institute's research efforts. Studies examine ways to identify and control tick species that vector Rocky Mountain Spotted Fever. A novel approach involved an all-natural botanical insect repellant for both ticks and mosquitoes. Biochemical research is developing technologies to produce effective vaccines against insect vectored diseases. Biochemists are seeking to understand ribosomal RNA targets for antibiotics in an effort to understand why antibiotics lose their effectiveness, ways to enhance the effectiveness of existing materials and possibly find new antibiotics with enhanced effectiveness or new modes of action. Also researchers are looking at the various potential uses of biofilms associated with bacterial masses, including the possibility of inactivating biofilms associated with disease causing organisms, making them susceptible to existing or new antibiotics or other antibacterial compounds. Geneticists are seeking to understand relationships between genetic makeup of susceptible animals and how environmental influences (chemicals, toxicants, food compounds) might influence cancer development. Research is also underway investigating biological processes including probiotic activation of brown fat to increase fat burning metabolism and the contribution of maternal genetics to development of cross generational obesity (in mice). Outreach with partner and interested life sciences communities, the food and pharmaceutical industries and peer scientific communities provides new technologies and scientific information which may become the basis of startup or existing manufacturing companies.

2. Brief description of the target audience

Target audiences include: peer researchers and collaborators, including health care providers, food processors and manufacturers, farmers and growers, consumers, and allied technical service providers and consultants to growers, processors and marketers.

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	6505	110	0	0

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

Patent Applications Submitted

Year: 2018
Actual: 14

Patents listed

G+D5:E11enetically Engineered Larvae for Wound Healing15/923,595
Engineered Salmonella Serovar Typhimurium Strains, Compositions Thereof, and Methods of Use PCT/US2017/044336
Non-Chemical, Mosquito Bite-resistant Garments62/534,663
Combined Lock and Light Signaling System for Multi-Wheeled Vehicles29/623,606
Insect and Tick Repellent Formulations and Methods of Use Thereof62/611,178
A Population Genetics Approach to Biological Control of Mycotoxin Prodcution62/664,421
Methods and Compositions for Killling a Target Bacterium62/676,818
Genome Engineering with Type I-B CRISPR-CAS Systems from Listeria Monocytogenes62/683,586
Aspirin derivatives and uses thereof US 9850195
Aspirin derivatives and uses thereof US 9950987
Process for preparing hypoallergenic and non-allergenic peanuts (Arachis hypogaea) utilizing an endopeptidase EP 2170106

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	11	125	136

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of non-degree credit group activities conducted related to human health, nutrition and well-being
  Not reporting on this Output for this Annual Report

Output #2

Output Measure

- Number of participants in workshops and demonstrations on human health, nutrition and well-being
  Not reporting on this Output for this Annual Report

Output #3

Output Measure

- Conduct research projects related to human health, nutrition and well-being

Year	Actual
2018	48

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Identify and develop new food constituents or compounds that can benefit human health or nutrition
2	Create new plant materials (germ plasm, breeding lines, cultivars) that contain health benefiting compounds
3	Research projects generate findings that impact the knowledge of and control of vectors that impact human health and safety
4	Research projects generate findings that impact the knowledge of prevention or curing of diseases influenced by interactions of genetics and the environment

Outcome #1

1. Outcome Measures

Identify and develop new food constituents or compounds that can benefit human health or nutrition

2. Associated Institution Types

- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The connection between consumption of deep-fried foods and obesity has long been recognized. However, many consumers are reluctant to reduce their consumption of these foods. A food preparation approach that reduces fat content via displacement during food preparation would offer consumers an appealing and healthier alternative to traditionally deep-fried foods.

What has been done
Researchers at NC A&T are investigating a process that would produce a fried food with significantly reduced fat content. This process focuses on preparation of an edible protein-based coating batter that will retain less oil from the frying process.

Results
Protein isolated from chicken and fish by-products has been used to develop edible coatings. A&T researchers have successfully isolated the pure protein from muscle-based food processing by-products and solidified these proteins using sweet potato starch. The application of this edible coating reduced fat intake by 65% in fish and 85% in chicken samples.

4. Associated Knowledge Areas

KA Code	Knowledge Area
502	New and Improved Food Products
701	Nutrient Composition of Food
702	Requirements and Function of Nutrients and Other Food Components

Outcome #2

1. Outcome Measures

Create new plant materials (germ plasm, breeding lines, cultivars) that contain health benefiting compounds

2. Associated Institution Types

- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Excessive consumption of sugar is heavily linked to obesity, type 2 diabetes, heart disease, tooth decay, gout, and various other serious and chronic health problems. According to the CDC, sugar-sweetened beverages are the leading source of added sugars in the American diet, and over 35% of NC citizens report consuming sugar-sweetened beverages at least once daily. Stevia is one of few crops that can serve as a natural healthier alternative to cane sugar, but over half of the population does not like the taste of the standard varieties.

What has been done
NC State researchers have been investigating means to produce new stevia varieties with different concentrations of the glycosides that give stevia its sweet taste. Researchers have also investigated methods for creating stevia varieties adapted to overwintering in NC.

Results
A total of 31 improved clonal varieties of stevia have been released for industry use. These new varieties not only provide a new taste profile for consumers but also exhibit high yields, rapid growth, and adaptation to NC?s climate. NC State researchers continue to explore development of new varieties to provide consumers with an increasing array of healthy, appealing options for naturally sweetening foods and beverages.

4. Associated Knowledge Areas

KA Code	Knowledge Area
206	Basic Plant Biology
502	New and Improved Food Products

701 Nutrient Composition of Food

Outcome #3

1. Outcome Measures

Research projects generate findings that impact the knowledge of and control of vectors that impact human health and safety

2. Associated Institution Types

- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	8

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There is mounting public concern surrounding the use of antibiotic growth-promoting feed additives in poultry due to the fears of antibiotic-resistant bacteria development. Recently enacted Food Safety and Modernization Act regulations will significantly reduce the use of antibiotics for growth promotion in poultry, and most antibiotics of concern will be managed in feed milling operations by veterinary feed directives. To comply with these regulatory changes and meet public demand for antibiotic-free poultry products, sustainable alternatives must be discovered.

What has been done
NC State researchers have conducted several studies to demonstrate the efficacy and mode of action of dietary supplementation with various nutraceuticals, identifying several substances and feed formulations with a demonstrated ability to improve resistance to pathogens that threaten human and animal health. These studies have elucidated the mechanisms of action for these nutraceutical feed additives and demonstrated how they can be strategically used as alternatives to antibiotic growth promoters.

Results
NC State research and extension programs have increased the confidence of poultry producers to reduce the use of antibiotic feed additives in order to meet consumer and social health demands. All of the large integrated poultry production companies, as well as a few independent poultry producers that operate in NC, have replaced antibiotics with alternative feed additives and production strategies. Although this change may mean increased feed additive costs for producers, these costs can be offset by savings realized via use of other technologies, such as enzymes, grain co-products, and feed manufacturing innovations.

4. Associated Knowledge Areas

KA Code	Knowledge Area
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
722	Zoonotic Diseases and Parasites Affecting Humans

Outcome #4

1. Outcome Measures

Research projects generate findings that impact the knowledge of prevention or curing of diseases influenced by interactions of genetics and the environment

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	7

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Protein kinases are major signal transmitters in eukaryotic cells. Protein kinases make up about 2% of all genes within the human genome. Cancer, diabetes, autoimmune diseases, and many other common illnesses are associated with the dysregulation of protein kinases. Therefore, elucidating the mechanisms of interaction between kinases and their substrates and regulators is an essential step toward understanding and treating these conditions.

What has been done
NC State researchers are carrying out two laboratory research projects to understand the mechanisms and structures of particular protein kinase classes. Thus far, several important interactions have been identified, and pure forms of protein complexes have been isolated and reproduced in the lab.

Results
The knowledge gained from these studies will advance the general understanding of how important biological molecules function within cells, paving the way to promising new clinical and pharmacological tools for disease diagnosis and treatment.

4. Associated Knowledge Areas

KA Code	Knowledge Area
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
722	Zoonotic Diseases and Parasites Affecting Humans

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

Rapidly changing political, policy and economic conditions influence citizens' and businesses' abilities to adapt to change while ensuring healthful living and high quality life. Continued economic conditions affect federal, state and local support for research and extension programs, in some cases creating challenges to maintain productive and impactful programs. The regulatory environment often creates challenges for farmers, processors, handlers and food providers; often compliance is expensive and complicated, especially the required documentation. Nevertheless, successful entities develop strategies to comply to ensure that the food supply is safe and plentiful and the environment is protected. Emphasis will continue to be placed on those programs in research and extension that have the greatest effect on sustainability of citizens, families and businesses. Like, programs will continue to explore solutions to vector-borne diseases and genetic by environmental interactions, both of which can impact human and community health.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Data from faculty activity reports and impact statements, and Office of Technology Transfer were used to assess outcomes in this program area. Current research programs focus on areas such as how foods affect our genes and how our genetic makeup influence response to dietary constituents; biological chemistry and discovery of bioactive molecules in the area of inflammation and skin care; identification of food science strategies that will contribute to the development of improved food products that prevent chronic disease and enhance the quality of life; studies the development of endosperm, which plays a critical role in human nutrition and health; plant breeding and genomics to improve the nutritional value of small fruit and vegetables; establishing the metabolism of dietary phytochemicals and the potential impact this has on their biological activity; pathogenesis of metabolic disorders and associated inflammation; production of crops, vegetables and fruits for enhanced health-promoting properties; characterization of plant-derived bioactive chemicals (phytoactives) that interface with human therapeutic targets to modulate human

health; evaluation of genotypes, cultivars, production and environmental effects, storage strategies and packaging to develop postharvest technologies to extend quality and shelf life; and mechanisms by which modified redox homeostasis can affect tissue physiology and develop in patho-physiological processes.

Key Items of Evaluation

We are continually working to keep evaluation principles and tools aligned with plans of work, goals and objectives of our programs, and current best practices in program evaluation so that we can effectively report the results of our efforts.

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
26642	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)	
18685	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)	
0	Number of viable technologies developed or modified for the detection and
Sustainable Energy (Outcome 3, Indicator 2)	
161	Number of farmers who adopted a dedicated bioenergy crop
Sustainable Energy (Outcome 3, Indicator 4)	
220465	Tons of feedstocks delivered.