2017 North Carolina A&T State University and North Carolina State University Combined Research and Extension Annual Report of Accomplishments and Results

Status: Accepted

Date Accepted: 08/21/2018

I. Report Overview

1. Executive Summary

In North Carolina, a wide array of research and extension efforts are designed to enhance the lives and livelihoods of North Carolinians and make the state a productive and satisfying place in which to live. These efforts are the result of work at two institutions: North Carolina State University (NC State) and North Carolina A&T State University (NCA&T). Research and extension programs at the two institutions are housed largely in the College of Agriculture and Life Sciences (CALS) at NC State and in the College of Agriculture and Environmental Sciences (CAES) at NCA&T. The North Carolina Agricultural Research Service (NCARS) is the research arm within CALS at NC State, while research at NCA&T is conducted through the Agricultural Research Program (ARP) within CAES. At both institutions, the research efforts serve interests in agriculture, environmental, biological and life sciences. In addition, research programs provide the scientific base for academic and extension programs delivered by the two universities.

CALS continues working under a strategic plan launched in 2013, focused on people, partnerships, and programs. In 2017, the college continued to strengthen relationships with external partners, including state commodity groups, continuing to build a significant support base for two major efforts: the North Carolina Plant Sciences Initiative (NCPSI) and the Food Processing and Manufacturing Initiative. The NCPSI is based on an interdisciplinary systems approach. North Carolina's largest agriculture and biosciences assets will be concentrated in a new world-class interdisciplinary Plant Sciences Research Building on NC State's campus. In a statewide bond referendum on March 15, 2016, voters approved $85 million for the complex. In 2016, the Golden Leaf Foundation approved an additional $45 million (in addition to $3 million for planning) for the project. Another $6 million was raised from commodity organizations, as well as $5 million from NC State University. This effort is intended to establish NC State as the world leader in plant sciences research and innovation. Transdisciplinary interactions and integrated approaches will allow leading university, government and industry scientists to tackle grand challenges in agriculture. Emerging trends that link data sciences, plant improvement and food systems, sustainability and resilience offer the NCPSI a chance to seed discoveries and co-develop technologies that increase profitability, inform policy, and revolutionize practices in industry and farming. The Plant Sciences Building is expected to be complete in fall 2021. The North Carolina Food Processing and Manufacturing Initiative will diversify and add value to agriculturally-based businesses through food processing. Originally supported in 2014 by the North Carolina General Assembly, the initiative is designed to help increase the economic impact of agriculture and agribusiness in our state by 22 percent -- to $100 billion -- by 2025. The initiative has four main goals: to capture added value from North Carolina's agricultural commodities through the development of innovative food products and processing technologies; to foster the growth of food manufacturing entrepreneurial endeavors; to proactively target site selection attraction opportunities within the food manufacturing supply chain; and to provide regulatory training and outreach to the food processing/manufacturing sector. CALS Dean Richard Linton was appointed by the governor to serve as chair of the 35-member task force leading the initiative. The task force report was published and presented to NC Governor in April 2016. Based on one of the report's recommendations, a business development manager was hired. The report's further recommendations will be submitted to the state legislature for further consideration and possible funding. In 2017 the legislature dedicated funds to up-fit a building on

the North Carolina Research Campus in Kannapolis. This innovation center is projected to open in late 2018 and will support plant-based food research for entrepreneurs, farmers and manufacturers in North Carolina and beyond. According to economic feasibility studies released in 2015, the NCPSI is expected to add up to 32,000 jobs and boost associated economic output by $9.2 billion by 2024, while the Food Processing and Manufacturing Initiative could add 38,000 jobs and increase economic output by $10.3 billion by 2020.

Leadership, student access and food animal programming are areas that received additional CALS attention in 2017. The Leadership Initiative strives to support the young people of North Carolina through 4-H and FFA programming through faculty and staff on campus and stakeholders across the state. With the Access Initiative, CALS is working closely with university leaders to develop pathways for competitive students to gain admission to the university when traditional methods are insufficient due to an incredible student applicant pool. Lastly, North Carolina is a recognized leader in food animal production. CALS has partnered with the College of Veterinary Medicine (CVM) to lead the Food Animal Initiative, and work on nutrients and animal health from birth through production.

At NCA&T, CAES researchers continue to make strides towards improving the quality of life for the state's citizens by contributing to the body of knowledge that enhances productivity in animal and crop production for food sources and providing solutions for improved family health. On-going efforts in finding ways to reduce foodborne pathogens in poultry and swine, establishing community gardens in urban areas to alleviate urban deserts, developing biodegradable film packaging for produce, and introducing methods to produce locally grown truffles are a few of the many areas of study being undertaken by scientists at the university. While a majority of the research is being conducted in on-campus laboratories and the university farm, additional studies are handled at the Center for Environmental Farming Systems in Goldsboro, NC and in Kannapolis at the Center for Excellence in Post-Harvest Technologies.

The college's research arm, NCARS, conducts research at facilities on and off the NC State campus. On-campus facilities include highly specialized laboratories (i.e., molecular imaging, soil analysis, and x-ray crystallography), greenhouses, the Phytotron controlled environment facility, Pesticide Residue Laboratories, the Animal and Poultry Waste Management Center, Feed Mill, Structural Pest Training Center, Genomic Sciences Laboratory, Plant Transformation Laboratory, Bioinformatics Research Center, Food Rheology Lab, Nuclear Magnetic Resonance Facility, Structural Biochemistry Resource, Plant Disease and Insect Clinic and Food Processing Pilot Plants.

Off-campus facilities include 10 field laboratories with extensive animal and crop research capabilities and facilities for agricultural and municipal waste management research, regional research and extension centers with resident research and extension faculty in both western and eastern North Carolina, plus an additional 18 agricultural research stations strategically located throughout the state. The Center for Environmental Farming Systems, a partnership of NC State, NCA&T and the state agriculture department, specializes in sustainable agriculture research and extension and is located in Goldsboro.

The knowledge and technology developed through research conducted by the NCARS and ARP are delivered directly to North Carolina farmers, families and citizens through Extension programs emanating from the two institutions. 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 hand-in-hand 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.

In 2017, NC State Extension continued strategic efforts to restructure the century-old organization. The strategic plan targets NC State Extension's strengths, improves access to services across the state, and refocuses resources to support its refined core program areas: agriculture, food and nutrition, and 4-H youth development. The organization focuses its resources where Extension is most needed, best equipped to provide solutions, and can make the greatest impact on North Carolina's communities and economy. 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 translated the research-based knowledge generated by researchers and faculty members into everyday solutions that helped keep North Carolina's $84 billion agriculture and agribusiness industry growing and sustainable. NC State Extension provided educational programs to address public health issues, improve economic well-being, and help people make healthier, better-informed decisions. Programs ranged from breeding more profitable crops to creating local food markets, from shaping socially responsible youth to supporting healthier communities. NC State Extension conducted 4-H programs where young people learn by doing. 4-H programs and camps help develop 263,000 young people into active, contributing citizens each year. Extension partnered 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.

Cooperative Extension at N.C. A&T delivers educational programs and technology that enrich the lives, land and economy of small farmers, targeting limited-resource individuals, youth, families and communities in North Carolina. Although a non-formal instructional unit, Cooperative Extension is CAES' outreach arm. Helping North Carolina citizens lead healthier, more profitable, more secure lives, has been our mission for more than a century. Today, we continue outreach efforts that make a difference across the state. Our mission is to provide educational programs to inspire North Carolina's under-served 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.

In 2017, Cooperative Extension at N.C. A&T continued its work with the five-year strategic plan, Mission Possible, which is based upon issues that have been identified as critical to improving the quality of life of people in some of North Carolina's most economically stressed communities. The plan 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; and Emergency Preparedness for Minority Audiences.

Mission Possible also outlines six overall strategies to strengthen the organization and educational programming. These include: 1) increase use of and access to technology to enhance program delivery; 2) effectively target marketing, promotion and communications initiatives; 3) enhance program development and evaluation; 4) align and focus staff and professional development; 5) expand collaborations; and 6) ensure organizational capacity, resiliency and effectiveness. A number of accomplishments were achieved in 2017, some are listed here. In the area of marketing, promotion and communications, Cooperative Extension at N.C. A&T underwent a brand refresh that included a new logo, updated name, and the development of communications designed to share information with the target audience. Our Try Healthy program (SNAP-Ed) also launched a social marketing bus campaign to promote each of the following objectives in the SNAP-Ed Guidance: increase fruit and vegetable intake; drink more water; increase physical activity; drink 2% or less milk; and eat more whole grains. As it relates to program development and evaluation, the state specialists and associates participated in a 3-day workshop focusing on instructional design in January 2017 and then spent the year focusing on designing educational materials to meet the needs of limited resource audiences. Several educational products

should be finalized in 2018. A number state and county staff vacancies were filled in 2017, in addition to several new positions were added to better address the needs of limited resource audiences across the state. During 2017, a considerable amount of effort was placed on increasing state matching funds and increasing support from local county government. The lack of 100% state matching funds has also been made a priority for the University.
In an effort to direct faculty, staff, students, alumni, and stakeholders to greater success and accomplishments over the next five years, the College of Agricultural and Environmental Sciences (CAES) at North Carolina A&T began work under its strategic plan, "Destination Excellence" in 2017. The plan focuses on five major goals: Academics, Research, Work Climate, Outreach and Extension, and International Engagement that are in alignment with the university's strategic plan as well as the mission, vision, and core values of CAES. Destination Excellence sets forth measurable, specific goals and strategies to enable the college to invest, and lead in the agricultural, food, and environmental sciences.

This report represents the programs, outcomes and impacts of research and Extension efforts at North Carolina's two land-grant universities. 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. The research and Extension programs documented here are helping North Carolina's population of nearly 10 million citizens address critical challenges today and in the future. Following are examples of research and Extension activities and impacts from NC State and N.C. A&T within each program area.

Global Food Security - Plant Production Systems and Health

Fertilizer and nutrient management education increases profits and reduces runoff into NC waterways: In 2017, 625 people statewide attended Extension nutrient management training programs and 1,030 attended related field days. If program efforts lead to a 5-pound reduction in nitrogen per acre, 2 million pounds of nitrogen (valued at approximately $1 million) will be saved annually. In Hyde County, producers used composted layer manure, instead of inorganic fertilizers, on 20,000 acres of wheat and corn, saving $60,000.

Breeding program leads to turfgrass with better aesthetics, performance and disease resistance: North Carolina is in a transition zone, where no single type of grass (cool or warm season) can thrive year-round. NC State scientists combined conventional breeding methods with modern genomic tools to develop improved germplasm in five turfgrass species. To date, over 5,000 mutants have been generated, and a trial with 80 advanced lines is under evaluation. A new DT-1 bermudagrass ("TifTuf") released in 2015 became commercially available in 2017.

On-farm research and testing helps growers identify row crop varieties that perform best locally: In Johnston County, Extension worked with growers to conduct on-farm research and tests to identify high-performing varieties of cotton, corn, soybean, and wheat on Johnston County's wide range of soil types and rolling to fairly flat topography. Overall, selecting higher-yielding varieties could increase gross farm income in Johnston County by $9.5 million annually.

Training helps vegetable farmers analyze high tunnel and agroforestry technologies: Although costly, high tunnel technologies can extend vegetable growers' production seasons and diversify their income streams. Cooperative Extension at NCA&T led a workshop addressing cost and marketing issues. In-class presentations and hands-on field visits enabled 18 growers to better evaluate their options.

Researchers address farm-level food waste issues: The Center for Environmental Farming Systems' new Whole Crop Harvest Initiative applies innovative interdisciplinary research to reduce vegetable losses in the field and develop new ways to increase recovery of unharvested crops. CEFS research has generated protocols that enable growers to develop a more accurate picture of how much of their crop is marketable, and CEFS is working to develop economically viable pathways for distributing this large volume of previously wasted food.

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

Using ethanol processing co-products with enzyme blends reduces poultry feed costs: Through a series of experiments, NC State scientists found that including ethanol processing co-products along with appropriate enzyme blends can reduce feed costs for broilers by $20 per ton without compromising poultry growth or welfare.
Cattle producers benefit from conferences on herd management and production practices: To help producers increase the profitability of their cattle operations, Extension offered two beef conferences - one in the mountains and one near the coast. Participating farmers estimated the total economic impact of the knowledge gained to be worth more than $130,000.
Workshops improve livestock farmers' business, marketing and resource management strategies: NC Choices held a 2017 Carolina Meet Conference with 26 sessions on niche meat production and distribution for beginning and experienced farmers and Extension educators. Topics included local meat business basics, sales tax, liability insurance, and diversification. NC Choices' workshops reached 950 attendees, with attendees reporting a 97-100% increase in understanding of and motivation to apply the strategies they learned.
Research helps turkey growers treat blackhead disease without drugs or antibiotics: After de-registration of anti-protozoal drugs in the 1980s, cases of blackhead disease and other conditions caused by parasites in poultry reached epidemic proportions. Research has uncovered a link between gut health and blackhead disease in turkeys and identified a subpopulation of turkeys resistant to blackhead disease, providing new insights into how the disease can be prevented. Insights gained from this ongoing research have given growers ways to treat the disease without drugs or antibiotics.
Intestinal health of post-weaning pigs: North Carolina is one of the leading states in pork production. The ability of pork producers to successfully wean piglets with less use of antibiotics in animal feed is being addressed by researchers. Researchers at NC A&T are actively seeking alternatives to the use antibiotics. Results have shown that gut microbes influence immune responses and it is known to help prevent post weaning diarrhea. Recent test samples show the presence of segmented filamentous bacteria (SFB)--a positive bacteria - but not in a significant quantity to deduce what influences development of intestinal immunity and incidence of post-weaning diarrhea.
Climate Change
Breakthroughs in the development of sensing system prototypes could lead to better agricultural irrigation: To improve water use efficiency on farms, NC State researchers are exploring the use of fiber-optics-distributed temperature sensing to monitor environmental processes. Major technological breakthroughs in the prototype development for sensing systems provide researchers with unprecedented density of measurements of key components or controls of the hydrological system. That data could lead to novel approaches to improving the drought resiliency and profitability of ag production systems by reducing water, energy, and fertilizer use and improving yield.
Cover cropping to evaluate carbon sequestration: Developing soil management practices that increase soil organic matter and improve soil properties will enhance soil quality, increase crop yield, and improve crop quality. Reducing tillage practices and adding cover cropping by researchers at NC A&T has shown greater infiltration rates and soil-water content in reduced tillage plots compared to tilled plots. Cover crop residue has also increased water infiltration and soil-water content. This resulted in greater crop yields. In general, the practices of cover cropping for residue cover, reducing or eliminating tillage, using raised beds for vegetable production improved soil quality, increased water and nutrient retention, and increased crop productivity over conventional production practices. Many urban growers, including Montagnard refugee participants, have adopted these sustainable practices in their urban vegetable production fields.
Extension trains thousands in waste and nutrient management and watershed protection: NC State's soil science program offered 62 short courses and conferences in 2017 for erosion and sediment control professionals, municipal and industrial wastewater operators, environmental health specialists, septic system installers and operators, engineers, well contractors, government agency employees, elected officials and others. More than 3,250 participants received technical training for license renewal or professional development. Statewide, Extension agents provided county-level training on animal waste land application to 2,015 individuals, helped 1,733 individuals gain re-certification in waste management,

and helped 120 individuals become newly certified in waste management.
Extension assistance helps farmers meet waste-related rules: Regulations require swine farm owners and operators with certified animal waste management plans to meet annual requirements or face significant fines. Extension agents in Sampson and Bladen counties provided producers with assistance related to sludge management, irrigation calibration, litter calibration, record-keeping, manure sampling, general permits, and nutrient management plans. Agents worked with producers to conduct sludge surveys for 72 lagoons. After completing the surveys, the farmers were provided with the completed sludge reports for their annual inspection. By doing their own sludge surveys and calibrations, farmers not only meet requirements but also save money.
Extension team helps stakeholders keep water clean: Extension's water team partners with local stakeholder groups in installing innovative water harvesting demonstrations and provides workshops and design, inspection, and maintenance courses across the state. In 2017, over 18 million gallons of stormwater runoff were captured and tested, reducing nitrogen and phosphorus pollutants by 35% and 45%, respectively. The value of the nitrogen removed from state waterways is approximately $1.3 million, and the total value of water harvesters (value of the potable water plus the value of reduction in nitrogen and phosphorus) is $7.4 million.

Sustainable Energy and Biotechnology
NC State develops new crops and crops with new uses. Value-added products from the sweet sorghum crop have been identified through NC State ensilage and feedout studies and are now emerging as promising biomass crops. In addition, fermentation studies with adapted C. beijerinckii strain SA1 for butanol production and C. thermocellum using carbon (soluble and gaseous) derived from sweet sorghum and perennial grasses are providing key information for the next phase of "advanced" biofuels, and camelina crop production efforts are elucidating the best management techniques for producing a fuel feedstock and winter cover.
Biochar-based functional materials from biomass for energy storage and environmental protection applications: Environmental pollution and global warming are serious problems. NC A&T researchers are investigating sustainable, economical and environmentally friendly energy sources with the aim of resolving these problems. University scientists are studying new technologies to convert biomass (pyrolysis and hydrothermal carbonization) into biochar-based functional materials with applications in energy storage, catalysis, and environmental protection.
Extension workshops help homeowners conserve energy: Cooperative Extension at NCA&T trained new and existing Habitat for Humanity homeowners in energy conservation and home maintenance. Each participant received one energy kit, valued at $50, that could save families approximately $1,000 on energy costs.

Childhood Obesity
Extension helps food-insecure families learn how to provide nutritious meals on limited budgets. More than 20,000 participating 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. Its Expanded Food, Nutrition and Education Program assistants enrolled 1,798 families and 3,229 youth to address food resource management, nutrition practices, food safety, and physical activity.
Extension education helps young people improve their nutrition: According to the North Carolina CHAMP survey, only 37.7% of children eat the recommended five or more servings of fruit and vegetables per day. Extension offers a variety of child nutrition programs to increase fruit and vegetable consumption, reduce consumption of sugary beverages, and increase physical exercise. Cooperative Extension at NCA&T houses Speedway to Healthy, a 1,200 square-foot interactive exhibit that incorporates experiential education to combat childhood obesity, In 2017, more than 6,500 elementary school children from 16 counties visited the Speedway exhibit. Statewide, Extension programs helped 28,744 youth increase their fruit and vegetable consumption and get more exercise.
Eat Smart, Move More, Weigh Less program participants reduce their BMI and decrease blood pressure: Created by a team of professionals with expertise in nutrition, physical activity and behavioral

change, the 15-week "Eat Smart, Move More, Weigh Less" curriculum addresses North Carolina's need for accurate educational materials that address weight management. Since January 2011, the program has been regularly delivered in a real-time, online environment. A live instructor uses synchronous distance-education technology to lead the classes. As of July 2017, 338 online classes have been offered to members of the NC State Health Plan. Total enrollment was 7,756. Results show that participants improved their body-mass index scores, with 12.0% in the healthy BMI range of less than 25 at the start of the program and 16.8% in that range at the program's end. Results also show that participants improved their blood pressure, with 28.3% in the healthy blood pressure range at the start of the program and 40.9% in that range at the program's end.

Adult program participants reduce their cholesterol: In 2017, with the Richmond County Health Department, Extension started a yearlong diabetes education program for 16 people. And with Scotland County's Extension and Community Association, Extension offered a weekly line dancing class that has expanded to include health and nutrition information and on-site blood pressure checks. Statewide, 1,502 adults reduced their total cholesterol through Extension programs. The 16 participants in the Rockingham County program lost a total of 186.8 pounds in 16 weeks, and many participants also decreased both cholesterol and A1C levels. Of the 43 participants in Scotland County's line dancing program, 23 reported lower cholesterol, 23 reported improved blood pressure, 27 lost weight, and 39 reported more energy and a more active lifestyle.

Families, children, and youth gain access to healthy food: Using the Junior Master Gardener curriculum, Wilson County Cooperative Extension created a program for the White Oak 4-H Club to maintain the local 4-H Community Garden. Fifty low-income families with limited access to grocery stores are now receiving fresh fruits and vegetables year-round. In addition, all interviewed youth participants involved in this garden project stated that they are eating more fresh fruits and vegetables and are involved in more healthy activities.

Food Safety

Extension helps program participants pass food safety certification exams: Food safety education is vital to preventing foodborne illness outbreaks, which cost an average of $75,000 each. NC State Extension agents provide ServSafe and NC Safe Plates food safety training and certification programs for food service managers and food handlers. Statewide, 654 food service employees received SafePlates certification, 604 participants implemented SafePlates standards, and 769 food handlers received food safety training and education in safe food handling practices.

School nutrition services staff complete HAACP certification: To protect children from foodborne illnesses, Extension provided 84 Franklin County school nutrition service staff members with Hazard Analysis and Critical Control Points training to meet USDA certification requirements. There was a 94% success rate on the application exercises completed by staff. One school learned enough to reject an unacceptable food delivery that could have endangered student health. Statewide, Extension trained 199 school personnel in school HAACP principles.

Extension helps growers learn Good Agricultural Practices (GAPs): Cooperative Extension is taking the lead to ensure that growers understand the requirements, benefits, and costs associated with GAPs certification. In Lee County, agriculture agents worked with the state agriculture department to present information about the GAP audit process and the differences between various GAP certifications, equipping them with knowledge to reduce their risk of spreading foodborne illness and to improve their access to market opportunities. In Jones County, Extension worked with a producer interested in growing organic tomatoes in greenhouses for a large grocery-store chain that required GAP certification. The grower passed a food-safety audit, received GAP certification and secured a $72,000 contract with the chain. Statewide, 1,166 individuals were recertified in GAPs, and 73 were newly certified.

Greek yogurt and acid whey: Greek yogurt continues to be a hot commodity in demand by consumers., but production of Greek yogurt generates acid whey. There are strict federal regulations prohibiting dumping of this acid. Disposal of acid whey is an additional cost to the dairy industry. NC A&T researchers, by developing a method of separating and purifying lactic acid from acid whey, have designed a new way of producing economically valuable products from waste acid whey--an acid-free

usable protein. This technology will have a direct economic impact on the state of North Carolina and on dairy industry stakeholders, both by reducing the costs of waste management, and by creating a new marketable product. Researchers have also developed a system for converting acid whey into a usable product. Significantly, this project has promoted the concept of utilizing food by-products instead of disposing of them. The university also has gained the tools needed to establish a specific research program into the exploitation of food processing by-products.

Human and Community Development

Extension empowers participants to manage their financial accounts and protect their financial identity: In Nash County, Extension presented Money Management workshops for limited-resource residents. Participants gained tips and resources on how to create a budget, save money, and review credit reports. The workshops were conducted in partnership with the Rocky Mount Senior Center, the Williford Family Resource Center, and the Rocky Mount/Edgecombe Community Development Corporation NC Housing Coalition. As a result of the workshops, 98% of participants reported that they will create a household budget, keep track of and decrease daily spending, and annually review activity on their credit reports.

Limited-resource families learn to cut their energy use: High energy bills cause limited-resource families to make important tradeoffs between food, medicine, keeping the lights on, and other basic necessities. NCA&T Extension agent collaborated with Macedonia Family Resource Center in Guilford County to offer a series of three programs focusing on great ways to save energy and money. Evaluation results showed that each participant had learned at least one way to reduce home energy use. Follow-up interviews with two participants indicated that they had used two or more of the strategies they learned about. One participant reported a decrease in utility bills.

Parenting classes help participants adopt positive practices: When parents lack support or feel isolated, they may be more likely to make poor decisions that can lead to neglect or abuse, but parent education programs help. In Hoke County, Extension partnered with the Department of Social Services to offer the Parenting Matters program to 11 families, while Lenoir County offered the program to more than 100 people. For one family, a social worker dismissed a case against participating parents, and one parent expressed that her son's grades and interpersonal skills had dramatically improved.

School enrichment programs help bring learning to life: In 2017, 210,535 youth participated in 4-H school enrichment programs in classrooms throughout the state. The programs, designed to fit the N.C. Essential Standards, were jointly delivered by 4-H agents from NCA&T and NC State. Statewide in 2017, 155,837 youth increased their knowledge in science, technology, engineering and math (STEM); 19,471 youth gained competence in family and consumer science; 109,216 youth gained personal development and leadership skills; 88,879 youth increased their knowledge of expressive arts and communication; and 114,485 youth gained hands-on experience in community service and civic engagement.

Extension 4-H day camps help children learn while having fun: In 4-H day camps spread throughout the state in 2017, 10,766 young people learned about STEM, robotics, citizenship, healthy living, agriculture and more.

4-H addresses local need for STEM education through expanded robotics program: To provide young people with more STEM opportunities, Mitchell County 4-H implemented a robotics program for middle schoolers. Through the leadership, training, and equipment provided by N.C.A&T, a robotics competition team was formed. Participants not only engineered an autonomous robot, they gained teamwork skills. The 4-H STEM specialist at N.C. A&T trained 40 4-H agents (nearly half of the 4-H agents in the state) on robotics, emphasizing the importance of reaching non-traditional youth in 4-H. To grow opportunities for other youth to participate, 4-H obtained funding through United Way, a local foundation and a local manufacturing company to offer robotics programs at the elementary and high school levels.

Aging-in-place (AIP) for elderly renters: Elderly renters have less flexibility in home modifications due to lack of ownership. Researchers at NC A&T SU are examining the unique factors which may affect elderly renters when pursuing their desire for AIP and improving/maintaining a desired quality of life. The aim is to examine the strategies NC low-income elderly renters can employ should they want to stay in their living place or communities. Preliminary result show that environmental factors encountered by the elderly included bathroom deficiencies (door width, toilet height, grab bars); height of door entrances to the

home; uneasy access to cabinets in the kitchen; lighting; and lack of non-slip floors. These environmental challenges could negatively affect residents' health and well-being.

Human Health, Nutrition and Well-Being

Researchers develop shelf-stable functional ingredients from plants: NC State researchers have investigated the healthy functionality of plant-derived compounds on diverse fronts, and that research led to the development of functional ingredients derived from plant proteins that improve physical endurance and weight management and the development of hypoallergenic egg protein ingredients with promising applications for oral immunotherapy. Ongoing projects include identifying berry extracts that improve bone health in post-menopausal women and a partnership with NASA on the formulation of high-protein bar formulations to enhance shelf-life and nutrient availability.

Scientists use genomic tools to enhance health-promoting qualities of fruits and vegetables: At NC State, scientists are developing genomic resources for fruit and vegetable crops and using these resources to identify DNA markers associated with genes controlling phytonutrient accumulation. These tools can be further integrated into advanced breeding programs to boost nutritional value and enhance other agronomic traits into new fruit and vegetable varieties. An NC State researcher has dramatically enhanced understanding of the blueberry genome by completing the first chromosome scale genome assembly for the blueberry crop. Research is now focusing on extending these efforts to enable enhancement of health-related substances

Total Actual Amount of professional FTEs/SYs for this State

Year: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	691.0	66.0	387.0	46.0
Actual	759.0	61.0	341.0	38.8

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

At NC State, leadership from the College of Agriculture and Life Sciences which includes the North Carolina Agricultural Research Service (NCARS) and NC State Extension serve as merit reviewers for the Federal Plan of Work and Federal Report of Accomplishments and Results. This review is conducted by senior administrative staff, program leaders, department heads, and department extension leaders. A thorough scientific and merit review of each proposed new or revised HATCH research project is conducted at the departmental level before submission to the North Carolina Agricultural Research Service (NCARS) at NC State University. This departmental review consists of two parts: 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 NC 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. County centers also analyze information pertinent to the economic, social and environmental situation. State program leaders, specialists, district directors, and selected county faculty conduct a rigorous review of the data. Collectively, these individuals provide an internal and merit review of programs based on the needs and expectations expressed in the stakeholder input process. 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 basis requirements for Smith-Lever funds. Objectives are updated, revised or deleted as changes and circumstances occur. Specialists develop curriculum, training and technical assistance to assist county faculty address the needs that have been identified in the assessment.

The research director in NC A&T State University's College of Agriculture and Environmental Sciences (CAES) 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. The procedure assures that research proposals are scientifically sound, relevant to society's food and agricultural needs, and not 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. The merit review process 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. The proposal is 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, the proposal is submitted for budgetary review by the Office of Agricultural Research and then transmitted to NIFA/USDA for approval.

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 selected individuals from the general public

Brief explanation.

The NC State College of Agriculture and Life Sciences (CALS) has made a concerted effort to involve and inform college partners and other stakeholders as it has planned and carried out its strategic plan, Our Envisioned Future (2013-2020). As Dean Richard Linton traveled across the state to hear firsthand what our agriculture and life science stakeholders needed for future growth and success, the resounding response was more plant science research, applied innovation and education. With that knowledge, the College -- working in partnership with N.C. Department of Agriculture and Consumer Services and a dynamic group of stakeholders -- defined a world-class, interdisciplinary approach to plant science research and education that became the NC Plant

Sciences Initiative. The initiative, which has strong involvement from both the farming and ag biotechnology industries, was included in a statewide bond package, and information meetings related to the bond referendum gave college administration another chance to connect with local stakeholders throughout the state. They also reached out nationally and internationally to potential plant sciences partners. In Raleigh, the college also held an annual partnership meeting that brought together more than 100 representatives of 50+ commodity organizations, ag biotechnology companies, service organizations and societies, agricultural advocacy groups and others to encourage their input and support and put on an annual Stewards of the Future conference in which 500 participants shared concerns and insights into issues related to water quality and quantity, with an emphasis on North Carolina agriculture.

NC State Extension has a continuous system in place for obtaining stakeholder input in program planning, implementation and quality assessment. NC State Extension utilizes various methods to reach stakeholder groups including residents, governmental officials, advisory, commodity group representatives, volunteers and other clients. Stakeholders are provided the opportunity to give feedback and ensure that local programs meet local needs and priorities. Stakeholder input is obtained through surveys, focus groups, interviews, and public forums. An Advisory Leadership System is functional in each of North Carolina's 100 counties. The system includes an Advisory Council and many specialized committees. The Advisory Council represents geographic, cultural and economic diversity within communities of the county. Its function is to provide overall programmatic review and assist with environmental scans and needs assessment for program direction. While the advisory council meets quarterly, the specialized committees meet at least annually to discuss accomplishments and needs still to be addressed. This system is monitored administratively to assure that stakeholders provide program input and actions. At the state level, a Statewide Advisory Council provides programmatic inputs, review, and guidance for the overall program functions of NC State Extension. The State Advisory Council for NC State meets quarterly and meets jointly once a year with the NC A&T Strategic Planning Council. The Statewide Advisory Council also attends other special meetings to provide organizational review and input.

The Strategic Planning Council (SPC) is the advisory leadership group for Cooperative Extension at N.C. 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. They are the voices for NC residents that lack the financial resources, educational background or other social factors which limits their involvement in the decision-making process. 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.

The NC State College of Agriculture and Life Sciences has made a concerted effort to involve and inform college partners and other stakeholders as it has planned and carried out its strategic plan, Our Envisioned Future (2013-2020). As Dean Richard Linton traveled across the state to hear firsthand what our agriculture and life science stakeholders needed for future growth and success, the resounding response was more plant science research, applied innovation and education. With that knowledge, the College -- working in partnership with N.C. Department of Agriculture and Consumer Services and a dynamic group of stakeholders -- defined a world-class, interdisciplinary approach to plant science research and education that became the NC Plant Sciences Initiative. The initiative, which has strong involvement from both the farming and ag biotechnology industries, was included in a statewide bond package, and information meetings related to the bond referendum gave college administration another chance to connect with local stakeholders throughout the state. They also reached out nationally and internationally to potential plant sciences partners.
NC State Extension has a continuous system in place for obtaining stakeholder input in program planning, implementation and quality assessment. NC State Extension utilizes various methods to identify stakeholder groups including residents, governmental officials, advisory, commodity group representatives, volunteers and other clients. NC State Extension 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 the Advisory Leadership System and the Needs Assessment process to obtain input through surveys, focus groups, interviews, and public forums. An Advisory Leadership System is functional in each of North Carolina's 100 counties. The system includes an Advisory Council and many specialized committees. The Advisory Council represents geographic, cultural and economic diversity within communities of the county. Its function is to provide overall programmatic review and assist with environmental scans and needs assessment for program direction. While the advisory council meets quarterly, the specialized committees meet at least annually to discuss accomplishments and needs still to be addressed. This system is monitored administratively to assure that stakeholders provide program input and actions. At the state level, a Statewide Advisory Council provides programmatic inputs, review, and guidance for the overall program functions of NC State Extension. The State Advisory Council for NC State meets quarterly and meets jointly once a year with the NC A&T Strategic Planning Council. The Statewide Advisory Council also attends other special meetings to provide organizational review and input.
County and/or campus based Cooperative Extension staff at North Carolina A&T nominate individuals to serve on the Strategic Planning Council. The nominees are generally persons from the community that staff have collaborated with or have attended events with such as conferences, trainings, and/or workshops.

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
- 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.

NC State Extension uses mailed surveys, electronic/web surveys, telephone surveys, one-on-one interviews, focus groups, and community forums to collect stakeholder inputs for the needs assessment and program prioritization process. NCARS is committed to seeking, receiving and using input from all stakeholder groups, including under-represented groups and the general public. A significant portion of the input from individuals throughout the state comes from interactions of research scientists with county-based extension personnel and directly with producers, industry and other agribusiness representatives. Many research faculty also have extension appointments. These faculty are the primary day-to-day communication link between agribusiness, county extension centers and NCARS. 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. In addition, faculty interact with county extension personnel in such a way that input from individual consumers is also effectively communicated to NCARS administration and faculty. Strategic planning efforts in Extension and for the entire college have benefited from concentrated efforts by college leadership to engage stakeholders through listening sessions, focus groups, and state-wide conferences and workshops and have all benefited from engagement of relevant stakeholder groups.NCARS 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 NCARS 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. 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 to centers within the college with industry advisory boards that meet at least twice per year, adding additional stakeholders providing input and direction for research programs. NCARS receives support annually from college-based foundations, including the Agricultural Foundation, Tobacco Foundation and Dairy Foundation. These foundations fund research projects and graduate students on a competitive basis across a wide range of areas. NCARS administration meets with the research and extension committees each fall to discuss priority areas for research in all aspects of agricultural production and agribusiness. In late winter, these committees meet again to select and approve research projects for funding, with provides another opportunity for input on research priorities. As greater emphasis is placed on integrated extension and research efforts, administrators and program personnel hold both research and extension appointments and duties. These personnel continuously interface on decisions for program prioritization, budgeting and staffing. These efforts help ensure a greater exchange of information from the state's citizens and that all audiences are identified and served to the extent possible given research and extension resources.
In November 2017, Cooperative Extension at N.C. A&T hosted its annual Grassroots Leadership Conference, a forum which brings together a diverse group of local stakeholders throughout the three regions of North Carolina (Mountains, Piedmont and Costal Plains). 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. Members of the Strategic Planning Council (SPC) participated in the planning of the conference. Their input helped to determine the theme, program

structure/content, and location. The theme for 2017 was Growing from Within: Building Community Capacity. A conference planning committee was made up of SPC members and campus-based Cooperative Extension staff. SPC members also participated on subcommittees to work in areas such as logistics, fundraising, and/or programs. SPC members were tasked with helping to advertise the conference to stakeholders in their county. As in years past, they also served as workshop presenters. This year's Grassroots Leadership Conference drew a capacity crowd of more than 100 stakeholders, representatives from partner agencies and members of county Extension staff to the Chatham County Extension Center in Pittsboro, NC. The majority of the participants rated the conference as "excellent" or "very good" on the conference evaluation. Furthermore, all of those surveyed agreed that the conference content could be used in their work to build community capacity. In addition to the stakeholder input provided by the Strategic Planning Council, North Carolina A&T State University conducted Community Listening Sessions throughout North Carolina in 2017. The purposes of these Community Listening Sessions were: (1) to meet and connect with people in the community; (2) to share updates of A&T and USDA; (3) to introduce the new director of Center for Environmental Farming Systems at North Carolina A&T and her vision of future work; and most importantly (4) to gather input and ideas to develop programs and projects that would better serve our stakeholders. Local extension agents were contacted to announce the listening sessions and to recruit participants. The participants included farmers, extension agents, local residents, teachers, nonprofit organization representatives, and youth group representatives.

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.

At NC State, the environmental scanning process entails obtaining both secondary and primary data on key issues of concern, needs and assets in the community. Secondary data are used to assess the analyzed needs (data and statistics) as well as needs identified/prescribed by experts. Primary data were collected by holding meetings, focus groups and/or interviews with key stakeholders such as extension advisory leaders and county government partners. These combined data and input were used to prioritize and target issues, needs and assets that serve to focus, guide and direct extension programming. For research, stakeholder input is especially 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. Also, leaders in the North Carolina Agricultural Foundation, N.C. Farm Bureau Federation, N.C. State Grange, N.C. Department of Agriculture and Consumer Services, N.C. Agribusiness Council and numerous other organizations not only provide insight on research needs and priorities but also assist in program reviews as well as advocate for research by promoting the importance of agricultural and life science research. 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.
The Community Listening Sessions conducted by North Carolina A&T also provided invaluable feedback from stakeholders. The top issues faced by small-scale producers included: marketing and diversification in production; farm succession planning; and small scale equipment and tools for small farmers. The programs offered through Cooperative Extension that benefited stakeholders the most were: Small Farms Week, farm visits, programs centering on leadership development; 4-H and other youth programs; and stateside Snap-Ed.

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, 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	7649380	946292	6729121	3443547
Actual Matching	7649380	1529663	6729121	3188027
Actual All Other	5591500	745656	27217000	1702855
Total Actual Expended	20890260	3221611	40675242	8334429

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	0	0	0	850000

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%	10%	20%
202	Plant Genetic Resources	10%	10%	10%	10%
204	Plant Product Quality and Utility (Preharvest)	5%	10%	5%	5%
205	Plant Management Systems	18%	30%	15%	25%
206	Basic Plant Biology	5%	10%	10%	20%
211	Insects, Mites, and Other Arthropods Affecting Plants	10%	0%	10%	10%
212	Pathogens and Nematodes Affecting Plants	10%	0%	10%	0%
213	Weeds Affecting Plants	12%	0%	10%	0%
216	Integrated Pest Management Systems	5%	15%	5%	10%
601	Economics of Agricultural Production and Farm Management	4%	10%	5%	0%
602	Business Management, Finance, and Taxation	5%	5%	5%	0%
604	Marketing and Distribution Practices	6%	10%	5%	0%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	139.0	20.0	142.0	7.0
Actual Paid	197.3	12.0	129.6	10.4
Actual Volunteer	107.0	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**
1988839	260126	2557066	1011741
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1988839	299218	2557066	701450
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
1453790	121029	10342460	174472

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 Communities of Practice are utilized by field crops, horticultural, ornamental and related areas that provide a resource for producers, handlers, processors and marketers.

V(E). Planned Program (Outputs)

1. Standard output measures

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	396490	1486246	96511	253976

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

Patent Applications Submitted

Year:	2017
Actual:	31

Patents listed

Sweetpotato - Ornamental Sweetpotato - Sweet Caroline Sweetheart Jet Black16-8969
Sweetpotato - 'NCORNSP-020BWGWE' Ornamental Sweetpotato - Sweet Caroline Bewitched Green With Envy16-8968
Sweetpotato - 'NCORNSP-023BWAM' Ornamental Sweetpotato - Sweet Caroline Bewitched After Midnight16-8967
Synthetic Pathway for Biological Carbon Dioxide SequestrationPCT/US2016/043054
Systems and Methods of Carbon Fixation Using Solventogenic Clostridium Beijerinckii62/371,562
Methods and Compositions for Killing of Insect Pest Eggs62/371,314
Methods and Compositions for Modification of Plastid Genomes62/383,074
Methods for Diagnosis of Pseudoperonospora Cubensis Infection and Selection of Plant Resistance Genes to the Same62/384,817
Autonomous Aquatic Herbicide ApplicationPCT/US2016/055986
Cercis plant named `Ruby Falls`2016/243
Cercis plant named 'Merlot'2016/244
Compositions and Methods for Enhanced Plant Growth and Seed YieldPCT/US2016/058109
Ornamental Sweetpotato Plant Named 'NCORNSP-023BWAM'15/330,770
Ornamental Sweetpotato Plant Named 'NCORNSP-020BWGWE'15/330,762
Ornamental Sweetpotato Plant Named 'NCORNSP-021SHJB'15/330,763
022SCRM - Ipomoea16-9036
Illicium 'NCIH2'15/330,892
Illicium 'NCIH1'15/330,894
Multi-Sample Imaging Chamber for Long Term Lightsheet Imaging62/423,935
Methods and Compositions for Attenuating Allergencity in Protein Products 2,962,791
Berberis thunbergii H2006-059-01417-9156
Berberis thunbergii H2005-094-004 17-9157
Miscanthus NCMS1 My Fair Maiden17-9170
Miscanthus NCMS2B Bandwidth17-9171
Miscanthus Sinensis Plant Named 'NCMS2B'15/731,079
Sweetpotato Plant Named 'NC05-198'15/731,073
Methods and Compositions for Attenuating Allergencity in Protein Products 15/524,087
Blueberry Plant Named 'Pinnacle'TBD
Blueberry Plant Named 'Heintooga'TBD
NCHA8 Limetta15/731,345
Re-Engineering of Mycorrhizal Symbiosis in Plants62/522,917

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	111	453	564

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
2017	100

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
2017	107357

Output #3

Output Measure

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

Year	Actual
2017	3287

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
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Nursery and floriculture crops represent one of the fastest growing agricultural sectors in North Carolina, and the wholesale value of these crops exceeded $719 million in 2012. These crops also play a vital role in protecting natural areas from being lost to expanding urbanization. Thus, there is a continual need for robust, non-invasive cultivars. In addition, the demand for renewable bioenergy crops is increasing throughout the world.

What has been done
A research program at NC State University has analyzed the physiology, production, selection, genetics, and reproductive biology of nursery and bioenergy crops, leading to the identification of superior germplasms, the development of more efficient production techniques and improved understanding of the physiological and biochemical mechanisms involved in developing improved hybrids.

Results
In 2017, new commercial nursery crops were developed and introduced into NC nurseries. One exceptional new nursery cultivar could generate wholesale sales of $1?2 million annually, with retail sales reaching twice that amount. In addition, projects surrounding new bioenergy crops are laying a promising foundation for NC's future in renewable bioenergy.

4. Associated Knowledge Areas

KA Code	Knowledge Area

202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants
216	Integrated Pest Management Systems
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
2017	22756829

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Educating farmers on best practices for fertilizer and nutrient management increases profits and reduces runoff of nitrogen, phosphorus, and sediments into state waterways. Fertilizer recommendations are under continual revision with changing production systems and new crops, and newly marketed fertilizer materials require constant re-evaluation.

What has been done
NC State crop and soil scientists have provided training, and ongoing collaborations between the university and the NC Department of Agriculture and Consumer Services enhance the skills and knowledge of Extension agents. These agents, in turn, help farmers resolve crop yield limitations due to nutrient deficiency and voluntarily adopt best practices for nutrient management.

Results
Total attendance at nutrient management training programs in 2017 was 625, plus an additional

1,030 field day attendees. In addition, Cooperative Extension agents were trained on fertilizer materials commonly available for North Carolina field crops. If program efforts lead to a 5-pound reduction in nitrogen per acre, 2 million pounds of nitrogen (valued at approximately $1 million) will be saved annually. In addition, Hyde County estimates suggest that Extension efforts led to producer usage of composted layer manure, instead of inorganic fertilizers, on 20,000 acres of wheat and corn, representing a total savings of $60,000 for farmers.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes Affecting Plants
213	Weeds Affecting Plants

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
2017	23

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
According to the last North Carolina Turfgrass survey (conducted in 1999), the state?s total acreage of turfgrass neared 2.14 million acres and required $1.22 billion to maintain. North Carolina is in a transition zone, where there?s no one type of grass (cool or warm season) that can thrive year-round. Genetic and breeding techniques can be used to improve the aesthetics, performance, and disease resistance of turfgrass cultivars.

What has been done
NC State scientists use a combination of conventional breeding methods and modern genomic tools to develop improved germplasm in five turfgrass species. Genetic selection techniques are being used to improve drought and summer stress tolerance in tall fescue, and artificial

hybridization and embryo rescue techniques are being used in St. Augustine grass to develop populations with improved cold tolerance and disease resistance.

Results
To date, over 5,000 mutants have been generated, and a trial with 80 advanced lines is under evaluation. A new DT-1 bermudagrass ("TifTuf") was released in 2015 and became commercially available in 2017.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
206	Basic Plant Biology
212	Pathogens and Nematodes Affecting Plants

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
2017	69

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Nematode infestations cause devastating worldwide crop damage and represent a significant threat to global food security. The traditional non-targeted application of nematicides fails to yield effective delivery directly to the point of infestation during the most susceptible period of infection: the seedling phase. In theory, seed treatment for nematode control is optimal, but it is largely ineffectual due to poor rhizosphere delivery.

What has been done
NC State scientists have researched the incorporation of nematicides into a biodegradable, renewable fibrous matrix seed coating. The effectiveness of this method has been demonstrated

under greenhouse conditions and in field trials in sub-Saharan Africa.

Results
A non-traditional and environmentally friendly delivery method for nematicides has been developed. This method is both efficacious and applicable to a broad variety of cropping systems, and it will be especially useful in a tear-and-wrap treatment for seeds that are hand planted. Scientists are continuing to refine this approach for safer, more targeted delivery of other agricultural chemicals.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
206	Basic Plant Biology
212	Pathogens and Nematodes Affecting Plants

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
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Growers must remain informed of how soil type, topography, and other environmental factors affect the performance of various crop varieties so that they can select varieties with the highest potential quality and yield.

What has been done
Extension sought out volunteers to conduct local on-farm research and testing to identify high-performing varieties of cotton, corn, soybean, and wheat on Johnston County?s wide range of soil types and rolling to fairly flat topography. Test results were reported to local farmers via newsletters, web postings, and cotton and grain crop meetings.

Results
By using the local results to select varieties with higher yields, county wheat yields can be increased by 19 bushels/acre, corn yields by 42 bushels/acre cotton yields by 389 pounds/acre, and soybean yields by 13 bushels/acre. Overall, the selection of higher yielding varieties could increase gross farm income in Johnston County by $9.5 million annually.

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
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
2017	49387

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In 2016, the EPA approved pesticide labeling of several new auxin herbicides for use in-season for dicamba and 2,4-D tolerant cotton and soybeans. To comply with pesticide labeling and state law, applicators required training on the proper use of newly labeled auxin herbicide products.

What has been done
Extension Centers in Hoke, Robeson, and Scotland counties partnered with NC State University?s weed science program and the NC Department of Agriculture and Consumer Service's Pesticide Division to deliver best practice pesticide management training to 167 cotton and soybean growers.

Results
Thanks to the quick response from North Carolina Cooperative Extension, attendees received mandatory training prior to the 2017 growing season, allowing farmers to use the newly-labeled products in-season. One-hundred percent of survey respondents felt the training reduced potential for dicamba or 2,4-D herbicide drift, and herbicide drift complaints were significantly lower than in surrounding states. This resulted in reduced damage to crops and reduced negative environmental impacts. Respondents reported an average economic benefit of $5.50 per acre, for a total program benefit of $50,000.

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
216	Integrated Pest Management Systems

Outcome #7

1. Outcome Measures

Increased acreage of organic crops and specialty crops.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
New rootstocks are becoming available that will increase orchard sustainability in replant and newly planted sites. An NC State program has been working to develop strategies for the state?s fruit tree growers to increase orchard productivity and profitability and tree survival.

What has been done
In 2017, NC State University continued 20 plus years of research into the evaluation of preplant soil treatments and new rootstocks by conducting a NC-140 peach rootstock trial and providing educational programs to growers and potential growers of fruit trees.

Results
Data from NC State's research and the application of best practices delivered via workshops and educational programs have increased planting of apples and peaches across the state. High-performing rootstocks identified by NC State's research efforts are playing a key role in the establishment of new commercial apple and peach orchards. Researchers estimate a potential profitability exceeding $8,000/acre. If orchard productivity and survival are increased by only 10?15% within this $45-million industry, annual benefits could reach $3?4 million.

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
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
2017	8

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Fungi cause many economically devastating diseases that threaten field, nursery, and greenhouse plant production. Although traditional breeding and chemical control methods are helpful, biotechnology represents a promising avenue for mitigating fungal damage to highly economically valuable crops.

What has been done
NC State scientists have conducted genetic research to validate the link between a naturally occurring plant enzyme (mannitol dehydrogenase or MTD) and increased fungal disease resistance, paving the way for the development of lower-maintenance plants and more resistant varieties.

Results
Successful application of this discovery would lower pest management costs and associated environmental impact. Although the impact on tomatoes and other regionally restricted high-value crops is expected to be the greatest in terms of dollar value, fungal diseases are not confined to a single region, so growers in all locales could benefit from this research. If the average tomato grower spends $250/acre on fungal disease control, the over 7,453 acres of tomato production in North Carolina translates into a $1.8 million annual expense that could be significantly reduced by growing tomato varieties resistant to multiple fungal diseases.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
202	Plant Genetic Resources
204	Plant Product Quality and Utility (Preharvest)
206	Basic Plant Biology
211	Insects, Mites, and Other Arthropods Affecting Plants
212	Pathogens and Nematodes 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
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The Christmas tree industry has been struggling in the past decade, with Madison County growers dwindling and being forced out of business. The traditional marketing strategy of selling wholesale trees by the tractor tailor load is not effective during slower economic periods.

What has been done
Cooperative Extension in Madison County partnered with the NC Department of Agriculture and Consumer Services to win a specialty crop grant to establish a relationship between its food hub (Madison Family Farms) and Whole Foods, allowing the chain to sell Madison County Fraser firs, wreaths, and garlands in 36 Whole Foods locations across the southeastern United States.

Results
With Cooperative Extension's help and advice to both the grower and store managers, high-quality trees were marketed, resulting in over $300,000 in sales to Madison Family Farms.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
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
2017	2934

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Due to continuing cuts in tobacco acreage and low commodity prices, farmers are seeking alternative ventures to make their farms profitable. Cooperative Extension was contacted by a farmer interested in growing yellow, zucchini, and butternut squash because he had found a market looking to purchase these crops.

What has been done
The Extension agent met with the grower in the fall to assist with the collection of soil samples on the new organic farms. Over the winter and early spring, the agent met with the grower and buyer several times to discuss organic certification, varieties, fertility, harvest timing, and storage. Throughout the first season, the grower received assistance from other agents experienced with organics. Specialists were consulted for advice on variety and fertility, and private groups assisted the grower with organic certification. Mid-season applications of fertilizer were needed, and recommendations were given based on prior knowledge of squash fertility needs and tissue samples that were taken.

Results
Cooperative Extension was able to advise the grower as he planted 20 acres of organic squash in the summer of 2017. After a mid-season fertilizer application recommended by Cooperative Extension, the grower was very pleased with the crop's growth and harvest. The grower is estimating a return of $8,800 per acre on 20 acres, for a total of $176,000 of potential added income to the farm.

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 #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
2017	19792

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
According to an agriculture census conducted in 2012, North Carolina suffered the loss of 21% of farmers who had been farming for 10 years or less in 2008?2012 (an estimated 13,000 farmers). This puts North Carolina in the bottom half of the nation in terms of farmer losses. Helping the state?s growers develop successful farms is critical to the agricultural economy.

What has been done
The North Carolina Farm School (NCFS) organized two farm schools: the Catawba River Farm School and the Eastern Piedmont Farm School. Over 60 farmers attended. In addition, the farm school curriculum was revised, and farm school agents were provided intensive training on policies and requirements for farmers, incorporation of field days and business sessions, and the development of an evaluation system.

Results
Since 2012, NCFS has successfully operated 12 different schools in eight locations throughout the state, serving over 342 graduates representing 289 farms, with 46 new farming operations in the state as of 2017. In 2017, 94% of students indicated that they had a business plan upon graduation, and 21% and 17% planned to add an enterprise or to improve an existing operation, respectively. The economic impact of the past few years of the program is estimated to be a $300,000 contribution to the local tax base, creation of 50 jobs, and a $950,000 impact on farm-level income.

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
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Producers are constantly looking for ways to extend their production season and diversify their income streams. High tunnel production is a potential avenue for season extension, but it can be cost prohibitive.

What has been done
Cooperative Extension at NCA&T led a workshop addressing cost and marketing issues associated with high tunnel production in conjunction with the Center for Environmental Farming Systems and NC Growing Together. About 18 producers with wide-ranging levels of experience attended in-class presentations and hands-on field visits to NCA&T's farm and high tunnels to see the research being conducted there first hand.

Results
All the participants stated that the high tunnel training met or exceeded their expectations and that they would recommend it to other growers, 78% expressed intent to sign up for the High Tunnel Cost Share Program through the Natural Resources Conservation Service, and 89% said they would attend additional high tunnel training in the future.

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
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Consumer demand for organically and sustainably raised produce and meats has increased significantly over the past 20 years. As farmers struggle to keep up, there is need for information about production, marketing, sustainability, supply chains, local foods, and other topics. Public interest in small-scale food production has also skyrocketed. Producers rely heavily on the expertise of university researchers and extension agents to keep them abreast of the latest research and production techniques, but this information is not always easily accessible.

What has been done
The Center for Environmental Farming Systems (CEFS) has become a national leader in sustainable agriculture research and education. CEFS trainings have expanded over the years and now include a full year's worth of high-quality, affordable, and accessible workshops that bring together the state's (and often the country's) foremost experts on topics ranging from community-based food systems to high tunnel season extension to sustainable production to supply chains and more.

Results
In 2017, over 2,500 people attended over 30 CEFS educational workshops and conferences. Over 8,00 people attended the Farm to Fork Picnic Weekend, CEFS' largest fundraising and public event of the year. Cooperative Extension at NCA&T partnered with NC Growing Together

to offer a NC Meat conference to bring producers and buyers together, with more than 500 participants from both sides. In 2017, Community Food Strategies organized eight regional gatherings of food councils with support from regional partners and the Local Food Council of NC. An annual meeting was offered to all NC local food councils to share information, update, challenges, and development. The Local Food Economies initiative worked with 50+ community colleges and six universities in 2017 to train and educate business counselors to better serve agricultural and food businesses, and it partnered with the Association of Regional Councils of Government (ARCOG) of North Carolina to integrate supply chain development and agricultural economic development into their comprehensive economic development plans.

4. Associated Knowledge Areas

KA Code	Knowledge Area
601	Economics of Agricultural Production and Farm Management
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

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 2017 North Carolina was still recovering from Hurricane Matthew and suffered additional crop damages from Hurricanes Maria and Irma. Wildfires were another environmental factor impacting North Carolina in 2017.

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 (feed grains initiative), 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. In addition, our research and extension enterprises represent productive environments in which our faculty are productive in terms of peer reviewed publications and creation of intellectual properties.

Key Items of Evaluation

We are continually challenged to keep evaluation principles and tools aligned with plans of work, goal and objectives of our programs, and current best practices in program evaluation so that we can effectively report the results of our efforts. We are proud of the many accomplishments of the plant production systems program. A couple examples: After 2 years of research to evaluate effectiveness of different fertilizer rates growers were educated on 2 x 2 x 2 banded applications with an overall impact on grower gross income of $6.68 million in the first year at a corn price of $4.00 per bushel. Thousands of people throughout North Carolina and the world have learned how to correctly compost or vermicompost on a small, medium, or large scale by reading NC State's publications, website resources, attending seminars or conferences, or touring the Compost Learning Lab.

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%	20%	30%
302	Nutrient Utilization in Animals	15%	10%	20%	20%
303	Genetic Improvement of Animals	10%	20%	17%	20%
307	Animal Management Systems	20%	20%	20%	0%
311	Animal Diseases	5%	0%	8%	20%
312	External Parasites and Pests of Animals	5%	0%	5%	0%
313	Internal Parasites in Animals	2%	20%	5%	0%
315	Animal Welfare/Well-Being and Protection	5%	5%	2%	7%
404	Instrumentation and Control Systems	5%	0%	0%	0%
511	New and Improved Non-Food Products and Processes	3%	0%	0%	0%
512	Quality Maintenance in Storing and Marketing Non-Food Products	5%	0%	0%	0%
601	Economics of Agricultural Production and Farm Management	4%	5%	1%	1%
602	Business Management, Finance, and Taxation	3%	5%	1%	1%
604	Marketing and Distribution Practices	3%	5%	1%	1%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	80.0	5.0	95.0	8.0
Actual Paid	113.9	9.0	85.3	6.6
Actual Volunteer	7.0	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**
1147407	99513	1682281	699897
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1147407	409731	1682281	753571
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
838725	61816	6804250	12042

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?

A number of animal systems Communities of Practice were utilized in eXtension, providing a valuable resource for production practices, animal health and management, and marketing. These resources are available to extension agents, producers and others supporting the food animal industries.

V(E). Planned Program (Outputs)

1. Standard output measures

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	297086	983072	100757	265151

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

Patent Applications Submitted

Year:	2017
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	21	169	190

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Participants in non-degree credit group training activities

Year	Actual
2017	60989

Output #2

Output Measure

- Relevant and impacts focused research projects to be conducted

Year	Actual
2017	100

Output #3

Output Measure

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

Year	Actual
2017	1418

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
2017	15929535

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Optimization of least-cost feed formulation for commercial meat and egg poultry is critical to profitable poultry production. Optimization techniques using grain processing co-products and new feed additives are constantly changing. It is particularly important to develop feed formulations that not only enhance production efficiency but also address public concerns surrounding food safety, environmental sustainability, and animal welfare.

What has been done
NC State researchers conducted a series of experiments that demonstrated that the inclusion of ethanol processing co-products in combination with appropriate enzyme blends can be used to reduce the cost of broiler feeds, improve growth performance, and enhance the yellow coloring of broiler skin and egg yolks.

Results
By incorporating ethanol processing co-products and appropriate enzyme blends, animal producers could reduce feed costs by $20 per ton without compromising poultry growth or welfare. Assuming 5 million tons of poultry feed produced in North Carolina, the potential economic impact of NC State's research on the state's feed and poultry industry is over $100 million. The poultry industry has already adopted many of the recommendations developed from this research, and during the last five years, all major poultry producers in North Carolina have used a significant amount of biofuel production co-products, locally produced alternate grains, and supplemental enzymes to reduce feed costs.

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
2017	15929535

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In January 2017, the USDA implemented new veterinary feed directives (VFDs) for all antimicrobials applied in aquatic food animal production. The trout aquaculture industry in western North Carolina does not have access to sufficient veterinary services for aquatic animals to implement this requirement in a timely fashion.

What has been done
An NC State specialist and an Extension agent engaged in a collaborative effort with Cooperative Extension, the NC Department of Agriculture and Consumer Services, and the Western NC Animal Diagnostic Lab to deliver training and raise awareness of the new requirements. They also partnered with veterinarians to identify specific pathogens and health conditions in fish and worked with producers to help them with treatment applications.

Results
In 2017, 55 VFDs were issued, and all but one of these was executed. As a result, over 6.5 million fish were treated (valued at $2.3 million). The potential savings to the industry from losses

prevented by this effort is estimated at $600,000 to $1 million.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
307	Animal Management Systems
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
2017	11450

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Cattle represent a significant economic contribution to NC, and the profitability of beef cattle operations is highly dependent on production costs. Producers need access to resources that will allow them to continuously refine their herd management and production methods to increase the profitability of their herds.

What has been done

Extension livestock agents of the Northeast District collaborated with industry partners to organize the 2017 Northeast Beef Conference as an educational resource for cattle producers. The conference provided hands-on demonstrations of best practices for herd management, with a focus on beef quality assurance. In addition, a team of Cooperative Extension Agents partnered with the North Carolina Cattlemen's Association and the Western North Carolina (WNC) Regional Livestock Center to host the WNC Area Beef Conference, which provided training on bull selection, bull feeding and supplementation, live animal evaluation, and bull breeding soundness examinations.

Results

Of the 34 people who attended the 2017 Northeast Beef Conference, 18 received beef quality assurance certifications, and 100% of the attendees indicated that they had learned new practices to improve their herd management, estimating a total economic impact of $5,900. Of the 65 beef cattle producers who participated in the WNC Area Beef Conference, 45 completed evaluations, and 100% of respondents indicated that the conference enhanced their knowledge of cattle husbandry. They estimated the total impact of the conference as $125,350.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
307	Animal Management Systems
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
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	11450

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Meat producers constantly seek to diversify and enhance their income sources. To optimize revenue, these producers must continually adapt and apply innovative strategies for production, marketing, product development, and business management.

What has been done
NC Choices held a 2017 Carolina Meet Conference with a pre-conference for Cooperative Extension. There were 26 sessions on niche meat production and distribution for beginning and experienced farmers and Extension educators. Topics included local meat business basics, sales tax, liability insurance, and diversification.

Results
NC Choices' workshops reached 950 attendees, 80% of whom reported meeting multiple contacts who will enrich their business. Attendees also reported a 97?100% increase in understanding of and motivation to apply the business, marketing, and resource management strategies that they learned.

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
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Flagellated protozoa pose a significant threat to poultry health and production. After de-registration of anti-protozoal drugs in the 1980s, cases of blackhead disease and other conditions caused by parasites in poultry reached epidemic proportions. The only remaining preventative treatment for blackhead disease (Histostat50) was removed from the market on Jan. 1, 2016, resulting in the destruction of entire flocks of poultry in 2017.

What has been done
Research conducted at NC State's Prestage Department of Poultry Science has uncovered a link between gut health and blackhead disease in turkeys and identified a subpopulation of turkeys that is resistant to blackhead disease, providing new insights into how the disease can be prevented.

Results
NC State's research has laid the foundation for a large-scale genetic screen in 2018 to identify the genetic factors associated with protozoal disease resistance in turkeys. Insights gained from this research have already provided methods for treating blackhead disease without drugs or antibiotics.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
311	Animal Diseases
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
2017	2934

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Women farmers and ranchers make up a growing portion of livestock and meat businesses as growers, marketers, and entrepreneurs. Although the meat industry is male-dominated (male ranchers account for 97% of all US livestock sales [2012 census]), women are entering the local meat business at a rate well above the national average in North Carolina. However, profitability is still a struggle, with the early years being the most difficult. Women farmers and meat entrepreneurs need focused training and support structures to help them succeed in the growing local and niche meat movement.

What has been done
In 2017, a group of women farmers in Franklin County formed the "Tar River Poultry Initiative" to support themselves in marketing their locally raised poultry and donate healthy local poultry to food-insecure residents of Franklin County. With the support of Franklin County Extension, they were awarded a RAFI grant to purchase a mobile poultry processing unit. In addition, the Watauga County livestock agent partnered with Blue Ridge Women in Agriculture to secure freezer space for local meat producers.

Results
The mobile poultry processing unit allows the women of the Tar River Poultry initiative to process at least 100 birds daily and provides supplementary income in the form of leasing fees from other local poultry producers. In Watauga County, under the guidance of Blue Ridge Women in Agriculture, 10 meat producers are selling their products, and three have doubled their meat sales. In addition, two producers have expanded into marketing cull cows as local meat, increasing their gross income by $2500 per animal.

4. Associated Knowledge Areas

KA Code	Knowledge Area
511	New and Improved Non-Food Products and Processes
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 2017 North Carolina was still recovering from Hurricane Matthew and suffered additional crop damages from Hurricanes Maria and Irma. Wildfires were another environmental factor impacting North Carolina in 2017.

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. The information also demonstrates the research and extension programs at our institutions are creative environments for our faculty to be productive in making new discoveries, publishing in quality journals, and creating new business opportunities.

Key Items of Evaluation

Qualitative and quantitative data collected show that our efforts in this planned program area are having significant benefit to users and to the state. An area beef conference prior to a bull test sale educated producers on bull selection and management. The conference program induced an economic impact of $3,081 per producer. In total, the results from this program and the gain in genetic improvement through bull selection and management would increase cattle value in the region by $123,250.Working closely with the trout industry to implement the new requirements for Veterinary Feed Directives (VFDs) 6.5 million fish were treated through these VFDs with a value of over $2.3 million. Potential savings to the industry directly from losses prevented is estimated at between $600k and $1million.

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%	20%	35%
111	Conservation and Efficient Use of Water	10%	20%	5%	5%
112	Watershed Protection and Management	10%	20%	10%	10%
133	Pollution Prevention and Mitigation	5%	10%	10%	10%
141	Air Resource Protection and Management	5%	10%	7%	5%
401	Structures, Facilities, and General Purpose Farm Supplies	5%	0%	5%	0%
402	Engineering Systems and Equipment	10%	0%	10%	5%
403	Waste Disposal, Recycling, and Reuse	8%	0%	5%	0%
404	Instrumentation and Control Systems	7%	0%	8%	5%
405	Drainage and Irrigation Systems and Facilities	5%	0%	5%	5%
605	Natural Resource and Environmental Economics	15%	0%	15%	20%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	72.0	2.5	23.0	6.0
Actual Paid	98.7	3.0	20.5	0.7
Actual Volunteer	5.0	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**
994420	60327	403747	90699
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
994420	37178	403747	148243
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
726895	44186	1633020	427812

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?

Participation in the Climate, Forests and Woodlands Community of Practice.

V(E). Planned Program (Outputs)

1. Standard output measures

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	38621	41816	72927	191914

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

Patent Applications Submitted

Year: 2017

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	2	79	81

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Waste Management Certification Programs

Year	Actual
2017	35

Output #2

Output Measure

- Number research project completed on environmental/natural resource issues

Year	Actual
2017	75

Output #3

Output Measure

- Enrollees for Natural Resources Leadership Institutes training
  Not reporting on this Output for this Annual Report

Output #4

Output Measure

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

Year	Actual
2017	483

Output #5

Output Measure

- Number of participants in non-degree credit activities

Year	Actual
2017	22799

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
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
With irrigation-related water use on the rise in North Carolina, it is important to optimize water management to improve net economic return and protect water resources. Characterization of the pattern of water movement across the soil-plant-atmosphere continuum and better understanding of these underlying hydrological processes are key to designing effective strategies to improve agricultural water use efficiency.

What has been done
NC State researchers have been exploring the use of fiber optics distributed temperature sensing (DTS) to monitor environmental processes, resulting in major technological breakthroughs in the development of prototypes for sensing systems that provide unprecedented density of measurements of key components or controls of the hydrological system, such as soil water content and atmospheric fluxes. In addition, in a collaborative effort with researchers from Columbia University, a large-scale fiber optics deployment has been designed and deployed at the Southern Great Plains (SGP) climate research facility in Lamont, OK.

Results
The potential deliverables of the research projects initiated in 2017 are (1) practical sensing systems to quantify water and energy movement across the soil-plant-atmosphere continuum from individual plants to field and watershed scales, (2) better understanding of field scale variability of soil water content and the influence of this variability on key hydrological processes, and (3) the development of novel approaches to improve agricultural water use efficiency in North Carolina, which can improve the drought resiliency of agriculture production systems and increase the profitability of farming operations by reducing water, energy, and fertilizer use and improving yield.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation

Outcome #2

1. Outcome Measures

Number farms implementing best management practices for animal waste management

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	2216

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
To comply with USDA-NRCS standards, farmers must use phosphorus indices to determine the risks of manure applications. USDA-NRCS was considering changing the standard from the use of phosphorus indices to a water quality model (APEX), which requires a large investment of field information and time in order to run.

What has been done
A group of over 20 research and extension faculty completed a five-year project to help the USDA-NRCS determine whether to continue using phosphorus indices as a risk measuring tool for animal waste applications. Researchers in North Carolina partnered with states in the Heartland, the Chesapeake Bay region, and the South to independently test their state phosphorus indices and multiple water quality models.

Results
The southern group, led by NC State, discovered that phosphorus indices work as well or better than water quality models, and the other groups found similar results. This national research effort

resulted in the publication of 20 papers in the November/December special issue of the Journal of Environmental Quality, and as a result of this important work, USDA-NRCS will not change their nutrient management system to include APEX. This has far-reaching implications for farmers, who will not be subjected to the increased investment of time and money demanded by water quality models.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
141	Air Resource Protection and Management

Outcome #3

1. Outcome Measures

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

Not Reporting on this Outcome Measure

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
2017	1853

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 North Carolina on waste management, nutrient management, and watershed protection.

What has been done

Extension specialists with NC State?s soil science program offered 62 short courses and conferences in 2017 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 2017, 3,251 participants received technical training for license renewal and/or professional development in waste and nutrient management and watershed protection. Statewide, Extension agents provided county-level training on animal waste land application to 2,015 individuals, helped 1,733 individuals gain re-certification in waste management, and helped 120 individuals become newly certified in waste management.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
141	Air Resource Protection and Management

Outcome #5

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	1106677

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

According to permit regulations in North Carolina, swine farm owners and operators with certified animal waste management plans must meet annual requirements. If a producer is out of compliance, they can have notices or fines from the NC Division of Water Resources. The fines can range from $500 per incidence to $25,000 per day they are in violation. One such requirement is to conduct a sludge survey of lagoons annually to determine the amount of sludge that has accumulated at the bottom of the lagoon. If the ratio of sludge is determined to be too great, the operator must submit a plan of action showing how they will get back into compliance or risk a minimum $1,000 fine for each lagoon out of compliance.

What has been done

Extension agents in Sampson and Bladen counties provided assistance to swine and poultry producers on sludge management, irrigation calibration, litter calibration, record-keeping, manure sampling, general permits, and nutrient management plans. Agents worked with producers to conduct sludge surveys for 72 lagoons. After completing the surveys, the farmers were provided with the completed sludge reports to aid in their annual inspection from the Division of Water Resources. The agents assisted 2 producers in calibrating 3 equipment systems.

Results

Farmers doing their own sludge surveys and calibrations saved the producers over $9,500. An NC State Extension agent completed a plan of action for high freeboard for one lagoon to help them stay in compliance. Ten waste utilization plans were updated on 400 acres. Two sludge plans were written for 80 acres, resulting in 17,000 extra pounds of plant available nitrogen (PAN) to be applied to these fields. Two poultry growers were assisted with written nutrient management plans for their farms.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation

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
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Sediment in water due to storm water flows is North Carolina's top pollutant, according to the North Carolina Department of Environmental Quality. Traditional methods of stream bank stabilization are prone to failure and cost prohibitive. Nursery owners, landowners, regulators, cities, towns and local partners are seeking cost-effective solutions to control eroding stream banks.

What has been done
For the past five years, Cooperative Extension has offered hands-on "Backyard Stream Repair" workshops in association with local Extension and local?state partners. In 2017, 12 workshops were held, with participants including nursery and creek owners, state and local government employees, environmental groups, and landscapers. Over 25 site visits were conducted to assist stream owners.

Results
Property owners, real estate agents, and professional engineers report that properties with repaired streams increase in value by 10%. In 2017, Backyard Stream Repair workshop participants reported stabilizing over 4,000 linear feet of streambanks, which will reduce annual runoff by 500 tons of soil, 350 pounds of phosphorus ($110,000) and 650 pounds of nitrogen ($152,000). In addition, a storm water demonstration/education project in Wake County attracted $120,000 in grant money for Umstead State Park.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
404	Instrumentation and Control Systems
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
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Water quality in North Carolina is threatened by storm water runoff. Citizens depend on clean drinking water, and water-related recreation contributes significantly to the $19 billion in annual tourism spending in the state. Extension delivers education to designing engineers, landscapers, planners, gardeners, and property owners to ensure proper installation and maintenance of storm water harvesters.

What has been done
The Extension water team partners with local stakeholder groups in installing innovative water harvesting demonstrations. The team provides workshops and design, inspection, and maintenance courses across North Carolina in cooperation with local governments and county Extension educators. Over the past 11 years, over 3,700 people have been trained and certified in storm water harvester maintenance.

Results
In 2017, over 18 million gallons of storm water runoff were captured and tested, reducing nitrogen and phosphorus pollutants by 35% and 45%, respectively. The value of the nitrogen removed from state waterways is approximately $1.3 million, and the total value of water harvesters (value of the potable water plus the value of reduction in nitrogen and phosphorus) is $7.4 million.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation

402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
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
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
As the demand for alternative energy increases, further development of renewable bioenergy crops will become increasingly important. Research from throughout the world builds a strong case that energy grasses will become key agricultural, industrial, and bioenergy crops. These crops can be used as fuel for heat and electric power generation, for production of fiber composite products, as forage for livestock, and ultimately as a fuelstock for cellulosic ethanol production. In Sampson County, BioChemtex International is constructing a cellulosic ethanol plant that will use energy grasses as a primary feedstock.

What has been done
An NC State research program has addressed diverse aspects of the physiology, production, selection, genetics, reproductive biology, and improvement of nursery and bioenergy crops. Accomplishments thus far include the identification of superior germplasm with greater environmental adaptability and pest resistance. Research efforts are also underway to evaluate the performance of energy grasses in North Carolina, develop production practices and recommendations, breed and develop improved varieties, and improve the efficiency of bioprocessing and cellulosic ethanol conversion.

Results
Projects on new bioenergy crops are serving North Carolina's diverse energy and economic needs. Overall, these engagements are fostering a healthy environment, careers, energy

independence, and economic development. In short, NC State's research on energy grasses is growing a greener and more prosperous world.

4. Associated Knowledge Areas

KA Code	Knowledge Area
401	Structures, Facilities, and General Purpose Farm Supplies

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
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Vance County small farmers needed to increase the use of drip irrigation systems to supply water to their vegetables. Drip irrigation is a very efficient method of applying water to crops. Crop yields can increase with proper water management. These farmers needed drip irrigation to sustain their crops and increase yields.

What has been done
Cooperative Extension at NCA&T responded to this need by conducting a workshop titled Drip Irrigation for Small Farms. Six small farmers attended this workshop. Cooperative Extension partnered with Berry Hill Irrigation, which provided drip irrigation equipment for the workshop. The Henderson Daily Dispatch newspaper assisted Cooperative Extension in promoting the workshop. WIZS local radio also promoted the workshop and provided Cooperative Extension radio time to provide drip irrigation information. In addition, Cooperative Extension conducted one-on-one consultations with farmers from Dabney, Bearpond, Middleburg, Kittrell, and Henderson communities.

Results

The six farmers stated on their post-workshop surveys that they had all increased their knowledge of drip irrigation and would adopt drip irrigation practices learned during the workshop. The five farmers surveyed in November stated that they had purchased drip irrigation equipment and had used this equipment to increase their crop yields. The farmers also stated they had each increased their income by $500 by following Cooperative Extension recommendations. The farmers indicated that they want more drip irrigation training in 2018.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
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 progress and benefit 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. As pressures increase for access to large quantities of irrigation water, it is anticipated that our research and extension programs will need to play a greater role in providing technology and systems to manage that water efficiently to optimize crop and food production, use nutrients efficiently and conserve water.

Key Items of Evaluation

Our strong programs in water quality and animal waste management and utilization continue. Animal Waste Operator certification training, continuing education programs, sludge surveys, and equipment calibrations have helped numerous hog farms maintain compliance and protect the natural resources in the state of North Carolina.

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
202	Plant Genetic Resources	15%	0%	15%	20%
205	Plant Management Systems	15%	0%	20%	20%
401	Structures, Facilities, and General Purpose Farm Supplies	5%	0%	5%	20%
402	Engineering Systems and Equipment	25%	100%	25%	10%
403	Waste Disposal, Recycling, and Reuse	10%	0%	10%	20%
404	Instrumentation and Control Systems	15%	0%	10%	0%
511	New and Improved Non-Food Products and Processes	15%	0%	15%	10%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	8.0	0.0	8.0	5.0
Actual Paid	7.6	0.0	6.8	3.5
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
76494	0	134582	447866
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
76494	0	134582	590724
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
55915	0	544340	2633

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

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	382	1063	737	1637

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

Patent Applications Submitted

Year:	2017
Actual:	2

Patents listed
Methods and Compositions for Enhanced BioMass Production and Increased Abiotic Stress Tolerance PCT/2016/043064

System and Method for Continuous Microwave-Assisted Extraction of Bioactive Agents from Biomass 62/430,086

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	0	49	49

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Studies on producing agricultural and forestry substrates for biofuel production

Year	Actual
2017	6

Output #2

Output Measure

- Studies on engineering conversion processes for biofuels and other components

Year	Actual
2017	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
2017	778

Output #4

Output Measure

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

Year	Actual
2017	27

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 Extension
- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Agro-industrial residues and dedicated biomass crops contain complex carbohydrates that can be converted into high-value products, including biofuels. The identification of new value-added products and the development of biologically-based methods for converting and processing raw materials into such products will increase the feasibility of using plant/crop-based resources as additional feedstocks for consumer goods.

What has been done
Researchers at NC State have been focusing on the production of bio-based products, such as enzymes, biochemicals, and biofuels from agro-industrial residues and dedicated biomass crops. The projects and activities in these areas have evolved over time; however, the primary goal of establishing functional uses for renewable materials suited to North Carolina has remained the same. The research approach involves both basic and applied objectives, leading to the development of processes at various scales (lab to industrial) that often integrate multiple operations within a given system.

Results
Value-added products from the sweet sorghum crop have been identified through ensilage and feedout studies at NC State Field Labs and are now emerging as promising biomass crops that are nearly market ready. In addition, fermentation studies with adapted C. beijerinckii strain SA1 for butanol production and C. thermocellum using carbon (soluble and gaseous) derived from sweet sorghum and perennial grasses are providing key information for the next phase of ?advanced? biofuels, and camelina crop production efforts are elucidating the management techniques required to effectively produce this oilseed as a fuel feedstock and winter cover in North Carolina.

4. Associated Knowledge Areas

KA Code	Knowledge Area
202	Plant Genetic Resources
205	Plant Management Systems
511	New and Improved Non-Food Products and Processes

Outcome #2

1. Outcome Measures

New bioprocessing technologies developed

2. Associated Institution Types

- 1862 Extension
- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There is increasing demand for renewable carbon sources to produce fuels. Although plants are capable of converting light energy to chemical energy and thus have great potential to meet this need, a better understanding of plant specialized metabolism is required to harness plants' huge catalytic potential.

What has been done
NC State scientists have been working to identify novel plant specialized metabolites and to discover the genes and pathways that govern the biosynthesis of these compounds in Arabidopsis thaliana, a widely used model plant, as well as in real crops, such as black raspberry, blueberry, and hops.

Results
Research is ongoing. A better understanding of the versatile biochemistry involved in plant secondary metabolism will provide knowledge of chemicals, genes, and enzymes that can be used to produce renewable fuels, serving as the foundation of a sustainable bio-based economy. This research also has far-reaching implications for the production of industrial chemicals and

pharmaceuticals.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes

Outcome #3

1. Outcome Measures

New bioproducts identified

2. Associated Institution Types

- 1862 Extension
- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
To facilitate the creation of a robust, resilient bio-based energy economy and phase out dependence on fossil fuels, new avenues for sustainably generating energy must constantly be explored. Biofuels produced from algal cells are one such promising avenue.

What has been done
NC State researchers are developing scalable algal bioreactor systems and algal strain improvements to promote improved carbon dioxide assimilation and algal oil production. Scientists have been studying how algal cells attach to solid surfaces, which could enable semi-immobilized algae production in the ocean and support the development of a platform for harvesting biofuels from algal cells.

Results
Microbial genes have been identified and characterized that can improve oil production in microalgae, and a patent has been filed describing a promising genetic modification of the marine microalgae Dunaliella salina. This research will eventually enable bioreactor design strategies

that support full exploitation of the algal life cycle, maximizing the production of algal oil.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
403	Waste Disposal, Recycling, and Reuse
511	New and Improved Non-Food Products and Processes

Outcome #4

1. Outcome Measures

Number of households improving energy conservation measures

2. Associated Institution Types

- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	699

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
A review of 48 major U.S. metropolitan areas reveals that low-income households, including African-American and Latino households and renters in multifamily buildings, devote up to three times as much income to energy costs as average households in the same city. High energy burdens and poor housing quality then contribute to health problems: poorly heated or cooled homes contribute to asthma, respiratory problems, heart disease, arthritis, and rheumatism. Families struggling to pay energy bills may sacrifice nutrition, medicine, and other necessities, which compound the effects of economic inequality. Although these findings are alarming, opportunities are available to help ease the hardship of energy costs on families.

What has been done
Cooperative Extension agent at NCA&T responded to a request from Habitat for Humanity to provide a workshop to new and existing homeowners on the topic, Energy Conservation and Home Maintenance. Nineteen participants attended the session.

Results

Participants received information on practical ways to save energy by caulking/sealing cracks, changing filters regularly, maintaining thermostats at specific temperatures, using CFL/LED bulbs instead of incandescent bulbs, and installing low flow shower heads. At the end of the workshop, all the participants indicated that they had learned at least home energy conservation method and would share the information with others. Twelve participants reported that the information was particularly useful to homeowners, and 50% of the participants stated that they planned to purchase several items to make their home more energy efficient. Each participant received one energy kit to use at home valued at $50. When used, the kit would save families approximately $1,000 on energy costs.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment

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
2017	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, animal welfare issues, and increasing energy costs all heighten the challenges. The animal industry needs a trained, knowledgeable workforce to overcome these challenges with sustainable solutions.

What has been done

An NC State project team has developed and is continuously refining eLearning curricula on Controlled Environmental Animal Production (eCEAP). This project taps into cross-disciplinary expertise spanning sustainable energy, climate change, and food security/safety to disseminate knowledge and best practices to faculty and students.

Results
In 2017, the project team strengthened modules covering sustainable development and management strategies for animal production. This effort improved the quality of teaching in eCEAP and increased the number, diversity, and workforce skills of undergraduate students in agricultural science and engineering. In the long term, this project is expected to directly contribute to the adoption of renewable energy systems on farms, as well as improved animal health, air quality, and sustainable feeding operations.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment

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
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Dwindling petroleum reserves and the significant environmental impact of exhaust gases from petroleum diesel have generated increased demand for renewable, environmentally friendly biofuels. Although it burns clean, biofuel derived from unimproved oil crops cannot realistically compete with the enormous demand for fossil fuels due to production costs and limited availability of cultivable land.

What has been done
A researcher with NC State?s Department of Plant and Microbial Biology has devised a strategy to increase the yield of oilseed feedstocks by increasing carbon fixation via adaptation of a condensed reverse TCA cycle to plants. A reverse TCA cycle utilizes carbon dioxide and water to form carbon with the help of two carbon-fixing bacterial enzymes. Because these enzymes were originally found in anaerobic bacteria, they are not optimized to function in plants. NC state

researchers are identifying the structures of these two enzymes to devise mutations that improve their activity in plants.

Results

In vitro tests of the synthetic carbon fixation enzymes developed by NC State researchers have shown the desired effects for modifying oilseed crops, and a patent has been submitted for this technology. This modified pathway could be introduced into any oilseed feedstock plant in order to increase its yield, an important step toward increasing the economic competitiveness of biofuel production.

4. Associated Knowledge Areas

KA Code	Knowledge Area
401	Structures, Facilities, and General Purpose Farm Supplies

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, though commercial applications are not in operation in the state. One recent challenge was defunding by the

state of the North Carolina Biofuels Center, which provided significant funding for biofuels research, although a portion of the funding was restored through another agency. Continued opportunities may exist for exploiting this area, particularly in research of producing biomass and discovering processes to make production of cellulosic ethanol efficient.

Key Items of Evaluation

Evaluation efforts in this program area include review of program data on use of energy saving products and techniques in homes and businesses. Expanded use of biofuels and forestry practices are also examined to demonstrated effectiveness of programs in this area.

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: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	48.0	15.0	8.0	3.0
Actual Paid	68.3	15.0	6.8	5.6
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**
688444	178756	134582	318343
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
688444	129429	134582	308889
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
503235	382058	544340	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 children, but actively engage an array of audiences. 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. NC State University's SNAP-Ed Program Steps to Health works with preschoolers, kindergarteners, 2nd grade students, 3rd grade students, and high school students. Steps to Health provides nutrition and food resource management education designed to serve the needs of specific groups. Program for preschoolers, kindergarteners, 2nd grade students, and 3rd grade students focus on nutrition education, while the programs for adults, Latino families, and older adults include nutrition and food resource management education.

N.C. A&T's Try Healthy utilizes five programs: Go, Glow, Grow (Pre-K), Learn to be Healthy (K-5), Speedway to Healthy Curriculum (K-17), Speedway to Healthy Exhibit (K-5), and Eat Smart, Live Strong (Adults and Seniors). Go Glow Grow is a nutrition curriculum developed by University of California Extension for preschool children. Using the book Go Glow Grow: Foods for You, children learn about healthy eating, exercising and the importance of hand washing. Using a simplified version of MyPlate, children learn the connection between healthy foods and what they do for the body. The Learn to be Healthy program (developed by Byrnes Health Center) consists of interactive, paper based and video lessons delivered in a variety of methods including instructor led, individually or in small or large groups. The nutrition education sessions are designed to engage youth in healthy decision making. Topics include how to measure servings, the importance of eating a variety of healthy foods, the function of the digestive system, how to identify parts of a food label and the various food groups. The Speedway to Healthy Project exhibit and curriculum was created by North Carolina Agricultural and Technical State University's Cooperative Extension Program. This specialized program provides practical nutrition and physical activity messaging, health information, and hands-on demonstrations. Students travel through the pit stops, engaging in experiential learning activities. Each pit stop is representative of a different area of the body. The pit stops include (1) starting line, (2) brain, (3) mouth, (4) stomach, (5) small intestines, (6) heart, (7) lungs, (8) kidneys, (9) bones, (10) muscles, (11) skin. In each pit stop, a volunteer educator engages students in a five-minute activity that focuses on healthy lifestyle choices and understanding the impact those choices have on the body. This project provides a fun, interactive educational experience that encourages healthy eating and behaviors in youth in grades K-5. Eat Smart, Live Strong is an intervention designed by the Food and Nutrition Service (FNS) to improve fruit and vegetable consumption and physical activity among adults. The N.C. A&T State University EFNEP curriculum, Table for Two, was developed to work with limited resource, young moms, ages 13 - 26. Table for Two teaches young mothers: (1) how to make good choices when eating out; (2) how the body changes during pregnancy and how those changes affect the growing baby; (3) what foods are safe and healthy for the baby to ensure proper development; and (4) how physical activity can play a role in keeping the body healthy during pregnancy.

Color Me Healthy is a program developed to reach limited resource children ages four and five. Color Me Healthy uses color, music, and exploration of the senses to teach children that healthy food and physical activity are fun. Agents train child care providers in the use of the program in their setting. Faithful Families Eating Smart and Moving More is a program that helps faith communities in North Carolina make and sustain changes that promote healthy eating and physical activity. Eat Smart, Move More Weigh Less(ESMMWL) is a weight-management program for adults. This 15-week evidence-based program includes strategies proven to work to achieve and maintain a healthy weight and encourages small changes that can be sustained over time. The program includes a family component to influence the eating and physical activity of all family members. Cook Smart, Eat Smart teaches simple, basic cooking for teens and adults. Eating more meals at home is an important strategy for eating a healthy diet. Cook Smart, Eat Smart provides hands on education on how to plan, shop, fix and eat healthy family meals. In addition to these methods, social media tools will be used by researchers as a means of helping to reinforce

information about healthy eating and physical activity behaviors among adolescents.

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. No time is more critical than childhood to promote healthy eating and sound health practices. Children do not consume sufficient fruits or vegetables and have diets that are low in fiber and higher in fat than recommended. Children need quality nutrition education to help positively influence their food choices. For nutrition education efforts to be effective, they must also include parents and care givers. Helping families make informed decisions about their nutrition will help ensure that North Carolina's children grow to reach their full mental and physical potential. Overweight in children continues to rise. Treatment of overweight and obesity is difficult. Prevention of overweight and obesity in children is essential to address this issue. Demographic changes in the state's population continue to impact nutrition and health issues. The fastest growing age group is the 65 years and older segment. The elderly have disproportionate risk of malnutrition and poverty, as well as poor overall health. In many cases they are either care-givers or influence the care of children. Because of the influence that adults have with different age groups, and because of their own health concerns, healthy nutrition and well-being educational programs are important for adults as well. Programs geared towards young adults and middle-aged consumers will continue to impact the health of the population as it ages. There are an estimated 34.2 million families with children under age 18. At least one parent was employed in 89.7 percent of families with children in 2017. For working parents with limited resources, lack of after-school and summer programs for youth is a major concern, as it relates to nutrition, health, and obesity since for many children, school may be the only place where they can receive nutritious meals.

3. How was eXtension used?

The Families Food and Fitness CoP of eXtension offers frequently asked questions, articles, online learning activities, and interactive tools on families, food and fitness topics. The CoP's aim is to become a source of research-based information for families as they work to eat smart, move more and achieve a healthy weight. The Community Nutrition Education CoP of eXtension provides information to support low-income nutrition education. Both Communities of Practices are used in this program area.

V(E). Planned Program (Outputs)

1. Standard output measures

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	285893	703083	237329	354223

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

Patent Applications Submitted

Year:	2017
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	0	4	4

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
2017	3134

Output #2

Output Measure

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

Year	Actual
2017	98933

Output #3

Output Measure

- Relevant and impact focused research projects conducted

Year	Actual
2017	2

Output #4

Output Measure

- Number of participants in non-degree programs and activities

Year	Actual
2017	98933

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
2017	20286

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 North Carolina, about 66% of adults are overweight or obese, and 27% of U.S. 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 to reduce the risk of overweight and obesity, including low consumption of fruits and vegetables.

Results
Statewide, 20,286 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. EFNEP nutrition program assistants enrolled 1,798 families and 3,229 youth 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, 54% of adult graduated participants increased vegetable consumption, and 56% increased fruit consumption.

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
2017	28744

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
North Carolina has the 23rd highest overweight and obesity rates among children age 10 to 17 in the United States. About one in three (32.3%) of high school students in North Carolina are either overweight or obese. Among North Carolina children age 2?4 who participate in the WIC program, 29.7% are overweight or obese. According to the North Carolina CHAMP survey, only 37.7% of children eat the recommended 5 or more servings of fruit and/or vegetables per day.

What has been done
A variety of child nutrition programs are used to target increased consumption of fruits and vegetables, reduced consumption of sugary beverages, and increased physical exercise for youth in North Carolina. These include programs such as Speedway to Healthy, Color Me Healthy for preschoolers and kindergarteners, Try Healthy, Steps to Health, Catch Kids Clubs, 4-H Youth Voice Youth Choice, and 4-H Health Rocks.

Results
Statewide, 28,744 youth increased their fruit and vegetable consumption. Steps to Health in partnership with Family & Consumer Science, 4-H Youth Development Agents, and Steps to Health Nutrition Educators reached 9,499 participants (8,214 children and 1,285 adults) and made 67,843 educational contacts within 63 counties across North Carolina through direct

education programs. As a result, more than 80% of preschool children are more willing to try fruits and vegetables, 72% of elementary school children are eating more fruits and vegetables, and 77% of children and youth are more active. More than 6,500 youth were reached through N.C. A&T's Speedway to Healthy exhibit to encourage better nutrition. In addition, N.C. A&T county agents, EFNEP, and Try Healthy Educators helped to influence the increase in consumption of fruits and vegetables in 2,428 youth directly and 700 youth indirectly through the 4-H Youth Voice Youth Choice program. As a result of the program, 75% of the participants stated they would encourage family members to try different fruits and vegetables and 65% stated they would consume at least 5 servings of fruits and vegetables a day.
Data from pre- and post-tests for the Speedway to Healthy exhibit indicated an increase in the mean number of days per week students engaged in eating vegetables and making healthy choices. On average, students reported eating vegetables and making healthy choices on ?some days? on the pre-test. However, after going through the Speedway to Healthy exhibit, students indicated that they intended to eat vegetables and make healthy choices on ?most days.? The results suggest that after children complete the Speedway to Healthy exhibit, there is an increase in their intention to engage in healthy behaviors. such as increased fruit and vegetable consumption.

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
- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	27659

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. As reported in 2013, 48.6% of North Carolina adults and 25.9% of North Carolina adolescents meet physical activity guidelines. 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.

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. Other programs?such as Fit in Fitness, line dancing, and clogging?provide ways for people to add physical activity into their lives and have fun.

Results
Statewide, 27,659 individuals increased their physical activity through Extension programs. EFNEP nutrition program assistants enrolled 1,798 families and 3,229 youth 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, 73% of adult graduated participants increased physical activity, and 40% of youth improved their physical activity practices. In addition, more than 6,500 youth were reached through the Speedway to Healthy exhibit to encourage higher levels of physical activity.

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

Program participant reduce their BMI

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	3374

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
North Carolina has the ninth-highest prevalence of overweight and the 26th highest prevalence of obesity among adults in the United States. An estimated five million North Carolina adults (66%) are either overweight or obese. North Carolina has the 23rd highest overweight and obesity rates among children age 10 to 17 in the United States. About one in three (32.3%) of high school students in North Carolina are either overweight or obese. Among North Carolina children age 2-4 who participate in the WIC program, 29.7% are overweight or obese. Overweight and obesity increases the risk of hypertension, heart disease, stroke, high cholesterol, diabetes, and other chronic health conditions.

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, Weigh Less? curriculum addresses North Carolina's need for accurate educational materials that address weight management. To improve reach and assess the scalability to a national model, an online version was created. Since January 2011, the program has been regularly delivered in a real-time, online environment. A live instructor uses synchronous distance-education technology to lead the classes. Participants can attend weekly sessions using a computer. They can see and hear their instructor, as well as interact with the instructor and other participants via the chat box.

Results
Statewide, 3,374 individuals reduced their BMI through Extension programs. As of July 2017, 338 ?Eat Smart, Move More, Weigh Less? online classes have been offered to members of the NC State Health Plan. Total enrollment in these classes was 7,756. Results show that participants improved their body-mass index scores, with 12.0% in the healthy BMI range of less than 25 at the start of the program and 16.8% 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
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	1864

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
According to the Centers for Disease Control and Prevention, 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 cancer. Heart disease is the second leading cause of death in North Carolina. In 2015, heart disease caused 28,467 deaths in NC; the equivalent of two heart disease deaths every hour and 21% of all deaths. Heart disease led to 100,123 hospital admissions and $4.5 billion in hospital charges in 2014.

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, Weigh Less? curriculum addresses North Carolina's need for accurate educational materials that address weight management. To improve reach and assess the scalability to a national model, an online version was created. Since January 2011, the program has been regularly delivered in a real-time, online environment. A live instructor uses synchronous, distance-education technology to lead the classes. Participants can attend weekly sessions using a computer. They can see and hear their instructor, as well as interact with the instructor and other participants via the chat box.

Results
Statewide, 1,864 adults reduced their blood pressure through Extension programs. As of July 2017, 338 ?Eat Smart, Move More, Weigh Less? online classes have been offered to members of the NC State Health Plan. Total enrollment in these classes was 7,756. Results show that participants improved their blood pressure, with 28.3% in the healthy blood pressure range at the start of the program and 40.9% 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
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	1357

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In North Carolina, almost 827,000 adults report having been diagnosed with diabetes, and it is estimated that an additional 280,000 North Carolinians may have diabetes but are unaware of their condition. Medical costs associated with patients who have diabetes are 2.3 times higher than medical costs for patients without diabetes. During 2012, $245 billion was spent in the United States to cover medical costs associated with diagnosed diabetes.

What has been done
Northampton County Cooperative Extension has established diabetes support groups in the Rich Square and Jackson communities, providing guidance on the importance of managing diabetes with medication, diet, exercise, and stress management. Scotland County Cooperative Extension partnered with the Extension and Community Association to offer a no-cost, weekly line dancing class for adults, a program which has expanded to include health and nutrition information and on-site blood pressure checks.

Results
Statewide, 1,357 adults improved their blood glucose (A1C) levels through Extension programs. Of the over 150 participants in Northampton County's program, 70% reported A1C level under 7.0%. All participants reported checking their feet daily, and 86% reported increasing fruit and vegetable intake. Of the 43 participants in Scotland County's line dancing program, 20 reported a decrease in their A1C levels, along with decrease in joint pain, lower stress, improved arthritis, an enhanced feeling of overall wellbeing, and better social skills.

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
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	1502

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 North Carolina, 41% of adults report they have 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 North Carolina, 17.9% of adults have never had their cholesterol checked. Of those who have had their cholesterol checked, nearly 80% had it checked within the past 12 months.

What has been done
In February of 2017, a yearlong diabetes education program was started in Rockingham County in partnership with the Health Department. Each week, an hour-long class was to educate 16 participants on making healthier food choices, increasing physical activity, and eating healthier on a budget. Scotland County Cooperative Extension partnered with Extension and Community Association to offer a no-cost, weekly line dancing class for adults, a program which has expanded to include health and nutrition information and on-site blood pressure checks.

Results
Statewide, 1,502 adults reduced their total cholesterol through Extension programs. The 16 participants in the Rockingham County program lost a total of 186.8 pounds in 16 weeks, and many participants also decreased both cholesterol and A1C levels. Of the 43 participants in

Scotland County's line dancing program, 23 reported lower cholesterol, 23 reported improved blood pressure, 27 lost weight, and 39 reported more energy and a more active lifestyle.

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
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	13653

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
Rutherford County Extension conducted five programs for adults in 2017 to build skills in choosing and preparing healthy foods. These programs reached a total of 151 participants with insights on healthy cooking and healthy living. In Currituck County, Extension held a series of hands-on cooking classes, including "Mediterranean Cooking," "Gardening and Cooking with Herbs," and "Gardening and Cooking with Root Vegetables," which reached a total of 42 residents.

Results

Statewide, 13,653 adults reduced sodium intake through Extension programs. Rutherford County Extension's "Take Control" program resulted in 60% of participants selecting food with less sodium, saturated fat, and added sugar and being more physically active. Seventy-five percent of participants in Rutherford's "Cooking with Herbs" program reported using more herbs and spices as an alternative to salt. Of those who completed evaluations for Currituck County Extension's cooking classes, 71% stated that they would decrease sodium in their diet, and 20% indicated that they were already practicing healthy cooking and would continue to do so. Participants left each class excited to cook healthier meals for themselves and their families.

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
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Most 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. Low-income families in rural areas face even more obstacles to obtaining healthy food because they cannot easily reach grocery stores.

What has been done
The Expanded Food and Nutrition Education Program (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 2017, 448 adults and 4,546 youth were

enrolled in EFNEP. Using the Junior Master Gardener curriculum, the N.C. A&T extension agent in Wilson County worked with limited-resource youth to create a program for the White Oak 4-H Club. The program was aimed at maintain the 4-H Community Garden within the White Oak Community.

Results

Because of EFNEP educators' efforts, 46% of graduating adult participants showed improvements in family resource management practices, and 36% improved nutrition practices. In addition, 88% of graduated youth participants improved diet quality. Thanks to the White Oak 4-H Community Garden, 50 low-income families with limited access to grocery stores are now receiving fresh fruits and vegetables year-round. In addition, all interviewed youth participants involved in this garden project stated that they are eating more fresh fruits and vegetables and are involved in more healthy activities.

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.

Key Items of Evaluation

For FY17, Steps to Health reached 9,499 participants (8,214 children and 1,285 adults) and made 67,843 educational contacts within 63 counties across North Carolina. Additionally, Steps to Health promoted positive policy, systems, and environmental (PSE) change across sites and communities receiving direct education by providing site-specific resources and engaging site leadership. Forty-seven sites made at least one PSE change, with an estimated reach of 34,676 individuals. 61% of participants improved their healthy eating behaviors, 36% of participants improved their physical activity behaviors, 82% of parents of participating 2nd, 3rd, and 4th graders improved their own healthy eating and/or physical activity behaviors. In 2017, EFNEP served 45 counties in North Carolina. 97% of EFNEP participants improved dietary intake, 58% now practice daily physical activity, 93% practice better food resource management, and 77% have improved their food safety habits.

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	15%	0%	20%	30%
502	New and Improved Food Products	15%	0%	15%	50%
503	Quality Maintenance in Storing and Marketing Food Products	15%	15%	10%	10%
504	Home and Commercial Food Service	10%	20%	5%	0%
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources	10%	25%	10%	0%
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	35%	40%	40%	10%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	74.0	5.0	51.0	6.0
Actual Paid	106.3	3.5	44.3	2.1
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**
1070913	29964	874786	190228
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1070913	60438	874786	171801
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
782810	19527	3538210	676999

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. Specific research projects identify effective nutritional control strategies for replacement of growth-promoting antibiotics for improving gut function and reducing intestinal colonization and shedding of Salmonella; assessing the incidence, populations, serotypes, genotypes, and antibiotic susceptibility of Salmonella and Campylobacter fecal isolates as a function of farm, bird age, season, management practices, and strategic processing of commercial broiler, turkey, and layer farms; assessing novel antimicrobial strategies for use in reducing foodborne pathogens and biofilm formation on food processing contact surfaces; employing the antimicrobial properties of eggshell membranes for reducing the heat resistance of foodborne pathogens; development of Salmonella-specific inhibitory nanoparticles for preventing intestinal colonization; development of alternative layer molting diets for reducing the risk of Salmonella contamination of shell eggs; characterization of Campylobacter respiratory chain genes for use in developing rational drugs for controlling infection of food animals; conduct ecotoxicological studies to identify chemical pollutant sources that contaminate aquatic human foods; development of a high hydrostatic pressure system for reducing toxigenic histamine-forming bacteria in scombroid fish and vacuum and MAP packaged fresh tuna; develop a more efficient means of producing a high-gelling protein isolate from underutilized fish species and other meat sources that could replace surimi manufacture and improve the quality, sensory and yield characteristics of new and existing muscle food products; development of a Vienna sausage product without casings via an in-tube focused microwave field heating technology; improving the texture and yield of canned/pouched Albacore tuna by controlling precook proteolysis and injection of a tuna-derived protein isolate; application of continuous flow processing of foods and biomaterials using advanced focused microwave technology; and development and testing of tools, methods and devices for rapid sterilization and production of high quality vegetable and fruit purees; isolating, identifying and characterizing bioactive compounds from peanuts skin, sweet potato peels/flesh, pokeweed roots and rosehip fruits and wine grapes skins /seeds; developing value-added products incorporating bioactive compounds from select extracts and evaluating them for consumer acceptability; exploring industry partnerships for commercial utilization of prototyped products incorporating bioactive extracts; and isolating the most active fractions from pokeweed and rose hip that show strong antiproliferative and apoptosis activity against breast, colon, and cervical cancer cells. An additional line of inquiry focused on the development of nutritionally enhanced foods through innovative food processing technologies including microfluidization to combining oat and corn brans for use in bakery products. 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. Extension provides the newly

Practices (GFMP) educational program that includes: Food Safety Principles, Personnel Health & Hygiene, and Food Sampling. Good Agricultural Practices (GAPs) are specific practices and behaviors used in agricultural production to ensure the safety of food and food products and reduce the risk of foodborne illness. 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 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 provides Food Safety Communities of Practice that provide relevant information and strategies for producers, processors and marketers.

V(E). Planned Program (Outputs)

1. Standard output measures

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	34855	235120	26370	125571

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

Patent Applications Submitted

Year:	2017
Actual:	24

Patents listed

Methods and Composition for Sequences Guiding CAS9 Targeting2936646
Methods and Composition for Sequences Guiding CAS9 Targeting2016-547162
Synthetic Pathway for Biological Carbon Dioxide SequestrationPCT/US2016/043054
Methods and Composition for Sequences Guiding CAS9 Targeting15/113,656
Engineered Salmonella Serovar Typhimurium Strains, Compositions Thereof, and Methods of Use. 62/368,507
Methods and Apparatuses for Thermal Treatment of Foods and Other Biomaterials and Products Obtained Thereby16182224.2
Systems and Methods of Carbon Fixation Using Solventogenic Clostridium Beijerinckii62/371,562
Methods and Composition for Sequences Guiding CAS9 Targeting15740979.8
Methods and Apparatuses for Thermal Treatment of Foods and Other Biomaterials and Products Obtained Thereby1809565
Methods and Apparatuses for Thermal Treatment of Foods and Other Biomaterials and Products Obtained Thereby1809565
Methods and Apparatuses for Thermal Treatment of Foods and Other Biomaterials and Products Obtained Thereby1809565
Encapsulation of Nutritional and/or Compounds for Controlled Release and Enhancing their Bioavailability by Limiting Chemical or Microbial Exposure62/419,218
Protease-Resistant Peptide Ligands14826202.5
Protease-Resistant Peptide Ligands16113436.7
Aptamers with Binding Affinity to Norovirus15/317,002
Modular Devices and Systems for Continuous Flow Thermal Processing Using Microwaves MX/a/2016/016723
Modular Devices and Systems for Continuous Flow Thermal Processing 2015283971
Modular Devices and Systems for Continuous Flow Thermal Processing Using Microwaves 15/320,676
Methods and Compositions for Delivery of CRISPR Based AntimicrobialsPCT/US2016/067657
Polyphenol-Protein Compositions and Methods of Making62/438,246
Novel CAS9 Proteins and Guiding Features for DNA Targeting and Genome Editing15/507,176
Novel CAS9 Proteins and Guiding Features for DNA Targeting and Genome Editing15836709.4
Methods and Apparatuses for Thermal Treatment of Foods and Other Biomaterials and Products Obtained Thereby15/482,069
Recombinant Lactobacillus with Decreased Lipoteichoic Acid to Reduce Inflammatory Responses 2.0171E+11
Altering Guide RNAs for Modulating Cas9 Activity and Methods of Use62/511,462

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	3	82	85

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
2017	478

Output #2

Output Measure

- Relevant and impacts focused research projects to be conducted

Year	Actual
2017	30

Output #3

Output Measure

- Number of firms adopting quality and safety strategies

Year	Actual
2017	0

Output #4

Output Measure

- Program participants trained in home food preservation

Year	Actual
2017	1077

Output #5

Output Measure

- Program participants trained in good farmer's market practices

Year	Actual
2017	111

Output #6

Output Measure

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

Year	Actual
2017	6758

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
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	919

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
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 is believed to play an integral role in preventing foodborne illness outbreaks.

What has been done
NC State and N.C. A&T Extension agents provide NC Safe Plates and ServSafe food safety training and certification programs for food service managers and food handlers. 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.

Results
Statewide, 654 food service employees received SafePlates certification, 604 participants implemented SafePlates standards, and 769 food handlers received food safety training and education in safe food handling practices. It is estimated that each foodborne illness occurrence can have an average cost of up to $75,000. If each of the 769 food service employees who received food safety training avoids just one foodborne illness outbreak, the potential cost savings could be nearly $58 million statewide.

4. Associated Knowledge Areas

KA Code	Knowledge Area

503	Quality Maintenance in Storing and Marketing Food Products
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 #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
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	267

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Every year in the United States, one in every six Americans (about 48 million people) contracts a foodborne illness. Most cases of foodborne illness are caused by consumption of food and drink that has been prepared with improper hygiene practices. The United States Department of Agriculture (USDA) requires all schools to have a Hazard Analysis Critical Control Points (HACCP) food safety plan in place to protect children from foodborne illnesses.

What has been done
Franklin County Cooperative Extension provided training to meet USDA certification requirements and ensure the safe handling of food at every stage of the preparation process. HAACP Certification training was provided for 84 staff members of the Franklin County Schools Nutrition Services Department.

Results
There was a 94% success rate on the application exercises completed by staff. One school became knowledgeable enough to reject an unacceptable food delivery that could have endangered the health of students. Statewide, 199 school personnel were trained in school HAACP principles.

4. Associated Knowledge Areas

KA Code	Knowledge Area
503	Quality Maintenance in Storing and Marketing Food Products
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
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Diary operations demand significant resources, and universities nationwide have struggled to support emerging areas of study while maintaining traditional programs. Faced with similar challenges, NC State is using unique operational and programmatic access to enhance program offerings while providing substantial self-support.

What has been done
The Dairy Enterprise System, created in 2009, combines multiple components of dairy farm production, product development, and processing into a vertically integrated system, which has generated significant gains in efficiency and performance. This system is now a financially stable and sustainable model that supports transformational technological improvements within a traditionally slow-moving industry.

Results
The Dairy Enterprise is currently serving as a testing ground for high-risk, yet potentially high-return technological advances in the dairy industry. This allows dairy industry leaders to observe and evaluate changes to traditional industry practices while insulating those most vulnerable to risk. This system is now almost entirely self-supporting, with 92% of funding being derived from

self-generated revenue.

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

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Number of food industry companies undergoing equipment and food safety audits

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Increased concerns about foodborne illness from fresh produced and associated economic losses have motivated many growers to voluntarily adopt good agricultural practices (GAPs). Cooperative Extension is taking the lead to ensure that growers understand the requirements,

benefits, and costs associated with GAP certifications.

What has been done
Lee County agriculture agents worked with the NCDA&CS to present information about the GAP audit process and the differences between various GAP certifications. To conclude the training, Extension coordinated a discussion between area produce growers and regional produce buyers on how to meet retailers' on-farm food safety requirements.

Results
All of the attendees were satisfied with the quality of the program, and 50% increased their knowledge of the GAP audit process. Lee County produce growers are now equipped with the knowledge to reduce their risk of spreading foodborne illness and to improve their access to market opportunities. This will allow continued growth in local produce production, which could add an estimated $1,000 to $10,000 in revenue per acre, depending on the crop.

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

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
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Military operations may require high levels of physical activity under stressful conditions that demand vigilance but offer little opportunity for sleep. In these extreme conditions, lack of

adequate nutrition and sleep loss can combine to impair physical and mental performance. Under these conditions, military personnel are often forced to "field strip" (throw away packaging and some food content) of standard MREs in order to reduce the weight of their packs. Military personnel need lightweight, nutrient dense, and shelf-stable food products to overcome these problems.

What has been done

In collaboration with the SMRC (Systems and Materials Research Corporation) and the DLA (Defense Logistics Agency), NC State researchers created four shelf-stable, nutrient dense bar prototypes to address these challenges. These bars were designed to serve as the sole source for nutrition for short-term (48 to 72 hour) military operations. Bars were produced in two flavors, milk chocolate and savory cheese and crackers, based on feedback from active duty military. Each flavor was produced in caffeinated and non-caffeinated versions.

Results

Four high energy density bar prototypes were created and assessed for shelf stability. Future studies will include sensory and shelf-life testing, as well as testing of the effects of the bars on mental and physical performance in simulated military operations. Bar prototypes are now being tested by branches of the armed forces. Future work/proposals with the SMRC and the DLA will focus on creating 3D printable bar formulae and commercializing the high nutrient density bars for public consumption.

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
2017	615

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Locally grown tomatoes may have an opportunity to capture retail market prices if they can be delivered to market during the months of November through May, when supply is reduced. A local producer recognized this opportunity and invested in building a greenhouse to grow organic tomatoes. The grower wanted to introduce his product through Whole Foods, which required GAP certification.

What has been done

Jones County Cooperative Extension worked with the grower to develop at GAP plan and made contacts with Carolina Farm Stewards to prepare for an audit. Through one-on-one farm visits, Extension and the grower worked together until all food safety requirements were met.

Results

The grower passed the audit and received GAP certification, which led to a contract with Whole Foods and an estimated revenue of nearly $72,000. Statewide, 1,166 individuals were recertified in GAPs, and 73 were newly certified.

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.)
- Other (National public health problem)

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, the food supply continues to both safe and one that's evolving with new process and products. We continue to foster and lead change in this program.

Key Items of Evaluation

Note the role that faculty in this program area have in helping keep the state's population of food handlers and servers trained and certified. Tools are used to track training and certification records for food safety certification programs.

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	5%	5%	5%	25%
801	Individual and Family Resource Management	5%	20%	5%	5%
802	Human Development and Family Well-Being	25%	10%	20%	25%
803	Sociological and Technological Change Affecting Individuals, Families, and Communities	10%	15%	15%	0%
804	Human Environmental Issues Concerning Apparel, Textiles, and Residential and Commercial Structures	10%	0%	25%	15%
805	Community Institutions, Health, and Social Services	10%	20%	5%	30%
806	Youth Development	35%	30%	25%	0%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	103.0	20.0	8.0	5.0
Actual Paid	144.2	17.0	6.8	4.7
Actual Volunteer	207.0	3.0	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**
1453382	317606	134582	248704
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1453382	593669	134582	201818
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
1062385	117040	544340	204715

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?

Relevant eXtension Communities of Practice include: Family Caregiving, Financial Security for All, Better Kid Care, Military Families, and Home Energy. These sources provide valuable information for educators, volunteers, children and their families. The sites offer frequently asked questions, articles, online learning activities, interactive tools and webinars in the various subject matter areas.

V(E). Planned Program (Outputs)

1. Standard output measures

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	825785	1801053	269112	420488

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

Patent Applications Submitted

Year: 2017

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	17	28	45

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

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

Year	Actual
2017	27

Output #2

Output Measure

- Number of educational workshops for family financial management skills.

Year	Actual
2017	342

Output #3

Output Measure

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

Year	Actual

2017	3189

Output #4

Output Measure

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

Year	Actual
2017	137

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
2017	1419

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
2017	520

Output #7

Output Measure

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

Year	Actual
2017	37312

Output #8

Output Measure

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

Year	Actual
2017	148397

Output #9

Output Measure

- Relevant and impact focused research projects conducted

Year	Actual
2017	5

Output #10

Output Measure

- Total number of participants in non-degree credit educational programs and activities
  Not reporting on this Output for this Annual Report

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	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
2017	2105

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
There?s more to leaving poverty than finding a job. People need a complex set of skills to make sound financial decisions, build savings, establish good credit, and achieve the American dream of owning a home, car, or small business or pursuing higher education. Making effective financial decisions is critical to enjoying a secure financial future, but many individuals and families lack the knowledge necessary to make sound financial choices, as evidenced by falling savings rates, mounting consumer debt, and a growing dependence on alternative banking institutions.

What has been done
N.C. A&T Cooperative Extension agent in Forsyth County provided monthly classes and workshops on money management to 56 limited-resource adults attending the Ways to Work Program via Family Services, Inc., a company that provides loans to people so that they can remain employed or seek employment.

Results
Based on evaluation results, 52 participants (93%) increased their knowledge about money management and budgeting; 42(79.2%) indicated that they would adhere to a monthly budget; and 44 (80.2%) indicated that they would try to start a savings account. Post workshop findings show that 81% of the participants have not acquired any new installment or revolving debt since the Ways to Work loan, and 25% have increased their credit score.

4. Associated Knowledge Areas

KA Code	Knowledge Area
607	Consumer Economics

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

- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	440

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Many limited-resource families and senior citizens continue to struggle to handle daily expenses, such as food, housing, and utility bills. They have little to no savings available for financial emergencies. For families to make ends meet and eventually get ahead during the forever-changing economy, they need to learn ways to budget, save money, and create practical financial road maps.

What has been done
Cooperative Extension in Nash County presented Money Management workshops?including tips and resources on how to create a budget, save money, and review credit reports?to limited-resource residents in Nash County and the surrounding area. This was conducted through partnerships with The Rocky Mount Senior Center, the Williford Family Resource Center, and the Rocky Mount/Edgecombe Community Development Corporation NC Housing Coalition. Participants were also given resources, such as The H Plan and Money Tracker tools, as well as access to online resources, including PowerPay.

Results
As a result of the Money Management workshops, 98% of participants reported that they will create a household budget, keep track of and decrease daily spending, and annually review activity on their credit reports.

4. Associated Knowledge Areas

KA Code	Knowledge Area

607	Consumer Economics
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
2017	2345

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Many families are unaware of how to select and prepare healthy, affordable meals, which contributes to short-term and long-term economic losses in the form of higher food and medical costs. In response, Cooperative Extension provides the Cook Smart/Eat Smart program to teach basic nutrition and cooking skills.

What has been done
Cooperative Extension in Tyrrell County acquired a grant from Vidant Chowan Hospital to teach Cook Smart/Eat Smart in both English and Spanish, reaching a total of 45 participants. Cooperative Extension in Rutherford County provided five programs for adults to build skills for choosing and preparing healthy foods, including the Cook Smart/Eat Smart program, which reached 43 participants.

Results
All 45 participants completed the Tyrrell County Cook Smart/Eat Smart program, acquiring knowledge of unit pricing, serving sizes, food labels, and preparing affordable, nutrient-dense meals. After participation in the Cook Smart/Eat smart program offered by Rutherford County Extension, 85% of participants reported using healthier cooking techniques and investing in more whole foods.

4. Associated Knowledge Areas

KA Code	Knowledge Area

801 Individual and Family Resource Management

802 Human Development and Family Well-Being

Outcome #4

1. Outcome Measures

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

2. Associated Institution Types

- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	699

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Many households across the country suffer from high energy costs, especially low-income households. These households typically have older and less efficient appliances and heating/cooling equipment, as well as other structural issues that allow for energy waste. High energy burdens cause families to make important tradeoffs between food, medicine, keeping the lights on, and other basic necessities. They also affect a households? ability to meet monthly utility payments.

What has been done
N.C. A&T Cooperative Extension agent in Guilford County collaborated with Macedonia Family Resource Center to offer a series of three programs focusing on great ways to save energy and money. Ten residents attended the March?May 2017 sessions.

Results
Evaluation results showed that each participant had learned at least one way to reduce energy needs in the home, such as looking for the energy star on products and appliances, turning lights off when not in use, keeping the house at a set seasonal temperature, and purchasing energy efficient light bulbs. Follow-up interviews with two participants indicated that they had utilized two or more of the strategies they learned about. One participant remarked that they had noticed a decrease in their utility bills and had even shared some tips with their neighbors.

4. Associated Knowledge Areas

KA Code	Knowledge Area

607	Consumer Economics
804	Human Environmental Issues Concerning Apparel, Textiles, and Residential and Commercial Structures

Outcome #5

1. Outcome Measures

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

2. Associated Institution Types

- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	208

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Create the Future defines capacity building as ?the intentional, coordinated and mission-driven efforts aimed at strengthening the management and governance of nonprofits to improve their performance and impact.? Capacity building is important for organizations to be able to effectively deliver its mission, both now and in the future. Capacity building projects, such as creating a communications strategy, improving volunteer recruitment, updating an organization?s technology, and improving how it measures outcomes all work to help build the capacity of an agency to effectively deliver its mission. When capacity building is successful, it strengthens an organization?s ability to fulfill its mission over time, thereby enhancing the organization?s ability to have a positive impact on lives and communities.

What has been done
In 2017, Cooperative Extension at North Carolina A&T sponsored the Grassroots Leadership Conference at the Chatham County Extension Center. The theme of the conference was Growing from Within: Building Community Capacity. Strategic planning council members, local stakeholders, and extension staff were responsible for planning the event which included a keynote speaker and several concurrent breakout sessions. Session topics included: Collaboration and Coalition Building: Lessons Learned from the Field; Strategies and Tools for Engaging Youth in Changing Communities; and Triple Bottom Line: Deepening Impact.

Results
Attendees were asked to complete an evaluation at the completion of the conference. The majority of survey respondents rated the overall quality of the conference as either ?excellent? or ?very good? with no one rating it as fair or poor. In addition, all of the survey respondents agreed

that the conference content could be used in their work to build community capacity. Some of the comments from the respondents indicated that they had learned several best practices when engaging with children, youth, and/or adults. For example, one person stated that they gained the ability to communicate with others better. Another person commented that they learned ?how to reach outward to people. And finally, one respondent wrote, "I enjoyed Sarah's presentation (Strategies and Tools for Engaging Youth in Changing Communities). Now I have some tools in my toolkit for working with the youth in my community!"

4. Associated Knowledge Areas

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

Outcome #6

1. Outcome Measures

Program participants adopting positive parenting practices.

2. Associated Institution Types

- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	419

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
According to the Center for Disease Control and Prevention (CDC), there were 683,000 victims of child abuse and neglect reported to child protective services (CPS) in 2015. About 1,670 children died from abuse or neglect in 2015. The total lifetime cost of child abuse and neglect is estimated at $124 billion each year. According to the Hoke County Department of Social Services, there are 55 children in foster care. It would cost the county $475 a month to place a child 0?5 years of age in foster care, $581 for a child 6?12, and $634 for a child 13?18 years of age. When parents lack support or feel isolated, they may be more likely to make poor decisions that can lead to neglect or abuse, but research shows that child abuse and neglect can be prevented through parent education programs.

What has been done
To address the issue, the family and consumer sciences agent from N.C. A &T in Hoke County partnered with the Hoke County Department of Social Services to offer parenting classes for 11

parents utilizing the Parenting Matters Curriculum. Topics presented were Parenting Challenges, You?re a Role Model, Taking Care of Yourself To Better Take Care of Your Child, Understanding Your Child?s Behavior, Discipline vs Punishment, Avoiding Power Struggles, Strengthening Families, and Coping with Parenting Stress. The Parenting Matters program was also provided to over 24 youth and 76 parents in Lenoir County.

Results
After follow-up phone calls, the social worker has dismissed the case for one set of parents enrolled in the parenting classes, and their three children were able to remain in the home. This has resulted in not only an estimated yearly savings of $19,644 for the county but also immeasurable emotional benefits for the affected family. In addition, one parent who participated in Lenoir County's Parenting Matter program reached out to express that her son's grades and interpersonal skills have dramatically improved. Due to high need within the community, Cooperative Extension will continue to offer parenting classes.

4. Associated Knowledge Areas

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

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
2017	10766

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
North Carolina 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 2017, 14,095 youths attended 4-H camping programs (10,766 in day camps). 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. In addition, the N.C. A&T Cooperative Extension agent in Beaufort County teamed up with Beaufort Community College to host a one-week 4-H Little Chefs day camp to 24 rising 1st and 2nd graders. The children learned to use an oven and small utensils to prepare healthier alternatives to the meals they normally eat and enjoyed opportunities to sample new types of fruit. During break times, they participated in a "dance off" to burn calories and have fun. NC State Cooperative Extension partnered with several community groups to offer day camps focused on STEM, robotics, citizenship, healthy living, and agriculture.

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
2017	17363

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
North Carolina 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 North Carolina 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, Johnston County 4-H partnered with the Farm-City Week Committee and county FFA chapters to encourage 4-H clubs to collect food for local food banks and Backpack Buddies, a program that provides take-home food to low-income students.

Results
In 2017, 8 4-H clubs and 2 FFA chapters worked together to collect 1,421 pounds of food, valued at $8,383. National positive youth development studies show that, compared to youth who don't participate in 4-H clubs, 4-H'ers are four times more likely to actively contribute to their communities, twice as likely to make healthy choices (by choosing better food, exercising, and avoiding risky behaviors) and twice as likely to pursue careers in science, technology, and engineering.

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
2017	210535

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Over the past decade, America has started to understand the magnitude of its dropout epidemic and take important steps to measure and address it. Educators, administrators, community leaders, policy makers, and others have been active at the school, state, and national levels to

ensure dropout prevention and recovery and college readiness are part of a comprehensive educational improvement strategy tailored to local conditions.

What has been done

In 2017, 210,535 youth participated in 4-H school enrichment programs in classrooms throughout the state. 4-H school enrichment programs are designed to fit the NC Essential Standards and are used to bring learning to life in classrooms throughout the state. Cooperative Extension at North Carolina A&T continues to provide leadership, equipment, and training around robotics for youth involved in 4-H. The 4-H STEM specialist at N.C. A&T trained 40 4-H agents (nearly half of the 4-H agents in the state) on robotics, emphasizing the importance of reaching non-traditional youth in 4-HIn Wilson County, the 4-H agent worked with parents, Chamber of Commerce members, and the principal of Darden Middle School to create an enrichment program to teach soft career skills to middle school youth. In Mecklenburg County, the 4-H School Enrichment Embryology project provided an evidence-based science enrichment curriculum to students.

Results

Statewide in 2017, 155,837 youth increased their knowledge in science, technology, engineering and math (STEM); 19,471 youth gained competence in family and consumer science; 109,216 youth gained personal development and leadership skills; 88,879 youth increased their knowledge of expressive arts and communication; and 114,485 youth gained hands-on experience in community service and civic engagement. In Wilson County, each of the 15 participants in 4-H's You're Hired: If Your Soft Skills Work curriculum developed by N.C. A&T gained hands-on knowledge in communication, conflict resolution, customer interaction, and time management. Mecklenburg County's 4-H School Enrichment Embryology project reached 34 schools and 5,609 youth, providing them with hands-on experiential learning activities focused on egg incubation and hatching.

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

2017 106796

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The Institute of Emerging Issues 2016 report states that North Carolina faces an enormous future job challenge, with the technological revolution possibly eliminating or reshaping more than one million current jobs. The U.S. Department of Education projects that STEM jobs will increase over 60% by 2020, yet only 16% of high school students are proficient in math and interested in STEM careers. This trend will have a large impact on our current youth?s future employment prospects. Positive community youth development through 4-H can help young people gain career skills, such as critical thinking, problem solving, digital and technical competencies, teamwork, and communication.

What has been done

To address this emerging issue, a Mitchell County 4-H program assistant implemented a robotics program at the middle-school level to address the need for more STEM opportunities. Using robotics equipment, training, and leadership provided by N.C. A&T, a robotics competition team was formed. By forming a team and engineering an autonomous robot, the participants learned many of the skills that employers will be looking for. To grow opportunities for youth to participate, the 4-H program assistant obtained funding through United Way and a local foundation. Another partnership was formed with a local elementary school to provide a robotics program for 2nd ?4th grades, and a sponsorship from a local manufacturing company enabled the program to expand to include a high-school robotics competition team.

Results

In 2017, because of volunteer recruitment, dedication and community support, the County's 4-H robotics program now has a junior program available in two areas of the county, as well as middle school and high school level programs. The program serves youth from ages 8?18. The program had six junior teams representing 4-H during the first competition at UNC Asheville in March, receiving awards for teamwork, engineering, and problem solving. The high school team had members that had participated for six years, who shared their experience and knowledge with the junior teams by leading engineering sessions and teaching programming. The high school team has also shown tremendous leadership and teamwork by initiating and organizing a recruitment drive to replace the graduating team members and transfer students accepted at the School of Math and Science.

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
2017	3329

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
North Carolina 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 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.

Results
In 2017, 14,095 youth attended 4-H camping programs (3,329 in residential camps). The focus of the various activities included cooking and healthy eating, career preparation, building community volunteerism, developing life skills, and achieving academic and educational success.

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
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Youth ages 5-19 need education on the components of well-balanced diet and exercise. In 2015 North Carolina-Nutrition and Physical Activity Surveillance System (NC-NPASS) ranked Yancey County 98th out of our 100 counties with the worst (highest) rate of overweight or obese youth at 44.6%. Additionally, obesity prevalence is higher among children from low-income households. Yancey County has a poverty rate is 20.6% and the child poverty rate 31%. More than 57% of students enrolled in Yancey County Schools qualify for free or reduced-price meals and some schools qualify at rates of over 60%. The SNAP food stamp eligibility at one of the counties middle schools we chose to target was 55.87%.

What has been done
Working with Cooperative Extension at N.C. A&T, the Yancey County 4-H Program Assistant used the Fuel Your Performance eLearning Kit to work with 60 youth grades 5-8. N.C. A&T supplied everything needed to easily implement health education to the participants, including incentives and snacks. At two middle school afterschool sites and during one week-long cooking camp at the Yancey Extension Center, the program assistant with the help of volunteers taught students with online lessons. Students created a health log, journaled and learned to track their diet, exercise and overall mood on the eLearning site. The site provided access to supplemental worksheets and paper-based activities for participants to take home or do in the classroom. The program conveyed empowering concepts to the youth about their physical and mental health and taught them solutions to change their daily habits that will affect them for life. Conducting the program in the structured setting of an after-school site and summer camp provided an opportunity to work closely with students and help them find out just how important nutrition and physical activity are

Results
Of the 41 students who filled out a post-test, 29 (73%) reported that they would continue to read food labels to make better choices in the future and understood the components of a well-balanced diet and 28(68%) could identify the mental benefits of getting regular exercise. Surveys showed that youth will improve their health by exercising more and making healthy food choices by limiting their salt, sugar and fat intake. Research says that a 10% weight loss could reduce an overweight person's lifetime medical costs by $2,200 to $5,300. One afterschool student said, ?My favorite part of the program was writing about my day, how it was and keeping up with what I eat, because I learned eating healthy is important.?
During activities, the staff observed youth choosing the components of a well-balanced diet. They

were observed reading food labels during snacks that were provided and made the correct choices when offered a variety of food items. One of the summer camp participants said ?I learned how to eat healthy, exercise better and pick healthier foods. ?

Participants reported they loved getting the useful incentives provided by NC A&T such as a water bottle, a backpack and Chop Chop magazines that included healthy recipes to prepare at home. Their favorite activity was playing ?What?s Your Deal? (a Jeopardy style game) that helped them learn healthy living facts.

Participants liked the eLearning format and were actively engaged in the Fuel Your Performance lessons. All the facilitators reported they felt the students learned how to improve their health and are excited to conduct the program again the next school year.

4. Associated Knowledge Areas

KA Code	Knowledge Area
804	Human Environmental Issues Concerning Apparel, Textiles, and Residential and Commercial Structures
805	Community Institutions, Health, and Social Services

Outcome #13

1. Outcome Measures

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

Not Reporting on this Outcome Measure

Outcome #14

1. Outcome Measures

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

Not Reporting on this Outcome Measure

Outcome #15

1. Outcome Measures

Identify the factors associated with successful entrepreneurship in rural communities.

Not Reporting on this Outcome Measure

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

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.

Key Items of Evaluation

Note aggregation of participant data for different 4-H and youth activities. This program can benefit from more clearly capturing well-defined impact statements, as well as some revision in the Extension Reporting System's ability to capture outcomes and impacts.

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
202	Plant Genetic Resources	0%	0%	15%	15%
206	Basic Plant Biology	0%	0%	15%	5%
502	New and Improved Food Products	0%	0%	15%	25%
701	Nutrient Composition of Food	0%	0%	10%	25%
702	Requirements and Function of Nutrients and Other Food Components	0%	0%	10%	25%
703	Nutrition Education and Behavior	100%	0%	0%	0%
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	0%	0%	5%	0%
721	Insects and Other Pests Affecting Humans	0%	0%	10%	5%
722	Zoonotic Diseases and Parasites Affecting Humans	0%	0%	10%	0%
724	Healthy Lifestyle	0%	0%	10%	0%
	Total	100%	0%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2017	Extension		Research	
	1862	1890	1862	1890
Plan	15.0	0.0	45.0	6.0
Actual Paid	22.8	0.0	40.9	5.2
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**
229481	0	807495	436069
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
229481	0	807495	311531
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
167745	0	3266040	204182

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

2017	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	0	0	0	0

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

Patent Applications Submitted

Year: 2017

Actual: 3

Patents listed

Aptamers with Binding Affinity to Norovirus15/317,002

Genetically Engineered Larvae for Wound Healing62/473,704

Recombinant Lactobacillus with Decreased Lipoteichoic Acid to Reduce Inflammatory Responses2017-109331

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2017	Extension	Research	Total
Actual	8	190	198

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
2017	45

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 Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In this era of diminishing returns for novel drug development and escalating health care costs, plants and their derivatives offer a final frontier for new drug and health product discoveries. Plant-derived bioactive compounds can provide therapeutic benefits for people. In addition, plant-derived compounds are far less likely to be overcome by a microbe's ability to build up immunity.

What has been done
NC State researchers have investigated the healthy functionality of plant-derived compounds on diverse fronts and have recently engineered the development of shelf-stable functional ingredients for use in fortified foods that have been proven to convey a wide variety of benefits to humans.

Results
Successful efforts thus far include the development of functional ingredients derived from plant proteins that improve physical endurance and weight management and the development of hypoallergenic egg protein ingredients with promising applications for oral immunotherapy. Ongoing research efforts include identification of berry extracts that can improve bone health in post-menopausal women and a partnership with NASA on the formulation of high-protein bar formulations to enhance shelf-life and nutrient availability.

4. Associated Knowledge Areas

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

701	Nutrient Composition of Food
724	Healthy Lifestyle

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 Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Functional nutrients or bioactive compounds are of increasing interest in the prevention and/or treatment of at least four of the leading causes of death in the United States: cancer, diabetes, cardiovascular disease, and hypertension. This makes the development of fruits and vegetables with improved nutritional value an attractive breeding objective. The development and expansion of available genomic resources for fruits and vegetables is key to achieving this objective.

What has been done
NC State University scientists are developing genomic resources for fruit and vegetable crops and using these resources to identify DNA markers associated with genes controlling phytonutrient accumulation. These tools can be further integrated into advanced breeding programs based on genomic selection, allowing the improvement of both nutritional value and other agronomic traits into new varieties of fruit and vegetables.

Results
An NC State researcher has dramatically enhanced understanding of the blueberry genome by completing the first chromosome scale genome assembly for the blueberry crop, which is well-recognized for its beneficial effects on human health. Research is now focusing on extending these efforts to extract insights that will enable enhancement of health-related substances found in the blueberry. Expanded research efforts are also being coordinated with other scientists at the national and international levels to establish critical breeding needs for stakeholders in the blueberry and cranberry industries.

4. Associated Knowledge Areas

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

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 Extension
- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2017	8

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Antimicrobial resistance (AMR) within the food chain is a leading public health concern in the U.S. and in other nations. Campylobacter accounts for nearly one million cases of human foodborne disease in the U.S. annually. Exploration of the genetic mechanisms of AMR Campylobacter strains carried by animals and insects will yield important insights into potential approaches to controlling AMR in Campylobacter.

What has been done
NC State researchers investigated genetic mechanisms affecting AMR in Campylobacter strains found in turkeys and in houseflies on turkey farms. The researchers identified the genes responsible for resistance to macrolides, one of the two current drugs of choice for treating human Campylobacter infections. Emerging genetic changes in Campylobacter strains common to North Carolina were also discovered.

Results
These findings alert the turkey production industry to the high prevalence of AMR in Campylobacter infecting these birds and to the environmental factors that exacerbate

Campylobacter infection, including exposure to Campylobacter-infected insects. These data will compliment those derived from analyses of Campylobacter strains isolated from human patients in other regions of the U.S., enabling a more in-depth understanding of the ecology and food safety hazards associated with specific AMR profiles and facilitating the development of effective environmental controls.

4. Associated Knowledge Areas

KA Code	Knowledge Area
721	Insects and Other Pests Affecting Humans
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
2017	7

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Many diseases can be traced to aberrant protein function, and the underlying mechanisms of protein dysfunction are often related to unpredictable changes in protein behavior. Discovery of these mechanisms is thus highly challenging, demanding cross-disciplinary scientific efforts and millions of research dollars.

What has been done
Scientists at NC State are currently developing new and effective techniques to identify protein interactions, and they have already successfully increased the efficiency and sensitivity of methods used to isolate and analyze phosphopeptides, immune-response-inducing components that influence human disease states. These methods are currently being used to map out and quantify protein characteristics associated with cancer, respiratory diseases, viral infections, and lung stem cell differentiation.

Results

The researchers have developed several mass spectrometry approaches and instruments, as well as software algorithms, that can be used to efficiently define protein-to-protein interactions. These developments will pave the way to a better understanding of biological signaling networks and protein interactions that can be exploited to improve human health.

4. Associated Knowledge Areas

KA Code	Knowledge Area
722	Zoonotic Diseases and Parasites Affecting Humans
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

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. Despite the challenges and influencers noted above, the data available indicate that this program is reaching suitable segments of the audience and that faculty are productive, when considering development of new technologies and publication records. We will continue to strive for a program that is relevant and productive for stakeholders and supports a creative and productive faculty.

Key Items of Evaluation

Efforts will continue to discover and develop natural products and other technologies to enhance healthy living, reduce disease and enhance nutrition, including developing new plants from which compounds to enhance health might be derived. Our faculty and extension reporting efforts can be improved to capture more concrete impacts of this planned program area

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
28744	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)	
31242	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)	
207	Number of farmers who adopted a dedicated bioenergy crop
Sustainable Energy (Outcome 3, Indicator 4)	
385161	Tons of feedstocks delivered.