2016 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: 06/13/2017

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 (NC A&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 NC A&T. The North Carolina Agricultural Research Service (NCARS) is the research arm within CALS at NC State, while research at NC A&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 2016, CALS administration implemented a college reorganization. It merged certain departments and aligned all departments and interdisciplinary programs and centers around one of four focus area or systems: plant systems; animal systems; food, biochemical, and process systems; and human and resource systems. The changes are designed to allow for more strategic, interdisciplinary decision making across the college.

The college continued to strengthen relationships with external partners, including state commodity groups, continuing to build a significant support base for two major initiatives:
The North Carolina Plant Sciences Initiative (NC PSI) is based on an interdisciplinary systems approach. The state's largest agriculture and biosciences assets will be concentrated in a new world-class interdisciplinary Plant Sciences Research Complex on the NC State 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 aimed 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, food systems, sustainability and resilience, and plant improvement offer the NC PSI a chance to seed discoveries and co-develop technologies that increase profitability, inform policy, and revolutionize current practices in industry and farming. To this end, Plant Improvement; Plant Data Sciences; and Food Systems, Environmental Sustainability, and Resilience will form three highly connected research platforms of the NC PSI.

The North Carolina Food Processing and Manufacturing Initiative will diversify and add value to agriculturally-based businesses through food processing. Funded 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 state's governor to serve as chair of the 35-member task force leading the initiative. The task force report was published and presented to the governor in April 2016. Based on one of the report's recommendations, a Business Development Manager for the food manufacturing industry was hired. The report's other recommendations will be submitted to the state legislature for further consideration and possible funding.

According to economic feasibility studies released in 2015, the Plant Sciences Initiative 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.

The college's research arm, NCARS, conducts research at facilities on and off the NC State campus. On-campus facilities include highly specialized laboratories (e.g., 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, and 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. Among them is the Center for Environmental Farming Systems in Goldsboro, which specializes in sustainable agriculture research and extension.

During this reporting period, agricultural research in the CAES at N.C. A&T was consistent in its efforts to bring health benefits to the market as human trials of reduced allergen peanuts and peanut products have begun. The process used to reduce allergens in peanuts has been patented. CAES researchers are also spearheading community-based gardening efforts in an area classified as a food desert with several harvests ongoing. This project is giving the local community access to fresh vegetables. Partnerships with faith-based communities have also yielded promising results of bringing about better decision making in food choice selections. Providing teen mothers with tools, coping mechanisms and skills to break the cycle of teen pregnancy has also been an impact for this reporting period. Increasing the shelf life of certain produce with the use of a plant-based film has seen some hopeful signs. CAES researchers hope to successfully increase shelf life and reduce the amount of plastic-based packaging in the food industry while minimizing consumer waste. Cultivating and harvesting truffles grown from the roots of loblolly pine trees has also been a successful development with university researchers and stakeholders. Pines are a common tree that can be used to produce truffles for a profit versus harvesting trees for timber.

In addition to campus laboratories, locations of ongoing research in CAES are at the university farm, Center for Excellence in Post-Harvest Technologies at Kannapolis and the Center for Environmental Farming Systems in Goldsboro.

The knowledge and technology developed through research conducted in NCARS and ARP are delivered directly to North Carolina farmers, families and citizens through extension programs emanating from the two institutions. The mission of North Carolina Cooperative Extension is to empower people and provide solutions. This is done by helping people put research-based knowledge and technology to work to foster economic prosperity, environmental stewardship, and improved quality of life. Extension faculty at the two

land-grant universities work hand-in-hand with field faculty stationed in all 100 North Carolina counties and on the Cherokee Reservation. To achieve 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 2016, NC State Extension continued strategic efforts to restructure the century-old organization. The strategic plan targets Extension's strengths, improves access to services across the state, and refocuses resources to support its refined core program areas: agriculture, food, and 4-H youth development. The organization is focusing its resources where it is most needed, best equipped to provide solutions, and can make the greatest impact on North Carolina's communities and economy. Each core program area includes multiple subprograms, and volunteer-driven programs--such as Extension Master Gardener--will continue to be an integral part of Extension. Significant structure and staffing changes were made to optimize services access throughout North Carolina.

NC State Cooperative Extension programs translated the research-based knowledge generated by researchers and faculty into everyday solutions that help keep North Carolina agriculture 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 local foods and food safety to food preservation, gardening and environmental efforts, among others. NC State Extension conducted 4-H programs where young people learn by doing. 4-H programs and camps help develop 230,000 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 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.

The Cooperative Extension Program at N.C. A&T delivers educational programs and technology that enrich the lives, land and economy of small farmers, and limited resource individuals, youth, families and communities in North Carolina. A non-formal instruction unit, the Cooperative Extension program is the outreach arm of the CAES and NC A&T. Helping North Carolinians lead healthier, more profitable, more secure lives has been our mission for more than a century. Today, outreach efforts are continued that make a difference across the state. The mission of N.C. A&T Cooperative Extension is to provide educational programs to inspire North Carolina's underserved farmers, families, individuals, youth, and communities to make decisions to improve their lives. Using a continuous long-range planning and evaluation process, the Cooperative Extension Program is able to adapt programs rapidly in response to emerging needs and issues.

In 2016, the Cooperative Extension Program launched a five-year strategic plan 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; Emergency Preparedness for Minority Audiences. These program priority areas are implemented through the expertise of specialists, associates and county-based personnel.

Partnerships and collaborations are functional at the national, state, regional, local, and inter-institutional levels. Partnerships with local governments and Cooperative Extension centers in all 100 counties and the Eastern Band of Cherokee Indians extend the reach and access to Extension programs across the state. Extension in North Carolina is committed and dedicated to providing educational programs that make a

difference in the lives of the clientele that we serve.

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 at 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 NCA&T within each program area.

PLANNED PROGRAMS

PLANT PRODUCTION SYSTEMS AND HEALTH

Creating better-yielding tomatoes. NC tomatoes generate $47 million in annual farm income, but farmers face several obstacles to optimum yield, including bacterial wilt, bacterial spot and bacterial speck. NC State University researchers have begun to identify the novel source of resistance for these diseases and have evaluated breeding lines. There is now enough data to release breeding lines and hybrids with multiple disease resistance.

Educating farmers about **optimum fertilizer management** and production practices improves farm profitability and reduces the likelihood of runoff of nitrogen, phosphorus and sediments into waterways. NC State Extension conducts training to encourage the voluntary adoption of related best practices. In 2016, 381 attended meetings, and an additional 1,065 attended field days. Many were professional agronomists pursuing recertification. In Hyde County alone, Extension efforts led to producer usage of composted layer manure instead of inorganic fertilizers on 20,000 acres of wheat and corn, saving farmers an estimated $30 per acre, or a total of $600,000.

Expanding green industry options. Cercis canadensis, the eastern redbud, is a popular landscape tree. Taking advantage of the redbud's genetic diversity, NC State scientists have developed novel landscape types through the recombination of weeping growth habit, variegated leaf, purple leaf, golden leaf and compact growth habits. In 2016, total sales of cultivars developed from this program totaled about 40,000 units. Assuming typical wholesale and retail market value, these cultivars generated over $2 million for the industry in 2016.

Improving cotton performance and yield depends on many factors, including variety selection, lint quality and timely management applications. NC State and NCA&T agents in Cumberland, Harnett, Johnston, Sampson and Duplin counties partnered with state specialists to provide cotton growers and other interested parties with two hours of research-based training on production practices, including variety selection and pest management. Pre- and post-test evaluation showed that 68 percent of participants improved their knowledge of cotton management and thought the information gained could increase their profits an average of $58 per acre. Over the combined total of 22,710 acres, the impact is estimated at $942,500.

Record corn crop benefits crop and livestock producers. The southeastern United States produces more hogs and poultry each year than it can feed from local sources, and the costs of importing feed grains into this region are substantial. The potential to sell corn locally, plus a favorable weather forecast and corn yield trends led NC State Extension specialists and agents to launch an initiative called "Year of the Corn." Over 48 meetings and field tours, plus popular press articles, were offered, reaching over thousands of growers, consultants, industry agronomists, state leaders and others key agricultural decision makers. A large increase in the number of planted acres - 280,000 - along with record yields resulted in a record corn crop of 144 million bushels. This crop helped the livestock industry meet their requirement for local feed grains, and corn turned out to be the most profitable crop for growers in 2016. If the value of the corn raised on the extra 280,000 acres is calculated based on the average yield of 144 bushels per acre and a conservative average yearly price of $4.25 per bushel, the Year of the Corn initiative had an impact of over $171 million.

Increasing organic grain production. In 2006, less than 1,000 acres of organic grains were grown in North Carolina, and large processors here were buying most of their grains from other states. But with NC

State research and Extension efforts focused on providing production and storage information, organic grain acreage has grown quickly in the state to over 12,000 acres, making North Carolina the region's leader in organic acreage in 2016. The state's success has attracted new buyers: Perdue now has multiple buying stations in North Carolina and operates an organic soybean crusher in Hyde County. In addition, Pilgrim's Pride began producing organic broilers in 2016 and is building an organic grains processing facility in Staley. With a price premium for organic crops about three times that of prices across conventional commodities 2016 also saw a wave of new farmers attempting to enter the market.
Making alternative crops viable for local producers. Since the loss of tobacco as profitable crop in Yancey County, farmers have struggled to replace it. Many want to transition into vegetable production but face issues related to scale and lack of infrastructure. In partnership with county government and local stakeholders, NC A&T Extension developed a non-profit food hub (TRACTOR, or the Toe River Aggregation Center Training Organization Regional) near Asheville. The goals are to ensure that food dollars stay in the local economy, to increase farm income in the community, to preserve farm culture and greenspace, and to expand access to the freshest local produce. Nearly 100 growers have sold produce through TRACTOR in four years, selling nearly $500,000 in local produce to 65 different markets.
The use of **high tunnel production systems** can provide improved economic returns for growers, but limited availability of information on the benefits and requirements has kept many small farmers from taking advantage of this technique. NC A&T researchers developed temperature and moisture management strategies for pest management and yield improvement and provided production and economic recommendations for organic tomato, cucumber, bell pepper, bok choy, lettuce, spinach, salad mixes, and green mixes. Grown in high tunnels, these crops should have a net return of $1.5-5.75 per square foot in one season. Researchers also worked to expand high and low tunnel opportunities for organic strawberry growers, finding that growers can increase yield and improve fruit quality by using low tunnels in open fields and high tunnels to further extend the harvesting and marketing seasons. They identified four organic cultivars suitable for high tunnel production in hardiness zones 7 and 8. Choosing the appropriate cultivars could provide farmers with a net gain of about $4.5 per square foot. Information on this research has been delivered to over 500 small farmers, Extension educators, and other horticultural professionals via publications, field days, and presentations.

ANIMALS AND THEIR SYSTEMS PRODUCTION AND HEALTH

Several research and extension demonstration projects at NC State have contributed to the optimization of least-cost feed formulations that enhance economic and environmental sustainability, food safety, and animal welfare. Through the **dietary inclusion of ethanol co-products** (distillers dried grains and corn distillers soluble oil) in chicken and turkey feeds, along with appropriate blends of feed additive enzymes, feed costs can be reduced $20 per ton without compromising growth performance, efficiency or welfare of commercial poultry. Assuming 5 million tons of poultry feed produced annually in North Carolina, this strategy impacts the feed and poultry industry by over $100 million. All the state's major poultry companies use a significant amount of ethanol co-products, locally produced grains and supplemental enzymes to reduce feed costs.
Increasing market value of beef cattle is an aim of beef producers. NC State Extension in Rutherford County, partnering with Mountain Cattle Alliance and Southeast Livestock Exchange helped bring producers together to co-mingle calves to sell in truck-load lots. This group evaluated and processed calves to verify that all health and quality issues were addressed. Over 30 producers sold nine loads (700 head) in 2016 valued at $845,000. At an average premium of $150 per head over local auction prices, this represented an additional $105,000 profits to the producers. Using a multiplier of 6, the western North Carolina region had an estimated direct economic impact of $630,000.
Researchers at NC A&T are studying **sustainable parasite control** strategies for ruminants. The researchers have found that polyphenols extracted from cowpea and sericea enriched feed supplements may possess characteristics that can be exploited to counteract the pathological processes that occur due to inflammation, which could help ruminants combat parasites.
Sow longevity. NC State researchers, supported by NC Pork Council and National Pork Board, have developed neonatal management strategies for replacement gilts to improve sow longevity. In the past,

sow replacement rates have been as high as 60% annually. Sow retention rates have doubled in the past for years for farms that have adopted these management approaches, reducing the culling rate to 30%. This translates into each sow producing about 25 more pigs over her lifetime. Given current market prices, this translates into a $5,000 increase in gross income generated per sow. These results have encouraged the National Pork Board to commit an additional $1.2 million for 3 years to further study factors affecting sow longevity.

Respiratory disorders in pigs. NC A&T researchers are exploring factors involved in how pigs in high-density facilities develop respiratory disorders. The work focuses on understanding production environmental exposures that "prime" animals for respiratory disease occurrence. They are identifying dust components that deposit within the lungs of pigs that may contribute to immune response and disease development. Reducing exposure to environmental conditions that negatively affect the respiratory system will improve animal health, production and economic outcome.

Hybrid striped bass genetics. NC State co-coordinates the National Program for Genetic Improvement and Selective Breeding for hybrid striped bass at its Pamlico Aquaculture Field Laboratory at Aurora. Over 90% of the hybrid striped bass raised in the United States are produced using improved broodstock from this program. The combined farm-gate value of both food fish and fingerlings produced in North Carolina is about $10 million per year. This year, 53 beneficiaries, including 27 commercial producers, were involved in the research program.

Women in agriculture. Partly funded by the Southern Risk Management and Education Center, two Center for Environmental Farming Systems initiatives collaborated to provide production-to-market training for women. Participants gained skills in fencing and pasture management, marketing and sales, and finance and tax management. NC Choices "Women Working in the Meat Business Conference" sold out over a month in advance with 70 registrants. Participants gained skills in electric fencing, pasture management, soil health, and nutrition management. Evaluations indicated that they experienced a three-fold gain in knowledge and skills.

CLIMATE CHANGE

Precision farming. Remotely sensed metrics can help farmers more precisely deliver and time nitrogen inputs to reduce contamination of groundwater and surface waters. NC State researchers obtained field and airborne hyperspectral data together with airborne lidar measurements over several seasons for experimental corn plots in three North Carolina coastal plain locations. The information gained will be the basis for analytical products that help farmers optimize profit, protect water quality and adhere to environmental regulations.

Managing agricultural wastes. If North Carolina producers are to be competitive and reduce environmental impact, they must effectively manage the manure, litter, mortalities, hatchery and processing plant offal, and wastewater they generate. Statewide, 1,140 waste management certifications were gained or maintained due to NC State Extension educational efforts. Extension also made over 100 application equipment calibrations, developed over 200 waste management plans, and conducted over 125 sludge surveys. In just one case, recommendations saved over $300,000 in fertilizer costs.

Protecting watersheds. To meet a growing need for North Carolina training programs on waste and nutrient management and watershed protection, NC State University soil scientists offered 61 short courses and conferences for erosion and sediment control professionals, municipal and industrial wastewater operators, environmental health specialists, septic system installers and operators, professional engineers, soil scientists, well contractors, water quality specialists, government agency employees, and elected officials. Thus, 3,212 participants received technical training for license renewal and professional development.

Better use of poultry waste. Poultry production is North Carolina's largest agriculture sector, and it generates large volumes of manure and bedding material, referred to as poultry litter. Although litter is a waste byproduct for poultry growers, crop farmers can use it as a cost-saving alternative to commercial fertilizers. NC State Extension-recommended soil and waste analysis supported proper use of poultry litter as fertilizer on 20,000 acres.

Rural and urban water-quality solutions. To reduce algal growth in the Jordan Lake watershed, all

sectors are expected to reduce nutrients. NC State conducted research to gauge whether farmers were interested in and had enough land to sell agricultural riparian buffers (credits) to the development community to reduce the cost of urban best management practices, and they found that a comprehensive program that reduces nutrients from all sources would be a better solution. They shared these results with appropriate agencies, municipalities and farmers.

Expanding and improving private forest management. NC A&T Extension worked with faith-based organizations, community leaders and others to conduct trainings and workshops on family landownership, forestry, and forest land management. As a result, landowners have created and submitted forest management plans to reduce their tax burden, and forest woodland owners received important information on prescribed-burn-related topics such as liability insurance, burn plans, fire breaks, equipment and funding opportunities.

Identifying better soil management practices. To ameliorate Piedmont soil issues, NC A&T researchers have evaluated the effectiveness of combining reduced tillage practices with cover cropping alternatives. Results showed that the practices of cover cropping for residue cover, of reducing or eliminating tillage, and of using raised beds for vegetable production improved soil quality, increased water and nutrient retention, and increased crop productivity over conventional production practices.

SUSTAINABLE ENERGY INCLUDING BIOTECH

Giant miscanthus for biofuels. The giant miscanthus plant presents an attractive source for biomass that could be used to produce fuels and chemicals, because it is versatile and renewable and has little environmental impact. NC A&T research suggests that growing the crop on land treated with swine waste can lead to higher yields and that the crop can be grown on marginal lands with minimal nitrogen inputs.

Other sources for biofuels and value-added products. NC State researchers are considering how carbohydrates from **a**gro-industrial residues and dedicated biomass crops can be converted into high-value products, including biofuels. They have identified value-added products from the sweet sorghum crop through ensilage and feedout studies and conducted 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. These studies are providing key information for the next phase of advanced biofuels.

Recovering energy and nutrients for microalgal biomass. Developing efficient and economic biological processes to recover energy, nutrients and water from farm and food wastes can enhance sustainable agricultural production and rural economies. NC A&T researchers have constructed and used a 10 L anaerobic digester to continuously treat swine wastes and biomass, have studied the effects of feedstocks and operating conditions on biogas productivity during anaerobic co-digestion, and have gained insight into aerobic treatment to enhance anaerobic digestion and remove ammonium in the manure for algal cultivation. With the input of off-gas from the manure treatment unit, they improved yields of microalgal biomass, a source of valuable hydrocarbons and fertilizers, by 130-300%.

Improving the potential for lignocellulosic biomass could make it a viable source of bioenergy. While it does not compete with production of food and animal feed, finding ways to extract it has proven difficult. Attempts at genetically down regulating lignin biosynthesis have resulted in growth retardation and abnormal development, but NC State researchers have found that in the model plant Arabidopsis they can suppress these effects by modifying genes not previously known to be involved in the lignin biosynthesis pathway. Their results should facilitate modification of lignin in plants for maximum plant biomass growth, which may lead to sustainable biofuel production that reduces greenhouse gas emissions.

Energy conservation education. Teaching residents how to conserve energy has environmental benefits. NC A&T Extension conducted a series of programs focusing on Great Ways to Save Energy and Money. Pre- and post-evaluations show that of the 24 participants, 21 gained new knowledge and were using at least one energy saving technique taught in the class. Moreover, some indicated that they were continuing to reduce their daily home energy needs by turning off lights when not in use, by buying energy-saving bulbs and by replacing old or broken appliances with ENERGY STAR products.

Reducing propane use in poultry production. Transpired solar collectors (TSCs) can greatly reduce propane use in livestock brooding by heating the ventilation air with solar energy, but metal TSCs are too

expensive to be cost-effective without government and tax incentives. NC State researchers evaluated a plastic TSC made by perforating a PVC pond liner for heating brooding room for turkey poults and found it increased air temperature by as much as 25.3 C, comparable to metal TSCs. Even more encouraging, in a side-by-side test they found that a double layer of black landscape fabric resulted in a greater temperature rise compared to lab-built metal TSC and plastic TSC.

CHILDHOOD OBESITY

Extension programs target childhood obesity. About one in three NC high school students is either overweight or obese, as are close to 30% of children ages 2-4 who participate in the Women, Infants and Children program. That's important because overweight and obesity increase the risk of several chronic health conditions. NC State and NC A&T Extension increase children's nutrition through several programs: The Steps to Health program is an example; it reached 8,691 participants (7,670 children and 1,021 adults) within 60 counties. As a result, 93% of preschool children are more willing to try fruits and vegetables, 74% of elementary school children are eating more fruits and vegetables, and 55% of children and youth are more active. In addition, 58% of youth EFNEP participants improved their physical activity practices.

Developing role models. Extension also offered programs for adults, who influence children's nutrition and serve as role models. Evaluations showed that 8,122 of these adult Extension program participants increased their fruit and vegetable consumption. In addition, results for Extension's "Eat Smart, Move More, Weigh Less" curriculum offered to 7,034 State Health Plan members show that participants improved their body-mass index scores, and 60 percent of adult graduated EFNEP participants increased physical activity.

Better nutrition for food-insecure families. Most food insecure families avoid hunger by limiting the types of food they buy and by participating in public and private food-assistance programs. This reduces their access to healthy meals and exacerbates problems caused by unhealthy body weight. EFNEP paraprofessionals taught 757 adult homemakers in 12 counties lessons addressing food resource management, nutrition practices, food safety, and the importance of being physically active. Of graduating participants, 87% showed improvements in one or more food resource management practices and 91% showed improvements in two or more nutrition practices. In addition, 91% of children and youth improved their ability to choose foods or gained knowledge about federal dietary recommendations.

Research for solutions. Childhood obesity has been identified as the top U.S. nutrition-related problem. NC A&T research showed that when given the option to eat less fried foods, consume more fresh vegetable and fruits, and try new foods or foods prepared in a healthy manner, children adapted to the changes, therefore improving their chances of developing and maintaining a healthy lifestyle.

Try Healthy. Extension empowers North Carolinians both young and old with the knowledge and skills to combat obesity and poor health through its Try Healthy program (also known as SNAP-Ed). Since the launch of Try Healthy's Speedway to Healthy K-12 curriculum in 2015, 13,555 NC youth have gone through this program, and an associated exhibit has visited 16 counties. Pre- and post-test evaluations show that many Try Healthy program participants not only increase their knowledge of healthy eating but also increase their fruit and vegetable intake and physical activity.

FOOD SAFETY - FOOD PRODUCTION SYSTEMS

Food safety education is believed to play an important role in preventing foodborne illness outbreaks. NC State Extension agents provide ServSafe and NC Safe Plates food safety training and certification programs for food service managers and food handlers. Statewide, 1,290 food service employees received ServSafe or NC Safe Plates training. It is estimated that an average foodborne illness occurrence can cost $75,000. Based on this cost, these 1,290 trained employees could represent a potential cost savings of over $96 million by avoiding foodborne illness occurrences.

Hazard Analysis Critical Control Points is a system that identifies, evaluates and controls hazards affecting food safety. HACCP training includes principles related to food handler personal hygiene, proper temperature control during food preparation and storage, cross contamination, food preparation and other

topics. HACCP training was provided by NC State Extension agents in more than 15 counties. In Davidson County, all 256 school food service workers are certified for the school year. Statewide, 1,500 school employees have participated in HACCP training delivered by NC State Extension and NC A&T State Extension.

Biodegradable packaging. NC A&T researchers are working to develop bio-nanocomposite films that can be used to package fresh produce. They hope that such a produce packaging material could reduce existing packaging materials, reduce plastics in landfills, and increase value to consumers. Early stage work involves combining sweet potato starch, montmorillonite nanoclay, and thyme essential oil.

Food manufacturing processes. Shure Foods LLC is a North Carolina startup company seeking to revamp the crab processing industry by mechanizing the meat extraction process and developing markets for raw crabmeat. Their technology restructures raw crabmeat paste using specific additives, but the process does not yield a consistent product. NC State researchers sought process steps to aggregate the material so that it successfully interacts with the gelling process. The improved process will enable the production of "all-crab" versions of the popular fish (surimi)-based crab analogs. As a result of this research collaboration, a major surimi manufacturer is now developing all-crab products using USA-sourced, mechanically-extracted raw crab. Products will be test marketed in 2017.

Vitamin A deficiency is a major global micronutrient deficiency related to eyesight, weakened immune systems and xerophthalmia. B-carotene is a bioactive precursor to vitamin A. It was proposed that sweet potato bread could be a carrier of B-carotene, which could provide the vitamin A in a diversified diet. NC State researchers found that one sweet potato bread formulation, using sweet potato puree, gave a 96% recovery of B-carotene provided in the puree. Similar results were found with sweet potato flour. This development offers possibilities for helping reduce vitamin A deficiencies and for marketing sweet potatoes.

HUMAN AND COMMUNITY DEVELOPMENT

Financial management. NC State and NC A&T Extension programs empowered residents to improve their finances. For example, after going through the Better Food Better Health program, nearly 50% of participants planned to incorporate healthy eating into their budgets by purchasing during sales and over 80% planned to save money by preparing healthy snacks at home. Through the Expanded Food and Nutrition Education Program, 292 limited-income individuals developed their first written household budget. In all, 1,542 people gained knowledge and skills in budgeting, record keeping, goal setting, writing goals and consumer decision-making, and nearly a third implemented these financial management strategies. In addition, over 10,000 youth learned life skills in financial management, career development and more through the 4-H Awards and Incentives program.

Family economic security. Not all households that can't meet basic needs though earnings alone are aware of resources available to them through government programs and other means. NC State Extension agents in Greene County coordinated a joint effort with volunteers, local pharmacies, a senior center and health, insurance and social services agencies to raise awareness of the low-income subsidy prescription drug program. As a result, 78 low-income individuals have a more affordable prescription drug plan and saved a total of over $27,500. Statewide 3,604 people have gained knowledge or skills to increase family economic security such as how to access SNAP benefits and SHIIP Medicare Part D; how to comparison shop and manage food costs, and how to shop for reverse mortgages and long-term care insurance.

Youth leadership programs. In some communities, youth have limited access to leadership development programs. That was the case in Montgomery County until NC State Extension and its partners offered a countywide youth leadership program. All 25 students who enrolled and graduated from the program in 2015-16 indicated they gained confidence in public speaking and civic action. They also met with legislators and spent Martin Luther King Jr. Day packaging 3,000 meals for county families. In Wayne County, through a Junior Leadership Program, 25 young people learned communication skills, empathy, teamwork and the importance of agriculture. Statewide, 10,385 youth increased their knowledge, skills, and/or attitudes regarding leadership, and 4,142 youth took on new or expanded leadership roles in the community.

Positive parenting practices. In Cleveland County, nearly 25,000 grandparents live with grandchildren

under the age of 18. About 20 volunteers and agencies, led by NC State Extension, collaborated to form the Broad River Grandparents Raising Grandchildren (BRGRG) Kinship Care Support Group. Approximately 360 educational contacts were made with caretakers, children, volunteers, and advisory board members in 2016. Caretakers rated the support group as very helpful to them as a source of information, new resources, community programs, and professional guidance. They reported more confidence in caregiving roles and indicated that the support group provided a valuable opportunity to socialize and learn from others. Participants' children also benefited. Statewide, Extension programs helped 1,292 parents and other caregivers adopted positive parenting practices.

STEM education. NC State and NC A&T 4-H agents from across the state addressed rising interest in science, technology, engineering and math (STEM) education through school enrichment programs designed to bring learning to life while fitting state educational standards. Statewide in 2016, these programs helped 30,849 youth increase their STEM knowledge. NC A&T's 4-H STEM program offered the Junk Drawer Robotics and Lego Mindstorms EV3 Robotics enrichment curricula to provide over 450 students with hands-on experiences in building and programming robots to solve simple, everyday problems.

Food deserts. Areas of Greensboro have been nationally recognized as lacking adequate fresh food options. NC A&T researchers and Extension professionals are working to address the impact of food deserts on residents' ability to develop and maintain healthy eating habits. Researchers have worked with residents of 12 minority communities to establish a high-tunnel garden in one food-desert area and a marketing/distribution channel to provide convenient access to the garden harvest. Partnering with community organizations, the university is also spreading knowledge about the benefits of healthy eating. Over 200 participants learned more at an Extension "Try Healthy" fair.

Career readiness. To help middle and high school students develop employability skills, NC A&T has developed the Extreme Makeover: Soft Skills Edition program, which is now called "You're Hired!" The program, which also introduces them to STEM careers, covers building your brand, communication, conflict resolution, customer interaction, and handling time and responsibility. In 2016, 88 young people were exposed to the program's different modules.

HUMAN HEALTH, NUTRITION AND WELL-BEING

Fruits and nuts for better human health. A whole plant-derived extract containing a complex mixture can exert pharmacological activity that a single chemical entity cannot, making them promising sources of bioactives that improve human health. Intensive research at NC State's Plants for Human Health Institute has proven that blueberries and other berries contain bioactive compounds that combat chronic human disease. Researchers have also studied how to identify and increase the production of bioactive constituents in blueberries by identifying the genes responsible for their formation, and they are working on an innovative technology that produces food products rich in bioactive components. Additionally, researchers are studying the bioactive constituents in nuts to discover how their phytochemicals combat chronic diseases like cancer, inflammation, and diabetes.

Grape pomace could be a good source of health-enriching polyphenols and a fiber-rich food ingredient. To optimize its nutritional and functional value, NC A&T researchers have evaluated particle sizes of grape pomace and found out how different particle sizes affected consumers' perception of cookie color, aroma and taste.

Fly control for disease prevention. Flies can carry pathogens that cause diarrhea from surrounding animal or human populations. For the control of filth flies in human settings, elimination systems must be expanded to include new active ingredients applied to highly attractive lethal traps. NC State researchers have been exploring the use of plant-derived methyl ketones for topical application and as fumigants. They've found that these test materials kill blow flies, house flies and flesh flies as expected.

Toward better health for older adults and people of color. Adults are living longer, but people of color and the impoverished are more likely to experience higher incidences of chronic diseases and health issues. NC A&T researchers are increasing awareness of health disparities and social determinants of health that influence older African Americans and attempting to improve the dietary intake and physical activity levels of individuals 63 years of age and older. A diverse partnership is reaching older adults and

congregants in a faith-based setting. Ministry leaders and participants have begun to improve their knowledge and awareness of the interplay of spirituality, nutrition and physical activity.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	493.0	72.5	407.0	46.0
Actual	613.0	83.0	389.0	42.5

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

For NCARS, a thorough scientific and merit review of each proposed new or revised research project is done at the departmental level before submission to NCARS. This departmental review consists of two parts: an informal review (PI's responsibility) and a formal review (Department Head's responsibility). Cooperative Extension's work is closely coordinated with NCARS efforts. In fact, numerous Extension faculty within the College of Agriculture and Life Sciences at North Carolina State University have joint appointments with NCARS. Extension on-campus faculty collaborate with almost 400 state and county supported Extension agents, who plan and deliver educational programs across the state. This effort is further strengthened by the Extension programmatic efforts of N.C. A&T agents and faculty, who collaborate with N.C. A&T researchers. In addition to this alliance with research faculty at both institutions, Extension benefits from the input of a well-established statewide system of lay advisers representing the state's diverse population. Also, each county routinely conducts an environmental scan to determine emerging needs and appropriate education responses. These scans give residents, advisers, commodity group representatives, volunteers and other clients the opportunity to ensure that local programs meet local needs and priorities. Stakeholder input undergirds all of Extension's efforts.

The research director in 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 duplicative 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 principal investigator incorporates suggestions made by the reviewers and must give reasons for any substantive suggestions not included or addressed. 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.

A variety of instruments are utilized to assess the needs, make value choices or set priorities on what educational programs Cooperative Extension will address. County and state extension centers identify, collect and analyze information pertinent to the economic, social and environmental situation. Data collected are used to determine what priority issues are within the scope of the organization's mission. Issues or problems are examined to determine new potential impact or benefit to the clientele and Extension's ability to address the issue or problem compared to other agencies or organizations. State extension specialists determine if adequate research and the knowledge base is adequate to address the problem or issue. Assessment measures most commonly used by Cooperative Extension are surveys, advisory leadership system, focus group interviews, media monitoring, nominal group techniques, public forums, demographic data, face-to-face interviews, and pre- and post-testing.

To ensure appropriate, inclusive and adequate stakeholder input, Cooperative Extension implements environmental scans in each county and on the Eastern Band of Cherokee Indian reservation. The scans provide a wide range of needs, issues, trends and emerging issues. They are submitted and stored in a central data base. In addition, state specialists (at N.C. A&T and North Carolina State University) review and compile trend data relative to their area of expertise. Trend data are shared with county staff on alternate years or more often depending on the severity of the issue.

Following the submission of data, state program leaders, specialists, district directors, regional program coordinators and selected county faculty conduct a rigorous review of the data. Collectively, these individuals provide a significant 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.

Teams of individuals, (15-20 specialists and subject matter agents) develop specific objectives, program descriptions, measures of progress, impact indicators, cost - benefit analyses and volunteer involvement/ value for each objective. This procedure results in the development of a state long range plan and provides the basis requirements for the Agricultural Research, Extension, and Education Reform Act report submitted for Smith-Lever funds. Objectives are updated, revised or deleted as changes and circumstances occur.

County Extension Centers select objectives that most fit local needs. They plan, implement and evaluate educational programs to address objectives outlined in the state plan of work. Specialists develop curriculum, training and technical assistance to assist county faculty address the needs that have been identified in the assessment measurements. In June and December of each year, county extension faculty input their results into a statewide reporting database (Extension Reporting System). Specialists compile data from counties related to their area of expertise and submit a state report of accomplishments.

III. Stakeholder Input

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

- Use of media to announce public meetings and listening sessions
- Targeted invitation to traditional stakeholder groups
- Targeted invitation to non-traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals
- Targeted invitation to non-traditional stakeholder individuals
- Targeted invitation to selected individuals from general public
- Survey of traditional stakeholder groups
- Survey of traditional stakeholder individuals
- Survey of selected individuals from the general public

Brief explanation.

The 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. 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. In addition, the college hired a chief communications officer in 2015, who is leading strategic efforts to reach key stakeholder group.

Cooperative Extension has a continuous system in place for obtaining stakeholder input in program planning, implementation and quality assessment. This continues to be a primary commitment for North Carolina Cooperative Extension. 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 conduct 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, two Statewide Advisory Councils provides programmatic inputs, review, and guidance for the overall program functions of the North Carolina Cooperative Extension Service at NC State University and The Cooperative Extension Program at N.C. A&T. The State Advisory Council for NC State meets quarterly and the Strategic Planning Council for N.C. A&T meets three time per year. Annually both statewide advisory councils meet

jointly. Both Councils also attend other special meetings to provide organizational review and input. Each are made up of influential individuals who represent a broad scope of the diverse population in North Carolina and who have distinguished themselves as respected, responsible, and knowledgeable leaders who can provide local perspectives to a statewide organization. Networking and collaboration between both councils is 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 year, with greater frequency encouraged. However, the respective advisory groups provide more frequent stakeholder input, which means a continuous process of program review and adjustment is available to address changes in local needs. An environmental scanning process is implemented in each of the state's 100 counties. This scanning process helps to assure that a large amount of input is gained from the citizens whom the research and extension efforts are intended to serve.

The Strategic Planning Council (SPC) is the advisory leadership group for The Cooperative Extension Program at N.C. A&T. The SPC membership is comprised of 24 influential volunteers representing the board 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 meetings three times per year, one of which is a joint meeting with NC State's State Advisory Council. Networking and collaboration between both councils is 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. The Cooperative Extension Program at N.C. A&T hosted its annual Grassroots Leadership Conference, a form which bring 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. In 2016, the Grassroots Leadership Conference drew a capacity crowd of more than 200 stakeholders, representatives from partner agencies and members of county Extension center staffs to Greensboro on November 3. The conference agenda was built around community leadership - creating youth and adult partnerships.

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

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.

Cooperative Extension has a continuous system in place for obtaining stakeholder input in program planning, implementation and quality assessment. 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 conduct 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, two Statewide Advisory Councils provides programmatic inputs, review, and guidance for the overall program functions of the NC State Extension and The Cooperative Extension Program at N.C. A&T. The State Advisory Council for NC State meets quarterly and the Strategic Planning Council for N.C. A&T meets three time per year. Annually both statewide advisory councils meet jointly. Both Councils also attend other special meetings to provide organizational review and input. Each are made up of influential individuals who represent a broad scope of the diverse population in North Carolina and who have distinguished themselves as respected, responsible, and knowledgeable leaders who can provide local perspectives to a statewide organization. Networking and collaboration between both councils is 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 year, with greater frequency encouraged. However, the respective advisory groups provide more frequent stakeholder input, which means a continuous process of program review and adjustment is available to address changes in local needs. An environmental scanning process is implemented in each of the state's 100 counties. This scanning process helps to assure that a large amount of input is gained from the citizens whom the research and extension efforts are intended to serve. This is an on-going function that is ingrained in the program planning and implementation for both research and extension in North Carolina. It is our intent to involve and serve the citizens of the state in the most effective ways possible to enhance the quality of North Carolinian's lives and economic well-being.

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

1. Methods for collecting Stakeholder Input

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

Brief explanation.

Cooperative 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 Cooperative Extension and for the entire college have benefitted from concentrated efforts by college leadership to engage stakeholders through listening sessions, focus groups, and state-wide conferences and workshops and have all benefitted from engagement of relevant stakeholder groups.

3. A statement of how the input will be considered

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

Brief explanation.

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 Cooperative Extension and the college focus on those programs that are consistent with the college's mission and vision. In addition, relationships developed during these processes are providing stakeholder support for major legislative initiatives, financial development opportunities, student recruiting and positive stakeholder involvement in the future.

Brief Explanation of what you learned from your Stakeholders

Many issues identified as key concerns by North Carolina citizens are addressed by Cooperative Extension programs. Agricultural preservation, sustainability and development, and nutrition and health 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 opportunities for the state's citizens were all labeled key issues facing North Carolina. 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.

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
11906502	3698071	8003574	4250701

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	7058513	1479792	8380692	4249346
Actual Matching	7058513	1148649	8380692	3219240
Actual All Other	6150000	1506964	28420000	2694910
Total Actual Expended	20267026	4135405	45181384	10163496

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

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%
404	Instrumentation and Control Systems	1%	0%	0%	0%
511	New and Improved Non-Food Products and Processes	1%	0%	0%	0%
512	Quality Maintenance in Storing and Marketing Non-Food Products	1%	0%	0%	0%
601	Economics of Agricultural Production and Farm Management	3%	10%	5%	0%
602	Business Management, Finance, and Taxation	3%	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: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	125.0	20.0	156.0	7.0
Actual Paid	158.0	22.5	147.0	11.0

Actual Volunteer	109.0	1.5	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**
1820284	318250	3156653	1191297
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1820284	628744	3156653	384337
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
1585993	252003	10704615	721025

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?

Communities of Practice eXtension are utilized by field crops, horticultural, ornamental and related areas that provide a resource for producers, handlers, processors and marketers. NC State Cooperative Extension is leading several eXtension i-Three Issue Corps Projects including - A Statewide Local Food Program Team to build capacity of agents, identify resources for stakeholders, and share successful programming that will benefit food systems and Sustainable Crop Production to develop a teaching garden to serve as a training center to provide hands on learning experiences to students, agents, growers, and industry personnel.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	490294	1303615	98192	261078

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

Patent Applications Submitted

Year:	2016
Actual:	32

Patents listed
14/756,094: Shrub-Buddleja 'Miss Pearl'-NC2001-4 (PP; CA PBR)
14/820,133: Peptide aptamers that bind to the rep proteins of ssDNA viruses
15-8711: Ilex verticillata, NCIV2, Little Goblin Orange (PP; CA PBR)
15-8714: Ilex verticillata, NCIV3, Little Goblin Guy (PP; CA PBR)
15-8710: Callicarpa hybrid, NCCX2 (PP; CA PBR)
15-8715: Spiraea hybrid, NCSX1 (PP; CA PBR)
62/210,552: Methods and compositions for modification of plastid genomes
14/775,526; PCT/US2015/049806: Methods and compositions for plant pest control (USA; PCT; 2 foreign patents)
62/239,519: Autonomous aquatic herbicide application
62/245,502: Compositions and methods for enhanced plant growth and seed yield
14/756,939: Ornamental sweet plato plant named NCORNSP-019SCSHLM
#TBD: Shrub-Buddleja 'Pink Micro Chip' butterfly bush
14/900,775: Transgenic expression of archaea superoxide reductase
14/900,799: Method and compositions for improvement of seed yield
62/387,278: Blueberry plant named 'Heintooga'
A201600397: Blackberry plant named 'Von'
14/999,119: Magnolia 'NCMX1'
14/999,516: Shrub-Berberis 'NCBX1'
14/999,518: Shrub-Berberis 'NCBT1'
2014/2938: Sweet Carolina Dijon (PBR)
TRM121: Cercis plant named 'Ruby Falls' (foreign)
TRM120: Cercis plant named 'Merlot'
14/999,639: Evergreen dogwood 'NCCE1'

U.S. Serial No. 15/262,077 Micropropagation for Black Cohosh

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	99	393	492

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
2016	100

Output #2

Output Measure

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

Year	Actual
2016	2773

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Tomatoes generate $47 million in annual farm income in North Carolina, but farmers face several obstacles to optimum yield, including bacterial wilt, bacterial spot and bacterial speck. They need varieties that not only are resistant to these diseases but also have improved fruit qualities, including lycopene content and flavor.

What has been done
NC State University researchers have begun to identify the novel source of resistance for bacterial speck, bacterial spot and bacterial wilt in tomato plants. To expedite this process, they have taken a molecular breeding approach to target resistance to these conditions.

Results
Researchers have managed to discard unwanted materials at early generations (F2) and advance the materials with desired gene combinations into later generations. As a result, breeding lines and hybrids resistant to bacterial speck and tomato mosaic virus were evaluated, and there is now enough data to release breeding lines and hybrids with resistance to multiple diseases.

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
511	New and Improved Non-Food Products and Processes
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 Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	25361212

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Educating farmers about optimum fertilizer management and production practices improves farm profitability and reduces the likelihood of runoff of nitrogen, phosphorus and sediments into state waterways. New fertilizer materials, including increasing amounts of poultry litter and layer manure, need to be evaluated for efficacy in commercial farms.

What has been done
An Extension specialist with NC State's Department of Crop and Soil Sciences implemented training to encourage voluntary adoption of best practices in nutrient management. Total attendance at 2016 training programs was 381 at cooperative extension meetings, plus an additional 1,065 field day attendees. Many of these attendees were professional agronomists receiving credit hours for recertification training, and raining sessions were held to educate cooperative extension specialists on use of statistics to design and evaluate field research experiments.

Results

If program efforts lead to a 5-pound-per-acre reduction in nitrogen fertilizers in this region, farmers would save approximately $1 million worth of nitrogen fertilizer annually. In Hyde County alone, extension efforts led to producer usage of composted layer manure instead of inorganic fertilizers on 20,000 acres of wheat and corn, saving farmers an estimated $30 per acre for a total savings of $600,000.

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
404	Instrumentation and Control Systems

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 Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	21

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Cercis canadensis, the eastern redbud, is a popular landscape tree. It is a native plant, relatively small in stature, and drought tolerant. Considerable genetic diversity exists in the redbud, but little of this diversity has been exploited through controlled breeding. Such controlled breeding could allow for the development of novel landscape types that stimulate the nursery industry.

What has been done
NC State scientists have been taking advantage of the redbud's genetic diversity to develop novel landscape types through the recombination of weeping growth habit, variegated leaf, purple leaf, golden leaf and compact growth habits. Cultivars, including Pink Pom Poms, have been released

and accepted into the green industry.

Results
In 2016, total sales of cultivars developed from this program totaled about 40,000 units. Assuming typical wholesale and retail market value, these cultivars generated over $2 million for the industry in 2016.

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 Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	9

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Soil strength is an important factor in crop production and water infiltration/percolation through soil. Load-bearing capacity is also important for road and airplane runway construction. The most commonly used hand-tool for determining soil strength is a dynamic or a static cone penetrometer. These devices are lightweight and portable, but the force needed to push them into the ground is limited by the operators? weight and strength. Not only that, operating the dynamic cone penetrometer requires two operators and is physically taxing and noisy.

What has been done

NC State University crop and soil science researchers have developed a static cone penetrometer that is not only quiet, easy to operate, lightweight and portable but also can apply significantly higher force than the weight of the operator to push the cone into the ground. In addition, the device electronically measures and records the applied force and depth of penetration of the cone simultaneously and continuously, eliminating the need for two operators.

Results

Tests at three separate sites demonstrated that this static cone penetrometer achieves comparable results to those of a commercially available dynamic cone penetrometer. Both penetrometers showed similar trends in assessing soil strength with depth. This new penetrometer significantly reduces operator effort. In addition, its relatively small size and portability allow for measurement of soil surface and subsurface compaction at multiple locations within agricultural fields. Overall, it provides more reliable information and can measure soil strength at deeper depths than currently available static cone penetrometers.

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
404	Instrumentation and Control Systems

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 Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Cotton performance and yield depends on many factors, including variety selection, lint quality and timely management applications.

What has been done
NC State Extension agents in Cumberland, Harnett, Johnston, and Sampson counties and NC A&T Extension agents in Duplin County partnered with NC State specialists to provide cotton growers with two hours of research-based training. The training focused on production practices, including variety selection and pest management. Meanwhile, NC State established an on-farm cotton variety evaluation program to test 10 varieties widely adapted and best fit for North Carolina; in 2015 and 2016, 17 trials were held in producers' fields across the state.

Results
68% of training participants improved their knowledge of cotton management and thought the information gained could increase their cotton profits by an average of $58 per acre. With an estimated combined total of 22,710 acres produced in participating counties, growers had a combined potential profit increase of $942,500. The on-farm cotton evaluation program had even broader impact, showing growers statewide that improper variety selection could cost them an average of $74 to $173 per acre in 2016 when selecting only from the best varieties. The top three varieties in the 2015 program represented 42.76 percent of the state?s cotton acreage in 2016. Comparing average yield of the top three varieties to the average yield of the remaining seven varieties tested in 2015 suggests a statewide economic impact of $14.3 million in 2016.

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
2016	2773

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

In meetings with a leading hog company production division, it was estimated that the livestock and poultry industries in the southeastern United States require over 320 million bushels of feed grains per year. The costs of importing feed grains into this region are substantial. The decline in wheat production in the Southeast means that production of other feed grains, particularly corn, must increase to fill this need.

What has been done

NC State Extension specialists and agents held statewide growers' meetings to promote the "Year of the Corn." Over 48 meetings and field tours were held, reaching over 2,000 growers, consultants, industry agronomists, state leaders and others key agricultural decision makers. Two extension agent training workshops were also held to highlight proper corn management practices based on recent research and weather forecasts. Popular press articles were used to reach growers and agronomists across the Southeast.

Results

Growers planted over 1 million acres of corn in 2016, an increase of 280,000 acres over the previous year. Industry and extension agents credited the "Year of the Corn" campaign for this increase. The corn management information presented helped growers avoid yield losses. The combination of the large number of planted acres with record yield resulted in a record corn crop of 144 million bushels. This crop helped the livestock industry meet their requirement for local feed grains in 2016. Given the weather, corn turned out to be the most profitable crop for growers in 2016. If the value of the corn raised on the extra 280,000 acres is calculated based on the average yield of 144 bushels per acre and a conservative average yearly price of $4.25 per bushel, the impact of this initiative was over $171 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
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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In 2006, less than 1,000 acres of organic grains were grown in North Carolina. The large processors in the state -- Braswell Milling, Lindley Mills and Organic Valley -- were importing most of their grains from out of state. NC State's Department of Crop and Soil Sciences has been working to provide production and storage information so that North Carolina farmers can supply organic markets.

What has been done
A researcher from the Department of Crop and Soil Sciences currently conducts a research program on organic grain production covering issues of weed management, soil fertility, and cover crop management. He also collaborates extensively with plant breeders in corn, soybeans, wheat, peanuts, and several cover crop species to develop breeding protocols appropriate to organic systems. Farmers have singled out access to advanced information on genetics as one of their largest concerns.

Results
Organic grain acreage has grown quickly in the state to over 12,000 acres. And as of 2016, North Carolina is the leader in organic acreage in the region. The state's success has attracted new buyers into the market. Perdue now has multiple buying stations in North Carolina and operates an organic soybean crusher in Hyde County. In addition, Pilgrim's Pride began producing organic broilers in 2016, and the company is now building an organic grains processing facility in Staley. 2016 also saw a wave of new farmers attempting to enter the market, and the price premium for organic crops is now approximately three times that of conventional pricing across commodities.

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 Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	10

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Soil microorganisms exert critical controls over the structure and functioning of terrestrial ecosystems, impacting plant growth and community structure. Symbiotic microbes play a particularly important role in plant nutrient acquisition, soil carbon sequestration, and plant resistance to stresses. Perturbations, such as management practices and climate change, profoundly affect soil microbial biomass, activity, and diversity. However, how the resulting changes in microbes influence ecosystem stability and functioning is still unclear.

What has been done
In 2016, NC State University continued research that included a series of experiments examining the effects of natural and anthropogenic perturbations (including tillage, nitrogen inputs, climate warming, and elevated atmospheric CO2 and O3) on soil microbes and microbially-mediated processes and the impact of farming practices on soil carbon and nitrogen cycling, greenhouse gas emissions from soil, and soil microbial properties.

Results

Research results have been shared with communities of interest, mainly through publications, presentations and lectures to students and scientists. These results have the potential to lead to better management of soil microbial communities for nutrient retention and soil carbon sequestration to reduce the CO2 concentration in the atmosphere in both agroecosystems and bioenergy cropping systems. In addition, the results of this research may facilitate the design of fertilizer management and farming practices that reduce greenhouse gas emissions.

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Since the loss of tobacco as profitable crop in Yancey County, farmers have been struggling to replace it. Many want and have tried to transition into vegetable production. The issue they have is their scale and lack of infrastructure.

What has been done

In partnership with county government and local stakeholders, NC A&T's Cooperative Extension in Yancey County developed a non-profit food hub (TRACTOR) that works with over 50 small family farms. They support local agriculture and provide area restaurants and local grocery stores with a diverse selection of fresh produce. Their goal is to make sure food dollars stay in the local economy, increase farm income in their community, preserve farm culture and greenspace, and expand access to the freshest local produce.

Results
Nearly 100 growers have sold produce through TRACTOR in four years, selling nearly $500,000 in local produce to 65 different markets.

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
2016	1465

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Across rural North Carolina, many communities are locked in a downward economic spiral, partly due to the downturn in the tobacco industry. To compete in today's global market, family farms must explore innovative strategies to improve the economics of their operations. NC State University Extension professionals are uniquely positioned to help local producers explore new opportunities and disseminate the results statewide.

What has been done
The North Carolina Agricultural Foundation applied for and received a grant from the Tobacco

Trust Fund Commission to set up a mini-grant program for farms in counties severely impacted by the downturn in the tobacco economy. NC State Extension coordinates the NC AgVentures Grant Program, the primary goal of which is to strengthen agriculturally dependent families and communities by providing support and funding directly to North Carolina farm operators who plan to diversify, expand or implement entrepreneurial plans in their operations or communities.

Results

The grant review committee initially awarded 20 farmer/individual grants in seven of the 10 participating counties, as well as three community grants. The grant projects incorporated new or adapted equipment, new or adapted technology, innovative repurposing projects, and innovative marketing strategies. Later in the fall of 2016, additional funds were awarded, and the opportunity expanded from 10 to 17 counties: Guilford, Forsyth, Stokes, Yadkin, Surry, Rockingham, Wilson, Nash, Pitt, Edgecombe, Martin, Johnston, Sampson, Duplin, Greene, Wayne, and Lenoir. In addition, another 26 grants were awarded. Thus, 72 new jobs were created, 11,113 acres of farmland were protected, and income from production/distribution increased by $188,319.

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

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
2016	19620

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

According to the census of agriculture conducted in 2012, from 2008 to 2012, North Carolina suffered the loss of 21 percent of farmers who had been farming for 10 years or less. This is a loss of an estimated 13,000 farmers, which puts the state in the bottom half of the nation in terms of farmer losses. Helping North Carolina farmers develop successful business practices is critical to the growth of the state's agricultural economy.

What has been done

To increase the number of sustainable and economically viable farms in North Carolina, NC State Extension organized two farm schools: the Southern Piedmont Farm School and the Eastern Piedmont Farm School. Over 68 farmers attended in 206 to learn economically sustainable farming methods. These sessions give students the tools to create viable farm business plans over a 7-month time frame.

Results

Each farm school participant was required to maintain good attendance by attending 6 of the 8 business sessions and have a functional business plan 75% written at the end of the class sessions. After graduation, 72% of students had a written business plan and 70% found new markets.

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The use of high tunnel production systems on small farms can provide improved economic returns for growers. However, limited availability of information on the benefits and requirements for high tunnel vegetable production prevents many small farmers from taking advantage of this technique.

What has been done
An NC A&T horticulture specialist provided recommendations to growers on tailoring crop choices, crop management, and planting calendars for high tunnel vegetable production, as well as information about potential economic returns. In addition, general strategies were developed for temperature and moisture management in high tunnels for pest management and yield improvement.

Results
Improved high tunnel production of organic tomato, cucumber, bell pepper, bok choy, lettuce, spinach, salad mixes, and green mixes should have a net return of $1.5-5.75 per square foot in one season. Four organic strawberry cultivars suitable for high tunnel production were identified in hardiness zones 7 and 8. By choosing the appropriate cultivars, farmers could have a net gain of about $4.5 per square foot. In addition, based on the 2016 high tunnel study, growers now have a better understanding of microclimates in both high tunnel and open field settings. Information extracted from this research has been delivered to over 500 small farmers, extension educators, and other horticultural professionals via extension publications, field days, and presentations at national, regional, and local conferences and workshops.

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

- 1862 Extension
- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	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 2016, over 3,300 people attended over 50 CEFS educational workshops and conferences. Over 1,000 people attended the Farm to Fork Picnic Weekend, CEFS' largest fundraising and public event of the year. In 2016, Community Food Strategies organized six regional gatherings of food councils with support from regional partners and the Local Food Council of NC. The Local Food Economies initiative worked with 58 community colleges and six universities in 2016 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

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. 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. 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.

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, program implementation practices in the field, and outcome observations 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: The swine industry, NC State University, NC Department of Agriculture & Consumer Services, NC Biotech Center collaboration that spent over $1 million for research and education to stimulate feed grain production. Not counting increased corn and wheat production, additional grain from sorghum, which was promoted in the program, in just one year was worth an estimated $33 million. Including increased corn and wheat production has increased the value of this effort even more. Our plant breeding programs for sweet potatoes and peanuts have a

record of generating new varieties that become the predominant varieties used by the industry in a matter of just a few years after release. 'Covington' sweet potato and 'Bailey' and 'Sugg' peanuts are three notable cultivars. Equally important are our ornamentals and tomato breeding programs, both of which are licensed and commercialized by leading nurseries and seed companies.

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: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	74.0	10.0	101.0	8.0
Actual Paid	91.0	3.0	98.0	5.5
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**
1047646	148019	2111845	587026
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1047646	0	2111845	806939
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
912802	0	7161538	86135

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

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	326863	869076	81659	217118

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

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	13	109	122

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Highly focused non-degree credit group training activities to be conducted

Year	Actual
2016	1018

Output #2

Output Measure

- Relevant and impacts focused research projects to be conducted

Year	Actual
2016	100

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 Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	15447384

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
With beef prices declining, beef cattle producers have sought ways to add value to their calf crop. Cattle producers have looked for ways to boost profits, specifically through value-added marketing. Many of these more progressive-minded producers are already managing their cattle at a level that would bring them top prices at the local auction barn, but were interested in co-mingling cattle for truckload sales.

What has been done
Cooperative Extension in Rutherford County, partnering with the Mountain Cattle Alliance and Southeast Livestock Exchange helped bring beef cattle producers together to co-mingle calves to sell in truckload lots. This group evaluated and processed the calves to verify that health and quality issues were addressed in order to market high quality cattle.

Results
Over 30 producers sold 9 loads of cattle (~700 head) in 2016 valued at $845,000. These calves were sold at premiums ranging from $100-$200/head. At an average of $150/head on 700 head of cattle, that is an additional $105,000 profits back in the pockets of these producers. Using a multiplier of 6, there was a direct economic impact of $630,000 to the region.

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 #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 Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	15447384

3c. Qualitative Outcome or Impact Statement

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

What has been done
NC State researchers in the Department of Animal Science have worked with the North Carolina Pork Council and the National Pork Board to develop neonatal management strategies for replacement gilts to improve sow longevity. NC State is also partnering with these organizations to create a proactive physiological test for sow longevity.

Results
Sow retention rates have doubled in the past four years on farms that have adopted these

management strategies. This has reduced the annual culling rate for sows from about 60% to 30%. This translates into each sow producing about 25 more pigs over her lifetime. Given current market prices, this translates into a $5,000 increase in gross income generated per sow. These results have encouraged the National Pork Board to commit an additional $1.2 million over the next 3 years to further study factors affecting sow longevity.

4. Associated Knowledge Areas

KA Code	Knowledge Area
301	Reproductive Performance of Animals
302	Nutrient Utilization in Animals
303	Genetic Improvement of Animals
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
2016	8472

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Aquaculture is the fastest growing food animal agriculture sector in the world. Hybrid striped bass is a major U.S. aquaculture species that tolerates a wide range of water temperatures and salinities, and tremendous potential exists for expansion of this industry. Farmers in the industry

benefit from domestic fish broodstocks to ensure a reliable supply of animals with good growth and health.

What has been done

NC State co-coordinates the National Program for Genetic Improvement and Selective Breeding for the hybrid striped bass industry, a nationwide consortium dedicated to improving the hybrid striped bass aquaculture cultivar. These fish are produced annually at the Pamlico Aquaculture Field Laboratory. In 2016, 104 different families of domestic striped bass were produced and new breeding technology was optimized for commercial scale production, which will enable consistent production of many millions of fry in the near future.

Results

Over 90% of the hybrid striped bass raised in the US this year were produced using improved broodstock from the National Program for Genetic Improvement and Selective Breeding for the hybrid striped bass industry. The combined farm-gate value of both food fish and fingerling production in North Carolina is approximately $10 million a year, and nearly all of these fish were produced using domestic male striped bass broodstock derived from the breeding program. Fifty-three beneficiaries were involved in the research program this year, including 27 commercial producers. Millions of striped bass fry and thousands of juvenile domestic striped bass were also transferred into the industry.

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

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	8472

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Seventy-two percent of meat producers have been selling meat for five years or less and are relatively new to the meat business. However, little training is provided for Cooperative Extension agents on niche meats. In fact, according to a recent survey of Cooperative Extension agents, 78% reported an interest in receiving training in pasture-based meats, with specific focus on marketing, business training, pasture management, and production training so that they can better serve their farm communities.

What has been done

NC Choices, an initiative of the Center for Environmental Farming Systems, promotes sustainable food systems through the advancement of the local, niche, and pasture-based meat supply chain in North Carolina, conducted niche meat workshops. In 2016, NC Choices partnered with the Cooperative Extension Center in Forsyth County to present the May Meat Series.

Results

Cooperative Extension attendance at NC Choices training events has increased dramatically because of this intentional partnership and training. The Pastured Porkshop conference sold out at 100-person capacity a few weeks before the event, including some participants who flew to North Carolina from Pennsylvania and Virginia just to attend the seminar. Business decision-making remained among the most popular topics.

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
315	Animal Welfare/Well-Being and Protection

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Use of in vitro fertilization (IVF) can increase the genetic contribution of female cows. Widespread use of IVF has been limited by evidence that suggests that some offspring from these procedures grow abnormally fast, becoming larger than normal at birth. The term abnormal offspring syndrome (AOS) has been coined to describe this phenomenon. In addition, advanced methods of parasite control in ruminants are needed to advance global food security and develop a greater understanding of the innate immune response to pathogens.

What has been done
Scientists at NC State have identified a mechanism that may underlie abnormal offspring syndrome (AOS). They have documented alterations in the expression of genes and in associated epigenetic DNA markings in cattle fetuses and placentas that exhibit AOS characteristics. These genes and markings are responsible for control of normal fetal growth; thus, it is likely that their altered expression contributes to the occurrence of AOS in affected fetuses and placentas. At N.C. A&T, researchers are studying sustainable parasite control in ruminants.

Results
Understanding the mechanism underlying AOS will allow scientists to develop diagnostic tests for use either before the IVF embryos are implanted or early in gestation at a time that will allow producers to effectively manage these pregnancies. In addition, an understanding of the mechanism underlying AOS will allow development of IVF methods that eliminate the occurrence of AOS completely. This will provide greater opportunities for producers to take advantage of IVF and related reproductive technologies in their operations. In addition, N.C. A&T researchers have discovered that polyphenols extracted from cowpea and sericea enriched feed supplements may possess characteristics that can be exploited to counteract the pathological processes that occur due to inflammation, which could help ruminants combat parasites.

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

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	977

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
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. Marketing, business training, pasture management, and production training remain the top need areas according to ranchers in the 2016 niche meat survey. Women farmers and meat entrepreneurs need focused, women-only training to help them succeed in the growing local and niche meat movement.

What has been done
Two initiatives from the Center for Environmental Farming Systems and NC State Extension, (NC Choices and Amazing Grazing) collaborated to provide production-to-market development training as part of their "Gate to Plate" grant awarded by the Southern Risk Management and Education Center. The comprehensive training included a full-day workshop and one regional three-day conference to develop the skills of 80+ female and local meat professionals. Participants gained skills in fencing and pasture management, marketing and sales, and finance and tax management.

Results

NC Choices? Women Working in the Meat Business Conference sold out over a month in advance with 70 registrants. Pre- and post-conference evaluations revealed that participants improved dramatically across all training topics offered, with gains of 270?339% in terms of skills and knowledge. All participants reported increased skills in the following categories: electric fences, pasture management and soil health, and nutrition management. Both events increased awareness among a broader range of female farmers and professionals.

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.

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. Nevertheless, we are challenged to keep our evaluation tool kit in lockstep with the regularly changing research and extension needs. We will continue to refine our reporting and data collection system to most effectively collect data that represent the real world situation with respect to the impacts of our programs.

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: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	68.0	2.5	24.0	6.0
Actual Paid	82.0	2.0	23.0	0.4
Actual Volunteer	1.0	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**
942881	120621	489059	106634
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
942881	0	489059	218429
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
821521	20184	1658462	90308

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. NC State Extension eXtension is leading the i-Three Issue Corps Project Climate Forests & Woodlands. This project was developed to increase impact on existing CoP via a communication plan, increased use of social media tracking and an unobtrusive evaluation system.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	37034	96559	72245	188366

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

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	1	43	44

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Waste Management Certification Programs

Year	Actual
2016	29

Output #2

Output Measure

- Number research project completed on environmental/natural resource issues

Year	Actual
2016	75

Output #3

Output Measure

- Number of non-degree credit environmental activities conducted

Year	Actual
2016	338

Output #4

Output Measure

- Enrollees for Natural Resources Leadership Institutes training

Year	Actual
2016	27

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Ground- and surface-water nitrogen contamination from southeastern Coastal Plain agriculture is a regulatory and social issue threatening regional crop production. Methods must be developed to assess the nitrogen status of crops to guide fertilization so as to optimize agronomic benefits and minimize nitrogen pollution.

What has been done
NC State researchers obtained field and airborne hyperspectral data and airborne lidar measurements over several seasons for experimental corn plots in three coastal plain locations. The experiments included a range of fertilizer nitrogen rates, two row spacings, and two fertilizer application times. Plant tissue samples collected at several points during the growing season and grain at harvest were analyzed for total nitrogen. Plant standing biomass at harvest will be estimated from lidar data and validated by field sampling. Statistical analyses continued in 2016.

Results
Remotely sensed metrics of crop nitrogen status and biomass as a part of a nutrient management plan can assist in more precise delivery and timing of nitrogen inputs and reduce offsite movement of nitrogen to receiving waters. Analytical products can be disseminated to stakeholders (such as growers), as well as federal, state, and local agricultural and environmental management agencies. This will help optimize profit while protecting water quality and aid in demonstrating adherence to environmental regulations.

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
2016	2128

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
If North Carolina producers are to be competitive and reduce environmental impact, they must manage the by-products they generate. In North Carolina, current regulations require animal waste management plans for every animal operation involving 250 or more swine, 100 or more confined cattle, 75 or more horses, 1,000 or more sheep, and 30,000 or more confined poultry that use a liquid waste management system as well as certification of operations of animal waste management systems.

What has been done
NC State Extension has provided technical assistance and educational training programs to animal producers and animal waste operators within North Carolina. Extension provided Initial OIC Training, 6- and 10-hour re-certification training, and other waste management workshops. Extension agents also provided technical assistance in the development of Waste Management Plans, application equipment calibration, soil and waste analysis, and sludge surveys.

Results
Statewide, 1,140 waste management certifications were gained or maintained due to extension educational efforts. Over 100 application equipment calibrations were made, over 200 waste management plans were developed, and over 125 sludge surveys were conducted by extension. In one instance, Extension-recommended soil and waste analysis supported proper use of poultry

litter as a fertilizer on 20,000 acres. In another instance, a recommendation to utilize nutrients generated to fertilize crops reduced fertilizer costs by over $300,000. In another location, extension animal waste management activity included 25 sludge surveys and 12 calibrations whereby the farmers realized a savings of over $9,000.

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
2016	1959

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 the North Carolina State University Soil Science Department offered 61 short courses and conferences in 2016 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 2016, 3,212 participants received technical training for license renewal and/or professional development in waste and nutrient management and watershed protection. Statewide, 1,140 waste management certifications were gained or maintained due to extension educational efforts.

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
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1091086

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Poultry production is North Carolina's largest agriculture sector, and commercial poultry production generates large volumes of manure and bedding material, referred to as poultry litter. Although litter is a waste byproduct for poultry growers, crop farmers can use litter as a fertilizer, reducing or replacing their use of commercial fertilizers, usually at a cost savings.

What has been done

In 2016, NC State Extension programs helped farmers understand and address a broad range of issues that impact profitability and sustainability of local farm enterprises, including waste management and land application of fertilizers. Profitable and Sustainable Agriculture was a priority area, and impact was gained through certification classes, adoption of BMPs, development of waste management plans, training in proper record keeping, sampling and handling regulations to protect water quality.

Results

Extension-recommended soil and waste analysis supported proper use of poultry litter as a fertilizer on 20,000 acres. An estimated 25,750 acres of farmland were maintained using conservation tillage or other BMPs. In Richmond County, Extension reached a total of 472 participants, and 85 producers reported increased profitability with 8,800 acres under conservation tillage or other BMPs. As a result of these efforts in Union County, approximately 56,000 tons of litter farms generate should be utilized to maximize crop production and preserve water quality for the citizens of North Carolina and protect the state's largest industry.

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
2016	63

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
North Carolina has more than 5,000 miles of streams that have degraded, mainly from erosion and sedimentation. Jordan Lake Watershed is nutrient impaired and all sectors, including agriculture, are expected to reduce nutrients into the lake to reduce algal growth that causes taste and odor problems in Jordan Lake. Water quality trading may help reduce the cost of urban best management practices by allowing the development community to buy agricultural riparian buffers (credits).

What has been done
A multi-disciplinary team from NC State conducted research relative to water quality and agriculture in Jordan Lake. An anthropologist talked to 90 farmers about conservation practices and water quality, and an agronomist/soil scientist and hydrologist conducted a paired-watershed study in Chatham county. The modelers determined the primary sources of nutrient releases and the effectiveness of conservation practices. These data were passed to the economist, who then determined the economics of a water quality trading program.

Results
Most farmers are not interested in trading their land to developers to receive credit, and most farmers use conservation practices. Pastures lose many more nutrients and sediment than cropland, and exclusion fencing is an effective practice for reducing nutrient and sediment loss. Waste water treatment plants are the primary source of nitrogen, but agriculture is the primary source of phosphorus. The solution to reduce nitrogen and phosphorus is a comprehensive program that reduces nutrients from all sources. This information was presented to the Department of Environmental Quality, NCDA&CS, relevant farm organizations, and towns and cities within Jordan Lake Watershed. In addition, extension agents working with livestock were presented data on nutrient losses from pastures.

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Storm water problems continue to impact water resources in North Carolina and worldwide, causing flooding, stream erosion, property loss, pathogen-closed shellfish waters, fill kills, and more.

What has been done
The field research projects completed in 2016 by the NC State University Biological and Agricultural Engineering Department resulted in a greater understanding of structural storm water practice design and installation. Statewide, approximately 332 participants attended storm water classes.

Results
Statewide, demonstration projects have resulted in positive feedback from citizens and decision-makers. This input has positively affected storm water management throughout the state and provides designers with more opportunities to receive credit for managing storm water, which benefits the public and North Carolina?s economy. Additional water quality projects, including the Green Neighborhoods Program in Cary, the NC State River Course, and additional rainwater harvesting resulted in 88% reduction in storm water runoff to local streams. In addition, participants used knowledge they gained to install over 360 bio-retention beds that will remove over $24,742,884 in nitrogen and $2,148,890 in phosphorus from state waters over a 30-year period.

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The development of economically viable bioenergy sources is vital to a sustainable industrial society. Among all the bioenergy substrates, lignocellulosic biomass has recently attracted interest because it does not compete with food production. Lignocellulosic biomass is also a carbon-neutral source of energy. Fuels derived from lignocellulose biomass include butanol, dimethylfuran, and ethanol. However, the extraction of lignocellulosic biomass for biofuel is hindered by lignin, one of the major components of the plant cell wall.

What has been done
Recent experimental results obtained by NC State researchers suggest that lignin modification induced dwarfism in Arabidopsis can be suppressed by modifying genes that were not previously known to be involved in the lignin biosynthesis pathway (?growth inhibition relived (gir)" genes). Researchers have submitted six suppressor lines for genome re-sequencing to identify new gir genes. The correlations between lignin content, biomass production, and cell wall saccharification yield of these suppressor lines were tested.

Results
With the identification of different gir genes, NC State researchers can further study the underlying mechanism of the LMID phenotype. The results should facilitate the development of techniques to modify lignin in plants in order to obtain maximum plant biomass growth, which may

lead to sustainable biofuel production and reduced greenhouse gas emissions. These findings may also be applied to modify forage to improve livestock feeding, since lignin content is known to affect the digestibility of feed stock.

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Commodity prices and the desire to shift to more locally-grown grain as a feed source for animal agriculture have increased the demand for irrigation. Additionally, emerging irrigation technologies have had minimal testing under North Carolina soils. Water management in urban areas is also becoming increasingly important. In addition, drought accounts for 25% of economic loss in the North Carolina green industry, so drought mitigation though efficient use of existing water supplies is essential.

What has been done
Irrigation and water management presentations have been provided by NC State Extension specialists to growers, certified crop advisors, North Carolina Department of Agriculture & Consumer Services agronomists, and conference/workshop attendees through requests to Extension agents. In addition, the annual irrigation society conference provides education opportunities and credits for irrigation professionals. Recently completed and ongoing applied research projects have brought smart irrigation technology into residential settings.

Results

Growers have been given valuable information to evaluate their irrigation options and efficiently manage their water resources. Extension bulletins on subsurface drip irrigation based upon local applied research will allow growers to make more informed decisions surrounding the application of this technology to their cropping systems. Agricultural groups and state agencies have received technical input to help them guide policy and award cost-share funds. Local urban officials are turning to NC State for answers to questions regarding the adoption of ?smart? irrigation technology. Nearly 200 licensed irrigation contractors have received re-certification hours directly from NC State.

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. Our evaluation approaches are not collecting sufficient data and information on outcomes and impacts from our research and extension on irrigation and drainage systems and their benefits to farmers, communities and other land managers. We will strive to make changes in our evaluation tools to capture that information.

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: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	8.0	0.0	10.0	5.0
Actual Paid	9.0	0.0	8.0	4.9
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
104765	0	177840	457448
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
104765	0	177840	853688
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
91280	0	603077	871398

V(D). Planned Program (Activity)

1. Brief description of the Activity

• 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
• Exploit bioprocessing systems to produce a variety of compounds thatmight have utility in processing and manufacturing processes
• Advance or knowledge of energy use and conservation in human, agricultural, animal and processing environments
• Communicate solutions and systems to users through extension education and demonstration activities
• Further study of cattails as a feedstock for biofuels

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

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	427	952	730	1627

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

Patent Applications Submitted

Year:	2016
Actual:	2

Patents listed
62/194/550: Methods and compositions for enhanced biomass production and increased abiotic stress tolerance
62/194,446: Synthetic pathway for biological carbon dioxide sequestration

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	0	15	15

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Studies on producing agricultural and forestry substrates for biofuel production

Year	Actual
2016	7

Output #2

Output Measure

- Studies on engineering conversion processes for biofuels and other components

Year	Actual
2016	3

Output #3

Output Measure

- Educating homeowners, growers and processors through workshops and other group educational approaches on sustainable energy topics

Year	Actual
2016	15

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

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

Outcome #1

1. Outcome Measures

New crops or other biofuels substrates identified

2. Associated Institution Types

- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	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 NC 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.

Results
Value-added products from the sweet sorghum crop have been identified through ensliage and feedout studies at NCSU Field Labs and have shown promise as biomass crops as energy-related applications gain momentum. 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.

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 Research
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Agricultural production requires large amounts of energy, fertilizers, and water. The supply of energy, fertilizers, and water for agricultural production is becoming a constraint on food security and environmental sustainability.

What has been done
Researchers at NC A&T have accumulated knowledge in performing long-term thermophilic anaerobic co-digestion of swine manure and biomass. A 10 L anaerobic digester was constructed and continuously used to treat swine wastes and biomass. The effects of feedstocks and operating conditions on biogas productivity during anaerobic co-digestion have been studied. Additionally, researchers have accumulated knowledge in aerobic treatment of animal manure to enhance anaerobic digestion and remove ammonium in the manure for algal cultivation.

Results
The off-gas from the manure treatment unit was used to enhance microalgal cultivation. With the off-gas input, the microalgal biomass yields were improved by 130?300%. Researchers also created an integrated process for the production of hydrocarbons and fertilizers from microalgae, which will facilitate the development of an efficient and economic biological process to recover energy, nutrients, and water from agricultural and food wastes for sustainable agricultural production. Eventual introduction of a well-developed biological process into rural areas will promote rural economies by value-added processing of agricultural and food wastes, improve sustainable agriculture efforts by reducing the consumption of fossil-based fuels and fertilizers in

farming, and increase water use efficiency in the agricultural industry.

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 Research
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Bacteria and their phages impact honeybees, agricultural soils, and novel bioproducts. New biotechnology resources can be extracted from dsDNA phage genomes that could help control or eradicate American Foulbrood (AF), the most destructive and widespread of the bee brood diseases affecting American colonies. AF is caused by spore-forming Paenibacillus larvae (P. larvae). However, little is known about the most important biological pathways that regulate the behavior of P. larvae; thus, potential treatment options are seriously limited.

What has been done
Isolated P. larvae bacteriophage genomes have been sequenced, annotated, deposited into GenBank, and published by researchers at NC State. Projects on P.larvae-phage interactions have resulted in published genome isolation of new P. larvae strains causing AF in North Carolina bee hives, genome sequencing, and the identification of a reactive enzyme in the hemolymph of adult honey bees that protects against P. larvae infection. Collaborations involve NC State faculty NCDA (Beneficial Insect Lab)and industry (Bayer Bee Care Center).

Results

Publications, database entries, and scientific knowledge are of immediate impact in these microbiology areas. Downstream economic impacts will include novel enzymes, the development of biotechnology and therapeutic products that combat AF and other bee diseases, as well as products that provide agricultural (i.e., pollinator health) benefits. Interactions with the Bayer Bee Care Center show industry relevance.

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
2016	144

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Research has demonstrated that saving energy at home is easy. Teaching residents how to conserve energy will reduce their home energy needs, leading to environmental benefits. Individuals can do numerous things in their daily routine to conserve energy and reduce their home energy costs.

What has been done
NC A&T Extension in Guilford County partnered with Room At The Inn and High Point Housing Authority to conduct a series of three programs focusing on Great Ways To Save Energy and Money. Twenty-four residents attended the sessions, and 100% completed pre- and post-evaluations during the program.

Results

According to evaluation results, twenty-one participants reported gaining new knowledge and using at least one energy saving technique that was taught in class. Evaluations also indicated an improvement in how residents plan to reduce their daily home energy needs, including by turning off lights when not in use. After completing this program, residents have also have gone on to purchase energy saving bulbs and replace old or broken appliances with ENERGY STAR products.

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Transpired solar collectors (TSCs) can greatly reduce propane use in livestock brooding by heating the ventilation air with solar energy. However, due to high price of the metal TSCs and the low cost of propane, metal TSCs are only cost-effective with government and tax incentives. Limited lab-based research at the National Renewable Energy Labs has shown that TSCs made of perforated plastic sheets can be effective in heating air.

What has been done
Researchers at NC State evaluated a plastic TSC made by perforating a PVC pond liner for heating brooding room for turkey poults. The plastic TSC increased air temperature by as much as 25.3 C, comparable to metal TSCs, which are much-more expensive and heavier. Even more encouraging than the perforated pond liner was a double layer of black landscape fabric that resulted in a greater temperature rise compared to lab-built metal TSC and plastic TSC in a side-by-side test.

Results
The landscape fabric used as a TSC has the potential to considerably reduce drying and heating costs in agriculture.

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Biofuels are a promising source of renewable energy that will reduce our dependence on foreign oil and reduce greenhouse gases that contribute to global warming. Oils extracted from oilseed plants have been converted to car and jet fuel. For these plants to be commercially viable as oilseed feedstocks, oil yield efficiency must at least double.

What has been done
At NC State?s Department of Plant and Microbial Biology, a researcher 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. These enzymes were originally found in anaerobic bacteria and are not optimized to function in plants. NC State researchers are identifying structures of these enzymes to improve their activity in plants.

Results
The condensed reverse TCA cycle could be introduced to any oilseed feedstock plant to increase yield, an important step towards increasing the economic competitiveness of biofuel production.

Many different feedstock plants are currently being considered. At NC State, the focus is currently on modifying Camelina sativa, which grows in many different climates throughout the US. Increased CO2 absorption by these crops may also reduce atmospheric CO2.

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
702	Requirements and Function of Nutrients and Other Food Components	20%	0%	50%	0%
703	Nutrition Education and Behavior	30%	50%	30%	50%
724	Healthy Lifestyle	50%	50%	20%	50%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	43.0	15.0	8.0	3.0
Actual Paid	55.0	11.5	8.0	5.9
Actual Volunteer	9.0	1.0	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**
628587	75921	177840	544672
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
628587	0	177840	216349
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
547681	418881	603077	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. As a founding member of the movement, our programs are part of a larger effort to educate and change environments so that all North Carolinians have the opportunity to eat smart and move more. 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 State University's SNAP-Ed Program **Try Healthy** works with all ages across the entire life span. A&T's **Speedway to Healthy** exhibit and curriculum teaches children in how the foods they eat affect their bodies and their health. 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. **Color Me Healthy** is a program developed to reach limited resource children ages four and five. Color MeHealthy 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, and the elderly have disproportionate risk of malnutrition and poverty, as well as poor overall health, and 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 addressed to young adults and middle-aged consumers will continue to impact the health of the population as it ages, but including children as well. Women are employed outside the home in greater numbers, and many of them are among the working poor. Over 80% of women who had school-aged children were working outside the home; 67% of women with the youngest child under six years were in the labor force. For working parents with very limited resources, lack of after-school and summer programs for youth is a major concern, as it relates to nutrition, health, and obesity as well as other developmental needs of children.

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

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	303958	455604	41594	62345

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

Patent Applications Submitted

Year:	2016
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	0	4	4

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Non-degree credit group activities conducted Healthy Eating, Physical Activity and Chronic Disease Reduction

Year	Actual
2016	2366

Output #2

Output Measure

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

Year	Actual
2016	114995

Output #3

Output Measure

- Relevant and impact focused research projects conducted

Year	Actual
2016	2

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 Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	8122

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In 2015, 87 percent of North Carolina adults did not consume five or more fruits, vegetables, or beans daily, the amount recommended by the CDC. Eating the recommended amount of fruits, vegetables, and beans is critical to maintain a healthy diet and reduce the risk of many chronic diseases, including heart disease, high blood pressure, and diabetes. Reduce 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) helps food-insecure families learn how to provide nutritious, safe meals for their families on limited budgets. Eat Smart, Move More, Take Control provides strategies to help adults manage their health. The Better Choices program for adults address many of the top risk factors for malnutrition, such as dietary quality, food security, and shopping behavior or food resource management.

Results
8,122 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 698 families and 2,379 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, 53% of adult graduated participants increased vegetable consumption, and 55% increased fruit consumption. Through the ?Table for Two? Curriculum, 59% of young mothers increased fruit

consumption, and 70% increased vegetable consumption.

4. Associated Knowledge Areas

KA Code	Knowledge Area
702	Requirements and Function of Nutrients and Other Food Components
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 Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	21680

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 percent 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, reduction of sugary beverages, and increased physical exercise for youth in North Carolina. These include programs such as Color Me Healthy for preschoolers and kindergarteners, Steps to Health, Catch Kids Clubs, 4-H Health Rocks, and Go Glow Grow.

Results

In 2016, Steps to Health in partnership with Family & Consumer Science, 4--H Youth Development Agents, and Steps to Health Nutrition Educators reached 8,691 participants (7,670 children and 1,021 adults) and made 61,825 educational contacts within 60 counties across North Carolina through direct education programs. As a result, 93% of preschool children are more willing to try fruits and vegetables, 74% of elementary school children are eating more fruits and vegetables, and 55% of children and youth are more active. In addition, 6,821 youth were reached through the Speedway to Healthy exhibit to encourage better nutrition.

4. Associated Knowledge Areas

KA Code	Knowledge Area
702	Requirements and Function of Nutrients and Other Food Components
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
2016	23289

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 percent of North Carolina adults and 25.9 percent of North Carolina adolescents meet physical activity guidelines. Participation in physical activity is important to maintain a healthy weight and reduce 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 and Eat Smart Live Strong programs motivate participates to change their physical activity patters. Other programs, such as Fit in Fitness, line dancing, clogging, ski walking, and Zumba, provide ways for people to add physical activity into their lives and have fun.

Results

EFNEP nutrition program assistants enrolled 698 families and 2,379 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, 60% of adult graduated participants increased physical activity, and 58% of youth improved their physical activity practices. In addition, 6,821 youth were reached through the Speedway to Healthy exhibit to encourage higher levels of physical activity. Over 5,000 people participated in Eating Smart Moving More and similar programs. Extension provided over 225 opportunities for over 5,000 people to participate in organized physical activities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
702	Requirements and Function of Nutrients and Other Food Components
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
2016	2291

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
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. 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
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.

Results
As of December, 2016, 316 ?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 7,034. Results from 288 courses show that participants improved their body-mass index scores, with 12.4% in the healthy BMI range of less than 25 at the start of the program and 17% in that range at the program?s end.

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

Program participants (adults) decrease blood pressure

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	421

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
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.

Results
As of December, 2016, 316 ?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 7,034. Results from 288 courses show that participants improved their blood pressure, with 28.5% in the healthy blood pressure range at the start of the program and 41.6% in that range at the program?s end.

4. Associated Knowledge Areas

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

Outcome #6

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	267

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
Scotland County Extension offered a line dancing class to an average of 45 participants weekly. Gaston County Extension partnered with the Centralina Area Agency on Aging to offer three sessions of Stanford University?s Diabetes Self-Management Program to Gaston County residents during January to June, 2016. Twenty-six adults completed at least four sessions of this six-week, evidence-based program (15 hours).

Results
In Scotland County, 50% of participants reported a decrease in A1C levels. In Gaston County, all participants reported learning new skills to help manage diabetes, such as monitoring blood sugars, communicating with healthcare providers, and managing low/high blood sugar. All participants plan to use one or more of these skills within the next month. Nineteen (73%) participants reported improved blood glucose control as a result of skills learned. An estimated cost savings of $8,788 to $11,700 was provided by this program as a result of decreased utilization of healthcare services. This program will continue to be offered in Gaston County during 2016.

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 Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	369

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
People with high cholesterol have about twice the risk of heart disease as people with lower levels. In North Carolina, 41 percent 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 percent of adults have never had their cholesterol checked. Of those who have had their cholesterol checked, nearly 80 percent had it checked within the past 12 months.

What has been done
Cooperative Extension and the Craven County Health Department collaborated to offer "Give Your Heart a Healthy Beat" at Carolina East Heart Center. Six at-risk county employees attended 10 weekly sessions during 2016. In an effort to improve poor health outcomes in Scotland County, Cooperative Extension offers a weekly line dancing class. The class averages 45 people per week and is representative of the county demographics.

Results
As a result of the Craven County program, participants lowered their triglycerides levels by a group total of 160 points, cholesterol levels by 66 points, and weight by 25.4 pounds. Other reported benefits included reduced joint pain and arthritis severity, lower stress levels, more interest in health, and increased overall sense of wellbeing. Out of the 43 participants in the Scotland County line-dancing class, 21 reported that their cholesterol levels improved.

4. Associated Knowledge Areas

KA Code	Knowledge Area
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
724	Healthy Lifestyle

Outcome #8

1. Outcome Measures

Program participants consume less sodium in their diet

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	4674

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
Through collaborative efforts of Ashe County Center?s 4-H Expanded Food and Nutrition Education Program (EFNEP) and Ashe County Schools, 73 6th-grade students focused on improving their ability to select healthier meals and snacks by reading food labels and setting small goals each week. In addition, Cabarrus County was one of 29 counties offering the eight-week series "Better Choices" for older adults as part of Steps to Health; 103 senior adults completed the eight-week program, and there were a total of 838 educational contacts.

Results
Of the impacted 6th-grade students in Ashe County, 100% reported making at least four behavior changes over a six-week period, including monitoring and limiting sodium intake. In addition, over 40% of Cabarrus senior participants reported improve dietary choices, and 44.4% reported reading the nutrition labels more often to reduce consumption of sodium and added sugars.

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

- 1862 Extension
- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Most food insecure families avoid the state of 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.

What has been done
To address the needs of food insecure families in the Northeast District of North Carolina, EFNEP provided multiple training opportunities and model teaching techniques to 10 EFNEP paraprofessionals, who in turn taught nutrition and physical activity subject matter to their EFNEP target audiences in 12 northeast district counties. Those who worked with families taught 757 adult homemakers lessons that addressed food resource management, nutrition practices, food safety, and the importance of being physically active.

Results
As a result of these efforts, 87% of graduating participants showed improvements in one or more food resource management practices, and 91% showed improvements in two or more nutrition practices. In addition, 91% of children and youth improved their ability to choose foods or gained knowledge about Federal Dietary Recommendations. As a result of efforts by NC A&T EFNEP across seven counties (184 adults), 88% now practice better food resource management.

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

Eat Smart, Move More, Weigh Less is a weight-management program that uses research-based strategies for weight-loss/weight maintenance. This 15-week program informs, empowers and motivates participants to live mindfully as they make choices about eating and physical activity. The program provides opportunities for participants to track their progress and keep a journal of healthy eating and physical activity behaviors. Ongoing evaluations of this program are in place.

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: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	67.0	5.0	53.0	6.0
Actual Paid	84.0	2.5	52.0	2.6
Actual Volunteer	1.0	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**
969072	95502	1111497	222780
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
969072	20899	1111497	38494
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
844341	55228	3769231	13706

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

developed Good Farmers Market 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. NC State Extension has an I-Three Issue Corps Project with eXtension - Food Safety Answers.

V(E). Planned Program (Outputs)

1. Standard output measures

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	44468	213994	2189	10535

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

Patent Applications Submitted

Year:	2016
Actual:	4

Patents listed

PCT/US2015/039038: Modular devices and systems for continuous flow thermal processing using microwaves (USA and 1 foreign country)
14/832,650: Methods and apparatuses for thermal treatment of foods and other biomaterials and products obtained thereby
PCT/US2016/032403: Methods for the production of fermented beverages and other fermentation products

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	1	38	39

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Highly focused non-degree credit group training activities to be conducted

Year	Actual
2016	495

Output #2

Output Measure

- Relevant and impacts focused research projects to be conducted

Year	Actual
2016	35

Output #3

Output Measure

- Number of firms adopting quality and safety strategies
  Not reporting on this Output for this Annual Report

Output #4

Output Measure

- Program participants trained in home food preservation

Year	Actual
2016	1734

Output #5

Output Measure

- Program participants trained in good farmer's market practices

Year	Actual
2016	197

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
2016	735

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The Centers for Disease Control and Prevention (CDC) 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 Extension agents provide ServSafe and NC Safe Plates 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, 1,290 food service employees received ServSafe or NC Safe Plates. It is estimated that each foodborne illness occurrence can have an average cost of up to $75,000. If each of the 1,290 food service employees who received ServSafe or Safe Plates training avoids just one foodborne illness outbreak, the potential cost savings could be up to $96.75 million statewide.

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
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
2016	1067

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Each day, millions of children consume school meals in North Carolina. Young children are at a high risk of contracting a foodborne illness, sometimes with serious consequences. To ensure the highest level of food safety, the United States Department of Agriculture mandates that all schools receiving federal funding implement a Hazardous Analysis Critical Control Point (HACCP) plan. HACCP is a system that identifies, evaluates, and controls hazards affecting food safety.

What has been done
NC Cooperative Extension partnered with the child nutrition programs in over 15 counties to provide HACCP training. During the training, participants learned the proper procedures for time/temperature control, personal hygiene including handwashing and gloves, reporting foodborne illness, purchasing and receiving food products, food storage, chemical storage, first in first out, cross contamination, thermometer calibration and use, proper preparation techniques including thawing, cooling, and freezing, cleaning and sanitizing, and pest management.

Results
During a HACCP program presented by an NC State Extension Agent in Davidson county, all 256 participants are now HACCP certified for this school year. In post-training evaluations, participants reported that they feel more confident in their food safety knowledge and in their

abilities to practice the food safety skills learned in the course. Statewide, approximately 1,500 school employees have attended NC State and NC A&T Extension provided HACCP training.

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
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

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Number of new companies in food manufacturing

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Shure Foods, LLC is a startup company in North Carolina currently seeking to revamp the declining crab processing industry by mechanizing the meat extraction process and developing markets for raw crabmeat. This company has developed and patented a technology to restructure

raw crabmeat paste through the addition of transglutaminase and non-meat substrate additives; however, this technology performs inconsistently.

What has been done

Phase I research at NC State identified the problem: Freshly harvested and deshelled crabmeat paste does not gel well under use of Shure Foods? patented technology. The meat proteins must be denatured and aggregated to the point that they are somewhat particulate and able to interact successfully with the cold gelling matrix that is added. Researchers also identified a heat gelling ability of this frozen, raw paste that could be utilized to make ?all crab? versions of the popular fish (surimi)-based crab analogs now on the market.

Results

As a result of this research collaboration with Shure Foods, a major manufacturer of fish (surimi)-based crab analog products, is now developing all-crab versions based on mechanically extracted raw crab from U.S. sources. These products compete favorably in price with cooked, hand-extracted crab (mostly now of foreign origin) and will be test-marketed in early 2017.

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
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 #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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Environmental monitoring of food processing facilities for human pathogens has experienced a significant increase in regulatory oversight in recent years. This increased focus was due partly to several high-profile cases involving Listeria contamination in ice cream processing facilities. The heightened regulatory response called for an increase in the knowledge base of smaller ice cream processors in North Carolina that do not possess the resources of the larger regional or national entities.

What has been done
The NC State Dairy Enterprise System provided a seminar for 52 mainstream and farmstead dairy industry representatives on Listeria monitoring and control. In addition, the NC State Feldmeier Dairy Processing Lab volunteered to be the first ice cream processing operation in North Carolina to undergo the newly implemented, rigorous environmental Listeria audit developed by the NC Department of Agriculture & Consumer Services (NCDA&CS). The actions required to pass the NCDA&CS audit were used to develop a statewide educational workshop.

Results
The workshop was attended by all but one ice cream manufacturer within the state. Industry members are now better prepared for Listeria monitoring and control. There have been no reported issues of non-compliance to date.

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

2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Vitamin A deficiency is a major global micronutrient deficiency associated with xerophthalmia, blindness, and weakened immune systems that can lead to premature death. β-Carotene is a bioactive precursor retinoid that can form Vitamin A. Sweet potato bread could be a stable form of the micronutrient β-carotene, which can provide the vitamin A precursor in a more diversified diet.

What has been done
A researcher from NC State?s Food, Bioprocessing and Nutrition Sciences Department measured the β-carotene concentration of commercial sweet potato puree, sweet potato flour produced from fresh Covington sweet potatoes, and three sweet potato bread formulations by hexane extraction and absorption.

Results
One of the sweet potato bread formulations (sweet potato bread made with puree) showed a 96% recovery of the β-carotene supplied in the puree. Sweet potato bread from both sweet potato flour and puree yields high levels of β-carotene that may help prevent Vitamin A deficiency in developing countries or in the US. The study also suggests an alternate marketing opportunity for the sweet potato industry.

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
2016	573

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

According to nationwide foodborne illness data and the US census statistics for North Carolina, there are approximately 291,000 foodborne illness incidents, 1,732 hospitalizations, and 42 deaths in the state annually. The Economic Research Service of the USDA estimates the cost of these illnesses at $430 million to $4.7 billion annually for NC, based on the current population. Much of the responsibility of producing safe food rests on processors and on the inspectors that ensure processors follow regulatory guidelines.

What has been done

NC State Extension specialists, NC State Extension agents, the Carolina Farm Stewardship Association, and the Center for Environmental Farming Systems, presented two-part workshops across North Carolina to help farmers reduce farm hazards, prepare a food safety program and meeting market requirements for GAP certification. In addition, 573 persons were certified in Good Agricultural Practices and Good Handling Practices and 1,734 individuals were trained in safe home food handling, preservation, and preparation.

Results

Program facilitators observed participant interaction and comments during the two-day workshop. Participants said that they would implement a food safety plan on their farm and would seek GAP certification. Participants improved their knowledge of good agricultural practices as they relate to food safety on and off the farm. This training should significantly reduce the overall burden of foodborne illness on the state and result in reduced expenditure on foodborne illness-related damage control. An estimated $2,108,117 were saved in 2016 as a result of non-lost work days, and an estimated $5,348,980 were saved as a result of reduced risk associated with farm and food hazards.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	96.0	20.0	8.0	5.0
Actual Paid	117.0	37.5	8.0	6.6
Actual Volunteer	207.0	2.5	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**
1348844	721479	177840	637878
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1348844	499006	177840	509579
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
1175232	760668	603077	253729

V(D). Planned Program (Activity)

1. Brief description of the Activity

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.

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. Each team builds youth development professional practices and expands the impact of evaluations as they: 1) scan the environment and identify emerging focus areas representing educational needs; 2) design and deliver programs responsive to those needs; and 3) design and implement outcome and impact evaluation tools to report successes into the Extension Reporting System. Along with the development of the these programs and its curricula, an additional focus is to develop strategies to increase access to 4-H programs in local communities, with the intent to build strong networks of individuals who can address the unique needs of the targeted audience.

2. Brief description of the target audience

The target audience for the activities of this program includes individuals/family consumers, working poor, low to moderate income, minorities, women, homeowners, families with young children, limited resource parents, caregivers, court-mandated or DSS referred parents, and grandparents raising grandchildren in North Carolina. Other audiences include youth, 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

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	897815	1407728	145789	228590

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

Patent Applications Submitted

Year: 2016

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	6	9	15

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Educational workshops related to energy efficiency and conservation.

Year	Actual
2016	15

Output #2

Output Measure

- Educational workshops for family financial management skills.

Year	Actual
2016	115

Output #3

Output Measure

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

Year	Actual
2016	4142

Output #4

Output Measure

- Educational workshops for consumers related to parenting and caregiving skills.

Year	Actual
2016	116

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
2016	2341

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
2016	487

Output #7

Output Measure

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

Year	Actual
2016	31861

Output #8

Output Measure

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

Year	Actual
2016	125201

Output #9

Output Measure

- Relevant and impact focused research projects conducted

Year	Actual
2016	5

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 Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	435

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Although North Carolina's economy is in a slight upswing, many residents continue to feel the pinch in their wallets as daily expenses such as food, heating, and electric bills continue to rise. It has become more important for families to save money. In order to get ahead and meet essential needs during this forever changing economy, individuals must learn to budget.

What has been done
Various extension programs empowered residents to improve their finances through basic management practices, including NC State?s Better Food Better Health (BFBH) program, the Expanded Food and Nutrition Education Program (EFNEP), and NC State?s 4-H Awards and Incentives program.

Results
After going through the BFBH program, nearly 50% of participants planned to incorporate healthy eating into their budgets by purchasing during sales, and over 80% planned to save money by preparing healthy snacks at home. Through EFNEP, 292 limited income individuals have developed a written household budget for the first time. Statewide, Cooperative Extension programs have helped 1,542 people gain basic financial management knowledge and/or skills such as budgeting, record keeping, goal setting, writing goals, and consumer decision-making. Furthermore, 435 of these participants implemented these financial management strategies. Through 4-H Awards and Incentives, over 10,000 youth learned life skills in various areas, including financial management and career development.

4. Associated Knowledge Areas

KA Code	Knowledge Area

802 Human Development and Family Well-Being

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 Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	100

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Low-income and minority families lack financial literacy skills that lead to self-sufficiency and financial security.

What has been done
Financial management programs were offered to increase knowledge in money management and skill development in budgeting. Program participants used the H-Plan and money trackers to budget income. Handouts were created for distribution to participants. One television spotlight on Identity Theft was done in Forsyth County reaching 33,000 households.

Results
In Forsyth County, 687 family members increased their knowledge in money management and developed skills in budgeting for expenses. At least 60 percent of the individuals learned the steps in making a budget, making wise choices in spending money as well as the need for having a savings for unexpected expenses or emergencies. 60% of participants are tracking their income and expenses, 55% adhere to a monthly budget, 35% are paying their bills on time and avoiding late fees, 30% of participants opened savings accounts at banks or credit union instead of keeping money at home, 20% of participants improved their credit scores.

4. Associated Knowledge Areas

KA Code	Knowledge Area
802	Human Development and Family Well-Being
804	Human Environmental Issues Concerning Apparel, Textiles, and Residential and

Commercial Structures

Outcome #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 Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1659

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Economically self-sufficient families are able to secure the basic goods and services to support their household including: housing, child care, transportation, food, and health care. Not all households are able to meet basic needs though earnings alone and must secure resources from government benefits and non-monetary resources. Not all families are aware of the resources available to them.

What has been done
NC State Extension agents in Green County coordinated an joint effort with SHIIP program volunteers, the Department of Social Services, local pharmacies, the Greene County Health Department, the N.C. Department of Insurance, Greene County Social Services, the Greene County Senior Center, the local newspaper, and the N.C. Department of Insurance to provide outreach in the communities of Greene County about the Low Income Subsidy prescription drug program.

Results
To date, over 78 low-income individuals have been counseled into a more affordable prescription drug plan. As a result, these Medicare beneficiaries have saved a total of over $27,500. Participants indicate that they now understand the need to review their plans each year and make any necessary adjustments to save money. Statewide 3,604 people have gained knowledge and/or skills to increase family economic security such as; how to access: SNAP benefits, SHIIP Medicare Part D; food cost management, cost comparison skills, shop for reverse mortgages, select long term care insurance, etc. Statewide, 1,659 individuals accessed programs and implemented strategies to support family economic wellbeing.

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

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	144

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Research has proven that saving energy at home is easy. Teaching residents how to conserve energy will reduce their home energy needs, leading to environmental benefits. Individuals can do numerous things in their daily routine to conserve energy and reduce their home energy costs.

What has been done
NC A&T Extension agents in Guilford County partnered with Room At The Inn and High Point Housing Authority to conduct a series of three programs focusing on Great Ways To Save Energy and Money. Twenty-four residents attended the sessions, and 100% completed pre- and post-evaluations during the program.

Results
According to evaluation results, twenty-one participants reported gaining new knowledge and using at least one energy saving technique that was taught in class. Evaluations also indicated an improvement in how residents plan to reduce their daily home energy needs, including by turning off lights when not in use. After completing this program, residents have also have gone on to purchase energy-saving bulbs and replace old or broken appliances with ENERGY STAR products.

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	785

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Montgomery County youth have few opportunities to develop leadership skills due to the lack of programs offered. In order to meet this need, a countywide Youth Leadership program is offered by NC State Extension and its partners. A similar program is offered by NC State Extension in Wayne County.

What has been done
This year, Youth Leadership Montgomery participants met with local legislators in Raleigh to share their opinions on local and state issues and learn more about the legislative process. Participants also spent Martin Luther King Jr. Day completing a food packaging community service project, in which 3,000 packaged meals were prepared to feed Montgomery County families. The Wayne County Junior Leadership Program trained youth in communication skills, empathy, teamwork, and the importance of agriculture.

Results
The primary goal of Youth Leadership Montgomery is to build character and community awareness in graduates. Twenty-five students enrolled in and graduated from the 2015?2016 Youth Leadership Montgomery class, and their survey responses indicate that all graduates of this program gained confidence in public speaking and civic action. In Wayne County, 25 youth were trained to better serve as leaders in their community. Statewide, 10,385 youth increased their knowledge, skills, and/or attitudes regarding leadership, and 4,142 youth took on new or

expanded leadership roles in the community.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #6

1. Outcome Measures

Program participants adopting positive parenting practices.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	1292

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In Cleveland County, nearly 25,000 grandparents are living with grandchildren under the age of 18. Kinship caretakers take on 24-hours-a-day, seven-days-a-week care for these children. Participating caretakers range in age from 34 to 72, with approximately 60% aged 55 and above. Kinship caretakers are often raising 1?5 children, ranging in age from 1 to 14. The Broad River Grandparents Raising Grandchildren (BRGRG) Kinship Care Support Group was formed to address the rising need for kinship care.

What has been done
Approximately 20 individual volunteers and agencies collaborate to provide ongoing information and support. BRGRG meets 10 months throughout the year to hold support groups for adult caretakers, as well as younger and older children. These efforts are made possible by the support of NC State Extension, a dedicated advisory board, the Extension and Community Association, the Department of Social Services, and local sorority volunteers.

Results
Approximately 360 educational contacts were made with caretakers, children, volunteers, and advisory board members in 2016. BRGRG caretakers rated the support group as very helpful to them as a source of educational information, new resources, community programs, and

professional guidance. Participants also indicated that the support group provided a valuable opportunity to socialize and learn from the experiences of others. Participants? children also benefited from working with other caring adults and making friends with other kinship care children. Caregivers reported more confidence in their caregiving roles. Statewide, 1,292 parents and other caregivers adopted positive parenting practices as a result of Extension programs.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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
2016	14290

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
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. All North Carolina 4-H camps are accredited by the American Camp Association.

Results
In 2016, 16,997 youths attended 4-H camping programs (12,905 in day 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 #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
2016	0

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. To increase the opportunity to learn about agriculture and livestock animals, NC State and NC A&T Extension agents help solve this issue by providing youth the opportunity to participate in Area 4-H Livestock Shows and Sales.

Results
In 2016, 22,537 youth were involved in 4-H clubs. 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
2016	0

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 2016, 177,157 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. School enrichment programs were jointly delivered by 4-H agents from NCA&T and NC State.

Results
Statewide in 2016, 30,849 youth increased their knowledge in science, technology, engineering and math (STEM); 19,597 youth gained competence in family and consumer science; 46,223 youth gained personal development and leadership skills; 20,327 youth increased their knowledge of expressive arts and communication; and 59,937 youth gained hands-on experience in community service and civic engagement. In addition, NC A&T?s 4-H STEM program offered the Junk Drawer Robotics and Lego Mindstorms EV3 Robotics enrichment curricula to provide over 450 students with hands-on experiences in building and programming robots to solve simple, everyday problems.

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 Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
With yet another school year coming to an end, many school-aged children are faced with extra time that is no longer supervised through the typical school hours. Many of these children, especially high risk youth, do not have the means nor opportunity to make the most of their time and have a productive summer. Instead, some engage in activities that could promote delinquent behavior.

What has been done
In Anson County, NC State Extension?s 4-H Youth Promise program provided a summer camp that not only allowed youth to learn, but also enjoy their summer, as they had the opportunity to try new exciting experiences. Youth made piggy banks and treasure chests as they learned about the importance of budgeting money. Youth also got the opportunity to go to bowling, swimming, play laser tag and even zip lining. It is the 4-H Youth Promise goal to reduce recidivism and the juvenile?s chances of re-offending or committing other delinquent behavior.

Results
As many of the program's youth are court ordered when entering Anson County 4-H Youth Promise, it was important to significantly reduce recidivism and any new adjudication. Each of the participants successfully avoided delinquent behavior throughout their summer vacations.

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 Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	2628

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 spread out 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 to 17. All North Carolina 4-H camps are accredited by the American Camp Association.

Results
In 2016, 16,997 youth attended 4-H camping programs (4,092 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
803	Sociological and Technological Change Affecting Individuals, Families, and Communities
805	Community Institutions, Health, and Social Services

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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The USDA identified food deserts and their impact on communities as a priority, and areas of Greensboro have been nationally recognized as food deserts lacking adequate fresh food options. Researchers at NC A&T are working with communities in Greensboro, NC to address the impact of food deserts on residents? ability to develop and maintain healthy eating habits. NC A&T is also partnering with community organizations to spread knowledge about the benefits of healthy eating.

What has been done
Researchers have engaged residents of 12 minority communities of District 2 in east Greensboro in an action based research project to modify the food desert environment to produce desirable health outcomes for residents. A high tunnel garden was installed on city-owned land in one of the food desert areas. In addition, NC A&T?s ?Try Healthy? programming put on a health fair in partnership with the Hayes Taylor YMCA, attracting 25 vendors to provide health screenings and nutrition/cooking classes.

Results
The high tunnel garden has produced a small crop of cucumbers, and the entire tunnel was established with leafy cool season vegetables, including spinach, Chinese cabbage, brown leaf lettuce, and butter leaf lettuce. The project developed a marketing plan and established a marketing/distribution channel through the community grocery store and a supermarket chain to provide convenient access to the crop throughout the community. Over 200 participants attended the ?Try Healthy? health fair, and 50% of ?Try Healthy? participants have reported increased knowledge of healthy eating. Statewide, 8,122 adults have increased their consumption of fruit and vegetables through extension programs.

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.

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
According to the Guilford County Department of Public Health, poor birth outcomes are a significant problem for Guilford County, with rates of infant mortality and low birth weight considerably higher than national benchmarks. Low birth weight and preterm births, as well as teen pregnancies, occur at higher rates in areas of the county characterized by higher rates of poverty and unemployment and low educational attainment.

What has been done
The Expanded Food and Nutrition Education Program (EFNEP) uses the Table for Two curriculum to educate young moms and pregnant teens on the importance of making healthy lifestyle choices during and after pregnancy. The Guilford County EFNEP Program Assistant partnered with Nurse Family Partnership (NFP) to educate young, first-time moms with limited resources. The partnership is going on its second year.

Results
The Guildford County Program Assistant provided a series of 6?9 lessons to young moms. Lessons included ?Feeding Your Baby,? ?Healthy Baby Begins with You,? ?Food Selection,? and ?Food Safety.? All young moms enrolled in Table for Two gave birth to healthy weight babies, and all moms also initiated breastfeeding after giving birth.

4. Associated Knowledge Areas

KA Code	Knowledge Area
802	Human Development and Family Well-Being
805	Community Institutions, Health, and Social Services

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.

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Freezer and storage space has become a pressing need for small farmers in Watauga County due to increased production requirements to meet demand in the region's burgeoning local food movement. NC State Extension works with other local non-profit farming support organizations to enhance the productivity and profitability of local small farms.

What has been done
Watauga Cooperative Extension worked with Blue Ridge Women in Agriculture to identify space in the county Agricultural Services Center for freezer, cooler, and dry goods storage. Watauga County Commissioners approved the use of space in the Watauga County Ag Services Center,

County Maintenance helped clear out the space and contributed a drop ceiling, Blue Ridge Women in Agriculture purchased a freezer and a cooler, and the Town of Boone contributed $16,000 for an additional freezer.

Results

The Food Hub formally opened in June 2016, and the initial freezer was filled to capacity within a month. The freezer purchased with funds from the Town of Boone was installed in November 2016, and space in it is also filling up. Additionally, High Country CSA successfully operated their summer CSA of 50 shares out of the Food Hub space, and an online ordering system is being developed to facilitate distribution of products stored at the Food Hub. These efforts will help increase the economic reach and profitability of agricultural entrepreneurs in Watauga County.

4. Associated Knowledge Areas

KA Code	Knowledge Area
607	Consumer Economics
801	Individual and Family Resource Management

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

North Carolina does not report youth activities under subject matter categories for camps, special interests, school enrichment and 4-H clubs. Instead all are aggregated to result in one number of total participants for these categories. 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 largely Extension Reporting System data indicate that significant numbers of youth as well as adults engage with educational activities in this program area. One challenge in reporting on this planned program is that a number of the outcome indicators are conflicted with one another. For example the same group of youth participants that are aggregated as indicated above may be associated with different outcomes such as

volunteerism, building citizen leaders and gaining life skills. Many of the participants benefit from multiple programs, so similar or identical numbers of participants may be reported for different outcomes. Nevertheless, it is clear that nearly 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	5%	0%	15%	15%
206	Basic Plant Biology	5%	0%	15%	5%
502	New and Improved Food Products	10%	0%	15%	25%
701	Nutrient Composition of Food	10%	0%	10%	25%
702	Requirements and Function of Nutrients and Other Food Components	10%	0%	10%	25%
703	Nutrition Education and Behavior	15%	0%	0%	0%
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	20%	0%	5%	0%
721	Insects and Other Pests Affecting Humans	5%	0%	10%	5%
722	Zoonotic Diseases and Parasites Affecting Humans	5%	0%	10%	0%
724	Healthy Lifestyle	10%	0%	10%	0%
802	Human Development and Family Well-Being	5%	0%	0%	0%
	Total	100%	0%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2016	Extension		Research	
	1862	1890	1862	1890
Plan	12.0	0.0	47.0	6.0
Actual Paid	17.0	0.0	45.0	5.6
Actual Volunteer	10.0	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**
196434	0	978118	501611
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
196434	0	978118	191425
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
171150	0	3316923	658609

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

- Peer researchers and collaborators, including health care providers
- Food processors and manufacturers
- Farmers and growers
- Consumers
- 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

2016	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	303958	455604	52937	79348

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

Patent Applications Submitted

Year:	2016
Actual:	35

Patents listed

Beta-hexosyl-transferases and uses thereof (patents submitted to 4 foreign countries)
PCT/US2015/047136: Novel CAS9 proteins and guiding features for DNA targeting and genome editing
PCT/US2015/059214: Methods and compositions for attenuating allergenicity in protein products
62/271,114; 62/275,421: Methods and compositions for probiotic delivery of CRISPR based antimicrobials
14/904,715: Protease-resistant peptide ligands (USA and 16 foreign countries)
14/917,830: Novel methods and compositions to evaluate and determine inactivation of hazardous biological material
15/167,727: Methods for screening bacteria, archaea, algae and yeast using CRISPR nucleic acids (USA; PRV; PCT)
15/0971,524: Compositions and methods to reduce inflammatory responses
15/032,985: Compositions and methods related to a type-II CRISPR-CAS system in lactobacillus buchneri
PCT/US2016/038,046: Methods and compositions for genome editing in bacteria using CRISPR-CAS9 systems
62/352,176: Comfortable, non-chemical, mosquito bite-resistant textiles and garments

NOTE: some entries have multiple foreign or other type applications

U.S. Serial No. 62/313,547 6-Shogaol derivatives as novel Nrf2 activators
U.S. Patent Number 9,272,994 Ginger metabolites and uses thereof
U.S. Patent Number 9,187,402 B2 Aspirin derivatives and uses thereof

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2016	Extension	Research	Total
Actual	1	91	92

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Non-degree credit group activities conducted related to human health, nutrition and well-being

Year	Actual
2016	2366

Output #2

Output Measure

- Targeted audiences participate in workshops and demonstrations on human health, nutrition and well-being

Year	Actual
2016	114995

Output #3

Output Measure

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

Year	Actual
2016	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
2016	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Grape pomace (GP) contains up to 60 percent of dietary fiber and about 5 percent polyphenol; thus, it has great potential to serve as a polyphenol and fiber rich food ingredient.

What has been done
Researchers at NC A&T have been evaluating particle sizes of GP used in baking cookies to optimize nutritional and functional value. Reducing the particle size of GP mechanically can improve the accessibility of polyphenol, which may increase the bioavailability of GP polyphenols if GP containing food products are consumed. To increase the accessibility of GP polyphenols and to maintain the product texture, GP should be fine, but a particle size of 200 micrometers is acceptable.

Results
The particle size of GP showed significant impacts on consumers? perception of the appeal of cookie color, aroma, and taste?but not texture?when GP powder was in the range of 104?209 micrometers. GP with average particle size of 209 micrometers had a higher consumer evaluation score ($P<0.05$), indicating that the particle size of GP should not be too small for cookie making. To slow down the digestion of GP contained in food for an overweight and obese population, the particle size of GP should not be smaller than 200 micrometers. At the same particle size, cookies containing 2.5 percent GP were more appealing to consumers than cookies containing 5 percent GP.

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
2016	0

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 ambitious project to generate the first carrot genome sequence has been completed, and the results have provided the foundation to understand the genetic mechanisms regulating carotene accumulation in plants. In addition, over 200 genes directly involved in the biosynthesis of health-related metabolites have been annotated. This carrot genome research also lays the groundwork to design breeding and biotech strategies that will improve the bioactive properties of this important crop, with potential application to other crops.

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 Research
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2016	8

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Diarrheal diseases can quickly become a public health concern in temporary living conditions. Enteric pathogens are still readily transmitted through filth flies, which develop and feed on feces, carrion, and foodstuffs, making them potential mechanical vectors of enteric disease. However, fly control can be difficult because these insects are transient and can carry pathogens from the surrounding animal or human populations. Therefore, areawide management of filth flies and prevention of incoming fly recolonization is important.

What has been done
Plant-derived methyl ketones (PDMKs) are a class of biopesticide with many advantages over current, chemically based insecticides. PDMKs have been registered by the FDA for use in food and by the EPA for use on human skin because they are safe for humans and other mammals. In an ongoing project, NC State researchers have demonstrated that blow flies, house flies, and flesh flies are susceptible to PDMKs when they are applied topically or as fumigants. Bioassays were conducted to evaluate commercial attractants and supplements.

Results
Experiments have been expanded to large cage studies and open field tests. Fly populations were characterized, and initial field tests of attractants and PDMK treatments were conducted.

Researchers have demonstrated that test materials kill flies as expected. Additional experiments to scale up the control measures occurred in the spring, summer, and fall of 2016.

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
2016	7

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Abnormal gene regulation is a hallmark of cancer, disrupting genes that promote differentiation and up-regulating genes that promote proliferation. CRISPR/Cas9 technology offers the unique capability to characterize gene enhancers and determine how transcription has been disrupted.

What has been done
NC State researchers are developing tools to apply the CRISPR/Cas9 system to cut out and pull down a gene enhancer, with the regulatory proteins bound. Currently, the best way to analyze the proteins bound to an enhancer requires antibodies to a particular protein (by ChIP-Seq, Co-IP or by pull-down assays). These approaches are limited by antibody availability and inventory a limited number of proteins.

Results
The CRISPR/Cas9 technology would allow targeting of any gene enhancer and provide more complete data about gene regulation than is currently available. In particular, it could potentially allow comparison of gene regulation in diseased versus normal cells to develop new drug targets.

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 our Extension Reporting System, 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)	
21680	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)	
0	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)	
4	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)	
9	Number of farmers who adopted a dedicated bioenergy crop
Sustainable Energy (Outcome 3, Indicator 4)	
362090	Tons of feedstocks delivered.