

2015 North Carolina A&T State University and North Carolina State University Combined Research and Extension Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

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In North Carolina, a range of research and extension efforts are designed to better the lives of North Carolinians and make the state a better place in which to live. These efforts are the result of work at two institutions: North Carolina State University (NCSU) and North Carolina A&T State University (NCA&T). This report documents 2015 research and extension programs provided by these two universities. Research and extension programs at the two institutions are housed largely in the College of Agriculture and Life Sciences (CALs) at NCSU and in the School of Agriculture and Environmental Sciences (SAES) at NCA&T. The North Carolina Agricultural Research Service (NCARS) is the research arm within CALs at NCSU, while research at NCA&T is conducted through the Agricultural Research Program (ARP) within SAES. At both institutions, the research effort serves interests in agriculture, environmental, and biological or 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 and focused on people, partnerships, and programs. The plan, which outlines strengths, priorities, and opportunities for long-term growth and success, is built upon five core strategic themes:

1. Enhancing the production, quality, accessibility and profitability of food, plant, animal and bioenergy products for North Carolina, the nation, and the world;
2. Ensuring environmental stewardship and sustainability of air, land, soil, and water resources;
3. Creating a food supply that is safe, secure, healthy, affordable, and of high quality;
4. Improving human health and well-being for individuals, families, and communities; and
5. Preparing students and stakeholders for leadership and success in the global workforce.

In late 2015, CALs administration announced a college reorganization that would take effect in 2016: It would merge certain departments and align departments and interdisciplinary programs and centers around four focus areas: 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.

Throughout 2015, the college continued to strengthen relationships with commodity groups statewide and built a significant support base for two major initiatives:

1. The Plant Sciences Initiative is based on an interdisciplinary systems approach. North Carolina's largest agriculture and biosciences assets will be concentrated in a new world-class interdisciplinary Plant Sciences Research Complex on the NCSU campus. In a statewide bond referendum on March 15, 2016, voters approved \$85 million for the complex. Efforts are underway to raise a total of \$180 million to establish North Carolina as the world leader in plant sciences research and innovation. At the complex, leading university, government and industry scientists in plant-related disciplines -- plant and microbial biology, plant pathology, biochemistry and horticultural, soil, and crop sciences -- will work alongside animal and poultry scientists, engineers, mathematicians, physicists and economists to solve complex agricultural challenges. Research will lead to increased crop yields, nutrition diversification, sustainable production methods, extended growing seasons, and expanded production of field grains to support the state's important poultry and animal industries.
2. 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. Increases in food and beverage manufacturing -- entirely possible given North Carolina's highly diverse variety of crops, livestock, soils, and climate -- will be the cornerstone of this initiative. The initiative has four main goals: to capture added value from North Carolina's agricultural commodities through the development of innovative food products and processing technologies; to foster the growth of food manufacturing entrepreneurial endeavors; to proactively target site selection attraction opportunities within the food manufacturing supply chain; and to provide regulatory training and outreach to the food processing/manufacturing sector. CALS Dean Richard Linton was appointed by the governor to serve as chair of the 35-member task force leading the initiative, and the task force is preparing to submit its recommendations by April.

According to economic feasibility studies released in 2015, each of these two initiatives could boost North Carolina's economy substantially. 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 NCSU campus. On-campus facilities include highly specialized laboratories (i.e., molecular imaging, soil analysis, and x-ray crystallography), greenhouses, the Phytotron controlled environment facility, Pesticide Residue Laboratories, the Animal and Poultry Waste Management Center, Feed Mill, Structural Pest Training Center, Genomic Sciences Laboratory, Plant Transformation Laboratory, Bioinformatics Research Center, Food Rheology Lab, Nuclear Magnetic Resonance Facility, 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 16 agricultural research stations strategically located throughout the state, including the Center for Environmental Farming Systems in Goldsboro, NC, which specializes in sustainable agriculture research and extension.

During the reporting period, the Agricultural Program at NCA&T made significant contributions to agricultural research in all of NIFA's eight research priority areas. Much of NCA&T's research activity is sponsored by the U.S. Department of Agriculture. Research is conducted on the university farm, the Center for Environmental Farming Systems, the Center for Post-Harvest Technologies at Kannapolis, N.C., and in on-campus laboratories, where investigations span such disciplines as agricultural economics, animal science, plant science, landscape architecture and design, human nutrition, housing, food science, and animal health.

The Cooperative Extension Program at NCA&T made significant contributions NIFA seven priority areas. Applied research in agroforestry and season extension production was conducted at the university farm and the Center for Environmental Farming Systems. Also, the Speedway to Healthy an interactive human body exhibit for youth in grades K-5 was designed and implemented to combat obesity and poor health. The knowledge and technology developed through research conducted in NCARS and ARP are made available to North Carolina citizens through the North Carolina Cooperative Extension. The College of Agriculture and Life Sciences and the School of Agriculture and Environmental Sciences collaborate to provide educational opportunities that are relevant and responsive to the needs of individuals, communities, counties, and the state. The North Carolina Cooperative Extension is at the heart of this partnership and is the principal agency providing these educational opportunities. The Cooperative Extension's mission is to help people put research-based knowledge and technology to work to foster economic prosperity, environmental stewardship, and improved quality of life. To achieve this mission, Extension specialists and researchers 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 in the state. 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.

Cooperative Extension also maintains a civil rights plan that includes computer monitoring of program participation by gender and race. This effort ensures that underserved and underrepresented audiences are among those included in program development and implementation. A Diversity Task Force monitors programs, suggests policy, and develops and conducts training for the organization. Stakeholder input informs all Extension programs.

In 2015, the NCSU Cooperative 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 sub-programs, and volunteer-driven programs -- such as Extension Master Gardener -- will also continue to be an integral part of Extension. Significant structure and staffing changes were made to optimize service access throughout North Carolina. Tactics included an increased investment in technology, expanded communication and branding efforts, strengthened capacity and collaboration, and enhanced staff retention and expertise. Implementation of the strategic plan is expected to be complete by July, 2016.

This report reflects impacts of the joint educational programming efforts of the NC Cooperative Extension Service of NCSU and the Cooperative Extension Program of NCA&T. This report also updates and highlights accomplishments and impacts of research conducted through NCARS and ARP, emphasizing high-priority areas in agriculture and life sciences for North Carolina now and in the near future. 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 from both NCSU and NCA&T within each program area.

PLANNED PROGRAM #1

GLOBAL FOOD SECURITY - PLANT PRODUCTION SYSTEMS AND HEALTH

New heat-tolerant broccoli varieties extend season for NC growers: Based on the results of NC State's research, five new heat-tolerant broccoli varieties have been bred and released by seed companies and are now commercially available in North Carolina. NC growers are now growing through the summer months using these heat-tolerant varieties, which stand to benefit the broccoli industry of eastern North Carolina and beyond.

Sorghum acreage increased for profit and savings: As a result of NC sorghum hybrid testing programs and crop management research, as well as extension programs and agent training sessions for sorghum grower education, sorghum acreage in the state has increased to 62,000 in 2015 (from 17,000 in 2011). Sorghum yields averaged over 80 bushels per acre in 2015. Data from Murphy Brown, Inc. shows that the NC feed grain program has resulted in 70 million additional bushels of feed grains (sorghum, wheat, and corn) from North Carolina, representing an additional income for the state of over \$300 million. In addition, Murphy Brown, Inc. has saved \$142 million dollars in transportation and feed costs due to NC State's efforts over the past three years.

NCA&T researchers help improve cowpea production: Twenty cowpea varieties were selected for superior performance. Six were selected for detailed studies on possible insect resistance phenomena. Significant findings included: a) confirmation of new varieties for inclusion in the USDA-NRCS National Cover Crop Initiative; b) identification of four cowpea varieties with low damage levels from two of the major pests of cowpea, the cowpea curculio and the new invasive brown marmorated stink bug; and c) identification of new critical forage attributes in two varieties. A grower in Montgomery Co. who worked with the team has established a network of buyers for his cowpeas. He no longer applies pesticides on a schedule and has increased his farm income.

Production of wild harvested ginseng could yield big profits for NC farmers: As an expansion of a 2014 program, the Watauga County Cooperative Extension and NCA&T Cooperative Extension Program worked with PHARMN to obtain \$10,380 in grants to fund a ginseng production workshop and field demonstrations for over 55 potential growers. Thirty pounds of ginseng seed and 10 pounds of rootlets were distributed to participants, and extension agents assisted participants in site selection and

planting techniques. Over the next decade, this project could conservatively yield over \$100,000 in profits for local producers.

Eastern NC grower meetings improve management practices, profits for up-and-coming farmers: In 2015, over 600 growers attended eastern NC grower meetings covering topics such as crop management, pest control, fertility, and water management. Surveys found that the information presented at these grower meetings resulted in changes to management practices on over 440,217 acres in the counties of Beaufort, Hyde, Tyrrell, and Washington alone. Using these improved practices, these same growers estimated that they increased their annual economic returns by a total of \$13,416,179.

High tunnel production systems increase off-season yields: Extension specialist and researcher at NCA&T conducted a study comparing high and non-high tunnel vegetable production under conventional tilled and conservation agriculture production systems. They found that yield of the high tunnel system was considerably higher than that of conventionally produced vegetables. For example, high tunnels provided ideal growing conditions for early spring production and late fall production because of warmer temperatures inside unheated high tunnels. Farmers who have benefited from this research reported an increase in capacity to produce fresh vegetables off-seasonally for the local market.

Nematode genome research may yield more sophisticated nematicides: Scientists at NC State and colleagues at the University of California-Davis have been conducting genetic analysis of the root-knot nematode *Meloidogyne hapla*, which has led to the identification of loci in the nematode genome that elicit complex responses in host plants, including induction of known developmental pathways. Knowledge gained through this research will assist in the development of root-knot nematode control strategies and new nematicides, leading to higher yields, crops that are less susceptible to stress (particularly drought), and reduced grower reliance on environmentally-damaging control methods.

NCA&T researchers investigate novel truffle growing technique: NCA&T researchers conducted a truffle survival evaluation of seedlings out-planted in the root base of loblolly pines and pecan seedlings. Results revealed that all out-planted seedlings (of pine inoculated with *T. borchii* and pecan inoculated with *T. lyonii*) were positive in DNA testing for their presence in the root systems six months post planting. Researchers were able to establish one plot each (about an acre in size) for *T. borchii*/pine and *T. lyonii*/pecan. This is a first in universities in the entire southeastern US and will be useful for further testing and training of farmers and extension agents.

Shiitake mushroom growers expand through improved production, value-added products: Rockingham County Cooperative Extension held post-harvest workshops for shiitake mushroom growers as well as value-added product programs and local marketing programs for growers, restaurants, and grocers. Extension also used a RAFI grant to start a community kitchen and purchase a dehydrator. By using improved production practices (including dehydration and post-processing with forced air cooling systems), growers were able to better store mushrooms after harvest, yielding 800 pounds of fresh shiitake mushrooms (at an estimated value of \$8,000) and 200 pounds of value-added dehydrated mushrooms. The Sold on Shiitake: Growing Shiitake in North Carolina curriculum developed by NCA&T Extension and research was used to train participants.

PLANNED PROGRAM #2

GLOBAL FOOD SECURITY - ANIMALS AND THEIR SYSTEMS, PRODUCTION, AND HEALTH

Calves sold at premium in truckload lots: In Rutherford and Watauga counties, Extension assisted cattle farmers in marketing calves for sale in truckload lots. Over 47 producers sold over 1,200 calves at a premium ranging from \$50 to \$250 a head, resulting in a total profit increase of about \$220,500. Statewide, animal producer improvements—including those related to improved planning, marketing, and financial practices—have resulted in a net income increase of \$9,998,926.

Breeding practices improve profits for cattle farmers: Extension in the counties of Yadkin, Randolph, and Surry assisted cattle producers in adopting state-of-the-art breeding practices, including improved sire selection, estrous synchronization, artificial insemination, and breeding for consumer-preferred traits. This resulted in improved uniformity and higher performance in 285 calves in Yadkin County, increasing the combined net income of producers by about \$11,100. In Randolph and Surry, breeding improvements also led to increased profits (an average \$31,500 increase for Randolph producers and a \$65,000 total increase for Surry producers).

Breeding program strengthens, expands hybrid striped bass industry: Dr. Benjamin J. Reading of NC State's Applied Ecology Department co-coordinates the National Program for Genetic Improvement and Selective Breeding for the Hybrid Striped Bass Industry, which is dedicated to improving the hybrid striped bass aquaculture cultivar. Through this program, 42 different families of domestic striped bass were produced in 2015, along with two families of a novel triple crossed "truebreeding" hybrid striped bass. Striped bass breeding technology was also advanced, and many female fish were spawned without recourse to traditional hormone induction procedures. A draft of the striped bass genome sequence was also completed and is hosted online for public research access. Over 90% of the hybrid striped bass raised in the U.S. this year were produced using improved broodstock from this program.

Small-scale dairy operations evaluated as potential alternative enterprise: Researchers at NCA&T assessed existing local value-added dairy enterprises and their potential to succeed and examined prospective operational challenges. Market feasibility findings showed that the majority of the operations in the study utilized both direct-to-consumer and direct-to-retail sales outlets. Technical feasibility findings revealed standard equipment requirements for an on-farm cheese processing room. Financial feasibility findings revealed that all operators reviewed their capital requirement frequently and refrained from using credit. Organizational feasibility findings showed that all operators had structured their businesses as LLCs.

New targets identified for diagnosing, treating, and preventing GI parasites in ruminants: NCA&T researchers have been conducting experiments on the impact of mushroom and microbial probiotics on gene expression for the control of inflammatory and parasitic diseases in sheep, goats, and cattle. Results in sheep, cows, and goats indicate that oral probiotic supplementation impacts gene expression in peripheral blood in animals. The results suggest that in ruminants, as in other organisms, cross-talk exists between Toll-like receptor and WNT signaling pathways, offering new targets that can be exploited for animal improvement and production measures. This data may aid in further definition of the molecular basis of the cross-regulation between the Wnt and TLR signaling pathways in these animals for the design of potential therapeutic, diagnostic, and gene technologies to aid in selection for resistance to pathogens and disease.

NCA&T researchers investigate health effects of indoor pig rearing: To better understand the influence of production environments on animal health, an NCA&T research team investigated whether there were differences in airway lining morphology between pigs reared indoors and outdoors. The possibility of differences in tissue arrangement and cell types within the lining of the trachea (windpipe) of adult pigs was comparatively examined in pigs raised exclusively indoors and outdoors. Animals raised indoors have airways that are enhanced with goblet (mucus secreting) cells compared to pasture-raised pigs. While the significance of these observations is not yet known, the findings provide insights into the impact of production environment on animal health.

Research of Salmonella under anaerobic conditions could lead to new vaccine: NC State researchers have demonstrated the essential role of anaerobiosis and redox potential as controlled by the global regulator FNR in the survival and virulence of Salmonella. Research into the physiology of Salmonella under anaerobic conditions was used to develop a new vaccine strain of Salmonella that could be used as an oral vaccine against Salmonella spp. in poultry, other farm animals, and humans. In addition, this mutant strain could be engineered to serve as a vaccine vector for delivering epitopes of other disease-causing organisms.

NCA&T researchers investigate factors affecting development of post-weaning diarrhea in piglets: One common strategy used to increasing production is weaning piglets between 2-3 weeks old. However, weaning piglets at these ages can be challenging because the digestive and immune systems are not yet fully mature. Post-weaning diarrhea (PWD) often develops, leading to anorexia, growth inhibition, and death of piglets. Researchers at NCA&T investigated the colonization of segmented filamentous bacteria (SFB) in the small intestine of piglets weaned between 18-21 days old and assessed whether colonization of the gut with SFB influences development of intestinal immunity and of post-weaning diarrhea. Preliminary results reveal that more SFB DNA was detected in fecal samples of 18 day (weaned) animals than in 1 day old (pre weaning) animals, which is consistent with the literature that indicates SFB is more abundant in the guts of animals around the time of weaning.

Fledgling goat meat industry expanded through marketing and producer education: Meat goats can provide a protein source comparable to chicken in terms of calories and protein, but with lower overall levels of total and saturated fat. Educational programs targeting CES agents, commodity associations, and other agricultural professionals have been implemented to help ensure that meat goat producers will select, adopt, and successfully implement best management practices to maximize profits and expand the industry. In addition, since 2005, four "Goat and Sheep Roundup" conferences have been held to showcase the potential of this growing industry in various ways, including gourmet goat meat cook-offs with NC chefs. As a result of NC State's promotion of this alternative enterprise, over 720 farm families have been certified in goat meat quality management. Participants in the Hands On Goats XVI field day stated that they now feel better prepared to succeed in this fledgling industry.

PLANNED PROGRAM #3

CLIMATE CHANGE

Remote collection of soil data may improve nutrient management: NC State researchers obtained field and airborne hyperspectral data and airborne lidar measurements over several seasons for experimental corn plots in three North Carolina coastal plain locations. Plant standing biomass at harvest will be estimated from lidar data and validated by field sampling. Remotely sensed metrics of crop nitrogen status and biomass can assist in more precise delivery and timing of nitrogen inputs and reduce offsite movement of nitrogen to receiving waters. In addition, analytical products can be disseminated to stakeholders, helping to optimize profit while protecting water quality and facilitating the demonstration of adherence to environmental regulations.

Extension-recommended best practices improve animal waste management statewide: NC State's College of Agriculture and Life Sciences has established a multi-state eXtension Community of Practice called the Livestock and Poultry Environmental Learning Center. This site features web pages containing information related to waste treatment technologies, webcasts, and frequently asked questions as well as an option to "Ask An Expert." Through the internet, field days, tours, one-on-one contacts, and presentations, livestock producers, rural residents, and the public have learned of various waste treatment alternatives and how individual unit processes can be linked to achieve site-specific treatment objectives. Statewide, 2,129 animal producers adopted Extension-recommended best practices for animal waste management. By using livestock organic byproducts instead of synthetic fertilizers, growers statewide realized a net income gain of \$21 million.

NCA&T researchers evaluate carbon-sequestering growth practices: Reduced tillage practices, the application of compost, and the growing of summer and winter cover crops are being evaluated by researchers at NCA&T as practices that sequester carbon and increase soil carbon content. Results reveal greater infiltration rates and soil water content in reduced tillage plots compared to tilled plots. The presence of cover crop residue also increases water infiltration and therefore soil water content. Bell pepper and broccoli yields were greater in reduced tillage plots with cover crop residue than in tilled plots without having surface cover crop residue. Yields were also greater in urban production plots with raised beds than in rural farm production tilled plots with no raised beds.

Poultry litter used as valuable fertilizer: Although litter is a waste byproduct for poultry growers, crop farmers can use litter as an excellent fertilizer, thus reducing or replacing their use of commercial fertilizers, usually at a cost savings. One area specialized poultry agent developed 26 waste management plans for new and expanding growers so that they could comply with state laws. They learned proper record keeping, sampling and handling regulations. These farms also generated about 36,000 tons of litter, which was used to maximize crop production and preserve water quality. Statewide, Extension-recommended waste management analysis was used for proper land application on more than 134,000 acres.

NC State engineers advance research in bio-based products: NC State engineers have demonstrated extraction of value-added products from sweet sorghum through ensilage and feedout studies; these products have shown promise as a near-term market for the biomass crop. In addition, fermentation studies with adapted *C. beijerinckii* strain SA1 for butanol production using sugars derived from sweet sorghum and perennial grasses are providing key information for the next phase of advanced biofuels. And compositional changes measured in a variety of bale storage methods, including in-field stacked bales,

show promise for these methods as storage solutions for biomass feedstocks in the Southeast climate.

Smart irrigation technology benefits individuals, growers, regulators: NC State has recently completed ongoing research into smart irrigation technology under local conditions and held targeted, full-day workshops in irrigation water management and fertigation at multiple locations. These applied research and extension efforts have brought smart irrigation technology into residential settings, educated local water conservation officials, and informed growers and irrigation professionals. Nearly 200 licensed irrigation contractors have received re-certification hours directly from NC State in the first 3.5 years of the certification requirement, and trainings provided by NC State through other green industry organizations have reached hundreds more. Meanwhile, agricultural groups and state agencies have received technical input to help them guide recent water legislation and to help award cost-share funds.

Smart agricultural water management system could revitalize controlled drainage: NC State engineers have developed a smart agricultural water management system that could lead to the revitalization of controlled drainage in eastern North Carolina, where large areas of agricultural land are artificially drained. This will potentially increase crop production, reduce production costs, conserve water, and substantially improve surface-water quality. Meanwhile, the DRAINMOD suite of models is being used by many researchers in the United States and abroad to assess the long-term effects of emerging changes in land use and management practices on the hydrology and biogeochemistry of agricultural and forested lands with improved drainage.

PLANNED PROGRAM #4

SUSTAINABLE ENERGY INCLUDING BIOTECHNOLOGY

Camelina sativa may yield promising biofuel: A North Carolina State University research team of plant biologists, microbiologists, agricultural engineers, and chemical/mechanical and aerospace engineers are working to make *Camelina sativa* an economically viable feedstock for jet fuels. To increase the oilseed crop's productivity, scientists are engineering the entire carbon flux to create energy-rich molecules that will mostly consist of modified oils that are better-suited for jet fuels and will reduce the need for hydrogen and energy in the conversion process. The increased productivity of this enhanced "Jet-Camelina" crop and the development of energy- and cost-efficient harvesting, extraction, and conversion technology will provide an energy-dense liquid transportation fuel as a drop-in replacement for petroleum-based fuels.

Giant miscanthus identified as potential biofuel feedstock crop: Farmers in NC are in need of a promising biofuel feedstock crop that can produce biomass using swine waste. Researchers at NCA&T studied the growth and yield of giant miscanthus (GM) grown with the application of swine waste over a period of three years. Swine waste applied at a uniform rate produced GM yields with good utilization of nitrogen and quality biomass. Miscanthus treated with swine manure produced higher ethanol yields and concentrations. Overall, the results show that GM is a promising biofuel feedstock crop for NC farmers.

Enzymes from guts of wood-eating insects may improve biofuel manufacturing: Lignocellulose is the most abundantly available raw material for the production of biofuels, and improved lignocellulose-degrading enzymes could facilitate the conversion of lignocellulosic biomass into biofuels and high-value chemicals at reduced cost. From the guts of wood-eating insects, NC State researchers have isolated microorganisms that are capable of growing on lignin and lignocellulose as sole carbon sources over a range of pH levels. They have also identified genes from some of these microbes that encode lignocellulose-degrading enzymes and are in the process of recombinantly expressing and characterizing these enzymes to evaluate their utility for the degradation of lignocellulose under industrially relevant conditions.

Green microalga may provide alternative, renewable fuel source: A team of NCA&T researchers using DNA sequence analysis identified a new green microalga, *Chlamydomonas debaryana* AT24, and investigated ways to improve the alga's biomass yield. Initial tests showed that manure treatment could effectively remove total solid (TS), total phosphorus (TP), and total nitrogen (TN) contents, and microalgal growth can be enhanced by utilizing the off-gas from the manure digestion unit. Microalgal biomass yield was enhanced by utilizing off-gas from the manure treatment unit. The final biomass yield reached 3 g/L, and the typical biomass yield of this species in swine wastewater is between 0.6-1.5 g/L. Meanwhile, the off-gas brought P, N, and CO₂ into the algal growth media. When simulated flue gas was used to grow algae, a 5 vol% supply increased the biomass yields by three times.

Improved spider silk quality may lead to revolutionary new textiles: NC State and EntoGenetics, with North Carolina Biotechnology Center support, have inserted spider-silk genes into silkworms. After three generations, these silkworm strains are still spinning silks that are two to three times tougher than native silkworm silk and 1.5 times stronger. Scientists are optimistic that the improved silk quality is due to the expression of the spider-silk gene, and with the establishment of breeding lines, large-scale production of spider silk may become a reality. This should open the door for commercial production of spider silk for the textile market, including the production of stronger and lighter bulletproof vests for law enforcement and the military.

NCA&T researchers investigate waste-treatment potential of algae: Research is needed to develop an advanced biological system to efficiently and economically treat agricultural and industrial wastes and recover materials and energy from those wastes. A novel cultivation process was developed by a team of NCA&T researchers to enhance the growth of algae on swine wastes and green biorefinery wastes and to test biochar from biomass gasification. The highest yield of algae grown on swine wastewater was found to be 1.49 g/L, when the temperature, light intensity, and light duration were 19.7°C, 900 $\mu\text{mol m}^{-2}\text{s}^{-1}$, and 10.87 h/day, respectively. The by-product of juice from a green biofinery with fresh cattail as feedstock also proved to be a promising nutritional source to cultivate microalgae *Chlorella* spp. The process was also used to investigate sustainable production of biofuels and biochemicals from aquatic biomass sources, including algae, cattail, and duckweed.

Great miscanthus experiments yield promising alternative fuel, nutrient source for microalgal culture: Press cake made from a biomass press has typically been used as fodder pellets or solid fuel for direct burning. NCA&T researchers used the yeast *Saccharomyces cerevisiae* (ATCC 24858) to convert the fermentable sugars released from enzymatic hydrolysis of great miscanthus (GM) solid cakes into ethanol. The nutrient rich juice was then used to cultivate microalgae *Chlorella* spp. in two different media. The results revealed that glucose and xylose released from miscanthus solids was shown to efficiently ferment into ethanol using *Saccharomyces cerevisiae*, resulting in ethanol concentrations between 0.780 g/L to 3.715 g/L and a high theoretical ethanol yield of 71.78%. GM juice was also demonstrated to be a highly nutritious source for microalgal culture.

Middle school students increase energy literacy: The Energy Transformation school enrichment curriculum, created in partnership with 4-H, teaches students about renewable and non-renewable energy sources, energy consumption patterns, principles of heat transfer, characteristics of air leakage, weather stripping, insulation, and energy-efficient lighting. Six modules guide students through the building of a model home from a cardboard box, which they then insulate, wire, and test for air leakage. The curriculum also incorporates math problems, science experiments, and writing assignments. The Energy Transformation completed pilot testing in 18 counties in North Carolina in 2015. To date, 389 youth have completed the 4-H Energy Transformation Curriculum. Pre- and post-participation surveys found significant improvements in behavior and knowledge, and students also reported installing a total of 345 compact fluorescent bulbs in their homes.

PLANNED PROGRAM #5

CHILDHOOD OBESITY

Food-insecure families improve nutrition, increase physical activity, thanks to Cooperative

Extension: North Carolina Cooperative Extension's Expanded Food and Nutrition Education Program (EFNEP) helps food-insecure families acquire knowledge and skills to manage food resources efficiently and provide nutritious, safe meals for their families on limited budgets. In 2015, EFNEP nutrition program assistants enrolled 853 families and 2,972 youth to address food resource management, nutrition practices, food safety, and physical activity. According to EFNEP's web-based annual report, 93% of adult graduated participants showed improvement in one or more nutrition practices, 59% increased consumption of calcium-rich foods, 61% increased vegetable consumption, 60% increased fruit consumption, and 56% increased their amount of physical activity. Statewide, Cooperative Extension helped 10,067 adults increase their fruit and vegetable consumption.

NCA&T workshops help families adopt healthy habits: NCA&T researchers have examined the poor health and dietary habits of children and families, especially those in rural communities with high obesity rates. Families completed nutritional, health, and dietary assessments and received health and wellness

educational workshops. Results show: (1) parents are planning less fatty meals, (2) participants report more consciousness of food intake and weight, (3) participants have formed an exercise/walking group for youth and seniors, (4) participants have increased their knowledge and awareness of healthy preparations of fresh vegetables, and (5) the participating pastor of a local church, along with various auxiliaries in the participating church, have created programs centered on health and well-being.

Combating Youth Obesity and Poor Health: The Speedway to Healthy Exhibit was created as a resource to fight childhood obesity and poor health among children in North Carolina. The quality of adolescent diets is an area of concern as poor eating patterns established in childhood transfer to adulthood. Unhealthy eating and physical activity patterns have played a significant role in the increasing rate of childhood obesity over the past decades and are contributing factors to related health outcomes. As such, nutrition-related diseases that were once considered adult illnesses, such as type 2 diabetes and high blood pressure, are being increasingly diagnosed in children. Alarming, today's youth are on course to be the first generation to live shorter and less healthy lives than their parents. The Speedway to Healthy is a 1,200-square-foot, walk-through exhibit representing the human body. This creative educational exhibit teaches children in kindergarten through fifth (K-5) grades how the foods they eat affect their bodies and their health. The 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 the 1) starting line, 2) brain, 3) mouth, 4) stomach, 5) small intestine, 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. At the finish line of the Speedway to Healthy, 6,596 NC youth have learned the link between nutrition, health, and physical activity; built skills needed to practice lifelong healthy behaviors; and improve their health status. The Speedway to Healthy Exhibit in partnership with family and consumer and 4-H agent in Alexander, Brunswick, Currituck, Gates, Hertford, Hyde, Montgomery, and Perquimans counties reached 4,534 participants.

Steps to Health program gets NC families moving: North Carolina ranks 13th in the nation for obesity, and only 1 in 4 children eat the recommended amounts of fruits and vegetables. North Carolina Cooperative Extension provides Steps to Health programs targeting preschool/kindergarten students, second graders, and third graders, adults, older adults, and Latino/Hispanic families at low-income sites in counties across North Carolina. New this year, the CATCH Kids Club, which teaches nutrition through physical activity, was implemented. In 2015, Steps to Health reached 8,593 participants (7,663 children and 930 adults) and made 60,704 educational contacts across North Carolina. Across all participants in the Steps to Health school-based programs, 40% percent are trying new fruits more often, 39% percent are trying new vegetables more often, and 32% are more active. Statewide, Cooperative Extension programs helped 25,484 youth increase their fruit and vegetable consumption.

Eat Smart, Move More, Weigh Less expands to improve health of NC citizens with online classes: An estimated 50% of adults attempt to maintain or reduce their weight each year, but most people do not succeed. The 15-week Eat Smart, Move More, Weigh Less curriculum addresses North Carolina's need for accurate educational materials on weight management. To improve reach and assess the scalability to a national model, the program has been regularly delivered in a real-time, online environment since January 2011. As of December 2015, a total of 271 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 5,557, and results 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 16.7% in that range at the program's end. Through Cooperative Extension programs statewide, 2,210 participants reduced their BMI.

Adolescents improve dietary choices through NCA&T program: Because many adolescents do not consume the recommended varieties and amounts of food, more effective strategies are needed to address this disparity. To determine if adolescents are able to make changes in their dietary patterns, a team of NCA&T researchers randomly assigned adolescents to one of five food experiences: (a) less of certain foods, (b) more of certain foods, (c) foods currently eaten but prepared in healthier ways, (d) new foods as healthy food options, or (e) no change in diet. Observations made during and after the nutrition intervention sessions show that the students are making more healthy food choices and are utilizing

strategies such as the following: purchasing a blender to make healthy smoothies, purchasing ingredients for healthy recipes, controlling portion sizes, balancing their meals with more fruits and vegetables, and paying attention to food labels.

Better Choices program helps Jones County residents lower cholesterol: The top three leading causes of death in Jones County are heart disease, cancer, and stroke. Cooperative Extension in Jones County has been involved in offering the nine-week Better Choices program for the last 10 years. In 2015, participants learned about eating more dairy foods, increasing physical activity, choosing better snack foods, handling food safely, cutting down on salt and sugar, and food budgeting. Eighty percent of program participants said they made positive behavior changes. Statewide, Cooperative Extension helped 737 adults reduce their total cholesterol levels.

PLANNED PROGRAM #6

FOOD SAFETY - FOOD PRODUCTION SYSTEMS: DEVELOPMENT, PROCESSING, AND QUALITY

ServSafe certifications keep people healthy, food service establishments thriving: The Centers for Disease Control and Prevention (CDC) estimates that roughly 48 million people contract a foodborne illness each year. Food safety education is believed to play an integral role in preventing foodborne illness outbreaks. Statewide, 745 food service employees received ServSafe training and certification, resulting in a potential cost savings of up to \$55,875,000.

Food safety HACCP workshops stem foodborne illness outbreaks: Two major contributing factors to foodborne illness are poor hygiene practices and contaminated food and beverages. To address this training need, Cooperative Extension offers annual HACCP (Hazardous Analysis and Critical Control Point) training in proper hand washing procedures, employee safety practices, foodborne illness risks, procedures for purchasing, receiving, and storing food, and workplace safety. Statewide, 118 program participants were certified in food safety HACCP programs, including the National Seafood HACCP Alliance.

NC State food processing technology helps expand sweet potato industry: NC State's Food Science program has contributed to the development of a continuous-flow microwave heating process that can commercially sterilize difficult-to-process food materials. This process has been jointly patented by NC State University, the USDA-Agricultural Research Service, and Industrial Microwave Systems, with a local entity (Yamco, LLC) holding the end-user licensing rights for commercialization. Since its inauguration in March 2008, the Yamco processing factory has annually produced millions of pounds of aseptic sweet potato purees. As of 2015, Yamco is considering adding a second production line to meet growing demands. This is the first commercial venture in the world to produce shelf-stable sweet potato purees, and it creates new market opportunities for the sweet potato industry, boosts profits for farmers, offers new, highly nutritious products to consumers, and will eventually offer new jobs in rural areas.

Microfluidization treatment improves texture and nutritional content of corn bran: Increasing dietary fiber has important health benefits. Corn bran is an excellent dietary fiber source, containing 70-86% insoluble dietary fiber. However, the gritty taste and corny flavor limits its use in bread formulations. To alter the physical make-up of corn bran, a microfluidization process was used to significantly decrease particle size and bulk density. It also increased specific surface area, water-holding capacity, swelling capacity, oil-holding capacity, cation exchange capacity, and the exposure of the phenolic compounds bound to the fiber matrix. The results indicate that microfluidization treatment significantly improved corn bran's hydration properties and increased its antioxidant capacities. Microfluidized corn and oat brans can compatibly coexist at high concentrations in bread flour. Further research involves production of high quality and affordable fiber-enriched bread that combines the health benefits from both brans, which will promote intake of dietary fiber and may reduce the risk of obesity.

University/business partnership has potential to revive NC crab industry: 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. Scientists and engineers at NC State's Department of Food, Bioprocessing, and Nutrition Sciences have conducted research on the company's crabmeat processing technology. Based on State's research, the USDA has encouraged the company to proceed to Phase II research funding to further explore product outlets for raw crab, which will enable Shure Foods to process locally harvested crabs without long periods of frozen

storage in the shell.

NCA&T researchers develop novel, antibacterial film packaging for spinach: NCA&T researchers have developed a bio-nanocomposite film packaging system for baby spinach leaves and evaluating the sensory properties of the spinach leaves and the antibacterial effect of the film against *Salmonella* spp., *Listeria innocua*, and *E. coli* during refrigerated storage. Sweet potato starch, montmorillonite (MMT) nanoclay, and essential oil were used to develop the film. Further research will evaluate the antibacterial activity of the film and the sensory properties of the baby spinach leaves.

State's ei4f program supports entrepreneurs in NC and beyond: The Entrepreneur Initiative for Food (ei4f) program provides food product safety testing, nutritional labeling, and general advice to food entrepreneurs. In 2015, the ei4f program provided product testing and/or nutritional labeling services to approximately 400 customers, resulting in about 683 products tested and 530 products labeled, saving them an estimated combined total of \$956,200. ei4f also offers food labeling services at a price of \$100 per label, resulting in a savings of at least \$265,000 in labeling costs for these entrepreneurs. Over 50% of the products tested and labeled by ei4f are for customers based in North Carolina, indicating that the majority of the economic impact of the program directly benefits the state.

Researchers develop new sweet potato-based food products: Products derived from sweet potato have the potential to supplement or replace more conventional food staples and provide more nutritional options to the public. NC State's Department of Food, Bioprocessing, and Nutrition Sciences has developed an enriched sweet potato flour that is shelf-stable and nutritionally comparable to enriched white flour. This sweet potato flour has in turn been used as the base for a cheaply produced and nutrient-dense dehydrated food product called Mighty-Mix, which is a promising starvation-relief food product. General consumers will also benefit from the availability of nutrient dense and gluten-free sweet potato flour products.

NCA&T researchers investigate techniques to reduce acid whey production in dairy processing: Acid whey is a byproduct produced during processing of fermented dairy foods such as cottage cheese and Greek yogurt, the disposal of which is an additional cost for the dairy industry. NC A&T researchers are investigating an efficient technique to reduce the production of acid whey, as well as an effective, economically valuable, and environmentally friendly separation process for lactic acid. These techniques will allow the food industry to better utilize the generated acid whey and return economic benefits to the dairy industry and health benefits to consumers. Different concentrations of gums and milk proteins were evaluated, as well as the impact of different fermentation temperatures on acid production. The results showed that pectin and gum Arabic at 0.05% could be used to reduce acid whey production by 8-10%. In addition, milk proteins (skim milk or whey protein concentrate) at 0.075% could reduce acid whey production by 10-12%.

PLANNED PROGRAM #7

HUMAN AND COMMUNITY DEVELOPMENT - YOUTH DEVELOPMENT AND FAMILIES

Cooperative Extension helps youth and adults plan financial future: The Nash County Cooperative Extension presented money management workshops to over 40 limited-resource residents in Nash County. In Alexander County, Extension partnered with schools to provide a financial literacy program to 393 middle school students. As a result of the Nash County Extension money management workshops, 100% of participants said they would track and decrease daily spending, and 96% plan to use the information they learned to save money when shopping. Participants were also 82% more likely to adopt a budget for their household. Of the Alexander County middle schoolers, 72% stated that they increased their knowledge of how to make wise financial decisions, and 75% stated that they understood the need for a budget and felt competent to implement one. Statewide, 3,092 people gained knowledge of basic financial management skills, and 1,727 began implementing basic financial management strategies.

Extension educates potential homeowners: Cooperative Extension partners with real estate agents, the City of Jacksonville, and other organizations to educate potential homeowners in Onslow County about credit scores, purchasing steps, and what it takes to maintain a home. An eight-hour class is taught six times a year, with 15-20 participants in each class. Participants learned about various homeownership expenses, including those related to septic tank maintenance, prevention and treatment of pest infestation, mold prevention, and maintaining a landscaped yard. Some state that they are now aware of a need to

improve their credit scores and accumulate more savings before they proceed with purchasing a home. Statewide, 434 people began actively managing their financial identities (such as by obtaining credit reports and selecting credit products).

EFNEP and Extension assist low-income families with WIC program: EFNEP and Extension provided WIC participants with nutrition lessons and information about the program with the help of the WIC Tarawa Terrace and the Onslow County Farmers' Market. In 2015, more than 350 low-income military families were educated on how to use their WIC-Farmers' Market vouchers. They were able to lower their grocery bills, increase their consumption of fruits and vegetables, and support local agriculture. Statewide, 3,287 individuals accessed programs and implemented strategies to support family economic well being.

Nutrition education program leads to improved dietary choices, plans for urban farming: NCA&T researchers conducted a nutrition education intervention program, exploratory meetings, listening sessions, and a telephone survey among community residents and completed plans for the development of an urban farm in order to address the negative impact of food deserts. This led to approval from the city of Greensboro for development of an urban farm, an essential component in the effort to increase adoption of healthy eating habits. The project inspired the city of Greensboro to amend a land development ordinance to accommodate development of urban farms within city limits. Results of the nutrition education intervention program included increased knowledge of the role of macro food nutrients in a balanced diet; the effect of unhealthy eating habits on health, how to read and interpret food labels, and meal planning techniques. Workshop participants have reported making healthier dietary choices.

SNAP-Ed at NCA&T: NC A&T's program is Try Healthy, which has five programs **Go, Glow, Grow** (Pre-K), the target audience is preschool aged children, using simplified MyPlate concepts and messaging children will learn to identify healthy foods and understand the benefits of eating healthy foods to encourage life-long healthy habits. **Learn to be Healthy** is a program developed to reach ages five through 17. The key educational messaging in Learn to be Healthy for all grade levels include the importance of nutrition and physical activity and the impact of overall wellness of the body. In the race against childhood obesity, the **Speedway to Healthy Exhibit** provides a great walk-through learning environment representing the human body that targets youth in kindergarten through 5th grade. Youth will journey through the body in a race to health, visiting 11 pit stops where volunteers provide an experiential learning experience about nutrition and health. The pit stops include the 1) starting line, 2) brain, 3) mouth, 4) stomach, 5) small intestine, 6) heart, 7) lungs, 8) kidneys, 9) bones, 10) muscles, 11) skin. The **Speedway to Healthy Curriculum**, the purpose of this project is to provide students in grades K-5 additional nutrition, health, and physical activity educational opportunities and experiences in the classroom. Activities will be related to the pit stops in the Speedway to Healthy exhibit and students will learn more information about: nutrition, physical activity, heart, lungs, kidneys, bones, muscles, and skin. **Eat Smart, Live Strong** will focus on improving the fruit and vegetable consumption and physical activity among adults 18-74 year old SNAP and SNAP-eligible participants through four education sessions. The 2015 fiscal year was the Cooperative Extension Program at NCA&T first year implementing the SNAP-Ed program using the Try Healthy Curriculum. The program reached 6,914 adults and youth in Alamance, Alexander, Bladen, Brunswick, Scotland, and Stanly counties.

Families encouraged to reduce energy consumption: The Home Energy Management Program created by the Department of Youth, Family, and Community Sciences at NC State encourages consumers to be proactive in reducing their home energy consumption and in saving money through no- and low-cost energy efficiency measures, behavioral changes, and home retrofits. The program recently piloted a Master Energy Volunteer program with 10 volunteer participants, who conducted simple home energy audits for neighborhood groups. Over 570 agent- and specialist-led workshops have since been conducted on home energy management, and consumer energy kits have been distributed to more than 4,300 consumers across the state, resulting in approximately 3,920,350 kWh of savings in energy use, at least \$417,950 in savings on homeowner energy costs, and the professional installation of over \$147,000 worth of retrofits in homes across North Carolina. In addition, 476 homeowners increased their aspirations to save energy and completed a professional home energy audit, over 31% of energy workshop participants changed their behavior to improve energy savings, and approximately 30% engaged in do-it-yourself energy saving projects.

Research-based mentoring program and curriculum help teen mothers: NC State's Department of Youth, Family, and Community Sciences partners with Greene, Lenoir, and Harnett counties to offer the 4-H Very Important Parents (VIP) Program, which offers face-to-face and technology-assisted education and guidance to teen parents and adults up to 22 years of age who became parents as teenagers. Throughout the program, group meetings are offered, as well as online support through various internet platforms. Lesson topics include positive parenting, stress management, building and maintaining healthy relationships, child safety, and financial planning. To date, 31 teens have completed the program. Results show significant growth in parenting skills, nurturing attitudes, general social skills, ability to form and maintain healthy relationships, and decision making.

NCA&T researchers analyze, support development of rural agricultural entrepreneurs: NCA&T researchers are investigating strategies to increase the numbers and sustainability of entrepreneurs within the rural areas of North Carolina by conducting economic analyses and using the results to provide technical and educational support. Trade area analysis was employed to determine the magnitude of consumer migration to various counties. The data indicated a larger migration of consumers from rural counties to the urban counties, taking advantage of agglomeration. Further analysis revealed that the sustainability of entrepreneurs was dependent on demographic and socio-economic factors such as business structure, location, gender, obstacles, and marital status.

Thousands of youth gain critical life skills through 4-H: 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 gain employment skills and to learn how to be citizen leaders. In 2015, over 200,000 youth participated in 4-H day and residential camping, 4-H club activities, and school enrichment programs. The focus of the various activities included healthy eating, preparing youth for an employable future, building community volunteerism, developing life skills, and achieving academic and educational success. Additionally, as a result of 4-H school enrichment efforts, 115,990 youth increased their knowledge in STEM, 51,358 girls participated in 4-H STEM programs, 32,780 youth gained career/employability skills, 10,762 youth increased their knowledge of entrepreneurship, and 9,314 youth participated in 4-H drop-out prevention programs.

PLANNED PROGRAM #8

HUMAN HEALTH, NUTRITION AND WELL-BEING

Peanut crop waste materials could yield nutraceutical compounds: Researchers in the Food, Bioprocessing, and Nutrition Science Department at NC State have processed unused peanut plant material by distillation, solvent extraction, and spray drying. Extracts from peanut skins have been tested for their ability to reduce inflammation at the cellular level, and potentially bioactive compounds have been identified in seed and non-seed plant material (such as roots and stems). This research has provided the first report of bioactivity from non-seed peanut material in vivo, which opens up the possibility of this traditional waste material being exploited for functional ingredients.

Self-pollinating *Artemisia annua* plants may improve malaria treatment production: More than one billion people worldwide have a high risk of contracting malaria. Artemisinin combined therapy is the first-line malaria treatment recommended by the World Health Organization, and *Artemisia annua* L. is the only natural source. Due to low and varying yields of artemisinin produced by *Artemisia annua*, it is currently impossible to meet the growing demands for this medicine, and more than half a million people die every year due to a lack of artemisinin. Researchers at NC State's Department of Plant and Microbial Biology have bred for the first time self-pollinating *A. annua* plants, which have demonstrated unique properties, including increased production of artemisinin. Self-pollinating *A. annua* has the potential to overcome current limitations in artemisinin production. In addition, these plants can be used to study artemisinin biosynthesis in order to learn how this compound can be most efficiently produced and isolated for malaria treatment.

NCA&T researchers investigate properties of grape pomace: Grape pomace (GP), a residue of grapes from the wine industry, has great potential to serve as an antioxidant and fiber rich ingredient to improve the nutritional value of food products. However, the particle size of GP may influence its health benefits and applications. Researchers at NCA&T selected pomace of four cultivars of grapes grown in North Carolina and dried and processed them into powders by four different average particle sizes. A sugar

cookie model was used to evaluate the impacts of PG particle size on the physical properties of cookies. At the same GP level, reducing the particle size resulted in smoother and softer but darker cookies. At 7.5% and 10% GP level, the products looked like chocolate cookies. In addition, the diameter of the cookie decreased, but the thickness increased as GP particle size decreased. These findings indicate that particle size of GP affected texture, color, and geometric properties. More experiments are underway to evaluate nutritional properties, sensory quality, and shelf-life of cookies containing GP powders of different particle size.

NC State researchers re-sensitize antibiotic resistant bacteria: There is an impending worldwide disaster due to decreasing investment in antibacterial drug research and development alongside a rapid increase in the level of resistance to currently licensed drugs. An elegant solution to this problem would be to develop techniques for restoring the efficacy of existing antibiotics. NC State researchers used a combination of genetic, biochemical, and thermodynamic methods and high-resolution NMR spectroscopy to elucidate the mechanistic and molecular recognition features of proteins involved in the regulatory and protective processes of bacteria. The compounds developed through this research have demonstrated an ability to overcome antibiotic resistant traits in about 20 medically important pathogenic bacteria. In addition, several previously "off-the-shelf" antibiotics against highly resistant and dangerous bacteria have been reactivated.

Poultry model for ovarian cancer yields promising biomarker: Unlike many other animals, in which the development of ovarian cancer must be artificially induced, the egg-laying hen has a high incidence of spontaneous ovarian cancer. This makes the laying hen a promising animal model for isolating potential ovarian cancer biomarkers. A team from NC State's College of Agriculture and Life Sciences and the College of Sciences used the poultry model for spontaneous ovarian cancer and in-depth analysis of the chicken ovarian cancer proteome to discover a novel biomarker, OVOS2, which is associated with the pathogenesis of both chicken and human ovarian cancer and has the potential to facilitate the identification of agents that will assist in the prevention and treatment of ovarian cancer.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	523.0	82.0	403.0	46.0
Actual	691.0	63.5	377.0	44.7

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

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 NCA&T agents and faculty, who collaborate with NCA&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 SAES 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 SAES 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.

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 groups.

Extension has an ongoing system of securing stakeholder input in program planning, implementation, and quality assessment has and 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. Council members represent the diversity of the respective county population to assure the inclusion of under-served populations. While the advisory council meets quarterly, the specialized committees meet at least annually to discuss accomplishments and needs still to be addressed. This system is monitored administratively to assure that stakeholders provide program input and actions. At the state level, a Statewide Advisory Council provides programmatic inputs, review, and guidance for the overall program functions of the North Carolina Cooperative Extension Service at N.C. State University. This group meets quarterly as well as for other special meetings to provide organizational review and input. This Council is 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. In addition to being an integral part of the overall State Advisory Council, the Extension Program at NCA&T State University is also guided by a cadre of citizens who make up the Strategic Planning Council. The Strategic Planning Council includes community leaders, agribusiness persons, representatives from non-governmental organizations, representatives from the State Advisory Council, representatives from county-based specialized committees and elected officials. The Strategic Planning Council meets three times a year as a group. Networking and collaboration between the State Advisory Council and the Strategic Planning Council is facilitated by two members who serve on both Councils. Members of each Council periodically meet jointly. 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. 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.

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.

As indicated in the Plan of Work, a deliberate initiative is continuously underway by research and extension programs to meet, listen to, involve, and interact with any and all stakeholders. These efforts are carried out in a highly proactive manner. In addition, commodity association members and representatives, county commissioners, state legislators and many other leaders and policy makers both at the local and statewide levels have varying degrees of influence and interaction regarding program direction, issues identification, budgets, staffing and developing plans of action. 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 have all benefitted from engagement of relevant stakeholder groups. Brief explanation.

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

provide input and guidance into departmental research programs. In addition, there are formal 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
11864133	3661204	8025981	4215640

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	6675513	1164027	5554984	3979076
Actual Matching	6675513	645998	5554984	978015
Actual All Other	6000000	1041933	31000001	3014415
Total Actual Expended	19351026	2851958	42109969	7971506

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

S. No.	PROGRAM NAME
1	Global Food Security - Plant Production Systems and Health
2	Global Food Security - Animals and Their Systems, Production and Health
3	Climate Change
4	Sustainable Energy including Biotechnology
5	Childhood Obesity
6	Food Safety - Food Production Systems: Development, Processing and Quality
7	Human and Community Development- Youth Development and Families
8	Human Health, Nutrition and Well-being

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	5%	5%	8%	20%
202	Plant Genetic Resources	10%	5%	10%	10%
204	Plant Product Quality and Utility (Preharvest)	5%	5%	5%	5%
205	Plant Management Systems	18%	20%	12%	25%
206	Basic Plant Biology	10%	10%	10%	20%
211	Insects, Mites, and Other Arthropods Affecting Plants	10%	5%	10%	10%
212	Pathogens and Nematodes Affecting Plants	10%	5%	10%	0%
213	Weeds Affecting Plants	12%	10%	10%	0%
216	Integrated Pest Management Systems	5%	10%	6%	10%
404	Instrumentation and Control Systems	1%	0%	3%	0%
511	New and Improved Non-Food Products and Processes	1%	0%	2%	0%
512	Quality Maintenance in Storing and Marketing Non-Food Products	1%	0%	2%	0%
601	Economics of Agricultural Production and Farm Management	3%	10%	4%	0%
602	Business Management, Finance, and Taxation	3%	10%	4%	0%
604	Marketing and Distribution Practices	6%	5%	4%	0%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	133.0	16.0	155.0	7.0
Actual Paid	178.0	18.8	142.0	11.4

Actual Volunteer	115.0	0.0	10.0	0.0
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2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
1721514	308936	2092328	1179373
1862 Matching	1890 Matching	1862 Matching	1890 Matching
1721514	415848	2092328	145030
1862 All Other	1890 All Other	1862 All Other	1890 All Other
1547309	183835	11676393	380085

V(D). Planned Program (Activity)

1. Brief description of the Activity

- Conduct discovery research on plants and plant systems using approaches including genomics, metabolomics and proteomics
- Develop improved crop varieties using traditional and genomic approaches
- Introduce/discover new plants for food use and the green industry
- Develop systems for production of plants for biofuels
- Seek new uses for plants and plant byproducts
- Develop production systems for organic farmers
- Develop diagnostic techniques for indigenous and introduced pathogens
- Partner with industry
- Develop sustainable production systems for both large scale and limited resource farmers
- Enhance IPM programs through new techniques and strategies
- Set up applied research/demonstration plots
- Write papers for scientific community
- Prepare publications for grower and homeowner audiences
- Develop web sites to deliver information to grower and homeowner audiences
- Conduct focused educational programs for farmers, commodity groups, and industry.

2. Brief description of the target audience

- The scientific community
- Regulatory agencies
- Agricultural chemical companies
- Agribusiness
- Commercial and limited resource farmers
- New and Part-time farmers
- Homeowners
- Consultants
- News media
- General public
- Non-governmental organizations

- Other public agency staff

3. How was eXtension used?

Communities of Practice are available in eXtension for an array of field, horticultural and ornamental crops and related areas that provide a resource for producers, handlers, processors and marketers.

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	430159	1310334	50705	154456

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

Patent Applications Submitted

Year: 2015

Actual: 29

Patents listed

Y564 PROV - Root-knot Nematodes Encode Diverse Families of Secreted Peptides (12-50 Residues) which Mimic Plant Peptide Hormones to Elicit Developmental Responses in Their Host

Y564/CA - Method for Modulating Plant Root Architecture

Y564/BR - Root-knot Nematodes Encode Diverse Families of Secreted Peptides (12-50 Residues) which Mimic Plant Peptide Hormones to Elicit Developmental Responses in Their Host

5051.864 - Deutzia - Plant Named 'NCDX2'

5051.865 - Winterberry Holly 'NCIV1'

5051.866 - Ligustrum 'NCLX1'

NC2010-1-CA - Buddleja - 'Miss Violet' - NC2010-1

Y564/EP - Root-knot Nematodes Encode Diverse Families of Secreted Peptides (12-50 Residues) which Mimic Plant Peptide Hormones to Elicit Developmental Responses in Their Host

NCHA2-CA - Hydrangea

NCHA3-CA - Hydrangea

NCVR1-CA - NCVR1 - Viburnum Rhytidophylloides

NCVX1-CA - NCVX1 - Viburnum

NCHA4-CA - Hydrangea

5051.87 - Blackberry Plant Named 'Von'

36446.0005U4 - Methods and Compositions for Plant Pest Control

5051.874 - Cercis Plant Named 'NCCC1'

5051.875 - Cercis Plant Named 'Pink Pom Poms'

5051.876 - Hybrid Flowering Cherry 'NCPH1'

5051.877 - Wheat, common, 'NC01PT-1433'

5051.878 - Sullivan (peanut)

5051.879 - Wynne (peanut)

NCORNSP-019SCSHLM - Sweet Caroline Sweetheart Lime (sweet potato)

86.15 - Utilization of Non-Nutritive Adsorbents to Sequester Mycotoxins during Extraction of Protein or Other Value Added Components from Mycotoxin Contaminated Cereal or Seed Oil Meal

NCHA2 - Flower - Hydrangea 'NCHA2' Invincibelle Spirit II

NCHA3 - Flower - Hydrangea 'NCHA3' Invincibelle Ruby

NCHA4 - Flower - Hydrangea 'NCHA4' Incrediball Blush

NC2010-1 - Buddleja - 'Miss Violet' - NC2010-1

NCVX1 - Shrub - Viburnum 'NCVX1' Shiny Dancer

NCVR1 - Shrub - Viburnum 'NCVR1' Emerald Envy

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	128	346	474

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
2015	50

Output #2

Output Measure

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

Year	Actual
2015	2745

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Prices for wild harvested ginseng reached \$850 per dried pound in 2014. There is steady market demand for ginseng root and seed, the high country has ideal growing conditions for ginseng, and farmers and landowners are interested in cultivating it on their underutilized forestlands. However, there are no ongoing education, demonstration, or training resources available to potential local producers.

What has been done

As an expansion of a 2014 program, the Watauga County Cooperative Extension worked with North Carolina A&T Cooperative Extension Program and PHARMN, a local heritage agriculture non-profit organization, to obtain \$10,380 in grants to fund a ginseng production workshop and field demonstrations in October 2015.

Results

Ginseng takes seven to 10 years to mature to a marketable size; therefore, this project will be ongoing for the next several years. There are approximately 60 ginseng growers. Fifteen are active and have more than 5 acres of wild simulated ginseng. The prices for wild simulated ginseng may vary from \$750 to \$1,200.00 per pound.

4. Associated Knowledge Areas

KA Code	Knowledge Area
201	Plant Genome, Genetics, and Genetic Mechanisms
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 #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
2015	21000000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Educating farmers about optimum fertilizer management and production practices such as high population corn management, fertilizer spreader calibration, and legume and manure alternatives to inorganic fertilizers improves farm profitability and reduces the likelihood of runoff of nitrogen, phosphorus, and sediments into state waterways. New fertilizer materials are available and need to be evaluated for efficacy in commercial farms.

What has been done

NC State scientists have developed five research publications and corresponding extension training programs covering optimum nitrogen fertilization, nitrogen supply by alternative sources, and drainage water management alternatives. NC State's extension and research encourages and supports voluntary adoption of best management practices. Total attendance at training programs in 2015 was 427 at cooperative extension meetings, plus an additional 1,001 field day attendees. In addition, collaborations between NC State and NCDA&CS are enhancing the

professional development of extension agents and supporting agriculture by resolving crop yield limitations due to nutrient deficiency. Diagnostic consultation successes included nutritional problem evaluation on 3,525 acres of cropland.

Results

The direct impact of specific soil fertility problem consultations, assuming a \$25 per acre average due to fertilizer savings or yield increases on 3,526 acres, was \$88,150. Cooperative Extension Agent survey results from the Blackland Farm Manager's Association winter meetings indicate that producers valued the advice provided at meetings at \$21.85 per acre. An estimated \$961,874 of savings can be attributed to soil fertility advice based on the attendance of 334 persons representing 440,267 acres of farmland. In addition, Hyde Co. estimates suggest that extension efforts led to producer usage of composted layer manure instead of inorganic fertilizers on 20,000 acres of wheat and corn, saving farmers \$30 per acre for a total savings of \$600,000. The use of livestock organic by-products in place of synthetic fertilizers has had a particularly strong impact on NC growers, with an estimated statewide net income gain of \$20,967,071 from this practice alone. Statewide, 98,300 acres are under nutrient management as of 2015. In addition, a total of 62,918 NC producers are adopting improved management practices, including improved nutrient management, and 8,027 producers are reporting a reduction in fertilizer volume used per acre.

4. Associated Knowledge Areas

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

Outcome #3

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	23

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Research efforts contribute to the growth and development of the broccoli industry of eastern North Carolina and beyond. Through a multi-state program led by Cornell University, NC State's Department of Horticultural Science is supporting growers in identifying new varieties, management and marketing opportunities, and extension agent training in new topics.

What has been done

Research efforts were directed at developing heat tolerant broccoli varieties and contributing to management strategies and marketing improvements for eastern North Carolina and the entire east coast broccoli industry. Trials took place at the research station and at six on-farm sites. Extension personnel were trained on post-harvest management and agricultural research methodology.

Results

Based on the results of NC State's research, five new heat-tolerant broccoli varieties have been bred and released by seed companies. These were selected from over 150 varieties trialed by NC State researchers from 2011 through 2015 and are now commercially available in North Carolina. In addition, NC growers are extending the season during which local broccoli can be produced by growing through the summer months using these heat-tolerant varieties. Field management and post-harvest handling have also improved, with increasing efforts toward the economic and marketing aspects of the broccoli industry. By yearend, plant breeders had released 23 new plant varieties.

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
2015	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Ambrosia beetles have been identified as the most damaging nursery pest and the pest for which growers apply the most insecticide. To protect trees, growers have conventionally made broad-spectrum insecticide applications with an airblast sprayer that delivers a forceful insecticide mist throughout the nursery. Most of this insecticide lands on the ground, leaves the target area as drift, or lands in the canopy, where beetles do not attack. Drift into canopies also kills the ambrosia beetle's natural enemies. For this reason, the efficiency of pesticide applications should be increased using low-volume spray tactics.

What has been done

Stephen D. Frank, an assistant professor at NC State University's Entomology Department, has developed a manual spray wand with two opposing nozzles that can quickly apply insecticide to tree trunks and reduce insecticide volume.

Results

This insecticide wand reduces insecticide use to 1/12th of the application volume typically achieved with the conventional airblast method. It also reduces drift out of the target area, reduces lethal effects to natural enemies by up to 50%, and prevents secondary mite outbreaks and damage. Calculated on a per tree basis, total insecticide costs were 4.5 times higher when using a conventional airblast method versus the low volume insecticide wand. Although labor costs were 3.5 times higher with the manual wand, airblasted plots had twice as many spider mites as manually treated plots, resulting in a need for additional miticide applications. The cost of these applications would significantly overtake the labor cost savings associated with using the airblast method. Frank estimates that this new application method can save growers over \$300 per acre by reducing mite outbreaks and expensive miticide applications.

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Increasing transportation costs and rising prices of fats and oils have made the current practice of importing large amounts of feed grains into North Carolina to feed poultry, swine, cattle, and dairy animals economically unsustainable. The ideal solution is to increase sorghum production on marginal soils and to replace double-cropped soybean with double-cropped sorghum. Unfortunately, there is little information on hybrids and management practices for double-cropped sorghum, and NC growers and extension agents have little experience with this crop.

What has been done

Hybrid testing programs were conducted at two North Carolina sites in 2015, and crop management research was conducted at two locations. Research projects covered seeding rate and row spacing, herbicide testing, nitrogen timing and rate, the use of harvest aids, and the impact of herbicide timing. Three extension programs were conducted across NC to provide information on sorghum growth and management to growers. One agent training session was conducted to train agents in assisting first-time growers.

Results

Sorghum acreage in NC increased from 17,000 in 2011 to 62,000 in 2015. Sorghum yields averaged over 80 bushels per acre in 2015, and yields would have been higher had it not been for damaging rain in October. Data from Murphy Brown, Inc. shows that NC State's work has resulted in 70 million additional bushels of feed grains (sorghum, wheat, and corn) from North Carolina, and this represents an additional income for the state of over \$300 million. Murphy Brown Inc. has saved \$142 million dollars in transportation and feed costs due to the efforts of the

NC State University feed grains program over the past three years.

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
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	2745

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Growers in eastern North Carolina are younger than the national average and are using new technologies and information sources to adjust their management practices. However, one traditional learning method that they have embraced is face-to-face meetings offered by local counties. In 2015 in the eastern NC counties of Beaufort, Hyde, Tyrrell, and Washington, 334 growers and agronomists registered and attended educational meetings on the latest crop production practices. Estimates from other counties in the region indicate that over 600 growers attended meetings across this eastern NC region.

What has been done

These meetings are designed to bring the latest information to growers about crop management practices, including high-yield corn production systems, soybean and wheat production practices, pest control, fertility, and water management tips. These programs help growers make decisions about varieties, fertility, seeding practices, insecticides, fungicides, and a host of other factors.

Results

Surveys found that the information presented at these grower meetings resulted in changes to management practices on over 440,217 acres in the counties of Beaufort, Hyde, Tyrrell, and Washington alone. Using these improved practices, these same growers estimated that they increased their economic returns by \$21.85 per acre for a total economic value of \$13,416,179.

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

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Growers need to identify specialty crops that can yield a high income per acre. The pawpaw provides an opportunity to bring a "lost" fruit into the public eye, largely due to the efforts of plant

breeders who have re-discovered this delicious fruit. The pawpaw's flavor is described as a cross between a pineapple, a mango, and a banana. New varieties have been selected for richer flavor and larger fruit size, making the pawpaw a valuable horticultural crop that is highly attractive to consumers.

What has been done

A replicated cultivar trial of the pawpaw (*Asimina triloba*) was initiated to compare the yield and quality of four cultivars and to make recommendations to growers. One-year-old trees that were budded in the fall of 2006 at Peterson Pawpaws nursery in Winchester, VA were hand dug at the nursery on April 23, 2007 and were planted on the farm of a cooperator in Granville County. Data was taken in 2013 and 2015. The data collected included pounds of fruit per tree, pounds of fruit per acre, number of fruit per tree, and the average weight of fruit in pounds.

Results

Prior to 2013, production was erratic, mainly due to spring frosts that killed the blossoms. However, all cultivars yielded over 1,000 lbs. per acre in 2015. Assuming a fruit yield of 750 lbs. per acre, a grower can make \$1,500 by selling 500 half-pound fruits at \$3.00 each, plus \$2,500 by selling 500 one pound fruits at \$5.00 each for a total of \$4,000 per acre at retail farmers' markets.

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
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3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Plant-parasitic nematodes reduce the yield of the world's major food and cash crops by an average of over 12%. In the past, chemical nematicides helped, but most of these chemicals have been de-registered. Unless effective alternatives are developed, global agricultural productivity will be severely damaged. Understanding the biochemical and developmental pathways employed by the nematode parasite will reveal targets for designing new, environmentally-safe nematicides.

What has been done

Scientists at NC State University and colleagues at the University of California-Davis have been conducting genetic analysis of the root-knot nematode *Meloidogyne hapla*. This has led to the identification of loci in the nematode genome that elicit complex responses in host plants, including induction of known developmental pathways.

Results

Knowledge gained through this research will assist in the development of root-knot nematode control strategies and new nematicides. Controlling nematodes will lead to higher yields and crops that are less susceptible to stress (particularly drought) and help reduce reliance on environmentally-damaging controls.

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
2015	1760235

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Over the years, many growers have started producing shiitake mushrooms in oak logs in Rockingham County. During most years, two inoculation workshops are offered to farmers, and there is usually a surplus of fresh mushrooms in late spring and fall. However, growers cannot count on selling all of their mushrooms and maintaining a profitable business just selling at farmers markets in this area. The growers need to be able to better handle the mushrooms post-harvest, produce value-added products, extend the growing season with additional strains and forcing methods, and expand their local marketing.

What has been done

Cooperative Extension started a community kitchen at the Rockingham County Business and Technology Center using a RAFI grant, which was also used to obtain a dehydrator. Post-harvest workshops were held, and information on small forced air cooling buildings with air conditioners was distributed. Value-added product programs and local food marketing programs were also held with farmers, grocers, and restaurants. The Sold on Shiitake: Growing Shiitakes in North Carolina curriculum developed by NCA&T Extension and research was used to train producers.

Results

One grower reported that all the components of their farm shiitake mushroom business started coming together in 2015. Using different strains and log soak forcing methods, they extended the mushroom harvest season to eight months. By using the air conditioned forced air cooling system, growers were also able to better store fresh mushrooms after harvest. Growers now dehydrate mushrooms for value-added products using the farm inspected kitchen. In 2015, they sold 800 pounds of fresh shiitake mushrooms (valued at \$10 a pound, or \$8,000 total) and 200 pounds of value-added dehydrated mushrooms.

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
2015	5093

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Capital investments are essential for farmers to expand operations, pursue new markets, and diversify products. Reaching new markets through better crop production methods and product diversification remain critical lynchpins in the effort to maintain the momentum of the local food movement, ensure that farmland remains productive, and provide small farmers with additional revenue streams.

What has been done

The Wilson and Stokes County Cooperative Extensions partnered with NC AgVentures to administer a grant program funded by the Tobacco Trust Fund targeting producers with innovative project ideas for diversifying, expanding, or implementing new entrepreneurial plans in their farm operations. The extensions assisted farmers throughout the application process, offering critiques and suggestions to strengthen their applications.

Results

Eight Wilson County farmers received grants through NC AgVentures for a total of \$80,989 to implement new ideas to increase their farm income. In addition, two Stokes farmers were awarded grants in the amounts of \$15,000 and \$7,900 for a community kitchen and a high tunnel to expand a produce operation, respectively. These projects will open new entrepreneurial markets and represent added income potential for farmers. Statewide, over \$3 million added income resulted from expanded marketing opportunities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The demand for locally grown food continues to grow despite a faltering economy. Direct sales from farms to consumers grew 215% from 1992 to 2007. The average farmer in North Carolina is 57 years old and looking forward to retirement. Beginning farmers in the Foothills region need training to operate successful farm businesses that will address the need for new farmers and locally produced food.

What has been done

Agents from Gaston, Caldwell, and Catawba counties partnered with an Extension Associate and an NC farmer to deliver a seven-month training program, called the Foothills Farm School, for beginning and transitioning farmers. Since 2014, 53 entrepreneurs have completed the Foothills Farm School program. Data was collected through surveys before, during, and after the program.

Results

As a result of completing the Foothills Farm School, 57% of participants reported having completed a business plan. On average, students of the Farm School have reported a \$4,883 change in income since they began the program. Ninety percent of respondents said the program helped them prevent costly mistakes, with participants estimating an average savings of \$7,000 due to knowledge gained in farm school. The resulting changes in business behavior will improve the viability of local farms.

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Medicinal plants are becoming increasingly popular as alternate cash crops, especially for families with marginal woodland. Medicinal plants such as black cohosh and goldenseal are being overharvested from the wild. Re-growth of such plants is slow, and it is difficult to meet high and constant market demand.

What has been done

To reduce the depletion of these plants from their natural settings, a program has been implemented to produce these plants in managed growing settings. Researchers and Extension specialists at NC A&T are growing medicinal plants in local woodland and high tunnel/greenhouse settings to determine optimal shade and other growing conditions in order to help small scale farms find alternate ways to increase their productivity and profitability.

Results

Seedlings were selected for maximal shoot initiation and proliferation in laboratory micropropagation studies. As many as 15 plantlets were produced from one original piece of plant material. Acclimatization and shading requirements were established in the greenhouse and/or high tunnels. Researchers will continue to study plant growth regulators and their concentrations

and combinations to improve the efficiency of shoot proliferation.

4. Associated Knowledge Areas

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

Outcome #13

1. Outcome Measures

Improved national capacity to meet growing food demands

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The past twenty years have seen steadily growing consumer demand for organically, locally, and sustainably-raised produce and meats. To keep up with this demand, farmers need information about production, marketing, sustainability, supply chains, and local foods. Producers and others rely heavily on the expertise of university researchers, Extension specialists and agents, and governmental and non-governmental agencies to keep them abreast of the latest research and production techniques.

What has been done

The Center for Environmental Farming Systems (CEFS) has become a national leader in sustainable agriculture research and education. NC State and NCA&T partners through CEFS to provide the CEFS Workshop Series, which has expanded over the years and now provides 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 sustainable production and more. The scope of this educational series has grown to include educational opportunities beyond workshops, such as the annual Sustainable Agriculture Lecture, Author Series, Farm Festivals, Field Days and the weeklong Farm-to-Fork celebration.

Results

Since 2006, when the workshop programming started, over 15,000 people have been educated about sustainable agriculture through various events. Tens of thousands more have engaged in CEFS' work through various initiatives and outreach events, including Farm Aid in 2014. Participants have included participant throughout the food supply chain, from producers, educators, and extension agents all the way through to consumers. These educational events are making a difference in the lives and livelihood of a tremendous number of individuals who otherwise might not have access to this information, which has the potential to significantly impact food production.

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. Cooperative Extension is filling a position that will have responsibility for program evaluation and reporting, which will enhance our effectiveness in capturing program outcomes and impacts. We are proud of the many accomplishments of this program. A couple examples: The swine industry, NCSU, 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%	20%	20%	30%
302	Nutrient Utilization in Animals	15%	10%	20%	20%
303	Genetic Improvement of Animals	15%	25%	17%	20%
307	Animal Management Systems	15%	20%	18%	0%
311	Animal Diseases	5%	0%	10%	20%
312	External Parasites and Pests of Animals	5%	0%	5%	0%
313	Internal Parasites in Animals	2%	25%	5%	0%
315	Animal Welfare/Well-Being and Protection	5%	0%	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%	1%
601	Economics of Agricultural Production and Farm Management	4%	0%	1%	1%
602	Business Management, Finance, and Taxation	3%	0%	1%	1%
604	Marketing and Distribution Practices	3%	0%	1%	0%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	78.0	6.0	100.0	8.0
Actual Paid	102.0	4.0	95.0	9.6
Actual Volunteer	6.0	0.0	5.0	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
990800	183789	1399797	696533
1862 Matching	1890 Matching	1862 Matching	1890 Matching
990800	20882	1399797	178010
1862 All Other	1890 All Other	1862 All Other	1890 All Other
890538	996	7811671	53451

V(D). Planned Program (Activity)

1. Brief description of the Activity

This plan of work includes broad and extensive research and extension programs. NC Agricultural Research Service scientists will conduct research projects to study methods to improve the efficiency of animal production. Research will focus on methods to improve reproductive performance, nutrient utilization, and genetic influence on growth and reproduction. Scientists will also work 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 this plan of work are also very broad and include poultry such as turkeys, broiler chickens, and table-egg chickens. The plan of work also includes swine, fish such as flounder, and cattle such as beef and dairy, and numerous pests such as house flies. Research will include 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 will be 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 plan of work is to transfer technology and knowledge to our stake-holders and clientele. Therefore, an extensive outreach effort through Cooperative Extension will be 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 will be 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 will include long-distance education, newsletters, web sites, newspaper releases, television and radio programs, trade journals, scientific journals, and popular press articles. Participants and programs will be evaluated at least annually for success, progress, and effectiveness. Special educational programs focused on limited resource farmers will continue to be a priority for NCA&T focused Extension efforts in pasture based swine production systems, alternative breeds, and small ruminant parasite management.

2. Brief description of the target audience

The target audience will be primarily 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 will be the primary audience. In addition, the audience will include 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 are available in eXtension, providing a valuable resource for production practices, animal health and management, and marketing. These resources are available to extensionists, producers and others supporting the food animal industries.

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	236200	690055	56563	165248

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

Patent Applications Submitted

Year: 2015
 Actual: 1

Patents listed

5051.652.TS - Methods and Compositions for Improving Growth of Meat-Type Poultry

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	17	163	180

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

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

Year **Actual**
 2015 1406

Output #2

Output Measure

- Relevant and impacts focused research projects to be conducted

Year	Actual
2015	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
2015	10000000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

In Rutherford and Watauga counties, numerous beef cattle producers have asked how they can boost profits, specifically through value-added marketing. Many of these producers were interested in co-mingling cattle for truckload sales.

What has been done

Rutherford County Cooperative Extension partnering with the Polk, Cleveland, and McDowell County Extensions, the Mountain Cattle Alliance, and the Southeast Livestock Exchange brought these producers together to co-mingle calves to sell in truckload lots. The calves were evaluated and processed to verify their health and quality. In Watauga County, the extension service organized a weaning program to improve calf value and aid producers in marketing them for truckload sales. Seventeen producers from Watauga and Avery counties participated.

Results

In the Rutherford County group sale, over 30 producers sold 14 loads of cattle (~1,050 head) in 2015, valued at \$1,600,000. These calves were sold at premiums ranging from \$150-\$250/head. Assuming an average of \$200/head on 1,050 head of cattle, this constitutes an additional \$210,000 in profits. In Watauga and Avery, 210 calves were sold at an average premium of \$50/head, resulting in about \$10,500 in additional profits. Statewide, animal producer improvements including those related to improved planning, marketing, and financial practices have resulted in a net income increase of \$9,998,926.

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

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	10000000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The use of only one or two bulls to breed a beef cattle herd can limit the genetic potential and marketability of calves. Buyers want high-performing, uniform calves, and improper genetics can have a negative effect on production and marketability. Cattle producers must use the latest breeding practices and continually improve sire selection in order to remain competitive.

What has been done

Yadkin County Extension worked with four local cattle operations to implement an estrous synchronization and artificial insemination program, which was used to shorten the calving season and ensure a larger genetic pool of herd sires. Extension trained the producers in proper

estrous synchronization technique and determining when cattle should be artificially bred. Cattle genetic suppliers bred the cattle using semen from a variety of quality beef bulls. Buyers were interviewed to learn what qualities they would pay premiums for, and producers were trained in selecting for these traits. In addition, the Randolph County Extension hosted a hands-on livestock workshop, during which 58 farmers were educated on improving profitability through sire selection, body condition scoring, and other husbandry techniques; similar extension programs in Surry County helped cattle producers use better genetic selection to improve profitability.

Results

Synchronizing the Yadkin County herds condensed the calving season, resulting in 285 calves exhibiting higher performance as well as higher uniformity in age, size, and weight. This increased the calves' value by \$17 per head. Artificial insemination allowed the use of 11 different sires, which added genetic potential that increased production and marketability by over \$22 per calf. These practices increased customer satisfaction and added a total of \$39 of value per calf, increasing the combined net income of the producers by over \$11,100. Participants in the Randolph county livestock workshop estimated that the sire selection portion of the workshop improved their profitability by an average of \$31,500, and improved sire and replacement female selection in Surry County resulted in an additional \$65,000 in income for producers. Statewide, animal producer improvements including those related to improved animal husbandry practices have resulted in a net income increase of \$9,998,926.

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
2015	7015

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 (white bass *Morone chrysops* x striped bass, *M. saxatilis*) 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. Hybrid striped bass farmers are dependent on domestic fish broodstock to ensure a reliable supply of healthy animals. Broodstock must be continuously provided to commercial producers, and industry breeding techniques must remain on the cutting edge to ensure that the aquaculture industry remains strong in North Carolina and nationwide.

What has been done

Dr. Benjamin J. Reading of NC State's Applied Ecology Department co-coordinates the National Program for Genetic Improvement and Selective Breeding for the Hybrid Striped Bass Industry, a nationwide consortium of collaborators dedicated to improving the hybrid striped bass aquaculture cultivar through selective breeding and domestication. These fish are produced annually at the Pamlico Aquaculture Field Laboratory in Aurora, NC. In 2015, 42 different families of domestic striped bass were produced, along with two families of a novel triple crossed true-breeding hybrid striped bass. In addition, great advancement was made in the breeding technology of striped bass, and many female fish were spawned without recourse to traditional hormone induction procedures. A draft of the striped bass genome sequence was also completed and is hosted online for public research access, which will greatly facilitate striped bass research and breeding.

Results

Over 90% of the hybrid striped bass raised in the U.S. 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.

Thirty-nine beneficiaries were involved in the research program this year, including 16 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
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	7015

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Annual feed cost is the greatest expense for livestock producers. This includes expenses associated with purchasing hay and supplemental feed. Reduction in feed cost could greatly increase the profits of these producers, and this can be accomplished by improving forage quality and utilization.

What has been done

Person County Extension helps livestock producers understand soil reports, identify weeds, and make decisions about herbicide use and soil fertility improvement techniques. NC State University specialists and local agribusiness experts work to provide producers with up-to-date information. In 2015, the Person County Extension provided guidance and information on forage management to over 40 producers with more than 600 acres of pasture and hay land. In Bladen County, Extension educated producers on interpreting soil test results, managing forage crop pests and disease, and general forage management techniques through farm visits and phone communications. In 2015, 80 Bladen County producers received assistance managing over 767 acres of forage.

Results

As a result of recommendations provided by Extension, Person County producers have saved \$9,000 in feed costs by producing more forage on their farms to be utilized either as grazed forage or harvested forage. Bladen County producers have saved over \$17,965 due to increased forage crop production and quality. Extension will continue to provide assistance to livestock

operations in order to improve efficiency and increase profits. In addition, national webinars held by the Amazing Grazing team reached an audience of 931 livestock producers, saving an estimated total of \$241,442 in forage-related costs.

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Illness resulting from the consumption of poultry meat and egg products contaminated with *Salmonella enterica* is a major public health concern. The poultry industry in the US loses over \$350 million annually due to salmonella contamination of eggs and meat products. An efficient vaccine is needed to protect the food supply against salmonella and the consumers against salmonellosis.

What has been done

The essential role of anaerobiosis and redox potential as controlled by the global regulator FNR in the survival and virulence of salmonella was demonstrated. The role of the redox state in salmonella is of great importance to understanding the physiology of this pathogenic organism

and in developing vaccines.

Results

Research into the physiology of salmonella under anaerobic conditions was used to develop a new vaccine strain of salmonella that could be used as an oral vaccine against Salmonella spp. in poultry, other farm animals, and humans. In addition, this mutant strain could be engineered to serve as a vaccine vector for delivering epitopes of other disease-causing organisms.

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
2015	5093

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

North Carolina farmers are continuously searching for ways to diversify their production, and the past 15 years have seen a significant increase in the demand for goat meat due to a preference for this protein source among certain ethnic populations in NC and the southeastern US. Meat goats can provide NC consumers with a protein source comparable to chicken in terms of calories and protein, but with lower overall levels of total and saturated fat.

What has been done

Educational programs targeting CES agents, commodity associations, and other agricultural professionals have been implemented to help ensure that meat goat producers will select, adopt, and successfully implement best management practices to maximize profits and expand the industry. For example, the Johnston County Goat Producer's Association recently partnered with NC Cooperative Extension to plan and implement their seven hour Hands On Goats XVI Field Day, which 129 people attended. At this event, experienced goat producers presented seminars on various aspects of goat herd management, including disbudding, control of internal parasites, artificial insemination, and pregnancy ultrasound. In addition, since 2005, four "Goat and Sheep Roundup" conferences have been held to showcase the potential of this growing industry in various ways, including gourmet goat meat cook-offs with NC chefs.

Results

Publications from NC State's meat goat program webpage are being reproduced nationally and internationally. Local newspapers, food editors, and agricultural communications personnel at NC State have been spreading the word about the results of the "Goat and Sheep Roundup," especially in regard to the high quality and superior taste of goat meat. As a result of NC State's promotion of this alternative enterprise, over 720 farm families have been certified in goat quality management. Participants in the Hands On Goats XVI field day stated that they now feel better prepared to succeed in this fledgling industry.

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. Cooperative Extension is filling a position that will have responsibility for program evaluation and reporting, which will enhance our effectiveness in capturing program outcomes and impacts.

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%	25%	20%	20%
111	Conservation and Efficient Use of Water	5%	25%	5%	5%
112	Watershed Protection and Management	15%	20%	10%	10%
133	Pollution Prevention and Mitigation	10%	20%	10%	10%
141	Air Resource Protection and Management	5%	10%	5%	5%
401	Structures, Facilities, and General Purpose Farm Supplies	5%	0%	5%	5%
402	Engineering Systems and Equipment	5%	0%	5%	5%
403	Waste Disposal, Recycling, and Reuse	10%	0%	10%	10%
404	Instrumentation and Control Systems	5%	0%	5%	5%
405	Drainage and Irrigation Systems and Facilities	5%	0%	5%	5%
605	Natural Resource and Environmental Economics	15%	0%	20%	20%
	Total	100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	72.0	4.0	24.0	6.0
Actual Paid	92.0	1.8	22.0	1.4
Actual Volunteer	1.0	0.0	2.0	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
891720	67967	324163	124174
1862 Matching	1890 Matching	1862 Matching	1890 Matching
891720	2948	324163	60462
1862 All Other	1890 All Other	1862 All Other	1890 All Other
801484	22536	1809019	24166

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research will focus 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 will be proposed and evaluated with farmers, businesses, stakeholders and communities. Technology transfer will occur through demonstrations, workshops, and various media from Cooperative Extension in concert with researchers.

2. Brief description of the target audience

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

3. How was eXtension used?

eXtension was not used in this program.

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	46214	52304	27560	31192

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

Patent Applications Submitted

Year: 2015
 Actual: 1

Patents listed

035051/451185 - Autothermic Transportable Torrefaction Machine (ATTM)

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	2	78	80

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Waste Management Certification Programs

Year	Actual
2015	20

Output #2

Output Measure

- Number research project completed on environmental/natural resource issues

Year	Actual
2015	80

Output #3

Output Measure

- Number of non-degree credit environmental activities conducted

Year	Actual
2015	295

Output #4

Output Measure

- Enrollees for Natural Resources Leadership Institutes training

Year	Actual
2015	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

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	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 together with airborne lidar measurements over several seasons for experimental corn plots in three North Carolina 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 are in progress.

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

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
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	2129

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Animal waste management and its environmental impact is a significant issue for North Carolina, where animal agriculture is a multibillion-dollar-a-year industry. Growers need effective, economically feasible and practical management systems that protect environmental quality.

What has been done

North Carolina State University's College of Agriculture and Life Sciences has been conducting research and demonstrations of alternative waste treatment systems for more than 20 years while creating and disseminating educational programs and materials to producers, regulators, policy makers and the general public. Some materials have been produced in both English and Spanish to meet the need of changing demographics. To increase the availability of research-based information, a multi-state eXtension Community of Practice was established. Called the Livestock and Poultry Environmental Learning Center, the site features web pages containing information related to waste treatment technologies, webcasts, frequently asked questions as well as an option to "Ask An Expert."

Results

Through the World Wide Web, field days, tours, one-on-one contacts, and presentations, livestock producers, rural residents, and the public in general have learned of various waste treatment

alternatives and how individual unit processes can be linked to achieve site-specific treatment objectives. Statewide, 2,129 animal producers adopted Extension-recommended best practices for animal waste management, using 1.7 million tons of livestock organic byproducts. By using livestock organic byproducts instead of synthetic fertilizers, growers statewide realized a net income gain of \$21 million.

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

2. Associated Institution Types

- 1862 Extension
- 1890 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

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

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
2015	2099

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Swine production contributes about \$2.5 billion annually to North Carolina's economy, but it generates waste that must be managed properly to ensure environmental quality. The state requires swine farms to take courses to maintain an animal waste license.

What has been done

Cooperative Extension livestock and agricultural agents across the state partnered to hold training classes throughout the year to educate farmers on proper animal waste management.

Results

Statewide, 2,099 waste management certifications were gained or maintained due to extension education 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
2015	134520

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Poultry production is North Carolina's largest agriculture sector, accounting for 35.8 percent of total cash receipts. Commercial poultry production produces large volumes of manure and bedding material, referred to as poultry litter. While litter is a waste byproduct to poultry growers, crop farmers can use litter as an excellent fertilizer, thus reducing or replacing their use of commercial fertilizers, usually at a cost savings.

What has been done

One area specialized poultry agent developed 26 waste management plans for new and expanding growers so that they could comply with state laws. They learned proper record keeping, sampling and handling regulations.

Results

About 36,000 tons of litter these farms generate are used to maximize crop production and preserve water quality. Statewide, Extension-recommended waste management analysis was used for proper land application on more than 134,000 acres.

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
2015	29

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

North Carolina has more than an estimated 5,000 miles of streams that have degraded, mainly from erosion and sedimentation. Lack of streamside vegetation not only causes landowners to lose real-estate value and doubles the cost of treating drinking water for municipalities, it impacts aquatic habitat.

What has been done

Since 2012, Watauga County Extension partnered with NCA&T Cooperative Extension Program to deliver four workshops to demonstrate vegetation planting and provide native riparian plants to 174 landowners (farmers, business owners, families) to plant on their streambanks in Watauga County.

Results

A survey of participants showed that 8,225 linear feet near streams were planted, helping decrease sedimentation and increase knowledge of water-quality practices.

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

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Stormwater 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

NC State University's Department of Biological and Agricultural Engineering tests technologies to determine their hydrologic and water-quality benefits. This applied research has led to new design and crediting standards for various technologies, new professional and scientific publications and outreach workshops across North Carolina, the United States and the world. Extension regularly trains professionals across North Carolina in design and asset management.

Results

North Carolina continues to be one of the national leaders in stormwater management. The state is home to many of the newest non-proprietary technologies, and a wide assortment of tools are available to designers and regulators alike. This state is estimated to rank in the top 5-10 in terms of sheer numbers of stormwater practices installed. The state's best management practice design guidance remains at the forefront of those in the United States due to scientific and professional updates.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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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
2015	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 to high-value products, such as food products, pharmaceuticals, biochemicals, biopolymers and biofuels. The development of biologically-based methods for converting and processing raw materials into higher-value products that are cost effective and functional integration of processing/production steps along the supply chain (e.g. feedstock development, production systems, logistics, and end use) will increase the feasibility of using plant-based resources as additional feedstocks for consumer goods.

What has been done

NC State University engineers are focusing on the production of bio-based products, such as enzymes, biochemicals, and biofuels from agro-industrial residues and dedicated biomass crops. Among the areas being explored are semi-solid fermentation technology, including solid substrate cultivation and liquid cultivations using solid carbon sources; enzymatic conversion methods and fermentation for development of effective biomass conversion processes; hybrid application of thermal and microbial conversion technologies for biofuel production from lignocellulosic biomass; solvent extraction processes for biomass materials that contain natural colorants, nutraceuticals and other high-value compounds; and integrated processing systems that link crop production and storage practices to development of conversion technology, analytical methods and process

Results

Value-added products from the sweet sorghum crop have been demonstrated through ensilage and feedout studies and have shown promise as a near-term market for the biomass crop. Fermentation studies with adapted *C. beijerinckii* strain SA1 for butanol production using sugars derived from sweet sorghum and perennial grasses are providing key information for the next phase of 'advanced' biofuels. And compositional changes measured in a variety of bale storage methods, including in-field stacked bales, show promise for these methods as storage solutions for biomass feedstocks in the Southeast climate.

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
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

In North Carolina commodity prices and the desire to shift to more locally grown grain as an animal agriculture feed source have increased irrigation-related water use to improve agricultural yields. While emerging technologies such as subsurface drip irrigation and variable-rate pivot irrigation to make water use more efficient, they haven't been well studied under North Carolina soil conditions. Efficient water management is also a concern in the NC green industry, where drought accounts for 25 percent of economic loss, and in urban areas, where officials have questions about water use for landscaping.

What has been done

NC State University has conducted recently completed and ongoing research into smart irrigation technology under local conditions and held targeted full-day workshops in irrigation water management and fertigation at multiple locations. One applied research project on a grower's farm includes monitoring and controlling a subsurface drip irrigation system so that additional guidance may be developed and disseminated through Extension publications and other means.

Results

These applied research and extension efforts have brought smart irrigation technology into residential settings, educated local water conservation officials and informed growers and irrigation professionals. Nearly 200 licensed irrigation contractors have received re-certification hours directly from NC State in the first 3.5 years of the certification requirement, and trainings provided by NC State through other green industry organizations have reached hundreds more. Meanwhile, agricultural groups and state agencies have received technical input to help them guide policy in recent water legislation and to help award cost-share funds.

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. Cooperative Extension is filling a position that will have responsibility for program evaluation and reporting, which will enhance our effectiveness in capturing program outcomes and impacts.

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%	0%
402	Engineering Systems and Equipment	20%	0%	20%	20%
403	Waste Disposal, Recycling, and Reuse	20%	0%	15%	20%
404	Instrumentation and Control Systems	10%	0%	10%	0%
511	New and Improved Non-Food Products and Processes	15%	0%	15%	20%
	Total	100%	0%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	9.0	0.0	9.0	5.0
Actual Paid	10.0	0.0	8.0	7.2
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
99080	0	117878	411559
1862 Matching	1890 Matching	1862 Matching	1890 Matching
99080	0	117878	353170
1862 All Other	1890 All Other	1862 All Other	1890 All Other
89054	0	657825	1956131

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 that might 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

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1038	4621	4820	4820

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

Year: 2015
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	2	26	28

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Studies on producing agricultural and forestry substrates for biofuel production

Year	Actual
2015	10

Output #2

Output Measure

- Studies on engineering conversion processes for biofuels and other components

Year	Actual
2015	20

Output #3

Output Measure

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

Year	Actual
2015	23

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

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

Outcome #1

1. Outcome Measures

New crops or other biofuels substrates identified

2. Associated Institution Types

- 1862 Extension
- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Biofuels produced in the United States improve our energy security, but most crop plants currently used for biofuel production compete with food and feed production for resources such as land and water.

What has been done

An North Carolina State University research team of plant biologists, microbiologists, agricultural engineers and chemical/mechanical and aerospace engineers are working to make *Camelina sativa* an economically viable feedstock for jet fuels. To increase the oilseed crops productivity, scientists are engineering the entire carbon flux from increasing photosynthetic carbon dioxide uptake in the leaf to the synthesis of energy-rich molecules in the seeds. These energy-rich molecules will mostly consist of modified oils and terpenes. The modified oils are better-suited for jet fuels and will reduce the need for hydrogen and energy in the conversion process. The terpenes can be cost-effectively converted into aromatics; aromatics are essential jet-fuel components, but their chemical synthesis is more costly and energy-intensive than their extraction from biological materials.

Results

The increased productivity of this enhanced Jet-Camelina crop and the development of energy- and cost-efficient harvesting, extraction and conversion technology will provide an energy-dense liquid transportation fuel as a drop-in replacement for petroleum-based fuels. Because camelina can be grown on poor soils with little water or fertilizer input, it will not compete with food and feed production.

4. Associated Knowledge Areas

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

Outcome #2

1. Outcome Measures

New bioprocessing technologies developed

2. Associated Institution Types

- 1862 Extension
- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Dwindling petroleum reserves and significant environmental consequences of exhaust gases from petroleum diesel have resulted in an increased demand for biofuels as renewable and environmentally friendly fuels. Lignocellulose is the most abundantly available raw material on Earth for the production of biofuels, but better enzymes are needed to convert this biomass into viable biofuels and other products.

What has been done

From the guts of wood-eating insects, NC State University researchers have demonstrated that they can isolate microorganisms that are capable of growing on lignin and lignocellulose as the sole carbon sources and over a range of pH levels. They have also identified genes from some of these microbes that encode lignocellulose-degrading enzymes and are in the process of recombinantly expressing and characterizing these enzymes to evaluate their utility for the degradation of lignocellulose under industrially relevant conditions.

Results

Improved lignocellulose-degrading enzymes could make the conversion of lignocellulosic biomass

into biofuels and high-value chemicals more efficient and less costly.

4. Associated Knowledge Areas

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

Outcome #3

1. Outcome Measures

New bioproducts identified

2. Associated Institution Types

- 1862 Extension
- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Spider silk is one of the most sought-after biomaterials today. However, an individual spider generates only a very small quantity of silk, and large-scale commercial rearing of spiders is problematic because spiders are territorial and cannibalistic, thus requiring individual rearing cages.

What has been done

North Carolina State University and EntoGenetics, with North Carolina Biotechnology Center support, has inserted spider-silk genes into silkworms. After three generations these silkworm strains are still spinning silks that are two to three times tougher than native silkworm silk and 1.5 times stronger. While more tests are required, scientists are optimistic that the improved silk quality is due to the expression of the spider-silk gene.

Results

With the establishment of breeding lines, large-scale production of spider silk may become a reality. This should open the door for commercial production of spider silk for the textile market,

including the production of stronger and lighter bulletproof vests for law enforcement and the military.

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

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	465

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

According to the U.S. Department of Energy, there is a need to increase energy literacy including knowledge of energy, energy sources, and energy generation, as well as use and conservation strategies so that consumers can make informed decisions.

What has been done

The Energy Transformation school enrichment curriculum addresses energy literacy by teaching middle school students about energy conservation and efficiency while addressing important essential standards in science and math. Created in partnership with 4-H, this experiential curriculum teaches students about renewable and non-renewable energy sources, energy consumption patterns, principles of heat transfer, characteristics of air leakage, weather stripping, insulation and energy-efficient lighting. The curriculum includes six modules that guide students through the building of a model home from a cardboard box. They insulate, weather strip, wire for lighting and fans, and test the model for air leakage. This activity helps students to both visualize and test the principles of air movement, thereby learning ways energy is lost and gained in a home. The curriculum addresses a variety of student skills by incorporating math problems,

science experiments, and writing assignments into each unit. The Energy Transformation completed pilot testing in 18 counties in North Carolina in 2015.

Results

To date, 389 youth have completed the 4-H Energy Transformation Curriculum. Pre- and post-participation surveys found significant increases in behavioral and knowledge change, and students also reported installing a total of 345 compact fluorescent bulbs in their homes. Using the Energy Star CFL calculator, this behavior change has the potential to result in annual savings \$2,141 of electricity savings, 17,378 kWh savings and 26,762 pounds of carbon dioxide reduction. Statewide 532 Cooperative Extension program participants increased knowledge in best management practices related to reducing energy use and increasing energy efficiency for homes, businesses, agricultural industries or governments.

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Energy costs for electricity and curing fuel for tobacco represent one of the greatest expenses for tobacco growers, second only to labor costs. While energy prices may remain low in the short-term, the long-term outlook is unclear.

What has been done

As Cooperative Extension agents work with growers to reduce fuel costs and increase fuel efficiency, NC State University engineers continue to assess new and existing technologies that

care easily adaptable and economically feasible to reduce energy usage in existing curing barns. Averaged over the season, an exhaust air heat recovery system implemented on two different make barns resulted in approximately a 15 percent reduction in LP gas consumption per cure compared to the check barns without a system. Although this technology can be implemented on any make barn, it may be more beneficial on barns with tube-axial fan configurations.

Results

A 15 percent reduction in gas consumption is approximately 45 gallons per cure for a typical 10-box barn. Although 2015 fuel prices are the lowest seen in more than 10 years, the economic impact is approximately \$300 savings per barn per season. The savings is approximately \$450 per barn at 2014 fuel prices.

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 Extension
- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Biofuels produced in the United States improve our energy security, but most crop plants currently used for biofuel production compete with food and feed production for resources such as land and water.

What has been done

A North Carolina State University research team of plant biologists, microbiologists, agricultural engineers and chemical/mechanical and aerospace engineers are working to make Camelina

sativa an economically viable feedstock for jet fuels. To increase the oilseed crops productivity, scientists are engineering the entire carbon flux from increasing photosynthetic carbon dioxide uptake in the leaf to the synthesis of energy-rich molecules in the seeds. These energy-rich molecules will mostly consist of modified oils and terpenes. The modified oils are better-suited for jet fuels and will reduce the need for hydrogen and energy in the conversion process. The terpenes can be cost-effectively converted into aromatics; aromatics are essential jet-fuel components, but their chemical synthesis is more costly and energy-intensive than their extraction from biological materials.

Results

The increased productivity of this enhanced Jet-Camelina crop and the development of energy- and cost-efficient harvesting, extraction and conversion technology will provide an energy-dense liquid transportation fuel as a drop-in replacement for petroleum-based fuels. Because camelina can be grown on poor soils with little water or fertilizer input, it will not compete with food and feed production.

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

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

Tools to fully capture accomplishments in this field of science to be revised as we have indicated in other program areas. Cooperative Extension is filling a position that will have responsibility for program evaluation and reporting, which will enhance our effectiveness in capturing program outcomes and impacts.

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: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	46.0	12.0	8.0	3.0
Actual Paid	62.0	12.0	8.0	3.3
Actual Volunteer	4.0	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
594480	114694	117878	453364
1862 Matching	1890 Matching	1862 Matching	1890 Matching
594480	5561	117878	56466
1862 All Other	1890 All Other	1862 All Other	1890 All Other
534323	393727	657825	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

The Childhood Obesity Planned Program will provide science-based educational and experiential learning opportunities that focus on children, but actively engage an array of audiences--regardless of gender, income, age or race/ethnicity--because of the influence that these groups in society have on the health and well-being of themselves and their children. 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 NCA&T State University. For more than three decades, EFNEP has been helping limited resource youth and families with children learn how to eat healthier meals and snacks, stretch their food dollars and reduce the risk of food-borne illnesses. 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 is Steps to Health, which works with preschoolers, kindergarteners, 2nd grade students, 3rd grade students, and high school students. **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 the methods mentioned earlier, 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. NC A&T and NCSU researchers explore new ways to get families to adopt healthier eating patterns and to be able to more successfully access healthier foods such as fresh fruits and vegetables and less processed foods.

NC A&T's program is Try Healthy, which has five programs **Go, Glow, Grow** (Pre-K), the target audience is preschool aged children, using simplified MyPlate concepts and messaging children will learn to identify healthy foods and understand the benefits of eating healthy foods to encourage life-long healthy habits. **Learn to be Healthy** is a program developed to reach ages five through 17. The key educational messaging in Learn to be Healthy for all grade levels include the importance of nutrition and physical activity and the impact of overall wellness of the body. In the race against childhood obesity, the **Speedway to Healthy Exhibit** provides a great walk-through learning environment representing the human body that targets youth in kindergarten through 5th grade. Youth will journey through the body in a race to health, visiting 11 pit stops where volunteers provide an experiential learning experience about nutrition and health. The pit stops include the 1) starting line, 2) brain, 3) mouth, 4) stomach, 5) small intestine, 6) heart, 7) lungs, 8) kidneys, 9) bones, 10) muscles, 11) skin. The **Speedway to Healthy Curriculum**, the purpose of this project is to provide students in grades K-5 additional nutrition, health, and physical activity educational opportunities and experiences in the classroom. Activities will be related to the pit stops in the Speedway to Healthy exhibit and students will learn more information about: nutrition, physical activity, heart, lungs, kidneys, bones, muscles, and skin. **Eat Smart, Live Strong** will focus on improving the fruit and vegetable consumption and physical activity among adults 18-74 year old SNAP and SNAP-eligible participants through four education sessions.

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 Families Food and Fitness CoP provides education and skills to help families make informed decisions about healthy eating and physical activity by providing them with science-based information and learning opportunities through eXtension. Families Food and Fitness is organized around three goals:

-improved diets

-increased physical activity

-maintenance of body weight in a healthy range and avoidance of excess weight gain

The website content is focused on six key behaviors that have been identified in the literature to be associated with maintaining and achieving a healthy body weight:

-move more everyday

-tame the tube

-control portion size

-enjoy more fruits and vegetables

-prepare more meals at home

-re-think your drink

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	180160	130532	37732	27338

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

Year: 2015
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	0	3	3

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
2015	1879

Output #2

Output Measure

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

Year	Actual
2015	114995

Output #3

Output Measure

- Relevant and impact focused research projects conducted

2015 North Carolina A&T State University and North Carolina State University Combined Research and Extension Annual Report of Accomplishments and Results

Year	Actual
2015	3

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

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
2015	10067

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Limited-resource families are at greater risk of chronic diseases associated with poor nutrition, and these diseases are associated with significant health care costs.

What has been done

North Carolina Cooperative Extension's Expanded Food and Nutrition Education Program (EFNEP) helps food-insecure families acquire the knowledge, skills and attitudes needed to manage food resources efficiently. They also learn how to provide nutritious, safe meals for their families on limited budgets. EFNEP targets key behaviors, such as increasing physical activity and reducing the amount of sugary beverages in the diet, to reduce the risk of overweight and obesity.

Results

EFNEP nutrition program assistants enrolled 853 families and 2,972 youth addressing 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, 93 percent of adult graduated participants showed improvement in one or more nutrition practices (plans meals, makes healthy food choices, prepares food without adding salt); 59 percent increased consumption of calcium-rich foods; 61 percent increased vegetable consumption; 60 percent increased fruit consumption; and 56 percent increased the amount of physical activity. Statewide, Cooperative Extension helped 10,067 adults and youth increase their fruit and 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
2015	25484

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Obesity and related chronic diseases are prevalent among North Carolinians. With two-thirds of adults overweight or obese, North Carolina ranks 13th in the nation for obesity and 9th and 17th highest for adult diabetes and hypertension, respectively. Poor eating practices and physical inactivity are not limited to adults. Children are following closely in their footsteps, with only 1 in 4 eating recommended amounts of fruits and vegetables.

What has been done

To help North Carolina Supplemental Nutrition Assistance Program recipients make healthy choices within a limited budget, North Carolina Cooperative Extension offers the Steps to Health program and NCA&T offers the Try Healthy program in collaboration with the state's Health and Human Services Department and with funding from the U.S. Department of Agriculture. The ultimate goal is to promote positive behavior change related to nutrition and physical activity. Eleven distinct programs target all ages from preschool/kindergarten students to older adults second graders, and Latino/Hispanic families were provided at low income sites in counties across North Carolina. New this year, the CATCH Kids Club, which teaches nutrition through

physical activity, was implemented at sites hosting the summer meal program.

Results

In the 2014-15 fiscal year, Steps to Healthy and Try Healthy program in partnership with Family & Consumer Science and 4-H Youth Development agents and nutrition assistants, reached 15,507 participants (16,872 children and 1,635 adults) and made 95,274 educational contacts within 72 counties across North Carolina through direct education programs. Across all participants in the Steps to Health school-based programs, 40 percent are trying new fruits more often, 39 percent are trying new vegetables more often and 32 percent are more active. Statewide, Cooperative Extension programs helped 25,484 youth increase their fruit and 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 #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
2015	25571

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Two-thirds of Guilford County adults are overweight and obese and less than 23 percent meet recommended adult physical activity guidelines established by Healthy People 2010. Obesity and inactivity are leading indications that a person may develop chronic disease.

What has been done

To address this need, Extension offered low-cost Zumba and Urban Line Dance series for inactive adults. Classes met after work twice a week. Nutrition classes were provided as well, along with educational displays and incentives. More than 1,043 women have participated since the program's inception 6 years ago.

Results

Of participants completing exit surveys, 53 percent reported losing weight, 59 percent lowered their blood pressure, and 80 percent increased their physical activity level. Participants reported feeling less stressed and having improved mobility and better sleep. Statewide, Cooperative Extension helped 25,571 program participants increase their physical activity.

4. Associated Knowledge Areas

KA Code	Knowledge Area
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
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
2015	2210

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The issue of overweight and obesity continues to be the most pressing public health problem today. An estimated 50 percent of adults attempt to lose weight or not gain weight each year, but most people do not follow recommendations for calorie restriction and adequate levels of physical activity.

What has been done

Created by a team of professionals with expertise in nutrition, physical activity and behavior change, the 15-week Eat Smart, Move More, Weigh Less curriculum addresses North Carolina's need for accurate educational materials that address weight management. To improve reach and assess the scalability to a national model, an online version was created. Since January 2011, the program has been regularly delivered in a real-time, online environment. A live instructor uses synchronous, distance-education technology to lead the classes. Participants can attend weekly sessions using a computer. They can see and hear their instructor as well as interact with the instructor and other participants via the chat box.

Results

As of December 2015, a total of 271 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 5,557. Results from 258 courses show that participants improved their body-mass index scores, with 12.4 percent in the healthy BMI range of less than 25 at the start of the program and 16.7 percent in that range at the program's end. Through Cooperative Extension programs statewide, 2,210 participants reduced their BMI.

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
2015	801

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.

What has been done

In 2015, Cooperative Extension in Richmond County offered an Eat Smart, Move More program for 15 cafeteria managers, educating them on healthy eating and physical activity. One participant who could not walk a quarter mile was responsible for meals for her father, who took various medications for high blood pressure and diabetes.

Results

This participant reported making changes in shopping and meal preparation based on what she learned. She lost 12 pounds, while her father reduced his blood pressure medicine and insulin. She attributes this to his change in diet based on what she learned in class. Statewide, 801 Cooperative Extension program participants reported reducing their blood pressure.

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
2015	381

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Currently 25.8 million individuals in the United States, 8.3% of the population, have diabetes. North Carolina has an even higher rate of diagnosed diabetes. Medical costs associated with

diabetes are 2.3 times higher than medical costs without diabetes. During 2012, \$245 billion was spent in the United States for medical costs associated with diagnosed diabetes.

What has been done

In Gaston County, Cooperative Extension partnered with the Centralina Area Agency on Aging to offer the Stanford University's Diabetes Self Management Program. Twenty-seven adult participants completed this 6-week, 15-hour program.

Results

All participants reported learning new skills to help manage diabetes, such as tracking blood sugars, balancing their diet/carbohydrates, communicating with healthcare providers, and managing low/high blood sugars. All participants planned to use one or more of these skills within the next month. Several participants reported improved blood glucose control. Statewide, 381 adult Cooperative Extension program participants improved their blood glucose (A1c) levels.

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
2015	737

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The top three leading causes of death in Jones County are heart disease, cancer and stroke. The major risk factors for these conditions include high cholesterol, high blood pressure, obesity, physical inactivity, and tobacco use.

What has been done

Cooperative Extension in Jones County has been involved in offering the 9-week Better Choices program for the last 10 years. In 2015, the series was conducted in the Jones County Senior Center. Participants learned about eating more dairy foods, increasing physical activity, choosing better snacks foods, handling food safely, cutting down on salt and sugar and stretching their food dollars.

Results

Eighty percent of program participants said they made positive behavior changes. It's just one example of the ways Cooperative Extension statewide helped 737 adults reduce their total cholesterol levels.

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
2015	5725

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

In Onslow County, diseases of the heart are the second leading cause of death. High blood pressure makes the heart work harder and can lead to heart disease, stroke, heart failure, and

kidney disease. According to the U.S. Food and Drug Administration, in some people, salt contributes to high blood pressure.

What has been done

To address ways to reduce the risks of these conditions, Cooperative Extension in Onslow County offered a hands-on "make your own salt-free seasoning" class to seniors attending two local congregate nutrition sites. The classes consisted of 24 participants.

Results

Following the program 20 participants confirmed that they were still making and using the salt-free seasoning that they made in the program and 8 reported learning to make different blends not included in the class. Verbal reports from the participants show that many have reduced their blood pressure with one participant reporting a reduction in the amount of medication her husband required. Across the state, Cooperative Extension helped 5,725 program participants consume less sodium in their diets.

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. Cooperative Extension is filling a position that will have responsibility for program evaluation and reporting, which will enhance our effectiveness in capturing program outcomes and impacts.

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%	25%
502	New and Improved Food Products	15%	0%	15%	30%
503	Quality Maintenance in Storing and Marketing Food Products	10%	15%	10%	20%
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	40%	40%	40%	25%
Total		100%	100%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	71.0	5.0	52.0	6.0
Actual Paid	95.0	6.0	50.0	1.3
Actual Volunteer	1.0	0.0	5.0	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
916490	68197	736735	109698
1862 Matching	1890 Matching	1862 Matching	1890 Matching
916490	23919	736735	11596
1862 All Other	1890 All Other	1862 All Other	1890 All Other
823748	157128	4111406	200000

V(D). Planned Program (Activity)

1. Brief description of the Activity

Multiple research and educational outreach programs will be conducted under the umbrella of improving the quality, safety, security, and nutrition of food products produced in North Carolina. Specific research projects will 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 focuses 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 plan of work 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.

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 an array of plant and animal systems Communities of Practice that provide relevant information and strategies for producers, processors and marketers.

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	38721	66164	4820	8236

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

Patent Applications Submitted

Year: 2015
 Actual: 2

Patents listed

297/282 PROV - Modular Devices and Systems for Continuous Flow Thermal Processing Using Microwaves

5051.882.PR - Methods for the Production of Malt Beverages

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	5	61	66

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

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

Year	Actual
2015	528

Output #2

Output Measure

- Relevant and impacts focused research projects to be conducted

Year	Actual
2015	60

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
2015	1578

Output #5

Output Measure

- Program participants trained in good farmer's market practices

Year	Actual
2015	325

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
2015	974

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The Centers for Disease Control and Prevention (CDC) estimates 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

In cooperation with local health departments, Cooperative Extension provided ServSafe training to 148 food service managers in Robeson, Columbus, Bladen, and Scotland counties.

Results

Statewide, 974 food service employees received ServSafe training and certification. It is estimated that each foodborne illness occurrence can have an average cost of up to \$75,000. If each of the 974 food service employees who received ServSafe training avoids just one foodborne illness outbreak, the potential cost savings could be up to \$70 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
2015	663

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

In the U.S., approximately 48 million people fall victim annually to foodborne illness. Two major contributing factors to foodborne illness are poor hygiene practices and contaminated food and beverages. However, foodborne illness is unlikely when food is handled safely from the time of receipt until service. Scotland County Schools' child nutrition staff prepare and serve over 5,000 meals daily.

What has been done

To address this training need, Scotland County Cooperative Extension family and consumer science agent to provide annual School HACCP (Hazardous Analysis Critical Control Point) training. In 2015, approximately 100 school child nutrition staff received training in topics such as proper hand-washing, purchasing and receiving, storage, thermometers, temperature, preparation, and service. Additionally, all managers and PICs (persons in charge) are required to have a current food safety certification.

Results

A post evaluation revealed that 100% of the managers, PICs, and food service staff felt confident in the following areas: proper hand washing procedures, employee safety practices, foodborne illness risks, procedures for purchasing, receiving, and storing food, and workplace safety. In Scotland County, 84 food service managers and staff received the four-hour HACCP training. Statewide, 663 program participants were trained in food safety HACCP programs, including the

National Seafood HACCP Alliance.

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

North Carolina is the top national producer of sweet potatoes, yielding about 49% of the total U.S. production. In the past few years, recognition of sweet potatoes as the most nutritious vegetable by several prominent nutrition authorities has caused the demand for sweet potatoes to increase steadily. However, an irregular supply of raw product and the special storage conditions required for sweet potatoes impede the development of new sweet potato product lines. Therefore, there is a need for processing technologies to convert sweet potatoes into purees that are shelf-stable and readily incorporated into processed products.

What has been done

NC State's Food Science program has conducted research resulting in the development of a continuous flow microwave heating process that can commercially sterilize difficult-to-process food materials, such as sweet potato purees. Coupled with aseptic packaging, this innovative

process can produce aseptic sweet potato purees with high nutritional retention and desirable flavor, providing results that exceed those of all existing conventional methods of thermal processing. This process has been jointly patented by NC State University, the USDA-Agricultural Research Service, and Industrial Microwave Systems, with a local entity (Yamco, LLC of Snow Hill, NC) holding end-user licensing rights for commercialization.

Results

Yamco completed the construction of a \$6 million facility in the city of Snow Hill in December, 2007. Since its inauguration in March of 2008, the Yamco factory has annually produced millions of pounds of aseptic sweet potato purees for various food companies. As of 2015, Yamco is considering adding a second production line to meet the growing market demands for aseptic purees. This is the first commercial venture in the world to produce shelf-stable sweet potato purees. This development creates new market opportunities for the sweet potato industry, boosts profits for farmers, offers new, highly nutritious products to consumers, and will eventually offer new jobs in rural areas.

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

Number of new companies in food manufacturing

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	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

Researchers in NC State's Department of Food, Bioprocessing, and Nutrition Sciences have identified the problem with Shure Foods' technology: freshly harvested and deshelled crabmeat paste is not amenable to processing with this machinery. To optimize processing, 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 during the process.

Results

A reliable method for cold gelation of raw crabmeat will enable Shure Foods to process locally harvested crabs without long periods of frozen storage in the shell, which is usually required to ensure sufficient meat protein denaturation and aggregation. Based on this and other research that NC State has conducted on behalf of Shure Foods, the USDA has encouraged the company to proceed to Phase II research funding to further explore product outlets for raw crab.

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Entrepreneurial food businesses are important for the local economy. A focus on local foods makes selling value-added local products attractive to entrepreneurs. Selling value-added products at farmer’s markets or other stores can increase income for entrepreneurs, but entrepreneurs often need assistance navigating regulations to ensure that the products they manufacture are safe for consumers. Consultation with a process authority is required before some products can be sold. In addition, nutritional labeling of product packaging, although not required for small producers, is often desirable to consumers.

What has been done

The Entrepreneur Initiative for Food (ei4f) program helps entrepreneurs and businesses in North Carolina and beyond ensure that their food products are safe and in compliance with regulatory guidelines. The two main services that ei4f provides are food product safety testing and nutritional labeling. The program also offers general advice on the multitude of topics of importance to food entrepreneurs.

Results

In 2015, the Entrepreneur Initiative for Food (ei4f) program provided product testing and/or nutritional labeling services to approximately 400 customers, resulting in about 683 products tested and 530 products labeled. If these entrepreneurs had been required to pay for process authority consultants (approximately \$1,500 per day) for each product tested (only \$100 per product), it would have cost them a combined total of \$956,200, assuming the consultants spent only one day on each product. ei4f also offers food labeling services at a price of \$100 per label, as opposed to the typical industry price of \$600 or more, resulting in a savings of at least \$265,000 in labeling costs for these entrepreneurs. Over 50% of the products tested and labeled by ei4f are for customers based in North Carolina, indicating that the majority of the economic impact of the program directly benefits the state.

4. Associated Knowledge Areas

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

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Sweet potatoes have an excellent nutritional profile, and products derived from sweet potato have the potential to supplement or replace more conventional food staples. The development of such products would expand the market for sweet potatoes and provide more nutritional options to the public, especially to those suffering from food insecurity and gluten intolerance.

What has been done

NC State's Department of Food, Bioprocessing, and Nutrition Sciences has developed an enriched sweet potato flour that is shelf-stable and nutritionally comparable to enriched white flour. This sweet potato flour has in turn been used as the base for a nutrient-dense dehydrated food product called Mighty-Mix, which incorporates a sweet potato and mealworm based instant noodle, peanuts, and dried banana chips. Sweet potato flour has also been combined with other gluten-free flours to produce a high-protein gluten-free bread.

Results

Sweet potato flour is a promising carrier for micronutrients, which can be used to fortify starvation-relief food products for use in developing nations and in areas affected by natural disaster. Mighty-Mix can be produced very cheaply (for \$0.56 per serving when mealworms are produced on site), and is thus a promising disaster-relief and starvation-relief food product. General consumers will also benefit from the availability of nutrient dense and gluten free sweet potato flour products.

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
2015	2835

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

According to nationwide foodborne illness data and the U.S. 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?including medication, hospital visits, emergency room costs, hospitalization, chronic medical conditions, loss of productivity, and premature death?at \$430 million to \$4.7 billion annually for N.C., 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

Working with FDA instructors and other faculty, NC State trained approximately 1,546 food handlers in food safety and safe food handling practices, and 2835 individuals obtained certification in GAPs and GHPs. In addition, 1,578 individuals were trained in safe home food handling, preservation, and preparation.

Results

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 \$1,837,395 were saved in 2015 as a result of non-lost work days, and an estimated \$7,348,289 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 becomes 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. The tools to capture additional outcomes and impacts from this program area need some revision to realize the fuller benefit of this program to the interests of both food safety and innovations in food products and manufacturing. Cooperative Extension is filling a position that will have responsibility for program evaluation and reporting, which will enhance our effectiveness in capturing

2015 North Carolina A&T State University and North Carolina State University Combined Research and Extension Annual Report of Accomplishments and Results
program outcomes and impacts.

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

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	101.0	17.0	8.0	5.0
Actual Paid	133.0	21.0	8.0	7.1
Actual Volunteer	286.0	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
1275654	420444	117878	639230
1862 Matching	1890 Matching	1862 Matching	1890 Matching
1275654	176840	117878	138515
1862 All Other	1890 All Other	1862 All Other	1890 All Other
1146568	283711	657825	240441

V(D). Planned Program (Activity)

1. Brief description of the Activity

The family-focused goals of this program will be addressed primarily through a series of workshops that focus on developing family resource management, investment in healthy housing practices, and effective parenting. The goals will be to teach consumers:

1. Family resource management, debt reduction, developing budgets and saving plans
2. To be inclusive of low to moderate income families and families headed by women
3. About reducing home hazards
4. Disseminate of research findings related to agencies/organizations serving limited resource families

Youth impact will be achieved by developing and testing an educational curriculum designed to help youth develop characteristics associated with positive youth development. This will be 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 will be 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.

Contributions to community development will be achieved through a series of research activities including: (1) a study to determine the challenges of new manufactured home owners in the site installation of the units and develop recommendations to the industry for improving the installation process; (2) development of a database of community-based organizations (CBOs) by location, program priorities, capacity and method of operation to encourage collaboration among CBOs, policymakers, businesses and development agencies; and (3) a study to define the critical factors that impact leadership development in rural areas that could lead to new or improved programs for developing future leaders and contributing to the sustainability of rural communities.

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

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	956127	1169719	91178	111890

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

Patent Applications Submitted

Year: 2015
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	7	56	63

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Educational workshops related to energy efficiency and conservation.

Year	Actual
2015	23

Output #2

Output Measure

- Educational workshops for family financial management skills.

Year	Actual
2015	210

Output #3

Output Measure

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

Year	Actual
2015	60

Output #4

Output Measure

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

Year	Actual
2015	195

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
2015	1033

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
2015	371

Output #7

Output Measure

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

Year	Actual
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2015 32780

Output #8

Output Measure

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

Year	Actual
2015	115990

Output #9

Output Measure

- Relevant and impact focused research projects conducted

Year	Actual
2015	10

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
2015	1727

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

The Nash County Cooperative Extension presented money management workshops using the NCA&T financial literacy program "Creating a Budget" and "Shop Smart - Save Money" to over 40 limited-resource residents in Nash County. The workshops included information on how to create a budget, tips on decreasing overall spending, and easy ways to save money at the grocery store. Participants learned about budgeting and about how to decrease their overall spending. They also learned how to plan and prepare for shopping in order to save money and how to understand unit prices when shopping. In Alexander County, Extension partnered with NCA&T Extension specialist to provide the Real Money, Real World financial literacy program to 393 middle school students. Students were assigned careers and required to make simulated financial decisions based on their monthly income.

Results

As a result of the Nash County Extension money management workshops, 100% of participants said they would track and decrease daily spending, and 96% plan to use the information they learned to save money when shopping. Participants were also 82% more likely to adopt a budget for their household. Of the Alexander County middle schoolers, 72% stated that they increased their knowledge of how to make wise financial decisions, and 75% stated that they understood the need for a budget and felt competent to implement one. Statewide, 3,092 people gained

knowledge of basic financial management skills, and 1,727 began implementing basic financial management strategies.

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

- 1862 Extension
- 1890 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	434

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Potential homebuyers are often unaware of the fact that purchasing a home that needs repairs can result in significant unanticipated expense. As a result, homebuyers often do not set aside enough money or obtain enough credit to cover these home repair costs.

What has been done

Cooperative Extension partners with realtors, the City of Jacksonville, and other organizations to educate potential homeowners about credit scores, purchasing steps, and what it takes to maintain a home. The residents who benefit from this program live in Onslow County. An eight-hour class is taught six times a year, with 15-20 participants in each class. Every participant completes a survey at the end of the class.

Results

Evaluations confirmed that participants had learned about various homeownership expenses, including those related to septic tank maintenance, prevention and treatment of pest infestation, mold prevention, and maintaining a landscaped yard. Some state that they are now aware of a need to improve their credit scores and accumulate more savings before they proceed with

purchasing a home. Statewide, 434 people began actively managing their financial identities (such as by obtaining credit reports and selecting credit 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 #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
2015	3287

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

WIC participants have the option to improve their financial situation and increase their consumption of fruits and vegetables, all while supporting local farmers. However, many military families are unaware of the extra help they can access through the WIC Program.

What has been done

EFNEP and Extension provided WIC participants with nutrition lessons and information about the program with the help of the WIC Tarawa Terrace and the Onslow County Farmers' Market. Data was collected by a focus group.

Results

In 2015, more than 350 low income military families were educated on how to use their WIC-Farmers' Market vouchers. They were able to lower their grocery bills, increase their consumption of fruits and vegetables, and support local agriculture. Statewide, 3,287 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
2015	465

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

In the last decade, residential energy demands have increased, family economic concerns have grown, and alarm over greenhouse gas emissions has gained considerable attention. North Carolina citizens need effective solutions to help reduce their home energy use and increase the efficiency of their homes.

What has been done

The Home Energy Management Program, which was created by leaders in the Department of Youth, Family and Community Sciences at NC State University, encourages consumers to be proactive in reducing their home energy consumption and in saving money through no- and low-cost energy efficiency measures, behavioral changes, and home retrofits. The program recently piloted a Master Energy Volunteer program with 10 volunteer participants, who conducted simple home energy audits for neighborhood groups. Over 570 agent and specialist led workshops have since been conducted on home energy management, and consumer energy kits have been distributed to more than 4,300 consumers across the state.

Results

The most significant impacts from this Extension program are approximately 3,920,350 kWh of savings in energy use, at least \$417,950 in savings on homeowner energy costs, and the professional installation of over \$147,000 worth of retrofits in homes across North Carolina. In

addition, 476 homeowners increased their aspirations to save energy and completed a professional home energy audit, over 31% of energy workshop participants changed their behavior to improve energy savings, and approximately 30% engaged in do-it-yourself energy saving projects.

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
2015	1123

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 Cooperative Extension and its partners. A similar program is offered by the Wayne County Cooperative Extension.

What has been done

Youth Leadership Montgomery is overseen by the Montgomery County Cooperative Extension's 4-H Youth Development Agent. Partnering agencies include the Montgomery County Chamber of Commerce. The program requires participants to perform community service, learn about local and state government, shadow a leader in their field of career interest, and attend local board meetings. This year, students met with local legislators during a Legislative Breakfast held in the county to share their opinions and views on local and state issues. Youth Leadership Montgomery students spent their Martin Luther King Holiday completing a food distribution community service project, through which 428 families were served. They were also required to complete a five-hour

community service project of their own choosing. 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. Eighteen students enrolled in and graduated from the 2014-2015 Youth Leadership Montgomery class, and their survey responses indicate that the graduates of this program developed leadership skills that will benefit them throughout their lives. In Wayne County, 23 youth were trained to better serve as leaders in their community. Statewide, 4,544 youth increased their knowledge, skills, and/or attitudes regarding leadership, and 567 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
2015	2257

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Homelessness affects many families and communities. Partners Ending Homelessness of Guilford County reported that over 3,800 individuals and 375 households experienced homelessness in 2012. In order to participate in viable communities with transitional housing where they can succeed, mothers and soon-to-be mothers who are at risk of homelessness will need to enhance their parenting skills.

What has been done

To address issues related to stress and parenting, the North Carolina Cooperative Extension of Guilford County partnered with Room At The Inn of The Triad to implement a six-week parenting

program called Building Stronger Families. Six sessions were offered to 24 residents of Room At The Inn who were single, pregnant, and living in transitional housing. Hands-on activities and handouts reinforced strategies for nurturing their children and managing stress. All participants completed before and after evaluations during the program, and a follow-up survey was conducted four weeks after the completion of the program to measure impact. Parenting education materials developed by Extension Specialists at N.C. A&T were used for this program.

Results

Evaluation results revealed that 100% of the participants increased their understanding of the effects of stress in their lives, and 87% reported adopting at least one behavioral change to manage stress. In addition, 100% of participants stated that they had improved their parenting skills, and 87% stated that they had learned to communicate more effectively with their children. Evaluation results also indicated that 100% of participants are now making an effort to use more stress reduction techniques as a result of the parenting sessions. Statewide, 2,257 parents and other caregivers increased their knowledge of positive parenting practices.

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
2015	7913

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

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

Results

In 2015, 11,421 attended 4-H camping programs (7,913 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
2015	20017

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 and drugs and alcohol are all important factors addressed through 4-H programming.

Results

In 2015, 20,017 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
2015	173196

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 2015, 173,196 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 NCSU.

Results

Statewide in 2015, 115,990 youth increased their knowledge in STEM, 51,358 girls participated in 4-H STEM programs, 32,862 youth gained career/employability skills, 10,762 youth increased

their knowledge of entrepreneurship, 9,314 youth participated in 4-H drop-out prevention programs, and 2,907 teachers were trained in 4-H STEM curricula Junk Drawer Robotics and Robotics Platform.

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
2015	89467

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

One in four North Carolina children faces hunger. According to the 2015 Kids Count Data Book, North Carolina ranks 35th in the nation in overall child well-being. NC 4-H continues to promote health and wellness as one of its major focus areas in efforts to raise awareness about food safety and nutrition.

What has been done

In 2015, over 24,067 youth participated in the 4-H Expanded Food & Nutrition Education Program (EFNEP), which focused on encouraging positive behavior changes in the following areas: daily physical activity, healthy food choices, and food safety in preparation and storage.

Results

As a result of participation in EFNEP, 87% of youth improved their ability to choose foods according to Federal Dietary Recommendations or gained knowledge of nutrition, 62% of children and youth used safe food handling practices more often or gained knowledge in their usage, and 46% of children and youth improved physical activity practices or gained knowledge in this area.

Statewide, 89,467 4-H youth were active in special interest activities. Also in 2015, 82,287 4-H'ers participated in food and nutrition activities or programs, and 24,484 youth reported an increase in their consumption of fruits and vegetables.

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
2015	3508

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

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 2015, 11,421 attended 4-H camping programs (3,508 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
2015	46994

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

According to the NC Department of Health and Human Services, over 60% of North Carolinians are either overweight or obese. Overweight and obese individuals tend to suffer from chronic illnesses that place enormous burdens on individuals and on state infrastructure. Education on food budgeting, nutrition, and home food preparation can simultaneously improve the financial and physical health of families.

What has been done

In 2015, the Wilkes County Cooperative Extension again offered the Market Chef Program, which was introduced in 2014, to educate families on saving money and improving health by preparing meals at home using locally-grown, in-season produce. This program expanded this year to a second farmers market and included cooking demonstrations and healthy, affordable recipe tastings. In addition, Jeannie's Kitchen, an online educational program created by the Davidson County Extension in 2009, has continued to provide nutritional information, healthy recipes, and cooking demonstrations to citizens through Facebook.

Results

In 2015, the Market Chef Program reached over 600 people, and Jeannie's Kitchen currently has over 1,000 subscribers. Statewide, 41,269 adults and youth have increased their consumption of

fruit and vegetables, and 5725 participants consume less sodium in their diets.

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
2015	2257

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Teen pregnancy results in a burden of responsibility that many young people are not yet mature enough to handle. This makes teen parents especially vulnerable to excessive stress, which in turn affects their children. In the United States, three out of every ten girls will become pregnant before the age of 20, and North Carolina ranks 14th in the nation for number of teen pregnancies.

What has been done

NC State's Department of Youth, Family and Community Sciences partners with Greene, Lenoir, and Harnett counties to offer the 4-H Very Important Parents (VIP) Program. This program offers face-to-face and technology-assisted education and guidance to teen parents and adults up to 22 years of age who became parents as teenagers. The program consists of 12 weekly group meetings, followed by nine monthly group meetings. Throughout the program, online support is also offered to participants through Google Hangouts, Facebook, YouTube, and other internet platforms. Lesson topics include positive parenting, stress management, building and maintaining healthy relationships, child safety, and financial planning. To date, 31 teens have completed the program.

Results

Although the program is small and additional data is needed to confirm its efficacy, the results so far are promising. Pre and post results for participants (as measured by the Children, Youth, and Families at Risk [CYFAR] Common Measures) show significant growth in parenting skills, nurturing attitudes, general social skills, ability to form and maintain healthy relationships, and decision making. Participants reported significantly increased confidence in the following areas (among others): responding appropriately to child behavior, active listening, comforting an emotionally distressed child, communication with child care providers, positive conflict resolution skills, and responding appropriately during difficult situations.

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.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

As homeowners age, their quality of life at home is affected if homes are not built to accommodate their physical challenges. Little research exists related to home accessibility for older, limited-resource homeowners in retirement.

What has been done

NC A&T researchers conducted personal interviews with 30 limited-resource homeowners aged 55 and over and living in a central NC city who completed home modifications. Responses were tape recorded and transcribed. Content analysis was used for qualitative data analysis. Information regarding the types of home modifications, along with information concerning housing

costs and living conditions and the need for more improvements, was obtained.

Results

The two most frequently identified home modifications related to improving home accessibility were exterior ramps and bathroom grab bars. Seventy percent of homeowners reported needing additional improvements for home accessibility. With home modifications, elderly homeowners with limited resources can improve their well-being and quality of life while providing economic benefits to their neighborhoods and communities as they age-in-place.

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
805	Community Institutions, Health, and Social Services

Outcome #15

1. Outcome Measures

Identify the factors associated with successful entrepreneurship in rural communities.

2. Associated Institution Types

- 1890 Extension
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	9521

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Individual farmers and farming families are continuously approaching cooperative extensions statewide to learn how to farm their land to reap profit and tax benefits. These rural entrepreneurs rely on cooperative extensions for education and resources that help ensure success in every aspect of agricultural business management.

What has been done

Cooperative Extension in Ashe, Alleghany, Watauga, and Wilkes Counties partnered with NC State specialists, the Golden LEAF Foundation, the NC Association of County Commissioners, and Carolina Farm Credit to form the Blue Ridge NC Farm School (BRNCFS), a seven month educational program that trained beginning and transitioning farmers through seven business-planning seminars and seven, day-long field visits to working farms led by innovative and experienced local farmers. Throughout the program, specialists and agents worked closely with participants to develop individualized business plans. Seven individuals and seven couples participated from the four county area. In the Piedmont and Sandhills regions, Anson Cooperative Extension hosted two, six-hour field days to instruct rural entrepreneurs in small scale poultry production, shiitake mushroom production, beekeeping, and dairy production.

Results

Pre-program surveys revealed that 100% of the BRNCFS participants had no working business plan prior to completing the program. After completion of the class, 71% of participants had completed a business plan. Participants also advanced knowledge by a minimum of 33% in business organization, capital budgeting, record-keeping, marketing, and managing risk. Post surveys indicate that participants added an average of \$10,000 to their annual income as a result of participating in the BRNCFS. The field days hosted by Anson Cooperative Extension served a total of 40 participants, who were subsequently able to fine tune their business plans, acquire necessary licensing, and better define the direction and financial needs of their ventures.

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. Cooperative Extension is filling a position that will have responsibility for program evaluation and reporting, which will enhance our effectiveness in capturing program 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%	0%
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	10%	0%	5%	0%
721	Insects and Other Pests Affecting Humans	10%	0%	10%	10%
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	10%	0%	0%	0%
	Total	100%	0%	100%	100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	13.0	0.0	47.0	6.0
Actual Paid	19.0	0.0	44.0	3.4
Actual Volunteer	10.0	0.0	10.0	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
185775	0	648327	365145
1862 Matching	1890 Matching	1862 Matching	1890 Matching
185775	0	648327	34766
1862 All Other	1890 All Other	1862 All Other	1890 All Other
166976	0	3618037	160141

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 repellent 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 makeups of animals and based on that, how environmental influences (chemicals, toxicants, food compounds) might influence cancer development. 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?

2015 North Carolina A&T State University and North Carolina State University Combined Research and Extension Annual Report of Accomplishments and Results
eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	225200	163165	40273	29179

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

Patent Applications Submitted

Year: 2015

Actual: 20

Patents listed

030871-9044-WO00 - Protease-Resistant Peptide Ligands

5051.811.TS - Nanotechnology System for Agricultural Applications

5051.869.PR - Novel Cas9 Proteins and Guiding Features for DNA Targeting and Genome Editing

5051.869.PR - Novel Cas9 Proteins and Guiding Features for DNA targeting and Genome Editing

AG004213-PCT - Novel Methods and Compositions to Evaluate and Determine Inactivation of Hazardous Biological Material

5051.844.WO - Compositions and Methods Related to a Type-II Crispr-Cas System in Lactobacillus Buchneri

5051.873.PR - Novel Process for Reducing Allergenicity of Semi-soluble allergenic proteins

127/78 UTIL - Hypoallergenic Food-Grade Protein Matrices and Uses Thereof

5051.847.W - Methods and Composition for Sequences Guiding CAS9 Targeting

5051.773.TSDV - Inhibition of Bacterial Biofilms with Imidazole-Phenyl Derivatives

5051.881.PR - Methods for Screening Bacteria, Archaea, Algae, and Yeast Using CRISPR Nucleic Acids

127/81 UTIL - Beta-Hexosyl-Transferases and Uses Thereof

127/81 AU - Beta-Hexosyl-Transferases and Uses Thereof

127/81 JP - Beta-Hexosyl Transferases Expressed in Pichia for Production of GOS - Project: Aviator

127/81 SG - Beta-Hexosyl-Transferases and Uses Thereof

N61824-1450WO - Aptamers with Binding Affinity to Norovirus

127/81 NZ - Beta-Hexosyl-Transferases and Uses Thereof

5051.886PR - Methods and Compositions for Genome Editing in Bacteria Using CRISPR-CAS9 Systems

5051.883PR - Compositions for Multiple Guide Nucleic Acids and Methods of Use in CRISP-CAS9 Technologies

AG0033 0315 Enzymatic Treatment of Peanuts

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	5	83	88

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
2015	1879

Output #2

Output Measure

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

Year	Actual
2015	114955

Output #3

Output Measure

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

Year	Actual
2015	40

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Peanuts are a high value commodity and a valuable source of vitamins, fiber, unsaturated fat, and protein. However, the peanut plant has no real value after its seeds are harvested. The identification and isolation of nutraceutical compounds in the peanut plant would enhance its marketability.

What has been done

Researchers in the Food Science Department at NC State have been continually evaluating the nutritional content of wild peanut varieties as well as varieties in current production and varieties under development. Unused plant material, such as leaves and skins, has been processed by distillation, solvent extraction, and spray drying. Extracts from peanut skins have been tested for their ability to reduce inflammation at the cellular level.

Results

Plant breeders have been supplied with information on the nutritional quality of specific varieties. Potentially bioactive compounds have been identified in seed and non-seed plant material (such as roots and stems). This research has provided the first report of bioactivity from non-seed peanut material in vivo, which opens up the possibility of this traditional waste material being exploited for functional ingredients. Bioactive compounds have also been isolated in order to establish the best conditions for optimizing their extraction. Investigation into possible markets for plant material after the removal of bioactive compounds is ongoing.

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
2015	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

More than one billion people worldwide have a high risk of contracting malaria. Artemisinin combined therapy is the first-line malaria treatment recommended by the World Health Organization. Artemisia annua L. is the only natural source of artemisinin. Unfortunately, due to low and varying yields of artemisinin produced by Artemisia annua, it is currently impossible to meet the growing demands for this medicine. More than half a million people die every year due to a lack of artemisinin.

What has been done

Researchers at NC State's Department of Plant and Microbial Biology have bred for the first time self-pollinating Artemisia annua plants. These plants have demonstrated unique properties, including morphological changes and increased production of artemisinin.

Results

Self-pollinating Artemisia annua has the potential to overcome current limitations in artemisinin production. In addition, these plants can be used to study artemisinin biosynthesis in order to learn more about this compound and how it can be most efficiently produced and isolated for treatment of malaria.

4. Associated Knowledge Areas

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

Outcome #3

1. Outcome Measures

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

2. Associated Institution Types

- 1862 Extension
- 1862 Research
- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	10

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

There is an impending worldwide disaster due to decreasing investment in antibacterial drug research and development alongside a rapid increase in the level of resistance to currently licensed drugs. Developing new antibiotic complexes is extremely costly and time consuming, and new drugs will have finite lifetimes due to the onset of bacterial resistance. An elegant solution to this problem would be to develop techniques for restoring the efficacy of existing antibiotics.

What has been done

A combination of genetic, biochemical, and thermodynamic methods and high-resolution NMR spectroscopy was used to elucidate the mechanistic and molecular recognition features of proteins involved in the regulatory and protective processes of bacteria. Several new classes of therapeutics were developed to overcome antibiotic resistant traits.

Results

The compounds developed through this research have demonstrated an ability to overcome antibiotic resistant traits in about 20 medically important pathogenic bacteria. For example, MRSA has been re-sensitized to penicillin, methicillin, and oxycillin; multi-drug resistant A. Baumannii has been re-sensitized to imipenem and ciprofloxacin; and tetracycline resistant E. coli has been re-sensitized to tetracycline. In addition, several previously ?off-the-shelf? antibiotics against highly resistant and dangerous bacteria have been reactivated.

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
2015	5

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Ovarian cancer generally carries a poor prognosis because it tends to remain undiagnosed until it is in the later stages, and currently available treatments often fail once it has metastasized. A valid animal model for studying ovarian cancer in humans is vital to the development of chemopreventative strategies. Unlike many other animals, in which the development of ovarian cancer must be artificially induced, the egg-laying hen has a high incidence of spontaneous ovarian cancer. In addition, human ovarian cancer is thought to be related to ovulation-induced genetic damage, and egg-laying hens have a high ovulatory rate. This makes the laying hen a promising animal model for isolating potential ovarian cancer biomarkers.

What has been done

A team from NC State's College of Agriculture and Life Sciences and the College of Sciences used the poultry model for spontaneous ovarian cancer and in-depth analysis of the chicken ovarian cancer proteome to search for novel biomarkers.

Results

A novel biomarker, OVOS2, was identified in the pathogenesis of both chicken and human ovarian cancer. This biomarker has the potential to facilitate the identification of agents that will assist in the prevention and treatment of ovarian cancer. In addition, the success of this research supports the validity of the poultry ovarian cancer model, which can hopefully be further used to expedite the discovery and testing of new treatments.

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. Cooperative Extension is filling a position that will have responsibility for program evaluation and reporting, which will enhance our effectiveness in capturing program outcomes and impacts.

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

Childhood Obesity (Outcome 1, Indicator 1.c)	
25484	Number of children and youth who reported eating more of healthy foods.
Climate Change (Outcome 1, Indicator 4)	
2	Number of new crop varieties, animal breeds, and genotypes with climate adaptive traits.
Global Food Security and Hunger (Outcome 1, Indicator 4.a)	
62918	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)	
2	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)	
8	Number of farmers who adopted a dedicated bioenergy crop
Sustainable Energy (Outcome 3, Indicator 4)	
147801	Tons of feedstocks delivered.