# 2016 University of Delaware and Delaware State University Combined Research and Extension Annual Report of Accomplishments and Results

**Status: Accepted**

**Date Accepted: 06/13/2017**

## I. Report Overview

### 1. Executive Summary

Delaware agriculture increasingly operates in a global economy and we face ongoing challenges in our efforts to help ensure food security for a growing population, develop innovative means to improve profitability and productivity, and protect the environment. Emerging issues must also be addressed, including avian influenza, climate change, farmland loss to development, food safety, and social issues for families and youth such as addressing preventive health and nutrition issues across the food system. Agriculture in Delaware remains strong today, with the Delmarva broiler industry the biggest agriculture commodity. The state has 490,000 acres of cropland (45% irrigated) that provide the grain crops needed for a thriving poultry industry, an innovative and profitable vegetable production industry, and a "green industry" that supports horticultural and natural resource interests of its citizens. A 2010 report led by the University of Delaware College of Agriculture & Natural Resources ("The Impact of Agriculture on Delaware's Economy") found that the total economic contribution of all categories of agriculture in Delaware was $7.95 billion in industry output and that the agricultural industry contributed $2.5 billion in value added activity, and $1.6 billion in labor income, supporting 30,000 jobs.

Our plan of work has been designed to help Delaware agriculture remain competitive, to meet its environmental challenges, sustain the state's natural resources and support our rural and urban youth, families, and communities. We focus on the following four programs intended to provide research-based solutions to the complex, global challenges facing Delaware today. It is important to note that divisions between these programmatic efforts are artificial. Our research and extension efforts are most commonly conducted by multi-disciplinary teams working across programs, in collaboration with colleagues in other disciplines. We also regularly plan and work with stakeholders in other University departments, other governmental agencies, foundations, community groups, universities, and political or policy-making positions. Delaware is also uniquely situated geographically to share across states in the mid-Atlantic region and positions and programs are utilized across state lines.

**1. Sustainable Production Systems for Agricultural and Urban Landscapes**

Delaware agriculture is fully integrated into the global economy and driven by the need to produce a safe and secure food supply for a growing world population. Longstanding components of agriculture in Delaware are animal production, grain, vegetables, aquaculture, soil management and watershed protection, and agricultural and natural resource economics. Vegetable crops, specifically lima beans, and specialty crops continue to diversify the vegetable production component.

Animal-based agriculture is one of the largest and most profitable enterprises in Delaware with poultry production and processing activities accounting for over $3.2 billion dollars in industry output, 13,437 jobs, and $911.6 million in value added, according to the 2010 report. Other livestock industries ($32M farm sales from dairy, beef cattle, swine) compose a smaller but locally important part of the agricultural economy. Aquaculture has emerged as a new sector, in freshwaters and coastal areas with shellfish. For poultry, diagnosis and control of infectious avian diseases is a high research priority, while for all of animal agriculture, research and extension programs focus on key issues such nutrient management and water and plant/soil interfacial reactions key to plant nutrient use and plant adaptation to contaminated soils.

Environmentally sound management of soil resources requires that we address a range of issues impacting air, soil, surface and ground water quality such as efficient use of nutrients in animal and crop

production; fate, mobility, speciation, and bioavailability of metals and organic chemicals in soil and water environments; efficient use of ground water for irrigation; safe use of pesticides and herbicides; and emission of gases and particulates from soils and wastes that can affect air quality, climate change, and human and ecosystem health. We conduct basic research to increase our fundamental understanding of soil processes and applied research and extension programs to develop and implement management strategies that sustain agriculture and other land uses while protecting the quality of our air, soil, and water. Integrating economics with basic and applied research is a key aspect of this planned program. Our economics research foci is highlighted by The Center for Behavioral and Experimental Agri-Environmental Research CBEAR. The mission of the center is applying behavioral insights and experimental designs to improve programs related to agriculture and the environment.
The University of Delaware, in conjunction with the state and private industry, has devoted 25 years to developing research capacity and expertise in basic and applied biotechnology. Areas of existing strength are avian virology, physiology, and genomics and plant molecular biology and plant breeding. In our avian programs, biotechnology is used at the basic level to improve poultry health and immune competence and to understand fundamental mechanisms of avian diseases. At the applied level, biotechnology efforts focus on improving diagnostic testing methods, developing vaccines and other disease control methodologies, surveying for emerging avian disease causing agents, and developing disease resistant breeds of chickens. For plants, basic biotechnology efforts include understanding gene regulation in plants, particularly those associated with RNA turnover or small RNA-mediated gene regulation. Other efforts include understanding disease resistance and signal transduction pathways in plants, understanding nitrogen fixation via the application of molecular and proteomics approaches, and understanding, at the molecular and atomic levels, plant-soil interfacial relations important to nutrient and heavy metal uptake.

**2. A Safe and Secure Food Supply for Human Nutrition and Health**
The American food system provides consumers with an abundant supply of convenient, economical, high-quality, nutritious, and safe food products. However, foodborne illnesses still occur in the U.S. Outbreaks of foodborne illness due to microbial contamination continue to be a major but preventable public health problem. While advances in understanding and controlling foodborne pathogens have been significant, new pathogens, new food products, increases in imported foods, and increasing anti-microbial resistance present new challenges to the nation's food safety programs. Our research programs focus on understanding foodborne pathogens and reducing the occurrence of these microbes during pre- and post-harvest by intervention strategies (e.g., high pressure, ultraviolet light, antimicrobial packaging). Extension activities center on food safety education of food producers, food handlers and consumers; emerging food safety and nutrition issues; and public education about how to respond to outbreaks of foodborne diseases. Recent legislation related to food safety in food service establishments has doubled the need for food safety training for this audience. Extension successfully boasts a 90% success rate of those trained in successfully receiving food safety certification.
Extension programming aimed at addressing health issues such as obesity and diabetes involves the development of healthy eating and physical activity patterns. These programs are delivered by family and consumer science educators, youth agents, paraprofessionals, master food educators and in the last few years a corps of youth health ambassadors. Special emphasis is placed on minority, low-income and educationally disadvantaged individuals since nationwide data indicate these individuals have disproportionate health rankings. Grant funded programs further enhance the efforts in these program areas. Although many diseases occur more frequently with advancing age, dietary practices in young people significantly affect the occurrence and onset of these diseases. Extension activities center on selecting foods from My Plate, meal planning, and food preparation to increase fruit and vegetable intake, select beverage intake and increasing physical activity.
**3. Volunteer, Family and Youth Development**
The rapid economic and social changes occurring in Delaware today place high demands on families and communities. These problems occur in both rural and urban areas. Strong families are the basic building unit for our future citizens, yet those charged with this important responsibility often do not have the time,

money, or skills to carry out their family roles in a positive, productive manner. Preparing citizens to take prominent roles in shaping their future and the future of their communities and community policy is the fundamental goal of this planned program. Cooperative Extension activities are the major component of this program area.
Volunteer and Leadership development programming involves Master Gardener, Master Food Educators, Master Composters, youth health ambassadors and 4-H youth volunteers make up a volunteer corps of over 3000 volunteers. Advisory committees in each program area serve as additional volunteers. LEADelawares is an intensive 18 month leadership program for emerging agriculture leaders.
The 4-H youth development program focuses on mission mandate areas in STEM education, citizenship and nutrition and health. The goals of 4-H STEM are to increase awareness, understanding, and appreciation in the areas of science, technology, engineering, and mathematics.Through hands on learning experiences youth develop knowledge, skills, and abilities in science, technology, engineering, and mathematics that are both career and life skills. Reaching almost 46% of the youth 8-18 in Delaware, 4-H in multiple delivery formats is assisting Delaware youth to develop the leadership and life skills needed to become productive, independent, contributors to our society.
Farm, small business and family resource management remains critical to the economic stability of the state. Partnerships with FSA on risk management training as well as MD Ag Law program on farm transfer and succession planning are critical components of maintaining agriculture and it's infrastructure in DE. Likewise, with major changes in health care, education on smart choices of health care is another risk management program for both farm and families alike. Recent changes in DuPont ownership by DOW pose opportunities for enhanced work with encouraging agricultural entrepreneurship to maintain jobs in Delaware.

**4. Environmental Stewardship in a changing climate**

This program focuses on maintaining and restoring renewable natural resources and the vital services provided by healthy ecosystems in Delaware after 400 years of urbanization and agriculture. The impact of past and current land use changes, such as agricultural/forestry practices and encroachment of urban/suburban populations on native landscapes, is not fully understood but is thought to be contributing to the loss of many plant and animal species. Perturbation of ecosystems, such as by fragmentation of wildlife habitat, and nutrient enrichment of aquatic resources are key areas in need of more research and extension programming. New technologies in agricultural production that include control of insects, weeds, filamentous algae, and plant pathogens are needed to ensure sustainability of agriculture in Delaware while restoring and maintaining biodiversity and natural ecosystems located on farms. Finding ways to replace and sustain biodiversity in suburban landscapes, which today comprise 54% of Delaware, is another priority and is vital to future efforts to sustain natural resources in the face of increasingly rapid land use change.
Climate change will create major challenges for Delaware's agriculture and natural resource areas, due to a transition to a warmer climate, characterized by hotter summers and warmer winters and more extreme weather events. Sea level rise will lead to problems with salt water intrusion into ground waters used for irrigation, inundation of wetlands and other low-lying natural areas, and intensified flooding, particularly problematic for cropland near the coast that is only productive because of an extensive network of drainage ditches. Research and extension foci in his planned program are (i) improving fundamental understanding of why and how a changing climate affects animal and plant physiological processes related to health and productivity, the transformations of carbon, nutrients, organic chemicals, and toxins in soils, and biodiversity of plants and wildlife in natural ecosystems; (ii)developing cost-effective management strategies to help animal and crop producers and natural resource managers respond to weather extremes, greater pressures from insects and diseases, salinity and sea level rise; and (iii)contributing to the development of climate change policies (e.g., carbon trading) that provide farmers and others with resources needed to adopt practices to mitigate climate change problems.

**Total Actual Amount of professional FTEs/SYs for this State**

| Year: 2016 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| Plan | 42.9 | 16.5 | 80.5 | 8.3 |
| Actual | 23.4 | 18.0 | 78.1 | 9.0 |

## II. Merit Review Process

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

- Internal University Panel
- Combined External and Internal University Panel
- Combined External and Internal University External Non-University Panel
- Expert Peer Review
- Other (Northeast Cooperative Extension Directors )

### 2. Brief Explanation

**Scientific Peer Review of Research Programs**

We adopt by reference the National Standards for Peer Review.

**Merit Review of Extension Programs**

Merit review for Delaware Cooperative Extension consists of five levels of peer and stakeholder review. Extension professionals submit county plans that have been reviewed by their peers within the county and by county stakeholder advisory groups. These stakeholder groups provide input on critical needs and issues within their communities, which is used to develop the county plans. After county plans are complete, stakeholders review them for inclusion of the previously identified needs and issues, as well as, program delivery and evaluation methodologies. Each of these plans includes specific objectives that are examined for relevance, usefulness, and potential impact of the programs. This feedback is used to refine county plans and develop future plans. The second level of review is by college-wide issue teams that are cross-functional and multi-disciplinary. From this review, county plans are combined into a college-wide plan. The third level of review is both within and outside the university community. Copies of the plan are submitted to university administrators and related agency personnel who function as both present and future partners. These individuals are invited to comment on the objectives identified, areas of collaboration, and potential impacts. University administrators are also asked to comment on ways in which we might work across colleges and schools to increase our outreach efforts. A fourth level is with statewide stakeholder groups, including advisory groups, commodity organizations, volunteers, research partners, and state and local funding agencies. These groups are asked to provide feedback regarding objectives, potential impacts, and how it meets their specific needs. The final level is the Northeast Extension directors, who have agreed to share all state plans among each other. This peer review helps states advise each other on opportunities to strengthen individual state plans and ways that we can collaborate across state lines.

## 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 specifically with non-traditional groups
- Survey of selected individuals from the general public
- Other (Permanent advisory committees for extension programs and researc)

**Brief explanation.**

In the State of Delaware, the University of Delaware and Delaware State University use a multi-faceted approach to secure stakeholder input. We believe in direct contact with people and actively solicit input from a wide variety of clientele, users and stakeholders. College administrators, faculty working on research funded by state and federal agencies or industry, and Cooperative Extension staff regularly request input on the relevance of our research and extension priorities to state and regional problems. UD College of Agriculture and Natural Resources has a comprehensive College Advisory Board that meets twice a year and provides overall input into academic, research and extension programs. DSU College of Agriculture and Related Sciences also participate in numerous formal opportunities for input from stakeholders and include, but are not limited to, the following: extension overall advisory committees, extension issue-based advisory committees, strengthening families statewide advisory committee, 4-H volunteers, 4-H Foundation, LINKS, agriculture commodity groups, environmental interests, the green industry, agribusinesses, agriculture associations (i.e., Farm Bureau, Grange, Pork Producers Association, Delmarva Poultry Industry, Soybean Board, Sheep Producers Association, etc.), Master Gardeners, Master Food Educators, and Master Financial Planners. We meet with these groups on a regular basis and request their input on our programs and encourage their involvement in all of our planning efforts.

### 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 External Focus Groups
- Open Listening Sessions
- Needs Assessments

**Brief explanation.**

Stakeholders are identified by a combined effort of college administrators, research and teaching faculty, and cooperative extension staff. We are very familiar with our traditional agricultural stakeholders and have established a number of advisory committees, at the county and state levels,

to provide input on our research and extension programs. Similarly, we have long-standing contacts and good relations with many individuals, organizations, and agencies involved in the natural resource and environmental matters important to our research and extension programs. We work hard to ensure that these committees represent the range of agricultural production systems present in the state, the interests of those concerned about natural resources and the environment, and the social and economic issues related to communities, families, and youth development. We also take proactive steps to ensure that our advisory committees encompass the increasing diversity (age, gender, background, ethnic group) of our stakeholders. When new issues come forth, or a need for re-organization and re-direction of an existing program arises, we often establish focus groups composed of a mix of individuals internal and external to our universities to help guide our planning and to ensure that all interested parties are contacted for input. As appropriate, we also will use surveys and open listening sessions to solicit input from the public. Stakeholders search on each of our advisory search committees when new faculty and staff positions are filled.

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

**1. Methods for collecting Stakeholder Input**

- Meeting with traditional Stakeholder groups
- Meeting with traditional Stakeholder individuals
- Meeting with the general public (open meeting advertised to all)
- Meeting specifically with non-traditional groups
- Meeting with invited selected individuals from the general public
- Other (Meetings with permanent advisory committees)

**Brief explanation.**

We hold a variety of regular meetings across the state, which include a diverse mix of clientele, users, and stakeholders. These meetings include such things as: Agriculture Visiting Committee, State Chamber of Commerce, Kids County Advisory Council, Delaware Public Policy Institute Task Force, Council of Farm Organizations, USDA Food and Agricultural Council, State Agriculture Technical Committee, and user groups like 4-H parents and leader advisory groups Students enrolled in our colleges, faculty, professionals and salaried staff, are all encouraged to provide input on program priorities. We have conducted random surveys of users and non-users of the programs and activities on a variety of issues including land use and economic development. Other tools that we use to get input include visioning processes and focus groups. For the Plan of Work, specific stakeholder input was obtained via a committee assembled by the Delaware Secretary of Agriculture to participate in the develop of a statewide plan for agricultural research. This committee consisted of leaders in agriculture as well as faculty and administrators from the University of Delaware and Delaware State University. All of these efforts have been focused on both building commitment and getting input from stakeholders such as government agencies, industry partners, and regulatory agencies. Our programs have expanded and input continues to increase. We are recognized as a source of not only useful but also reliable information. We will continue to seek input in a variety of ways. These methods will change as the issues themselves change.

**3. A statement of how the input will be considered**

- To Identify Emerging Issues
- Redirect Extension Programs
- Redirect Research Programs
- To Set Priorities

**Brief explanation.**

We value all input from our stakeholders and use it to guide a number of our applied research and extension programs. It is particularly valuable in our efforts to make sure that any new and emerging agricultural, environmental, and social issues are identified early and that programs are developed to address them effectively. We carefully consider stakeholder input in our periodic reviews of extension programs to ensure that our goals are up-to-date and that we have the appropriately trained staff in place to meet these goals. We also use stakeholder input to identify areas where research is perceived to be needed. In some cases, where an adequate research base is already available, we respond through an increased extension effort to communicate research findings to end-users. However, if stakeholders identify areas where new or expanded research or extension is needed, we use their input to strengthen our requests for research support from funding agencies and to identify partners that can collaborate in research projects.

**Brief Explanation of what you learned from your Stakeholders**

Current and Future Unique strengths of the College
Current Strengths
Future Strengths
4-H & Youth development
Climate Science-mitigation and adaptation in agriculture, ecosystems and environment
Avian Biosciences and disease
Quantitative sciences: data analytics, predictive modeling, statistics related to large data sets
Ecosystem sciences and biodiversity
Legal and regulatory policy
Experimental economics
Sustainable landscapes and ecosystems
Food Safety
Urban agriculture
Genetics and Genomics
Integration of plant, animal and ecosystem health expertise with human health-a "one health" initiative
Integrated pest management
Protected agriculture (hoop house) management
Natural resource economics and policy
Public horticulture
Soil and water quality, nutrient management, irrigation
Pre-vet medicine and animal biology
Current and future partnerships needed to leverage resources and achieve selective excellence in the college programs have been identified.
Current and future resources for the College are identified. Future resources needed to support unique strengths include new research lab facilities to replace those in Worrilow Hall that have exceeded their useful lifetime.
Several attributes make the college unique among colleges at UD or compared to other colleges of agriculture and related sciences in the region including:

expertise in biological, physical, and social sciences that can address the human dimensions of problems as well as the underpinning science
Extension engages the College with stakeholders, deliberately aligns CANR with the core values of UD, and provides strong sense of relevance and value to Delawareans
CANR provides a small college feel within the context of a larger research university.
World-class faculty in many disciplines are approachable and accessible to students, stakeholders, industry and communities.
CANR is located in the heart of the east coast megalopolis and its 350 acre Newark farm is largely within the city limits. It provides excellent opportunities for urban agriculture interface studies as well as natural resource issues in a human dominated landscape
CANR enjoys unusually strong relationships with state and federal legislators and regional agencies in part due to the small size of Delaware relative to other states, but largely through our relevance to key sectors of the state's economy.

## IV. Expenditure Summary

| 1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS) | | | |
|---|---|---|---|
| Extension | | Research | |
| Smith-Lever 3b & 3c | 1890 Extension | Hatch | Evans-Allen |
| 1348396 | 1186766 | 1632416 | 1249750 |

| 2. Totaled Actual dollars from Planned Programs Inputs | | | | |
|---|---|---|---|---|
| | Extension | | Research | |
| | Smith-Lever 3b & 3c | 1890 Extension | Hatch | Evans-Allen |
| Actual Formula | 2069548 | 1186766 | 478119 | 1249749 |
| Actual Matching | 2341221 | 1186766 | 2625668 | 1249749 |
| Actual All Other | 905730 | 639653 | 2451644 | 2110130 |
| Total Actual Expended | 5316499 | 3013185 | 5555431 | 4609628 |

| 3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous | | | | |
|---|---|---|---|---|
| Carryover | 100226 | 0 | 504405 | 0 |

# V. Planned Program Table of Content

## V(A). Planned Program (Summary)

**Program # 1**

**1. Name of the Planned Program**

SUSTAINABLE PRODUCTION SYSTEMS FOR AGRICULTURAL AND URBAN LANDSCAPES

☑ 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 | 10% | 10% | 10% | 10% |
| 112 | Watershed Protection and Management | 5% | 5% | 5% | 5% |
| 201 | Plant Genome, Genetics, and Genetic Mechanisms | 10% | 10% | 10% | 10% |
| 203 | Plant Biological Efficiency and Abiotic Stresses Affecting Plants | 5% | 5% | 5% | 5% |
| 205 | Plant Management Systems | 10% | 10% | 10% | 10% |
| 212 | Pathogens and Nematodes Affecting Plants | 5% | 5% | 5% | 5% |
| 304 | Animal Genome | 10% | 10% | 10% | 10% |
| 305 | Animal Physiological Processes | 5% | 5% | 5% | 5% |
| 307 | Animal Management Systems | 5% | 5% | 5% | 5% |
| 311 | Animal Diseases | 15% | 15% | 15% | 15% |
| 405 | Drainage and Irrigation Systems and Facilities | 10% | 10% | 10% | 10% |
| 604 | Marketing and Distribution Practices | 5% | 5% | 5% | 5% |
| 903 | Communication, Education, and Information Delivery | 5% | 5% | 5% | 5% |
| | **Total** | 100% | 100% | 100% | 100% |

## V(C). Planned Program (Inputs)

### 1. Actual amount of FTE/SYs expended this Program

| Year: 2016 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| **Plan** | 16.8 | 5.1 | 34.1 | 2.0 |
| **Actual Paid** | 5.1 | 5.4 | 32.8 | 1.6 |
| **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** |
| 983418 | 357021 | 144068 | 54823 |
| **1862 Matching** | **1890 Matching** | **1862 Matching** | **1890 Matching** |
| 689398 | 357021 | 1813246 | 54823 |
| **1862 All Other** | **1890 All Other** | **1862 All Other** | **1890 All Other** |
| 236339 | 322241 | 392932 | 66302 |

## V(D). Planned Program (Activity)

### 1. Brief description of the Activity

Research and extension programs fall into the following target areas:

I. **Best Management Practices to maintain or enhance the competitiveness of Delaware's agriculture and food systems**

A. Animal Agriculture: For animal agriculture, research and extension programs will target: (1)Poultry Health and Disease Prevention and Control - mechanisms of disease induction, host genetic resistance and immune responses in poultry with a focus on diagnostic surveillance methodology, vaccination and biocontainment; (2) Poultry Growth and Development - basic molecular and cellular mechanisms regulating poultry growth, development and meat yield;(3) Avian Genomics - development and application of avian microarrays for: disease diagnosis, resistance, and control; growth and development; and optimization of desired production traits; (4) Alternative Production Systems - alternative production systems to reduce disease, mortality, and waste production, minimize antibiotic use, integrate alternative energy into production systems and foster compatibility between animal production, environmental quality, and urban populations; (5)Nutrient Utilization in Poultry and Ruminants - increased nutrient utilization and reduced nutrient excretion via improved understanding of animal biology; (6) Comparative Pathology Laboratory. This laboratory supports the efforts of poultry diagnostic laboratories in Delaware and Maryland and features collaborative research on histopathologic analysis for researchers engaged in studies related to animal disease and animal models of human disease, and consultation regarding tissue dissection, collection, trimming, fixation, image capture, and techniques in immune-histochemistry.

B. Plant Biology and Crop Production: Key activities are: (1) Agronomic, Vegetable and Horticultural Crops - improving varietal selection, disease and pest resistance, seed technology, cultural and marketing practices; (2) New Crops - financial and environmental impacts of new crops or new varieties of existing crops, emphasizing the growth of local food productions systems and sustainable landscape design practices for urban settings; (3) Integrated Pest Management - control of insect pests, weeds, and plant pathogens via biological and chemical methods; (4) Engineering Technologies - improvements in harvesting and guidance systems and expanded research and extension programs on irrigation management; implementing recent advances in remote sensing, tillage, and pesticide application; (5) Plant Breeding, Crop Genomics, Proteomics, and Bioinformatics - basic research on how plants adapt to their environments and soil/climate stress and the nature of soil microorganism-plant symbiotic relationships and plant/soil interfacial reactions affecting crop growth and quality; (6) Pasture and Forage Management - research on pasture-based animal production systems and forage research on improving biological control systems for alfalfa. (7) Nutrient Management for Water and Quality - fertilizer and waste management programs to ensure economic and environmental sustainability while considering crop

needs, nutrient reactions in soils, alternative fertilizer sources, and government policies.

**II. Develop and adopt appropriate technologies for food production and marketing in urban areas.**

Key activities are: (1) expand food production with micro entrepreneurship opportunities in urban/suburban areas; (2) leadership development for community leaders involved in urban food production projects; (3) increased educational programming to successfully plan and grow a garden/farm for individuals, communities, and community leaders (acquiring land to determine soil concerns and plant selection) increased educational programming to harvest and prepare healthy, local food for individuals, communities, and community leaders; and (4) develop appropriate technologies for food production in urban areas.

This will require us to maintain and develop new partnerships with other colleges/department/centers such as Urban Affairs and Public Policy, Institute of Public Administration, and Blueprint Communities, and others such as the Delaware Department of Agriculture, Department of Natural Resources and Environmental Control, the Delaware Center for Horticulture, City of Wilmington, Newark, and other cities in Delaware.

**2. Brief description of the target audience**

For animal agriculture, the target audience is primarily poultry integrators, growers, breeders, trade groups and allied industries; dairy and beef producers; livestock commodity groups; forage producers, equine owners, producers and interest groups; state and federal agencies; federal research laboratories; scientists in the U.S. and international colleagues, K-12 teachers, and environmental and community groups. For crop and soils related research and extension programs, the audience includes existing and prospective grain crop producers, vegetable and horticultural crop producers, mixed (animal and crop production, e.g., dairy, horse) farms, crop commodity and trade, the "green industry" ,certified crop advisors, private agricultural consultants, state and federal agencies, agrichemical and agricultural equipment companies, processors, marketers of plants of flavor, fragrance, and medicine, peer scientists in the U.S. and other countries, K-12 educators, and policy-makers. For urban agriculture the audience includes farmers, landowners, state agencies and federal agencies, land use organizations , environmental groups, business and community leaders, families, students, and the general public.

**3. How was eXtension used?**

In 2016 the eXtension Institutional Team comprised of faculty and staff from across all planned program areas was converted to the Innovation team consistent with eXtension. This group continues to provide the leadership for integration of eXtension at UD Cooperative Extension. This past year the team has focused on the following: • Social media plan was updated and Ask an Expert included on new website design. • On-line course development with Continuing and Professional Development • Became a premier

member of new eXtension structure-one specialist selected as I-corp member in climate change initiative and has nearly completed the 360 website on best management practices. Our Ag Week in early January 2016 was part of our social media campaign and targeted production practices. The largest percentage of our Ask an Expert aspect of eXtension is focused on consumer horticulture and landscape. We average about 451 questions through this format on a yearly basis we answered 41% more questions than we did in 2015. Our Delaware State Fair exhibit featured video feed of Extension program and we spoke to over 2000 individuals regarding this aspect of Extension program delivery. We are currently in development of two online courses related to this goal area: Nutrient Management Certification (almost complete) and Beginning Farmer program.

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

| 2016 | Direct Contacts Adults | Indirect Contacts Adults | Direct Contacts Youth | Indirect Contacts Youth |
|---|---|---|---|---|
| **Actual** | 19770 | 35589 | 1328 | 0 |

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

**Patent Applications Submitted**

Year: 2016

Actual: 2

**Patents listed**

#9023758 Methods for Promoting Plant Health

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

| 2016 | Extension | Research | Total |
|---|---|---|---|
| **Actual** | 12 | 120 | 132 |

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Competitive Grants Awarded

| Year | Actual |
|---|---|
| 2016 | 55 |

**Output #2**

**Output Measure**

- Undergraduate Researchers

| Year | Actual |
|---|---|
| 2016 | 147 |

**Output #3**

**Output Measure**

- M.S.and Ph.D. Students

| Year | Actual |
|---|---|
| 2016 | 149 |

**Output #4**

**Output Measure**

- Post-doctoral Research Associates

| Year | Actual |
|---|---|
| 2016 | 27 |

**Output #5**

**Output Measure**

- Refereed Journal Articles

| Year | Actual |
|---|---|
| 2016 | 132 |

**Output #6**

**Output Measure**

- Books and Book Chapters

| Year | Actual |
|---|---|
| 2016 | 9 |

**Output #7**

**Output Measure**

- Extension Bulletins and Factsheets

| Year | Actual |
|---|---|
| 2016 | 23 |

**Output #8**

**Output Measure**

- Webpage views/downloads

| Year | Actual |
|---|---|
| 2016 | 125628 |

**Output #9**

**Output Measure**

- Workshops at State, National or International Level

| Year | Actual |
|---|---|
| 2016 | 0 |

**V(G). State Defined Outcomes**

## V. State Defined Outcomes Table of Content

| O. No. | OUTCOME NAME |
|---|---|
| 1 | Best Management Practices to maintain or enhance the competitiveness of Delaware?s agriculture and food systems: Number of acres or animal units adopting practices to increase yield, increase profitability or more efficiently use inputs; |
| 2 | Development and adoption of appropriate technologies for food production and marketing in urban areas: Number of participants adopting appropriate technology for food production in urban areas. |

## Outcome #1

### 1. Outcome Measures

Best Management Practices to maintain or enhance the competitiveness of Delaware?s agriculture and food systems: Number of acres or animal units adopting practices to increase yield, increase profitability or more efficiently use inputs;

### 2. Associated Institution Types

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

### 3a. Outcome Type:

Change in Action Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2016 | 138 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Small grains are an essential crop in Delaware, with over 105,000 acres valued at 24 million $US planted in the state in 2016. Fusarium head blight FHB is considered to be the most damaging pathogen of small grains worldwide. This disease reduces yields of wheat and barley and also contaminates grain with a carcinogenic mycotoxin called DON. The use of varieties with moderate resistance to FHB and DON are key in managing this disease. In 2013, growers in Delaware and Maryland suffered significant losses in yield and quality due to FHB and DON. Discussions with growers indicated that they did not have reliable FHB resistance data on locally produced varieties to assist them in variety selection. Growers require a misted FHB nursery to minimize potential losses from FHB in the future.

**What has been done**
A collaboration between the Extension Field Crop Pathology Lab and the Maryland Field Trials was developed. Grants to fund a misted nursery were submitted to the USWBSI, Maryland Commodity Board, and Maryland Small Grains Utilization Board. All grants were funded. A misted nursery was constructed in 2016, assessing 57 wheat varieties for FHB and DON. Data were collected, and a report generated. The report was shared online on the SCABSMART website, on the USWBSI Website, as mailers to MD and DE growers, and as handouts at meetings. An online survey was administered to assess the potential impact of the misted nursery on grower productivity.

**Results**

Growers from DE (70%), MD (40%), PA (10%) and other states (10%), representing at least 3150 acres responded to the surveys.
66% of respondents indicated that they have been negatively impacted by FHB over the past 5 years.
80% indicated that they have never used FHB misted nursery data or were aware of misted nursery data prior to 2016.
77% indicated that the misted nursery will benefit their operation. 87.5% put the value of the misted nursery at between $5-10 per acre. These data indicate the misted nursery has the potential to save producers in DE between $500,000 and 1,050,000 $US annually.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 102 | Soil, Plant, Water, Nutrient Relationships |
| 112 | Watershed Protection and Management |
| 203 | Plant Biological Efficiency and Abiotic Stresses Affecting Plants |
| 205 | Plant Management Systems |
| 212 | Pathogens and Nematodes Affecting Plants |
| 307 | Animal Management Systems |
| 311 | Animal Diseases |
| 405 | Drainage and Irrigation Systems and Facilities |
| 604 | Marketing and Distribution Practices |

**Outcome #2**

**1. Outcome Measures**

Development and adoption of appropriate technologies for food production and marketing in urban areas: Number of participants adopting appropriate technology for food production in urban areas.

**2. Associated Institution Types**

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

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2016 | 1884 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Legumes represent major grain and forage crops in the USA and world, and the resources required for successful legume crop production can be reduced through the crops' interactions with soil microbes. In particular, rhizobia-legume symbioses decrease the carbon footprint associated with legume crop production. The crop plant must be genetically competent to establish these symbiosis, and many genes cannot be selected for by breeders because they are unknown.

**What has been done**
As part of a team of researchers from five research university/institutes, we developed research resources for the scientific community to better understand the genetic underpinning of legume symbioses.

**Results**
Our multi-institution team developed a population of Medicago truncatula with gene insertions for scientific study, marker line plants to study the proteins encoded by symbiotic genes, and identified new genes required for successful interactions with beneficial bacteria. All of these resources are now available to the international research community, advancing the opportunities to better exploit symbiosis in research and in generation of new crop lines.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 102 | Soil, Plant, Water, Nutrient Relationships |
| 201 | Plant Genome, Genetics, and Genetic Mechanisms |
| 203 | Plant Biological Efficiency and Abiotic Stresses Affecting Plants |
| 205 | Plant Management Systems |
| 212 | Pathogens and Nematodes Affecting Plants |
| 604 | Marketing and Distribution Practices |
| 903 | Communication, Education, and Information Delivery |

## V(H). Planned Program (External Factors)

**External factors which affected outcomes**

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

**Brief Explanation**

## V(I). Planned Program (Evaluation Studies)

## Evaluation Results

**Small Ruminant Workshop: Issue** There is a shortage of veterinarians in the state of Delaware with the knowledge, skills and desire to treat small ruminants. There are only four veterinarians in the state who practice on food animals, with limited assistance from veterinarians in neighboring states. Small ruminant producers in the state are deficient in professional veterinary care. As a result, producers need to further develop their skills in assessing animal health and treating common diseases.
**Response** Extension personnel developed a survey for veterinarians and producers to determine precise needs for technical training and skill development. Extension personnel conducted 2 workshops and train participants in basic veterinary skills based on the needs assessment. These skills were implemented by 10 participants to minimize the risk of common diseases and increase profitability. This exploratory project assisted project directors in determining specific knowledge and skill development needs for further implementation. Participants learned: How to perform a physical assessment and take vital signs (SOAP). How to perform an on-farm necropsy. How to perform an IP injection. How to use a prolapse harness. How to drench and tube a lamb or kid.
**Results** We had 30 producers that stated they are going to develop a better management plan. The participants represented 218 acres and over 168 livestock animals. As a result of the program one person shared with us that after learning IP injection they were able to perform it on a newborn without calling a veterinarian. This shows that the program has helped producers deal with lack of veterinarian care in our state. Respondents said they will alter their management by: Utilize the SOAP method for assessing animal health-9% Utilize body condition scoring -55% Utilize vital signs-64% Utilize eye lid scoring-64% Utilize IP shots-91% Utilize a prolapse harness-27% Drench or tube feed a lamb/kid-45% Perform an on farm necropsy-64% Keep more detailed health records-18%
**Pasture Walk: Issue** Livestock producers are constantly looking for ways to decrease their feed bill. One way to combat this issue is to utilize pasture. A pasture walk is a way to disseminate knowledge from Extension personnel to producers and for producers to learn from each other. While walking through pastures, producers can observe forage and weed species present and how the land is managed. As a result, producers are better equipped to evaluate and manage pastures.
**Response** A group of livestock producers were invited to attend a pasture walk workshop held in New Castle County. The event was held on a working farm that largely utilizes horses to harvest the forage as a means to cut down the cost of operating expenses.
**Results** At the conclusion of the pasture walks, 31 participants completed an evaluation. Participants learned: How to manage pasture effectively. How mud effects horse health. Weed Control Small equipment used in pasture maintenance. Heavy Use areas. Program Impact: We had 31 producers that stated they are going to develop a better pasture management plan. Respondents said they will alter their pasture management by: Spray for weeds earlier, Lime fields, manage weeds differently, manage mud differently with a heavy use area, and be more vigilant in weed ID and herbicide application.
**Wheat Quality and Marketing Opportunities: Maximizing Profits: Issue** Winter wheat is the third most planted crop in Delaware and is economically important to the region. However, the quality of winter wheat has been threatened by diseases such as Fusarium head blight and Glume blotch as well as environmental issues that result in lower grain quality. Local grain buyers demand quality wheat, often offering financial incentives to

growers for premium grain. Growers will need to shift management strategies in order to meet the demand for high-quality grain and avoid discounts at the elevator.

**Response** The Wheat Quality and Marketing Opportunities: Maximizing Profits meeting was held January 13, 2016 at the Delaware State Fairground in conjunction with 2016 Delaware Agricultural Week. The meeting was sponsored by the University of Delaware Cooperative Extension and the Maryland Crop Improvement Association. Experts from Syngenta, UD Cooperative Extension, Kansas State University, Mountaire Farms, Perdue Agribusiness, Hostetter Grain, and Nagel Farm Service presented. Topics included the agronomics behind wheat quality, Fusarium head blight overview, sampling techniques and grain storage for minimizing grain quality issues, local wheat markets, and a roundtable discussion was held at the end of the meeting.

**Results** A total of 42 of the 190 participants completed the program evaluation at the completion of the meeting. Respondents identified themselves as a grower (62%) followed by agribusiness salesperson (20%), grain buyer (7%), crop consultant (4%), academic (3.5%) and seed producer (3.5%). Most participants operated in Delaware (58%) or Maryland (35%) followed by Pennsylvania (5%), Virginia (1%) and New York (1%) and represented over 147,000 acres of winter wheat in the region. Approximately 67% of the participants indicated they gained knowledge and specifically noted a positive increase in the extent of knowledge gained in four categories: wheat quality (22%), diseases management (27%), sampling and storage (26%), and marketing wheat (19%). Based on what they learned at the meeting, several respondents noted they would make changes to their wheat management in the future including "variety selection, fungicide timing", "seed selection", "pay more attention to scab resistance" and "select varieties based on disease resistance." Respondents estimated the economic value of the information they received at the meeting was about $13 acre on average. The overall economic impact of the meeting (based on the 42 respondents) was estimated to be almost $2 million.

**2016 Weekly Crop Update Horticulture Articles - Fruit and Vegetable Culture: Issue** The Weekly Crop Update published by the University of Delaware Extension is the authoritative newsletter for disseminating information from the University of Delaware and neighboring Extension systems to horticultural and agronomic crop producers, consultants, and advisors in the Delmarva region. Past surveys have indicated that more information is desired in relation to fruit and vegetable (horticultural crop) culture including production practices, fertility, variety selection, plant stress mitigation, soil health, and the prevention of disorders. The blog and pdf version of the Weekly Crop Update are available for free online. There are currently over 600 subscribers and many other readers across the region that access the electronic version.

**Response** A total of 53 articles (37 from the University of Delaware Vegetable and Fruit Specialist, 5 from the University of Delaware Vegetable Research Associate, 8 from the University of Maryland Vegetable specialist, and 3 from the Delaware State University horticulturalist) related to fruit and vegetable crop culture were written and posted in 2016. This included information on growing sweet onions, Brussels sprouts, and day-neutral strawberries; blueberry and pepper variety trials; starter fertilizers, foliar fertilizers, slow release fertilizers, low pH in plasticulture, sulfur fertilization and correcting deficiencies in vegetables and fruits; frost and freeze protection, late freeze losses, and evaluating freeze losses in fruits and vegetables; vegetable and fruit disorders such as blossom end rot, rind necrosis, irregular ripening, edema, catfacing, sunburn, and yellow shoulders; cultural practices such as shading, windbreaks, proper transplanting, and row covers to protect plants; weather damage from cold, wind, hail, excess rain, and heat; stand losses in vegetable crops; produce food safety practices; and cover crop use in vegetable rotations.

**Results** Of the approximately 21,000 web views of the Weekly Crop Update Blog articles in

2016, Horticultural posts received 13,800 of those views (13 of the top 20 posts). Horticulture articles from the 2016 WCU were republished by extension workers and growers associations in Maryland, Pennsylvania, New Jersey, New York and Massachusetts. With this reposting, it is estimated that over 5,000 growers have been impacted in this 5 state region. Extension co-workers in the surrounding region state that his information has been regularly used for outreach to vegetable and fruit growers in their counties. Crop consultants state that they regularly supply information from these posts to their clientele to make decisions and troubleshoot problems with their crops. Quotes from users include "I read and use something from your vegetable articles in my work every week", "they are the most useful for my clients", and "this information is invaluable for my business".

**Developing a Profitable Organic Blueberry Production System in Underserved Communities of Delaware: Issue:** Delaware offers excellent income opportunities for underserved farmers entering into the specialty crop market. It has been reported that the price of organic blueberries is 20 to 50% higher than the conventional ones; however, there is no existence of organic blueberry production in underserved communities in Delaware. Thus, there is a great need for agriculture researchers to organize field research to investigate the best organic production systems that will foster more informed decisions to Delaware farmers who are interested in enterprise budget.

**Response:** Blueberry research or demonstration site was established in 2015 where farmers, researchers, and students can meet to interact with one another. Until recently, blueberry orchards of three varieties including early, mid and late season was established. All production practices were conducted according to the organic farming system. Workshops (production, marketing, and post-harvest); and demonstrations (pruning, mulching) were conducted to share production practices, and learn ways to insure plants are well established.

**Results:** Farmers gained knowledge about organic production practices, and some farmers are currently adopting blueberry plantation. At the end of this year, an enterprise budget will be developed based on expected revenue from fruits to be harvested in different season; as well as the cost of establishing blueberry orchards which will assist farmers to make informed decisions. Additionally, payout periods will be identified to make sure farmers receive a net profit from fruit farming once plants begin to fully bloom for fruiting. Once the orchard becomes established, it will be the foundation for further research to improve the small fruit program. Additionally, it will become the instrument for value adding and post-harvest quality research that ultimately will help to improve economic conditions of small farmers, particularly those in underserved communities.

**Issue:** The condition and quality of urban forest fragments are important for biodiversity conservation and are directly linked to human health and well-being. Non-native invasive plants alter forest structure and function which can change the distribution and abundance of small mammals and the ticks they support. Small mammal communities reservoir vector-borne diseases (e.g. Lyme Disease) that are transmitted to humans living within the urban-forest matrix. Urban forest condition also influences the breeding bird community which has been show to be closely tied to ecosystem health. Therefore, knowing the population dynamics of the forest breeding birds provides insight into the ecosystem services urban forest patches are providing to not only biodiversity conservation but also human health and well being.

**Response:** During this reporting period we addressed two objectives related to urban forest health. First, we assessed the effects of non-native invasive plants (specifically, Rosa multiflora) on the distribution and abundance of small mammals and ticks. We also estimated the prevalence of Lyme Disease within the sampled tick community. We also assessed the long-term dynamics of local host-parasite interactions between Wood Thrush

and the Brown-headed Cowbird, an obligate brood parasite. We then integrated our long-term population dynamics models into a meta-population framework to determine what management actions would have the largest impact on the declining Wood Thrush population.

**Results:** We found the effects of non-native plant invasions on the distribution and abundance of ticks were dependent on the scale at which the estimates were made. At the fine scale (within a site) we found over two-times more ticks under Rosa multiflora that we did at paired sites under native plants. At the patch scale, however, we found over three-times the number of ticks in R. multiflora free patches compared to forest patches invaded by R. multiflora. Our long-term demographic analyses indicated that brood parasitism has increased in the urban forest landscape and has had a negative impact on Wood Thrush population growth. We also found that the extent of forest cover in the urban landscape was positively related to Wood Thrush population growth. Therefore, to maintain a local meta-population of Wood Thrush, urban planners should reduce Brown-headed cowbird populations and increase or maintain forest cover by restoring degraded areas to forests. This would not only aid in reducing the population declines for Wood Thrush but also increase human health through the increased air quality and access to stress reducing natural areas for the local human population.

**Issue:** Human dominated landscapes are designed for aesthetics, not for ecosystem function. As our human footprint expands, this has caused widespread ecosystem degradation as well as the erosion of ecosystem services.

**Response:** I am studying how introduced ornamental plants from Asia impact local biodiversity and ecosystem function. One student is quantifying chickadee breeding success in suburbs as a function of the introduced plant load. Anther is looking at how introduced plants destroy herbivore based food webs. Another is studying what birds require to successfully rear young, and another is looking at whether cultivars of native plants are the ecological equivalents of their parent species.

**Results:** We have found that introduced plants reduce the number of insect herbivore species, the foundation of vertebrate food webs, 5 fold, reduce their abundance 22 fold, their biomass 22 fold and the interactions between herbivore and plant 7 fold. Chickadees cannot reproduce when the amount of productive native plant biomass in the landscape falls below a minimum threshold. Birds overwhelmingly prefer to feed young caterpillars, so when there are not enough caterpillars, bird reproduction fails.

**Issue:** The genetic basis of complex traits including environmental adaptation and disease resistance were investigated in maize. Studying environmental adaptation through the development and characterization of exotic genetic resources and new methods for genetic analysis are important for addressing long-term challenges of food security and the development of resilient cropping systems. In parallel, by studying the biology of quantitative resistance, a naturally durable form of resistance, new methods for disease control can be envisaged.

**Response:** Through the integration of biology, statistics, computer science and breeding, new methods, tools and techniques for translational plant biology were developed. Immortalized community genetic resources were developed and characterized for studying barriers to phenological adaptation. Unique approaches for targeted sequencing and analysis pipelines were developed for studying natural variation in large and complex genomes. A whole genome simulator was developed for studying new genetic designs for research. Pioneering techniques for 3D microscopic imaging and automated algorithms for image analysis of plant-pathogen interactions were developed. New databases and a comprehensive software tool for plant breeding programs was created.

**Results:** The genetic basis of response to artificial selection for phenological adaptation in maize was elucidated, revealing a complex genetic architecture with geographically broad

and specific components. The results suggested that contemporary, genomic-aided approaches for selection in breeding programs may be optimized by incorporating geographically trained models, but findings also revealed how the architecture shifts across time, which will demand new strategies for improving the efficiency of selection in order to optimize the capture of allelic variation in efforts to diversify a cropping system. Studying the biology of natural variation in quantitative disease resistance, specific genes and mechanisms for resistance in maize were determined. As this work advances, we anticipate it lead to new insights about the evolution of resistance and strategic thinking on approaches for disease control. Several computational tools and immortalized genetic resources were developed that represent substantial contributions to the field of plant genetics, genomics and breeding.

**Issue:** Our work focuses, in part on understanding how poultry respond to heat stress and identifying genes that control that response. The objective is to identify responses and genes that can be altered by genetic selection to improve the birds ability resilience to heat stress. In addition the largest single component of the poultry industry costs arise from the massive amounts of energy consumed to transport feed. Any increase in nutrient utilization in the chicken would reduce the overall environmental footprint of the industry. Since nutrient utilization is partly genetically controlled, the second major component of this work is to identify genes and alleles that regulate nutrient utilization.

**Response:** We have completed three gene mapping studies, identifying over 200 genetic loci that affect the broiler (meat) chicken response to either heat stress feed efficiency. In addition, our analysis of gene expression pattens in response to heat stress have identified over 600 genes, in multiple tissues of the chicken, that respond to heat stress.

**Results:** Once the genes and alleles are precisely identified that control heat response and/or nutrient utilization, this knowledge can be used by the chicken breeding industry to implement breeding strategies to improve these traits in production lines. These improvements will reduce mortality and morbidity due to heat and increase nutrient utilization. Because the chicken is likely to remain an important food source throughout the 21st century, the improved genetics of the chicken will play an important role in alleviating hunger.

**Issue:** Small farmers in Delaware are so interested to lower the post-harvest loss of their farm produce, fruits and vegetables so that they could be able to increase their farm profitability. Therefore, DSU Cooperative Extension organized a demonstration to empower farmers, extension agent and students about post-harvest cooling technology.

**Response:** A demonstration was organized where post-harvest specialist/horticulturist was also invited to address the queries of the audiences. Both a mobile and a walk-in cooler were demonstrated to encourage the farmers, ag producers, and other interested personnel to have one built on their farm. After harvesting most of the produce need to be kept in lower temperature immediately to remove field heat to lengthen the life and quality of the fruits and vegetables.

**Results:** Farmers, students, and extension agents were excited, and they said they gained knowledge and they would share all the benefits of having post-harvest cooling technology with another member of the farming community. Some have shown interest to build one for giving value-add on their produce. At least, the cooperative extension of DSU will be able to bring more audience and demonstrate the benefits of cooling technology to growers in future.

**Issue:** Plants respond to abiotic and biotic stressors by activating or down-regulating genes. The regulation of these genes is controlled by epigenetic factors such as histone modifications and DNA methylation. Understanding the location of these epigenetic factors is important in understand how plants respond to these stressors.

**Response:** Using common bean, an important legume crop in the United States, we

conducted integrated profiling of two histone modification marks (one repressive mark and an activation mark) and genome wide transcriptome sequencing in response to the bean rust pathogen.
**Results:** We were able to identify locations in the common bean genome where the two histone modifications marks bind. The genome was divided into promoter, transcription start site, exon, intron, and transcription termination site, and intergenic region. Correlated with this work, from the same tissue and from the same time points (hours after inoculation), messenger RNA sequencing (RNA-seq) was conducted in order to identify genes and networks for disease resistance in common bean.
**Issue:** Understanding of alternative sources of energy is an important problem in the United States. Conducting research and training in bioenergy crops is a useful way to approach this problem.
**Response:**We worked with the potential bioenergy crop switchgrass in order to understand its response to heat and drought individually and in combination.
**Results:** We developed a reference transcriptome for switchgrass genotypes AP13 and VS16. The results from this work help us determine genes expressed under non-stress conditions in these two ecotypes of switchgrass.

**Issue:** Proper management of water quality in aquaculture is a critical component dictating system performance, farm profitability, and environmental impacts. One of the primary water quality concerns in aquaculture is total ammonium nitrogen (TAN), which is produced as fish metabolize feed and subsequently passed from their gills and/or excreted as urine. When TAN accumulates, culture water must be discharged from the system or treated to maintain a healthy production environment. In recirculating systems, this is managed through the application of a biological filter, whereas in flow-through systems TAN accumulation is mitigated by flushing. Managing water becomes incredibly important as aquaculture production intensifies because maintaining good water quality not only determines success but can also lead to a higher demand on water resources and more nutrient pollution as exchange rates increase.
**Response:** In order to make fish farming more environmental friendly while maintaining or improving profits, we propose the incorporation of waste valorization technologies into aquaculture to simultaneously accomplish nutrient mitigation, increased water re-use, and creation of alternative revenue streams through the co-production of microalgae and other valuable â€˜by-productsâ€™ from recovered nutrients. This proposal represents a major paradigm shift in the management of water quality in aquaculture production and helps to ensure the industry becomes more environmentally sustainable and remains economically profitable.
**Results:** Our ability to bring together experts from disparate fields with this proposal will facilitate the infusion of new technologies into aquaculture. Direct end-users of knowledge generated by this project will be aquaculture producers as well as members of the research community interested in improving the operational efficiency of their production systems and minimizing their environmental footprint. Impacts from this research will be applicable throughout the Northeast region and beyond for both marine and freshwater aquaculture. While we intend to focus our initial research on two specific industry segments, fresh water flow-through (i.e. trout production) and freshwater recirculating (i.e. tilapia production), there will be a direct application to other freshwater and marine production systems as well, making this work beneficial to much of the aquaculture industry in the Northeast. Longer-term beneficiaries of this information are communities in which these aquaculture businesses are located. The ability to increase operational efficiency of aquaculture production systems, reduce the environmental footprints, and produce valuable â€˜by-productsâ€™ ensure that our work has the real ability to

significantly change the game with respect to domestic aquaculture production. By increasing the economic profitability of the aquaculture businesses and reducing their respective environmental footprints these small businesses can remain as contributing members of expanding local economies.

**Issue:** Urban forests make invaluable contributions to society. Establishing, assessing and inventory of urban forests help with maintaining the natural resource. A comprehensive tree inventory will be conducted on the Delaware State University campus and the ecological services will be quantified using i-Tree Eco software. All the trees will be identified and inventoried including geo-location to serve as an educational resource. Another project will conduct a comprehensive evaluation of the State of Delaware's community forestry grants awarded in the last 15 years. The information will help us evaluate the success of community forestry grant support to tree planting and management in communities across the state. These baseline data can be used to make further decisions for maintaining the urban forest resources in the state of Delaware.

**Response:** A complete survey of the Delaware State University Main Campusâ€™ trees was conducted. Field data was collected and combined with reference city data on tree growth and geographic variables for urban forest structure, environmental effects and the monetary value they offer to communities. The trees were in leaf-on season to appropriately measure their health. Using a measuring tape and hypsometer, DBH, height and size of the crown were measured and the species were recorded. The trees have a structural value of approximately $1,870,123 and more projected benefits generated by the inventory report. An Android app was also developed by MIT App Inventor software, focusing on the top 25 trees of DSUâ€™s Urban Forest and some information about each species including the ecological benefits generated by the i-Tree Eco inventory report. The app is free, easy to use and ready to download in the Google Play store. A comprehensive evaluation of Delawareâ€™s Urban & Community Forestry program examined program impact through audit of 15 years of tree planting grants. During the audit, all 235 planting sites were visited. GPS points were captured along with tree survival observations at each site. GIS maps were made to display the GPS points of each grant site and an Excel database offered navigation of grant file information and tree survival observations. Overall average tree survival from this study was 68.46%. Calculation of average annual tree survival was 94.8%. A feedback survey was used to identify any pre-planting, planting, or post-planting practices that correlate with urban and community tree planting survival. Delaware now has a baseline of data, which should be maintained henceforth. The U&CF program has had a successful impact on Delawareâ€™s urban forest through tree planting grants and is a valuable resource to Delaware forestry.

**Results:** Delaware now has a baseline of data, which should be regularly reassessed and maintained henceforth both for campus tree inventory as well as state grant awards impact. A website and a free android mobile app is available for the community to explore and learn about the tree resources on the DSU campus. The five most abundant species on campus were the Common crapemyrtle, Lagerstroemia spp , with a count of 153 trees (6.22% of total population), Eastern white pine, Pinus strobus, 127 (5.16%), and Honeylocust, Gleditsia triacanthos, 103 (4.19%), red maple, Acer rubrum, 101 (4.11%), and sweet crabapple, Malus coronaria, 87 (3.54%), three of which are native to Delaware.The U&CF program has had a successful impact on Delawareâ€™s urban forest through tree planting grants and is a valuable resource to Delaware forestry.

**Issue:** These projects target community outreach and increased awareness among the citizens and potential commercial aquaculture growers in DelMarVa region on coastal habitat conservation, shellfish as healthy food sources, regulators of water quality, enhancement of diverse marine communities, and protection of natural shorelines trough oyster research activities and oyster rehabilitation.

**Response:** PROJECT GOALS

1) Assessing oyster growth & survival at selected study sites.
2) Assessing water quality & potential nutrient dynamics in aquaculture sites
3) Monitoring algal blooms & availability of food supply, phytoplankton for oyster growth
4) Assessing relationship between lands use practices & nutrient dynamics and both phosphorus & nitrogen species compositions

Goal 1

For the gear assessment/oyster growth and survival study, 2 types of oyster gear were deployed - vinyl-coated wire mesh bottom cages(2â€™x3â€™x.2.5') and stack of 3 plastic aquaculture trays with lids (3â€™x3â€™x.1.5â€™) in each of the 3 Inland Bays (6 gear total) to collect scientific data during the growing season.

Oysters (Crassostrea virginica) were grown for one growing season (from April to November) and the suitability of two types of bottom aquaculture gear and their performance to optimize oyster growth and survival assessed, in each of the 3Delaware Inland Bays (Rehoboth, Indian River and Little Assawoman) in order to provide baseline information to the citizens interested in exploring sustainable oyster aquaculture business.

Spat collectors were placed in 3 locations in each of the Delaware Inland Bays in order to evaluate the production of spat in the Bays, 3 locations were selected in each of the Inland Bays. Genetics studies will be performed on the spat to determine if the spat are the offspring of oysters in nature or the disease resistant strain of oysters from Rutgers University, Haskin Shellfish Research Laboratory used in the Delaware oyster restoration project.

Goal 2

Water quality measured weekly - temperature,pH,dissolved oxygen,salinity,turbidity. Time,tide weather & storms also recorded. Nutrient analysis performed weekly - Nitrate,nitrite,ammonia,orthophosphate,alkalinity,hardness,total nitrogen,total phosphorous.

Benthic core samples (4â€?) were collected monthly underneath the oyster gear, 5m away, and 30m away using a 1 inch PVC pipe in order to study the effect of nutrient dynamics of oyster aquaculture on the macrobenthic life. Macrobenthic life was preserved and will be identified and quantified at a later date.

Goal 3

Algal blooms and chloropyll a concentrations were monitored weekly.

Goal 4

Oysters from each of the 3 aquaculture sites were collected and frozen to use as a bioindicator for future Î´15N and Î´31P isotope analysis in order to assess the major sources of nitrogen pollution and nitrogen load in the Delaware Inland Bays.

**Results:** Goal 1 Gear study Preliminary results show that in terms of ease of use, the wire cages are a more promising gear for oyster aquaculture than are the stacked plastic trays. Ongoing research will continue through 2017. Spat study Preliminary results show consistency in settlement for Indian River between the two seasons. Rehoboth and Little Assawoman showed significant differences between the two seasons, possibly due to different genetic populations. Genetic testing on oyster spat will begin in 2017. Ongoing research will continue through 2018

Goal 2 Water quality data and nutrient analysis data were analyzed. Significant differences in the water quality parameters tested over the 5 month study period, and significant differences between study sites. Data showed that Rehoboth Bay differed from the other two bays for minimum temperature, minimum salinity, maximum ammonia. Indian River differed from other two bays for minimum alkalinity, maximum hardness, and maximum total nitrogen. Little Assawoman differed for maximum Nitrite. Ongoing research will continue through 2018.

Benthic study The total abundance of the five most abundant families of worms was found

for each bay. The total number of worms collected monthly per site at distances of 5 meters, 1 meter and under the oyster gear for the three study sites was also found. Little Assawoman had the highest abundance of worms. This could be due to the fact that this bay is farther inland, water quality is more stable and the sediment conditions seem to be favorable. Ongoing research will continue to 2018 and will include sediment analysis to determine particle size, and the identification of species of all worm specimens collected.

Goal 3 Algal bloom and chlorophyll a data will be analyzed in 2017. Ongoing research will continue through 2018

Goal 4 Processing of oysters and Î´15N and Î´31P isotope analysis will begin in 2017. Ongoing research will continue through 2018.

**Issue:** Sustainable agricultural production demands fertile soil, healthy livestock rearing, and minimal environmental impacts. Crop growers and animal producers are always seeking for practical, effective approaches for enhancing soil fertility and animal health while minimizing greenhouse gas emissions and nutrient losses from agricultural production systems.

**Response:** Research has been conducted to explore generation of high quality biochar from organic agricultural byproducts and utilization of biochar as a soil amendment and a remediation agent in agricultural production and environmental treatment. Biochars from a variety of waste organic residues were characterized and evaluated in quality for agricultural and environmental applications. The pyrolysis conditions for farm-scale biochar production were determined and optimized. The potential of biochar for improving soil physical, chemical, and biological properties, reducing ammonia emissions from poultry litter, and removing nitrogen and phosphorus nutrients from stormwater was investigated.

The research **results** indicated that biochar manufactured from poultry litter at lower pyrolysis temperature contained slow-releasing nitrogen and phosphorus nutrients and if applied to soil at 2-3 mass% rates could significantly promote crop growth. Sulfuric acid-treated biochar was a promising poultry litter amendment, reducing ammonia emissions from chicken barns by 50% at relevant amendment rates. Waste wood-derived biochar, when used in combination of zero-valent iron, was effective in removing nitrate and phosphate from stormwater. Converting organic residues to biochar and applying the biochar in agricultural production is an optimistic strategy for sustainable agriculture and warrants further research.

## Key Items of Evaluation

## V(A). Planned Program (Summary)

**Program # 2**

**1. Name of the Planned Program**

SAFE AND SECURE FOOD SUPPLY FOR HUMAN NUTRITION 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 |
|---|---|---|---|---|---|
| 501 | New and Improved Food Processing Technologies | 5% | 5% | 5% | 5% |
| 703 | Nutrition Education and Behavior | 25% | 25% | 25% | 25% |
| 704 | Nutrition and Hunger in the Population | 10% | 10% | 10% | 10% |
| 712 | Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins | 20% | 20% | 20% | 20% |
| 723 | Hazards to Human Health and Safety | 5% | 5% | 5% | 5% |
| 724 | Healthy Lifestyle | 10% | 10% | 10% | 10% |
| 806 | Youth Development | 25% | 25% | 25% | 25% |
| | **Total** | 100% | 100% | 100% | 100% |

## V(C). Planned Program (Inputs)

**1. Actual amount of FTE/SYs expended this Program**

| Year: 2016 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| **Plan** | 8.5 | 6.6 | 14.8 | 1.2 |
| **Actual Paid** | 3.3 | 5.0 | 11.9 | 2.4 |
| **Actual Volunteer** | 0.0 | 0.0 | 0.0 | 0.0 |

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

| Extension | | Research | |
|---|---|---|---|
| **Smith-Lever 3b & 3c** | **1890 Extension** | **Hatch** | **Evans-Allen** |
| 466160 | 330575 | 172531 | 401945 |
| **1862 Matching** | **1890 Matching** | **1862 Matching** | **1890 Matching** |
| 638116 | 330575 | 346928 | 401945 |
| **1862 All Other** | **1890 All Other** | **1862 All Other** | **1890 All Other** |
| 116945 | 317412 | 938058 | 1780228 |

## V(D). Planned Program (Activity)

### 1. Brief description of the Activity

**I. Nutrition and Health Promotion**
Extension programs will have a nutrition and health focus. The Expanded Food and Nutrition Education Program (EFNEP) and the Supplemental Nutrition Assistance Education Program focus on low income adults and children. Nutrition education programs for the broader population will include Dining with Diabetes and Eat Smart for a Healthy Heart. Delaware will fully invest in the youth mandate area of healthy living by preparing youth for healthy lifestyle choices in nutrition and physical activities. Additional health approaches will include drug and alcohol prevention, and bullying and suicide prevention. Curricula will include Health Rocks, Up for the Challenge, and Food Smart Families. Master Food Educator Volunteers and trained adult volunteers and teen mentors will participate in program delivery.

**II. Food Safety**
Research efforts involve high pressure processing to reduce bacteria, viruses, protozoan oocysts, and bacterial endospores; inactivation of pathogenic bacterial species with high pressure and mild heat; using various antimicrobial films to control bacteria, such as Listeria monocytogenes; physiological and genetic analysis of pressure-resistant Listeria monocytogenes; testing of activity of antimicrobial films against native and inoculated bacteria on foods and surfaces; effects and mechanisms of non-thermal processes (ozone, UV, oxidative chemicals, iron, and/or high pressure processing) on protozoa, human pathogenic viruses, and bacteriophage, and increase understanding of basic biochemistry of these microorganisms.

**III. Healthy Living**
This is a new interdisciplinary focus on health beyond nutrition education. Research will explore the "One Health" concept and the contribution of plant, animal and ecosystem health to human health. Extension efforts will dovetail with the Cooperative Extension National Framework for Health approved by ECOP in spring 2014. The Delaware Extension program will focus on the topics of health literacy, chronic disease prevention and management, positive youth development for health, and integrated nutrition, health, environment, agriculture systems. This programmatic effort will highlight some new partnerships including the College of Health Sciences and the DE Department of Health.

### 2. Brief description of the target audience

Adults, youth, particularly low income adults and youth, 4-H adult and teen volunteers, as well as Master Food Educators are the primary target audiences for the Extension programs. Community groups and

health organizations will be another audience but also partners in outreach efforts.

**3. How was eXtension used?**

In 2016 the eXtension Institutional Team comprised of faculty and staff from across all planned program areas was converted to the Innovation team consistent with eXtension continue to provide the leadership for this work. This past year the team has focused on the following: • Social media plan was updated and Ask an Expert included on new website design • On-line course development with Continuing and Professional Development • Became a premier member of new eXtension structure-one specialist selected as I-corp member in climate change initiative and has nearly completed the 360 website on best management practices. The social media strategy particularly focused on safe and secure food supply issues during targeted holiday seasons as well as during food preservation time.

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

| 2016 | Direct Contacts Adults | Indirect Contacts Adults | Direct Contacts Youth | Indirect Contacts Youth |
|---|---|---|---|---|
| **Actual** | 12018 | 984741 | 15624 | 13702 |

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

**Patent Applications Submitted**

| | |
|---|---|
| Year: | 2016 |
| Actual: | 0 |

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

| 2016 | Extension | Research | Total |
|---|---|---|---|
| **Actual** | 0 | 53 | 53 |

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Competitive Grants Awarded

| Year | Actual |
|---|---|
| 2016 | 48 |

**Output #2**

**Output Measure**

- Undergraduate Researchersw

| Year | Actual |
|---|---|
| 2016 | 239 |

**Output #3**

**Output Measure**

- M.S. and Ph.D Students

| Year | Actual |
|---|---|
| 2016 | 76 |

**Output #4**

**Output Measure**

- Post-doctoral Research Associates

| Year | Actual |
|---|---|
| 2016 | 8 |

**Output #5**

**Output Measure**

- Refereed Journal Articles

| Year | Actual |
|---|---|
| 2016 | 60 |

**Output #6**

**Output Measure**

- Books and Book Chapters

| Year | Actual |
|---|---|
| 2016 | 7 |

**Output #7**

**Output Measure**

- Extension Bulletins and Fact Sheets

| Year | Actual |
|---|---|
| 2016 | 13 |

**Output #8**

**Output Measure**

- Webpage views/downloads

| Year | Actual |
|---|---|
| 2016 | 62386 |

**Output #9**

**Output Measure**

- Workshops at State, National, and International Level

| Year | Actual |
|---|---|
| 2016 | 0 |

**V(G). State Defined Outcomes**

## V. State Defined Outcomes Table of Content

| O. No. | OUTCOME NAME |
|---|---|
| 1 | Nutrition and Health: Increases in the knowledge, skills and plans to adopt and/or adoption of healthful diet practices and/or physical activity |
| 2 | Food Safety: Increases in the knowledge, skills and plans to adopt better food safety/food handling practices. The number of people certified in safe food handling practices. Basic and applied research will lead to enhanced safety and wholesomeness of foods as a result of improved understanding of the mechanisms whereby food pathogens exist, enter, survive, propagate and actuate disease syndromes in individuals who consume contaminated products. Gene-based methods to rapidly and accurately identify food-borne pathogens will increase the safety of food products. |
| 3 | Healthy Living: Increases in the knowledge, skills and plans to adopt and/or adoption of health literacy and chronic disease management and prevention skills. Increases in the knowledge, skills and plans to adopt and/or adoption of practices to prevent accidents and injuries. Increases in the knowledge, skills and plans to adopt and/or adoption of practices to prevent bullying and suicides. Increases in the knowledge, skills and plans to adopt and/or adoption of positive behaviors regarding health and legal risks of using tobacco, drugs, and alcohol. |

## Outcome #1

### 1. Outcome Measures

Nutrition and Health: Increases in the knowledge, skills and plans to adopt and/or adoption of healthful diet practices and/or physical activity

### 2. Associated Institution Types

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

### 3a. Outcome Type:

Change in Knowledge Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2016 | 6284 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**

According to the recently released ?Kids Count in Delaware 2015 Fact Book,? over 24% of children in Kent and Sussex Counties in Delaware are living in poverty, a number which has nearly doubled since 2005. Additionally, children who live in public housing in Kent and Sussex Counties are among the poorest in the state and they attend schools with high rates of poverty and low academic achievement. And, over 40% of children living in single-parent homes live in poverty. Countless studies have shown that one of the most serious risk factors hindering youth development is poverty and its underlying issues which foster increased risky behaviors. During the immediate afterschool hours, 3-6 pm, these children are at the highest risk for engaging in risky behaviors.

**What has been done**

The University of Delaware Cooperative Extension provides services to the youth in Kent County, 100% of them in these impoverished neighborhoods and 80% of them attending schools with high rates of poverty and low academic achievement. The 4-H Afterschool Programs provide homework help and engagement through quality programming during those peak times when children are most at risk to participate in risky behaviors like physical violence and drug and alcohol consumption. They explore their Spark?s, discover their Developmental Assets, assessed with the Search Institute?s Developmental Assets framework, and learn life skills, like healthy eating and the importance of staying active, personal responsibility, accountability, trustworthiness, honesty, basic money management, positive decision making, and being an everyday leader. More than 100 youth residing in or attending school in five impoverished areas in Kent County attended the 4-H Afterschool Programs during the 2015-2016 academic school

year and over the summer.

**Results**

Knowledge change was assessed by a pre and post survey that was given to the youth and behavior change was identified by improved behaviors in the program including less behavior referrals, suspensions and parent meetings, decreased school reports, positive teacher survey responses, and increased academic success. Youth in the program gained an appreciation for healthy foods, especially through their real-world experience of planting, maintaining, and harvesting a community garden. They further learned to manage their money through weighing purchase decisions and saving for greater rewards. As a result of attending the program sessions, youth reported the following: 100% of youth strongly agree and agree that they are now motivated to do well in school. 75% of youth agree or strongly agree that they understand the effects of drugs and alcohol. 81% of youth agree or strongly agree that they seek to resolve conflicts nonviolently. 100% of youth always or usually feel safe in the program.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 703 | Nutrition Education and Behavior |
| 704 | Nutrition and Hunger in the Population |
| 723 | Hazards to Human Health and Safety |
| 724 | Healthy Lifestyle |
| 806 | Youth Development |

**Outcome #2**

**1. Outcome Measures**

Food Safety: Increases in the knowledge, skills and plans to adopt better food safety/food handling practices. The number of people certified in safe food handling practices. Basic and applied research will lead to enhanced safety and wholesomeness of foods as a result of improved understanding of the mechanisms whereby food pathogens exist, enter, survive, propagate and actuate disease syndromes in individuals who consume contaminated products. Gene-based methods to rapidly and accurately identify food-borne pathogens will increase the safety of food products.

**2. Associated Institution Types**

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

**3a. Outcome Type:**

Change in Action Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2016 | 291 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Producing food items in home kitchens for sale to the public has increased in the last several years. A number of states have adopted laws (often called Cottage Laws) permitting production of a limited variety of products. Delaware is somewhat unique in that its Cottage Law permits production of specified foods only in on-farm kitchens. Another unique feature of Delaware?s law is the requirement that the operator be certified by a recognized food safety authority or participate in eight hours of safe food handling training and pass an examination prior to applying for a permit.

**What has been done**
In 2016, 16 individuals participated in the training. All individuals passed the examination at the end of the class. Sixty-nine percent indicated they would apply for a permit while 31 percent indicated that they already had a permit. As a result of the program, 100 percent indicated that they would improve at least one food handling practice. Furthermore, 94 percent indicated they would wash their hands more frequently. All participants reported that they had a better understanding of the need to protect consumers from unsafe produce, their role in keeping the product safe, the need for record keeping to document food safety practices, and the liability associated with selling an unsafe product. Additionally, 88 percent understood how good personal hygiene can reduce foodborne illness.

**Results**
In 2016, 16 individuals participated in the training. All individuals passed the examination at the end of the class. Sixty-nine percent indicated they would apply for a permit while 31 percent indicated that they already had a permit. As a result of the program, 100 percent indicated that they would improve at least one food handling practice. Furthermore, 94 percent indicated they would wash their hands more frequently. All participants reported that they had a better understanding of the need to protect consumers from unsafe produce, their role in keeping the product safe, the need for record keeping to document food safety practices, and the liability associated with selling an unsafe product. Additionally, 88 percent understood how good personal hygiene can reduce foodborne illness.

### 4. Associated Knowledge Areas

| KA Code | Knowledge Area |
|---|---|
| 501 | New and Improved Food Processing Technologies |
| 712 | Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins |
| 723 | Hazards to Human Health and Safety |
| 724 | Healthy Lifestyle |
| 806 | Youth Development |

## Outcome #3

### 1. Outcome Measures

Healthy Living: Increases in the knowledge, skills and plans to adopt and/or adoption of health literacy and chronic disease management and prevention skills. Increases in the knowledge, skills and plans to adopt and/or adoption of practices to prevent accidents and injuries. Increases in the knowledge, skills and plans to adopt and/or adoption of practices to prevent bullying and suicides. Increases in the knowledge, skills and plans to adopt and/or adoption of positive behaviors regarding health and legal risks of using tobacco, drugs, and alcohol.

### 2. Associated Institution Types

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

### 3a. Outcome Type:

Change in Knowledge Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2016 | 4787 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
The Botvin Life Skills Training, a research-validated effective substance abuse prevention program, is implemented to prevent the onset of cigarette and tobacco use among Delaware youth. Preventing the use of cigarettes among Delaware youth as a gateway drug will help prevent the onset of our youth from using alcohol, marijuana, and other illicit drugs.Even though youth and adult tobacco use has been steadily creeping down over the years, each year a new group of youth enter the marketing sphere of tobacco company advertising. Much of the decline in tobacco use has been the result of vigorous education of youth as well as the rising cost of tobacco products. The introduction has not yet been evaluated as to its potential impact on youth but sales of ecigarettes to minors are banned almost everywhere.

**What has been done**
The Life Skills Program was taught in private schools, afterschool programs at public schools, and community centers across Delaware to elementary school students. The Botvin LifeSkills Program helps to increase the knowledge of the consequences of tobacco and other substance use/abuse. The Botvins program also helps to prevent/and or decrease the use of tobacco and other substance use/abuse. The program also teaches youth about different life skills such as self-image, stress, communication, and assertiveness to help the youth make positive decisions for themselves.

**Results**

The elementary school students that participated in the Botvin LifeSkills Program take a pre/post questionnaire. The questionnaire summaries are prepared by National Health Promotion Associates. Inc. The summaries will show the students anti-smoking knowledge, life skills knowledge, smoking attitudes, and drinking attitudes. 2016 Botvin Elementry School Outcome Evaluation Anti-Smoking post test indicated: 98% of students indicated they learned cigarette smoking can cause your teeth to turn yellow or brown
98% of students indicated they learned cigarette smoking can cause your skin to wrinkle
96% of students indicated they learned smoking cigarettes causes mouth cancer
92% of students indicated they learned cigarette smoking causes your heart to beat faster
Life Skills Knowledge post test indicated:
94% of students indicated they learned that you should not let other people influence their decisions
84% students indicated they learned stress can cause you to get sick
87% students indicated they learned that a good way to refuse to do something is to be assertive.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 723 | Hazards to Human Health and Safety |
| 724 | Healthy Lifestyle |
| 806 | Youth Development |

## V(H). Planned Program (External Factors)

**External factors which affected outcomes**

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

**Brief Explanation**

## V(I). Planned Program (Evaluation Studies)

**Evaluation Results**

**Health Talk Hints: Issue:** The definition of health literacy is "the degree to which an individual has the capacity to obtain, communicate, process, and understand basic health information and services to make appropriate health decisions" (The Patient Protection and Affordable Care Act of 2010, Title V). According to the National Assessment of Adult Literacy, only 12% of Americans are considered proficient in health literacy. In the current medical world, patients are expected to become self-advocates of their own health. It is

important for patients and consumers to be knowledgeable about their personal, family, and sometimes peer medical conditions.

**Response:** With the number of health literate American's being so low, it is important to provide assistance to those in need. The Health Talk Hints workshop was developed through Cooperative Extension to provide information about communicating with doctors. The program invites individual clients and consumers to learn how to have a successful visit with their healthcare provider. During the workshop, participants learn and practice how to prepare for, communicate during, and follow-up after a healthcare appointment. Using specific scenarios to problem solve and lead group discussions, participants gain confidence in advocating for their own health.

**Results:** Through Health Talk Hints, a total of 32 participants were reached. After finishing the Health Talk Hints program, 96% of participants learned ways to decrease their anxiety or stress caused by visiting a health professional; 100% increased their confidence in preparing for a doctor's visit; 100% increased their confidence in managing their time during a doctor's visit; 82% felt less likely to leave a doctor's appointment feeling confused; and 90% were more likely to educate themselves on their own and their family's health history.

**Cenando con Diabetes: Issue:** Diabetes is the seventh leading cause of death in the United States, however, for the Hispanic/Latino population, diabetes ranks as the fifth leading cause of death. According to the CDC, from 1997 to 2014, diabetes rates per 100 Hispanics increased 7% for Puerto Ricans, 41% for Mexican/Mexican Americans, and the age-adjusted rates for Cubans showed no consistent change, remaining at 5%. The long-term health consequences of untreated or high blood sugar levels can result in blindness, heart disease, amputation of limbs, stroke and renal failure. Despite these staggering figures, in Delaware, only 51 percent of those diagnosed with diabetes have taken a class about managing their diabetes. Needs assessments indicate workshops on diabetes prevention for Hispanic audiences are not regularly held in Delaware.

**Response:** Cenando con Diabetes workshops, aligned with the National Dining with Diabetes model, consist of four classes that provide diabetes education, cooking demonstrations and tasting of healthy Hispanic foods. Following a careful meal plan is the first step in managing diabetes and keeping blood sugars in a therapeutic range. This is also the hardest step in diabetes management. Cenando con Diabetes helps by teaching persons with diabetes ways to reduce sugar, salt, and fat in foods, without giving up good taste. Meal planning, personal goal development, activities that can burn calories, and important laboratory tests for persons with diabetes are presented in Spanish to groups of mixed ages, genders, and races. Barriers to managing diabetes such as habits, time, myths, rising food costs and family pressures are discussed among the group. Cenando con Diabetes helps to sort through these barriers and move people to healthier lifestyles that address their unique situation.

**Results:** In 2016, a total of 34 individuals enrolled in the Cenando con Diabetes workshop series held twice in the spring and once in fall in New Castle County. As a result, behavior changes were reported, including eating 5 or more fruits and vegetables daily (88 percent), reading Nutrition Facts labels (50 percent), and being physically active at least 30 minutes 3 times per week (61 percent). Furthermore, eating smaller portions, using recipes from the class, and checking feet more frequently were noted as additional ways to manage their diabetes (by 56, 56, and 44 percent of participants, respectively.) Some of the participants commented on knowledge, attitude, and skills that changed because of their participation: "The program helped me become aware of the portions that I eat. I acknowledge that I have to add more fruits and vegetables to my food every day." "I learned how to improve diabetes, portions one should use, and the essential things that one should eat." "I learned about substitutes for sugar and now I am more willing to try and consume them instead of sugar

and honey." "I learned many things that I did not know about the sugar in the food, how many carbohydrates should be eaten and foods containing more vitamins and minerals." "The main foods to improve my daily living with diabetes." "I learned about the importance of vitamins, fibers in the food, to read the food labels, the importance of exercise, and the fats and carbohydrates." "I learned about proteins, carbohydrates and important vitamins; about the importance of fiber and healthy fats. Also the risks of a person with diabetes: blindness, amputations, nerve and dental problems."

**Sussex County 4-H Afterschool Program: Issue:** "School Connectedness is the belief by students that adults and peers in the school care about their learning as well as about them as individuals" (CDC, 2009). According to the CDC (2015), School connectedness--is an important protective factor, youth who feel connected to their school are less likely to engage in many risk behaviors, including early sexual initiation, alcohol, tobacco, and other drug use, and violence. Therefore, lack of school connectedness increases the chances youth participate in risk behaviors that are detrimental to their academic, social, and emotional development.

**Response:** Research has shown (Anderson-Butcher, 2010) that afterschool programs can help foster school connectedness. Partnering with the Delaware State Housing Authority, First State Community Action Agency, and local school districts we are currently offering five 4-H afterschool programs to low income underserved communities. Our hope is to increase the school connectedness of the youth we work with to better ensure their future success.

**Results:** July 1, 2015 - June 30, 2016 82 youth completed the 4-H program between the summer and afterschool programs from June 30, 2015 through July 1, 2016. All students enrolled participated in developing positive assets including: receiving support from non-parental adults, participating in a caring environment, feeling safe, modelling responsible behavior, youth programs, creative activities, etc. 100% of respondents (Hickory Tree 4-H and Burton Village 4-H) reported that as a result of their experiences in their 4-H afterschool program they understand the effects of drugs and alcohol. 75% of respondents (Hickory Tree 4-H and Burton Village 4-H) either agreed or strongly agreed that because of their experience in their 4-H program they know they have assets that will help them in the future. References Anderson-Butcher, D. (2010). The promise of afterschool programs for promoting school connectedness. Prevention Researcher, 17(3), 11-14. Centers for Disease Control and Prevention. (2009). School connectedness: Strategies for increasing protective factors among youth. Atlanta, GA: U.S. Department of Health and Human Services. Centers for Disease Control and Prevention. (2015). School connectedness. Retrieved from https://www.cdc.gov/healthyyouth/protective/school_connectedness.htm

**SNAP-Ed Policy, Systems and Environmental (PSE) Change Strategies ....Making the healthiest choice, the easiest choice! SNAP-Ed PSE Issue:** The overall goal of the Supplemental Nutrition Assistance Program (SNAP), the country's largest safety net nutrition program, is to provide eligible low-income households with nutrition benefits to ensure access to an adequate diet. SNAP-Ed is the collective evidence-based nutrition education and obesity prevention intervention that supports SNAP. SNAP-Ed direct education programs are not always enough to change behavior. If the environment in which a SNAP participant lives, learns, works, plays and prays does not support the intended behavior change attempts will less likely be effective.

**Response:** The passage of the Healthy, Hunger-Free Kids Act of 2010 requires SNAP-Ed implementing agencies to use evidence-based policy, system, and environmental, (PSE) change strategies to support their SNAP-Ed direct education programming. As a SNAP-Ed implementing agency, the University of Delaware Cooperative System (UDCES), began initial PSE work for the first time in early 2016. Initial PSE work to date has focused on introductory PSE trainings and presentations for SNAP-Ed implementing agencies and

community partners, the assessment and evaluation of UDCES programs and existing and potential PSE change strategies, and the development and initial execution of a Community/Organization Assessment designed for organizations serving low-income populations to identify potential areas of PSE change that will drive recommendations for evidence-based PSE change strategies.
**Results:** As a result of the completed PSE staff trainings and community presentations completed to date, over 20 organizations have been educated about the benefits of PSE, who collectively reach over 200,000 people. Of the completed PSE assessments to date, 34 percent have been from Sussex County organizations, 11 percent have been from Kent County organizations, 11 percent have been from New Castle County organizations, 11 percent have been from Kent/Sussex County organizations, 22 percent have been statewide organizations and 11 percent have been organizations who are headquartered outside of southern Delaware, just over the Maryland state line.

**Yes We Can/Si Yo Podemos-Healthy Eating and Physical Activity Program: Issue:** According to the Centers for Disease Control and Prevention (CDC), in 2014, over 40% of the Hispanic population and over 30% of the African American population in Delaware are overweight. Based on the 2014 Robert Wood Johnson Foundation county health rankings, Kent County has the highest rate of obesity (33%) and physical inactivity (28%) with New Castle County coming in second. The CDC has determined that among the top 10 indicators linked causally to early death are nutrition, physical activity and obesity. In addition, after years of steady decline the number of diabetes deaths have increased. Although the reason for the link is unclear, individuals who are overweight or obese are more likely to develop diabetes. Heart disease and certain cancers have also been linked to a poor diet and lack of physical activity.
**Response:** The Yes We Can (in Kent County) and the Si Yo Podemos (in New Castle County) programs were initiated in an effort to increase the health of populations in those counties. This program was a 7 month challenge that encouraged individual and community wellness through friendly competition. In New Castle County a Hispanic educator was hired to network with the Hispanic community in an effort to reach individuals with programming that Cooperative Extension might not otherwise reach. In Kent County an African American educator worked through African American churches since the African American population is heavily invested in their religious community. In each county a kickoff was conducted to introduce participants to the challenges. During the course of the 7 months, individuals participated in several Extension programs including Dining with Diabetes, Eating Heart Smart, Mealtime in Less Time, Mindful Eating and the Shopping Challenge. They also had access to website materials and a newsletter created to offer them tips to stay on track to be more physically active and eat better. Competitions were held at the end of each challenge in an effort to bring teams together and feature successes of the participants. A chili cook-off was held in New Castle County and a cooking challenge was held in Kent County.
**Results:** A total of 91 individuals (New Castle County-45, Kent County-46) completed the challenges. Pre and post evaluations showed that participants are consuming more than twice the amount of fruits and vegetables, decreased their body mass index and increased their leisure time exercise. Specific to the Dining with Diabetes program in New Castle County participants reported increases in eating 5 or more fruits and vegetables daily (88%), reading Nutrition Facts labels (50%), and being physically active at least 30 minutes 3 times per week (61%). Furthermore, eating smaller portions, using recipes from the class, and checking feet more frequently were noted as additional ways to manage their diabetes (by 56%, 56%, and 44% of participants, respectively). Anecdotally participants shared the following; "After working all day and going home, you just kind of throw anything in your

mouth. So with the nutrition side it made me more mindful to eat fruits and vegetables." "For me...[the challenge]...helped me choose products better when I go to the supermarket, because I'm more aware of what's good and what's not..."

**Issue:** Childhood obesity now affects 1 in 6 children and adolescents in the United States. DSU's SNAP-ED program assists in reducing childhood obesity through educational nutrition lessons and interactive activities designed for youth in grades 3 and 4. According to the Rethink Your Drink initiative, Americans consume approximately 300 more calories than their body needs, and nearly half of these 'extra' calories come from sugary drinks. One lesson in particular focuses on the importance of being mindful to the amount of sugar contained in a variety of beverages, from Gatorade to lemonade.

**Response:** The SNAP-ED program added a lesson on sugary beverages entitled, Rethink Your Drink to teach the importance of knowing the quantity of hidden calories from sugar that are contained in many commercial beverages. A display featuring a variety of beverages, along with the corresponding amount of sugar measured in teaspoons, is used as a visual to demonstrate one of the common pathways of sugar in our diet. This new lesson was implemented during the 2016-2017 school year at New Castle Elementary School as a pilot with approximately 80 fourth grade students.

**Results:** Prior to the SNAP-ED program and lesson, 80 students participated in the pre-test related to the 5 lessons. The question related to the Food Safety lesson was answered correctly on 64% of the tests for the New Castle Elementary students. Once the program was completed, the students scheduled a post-test approximately 4 months after the program completed. The total number of students who answered correctly increased to 93%. This increase demonstrates the knowledge obtained and received once the program was completed. A fourth grade teacher expressed to the educator how impressed and excited she was in regards to the food safety lesson. She loved how the SNAP-ED program evolved and incorporated real life application and interactive tools.

**Shepherds Place: Issue:** Many low-income individuals and families in Kent County lack the necessary knowledge and skills to make well informed food and physical activity choices which lead to healthy lifestyles. According to the University of Delaware's School of Public Policy and Administration, the official poverty rate for individuals in Delaware was 13.8% in 2013, with a higher rate of poverty is among families with children. The highest rate of poverty at almost 30% is found among families with a female head of household. The goal of the EFNEP program is to provide individuals, families and communities in Kent County with knowledge and skills that will enable them to be better informed about healthy foods, food safety practices and food budgeting.

**Response:** EFNEP offers a series of eight classes utilizing the Eat Smart, Be Active curriculum designed to teach low-income audiences lessons on food resource management; food safety; nutrition and meal planning; and physical activity. Participants meet once a week for eight weeks where they learn how to prepare low cost nutritious meals and snacks; learn how to read food labels that will enable them to make wiser food purchases; as well as ideas on how to incorporate physical activity into their daily lives.

A partnership was established with Shepherds Place, a local shelter for women with children, to teach EFNEP that involved 26 adult participants and their children. Accompanying each lesson, participants were provided an opportunity to sample healthy recipes during each class. Recipes included fruit/vegetable smoothies (Spinach Smoothies); an alternative dessert (yogurt parfait), a carbohydrate alternative (cauliflower rice); and protein substitutes (Greek yogurt, hummus and meatless chili).

The group completed more than 8 hours of nutrition based education combined with 4 additional hours of Fitness exploration. Participants explored fitness by completing jump roping tasks, hula hooping and Zumba. Feedback received from participants included the

statements like: they felt like children again, and how they thoroughly enjoyed the physical activities. Many participants chose to complete a full 30 minutes of physical activity per class session.
There were a total of 10 children that participated in the program and received 3 series of 4 lessons from the USDA My Plate curriculum. Children also participated in fitness exploration activities such as Zumba and hula hooping.
Weekly updates of program activities were posted on social media, along with healthy eating tips that the participants agreed were useful and fun. Regular postings are designed to encourage participants to continue healthy lifestyle behaviors.
**Results:** We experienced a 95% graduation rate with the 26 adult participants and 10 youth participants. Individuals who did not graduate because of missed lessons, were later contacted by EFNEP program staff offering them an opportunity to complete lessons missed. Certificates of Completion were presented to all graduates along with the following items that were used during the series and to promote long term behavioral change:
Water bottles to encourage increased water consumption
Grocery list to increase mindfulness of food budgeting
Resistant Exercise Band to promote muscle strength
10 tips for Nutrition Eating Series
USDA My Plate Handouts
All handouts from the Eating Smart and Being Active curriculum
Measuring cups and spoons to encourage portion control
Thermometer to encourage food safety practices
Vegetable Scrub to encourage food safety practices
Cookbook for healthy recipe ideas
**Issue:** My research has focused on behavioral and policy issues related to the nexus of agriculture and the environment. This research topic is relevant to almost everyone in society since it covers the food we eat, the water we drink, and the health of the environment that sounds us. These issues are fundamental to human health and human values for the environment.
**Response:**
During the time period, October 1, 2015 ‰ÛÒ September 30, 2016, I was engaged in a variety of research, teaching, and outreach activities related to the nexus of agriculture and the environment. I served as the Director of the Center for Experimental & Applied Economics at the University of Delaware and as the co-Director of the USDA-funded national Center for Behavioral & Experimental Agri-Environmental Research (CBEAR). In these roles I oversaw over a dozen research projects and advised undergraduate students, graduate students, and postdocs. I also collaborated with faculty at the University of Delaware and throughout the country.
**Results:** The impact of my work is difficult to measure precisely. I had seven peer-reviewed journal articles published and received over a dozen grants of various sizes to support future research. My research was also featured in over 20 selected and invited presentations. It is my understanding that the CAST Issue Paper that I chaired related to consumer behavior and process labeling of food was instrumental in informing and designing the bipartisan law on GMO labeling that was signed in 2016.
**Issue:** Can a preserved farm label help improve the profitability of production agriculture via direct and indirect sales to consumers? This matters to all farmers engaged in food production that is delivered to humans. It also helps consumers select the produce that best meets their needs
**Response:** Designed the first preserved-farm label. Conducted an economic experiment with Dr. Bernard. We found that consumers are willing to pay $2.38 more on average for Delaware watermelons that are labeled "preserved farm." Willingness to pay for local label

was also found: +$1.90 on average.
**Results:** Research shows that using preserved-farm and local labels can help farmers get more money for the exact same produce.
**Issue:** Examining issues at the interface of agriculture, the environment, and society, my research aims to identify how agri-environmental programs and policies can be designed to cost-effectively enhance ecosystem services in working agricultural landscapes. This is an important area of research because, despite spending over six billion dollars a year on federal conservation programs, agricultural nutrient runoff remains a persistent problem in watersheds with a high proportion of farmland. Key stakeholders include federal, state, and local conservation agencies, agricultural producers, and people who value clean water for recreation and consumption.
**Response:** I use behavioral and experimental economics methods to identify how conservation programs can be designed to promote environmentally sustainable land use practices while maintaining farm profitability. My research also examines how recreational ecosystem services are affected by nutrient runoff.

To provide meaningful, policy-relevant information to stakeholders, my research involves interdisciplinary collaborations with natural scientists, researchers outside of academia, and local stakeholder organizations, like county Soil and Water Conservation Districts.
**Results:** Palm-Forster, L.H., S.M. Swinton, T.M. Redder, J.V. DePinto, and C.M.W. Boles. 2016. ‰ÛÏUsing conservation auctions informed by environmental performance models to reduce agricultural nutrient flows into Lake Erie.‰Û? Journal of Great Lakes Research 42(6): 1357-1371.

--> Results from field experiments with farmers suggest that, in addition to direct payments, financial incentives such as tax credits and certification price premiums would motivate them to use more conservation practices.

**Issue:** The project focuses on one of the USDA-NIFA priority areas- food safety; especially concerning poultry products. The US is the worldâ€™s largest producer and market place of poultry and egg products and the demand for these products are continuously increasing each year. Despite effective process control such as GAPs/HACCP practices, poultry and egg products still serve as vehicles of Salmonella by which a number of food poisoning outbreaks are reported annually; the economic loss in the US has been estimated around $3.7 to $11.4 billion per year. In order to prevent Salmonella & Campylobacter contaminations during the post-harvest processing, development of a rapid detection assay in poultry and egg products is crucial for the benefit of farmers, private sectors, stakeholders, and consumers.
**Response:** The rapid detection assay based on Recombinase Polymerase Amplification (RPA) was developed for a quantitative detection of Salmonella and Campylobacter spp. Primers and probes of the RPA assay were designed for rapid detection of Salmonella Typhimurium and Campylobacter jejuni and coli. The RPA assay was examined detection specificity and sensitivity of each bacterial target and optimized its running protocol: incubation temperature and run-time. The RPA assay was applied to poultry, chicken broth, and egg products for detecting Salmonella and Campylobacter.
**Results:** The RPA assay could contribute to rapid monitoring application by detecting and quantifying Salmonella and Campylobacter in poultry egg products within 30 min running time. Through this project, two articles were published in the peer-reviewed articles. One graduate student successfully completed their thesis work and graduated with a Master of Science degree in Food Science as well as the project has provided unique research opportunities for undergraduate and graduate students.

**Issue:** Vibrio bacteria are the primary cause of shellfish-associated bacterial illness and lead to illnesses, deaths, closures of shellfish harvesting areas, and economic loss to the industry every year. Current tests for disease-causing Vibrio species are complex and expensive, and fail to meet the needs of regulatory agencies or the industry. This research will evaluate the use of an inexpensive, simple and rapid method we developed in collaboration with the United States Department of Agriculture (USDA) -Agricultural Research Service (ARS) for total Vibrionaceae (Vibrio) detection to determine if total Vibrio levels in seawater or shellfish would serve as a suitable indicator for pathogenic Vibrio or a better overall method for monitoring shellfish safety. This research impacts commercial oystermen, consumers, retailers, general public, seafood safety professionals, researchers.

**Response:**
PROJECT GOAL
Perform microbial & molecular analysis of oysters and validate the Colony Overlay Procedure for Peptidases (COPP) assay with Real-Time PCR.
Goal 1
Market-size Delaware Bay were purchased, and housed in 2 at the 3 DE Bay research sites:Lewes, Slaughter Beach,& Bowers Beach. Seawater and 9 oyster samples were collected monthly from the 3 sites from June-October 2016. 3 oysters in triplicated were processed, divided into 3 sub-samples. 1:10 dilutions of oyster homogenate and water were prepared in phosphate buffered saline (PBS). 100 ÂµL of each dilution was spread on 1% NaCl tryptic soy agar (TSA) plates & incubated 18 hours at 37Â°C for total bacterial monitoring. COPP assay was performed on each countable TSA plate (â‰ˆ50-100 colonies).Cellulose acetate membranes previously soaked in L-lysyl-7-amino-4-trifluoromethylcoumarin substrate were used in this assay. Plates were incubated for 10 min at 37Â°C
Membranes were then removed and observed under long-wave UV light for fluorescence. Fluorescent colonies were counted and CFU/mL were calculated.
Real-Time PCR was performed to confirm presence of pathogenic bacteria Vibrio parahaemolyticus & Vibrio vulnificus. Identification of Vibrio parahaemolyticus (Vp) and Vibrio vulnificus (Vv) were made using culture based methods (CHROM agar).Validation of Vp and Vv using conventional PCR methods were performed. Validation of the total vibrio counts from COPP assay using Real-time PCR based methods was also performed.
**Results:** Total Bacterial and Total Vibrio were determined for water & oyster samples. Total Bacteria levels in oysters and water samples were high at Bowers Beach. Trends in Total bacterial numbers remained similar in oyster and water samples throughout the study. Total Vibrio levels were higher in Bower Beach. Molecular analyses will be completed in 2017. Research will be carried out for a second season in 2017.

**Issue:** Organic farming has been popular in local food system of Delaware. Small farmers are trying to switch to organic farming to capitalize the niche opportunity. But, underserved farmers still face challenges to be a certified organic grower due to lack of knowledge and information to find a suitable crop to grow as an alternative agriculture enterprise during organic transitioning.

**Response:** Four accessions of sweet potato were evaluated during growing season of 2012 to 2015 to determine if these accessions of sweet potato fit well in relatively shorter and cooler climate of Delaware. Therefore, field experiments were conducted at Outreach and Research Center (ORC) of Delaware State University located in Smyrna, DE, 19901. Randomized Complete Block Design was adopted for this experiment and â

€œBirmingham" was considered as control. Accessions were replicated three times on sandy loam soil with a pH of 6.8, and same agronomic practices were maintained throughout the growing season. The purple fleshed â€œBirminghamâ€? showed the highest yield (34833 kg ha-1) followed by â€œcreamy fleshedâ€? TUI-001 (31847 kg ha-1), â€œlight creamy fleshedâ€? A-193-217 (28935 kg ha-1), and â€œwhite fleshedâ€? TI-6008 (26481 kg ha-1), respectively, in comparing the ungraded storage root yield.

**Results:** The way the yield results shown by these sweet potato accessions, it is clear that here in the Delaware sweet potato have great potential to be a good crop for organic transition in Delaware climate without adding any chemicals in the forms of synthetic fertilizer and pesticides. The fact is that sweet potato is one of the best crops to minimize the weed and drought effect. Thus sweet potato has a high potential to become a great food security crop for those who are economically underprivileged.

**Key Items of Evaluation**

## V(A). Planned Program (Summary)

**Program # 3**

**1. Name of the Planned Program**

VOLUNTEER, FAMILY AND YOUTH DEVELOPMENT

☑ Reporting on this Program

**V(B). Program Knowledge Area(s)**

1. Program Knowledge Areas and Percentage

| KA Code | Knowledge Area | %1862 Extension | %1890 Extension | %1862 Research | %1890 Research |
|---|---|---|---|---|---|
| 601 | Economics of Agricultural Production and Farm Management | 15% | 15% | 15% | 15% |
| 801 | Individual and Family Resource Management | 15% | 15% | 15% | 15% |
| 803 | Sociological and Technological Change Affecting Individuals, Families, and Communities | 25% | 25% | 25% | 25% |
| 806 | Youth Development | 35% | 35% | 35% | 35% |
| 901 | Program and Project Design, and Statistics | 10% | 10% | 10% | 10% |
| | **Total** | 100% | 100% | 100% | 100% |

## V(C). Planned Program (Inputs)

**1. Actual amount of FTE/SYs expended this Program**

| Year: 2016 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| **Plan** | 9.8 | 2.9 | 0.9 | 0.3 |
| **Actual Paid** | 7.9 | 6.9 | 0.0 | 0.0 |
| **Actual Volunteer** | 0.0 | 0.0 | 0.0 | 0.0 |

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

| Extension | | Research | |
|---|---|---|---|
| **Smith-Lever 3b & 3c** | **1890 Extension** | **Hatch** | **Evans-Allen** |
| 344156 | 452888 | 0 | 0 |
| **1862 Matching** | **1890 Matching** | **1862 Matching** | **1890 Matching** |
| 841965 | 452888 | 0 | 0 |
| **1862 All Other** | **1890 All Other** | **1862 All Other** | **1890 All Other** |
| 530424 | 0 | 0 | 0 |

## V(D). Planned Program (Activity)

### 1. Brief description of the Activity

Extension programs will target: (1) Science, Technology, Engineering, and Math (STEM) for youth development, (2) Volunteer and Leadership Development, and (3) Farm, Small Business and Family Resource Management and (4) Positive Youth Development

Science, Technology, Engineering, and Math (STEM) will be a key component of 4-H Youth Development programs. Incorporating a youth assets approach, 4-H programs will focus on life skills development, positive life choices, leadership development, citizenship/community involvement, and career exploration with emphasis on science, engineering and technology knowledge. Appropriate settings including clubs, camps, school enrichment and after school will use the latest technology to deliver the sustained opportunities. All programming will encompass the latest research on positive youth development and will incorporate the components of positive and sustained adult-youth relationships; life skills-building activities for youth; and opportunities for youth participation in and leadership of valued community activities.

Volunteer Leadership Development programs will be delivered across all program areas. With a core of 3000 volunteers in Cooperative Extension, this program will include core volunteer competencies for volunteer leadership development that will be implemented with 4-H adult and teen volunteers and camp counselors, master gardeners, master food educators; middle management volunteers (volunteers managing volunteers); and extension advisory committees. Core competencies as well as subject matter training and update training to maintain certifications will be provided. Delivery of educational program through volunteers will also occur across all program areas.

Farm, Small Business, and Family Resource managementeducational programs will be developed and delivered focusing on strategies for effective consumer decision making, financial planning and financial management practices, basic budgeting and credit management, and risk management including health insurance literacy. Additionally, business management strategies focused on business and marketing plans, new business development, business diversification, and improving employability and building human capital skills.

Positive Youth Development educational programs include skills in civic engagement, communication, and decision making skills

### 2. Brief description of the target audience

The target audience includes:Youth ages 5-19, 4-H members, 4-H volunteers, new 4-H volunteers,

Master Gardeners, Master Food Educators, Community Leaders, at-risk youth and families, court appointed and incarcerated youth and adults, parents of children (from birth through school-age), youth agency professionals, key decision-makers, human service professionals, child care/after school providers, family day home providers, social clubs, church groups, private and public school youth and teachers, after school 4-H clubs and school age child care programs, farm owners and farm families

**3. How was eXtension used?**

In 2016 the eXtension Institutional Team comprised of faculty and staff from across all planned program areas was converted to the Innovation team consistent with eXtension continue to provide the leadership for this work. This past year the team has focused on the following: • Social media plan was updated and Ask an Expert included on new website design • On-line course development with Continuing and Professional Development • Became a premier member of new eXtension structure-one communications personnel selected as I-corp member in a diversity and inclusion initiative. The social media strategy is particularly effective with our youth development program. 4-H has specific pages and posts as well as a focus on alumni gathering through social media efforts. The True leaders campaign for identifying alumni support for 4-H is very active on social media. We are almost complete with an Extension 101 introductory training in an online module for all volunteers.

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

| 2016 | Direct Contacts Adults | Indirect Contacts Adults | Direct Contacts Youth | Indirect Contacts Youth |
|---|---|---|---|---|
| **Actual** | 9476 | 2323 | 8902 | 3074 |

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

**Patent Applications Submitted**

| | |
|---|---|
| Year: | 2016 |
| Actual: | 0 |

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

| 2016 | Extension | Research | Total |
|---|---|---|---|
| **Actual** | 0 | 0 | 0 |

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Competitive Grants Awarded

| Year | Actual |
|---|---|
| 2016 | 0 |

**Output #2**

**Output Measure**

- Undergraduate Researchers

| Year | Actual |
|---|---|
| 2016 | 0 |

**Output #3**

**Output Measure**

- M.S. and Ph.D Students

| Year | Actual |
|---|---|
| 2016 | 0 |

**Output #4**

**Output Measure**

- Post-doctoral Researchers

| Year | Actual |
|---|---|
| 2016 | 0 |

**Output #5**

**Output Measure**

- Refereed Journal Articles

| Year | Actual |
|---|---|
| 2016 | 0 |

**Output #6**

**Output Measure**

- Books and Book Chapters

| Year | Actual |
|---|---|
| 2016 | 0 |

**Output #7**

**Output Measure**

- Extension Bulletins and Fact Sheets

| Year | Actual |
|---|---|
| 2016 | 6 |

**Output #8**

**Output Measure**

- Webpage views/downloads

| Year | Actual |
|---|---|
| 2016 | 124546 |

**Output #9**

**Output Measure**

- Workshops and regional, national, and international levels

| Year | Actual |
|---|---|
| 2016 | 18 |

**V(G). State Defined Outcomes**

## V. State Defined Outcomes Table of Content

| O. No. | OUTCOME NAME |
|---|---|
| 1 | Science, Technology, Engineering, and Math: 1) Increased knowledge of STEM content areas resulting in increased critical thinking and scientific inquiry. 2) Increased numbers of youth pursuing education and careers in science and in contributing to society using science skills. |
| 2 | Volunteer Leadership Development: 1) Increased knowledge of leadership skills and apply of these skills volunteering and leadership within the community. 2) Augmentation of Cooperative Extension program and resources through volunteer leaders providing education in communities and groups. |
| 3 | Farm, Small Business, and Family Resource management: 1) Increased knowledge, increased awareness of skills to use, and adoption of best practices in financial management. 2) Increased knowledge, increased awareness and adoption of skills to use and evaluate and enhance business and marketing plans. |
| 4 | Positive Youth Development |

## Outcome #1

### 1. Outcome Measures

Science, Technology, Engineering, and Math: 1) Increased knowledge of STEM content areas resulting in increased critical thinking and scientific inquiry. 2) Increased numbers of youth pursuing education and careers in science and in contributing to society using science skills.

### 2. Associated Institution Types

- 1862 Extension
- 1890 Extension

### 3a. Outcome Type:

Change in Action Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2016 | 1918 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Youth in New Castle County have lost interest and awareness around the topics of Science, Technology and Math. Youth particularly between the ages of 8-12 years old need to increase knowledge, interest and skills around the topics of Science, Technology and Math.

**What has been done**
In an effort to improve knowledge and skills around Science Technology and Math we put together four different workshops, called 4-H Science Saturday, that had 83 total youth participates. The topics included plant and soil science, geocaching and math, embryology, and engineering. We planned for six total classes but due to low participation numbers we did not complete the first two sections. Once interest grew from May to September we held the remaining workshops. To show growth of interest, knowledge, and skill a pre and post survey was conducted.

**Results**
A total of 83 youth answered the pre and post survey questions. 10 of those surveyed had participated in Science Saturday workshop before. Survey shows that science workshop?s help to increase interest in science and using science in everyday problems. The written answers to survey questions were very helpful in recognizing first-hand that the kids learned about team work and that the more hands-on the science activity is the more likely they are to enjoy learning and participating. Based on the survey, the science Saturday workshops have made an impact on youth wanting gain knowledge and are interested in a career in science, technology and math. New Castle County plans to also use the information to create more science activities on the county level. The following evaluation results were reported: (n=83)
60% increased knowledge of science and their appreciation for it.

58% plan to study in one of the following areas after graduating high school: Science, Technology and Math.
70% want to do more Science programming with 4-H.
65% plan or possibly plan to try geocaching on their own
40% increase in youth who know what Organic Matter is at the end of the workshop.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 803 | Sociological and Technological Change Affecting Individuals, Families, and Communities |
| 806 | Youth Development |
| 901 | Program and Project Design, and Statistics |

**Outcome #2**

**1. Outcome Measures**

Volunteer Leadership Development: 1) Increased knowledge of leadership skills and apply of these skills volunteering and leadership within the community. 2) Augmentation of Cooperative Extension program and resources through volunteer leaders providing education in communities and groups.

**2. Associated Institution Types**

- 1862 Extension
- 1890 Extension

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2016 | 68 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
4-H Embryology Program:
According to the 2014 Leaders and Laggers report on K-12 STEM Education, commissioned by the U.S. Chamber of Commerce, Delaware earned low grades in Technology education, and overall, a low return on its educational investment. Delaware?s quality of education received average grades in progress from a similar report issued in 2015.

**What has been done**
In order to reinvigorate interest and student performance in STEM education, Kent County 4-H provides a unique opportunity for elementary students. Within the tight rigors of the educational schedule, the embryology program brings a great tool into the Kent County elementary schools,

for students to enjoy while meeting many of their curriculum requirements. Teachers use this program to reinforce math skills, reading skills, writing skills and science concepts. Experiencing this program helps the students develop life lessons such as responsibility, caring and empathy, excitement and occasionally disappointment. Embryology provides priceless teaching opportunities where children are able to think and feel. With budget cuts and mainstream classrooms, the embryology program fits the needs of many classrooms and students!

**Results**

During the program year of 2016, 98 classrooms participated in this outreach effort; this included 2358 students and 120 teachers. As a result of the 2016 program evaluation, where the lead teacher of each school was surveyed, the following data was collected: (31 school lead teachers were asked to complete the survey; 26 were returned)
86% (26) See an increase in the student?s general excitement towards learning, during the program
77% (26) indicated students increased their science inquiry skills of observations, comparison, measurement and data recording
96% (26) felt the program helped students develop an understanding of biology concepts, through direct experience with the Embryology Program
92% (26) believed the program developed science processing skills; listening, observing, experimenting, and applying knowledge.

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 801 | Individual and Family Resource Management |
| 803 | Sociological and Technological Change Affecting Individuals, Families, and Communities |
| 806 | Youth Development |
| 901 | Program and Project Design, and Statistics |

**Outcome #3**

**1. Outcome Measures**

Farm, Small Business, and Family Resource management: 1) Increased knowledge, increased awareness of skills to use, and adoption of best practices in financial management. 2) Increased knowledge, increased awareness and adoption of skills to use and evaluate and enhance business and marketing plans.

**2. Associated Institution Types**

- 1862 Extension
- 1890 Extension

**3a. Outcome Type:**

Change in Action Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2016 | 39 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
US census data confirms that women are increasingly involved in managing farm operations. It is also well known that those involved in the equine industry are predominantly female. Often time extension equine programming focuses on the management of the horse itself and not the business side of an equine operation.

**What has been done**
Annie?s Project Supper with an Equine Business focus was developed by a team of extension professionals from the University of Delaware and the University of Maryland. This multi-state 3 night educational program was modeled after the Annie?s Project program which began in Delaware and Maryland in 2008. The program is designed to empower farm women in the area of farm management to be able to manage risk, and build local networks throughout the state and region. Each 3 hour evening session began with a meal followed by guest speakers and discussion. Topics covered during the three sessions included Business Structure, Personality IQ, Business Planning, Farm Insurance, Equine Insurance and Liability, Lender Requirements and Credit Reports, Social Media and Website Design Tips. In order to broaden the reach of the program, the Equine Annie?s Project Supper Series met simultaneously in both Salisbury, Maryland and Dover, Delaware. Participants were linked through distance technology and speakers presented from both locations.

**Results**
13 women representing more than 900 owned and leased acres participated in the inaugural offering of the equine business focused Annie?s Project Supper Series. Post session evaluations indicate:
?100%- Resource materials I can use
?70%- Names of other people to contact
?60%- Answers to my questions
?60%- Ideas I can try immediately
As a result of participating in the series:
?71.5% might or will get/change their insurance policy
?89% might or will write a farm business/marketing plan
?55.5% might or will check their credit report
?80% might or will Implement/ change their current business structure
?90% might or will Increase communication and family relations through personality traits and information learned
?89% might or will be more effective communicating with clientele through social media & website design.
In addition:
?90% of program participants indicated an interest in participating in follow up or advanced equine business management training classes.
?Equine Annie?s Project Supper participants shared feedback such as: ?The educators were very knowledgeable and it was a great place to network with other horse people-thanks!?, ?The course materials and the information that was gained is priceless. Extension Equine Annie?s was

so worth it.?, ?Your classes turned the light bulb on! Really got me thinking about hobby versus business?

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 601 | Economics of Agricultural Production and Farm Management |
| 801 | Individual and Family Resource Management |
| 806 | Youth Development |
| 901 | Program and Project Design, and Statistics |

**Outcome #4**

**1. Outcome Measures**

Positive Youth Development

**2. Associated Institution Types**

- 1862 Extension
- 1890 Extension

**3a. Outcome Type:**

Change in Action Outcome Measure

**3b. Quantitative Outcome**

| Year | Actual |
|---|---|
| 2016 | 1811 |

**3c. Qualitative Outcome or Impact Statement**

**Issue (Who cares and Why)**
Teens as Leaders Need: The National Alliance for Secondary Education and Transition reports that youth leadership is part of the youth development process and supports the young person in developing: (a) the ability to analyze his or her own strengths and weaknesses, set personal and vocational goals, and have the self-esteem, confidence, motivation, and abilities to carry them out (including the ability to establish support networks in order to fully participate in community life and effect positive social change); and (b) the ability to guide or direct others on a course of action, influence the opinions and behaviors of others, and serve as a role model (Wehmeyer, Agran, & Hughes, 1998).

**What has been done**
The Delaware Military program has developed many teen leaders over the year. This year we have 7 youth who are actively teaching both on base and off base, as well as another 25 teens participating in leadership project activities on base and their communities. The youth teach the

Up for the Challenge and Health Rocks curriculums, as well as the Food Smart earlier this year. The community projects where the youth provide leadership include community dinners and gardens, safe kids events, prevention carnivals, public speaking contests and roles as club officers to name a few.

**Results**

This is our first year surveying the teens as teachers and the response quantifies the impact and outcomes that the 4-H program provides to develop teens as leaders. 100% report that they agree and strongly agree that they personally make a difference in their community. 100% report that they agree and strongly agree that they can solve ?real life? problems. 100% reported that they agree and strongly agree that they gained skills through serving in their community that will help them in the future. While many adults fear public speaking, 100% of these youth ranked their ability to speak before a group as Good to Excellent at the completion of these programs this year. One of the quotes from a teen was ?The best part of participating as a teen teacher was getting to teach relevant and useful information to youth, so that they can make better decisions in order to live a happy and healthy life. It is very fulfilling knowing I got to be part of that.?

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 806 | Youth Development |

## V(H). Planned Program (External Factors)

**External factors which affected outcomes**

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

**Brief Explanation**

## V(I). Planned Program (Evaluation Studies)

**Evaluation Results**

**Issue:** 4-H Poultry: Delaware is one of the top states with regard to poultry production. The broiler, or meat chicken, industry started in the state and has continued to grow. Delaware 4-H has not sent a team of member to the National 4-H Poultry and Egg Conference in many years despite growing interest in such by the poultry participants. These poultry youth are potentially members of the poultry industry workforce in the future and all have an interest in a field related to the poultry industry.

**Response:** Dr. McCrea has been working with 4-H poultry youth since she began at Delaware State University. She has developed several novel programs to not only garner

interest in 4-H Poultry Judging Contest as well as the 4-H Avian Bowl program. She has been listening to the concerns of members and coaches/parents and has gradually adjusted programming to meet their needs and interests as the youth grow older. She has also worked to expand interest in both New Castle and Sussex Counties. She has developed learning activities based on programs in other states as well as hands-on activities to help members remember the contest details. Dr. McCrea also arranged tours for team members of an egg processing facility so that they could inquire about the process and skills needed for careers in this field.

**Results:** Dr. McCrea took a team of 4-H members to the National 4-H Poultry and Egg Conference held annually in Louisville, KY. The conference was held on November 16-17, 2016. The team participated in the careers workshop as well as 4-H Avian Bowl and 4-H Poultry Judging Contest. The funds for this trip were supported by the generosity of Dr. Harry Thayer through his 4-H Program at Delaware State University. Dr. McCrea has been a member of this conference planning committee for over a decade and has been strengthening the 4-H poultry program to help prepare youth for careers in the poultry industry. The team did well in 4-H Avian Bowl receiving 8th place. The Poultry Judging Contest yielded higher scores. Mr. Drew Harris of Peach Blossom 4-H Club placed 2nd nationally in the Hens portion of the contest. Ms. Leslie Webb placed 6th in the same section. Overall, Mr. Harris was 21st in the nation and Ms. Webb was 26th. The team placed in 11th place in the Poultry Judging Contest at the conference. The youth team members stated that they enjoyed going to nationals and seeing what careers were available to them in the poultry industry. Many said it was an experience that they would not soon forget.

**Issue:** Low income, largely at risk minority youth who are determined to be problem students are not obtaining the necessary educational skills required to pass the mandatory state test implemented by the State of Delaware's Department of Education. Without successful completion of these tests (DSTP), students will be retained. Individuals identified with negative behaviors, along with other social or academic issues are the primary target for this leadership development program.

**Response:** The goal for each student is to reach 100 points in a week. Points are earned for good progress reports, good behavior, appropriate attire on meeting days, and overall positive progress. Club goals are read and reinforced at each meeting, which helps to build unity among club members. Each student is required to conduct themselves with dignity-- like ladies and gentlemen at all times, hence the name of the club.

**Results:** As a result of the Ladies and Gentlemen's Club, student performances has improved in all three key areas of concentrations: School suspensions and detentions have decreased by 75%. Overall behaviors have significantly improved; and students' academic performance has increased by 45%, where many have earned the requirements for the club's honor roll, which uses higher standards than the general honor roll. Students, overall, are performing much better on state tests and greater than 65% have passed and advanced to higher grades in the 2015-2016 academic year, where they had previously failed. Confidence gained both in and outside the classroom is leveraging great strides in areas of positive youth development that goes beyond academic performance but is conveyed in attitudes, self- respect, and personal accountability.

**Issue:** During the summer months when at-risk youth may have less supervision, and no structured activities, there are greater opportunities for mischief. Additionally, many youth are not aware of skills required to mold them into more productive members of society.

**Response:** The **Sew Much More Summer Program** is an intensive 5 week camp, where campers meet with their instructor twice a week for 4 hours. Participants learn basic sewing skills, including hand and machine sewing. The final assignment is for each participant to

sew their own garment and to model it at fashion show hosted by the campers. At the program's conclusion, a certificate of completions is given to each participant for their individual achievement. **Results:** Everyone who participated was thrilled to learn a new skill and work on the machine for the very first time. After completing their garments, some participants further enjoyed their outfits by wearing them to church sponsored events following the end of camp. As a result of this program, participants now have the ability to extend the life of their clothes and accessories by making mends and repairs to torn items. Others have requested their own sewing machines to continue developing this skill.

### Key Items of Evaluation

## V(A). Planned Program (Summary)

**Program # 4**

**1. Name of the Planned Program**

ENVIRONMENTAL STEWARDSHIP IN A CHANGING CLIMATE

☑ Reporting on this Program

### V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

| KA Code | Knowledge Area | %1862 Extension | %1890 Extension | %1862 Research | %1890 Research |
|---|---|---|---|---|---|
| 111 | Conservation and Efficient Use of Water | 10% | 10% | 10% | 10% |
| 112 | Watershed Protection and Management | 10% | 10% | 10% | 10% |
| 124 | Urban Forestry | 5% | 5% | 5% | 5% |
| 132 | Weather and Climate | 10% | 10% | 10% | 10% |
| 135 | Aquatic and Terrestrial Wildlife | 15% | 15% | 15% | 15% |
| 136 | Conservation of Biological Diversity | 10% | 10% | 10% | 10% |
| 216 | Integrated Pest Management Systems | 20% | 20% | 20% | 20% |
| 302 | Nutrient Utilization in Animals | 5% | 5% | 5% | 5% |
| 806 | Youth Development | 10% | 10% | 10% | 10% |
| 903 | Communication, Education, and Information Delivery | 5% | 5% | 5% | 5% |
| | **Total** | 100% | 100% | 100% | 100% |

## V(C). Planned Program (Inputs)

### 1. Actual amount of FTE/SYs expended this Program

| Year: 2016 | Extension | | Research | |
|---|---|---|---|---|
| | 1862 | 1890 | 1862 | 1890 |
| **Plan** | 7.8 | 1.9 | 30.7 | 4.8 |
| **Actual Paid** | 7.4 | 0.7 | 33.4 | 5.0 |
| **Actual Volunteer** | 0.0 | 0.0 | 0.0 | 0.0 |

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

| Extension | | Research | |
|---|---|---|---|
| **Smith-Lever 3b & 3c** | **1890 Extension** | **Hatch** | **Evans-Allen** |
| 275814 | 46282 | 161520 | 792981 |
| **1862 Matching** | **1890 Matching** | **1862 Matching** | **1890 Matching** |
| 171742 | 46282 | 465494 | 792981 |
| **1862 All Other** | **1890 All Other** | **1862 All Other** | **1890 All Other** |
| 22022 | 0 | 1120654 | 263600 |

## V(D). Planned Program (Activity)

### 1. Brief description of the Activity

**I. Increased knowledge of and best management practices to mitigate the effects of climate change**
a. Animal agriculture: understanding impacts of climate change on animal physiological processes, health, and disease, particularly for poultry and dairy; developing management practices to rapidly diagnose, prevent, and mitigate (e.g., new vaccines) effects of avian diseases on poultry health and productivity, including current disease problems and new ones that may appear and proliferate under new climatic conditions; developing new systems and technologies to reduce effects of environmental stress on animal health and productivity. The latest research projects are focusing on animal care, management and environmental design to ensure animal well-being and raise awareness of environmental protection, law and legislation. These studies are on four fronts, including monitoring technologies for animal physiological and behavioral response, assessment of animal-environment interactions, quantitation of air quality and emissions from animal feeding operations, and assessment and development of best management practices aiming at mitigating air emissions based on their character, amount, and dispersion.
b. Agronomic crops: basic research on how environmental stresses associated with climate change (e.g., heat, moisture stress) affect crop physiology and productivity; plant genetics and breeding studies to develop cultivars of major crops better adapted to a changing climate, in terms of water use efficiency and resistance to insects and disease; applied research and extension programs on irrigation management and water use efficiency for periods of prolonged drought and restricted water use and for groundwater that may become more saline from salt water intrusion; integrated pest management to diagnose and control insects, weeds, and diseases (current and newly emerging) during longer growing seasons and under warmer and wetter growing conditions; nutrient cycling and management, particularly for manures and other byproducts where decomposition and nutrient release rates and timings are affected by warmer, wetter climates; basic and applied research on factors controlling C sequestration and new agronomic management practices that help mitigate greenhouse gas emissions by sequestering C in soils; and new studies now underway on how changing temperature and rainfall patterns will affect phosphorous management and water quality impacts, using isotope geochemistry to identify how and why the phosphorous has been released from cropland to surface and ground waters. Integrated Pest Management - developing and delivering integrated pest management (IPM) programs, a "systems" approach using chemical, cultural, mechanical, and biological control to increase profits to producers and protect the environment;
c. Natural Ecosystems: characterizing effects of climate change on biodiversity of plants and wildlife exposed to greater pressure from droughts, insects, disease, and invasive species; studying how climate change affects natural ecosystems and insects critical to crop production (e.g., pollination, honeybees); investigate value of marshes, wetlands, and forests to sequester C; increase C storage by encouraging

tree planting and sustainable forestry management; and new studies using weather radar to quantify bird distributions and to track migratory birds. Understanding stopover ecology of migratory birds, including how they select the habitats where they stop and how that impacts their behavior and the success of their migrations is an important area of ecological research today. Sustainable Agriculture/Forestry - developing and promoting efficient and sustainable agricultural, forestry, and other resource conservation practices and policies that ensure sustained ecosystem function and provide food and habitat for biodiversity, including crop diversification, agroforestry, native windbreaks, cover crops, living mulches, field border systems, and conservation buffers; Wildlife, Woodlands, and Aquatic Resources - understanding and mitigating the impact of agricultural practices and urbanization on biodiversity, woodlands, and aquatic resources. Focus will be on human impacts on the fundamental processes that create and maintain biodiversity, such as atmospheric nitrification of ecosystems, minimal habitat requirements, speciation, predator-prey interactions, community and ecosystem structure, and extinction processes. Approaches to develop and sustain biodiversity in agriculture, suburban landscapes, and natural habitats, will be studied. Nonpoint source nutrient pollution models will assess impacts of land use/cover change from agriculture to urban on water quality and quantity on local ponds and creeks; Wetlands Ecosystems - improve understanding of wetlands restoration, protection, and preservation. Emphasis will be on seasonally saturated and non-seasonally saturated wetlands, the wildlife species that inhabit them, and the importance of sedges in wetland habitats; Protection of Delaware's Native Species - research on non-indigenous invasive species, a leading cause of plant and animal extinction in Delaware, will focus on impacts of invasive species on ecosystem function and on methods of restoration after their removal. Wildlife Management - effects of human activity on migratory shore birds, box turtles in suburban habitat fragments, neotropical bird migrants in Delaware, Bobwhite quail in warm season grasslands, horseshoe crab ecology in the Delaware Bay, insect biomass production in suburban habitats, habitat restoration for bats and White-tailed deer populations and lead to recommendations for improved habitat management; new research focuses on the ecology and conservation of wild felids, the evaluation of wildlife behavioral response to human recreation, the development of new technologies in wildlife research, the application of hierarchical models, and monitoring bird and bat flight activity near wind turbines; Fisheries - population status, spawning areas, and management of Atlantic sturgeon in the Delaware River.

d. Resource economics: develop creative new economic policies to profitably link agriculture and forestry with those sectors generating significant quantities of greenhouse gases (e.g., energy, transportation) in cooperative efforts to mitigate greenhouse gas emissions; improve understanding of the relationship of climate change to agricultural and environmental policy development, including farmland preservation, conservation reserve programs; study impacts of climate change on groundwater aquifers, integrate climate change into the Chesapeake Bay water quality model; contribute to policies and educational programs on recycling, develop environmentally-friendly bio-based fuels from local feed stocks, and assist in analysis of Delaware's greenhouse gas inventories from energy use (mobile sources, utilities, residential, industrial, transportation, commercial, natural gas distribution, waste management, agriculture, land use, etc.).

**2. Brief description of the target audience**

For animal agriculture, target audiences are primarily poultry integrators, growers, breeders, trade groups and allied industries; dairy and beef producers; livestock commodity groups; forage producers, equine owners, producers and interest groups. For crop and soils related research and extension programs, the audience includes existing and prospective grain crop producers, mixed (animal and crop production, e.g., dairy, horse) farms, crop commodity groups and trade associations, the "green industry" (e.g., horticulture, nurseries, landscapers), and certified crop advisors. For natural resource and ecology programs, private and not-for-profit organizations managing forests, wetlands, marshes, and other natural resource areas; state and federal agencies responsible for wildlife, forestry management, and coastal ecosystems. For our

resource economic programs the audience includes farmers, landowners, policy-makers and state and federal agencies directly related to climate change policy (Delaware Development Office; Land Use Planning and Preservation; Department of Agriculture; Department of Health and Human Services; Department of Natural Resources & Environmental Control; Department of Transportation; Economic Development Office, USDA, NRCS, USEPA).

For all programs, audiences include farm owners and operators, aquaculture producers, recreational fisheries, seafood consumers, water quality managers, agribusiness and private consultants, horticultural professionals, city land use planners and other policy-makers, home gardeners, childcare providers, environmental educators, Delaware State Government and local legislators, homeowner associations, educators, community leaders, utility managers, retail stores distributing Energy Star products, fleet managers, building industry, Delaware Clean State Program members, Delaware Farm Bureau leaders, federal-state-local agriculture businesses, state and federal agencies; federal research laboratories; peer scientists in the U.S. and international colleagues, K-12 teachers, and environmental and community groups. Train the trainer programs will develop volunteers in Master Gardeners and Forest Stewards to augment program outreach.

**3. How was eXtension used?**

In 2016 the eXtension Institutional Team comprised of faculty and staff from across all planned program areas was converted to the Innovation team consistent with eXtension continue to provide the leadership for this work. This past year the team has focused on the following: • Social media plan was updated and Ask an Expert included on new website design • On-line course development with Continuing and Professional Development • Became a premier member of new eXtension structure-one specialist selected as I-corp member in climate change initiative. Extension specialist, Jenn Volk has been selected as an i-Three Issue Corps project by eXtension. Her project is entitled "Virtual Demonstration Network of Agricultural Climate Change Adaptation and Mitigation Strategies in the Northeast". Working with the USDA NE Climate Hub University Partners Network, Jennifer will develop a network of field demonstration sites to showcase agricultural climate change adaptation and mitigation strategies currently in place across the NE region. This network will be displayed using a web based story mapping tool that will include background information and multimedia content on practices and systems. This tool will virtually demonstrate effective climate change adaptation and mitigation strategies to Extension colleagues throughout the northeast and the agriculture and forestland clientele. Tool is nearing completion summer 2017.

**V(E). Planned Program (Outputs)**

**1. Standard output measures**

| 2016 | Direct Contacts Adults | Indirect Contacts Adults | Direct Contacts Youth | Indirect Contacts Youth |
|---|---|---|---|---|
| **Actual** | 23346 | 58707 | 545 | 0 |

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

**Patent Applications Submitted**

| | |
|---|---|
| Year: | 2016 |
| Actual: | 0 |

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

| 2016 | Extension | Research | Total |
|---|---|---|---|
| Actual | 4 | 38 | 42 |

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- Competitive Grants Awarded

| Year | Actual |
|---|---|
| 2016 | 14 |

**Output #2**

**Output Measure**

- Undergraduate Researchers

| Year | Actual |
|---|---|
| 2016 | 30 |

**Output #3**

**Output Measure**

- M.S. and Ph.D. Students

| Year | Actual |
|---|---|
| 2016 | 54 |

**Output #4**

**Output Measure**

- Post-doctoral Researchers

| Year | Actual |
|---|---|
| 2016 | 7 |

**Output #5**

**Output Measure**

- Refereed Journal Articles

| Year | Actual |
|---|---|
| 2016 | 42 |

**Output #6**

**Output Measure**

- Books and Book Chapters

| Year | Actual |
|---|---|
| 2016 | 4 |

**Output #7**

**Output Measure**

- Extension Bulletins and Fact Sheets

| Year | Actual |
|---|---|
| 2016 | 12 |

**Output #8**

**Output Measure**

- Webpage views/downloads

| Year | Actual |
|---|---|
| 2016 | 0 |

**Output #9**

**Output Measure**

- Workshops at regional, national, and international levels

| Year | Actual |
|---|---|
| 2016 | 10 |

**V(G). State Defined Outcomes**

## V. State Defined Outcomes Table of Content

| O. No. | OUTCOME NAME |
|---|---|
| 1 | We anticipate an increase in knowledge of, an acquisition of skills, and/or an adoption of practices that: 1) mitigate the effects of climate change; 2) reduce greenhouse gas emissions and increase carbon sinks; 3) use energy efficiently; 4) protect and improve soil, air, and water quality; 5) promote biodiversity and sustainable landscapes; 6) reduce risks through Integrated Pest Management tactics |

## Outcome #1

### 1. Outcome Measures

We anticipate an increase in knowledge of, an acquisition of skills, and/or an adoption of practices that: 1) mitigate the effects of climate change; 2) reduce greenhouse gas emissions and increase carbon sinks; 3) use energy efficiently; 4) protect and improve soil, air, and water quality; 5) promote biodiversity and sustainable landscapes; 6) reduce risks through Integrated Pest Management tactics

### 2. Associated Institution Types

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

### 3a. Outcome Type:

Change in Knowledge Outcome Measure

### 3b. Quantitative Outcome

| Year | Actual |
|---|---|
| 2016 | 667 |

### 3c. Qualitative Outcome or Impact Statement

**Issue (Who cares and Why)**
Identifying Heat Tolerant Lima Bean Germplasm to Use in the Breeding Program
Issue: Baby lima beans are an important processing vegetable crop for Delaware farmers and large seeded lima beans are a profitable fresh market crop. Heat stress causes delayed pod set, split sets and reduced yield in lima bean plantings that flower during high temperature conditions (usually in July and early August). Delaware lima bean growers and processors have identified heat stress as the major yield limiting factor for lima bean production.

**What has been done**
Response: Breeding for heat stress tolerance in lima bean is dependent upon identification of heat tolerant germplasm to use in crossing to develop new breeding lines. Field and greenhouse heat tolerance screenings were done in 2016 to identify heat tolerant germplasm to use in the breeding program.

**Results**
Results: I identified 28 lines that set and mature pods under high night temperature conditions. Two of these lines are large-seeded types that may be useful in developing heat tolerant Fordhook and pole lima varieties. I am making crosses with some of these lines to determine if they will be useful in the breeding program as sources of heat tolerance and if combining heat tolerance traits from multiple sources will result in even more heat tolerant breeding lines. (Again,

the real impact of this project will not be until I get a heat tolerant lima bean variety released, but I am making progress.)

**4. Associated Knowledge Areas**

| KA Code | Knowledge Area |
|---|---|
| 111 | Conservation and Efficient Use of Water |
| 112 | Watershed Protection and Management |
| 124 | Urban Forestry |
| 132 | Weather and Climate |
| 135 | Aquatic and Terrestrial Wildlife |
| 136 | Conservation of Biological Diversity |
| 216 | Integrated Pest Management Systems |
| 302 | Nutrient Utilization in Animals |
| 806 | Youth Development |
| 903 | Communication, Education, and Information Delivery |

## V(H). Planned Program (External Factors)

**External factors which affected outcomes**

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

**Brief Explanation**

## V(I). Planned Program (Evaluation Studies)

**Evaluation Results**

**Proper Pruning of Trees and Shrubs - Community Education Outreach** Issue: Over the past few years, it has become more apparent that many trees and shrubs in the urban communities and rural landscape - throughout Delaware - are being improperly pruned, thus damaging the specimen. Most cases involve complete 'topping' of the upper crown of a tree or excessive 'selection' removal of internal branches by untrained individuals who are taking advantage of misguided property owners & managers. The branch-leaf/needle portion of a tree or shrub performs nutrient development for that specimen - a plant will only produce enough leaves/needles and branches to support the biomass required to survive - no more or no less. Excess removal of these vital portions of the specimen cause undue stress to the entire vascular system, weakening the structure above and below

ground, and leading to an underpinning reason for disease and insect infestations.

**Response:** University of Delaware Cooperative Extension offered statewide training of proper tree and shrub pruning sessions for the ornamental landscape industry through annual Ornamental Horticulture Short Course classes, along with classes to individual homeowners through county Master Gardener programs. We partnered with the Delaware Urban & Community Forestry Council to provide "Proper Tree Pruning" classes to facility employees at various city governments and worked with the Delaware Nursery & Landscape Association to deliver a session at their annual summer meeting. An International Society of Arboriculture (ISA) 'certified' Arborist and 'retired' Master Arborist at Hagley Museum in Wilmington, Delaware conducted dual-presentation instruction with the UD-Extension Agent for Renewable Resources. In 2016, four classes on "Proper Pruning of Trees & Shrubs" were provided to 228 individuals. This is a 200% increase in classes provided and 407% participation rate increase over 2015 outreach efforts. Classes were held in all three counties in order to reach a broader audience. The Delaware Cooperative Extension Ornamental Horticulture Short Course series hosted one class in early winter. The Delaware Nursery & Landscape Association hosted a summer session in Sussex County. Two municipality classes were hosted by the Delaware Urban & Community Forestry Council.

**Results:** Written evaluations were conducted after two of the 2016 classes. All attendees (100%) indicated that they gained knowledge of proper pruning techniques and became more aware of why, when and how to prune tree and shrub specimens. All responding participants mentioned that they will use caution and share this information with neighbors, friends and family. The message of "Don't Top Trees" radiated throughout the Delaware landscape business community. This was apparent when one local lawn care services refrained from over pruning trees, and instead encouraged the landowner/manager to contact either the Delaware Forest Service or their local cooperative extension office for further guidance.

**Issue:** Populations of Japanese beetles, Popillia japonica, have been locally abundant over the past few years, and has caused significant defoliation of hosts in the landscape or at nurseries. Traditional chemicals used to manage adult beetles are typically have impacts on non-target arthropods. Many of these non-targeted arthropods help reduce pest populations. The research project evaluated alternative products compared to traditional chemistry for control of Japanese beetles.

**Response:** Our project evaluated alternative products that may conserve non-target arthropods, thereby potentially reducing additional insecticide applications. Our research projects focused on managing Japanese beetles at nurseries in the mid-Atlantic. Applications were made at various time intervals and evaluated against an untreated control. These products were applied to different species and sizes of host trees during the previous fall, spring, or during adult Japanese beetle activity.

**Results:** We found the diamide products provided sufficient control to significantly reduce defoliation caused by the adult Japanese beetles when applied during adult activity as a foliar spray. Our results were shared at stakeholder workshops in Maryland and in a weekly IPM newsletter. The results of the research is currently being prepared for presentation at another workshop, and as a publication next spring. Our results were shared at a workshop this past fall with over 40 stakeholders and other colleagues. Some of the stakeholders (15%) stated they would probably use the diamide products for managing Japanese beetles; however, many stated they would not because of the cost of those products. Many of the stakeholders (75%) found the information valuable, and colleagues stated they would share the information with their stakeholders in nearby states.

**Communicating Climate Change Issue:** Local data has shown that the annual average temperature in Delaware has increased two degrees in the last century. Similarly, over the

same period of time, the sea level along Delaware's coast has risen more than a foot. Our climate is changing. Farmers and natural resource managers - as well as the technical service providers who advise them - need information on adaptation and mitigation practices and tools that can help them maintain and strengthen agricultural production, natural resource management, and rural economic development under increasing climate variability.

**Response:** University of Delaware Cooperative Extension has partnered with the USDA Northeast Climate Hub to develop and deliver science-based information that enables climate-smart decision-making to agricultural and natural resource managers and their technical service providers. Throughout 2016, six presentations were made to these audiences on Delaware's climate trends, future projections, potential impacts to our resources, and most importantly, the resources and tools available to them. Additionally, two articles on climate trends and adaptation strategies were written for the Weekly Crop Update, which in an Extension Newsletter read by almost 600 growers, consultants, and other service providers. Finally, UD Extension has led the development of an online demonstration network featuring climate adaptation and mitigation strategies being utilized by other land grant universities in the northeast region. This tool, when complete in early 2017, will allow the user to feel "as if they were there" and will provide an interactive and innovative method to share successful strategies that anyone can access.

**Results:** From a post meeting evaluation, 93% of the participants at the Ag Week Woodland Management Workshop indicated that they increased their knowledge of practices and tools to adapt to and/or mitigate climate change. During conversations with participants following this and other presentations, many vocalized that they feel they have seen changes in our local climate such as a longer growing season, more extreme summer heat, or more frequent heavy flooding events. These anecdotal comments suggest support for the theory of climate change. Additionally, technical service providers throughout the northeast region - including Extension professionals at other land grant universities and staff from the Natural Resource Conservation Service - have shown support and enthusiasm for the online demonstration tool under development. Those who have participated in the development of the tool have committed to sharing the final product with the ag and natural resource managers they advise, which will further the total reach and impact.

**Issue:** Delaware land and forest owners were looking for information on how to make a profit from trees on their land. Residents were looking for resources and materials in the form of diagnosing problems, identification and alternative ways to make a profit on their land.

**Response:** The DSU Branch out Delaware - Forestry and Woodland conference was held on April 13th 2016 at the Modern Maturity Center in Dover Delaware. There were 69 participants in attendance. During this one day conference, participators had the chance to learn about different topics related to our forestland in Delaware. They had an introduction to the Delaware forestry economic development in the morning, followed by tree identification and identification and management of forest invasive species. Later in the day, they receive information via zoom from an educator in Minnesota that touched on the topic of intergenerational land transfer and preparing forest land for future generations. Toward the end of the day partakers were able to learn about some local NRCS programs and a climate change panel that focused on the effects of forests. There was also discussion regarding forest health in regard to present and potential pest issues. The day was rounded up by a talk on implementing proper Silva culture techniques.

**Results:** After attending the conference, participants gained knowledge on the topics of the overview of Delaware forest, Delaware tree identification, identification and management of forest invasive species, intergenerational land transfer, NRCS Programs, Climate change on

coastal forests of the Middle Atlantic States, forest health, and how to implement proper silviculture.
**Issue:** Conservationists, land use planners, ornithologists, students of ecology
**Response:** Tracked songbirds from a Delaware breeding site, down to Amazonia, and back using novel miniature GPS technology. Assess the migratory bird use of Gulf Coast Barrier Island (i.e., spring passage trans-Gulf songbirds).
**Results:** Better understanding of ecological connectivity between Mid-Atlantic forests and Amazon rainforest. Better understanding of migratory connectivity. Improved understanding of how songbirds effectively manage trans-hemispheric migration and what types of habitats are critical to preserve for their preservation. Use of the Amazon Basin by songbirds is also a major benefits with implications for conservation. Better understanding of how breeding season productivity and phenology is linked with Amazonian rainforest.
**Issue:** Climate change and nutrient excesses in water are two important environmental challenges that my group conducted research on and are of concern to policymakers and the general public.
**Response:** We investigated the role that soils components, particularly iron oxides, that are common in soils, play in sequestering carbon, thus reducing its release into the atmosphere. It was found that iron oxides play a significant role in sequestering carbon. Advanced technologies, employed at national laboratories, were used to determine the precise forms of phosphorus in soils containing high phosphorus contents. Determining the forms is important in modeling the fate of phosphorus into water bodies.
**Results:** See above
**Issue:** Stakeholders and the research community as there is need for information and knowledge about the underlying mechanisms that regulate the water and carbon cycle to provide information to improve environmental management under changing weather conditions.
**Response:** My group addresses these challenges by combining experiments, environmental monitoring and modeling at multiple spatial and temporal scales.
**Results:** This year we were able to focus on synthesis studies that summarizes multiple experiments and provide new knowledge by analyzing information across multiple research groups and study sites.
**Issue:** This year's work focused in drought effects on ecosystem dynamics. These effects are more evident in water limited ecosystems tÌ±which are very sensitive to precioitation variability. Noteworthy over 30% of terrestrial ecosystems are water limited so understanding their responses are critical from local to global scales.
**Response:** We published several studies on ecosystem responses to precipitation variability in the southwest US and in grasslands in the central plains.
**Results:** Outcomes were several peer reviewed publications that have had an impact on our understanding of water limited ecosystems across the US.

**Key Items of Evaluation**

# VI. National Outcomes and Indicators

## 1. NIFA Selected Outcomes and Indicators

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