2018 University of Delaware and Delaware State University Combined Research and Extension Annual Report of Accomplishments and Results

Status: Accepted

Date Accepted: 08/15/2019

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, farm gate prices, 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 fruit and 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 poultry production, field crop production, vegetables, soil management and watershed protection, and agricultural and natural resource economics. Vegetable and small fruit crops, specifically lima beans, and watermelons 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 groundwater quality such as efficient use of nutrients in animal and crop production; and bioavailability of metals and organic chemicals in soil and water environments; efficient use of groundwater 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 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. Efforts focus not only on individual direct education but also on community engagement in creating a culture of health through policy, system and environmental efforts. The community engagement work is preferred 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. A new focus in its second year is on addressing the social determinants of health. The Robert Wood Johnson Foundation (RWJF) Well-Connected Communities project has been initiated to engage three specific communities for health coalitions to address community-identified efforts to establish a Culture of Health.

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 community 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 42% of the youth 8-18 in Delaware, 4-H in multiple delivery formats including after-school programming Delaware youth 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 and the Northeast eXention center 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. As a college, we are focusing on One Health-the integration of animal, plant and human health.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	42.9	16.5	80.5	8.3
Actual	39.9	17.6	116.3	10.6

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

Merit review for Delaware Cooperative Extension consists of peer and stakeholder review. Extension professionals submit individual plans that have been reviewed by their peers and by stakeholder advisory groups. These stakeholder groups including advisory group, community organizations, volunteers, research partners and state and local funding agencies provide input on critical needs and issues within their communities, which is used to develop the state plan. 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 individual and state plans and develop future plans. The second level of review is by college-wide issue teams that are cross-functional and multi-disciplinary. The county plans and research plans are combined into a college-wide plan. The College plan are submitted to the College Advisory Committee. 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.

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 (1.Permanent advisory committees for extension programs and research 2.Statewide needs assessment to update five year plan of work.)

Brief explanation.

In 2018, the University of Delaware and Delaware State University undertook a formal statewide needs assessment process to formulate our next federal plan of work. Program Leaders identified one person per program area to participate on the stakeholder needs assessment development team. The team reviewed sample needs assessment survey tools used by various states and decided to blend several approaches for our survey instrument. The Spanish and English survey resulted in 690 responses.
Additionally, 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, 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.), Volunteer Programs. 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 and evaluation 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
- Other (Statewide needs assessment)

Brief explanation.

Beginning on Monday, May 7th, each Extension Agents and Specialists at both UD and DSU were asked to distribute the survey to at least ten stakeholders that they work with directly inviting them to participate in the needs assessment. There are approximately 40 UD staff and 20 DSU staff for potential distribution to at least 600 internal stakeholders. A number of staff maintain large email databases, so the actual distribution would far exceed this number. A few staff members noted that their clientele does not have access to, or do not feel proficient with computers. Therefore a paper version was prepared and staff manually entered those responses into Qualtrics as completed paper forms were received. To reach external stakeholders, a message was included in both the introductory statement and at the close of the survey requesting that respondents further distribute the survey to at least five others who may be interested in providing feedback. This is a form of snowball sampling. In addition, the survey was also posted on UD and DSU Extension Facebook and Twitter pages, which staff were encouraged to share with their personal social media networks in order to further distribute the survey to external stakeholders. In an effort to reach Spanish speaking populations, a second version of the survey was developed that allowed the survey taker to select their preferred language. If Spanish was chosen, the survey automatically translated from English into Spanish.

Additionally, 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 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. In particular, when new faculty comes on board focus groups with stakeholders are held to provide direction to individual plans. Stakeholders serve 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 (1.Meetings with permanent advisory committees 2. Distribution of Statewide Needs Assessment Survey)

Brief explanation.

The statewide needs assessment conducted this year was a major checkpoint on program priorities. We also 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: 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. 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
- Other (To Establish Updated Plan of Work)

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. The College Advisory Committee reviews and provides final input.

Brief Explanation of what you learned from your Stakeholders

The entire report of the **2018 Delaware Cooperative Extension Needs Assessment Survey** can be found at:
https://cdn.extension.udel.edu/wp-content/uploads/2016/06/14112835/Cooperative-Extension-and-Research-Needs-Assessment-Survey-Final.pdf
Ensuring the availability of clean water was the top issue chosen by 93% of respondents, followed closely by Keeping communities safe from crime (89%) and Managing natural resources sustainably (84%). Ensuring affordable housing for all residents was chosen least but was still checked by 60% of respondents as being "Very important".
(Figure 10) wp-content/uploads/sites/10/2019/03/13145030/State-Level-Issues-Chart.png
Respondents were asked about four community issues areas: economic development, leadership development, health, and, agriculture and environment in the economic development area. Access to job training or employment was chosen by the highest percentage of respondents (67%) whereas Availability of high-speed internet (53%) was picked by the lowest proportion of respondents
(Figure 12)https://cdn.extension.udel.edu/wp-content/uploads/sites/10/2019/03/13155346/Community-Issues.png
In the "leadership development" issues, Training youths and adults to think critically (85%) and Exposing youth to science, technology, engineering, and math topics (81%) were the top two issues that respondents thought were "Very important"
(Figure 13)https://cdn.extension.udel.edu/wp-content/uploads/sites/10/2019/03/13161321/Community-Issues-Leadership-Development.png
Respondents choose three areas of health as "Very Important" to their community by over 80%: Access to primary care doctors (85%), Caring for the elderly and disabled (84%), and, Access to mental health services (81%).
(Figure 14)https://cdn.extension.udel.edu/wp-content/uploads/sites/10/2019/03/13161312/Community-Issues-Heath.png
In the Agriculture & Environment issue area, preserving farmland and open spaces, received a majority of participants picking it as "Very Important". The second closest area was the balance of environmental regulations and agriculture production (76%).
(Figure 15)https://cdn.extension.udel.edu/wp-content/uploads/sites/10/2019/03/13161307/Community-Issues-Ag-and-Environment.png

IV. Expenditure Summary

1. Total Actual Formula dollars Allocated (prepopulated from C-REEMS)			
Extension		**Research**	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
{No Data Entered}	{No Data Entered}	{No Data Entered}	{No Data Entered}

2. Totaled Actual dollars from Planned Programs Inputs				
	Extension		Research	
	Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
Actual Formula	1371975	1125557	1260015	979349
Actual Matching	1371975	1125557	1260015	979349
Actual All Other	4031107	107098	6546917	542476
Total Actual Expended	6775057	2358212	9066947	2501174

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	301052	0	0	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: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	16.8	5.1	34.1	2.0
Actual Paid	15.2	4.9	39.2	2.1
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
165476	329846	343323	257647
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
165476	329846	343323	257647
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
371835	0	1853359	163833

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?

The eXtension Innovation Team comprised of faculty and staff from across all planned program areas is a key connection. This group continues to provide the leadership for integration of eXtension at UD Cooperative Extension. Last year the team has focused on innovation. A partnership of eXention matched UD/DSU funding for a total of $15,000 investment. Eleven innovation teams were formed and pitched innovation program plans. Five were selected for funding and are in development • On-line course development with Continuing and Professional Development is in process with a rollout of several nutrient management certification courses• Two individuals were selected as I-corp member in climate change initiative and diversity initiative. The largest percentage of our Ask an Expert aspect of eXtension is focused on consumer horticulture and landscape. We averaged about 600 questions through this format. 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 developed multiple data mapping projects of which the Associate Director has been trained as a Collaboration Facilitator.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	17007	17848	2114	2

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

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	59	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Competitive Grants Awarded

Year	Actual
2018	20

Output #2

Output Measure

- Undergraduate Researchers

Year	Actual
2018	60

Output #3

Output Measure

- M.S.and Ph.D. Students

Year	Actual

2018	45

Output #4

Output Measure

- Post-doctoral Research Associates

Year	Actual
2018	9

Output #5

Output Measure

- Refereed Journal Articles

Year	Actual
2018	56

Output #6

Output Measure

- Books and Book Chapters

Year	Actual
2018	3

Output #7

Output Measure

- Extension Bulletins and Factsheets

Year	Actual
2018	175

Output #8

Output Measure

- Webpage views/downloads

Year	Actual
2018	109521

Output #9

Output Measure

- Workshops at State, National or International Level

Year	Actual
2018	578

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
2018	22941

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The poultry industry has a tremendous impact on the financial stability of the Delmarva peninsula.

The poultry industry has a tremendous impact on the financial stability of Delmarva. Over the past five years, poultry companies had such a need for capacity that they accepted poor performance on farms and continued to place birds. In 2018, we had the perfect storm of circumstances. A company planning a major expansion had an issue. Then, with trade issues between China and the U.S., less pork and beef were exported. This resulted in surplus protein on the U.S. market and caused chicken prices to decline. Combined with some poor lending practices, a decline in poultry farm values and discontinued contracts occurred. A farm without a growing contract value declines to the value of the land. Many farms have been placed on Performance Improvement Plans.

What has been done
Farms house conditions and management were observed. The performances were reviewed over a six-flock period to determine the cause of poor performance; action plans were created to address specific issues. Farms were visited at critical points in the flock. Best management practices were discussed to improve flock performance. Items included brooding management to improve weight gain and feed conversion, ventilation to improve flock health and feed conversion, light management, mortality management, understanding controller programming, and history.

Results

Twenty farms on Performance Improvement Plans or experiencing a performance declines were visited. Those 20 farms totaled 62 poultry houses, representing 1,692,000 sq. ft of poultry housing on Delmarva. With additional guidance, 19 farms showed flock improvement and kept growing contracts. Unfortunately, one unsuccessful account was already on its last flock prior to contacting me. We worked with them on two other accounts and the poultry company will place birds back that the discontinued contract. Successfully improving performance helps keep farms sustainable, reduces the amount of idle houses and helps value for all poultry farmers. Our focus is on what is in poultry farmers? power to control and influence. It pays dividends not only on the current flock but on future performance. Farmers better understand of how settlement is calculated and empowers them to make better management decisions and use of financial resources.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
205	Plant Management Systems
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
2018	575

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The Importance of Making Food and Agriculture Systems more Robust and Resilient through Diversity and Inclusion.

There is a continued need to provide agriculture education to urban communities to improve accessibility to local foods and assist communities who desire to grow and market their own food.

What has been done
The Delaware Urban Farm and Food Coalition (DEUFFC) led by the Delaware Center for Horticulture (DCH), University of Delaware Cooperative Extension (UDCE), and New Castle Conservation District (NCCD) organized the urban agriculture session. After networking and refreshments prepared by the Delaware Local Food Exchange, Karen Washington, Famer/Owner of Rise and Root Farm, provided inspiration and professional development. The session reached 65 farmers, gardeners, educators, health professionals, and representatives from government, business, and/or non-profits.

Results
Of the 27 participants who completed the program survey, an overwhelming majority were residents of New Castle County, Delaware, with a few from neighboring, Pennsylvania, and almost half attending Delaware Agriculture Week for the first time. A summary of the surveys revealed participants most appreciated the speaker, networking and good food, gathering information, connecting with community resources, and better understanding local urban agriculture projects and how to get involved. New things learned included:

*The importance of collaborating at the local level and between existing organizations,

*The support available to Wilmington farmers and how to connect with these resources,

*How a farm can work to bridge the gap between low-income people and high-quality food choices,

*The breadth of programs and initiatives in urban agriculture, and

*The importance of creating intersectional and collaborative movements in order to empower marginalized communities to take ownership of food systems in their communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
205	Plant Management Systems
307	Animal Management Systems
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

Precision Agriculture for Delaware Farmers

Issue

Advancements in agricultural technology can come with unknown economic benefits. Although precision agriculture can increase efficiency in planting, fertilizing, and pesticide application, there is a cost associated with updating equipment. Extension plays a direct role in examining precision agriculture technologies for their practical application, benefits, and cost per acre. To keep Delaware farms profitable, the value of precision agriculture through research and outreach should be examined.

Response

Response research projects examined the value of active downforce on corn planters and remote sensing in the form of satellite imagery and drone photography. Drone imagery was used to assist in on-farm projects and the value of the images was shared with farmers.

Results

Results of this work were shared at agricultural field days, workshops, Extension articles, and the Mid-Atlantic Crop Management School. An introduction to drones was also given to Sussex County elementary students. Results A session on remote sensing terminology and value was given in the Crop Management section of the 2018 Mid-Atlantic Crop Management School. Of the 108 participants, 45 responded to a post-session survey. Based on evaluation responses, 93 percent learned something new about remote sensing and 80 percent indicated they would use the new information in the future. Comments on the evaluation included "Good foundational information on options for remote sensing" and "Provided some very good resources for future use."

Recognition of sponsors, in-kind contributors or partners: Research on drones was sponsored by the Maryland Grain Producers Utilization Board. Research in active downforce was supported by Ag Leader. Research in electrical conductivity mapping was supported by Willard ag services.

Delaware Ag Week - Agronomy Day 2018

Issue

The production of grain crops is significant to Delaware's economy, but it is not without

challenges. The aim of the 2018 Delaware Ag Week Agronomy Program on January 11 was to provide producers with the tools to meet on-farm grain storage, integrated pest management, and malting barley production challenges, among other topics.

Response

This program offered research-backed information, to assist farmers to produce grain crops efficiently and profitably, discussing:

- Whole-farm revenue protection crop insurance,
- USDA marketing assistance loans,
- On-farm grain storage,
- Insect pest management,
- Entomology,
- Soil types and management strategies for field crops,
- Legal issues with saving seed,
- Disease management,
- Management of malting barley,
- Protecting your farm from a cyber-attack, and
- Weed management.

Total attendance was 314. Of the 121 who completed the evaluation, respondents identified as 75% farmers, 9% agribusiness salesperson, 8% crop consultant, and 7% agriculture industry representative. The respondents represented 519,000 acres across DE, MD, VA, and PA.

Results

After the pest management update, evaluation responses reported:

- 93% learned something new and 79% would change their insect pest management strategy.
- 93% of the respondents indicated they learned something new about soil types and management and 85% indicated they would change management practices based on soil types.
- 100% of respondents indicated they learned something new in the disease management update and the weed management update.

Following the weed management update, more than 93% of respondents indicated they would change their weed management strategy in the upcoming year. Respondents estimated the economic value of the information they received at the meeting was $5.73/acre on average. The overall economic impact of the meeting, based on the 121 respondents, was estimated to be $2.97 million.

2018 Turfgrass Management Programs

Issue

Some Delaware Nutrient Management Program certified turfgrass managers find it difficult to maintain nutrient management and pesticide certifications, though 66 DE nutrient management continuing education credits (CEUs) were available in turfgrass or ornamentals in 2016 and 57 in 2017. The number of DE nutrient management credits offered for turf and ornamental programs is in line with poultry credits, yet many turfgrass managers apply for CEUs for out-of-state programs. Often, these programs are not pre-approved in Delaware. A need for more programs offering CEUs in Delaware.

Response

The Turfgrass Management Short Course was offered in each county in 2018 to those who feel challenged to obtain continuing education credits. Erik Ervin and Amy Shober presented from New Castle County; Jarrod Miller presented from Sussex County with the locations linked through Zoom Video Conferencing. The final program was offered in Kent

County in December. Topics included turfgrass selection, weed control, soil testing, and seasonal fertility needs. Delaware, Maryland and New Jersey credits were offered for nutrient management and pesticide certifications.

Results

Attendance of the three programs was 68 with 87 percent (59) completing the evaluation. Respondents reported managing 2,100 acres of turfgrass, representing 5.6 percent of Delaware's 37,600 acres of turfgrass. Participants were asked if they learned anything new.

- 94 percent (56) learned something new about turfgrass selection;
- 100 percent (59) learned something new about weed control programs;
- 81 percent (48) learned something new about soil testing; and
- 89 percent (53) learned something new about seasonal fertility needs.

Participants were asked if they would implement or change a practice based on the information they learned.

- 76 percent (45) will implement or change their turfgrass selections;
- 83 percent (49) will implement or change their weed control program;
- 71 percent (42) will implement or change their soil-testing program, and
- And 83 percent (49) will implement or change their spring and summer fertility programs.

Internal parasites

Issue

Internal parasites are a major health problem affecting small ruminants worldwide, particularly the blood-sucking abomasal parasite,Haemonchus contortus(barber pole worm). This parasite is a major threat because once in the abomasum of the animal it consumes large amounts of blood causing sickness and death that can hinder production. This parasite is very difficult to manage as there are data showing that the parasites have shown resistance to all available dewormers in the United State and across the world. Therefore, a more integrated approach is needed to control this parasite. Data have shown that there is a high level of resistance to the benzimidazole classes (white drenches) of dewormers and ivermectin in Delaware and surrounding states.

Response

Delaware State University's small ruminant specialist and University of Delaware's animal science extension agents conducted a one-day fecal egg counting and FAMACHA©workshop at the University of Delaware Research and Extension Center in Georgetown, DE that was designed to help producers learn the basics of selective internal parasite control. We provided hands-on training to certify producers in the use of FAMACHA©score card and fecal egg counts. In the morning, an integrative parasite management lecture was done to educated producers on all the major parasites and control methods, followed by hands-on FAMACHA©eyelid color scoring and fecal egg counting sessions in the afternoon of the program.

Results

A total of of9 participants attended the Fecal Egg Counting and FAMCAHA©workshop with all participants coming from Delaware and surrounding states (MD, PA & NJ). Post-conference evaluations (n = 8) returned showed that 75% of participants rated the overall workshop as excellent and the remaining 25% as good with all the participants believing the information was given in a clear and concise manner. Knowledge gained by participants: I00% learned how to conduct fecal egg count correctly I 00% were effective in conducting FAMACHA scoring As a result of the knowledge gained, 100% of the producers indicated that they will be implementing the use ofFAMACHA cards before treatment their animals. Recognition of sponsors, in-kind contributors or partners (please provide name,

organization, what was contributed).

Tomato Grafting

Issue

Tomato Grafting is becoming an important art for farmers and gardeners. Several tomato varieties that are either disease or high salt tolerant have been bred. While growers still believe in growing the preferred heirloom varieties, they appreciate the need for using the tolerant varieties as a rootstock. For the last 4 years, during my involvement with tomato grafting in the North East Region, I have noted renewed interest in this art.

Response

In the course of 2018 four different sessions of tomato, grafting demonstrations were held. 18 grower participants at University of Maryland Eastern Shore; 6 DSU Horticulture students; 16-Green Thumb members at DSU greenhouses; and 12- Master Gardeners at DSU greenhouses. Participants mastered the art of propagation, increased their knowledge about the right time to graft plants, and learned about the sources and choices of appropriate rootstock

Results

Two growers in Maryland planted their own grafted tomato plants; 5 specific email questions from persons actively practicing tomato grafting were answered. Recognition of sponsors, in- kind contributors or partners (please provide name, organization, what was contributed). Thanks to the greenhouse facilities at DSU for providing space for starting plants and for demonstrations. The Specialty Crop Research Initiative CAP Vegetable grafting team for an illustrative grafting handbook.

Waterfowl and Upland Gamebird Ecology

Issue

Waterfowl and Upland Gamebirds are of critical concern to The United States Fish and Wildlife Service, Fish and Wildlife State Agencies, and non-governmental organizations as it is under their jurisdiction to assure sustainable populations for yearly harvest as well as aiding in long term habitat conservation of related habitats that directly affect these species as well as for associated species in those ecosystems.

Response

During 2018, we conducted multiple research projects including assessment of 1) northern bobwhite quail reintroduction in the New Jersey Pinelands, 2) American black duck breeding success and habitat use in North Carolina, 3) Canada goose population status in Virginia, 4) building a predictive model for submerged aquatic vegetation to assess wintering food supplies for Atlantic brant geese, 5) determine the hearing ability for diving ducks to develop a deterrent system in gill-net fisheries, 6) the energetic expenditure of American black ducks occurring in different behavior traits to better refine daily energy expenditure models with application to landscape carrying capacity, and 7) wood duck nest box use based of differing landscape characteristics around the boxes.

Results

All projects are ongoing but for each, we actively are presenting the research at national meetings and working to write a peer-reviewed manuscript to release our information to the public and to granting agencies to aid better management strategies.

Producing Hyperpolyandrous honey bee queens to mitigate pests and pathogens

Issue

Beekeepers and land managers alike depend upon the health and success of honey bee colonies for economic livelihood and food production. Annual population declines of over 30% have been the normal trend since the mid-2000s. The Varroa mite, Varroa destructor, and the viruses it transmits are one of the main colony killers. With over decades of research, we still do not have a silver bullet for controlling these pests. The economic value

of honey bee pollination exceeds $15 billion dollars annually, not to mention the food security these small but efficient insects provide (important for pollinating 75% of crop species). It is imperative that we develop sustainable strategies for mitigating pests and pathogens so we can begin to rebuild robust and tolerant honey bee populations.

Response

Honey bee queens naturally mate with 12-20 drones and store the drone sperm to create a genetically diverse colony over the queen's lifetime. Research has shown that this intracolonial genetic diversity confers resistance to pests and pathogens. In collaboration with the University of Georgia we have produced 40 colonies headed by hyperpolyandrous queens (artificially inseminated with 50+ drones) to ascertain whether there is an upper limit or threshold to the benefits of polyandry. We are also testing whether we can mimic the benefits of intracolonial diversity by mixing brood frames from many queen sources into one colony, thereby artificially creating diversity. We will be testing whether brood mixing can mimic polyandry this coming spring.

Results

We found that colonies with hyperpolyandrous queens had lower Varroa pressure and higher levels of brood. We will be running this same experiment again this year in three states. Because artificial insemination is expensive and decreases the longevity and overall fitness of the queen, we will simultaneously be looking at brood mixing as a means of achieving high levels of diversity. If the brood mixing can relay the same benefits as hyperpolyandry this will be a practical and useful pest management technique for beekeepers.

Genomics of soybean bradyrhizobia and associated viruses

Issues

Increasing soybean production is critical for feeding the growing global population. Symbiotic soybean bradyrhizobia (SB) bacteria supply the soybean plant with essential nitrogen from the atmosphere. Remarkably, little genetic information is available about SB that may provide strategies for increasing yields. Even less information is available about viruses of SB; these may affect the ability of SB to improve soybean productivity.

Responses

Diverse representatives of the University of Delaware Bradyrhizobium Culture Collection are being analyzed by genomic DNA sequencing; these were previously studied using non-genomic approaches. A total of approximately 25 SB genomes will be sequenced; currently there are only 2 or 3 complete genome accessions available on public databases. Additionally, two broad types of viruses of SB will be studied to assess their potential to modify the symbiotic effectiveness and general ecology of SB.

Results

To date, four SB genomes have been sequenced; an additional 21 cultures of SB are in the process of being submitted for sequencing. In related research, we found that ~70% of SB harbor viruses as part of their chromosomes. We have also isolated additional viruses from soils that kill certain SB and, presumably, affect the latter's survival. Representatives of both groups of viruses are currently being purified and prepared for DNA sequencing. In aggregate, these efforts will add immensely to the information available regarding these organisms and may provide insights and strategies for sustainably increasing soybean yields.

Identifying ways to reduce feed costs by comparing feed rations on rate of grain

ISSUE

The goat meat industry is a growing enterprise that can be of great economic importance for small farmers as the demand is far greater than the supply. However, feed costs

associated with raising small ruminants is estimated to be as much as 60% of production costs. Therefore, it is important to identify the most efficient and cost effective means of feeding ta balanced diet to meat goats for them to attain market weight in a timely manner.

RESPONSE

Two project were conducted at Delaware State University's Hickory Hill farm 1) to evaluate the effect of supplementing animals with ground corn, ground barley or whole barley on growth performance and 2) to evaluate the effects of a commercial pellet versus a home-mixed corn based ration on performance in meat goat kids

RESULTS

In experiment one, BW was not influenced by treatment, however, there was a day effect on BW (P < 0.0001) with BW on day 0 being the lowest (22.6 ¬± 1.8 kg). Days 14 and 28 BW (24.8 ¬± 1.8 kg and 24.4 ¬± 1.8 kg, respectively) were similar but higher than day 0 while day 42 BW (28.5 ¬± 1.8 kg) was higher than all other time points measured. For objective 2, BW was not influenced by treatment and averaged 20.95 ¬± 1.75 kg. However, there were day effects (P < 0.0001) with an increase over time such that starting at d 7 (17.2 ¬± 1.3 kg), BW was greater than that measured on d 0 (16.1 ¬± 1.3 kg). In addition, BW on d 28 (18.6 ¬± 1.3 kg) was higher than d 0, 7, and 21 but similar to d 35 (19.4 ¬± 1.3 kg) and 42 (19.6 ¬± 1.3 kg) while d 49 (20.2 ¬± 1.3 kg) was greater than d 0, 7, 21, and 28 but similar to d 56 (21.2 ¬± 1.3 kg). Days 63 (23.0 ¬± 1.3 kg) and 70 (23.6 ¬± 1.3 kg) were similar but higher than all previous days and d 77 (25.3 ¬± 1.3 kg) and 84 (26.4 ¬± 1.3 kg) were similar but higher than all previous days. Day 91 was also greater (P < 0.0001) than all other time points measure.

Impact: Goat producers in Delaware have indicated they plan to mix their own feed ration instead of buying pelleted feed from the store since they have access to the feed ingredients. One produce indicated that he has already started to use barley in his ration instead of corn because he can get barley cheaper.

Testing and Application of Novel Probiotic Bacteria for Use in Marine Aquaculture

ISSUE

One strategy for controlling disease has been to utilize probiotics which are live microbial supplements that beneficially affect the host. The probiotic acts by either competing with other bacteria for essential resources or nutrients, antagonism, or by producing their own broad-spectrum antibiotics. While the application appears to be useful in a wide range of life-history stages, from larvae to adults, the application of probiotics is not systematically used in the aquaculture industryovel Probiotic Bacteria for Use in Marine Aquaculture

RESPONSE

Trials run at the DSU ARDF dose Nile tilapia (Oreochromis niloticus), rainbow trout (Oncorhynchus mykiss) and hybrid striped bass (Morone chrysops x M. saxatilis) with three probiotics Bacillus spp. (Iso 5 and Iso 11) and Shewanella spp. (Iso 12). Mortality was observed over a 56-day trial or until one tank in the trial attained 10% survival. Ammonia, nitrite and nitrate were monitored throughout the trial. Feed conversion ratios, specific growth rates, weight gains and mortality were assessed at the end of the study.

RESULTS

All three tested bacteria have the potential to be probiotics useful and used in aquaculture. Higher survival of finfish in the probiotic treatment tanks than the control tanks suggest that all three probiotics have the ability to increase survival in warm water (24 ¬C) conditions, though no significant results were observed for cooler water (19 ¬C). Additional testing of the three probiotic strains in different systems as well as under more temperatures and salinity profiles should be done to better understand the functions of these bacteria.

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: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	8.5	6.6	14.8	1.2
Actual Paid	8.4	5.3	22.7	0.2
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
798733	357050	540985	17893
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
798733	357050	540985	17893
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
1361641	46877	1500418	0

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?

The eXtension Innovation Team comprised of faculty and staff from across all planned program areas is a key connection. This group continues to provide the leadership for integration of eXtension at UD Cooperative Extension. Last year the team has focused on innovation. A partnership of eXention matched UD/DSU funding for a total of $15,000 investment. Eleven innovation teams were formed and pitched innovation program plans. Five were selected for funding and are in development • On-line course development with Continuing and Professional Development is in process with rollout of several nutrient management certification courses• Two individuals were selected as I-corp member in climate change initiative and diversity initiative. The largest percentage of our Ask an Expert aspect of eXtension is focused on consumer horticulture and landscape. We averaged about 600 questions through this format. 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 developed a multiple data mapping projects of which the Associate Director has been trained as a Collaboration Facilitators.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	14768	13804	10526	3878

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

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	48	41

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Competitive Grants Awarded

Year	Actual
2018	29

Output #2

Output Measure

- Undergraduate Researchersw

Year	Actual
2018	85

Output #3

Output Measure

- M.S. and Ph.D Students

Year	Actual
2018	49

Output #4

Output Measure

- Post-doctoral Research Associates

Year	Actual
2018	4

Output #5

Output Measure

- Refereed Journal Articles

Year	Actual
2018	48

Output #6

Output Measure

- Books and Book Chapters

Year	Actual
2018	8

Output #7

Output Measure

- Extension Bulletins and Fact Sheets

Year	Actual
2018	327

Output #8

Output Measure

- Webpage views/downloads

Year	Actual
2018	105346

Output #9

Output Measure

- Workshops at State, National, and International Level

Year	Actual
2018	277

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
2018	25153

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Delaware 4th H for Health Challenge:

Childhood obesity and its health impacts are well known. The national childhood obesity rate is 18.5 percent with one-third of children being overweight or obese. The rates vary among age groups, but rise as children get older. Teens who are obese have a 70 to 80 percent chance of becoming obese adults. In addition, significant environmental changes have decreased physical activity and increased food intake in youth. These changes include increased amounts of screen time, less outside play, less physical education in school, increased food portion sizes, fast food, and food used as rewards. Since it is much easier to start with healthy habits at a young age than try to change as an adult, establish healthy habits among youth is very important.

What has been done
In 2018, Delaware 4-H collaborated with Tufts University and the Healthy Kids Out of School Program to adopt the 4th H for Health Challenge. The key components of the challenge are:

* Drink Right - Choose water instead of sugar-sweetened beverages

* Move More - Incorporate movement and physical activity

* Snack Smart - Fuel up on fruits and vegetables

The 4th H for Health Challenge encourages 4-H Clubs to offer fruits and vegetables as the snack at three meetings, serve water as the main beverage at six meetings and do fifteen minutes of physical activity at six meetings. Challenge materials were customized for Delaware and packets prepared for each county office. The program kicked off in September 2017 and ended in August 2018. Clubs that completed the challenge were honored at their annual County Achievement programs with certificates, pins and a bag of tools to promote health at 4-H meetings. To build enthusiasm for the program, each county had a youth speak at this event on the impact it made on their club 4-H program.

Results

Twelve clubs and two afterschool programs statewide involving more than 500 youth participated in the challenge. In addition, other 4-H events followed suit by eliminating sugar-sweetened beverages, offering healthier snacks and building physical activity into events. Evidence shows that youth will try new things when they are in a group with their peers. By making it simple, achievable and fun, 4-H?ers are definitely changing their habits, and it is felt that healthy behaviors will be the norm for all 4-Hers. In this inaugural year of the challenge, we built awareness and enthusiasm. Year two of the challenge started at the beginning of the 2018-2019 4-H year. During this new year, a fourth social-emotional health element was incorporated and a monthly 4-H newsletter page offers ideas to incorporate healthy snacks and physical activity. In addition, some clubs added a Healthy Living Officer who is responsible for planning snacks and fun active games for club members. By the end of the second year, we hope to double the number of clubs participating. In addition, we hope the challenge will become a Policy Systems and Environment (PSE) change and continue to be adopted at camps, meetings and other Cooperative Extension events. The following quotes were received about this program:
?A parent reported, ?I am really seeing more healthy food choices and physical activity at home.?
?A leader shared, ?At our planning meeting they all said they really liked planning snacks that were fun and yet still (mostly) healthy. We only are doing four or five snacks throughout our year because they wanted to throw in yoga!! How cool is that!! My club is now super into it!?

4. Associated Knowledge Areas

KA Code	Knowledge Area
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
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 Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	2928

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Educating and Preparing Vegetable Growers for Food Safety Modernization Act (FSMA) Produce Rule Regulations

The Food Safety Modernization Act (FSMA) Produce Rule went into effect in 2016. Under the rule growers of fresh consumed produce must attend an approved training. The Produce Safety Alliance (PSA) Grower Training Course is the current way to satisfy the FSMA Produce Safety Rule requirement outlined in § 112.22(c) that requires ?At least one supervisor from the farm must complete food safety training at least equivalent to the standardized curriculum recognized by the FDA?. In addition, produce farms will be coming into regulation according to size and income with the first farms to be inspected in 2019. The Food Safety Modernization Act (FSMA) brought fresh consumed produce production under U.S. Food and Drug Administration regulation starting in 2016 under the Produce Rule of FSMA. State Departments of Agriculture are administering and regulating the compliance with the Produce Rule.

What has been done
Dr. Gordon Johnson and Dr. Kali Kniel took the train the trainer course to give the PSA training ? now serving as trainers for sessions offered in Delaware and Maryland. Dr. Johnson further qualified as lead trainer for PSA grower trainings and has served in that capacity as the only lead trainer in Delaware (as a lead trainer is required for each session). A total of seven trainings have been conducted since 2017.
A sample PSA training agenda in Delaware Topics Included:
1. Introduction to Food Safety 2. Worker Health, Hygiene, and Training
3. Soil Amendments 4. Wildlife, Domestic Animals, and Land Use 5 Agricultural Water-Production Water; Agricultural Water-Postharvest Water 6. Postharvest Handlings and Sanitation; 7. How to Develop a Farm Food Safety Plan; 8. FSMA Produce Rule Implementation in Delaware, On-Farm Readiness Reviews

Each attendee received a detailed 358-page manual with all slides, references to the regulations and explanations of the regulations.

Results

To help growers comply with Food Safety Modernization Act (FSMA) on-farm inspections, a team comprised of NASDA, State, FDA, and Cooperative Extension food safety leaders developed the On-Farm Readiness Review (OFRR) program. This program is designed to move farmers away from an audit checklist scheme. The OFRR is meant to foster a dialogue between the grower, regulators, and educators to address FSMA compliance needs. A team consisting of Dr. Gordon Johnson, Dr. Kali Kniel, and Jennifer Jones from the University of Delaware and Andrea Jackson and Anna Wicks from the Delaware Department of Agriculture received training in May of 2018 on how to conduct OFRR?s. In Delaware, the On‐Farm Readiness Reviews are conducted jointly by the Delaware Department of Agriculture and the Produce Safety Specialists from University Delaware Cooperative Extension. The OFRR consists of on‐farm observation to identify areas for produce safety improvements, help growers prepare for a FSMA Produce Safety Rule inspection, and help growers in utilizing best produce safety practices on their farm.
Each farm receives an OFRR manual and checklists to comply with the FSMA Produce Rule.

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
2018	3128

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Alleviating the impacts of social determinants on at-risk communities

In Delaware, we are aligning health and community development strategies across our system, partnering with others who are doing the same to alleviate the impacts of social determinants on at-risk communities. In the first year of Well Connected Communities, UDCES's focus was to ensure that staff and the system were provided the opportunity to learn about coalitions throughout the state, and the work that was being done as part of them. Team members were integrated into a state-based initiative known as Healthy Neighborhoods. Coalitions supported projects aimed at improving health in Wilmington, Dover/Smyrna, and Seaford.

What has been done
Throughout this first year, the University of Delaware Cooperative Extension Service worked to align work within and across program areas to increase impact on specific populations served. This is most evident in the alignment of Well Connected Communities with SNAP-Education. The work of SNAP-Education is focused on nutrition education and obesity prevention. Through our work with coalitions, we strive to bring youth leadership to the conversation related to building a culture of health in communities. As we work internally at changing the system, we also engage in conversations and work at the state level, creating investments and strategic alignment of community development and health as a way to create healthier communities across the state.

Results
Residents of the three communities have access to more opportunities to engage in healthy lifestyle activities because of UDCES and the collective work of the coalition. These healthy lifestyle activities were driven by community need through assessment and input, which is most important in terms of behavior change. In addition to the community members, the system has seen the following changes:

1.Working on the alignment of SNAP-Ed and Well-Connected Community work;

2.Facilitation of two coalitions, connecting with new partners and strategies for addressing health issues;

3.Engaged in a contract (approximately $25,000) with Health Management Associates, in partnership with the Center for Community
Research and Service and Institute for Public Administration as well as the Division of Public Health to build a model for investment and community work that will move the needle in Delaware in the future;

4.Contract (approximately $57,000) with Health Management Associates to engage in community

readiness work related to behavioral health, specifically opioid use.

Recognition of sponsors, in-kind contributors or partners (please provide name, organization, what was contributed). Rysheema Dixon, Councilwoman At Large, City of Wilmington. Lead program manager for Play Streets Wilmington. Partnered to lead the work and provide an opportunity for UDCES to be engaged. Also, co-Chair of Wilmington/Claymont Council with Gina Crist Sussex County Health Coalition. Lead for the Botvin training, providing support (financial and personnel) for the startup of the training, and ongoing support.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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

Farmers Markets Healthy Food Demonstrations 2018

Issue

Local farmers offer a variety of traditional and specialty produce from May through October at farmer's markets. This year with a USDA grant made to New Castle County Government, UD Cooperative Extension provided farmer's market visitors an opportunity to try new, healthy recipes using seasonal produce. By providing visitors with recipes and free samples in a fun and comfortable environment, this program increased the incentive to purchase from the farm vendors at the markets. In addition, it introduced consumers to new recipes that encouraged healthy eating habits by increasing consumption of fruits and vegetables.

Response

New Castle County Government manages and supports several farmer's markets throughout the county: Cool Springs Park, Route 9, Garfield Park, Rockwood Park, Carousel Park and Glasgow Park. Through a subcontract offered to UD Cooperative Extension, 24 weeks of

food demonstrations were conducted at selected markets from May to October 2018. Each recipe highlighted fresh produce to introduce consumers to tasty, healthy ways to use fresh fruits and vegetables as well as increase their consumption of these food groups. UD Cooperative Extension demonstrated different recipes each week at two markets: Route 9 and Cool Springs. The farmer's markets ran from 3:00 p.m. to 7:00 p.m. on Wednesdays and 4:00 p.m. to 7:00 p.m. on Thursdays. Demonstrations were conducted by the program coordinator as well as UD Nutrition and Dietetics students from opening until about 6:30 p.m. on market days. Department of Public Health permits were acquired for each demonstrated recipe. Each recipe was also tested for acceptability and nutrition facts information was provided. Copies of the recipes, food safety information about washing, preparing and storing fresh produce, produce fact sheets, and event handouts were made available to visitors each week. Visitors were also asked to fill out a recipe evaluation to determine the acceptability of each demonstrated dish. Additionally, the project partnered with a USDA grant-funded study, conducted by the UD Department of Behavioral Health and Nutrition, designed to measure the impact of produce item-specific marketing. In September and October, we distributed tomato-themed marketing materials and recipes to 281 market visitors. This study is ongoing beyond the timeframe of New Castle County's farmer's markets.

Results

Over the course of 24 weeks, 2,245 market attendees visited the booth to try the recipes at the Cool Springs Park and Rt. 9 markets. More than 1000 printed recipes were distributed to these visitors. Farm vendors were very appreciative of our efforts and often stopped by to thank us for being there to promote their product. After preliminary training, three nutrition and dietetics students improved their food demonstration skills and learned how to effectively interact with the public to answer questions about food preparation, food safety, and healthy eating. Feedback from and interaction with visitors was extremely positive. Many market visitors returned to the booth to take an additional sample for themselves or to share it with their families and friends. Evaluation survey comments showed that each recipe was well received. Visitors not only enjoyed the opportunity to try something new, fresh, and healthy but also appreciated recipes that introduced them to unique flavor combinations and simple-to-make recipes that they could incorporate into home meals. A few sample quotes were recorded throughout the market season.

Statewide Family and Consumer Science Food Safety Programs Impact Report

Issue

Foodborne illnesses are a common and costly - yet preventable - public health issue. According to the Centers for Disease Control and Prevention, approximately one in six Americans (nearly 48 million people) get sick, 128,000 are hospitalized and 3,000 die of foodborne illnesses each year (CDC, 2017). The actual incidences of hospitalization and death are probably higher, but many foodborne illnesses go undiagnosed. The State of Delaware requires a person in charge on each shift at a licensed food service establishment to be certified in food safety through an approved food safety course. In addition, individuals who want to produce certain foods from home are required to have an educational course that culminates in a certification exam. Churches and other organizations that prepare food for the public, although not required, realize the importance of providing education for their volunteers on the essentials of food safety.

Response

Servsafe®, Dinesafe, Food Safety for On-Farm Entrepreneurs and Food Safety for Cottage Entrepreneurs classes are offered by University of Delaware Cooperative Extension Family and Consumer Science staff. The pertinent class to each participant depends on the certification that is needed by that individual. Ten Servsafe® classes and nine Dinesafe

classes were offered statewide. One Food Safety for On-Farm Entrepreneurs training and two Food Safety for Cottage Entrepreneurs training were offered.

Results

One hundred thirty-five individuals attended Servsafe® classes, taking the certification exam with an additional 30 individuals taking the certification exam only. Eighty-four of those individuals passed the exam, becoming certified and meeting the requirements of the State of Delaware for the person in charge. Twenty-six individuals attended the Entrepreneur classes with all 26 passing the certification exam. In addition, 96 Delawareans attended a Dinesafe training program. Post-program surveys from participants who attended Servsafe® and Dinesafe classes showed that those individuals serve approximately 29,000 customers per day. In addition as a result of participating in a Servsafe® or Dinesafe class individuals responded in the following manner:

- 82 percent will calibrate thermometers on a regular basis.
- 85 percent will thoroughly wash and sanitize all food surfaces.
- 95 percent will wash hands properly.
- 80 percent will cool foods more rapidly.
- 80 percent will hold hot foods at or above 135° F.

Cooperative Extension staff responsible for these impacts: Kathleen Splane, MS; Kimi Moore, RD

Peoples Place Shelter

Issue

Obesity is a major public health problem, according to the U.S. Centers for Disease Control and Prevention (CDC). In 2017, 31.8 percent of Delaware adults reported being obese. The goal of the EFNEP program is to provide individuals, families, and youth in Kent County with knowledge and skills, which will enable them to make informed choices about diet and nutrition, as well as other aspects of health and well-being, such as physical activity and food safety.

Response

DSU's EFNEP uses the Eating Smart and Being Active, and evidence-based curriculum offering a series of eight to twelve lessons presented over a period of 4-6 weeks and covers topics on food safety and sanitation, food resource management, diet quality and physical activity. Participants learn to prepare and sample healthy, affordable recipes at each meeting. A new community partner, Peoples Place Relief Shelter, was established where 36 participants/graduates benefited from EFNEP. They especially enjoyed the recipes and trying new ways to prepare familiar dishes; as well as engaging in physical activities. Some of their most notable favorites included spinach smoothies, cauliflower rice, Greek yogurt, meatless chili, and hummus. Additionally, elements of physical activity were offered for 15 minutes per class via a variety of activities including jump rope, hula hoops, and a fitness maze. Children of adult participants received a series of 3-4 lessons utilizing USDA's My Plate curriculum, as well as physical activities.

Results

A total of 46 adults participated in Peoples Place Relief Shelter, with 36 graduating for a 78% graduation rate. Efforts to reach those adults who moved on from the shelter were made; however, contact information was not always readily available for many participants. For the adults who were able to complete all lessons, they were provided with certificates of completion as well as water bottles to encourage them to drink more water.

SNAP-Ed program

Issue

Over time the eating habits of Americans have changed. Our food portions have grown, and

physical activity has not increased to maintain energy balance leading to overweight and obese individuals. Portion sizes increased not only at home but in restaurants as well. Individuals need a guide to assist them in making healthier food choices.

Response

The SNAP-Ed program has incorporated a reading the food label lesson in elementary schools for both 3rd and 4th grade. Students learn where the Nutrition Facts Label is located, how to read it and use it to make healthier food choices. Discussions include information appearing on food labels, what they mean, and whether our numbers should be high or low.

Results

Third-grade students are given definitions of the contents as clues and work as detectives to solve the food label. Students are given two different food label and pick which one they would like to eat using the food label and personal preference such as appearance, test, and ingredients. Potato chips and baked potato chips are also compared. For fourth grade, the usual portion size of cereal was measured and compared to the actual recommended serving size. Students work in pairs looking at different food labels and determine which one is the healthy choice and why.

Foods that provide high amounts of fat and foods that are good sources of vitamin A, vitamin C, calcium and iron are discussed. Students are encouraged to bring nutrition labels from home and share with their classmates during the following lesson. Students discuss foods they would normally eat and compare them with labels that are healthier versions. Recognition of sponsors, in-kind contributors or partners (please provide name, organization, what was contributed).

Restoring Ecosystem Function to Human-Dominated Landscapes

Issue

Human dominated landscapes typically degraded local ecosystems because they are dominated by lawn and primarily landscaped with nonnative plants. These landscape approaches are causing declines in biodiversity nationwide. This is particularly true for native bees, insects in general and birds.

Response

We are conducting research that documents the inability of nonnative plants to support diverse ecosystems in suburban and urban settings as well as agricultural hedgerows in North America and coffee in Central and South America.

Results

- Insectivorous birds preferentially forage in native plants over nonnatives
- Some plant genera are disproportionately important at providing resources for insects and birds
- Yards landscaped with 30% or more nonnative plants function as ecological sinks for insectivorous bird populations
- Yards landscaped with nonnative plants provide lower biomass of high-quality prey (i.e. caterpillars) which can have deleterious impacts on the growth of nestling songbirds
- Cultivars of native plants in which green leaves have been changed to red or purple are unable to meet the needs of insect herbivores
- Birds select the most nutritious prey rather than the most abundant prey

• When nonnative plants displace native plant communities, there is a significant loss of biodiversity; the animal community shifts from one dominated by a diverse array of animals that eat living plants to a simplified community of animals that eat dead plants

• Hedgerows invaded by nonnative plants have 96% less caterpillar biomass than hedgerows dominated by native plants

• Coffee-shaded by native canopy trees supports greater abundance and diversity of migratory and resident birds than coffee shaded by non-native trees.

Amino acid nutrition of dairy cattle

Issue

Dairy cattle are ruminants, and the feed that they consume is subjected to microbial fermentation in the rumen prior to absorption in the intestines. This makes meeting amino acid requirements difficult, as the profile of fed amino acids does not match absorbed as it does in monogastrics. Rumen-protected amino acids offer a way to feed dairy cattle amino acids that resist degradation in the rumen and are then available for absorption in the intestines. These sources allow the potential to feed lower protein diets and reduce environmental nitrogen losses.

Response

We conducted three studies evaluating three different sources of rumen-protected methionine (1 prototype and 2 current products) and three prototype sources of rumen-protected lysine. We fed these products to cows and evaluated bioavailability by measuring the change in plasma amino acid levels in response to feeding the products.

Results

The methionine prototype product that we evaluated had high bioavailability and therefore is a viable source of rumen-protected methionine to be included in dairy cattle diets. Follow up studies are planned to further characterize the prototype. If proven efficacious, the product can be included in dairy cattle diets as a source of methionine and allow producers to feed rations that are lower in total protein content.

Enhancing environmental services in productive agricultural landscapes

Issues

Covering over a third of all global land area, agricultural systems constitute the world, largest engineered landscape. Agricultural systems are multifunctional and have the potential to provide marketed goods (e.g., crops) and non-marketed ecosystem services (ES); and producers, livelihoods depend on the productivity and resilience of their land. The challenge of enhancing environmental services while maintaining profitable agricultural production has motivated much of my research, which is focused on understanding producer decision-making and designing effective agri-environmental programs and policies.

Response

Examining issues at the nexus of agriculture and the environment, my research aims to identify how producer decisions and well-designed programs and policies can improve the performance and sustainability of agroecosystems. Most of my work investigates how U.S. producers make management decisions that impact the environment. I use a variety of research methods to analyze decision-making in different policy settings, including economic experiments in the laboratory and the field, surveys with embedded choice experiments, and mathematical modeling.

Results

Reeling, C.J., L.H. Palm-Forster, and R.M. Melstrom. (forthcoming) , Policy instruments and incentives for coordinated habitat conservation. Environmental & Resource Economics. https://link.springer.com/article/10.1007/s10640-018-0304-2

We use theoretical and experimental approaches to compare conservation effort and cost-effectiveness of species protection under each instrument when species protection requires spatially-contiguous coordination. Land use restrictions, either alone or coupled with subsidies, improve coordination.

Palm-Forster, L.H., S.M. Swinton, and R.S. Shupp. 2017. Farmer preferences for conservation incentives that promote voluntary phosphorus abatement in agricultural watersheds. Journal of Soil and Water Conservation 72(5): 493-505. http://www.jswconline.org/content/72/5/493

Understanding farmer preferences for different types of conservation incentives is critical to design cost-effective agri-environmental programs. We find that farmers prefer incentive programs with low transaction costs such as those offering direct payments or tax credits. Compared to nontargeted policies like environmental stewardship certification, agri-environmental programs that can successfully target conservation incentives to producers with environmentally sensitive cropland are more cost-effective.

Study of microbiome in fish products during refrigerated storage.

ISSUE

Quality and safety of fish and seafood products are closely associated with bacterial spoilage that is responsible for a huge economic loss in fish/seafood companies annually.

RESPONSE

For understanding bacterial spoilage during the refrigerated storage, fish fillets were treated with/without natural preservatives and then specific spoilage organisms and diversities in bacterial communities were investigated by metagenomics approach using next-generation sequencing technology.

RESULTS

Major SSOs and other pathogenic bacteria were specifically identified. Profiles of bacterial taxonomy in the early-, mid-, and late-phase of fish spoilage were obtained. All diversities from each sample was compared each other. Their similarity and correlation were represented using several distance metrics.

The results from this study will be informative in understanding the spoilage mechanism and will contribute to food safety by controlling spoilage and pathogenic bacteria in fish products.

Marker-Assisted Molecular Profiling, Deletion Mutant Analysis, and RNA-Seq Reveal a Disease Resistance Cluster Associated with Uromyces appendiculatus Infection in Common Bean Phaseolus vulgaris

ISSUE

Abiotic and Biotic stresses are detrimental to healthy growth habits of plants, including leguminous common bean Phaseolus vulgaris. Combating such stresses include addressing genomic, transcriptomic, and epigenomic changes at the molecular level. Common bean has the ability to serve as a major food source, complimentary to cereal crops such as wheat, corn, and rice. With its ability to fix atmospheric nitrogen, common bean is a perfect source for crop rotation. As the population continues to increase, there is a need to produce more food for human and livestock.

RESPONSE

Our work focuses on several aspects of abiotic and biotic stress in common bean. We have

studied the reactions of the transcriptome, methylome, and epigenome under salinity (abiotic) stress as well as fungal pathogen (biotic) stress. We have performed work towards identifying which loci of interaction with each stress

RESULTS

We have developed a reference methylome to identify methylation modifications throughout common bean. We have identified differential expression in common bean root and leaf genes at five weeks old, which has not been done previously.

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: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	9.8	2.9	0.9	0.3
Actual Paid	9.2	5.3	0.0	0.2
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
115180	357050	0	17893
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
115180	357050	0	17893
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
1730576	46877	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?

The eXtension Innovation Team comprised of faculty and staff from across all planned program areas is a key connection. This group continues to provide the leadership for integration of eXtension at UD Cooperative Extension. Last year the team has focused on innovation. A partnership of eXention matched UD/DSU funding for a total of $15,000 investment. Eleven innovation teams were formed and pitched innovation program plans. Five were selected for funding and are in development • On-line course development with Continuing and Professional Development is in process with rollout of several nutrient management certification courses• Two individuals were selected as I-corp member in climate change initiative and diversity initiative. The largest percentage of our Ask an Expert aspect of eXtension is focused on consumer horticulture and landscape. We averaged about 600 questions through this format. 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 developed a multiple data mapping projects of which the Associate Director has been trained as a Collaboration Facilitators.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	11060	11765	15034	835

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

Patent Applications Submitted

Year:	2018
Actual:	0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	0	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Competitive Grants Awarded

Year	Actual
2018	0

Output #2

Output Measure

- Undergraduate Researchers

Year	Actual
2018	0

Output #3

Output Measure

- M.S. and Ph.D Students

Year	Actual
2018	0

Output #4

Output Measure

- Post-doctoral Researchers

Year	Actual
2018	0

Output #5

Output Measure

- Refereed Journal Articles

Year	Actual
2018	0

Output #6

Output Measure

- Books and Book Chapters

Year	Actual
2018	0

Output #7

Output Measure

- Extension Bulletins and Fact Sheets

Year	Actual
2018	82

Output #8

Output Measure

- Webpage views/downloads

Year	Actual
2018	103265

Output #9

Output Measure

- Workshops and regional, national, and international levels

Year	Actual
2018	1009

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 Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	1915

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

According to the recently released Kids Count 2018 Factbook, more than 16.6% of children under the age of 18 in Delaware are living in poverty. Statewide, this alarming statistic equates to more than 35,300 youth. Many of our disadvantaged youth across the state attend schools with high rates of poverty and low academic achievement.

The Afterschool Alliance, a national organization advocating for families and afterschool programs, reports that youth, in general, engage in risky behaviors during the hours of 3pm-6pm when children are waiting for parents to return from work. As a result, students in poverty are at an even higher risk during this timeframe.

The Afterschool Alliance also reports over 48,000 Delaware youth are waiting for an available ?out of school time? (OST) placement. Additionally, the Alliance asserts 75% of parents appreciate OST programs, which are helping them maintain employment and 73% of parents agree OST programs reduce the likelihood their children will engage in risky behaviors. Ultimately, OST programs offering summer, spring break and afterschool programming focus on redirecting students with positive activities in lieu of risky behavior that may lead to juvenile delinquency.

What has been done

The University of Delaware Cooperative Extension 4-H Summer & Afterschool programs support youth and their families statewide at 14 afterschool sites throughout Delaware. These OST programs provide a safe environment, caring and credentialed staff, homework help, hands-on activities, enrichment, peer engagement and quality programming. The hands-on 4-H curriculum includes Civic Engagement, STEM and Healthy Living. It is our goal in 4-H to provide opportunities for students to develop skills through community service projects like community

gardens, as well as skills in public speaking, computer science, art, recreation, STEM and more. By attending summer and afterschool programming during OST, youth are less likely to engage in risky behaviors (i.e. violence, substance abuse, crime) and more likely to feel a sense of belonging in a safe environment while their parents are working.

Results

After participating in 4-H summer and/or afterschool programming statewide in 2018, youth were surveyed about their experiences and 172 responses were collected. These responses indicated the following:

*84% report gaining skills to use healthful diet practices

*78% report adopting healthful diet practices

*86% report gaining skills to use positive stress techniques

*75% report adopting positive stress techniques and coping skills they can use when they are frustrated or angry

*80% report demonstrating leadership skills in their schools, organizations, and/or communities

*90% report increased knowledge about the health and legal risks of using tobacco, drugs, and alcohol

*85% report gaining skills and planning to resist negative behaviors

*88% strongly agree 4-H adults care about them

*90% agree or strongly agree their new STEM skills will help them in the future

*89% feel their participation in STEM is more often introduced in 4-H than otherwise

*100% feel 4-H is a place they feel safe

*100% feel 4-H is a place they feel like they belong

*100% feel 4-H is a place where they have a chance to be a leader

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 Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	1186

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Delaware's population continues to inch towards 1,000,000 residents due to its favorable taxes, proximity to the coast, major metropolitan areas, and career and retirement opportunities. According to the Delaware Population Consortium's annual projections (released Oct. 26, 2017), Delaware?s population has grown by 49,500 between 2010 and 2015. It is expected to reach 1,019,558 residents by 2025. Delaware Cooperative Extension is charged with meeting the educational needs of its citizens in many areas, including home horticulture. This requires the dedication, creativity, and hard work of many volunteers.

What has been done
Master Gardeners are vital links in an educational chain that begins with research from the University of Delaware, Delaware State University, and the horticultural industry. Delaware Cooperative Extension specialists translate this research into science-based educational programs in home horticulture and environmental science for the citizens of Delaware. Master Gardeners then play a key role in distributing this information. Education is at the heart of all Master Gardener activities, which can take many forms, including teaching by example and demonstration. They are expected to volunteer 30 hours and gain an additional five hours of advanced training each year. Master Gardeners are committed to reaching out to help Delaware residents?adults and children alike?improving the quality of their lives.

Results
Master Gardeners help field the growing number of calls that come in daily to the county Extension offices. In addition, through workshops, garden walks, school and community visit these extraordinary volunteers provide practical and valuable gardening resources to Delaware's

citizens. They provide assistance and instruction in areas such as: identification and control of home, lawn, and garden pests; plant diseases; plant identification and selection; lawn and landscape management; wildlife problems; habitat development; water conservation; vegetable, flower, and/or herb gardening. Master Gardeners are the ambassadors of extension ?making it happen?. The activities listed below reached 11,892 people with the support of 400 MGs in 2018. Activity New Castle Kent Sussex Garden Helpline (#clients served/MG participants) 598/18 411/35 334/26 # Workshops/Events held (attendees/MG participants) 9 (191/43) 16 (550/20) 15 (610/27) # Speakers Bureau engagements* (attendees/MG participants) 32 (195/12) 22 (330/6) 10 (350/13) # Public Outreach events** (people reached/MG participants)

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 Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	2382

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Since 2001, the Targeted State Crop Insurance Education Program offered through the USDA Risk Management Agency (RMA) has been extremely beneficial to Delaware farmers. Compared to the year 2000 (the year prior to implementation of the Targeted States Program), Delaware has seen a 75% increase in the number of policies sold and a 40% increase in the number of acres

insured, more than triple the level of aggregate coverage. More farmers appreciate crop insurance as a part of a risk management strategy thanks to the Delaware-led network implementing the Targeted States Program.

What has been done

As a result of securing the 2017 USDA-RMA Targeted States Partnership Agreement, approximately 1,500 Delaware farmers were exposed to crop insurance programs and key deadlines through local industry media, both by paid advertising in the Delmarva Farmer as well as press releases. These farmers received information about crop insurance products and key deadlines through six direct mail newsletters, electronic news, and three to five postcard mailings. During 2018 Ag Week, crop insurance education was presented to over 200 growers during marketing sessions, and a similar topic presented at the Mid-Atlantic Women in Ag conference reached about 30 producers through an educational exhibit. A number of growers received educational handouts via an exhibit that was staffed at Delaware Ag Week (average 1800 in attendance). It is estimated that over 200 young, beginning, and socially disadvantaged farmers attended a crop insurance education session during one of the many opportunities that were offered through University of Delaware's programs, including the Beginning Farmer meetings, Mid-Atlantic Women in Ag Conference, and commodity association meetings, such as the Delmarva Poultry Industry, and Delaware Fruit and Vegetable Growers.

Results

Paper evaluation and personal interviews were conducted in an attempt to capture the impacts of the crop insurance education offered during the past year. Fifty producers reported increasing their level of understanding about using crop insurance in tandem with their marketing plans. One hundred producers reported that they learned about crop insurance decision deadlines as a result of receiving timely crop insurance newsletters. Sixty producers reported learning about how crop insurance could be used in building enterprise budgets. Two hundred producers reported increasing awareness about crop insurance policies and specific elements.

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 Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	2344

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

According to a 2017 report from the Delaware Department of Education, 41% of Delaware high school graduates are starting college without the skills required to be successful in a higher education environment. Although high school graduation rates have increased over the last few years, students do not possess the life skills required to be successful in collegiate life and often have to enroll in remedial classes to address these missing skills prior to continuing on to higher academics. Youth programs, such as 4-H, can help address this gap in life skills to help students succeed as they transition to this next phase. Tufts University examined the role of 4-H in helping students develop these critical life skills and found that 4-H participation results in improved engagement in the community and increased positive youth contributions to society (Lerner & Lerner, 2013). Lerner, Lerner, and Phelps (2009) also found youth who participated in 4-H were more likely to go to college, were 25% more likely to continue contributing to their communities and were 41% less likely to engage in high-risk behaviors. This demonstrates the impact that 4-H participation has on improving the chances of students pursuing college, remaining engaged in their community, and decreasing participation in activities which may result in decreased success in higher academics. Nebraska 4-H (2018) has also found that 4-H promotes informed decision making about college and careers, teaches students perseverance and accountability, and results in higher levels of campus involvement compared to youth who do not participate in 4-H.

What has been done

Delaware 4-H works with an average of 33,000 youth statewide each year. As members of community clubs, afterschool clubs or other outreach programs, youth ages 5-19 participate in a variety of project activities based around Science, Healthy Living and Civic Engagement. Leadership, Public Speaking, and Community Service are the most notable skills that our members learn while in 4-H. Our 4-H program relies on our engaging staff and volunteer leaders, who utilize critical thinking skills and experiences to foster positive relationships, improve acquisition of life skills and allow for application of these life skills in hands-on activities within the community. In 4-H, youth gain experiences that help prepare them for college and give them opportunities to work in areas that may help them choose a career path.

Results

A survey was developed and emailed to current or former Delaware 4-H members who were aged

18 to 29 years and also shared via Facebook. The survey requested anyone in this group who currently or previously attended college to respond to questions related to how their 4-H membership had assisted them in being prepared for their college experience. Participant responses showed attendance at diverse institutions of higher learning, (i.e. Public, Private, Large, Small, Urban, Rural, etc.) which demonstrated the depth and breadth of their educational goals.

College majors indicated by participants were shown to be reflective of the understanding our 4-H youth have related to community needs. Many of these majors are service oriented which is a strong tenet of the Delaware 4-H Program.

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

4-H Impact: Kent County 4-H Day Camp

Issue

While school is out for the summer, many kids find themselves bored and sitting at home on their electronic devices. Of households with children, 70% own a tablet, and 43% of children under the age of 12 use their access to that tablet to watch movies and TV (Reynolds Journalism Institute, 2015 & Newswire, 2012). Sitting at home all day staring at a screen has a detrimental effect on these children. In fact, there is a learning regression shown in children who do not engage in activities over summer vacation (Karl L. Alexander et al., 2007). Even if they do get out of the house, the chances of genuine social interactions with their peers are slim because 56% of adolescents ages 8-12 have their own cell phone (National Consumers League). On the other hand, kids who participate in programs and camps show greater achievement when the school year rolls back around.

Response

To keep children active, Delaware 4-H offers the "Day Camp" program. The camp is 5 days

long, offered Monday through Friday. Here, kids can engage in numerous activities, create friendships, and learn specific skills. This year's classes include foods and nutrition, cultural crafts, science, and team building where the campers will have opportunities to practice building trust and communication. This year we will also offer "counselor in training" classes to prepare members to direct groups and exhibit the valued characteristics every good leader should have. Aside from the classes, campers interact and play continuously which is what really makes them want to come back. During this week of camp, parents can feel relieved knowing their children are in great hands and making memories.

Results

The Kent County 4-H Day Camp at the Harrington Moose Lodge hosted 75 youth, ages 5-12. Participation at this camp included an introduction to new skills, physical activity such as kickball, football, swimming, and many more sports, team collaboration in group meetings, and a final council circle on Friday bringing out everyone's spirit and high energy. Positive relationships were cultivated all week between the campers as well as the counselors. Campers experienced a week of true interaction among peers and developed a better understanding of others. Above all, campers had a week of wholesome fun. All youth, parents, and counselors were surveyed at the conclusion of camp.

The following evaluation results from parent surveys were reported:

Do you feel 4-H is a place where adults care about your child?

- Yes 92%
- Usually/Some 4%
- Not Really 4%
- No 0%

Is Day Camp a place where you feel your child is included?

- Yes 88%
- Usually/Some 8%
- Not Really 4%
- No 0%

Is camp a place where your child gets along with others?

- Yes

Youth Biology

Issue

Children have a natural sense of curiosity about living things and the world around them. With this interest, students develop an understanding of biology through direct experiences with living things, their life cycles, and their habitats. Many educators believe students learn best through experiential learning and interacting with the world, i.e. listening, observing, experimenting and applying their knowledge to real-life situations.

Response

Delaware State University 4-H partners with local schools to deliver the Egg to Chick Embryology Program. This has proven to be an exciting and fun project for students that serves as an introduction to the life cycle of living things. In addition to teaching science, this project also has elements of math, writing, and so much more.

Results

Sixty students at Christ the Teacher, a local elementary school were given a pre and posttests on their knowledge of embryology and the life cycle of chickens. Following the series of (3) lessons, which included handling of embryos to the actual hatching, 100% of the students showed knowledge gained. Recognition of sponsors, in-kind contributors or

partners: Mountaire Farms provided the program with fertilized eggs.

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: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	7.8	1.9	30.7	4.8
Actual Paid	7.1	1.2	54.4	5.8
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**
292586	81611	375707	685916
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
292586	81611	375707	685916
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
567055	13344	3193140	378643

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?

The eXtension Innovation Team comprised of faculty and staff from across all planned program areas is a key connection. This group continues to provide the leadership for integration of eXtension at UD Cooperative Extension. Last year the team has focused on innovation. A partnership of eXention matched UD/DSU funding for a total of $15,000 investment. Eleven innovation teams were formed and pitched innovation program plans. Five were selected for funding and are in development • On-line course development with Continuing and Professional Development is in process with rollout of several nutrient management certification courses• Two individuals were selected as I-corp member in climate change initiative and diversity initiative. The largest percentage of our Ask an Expert aspect of eXtension is focused on consumer horticulture and landscape. We averaged about 600 questions through this format. 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 developed multiple data mapping projects of which the Associate Director has been trained as a Collaboration Facilitators.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	11733	146779	1276	49

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

Patent Applications Submitted

Year:	2018
Actual:	1

Patents listed

NOVEL SYSTEM FOR RAPID, ROBUST, AND EFFICIENT IN VITRO MASS PROPAGATION OF MISCANTHUS √ó GIGANTEUS

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	0	35	35

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Competitive Grants Awarded

Year	Actual
2018	19

Output #2

Output Measure

- Undergraduate Researchers

Year	Actual
2018	61

Output #3

Output Measure

- M.S. and Ph.D. Students

Year	Actual
2018	42

Output #4

Output Measure

- Post-doctoral Researchers

Year	Actual
2018	9

Output #5

Output Measure

- Refereed Journal Articles

Year	Actual
2018	59

Output #6

Output Measure

- Books and Book Chapters

Year	Actual
2018	11

Output #7

Output Measure

- Extension Bulletins and Fact Sheets

Year	Actual
2018	87

Output #8

Output Measure

- Webpage views/downloads

Year	Actual
2018	101335

Output #9

Output Measure

- Workshops at regional, national, and international levels

Year	Actual
2018	270

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
2018	4529

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Poultry is Delaware agriculture's main economic engine, with an estimated annual value of $1.7 billion. In recent years, the Delaware Nutrient Management Program has experienced a surge in the number of new poultry growers attending certification sessions. New and experienced growers face a variety of production issues including seasonal ventilation, as well as environmental and financial concerns.

What has been done
We developed the 2018 Poultry Grower Basics Series, which consisted of a series of three unique programs in Kent and Sussex counties held throughout the year to address issues faced by new growers. The courses also served as an excellent refresher for experienced poultry growers. Each program was approximately two hours long and was offered in the afternoon and evening in each county to accommodate growers varied schedules. Topics presented during the programs include neighbor relations, best management practices, warm weather ventilation, cool weather ventilation, mortality management, biosecurity, animal welfare, and settlement calculation. All of the programs offered Delaware Nutrient Management Continuing Education Credits.

Results

Total attendance at the 2018 Poultry Grower Basics Series was 152 for all five programs. A total of 140 program participants completed the program evaluation (92%). Respondents reported that their total poultry farm capacity is over 9.3 million birds, which accounts for roughly 3.6% of the 252 million broilers produced in Delaware annually. Participants were asked if they learned anything new during the program. Based on the evaluation responses, 94% learned something new about neighbor relations, 95% learned something new about best management practices, 93% learned something new about warm weather ventilation, 100% learned something new about cool weather ventilation and 96% learned something new about mortality management. Participants were also asked if they would implement or change a practice based on the information they learned during the programs. Based on the evaluation responses, 82% will change how they communicate with neighbors, 90% will change how they manage their farm and manure in order to minimize environmental impacts, 91% will change how they ventilate their poultry house during cool weather and 80% will change how they manage mortalities on their farm. One evaluation comment was ?I thought this class was very informative and well taught by instructors? and another comment was ?Sydney and Georgie have great presentation skills, definitely very helpful.?

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

UD Cooperative Extension Ornamentals Short Course Workshops

Issue

Impact Statement - Pest Walks June 6, 2018, and June 20, 2018 - Brian Kunkel, Nancy Gregory, Tracy Wootten, and Carrie Murphy

Stakeholders in gardens, agribusinesses, or landscapes observe plants in decline. Diseases and pests can impact income due to low-quality plants, loss of plants, and expenses for management. Plants are affected by pathogens, insect pests, environmental/cultural stresses, or a combination of factors. Management recommendations may be very specific. People may not recognize beneficial insects and predators.

Response

Attendees at two pest walks offered in Sussex County and New Castle County, Delaware, indicated that they attended due to proximity, interest in topics, and for pesticide credits. A Qualtrics survey was distributed to attendees via email a few days after the workshop. We received 17 responses from 26 attendees to a short and concise survey. In situ and hands-on learning opportunities are known to help people learn to recognize and remember type diseases, beneficial insects, and insect pests. Through UD Cooperative Extension Short Course training, participants see examples of plant diseases and arthropods in landscape settings.

Results

There was a range of knowledge before the classes, but 80% indicated that they learned something by their changed responses to a few fact questions such as one about integrated pest management (IPM) involving scouting for both pests and predators. With that increased knowledge, attendees agreed that more targeted use of insecticides was the best strategy. When asked if they would change their IPM practices, 47% indicated they would definitely do so. What changes they might make showed a bit more variation:

- Scout more often 26.67%
- Plant resistant cultivars 8.89%
- Spray less 13.33%
- Explore the idea of beneficial insects 22.22%
- Analyze recent weather patterns and determine how they may affect your plant(s) 15.56%
- Explore all possible problems 11.11%

All attendees learned something new, with 80% strongly agreeing they learned something new, and the remaining 20% somewhat agreeing. Most (80%) will have the opportunity to share new knowledge with others, including colleagues, employees, and students. The "Train the Trainer" aspect of these small group learning opportunities is therefore very valuable. For 63% of attendees, the walk was their first pest walk short course.

2018 Mid-Atlantic Crop Management School

Issue

Agricultural production in the Mid-Atlantic region is integral to local, regional, national, and even international food systems, so maintaining and improving the productivity and competitiveness of this industry is critical for both producers and consumers. However, this area is also under many environmental challenges and those operating within the agricultural industry in the region need to be educated on best practices to minimize

negative impacts on soil, air, and water quality, and human health. The International Certified Crop Adviser (CCA) Certification Program is a voluntary program offered by the American Society of Agronomy that provides a benchmark for practicing agronomy professionals in the United States, Canada, and India. Those that receive this certification are often considered to have the necessary education and expertise to appropriately advise clientele on agronomic practices. There are currently >300 active CCAs in the Mid-Atlantic region (DE, MD, VA, WV, and NJ) that must complete continuing education in four major competency areas: nutrient management, soil, and water management, integrated pest management, and crop management, as well as professional development. Additionally, many states within the region have certification requirements for nutrient (DE, MD, PA, VA, WV) and/or pesticide (DE, MD, NJ, PA, VA, WV) management, which also requires those certified to receive continuing education each year.

Response

The Mid-Atlantic Crop Management School was established in 1995 as a joint venture between the University of Delaware, University of Maryland, Virginia Tech, West Virginia University, and USDA's Natural Resources Conservation Service. The school addresses the continuing education needs of the CCA clientele group and also provides an opportunity for other regional agricultural clientele to receive continuing education for state required certification programs. The 2018 school was held from November 13-15 in Ocean City, Maryland. Of the 246 individuals attending in 2018, 93 were certified CCAs, 155 were nutrient management certified and 122 were pesticide certified in at least one of the states in the region - many maintain the same certifications in multiple states. Featuring speakers from across the country, five concurrent sessions were offered on the latest research and implementation strategies related to nutrient management (11 talks), crop management (9 talks), integrated pest management (7 talks), soil and water management (9talks), and a special hands-on session covering multiple topics (9 talks).

Results

The 2018 school drew 246 participants including crop consultants, extension educators, farmers and farm managers, agribusiness professionals, soil conservationists, and state department of agriculture and environmental personnel. A total of 134 participants completed a program evaluation. Participants indicated that the material presented in individual sessions was generally clear and well organized (1,620/1725) respondents; 94%). In addition, 89% of respondents (1,536/1,725) indicated that they gained knowledge in the CCA core competency areas by attending the sessions at Crop School. Of those completing the evaluation, 81% (1,397/1,725 respondents) indicated that they planned to use this information in the future (e.g., implement or advise clients to implement BMPs, etc.). Crop school participants that responded to the survey consult on 1,820,000 acres in the Mid-Atlantic region. Respondents estimated the economic value of the information they received at the crop school was up to $100/acre. The overall economic impact of the 2018 school (based on the 134 survey respondents) is estimated to be as much as $43 million.

Commercial Shellfish Aquaculture

Issue

Delaware is currently the only state on the Northeast Atlantic seaboard without commercial shellfish aquaculture. The legislation is developing policy and protocols for implementation, as the push for legalized aquaculture grows. Neighboring states have shown the economic and cultural benefits of the functioning industry. Three inland bays in southern Delaware, due to protection from open waters and ease of access for workers, offer promising future locations for bottom leases. Oysters are functionally extinct within the bays and with the

rapid development of the local watershed, the ecological services oysters contribute are more important than ever. Oyster aquaculture can help restore depleted wild populations of oysters while filtering the water, providing structural habitat, and creating new jobs. There is a unique opportunity to study directly how aquaculture facilitates restoration, but baseline statistics are essential. The research aims to further understand the current oyster population by I) developing baseline population locations and standardized survey methods to be used as management to measure changes over time and 2) investigating population dynamics by analyzing the genetics of spatfall within the Delaware Inland Bays. This project aims to establish baseline measurements to quantify population abundance change over.

Response

This multi-institutional effort to grow and enhance oyster growth using aquaculture gears in the bays has provided baseline data to the policy makers and resource managers to pass legislation to promote commercial oyster aquaculture practices in the Delaware Inland Bays (DIB). Our 14 years of oyster restoration effort by using oyster aquaculture gear, provides baseline information on the ecological value of oyster aquaculture in Delaware's Inland Bays. We have been using seed oysters that belong to a disease-resistant line that was developed at Rutgers Haskin Shellfish Research Laboratory (NEH). We found newly settled juvenile oysters within floating oyster gear in man-made, residential canal systems, and on riprap shorelines around the DIB. The effects of aquaculture and continued enhancement efforts in this lagoon system, both on the oyster population and on associated fauna become clearer with continued monitoring and improved water quality in the bays. Many species of economic and ecological importance are considered habitat-limited in the Inland Bays, particularly regarding juvenile refuge and forage areas. Oyster aquaculture gear provides habitat for these native estuarine fauna on small scales while supplementing oyster spawning stocks and enhancing natural recruitment, without difficult and costly types of habitat modifications. The DIB's wild oyster populations are poorly understood due to their rare occurrence in the system. Its unique genome has been compared to spat collected in the field in order to determine if there is any contribution to the local populations. Microsatellites, a repeat base pair sequence in a non-coding region of the genome, can be a powerful tool for analyzing population genetic diversity. Short, highly polymorphic regions provide the best candidates to detect change over relatively short evolutionary time. A knowledge gap of the native oyster population abundance and distribution exists. Intertidal surveys of the rip-rap were used to develop possible source-sink dynamics previously. This has allowed us to identify current locations and densities of oysters throughout the DIBs.

Climate change impacts on toxic metal cycling

Issues

Seas are rising around the world due to climate change and subsidence. In Delaware, a 1-meter rise is projected by 2100. There are numerous industrial legacy sites along the Delaware coast that are contaminated with toxic metals such as arsenic and chromium. They lie in areas where increased flooding is occurring. We do not understand how saline water impacts the mobility and cycling of the metals under flooding and retrenchment scenarios.

Response

Laboratory studies, using microcosms, were conducted to examine how seawater versus non-saline water affected the mobility and form of arsenic in contaminated soils and iron-bearing minerals. Solution and solid phase samples were analyzed to determine the form or species of arsenic.

Results
It was found that less arsenic was released from samples treated with sea water than river water. Preliminary studies suggest this is due to the high level of sulfate in the sea water sorbing on to the iron oxides, blocking arsenic release as well as salinity impacts on microbial activity. Further studies are ongoing.

Improving energy efficiency of poultry production system and environmental footprint with litter treatment
Issue
Maintaining a good comfort environment for animals in poultry operations requires energy for heating and ventilating the housing system to provide a good thermal environment and good air quality. The energy consumption and environmental footprint of the poultry operations have been increasing for growing populations. The public, poultry industries, and government agencies are aware of the sustainability of the poultry operation system. Best management practices are needed to improve the energy efficiency and mitigate the environmental footprint of the poultry productions.

Response
Acid-based litter amendments have been used to improve air quality and animal health in poultry operations. The efficacy of the litter amendments on energy saving and environmental quality improvement were evaluated through a multi-flock study at the University of Delaware.
Results
The results showed that the energy consumption of poultry grow out houses could be reduced by 50% while the ammonia emission is reduced by 10% with improved production performances. Litter amendment is a viable practice that offers lower energy consumption, lower environmental footprint, and more affordable food.

Ecoinformatics
Issue
We are living in a time where Environmental Science data is widely available but new techniques are required for data analysis, provide value-added products (e.g., maps, frameworks) and produce knowledge. These analyses are providing insights to address grand ecological challenges where CANR is taking a leading role.

Response
The Vargas research group has lead initiatives to analyze global environmental datasets and produce value-added products. This research group has consistently published in top tier research journals, participated in national and international scientific committees, and participated in syntheses efforts to support policy decisions (i.e., SOCCR report; see below).
Result
The Vargas research group published 18 peer-reviewed manuscripts in top journals including Nature and PNAS and participated in a $10M grant to develop modeling frameworks for plant dynamics. Some examples of highlights include: a) development of frameworks to improve environmental network designs; b) global analyses of soil CO2 emissions (published in Nature); c) development of a framework for ecological forecasting (published in PNAS); and d) digital soil maps of soil organic carbon, nitrogen and soil moisture for the conterminous United States. Finally, Vargas participated in as a chapter of the Second State of the Carbon Cycle Report (SOCCR2) a special interagency "highly influential scientific assessment," that was led and developed by the Carbon Cycle

Interagency Working Group (CCIWG) under the auspices of the U.S. Global Change Research Program (USGCRP)

Coastal and Estuarine Water Quality & Land Use Stressors

ISSUE

Over half of the United States population resides along the coastal and estuarine areas, threatening local ecosystems due to changing land use and causing changes in soil and groundwater chemistry, watershed-level hydrology, and dissolved nutrients in waterways, particularly in the form of nitrogen, and phosphorous species. As a whole, the United States has increased its use of commercial fertilizers from about 6.8 million metric tons in 1960 to roughly 20.0 million metric tons in 2011 in order to accommodate rapid population growth and need for increased food quantities, nearly a 3-fold increase. The coastal state of Delaware has grown slightly faster than the United States as a whole. Delaware grew 4.2% between 2010 and 2014 while the country grew about 3.3%.

Water resources throughout the Mid-Atlantic coastline of the United States are facing constant and increasing threats from growing human population. Therefore, water resource management needs to be a priority as land use is modified to accommodate this population increase. We have been monitoring water quality, ecosystem health (i.e. diatoms, microbial community in marsh plant roots, sediment), marsh habitat in relation to land use changes (i.e. forested versus agricultural, residential versus marsh grasses) in Blackbird Creek, Delaware.

RESPONSE

This is one of the long term program that has allowed us to monitor water quality, aquatic and ecosystem health in Blackbird Creek in relation to changing land use. All our studies were conducted in the Blackbird Creek, a tidal waterway located along the central Delaware that drains a watershed of about 80.29 km2 into the Delaware Bay. Roughly half of its 44 km in length is affected by tidal fluctuations while the upper portion of the waterway is comprised of freshwater only. Several sites were selected in the tidal portion of the creek, representative of the lower 8 km of the waterway nearest to the Delaware Bay.

After initial screening on the ground and using the Remote Sense technology, we selected study sites in relation to each research focus; agriculturally impacted versus not agriculturally impacted, Phragmites dominant versus Spartina dominant, mixed, forest versus residential, various salinity gradient. . Study sites were monitored by using GPS and data were analyzed using the Arc GIS. Ground survey using the camera attached to the balloon and flyover images of Blackbird Creek were monitored over the years to identify the study sites for other studies and monitor land use changes. On-site water quality parameters have been monitored for temperature, dissolved oxygen, pH, salinity, conductivity and total dissolved solids. Concentrations of dissolved nitrate (NO3), nitrite (NO2), ammonia (NH3), orthophosphate (PO4), alkalinity (Alk), and turbidity (Tbd) were measured at each station over the course of the field seasons. Chlorophyll-a was measured while diatom species were collected from the sediments. Microbial biome of Phragmites and Spartina roots and diatom species composition were analyzed using the molecular methods. Blue crab population dynamics and fish diversity were measured in relation to various habitat along the Blackbird Creek tributaries.

RESULTS

Most of our research outcomes have been published in the peer-reviewed journals. Based on our studies, we identified different diatom species that are monitored primarily undisturbed (forested) versus disturbed habitats (residential). Water quality conditions are more tidally affected and not so much site specific. When considered separately, nutrient concentrations on outgoing tides were elevated relative to nutrient concentrations on incoming tides. Overall, the highest concentrations for all parameters occurred at low tide

before the shift to the next incoming tide. This suggests that there are greater nutrient concentrations upstream than downstream. No major differences were monitored for water quality parameters between the sites selected as agriculturally impacted versus not agriculturally impacted. The lack of notable differences between habitats suggests that, while the watershed is generally impacted by agricultural land use practices, there appears to be no impact on the surface water chemistry. Because there were no differences between habitats, it was concluded that seasonal differences were likely due to basic seasonal variation and were not a function of agricultural land use practices. Juvenile blue crabs were more abundant in and around the Spartina sites although no major differences were monitored among the larger blue crab number and abundance however, sites near the mouth of Delaware Bay had higher abundance of the blue crabs. Fish diversity also varied based on the location in relation to salinity gradient and its proximity to the mouth of the bay and water dept. Geological Information System (GIS) and Remote Sensing (RS) confirmed the invasion of Phragmites over 10 year study timeline suggesting further efforts to control its invasion.

Novel Starchy and Lignocellulosic Feedstocks with ‚ÄúSelf-Processing‚Äù Ability for Efficient and Cost-effective Production of Fuels and Chemicals

ISSUE

The Energy Independence and Security Act of 2007 (EISA) requires an aggressive scale-up of cellulosic biofuels as part of the Renewable Fuel Standard (RFS) program, with a production target of 39.7 billion gallons per year by 2020. Currently, such production is less than 10% of the 2016 goal set by EISA. This production gap is primarily due to the cost of conversion technologies currently being commercialized, such as cell wall degrading enzymes and biomass pre-treatment both required by existing technologies and feedstocks. Additionally, innovative science and improved crop varieties are needed to achieve sustainable biomass production on marginal sites with poor soil or other undesirable characteristics, and to minimize competition with food crops for land. A necessary and transformational component to achieving this goal is the development of novel feed-stocks that are enhanced to resist biotic and abiotic stresses, higher overall biomass yield, and improved digestibility and conversion to fuels and high value co-products.

RESPONSE

One of the goals of our biotechnology research program is to take advantage of recent advances in genome sequencing and analysis, proteomics, bioinformatics, conventional breeding, nanotechnology, recombinant DNA, and genetic engineering technologies to enhance and accelerate the development of novel starchy feed-stocks and low-input perennial grasses with improved biomass yield and bio-processing characteristics. We have fully characterized novel transgenic cassava lines with higher expression of three hyperthermophilic starch hydrolyzing genes and a gene coding for starch yield using a state of the art gene stacking technology. Cassava produce high starch yield, is drought hardiness and favorable production make cassava an attractive feedstock for biofuel production. Likewise, we have developed and fully characterized various transgenic tobacco plants expressing a bacterial lignolytic enzyme (DypB) to understand to what extent we can degrade lignin in planta in order to enhance saccharification efficiency of lignocellulocic biomass. Targeting expression of this gene to cell compartment enabled us to enhance protein expression level and activity. We also employ a state of the art multiple gene expression system to express a suite of hyperthermophilic cellulose and lignin-degrading enzymes in Brachypodium, a model grass as a strategy to improve biomass digestibility. We have fully molecularly and biochemically characterized eight of these bio engineered Brachypodium. Data generated will pave the way to engineered these multiple biomass degrading gene constructs in high yielding dedicated biomass such as Miscanthus

x Giganteus.

RESULTS

Transgenic multigene-expressing cassava lines produced up to 60% more storage root yield than the non-transgenic control, and transgenic tubers released three-fold more reducing sugar than the non-transgenic control when incubated at 85OC without exogenous enzyme application, suggesting that the archaeal enzymes produced in planta maintain their activity and thermostability. To our knowledge, this is the first report of in planta production and activation of multiple archaeal enzymes that led to increased starch hydrolysis directly in the biomass. This approach has a great potential to improve cassava and other starch-rich feedstock for the production of bioethanol and industrial products. This technology can now be transferred to other starch biofuel feedstocks such sweet potato. This data is published in Frontiers in Plant Sciences.

Targeted accumulation of the bacterial lignin peroxidase and in vivo activation significantly reduces biomass recalcitrance and increases fermentable sugars production over 200% as compared to the non-transgenic control. To our knowledge, these findings reveal for the first time that production and in situ activation of a ligninase effectively decreases biomass recalcitrance. This data is now published in Scientific Reports. This technology is ready to be transferred to economically important lignocellulosic feedstocks, with the overall aim of developing ‚Äúdesigner biomass‚Äù with self-processing ability which will lead to reduced lignin recalcitrance.

Developing a novel approach to estimating populations of endangered sturgeons

ISSUE

Sturgeons are widely the most critically endangered group of species in the world. In the US, there are nine species of sturgeon of which all are considered threatened and or endangered over all or part of their range. The causes of sturgeon decline are many but often habitat loss and degradation through urbanization and agriculture as well as overharvest and bycatch in commercial fisheries. Once a species is listed under the Endangered Species Act the federal management agencies must work to conserve and recover populations. In the case of species impacted by bycatch this can lead to the closure of commercial fisheries and threatening food security in the US. Central to successful management of these species is evaluating the status and trends of their populations. Unfortunately, many traditional approaches to estimating fish abundance are intractable sturgeon due to their migratory nature and depressed numbers. Some of the largest remaining populations of Atlantic Sturgeon (Acipenser oxyrhinchus oxyrhinchus) are thought to occur in larger river systems (e.g. Hudson), which are inherently difficult to census

RESPONSE

In conjunction with federal and state biologists my lab has developed novel approaches to track population recovery in this cryptic species. Our efforts have demonstrated that high-resolution side-scan sonar imaging and acoustic receiver networks can be integrated to infer abundance in areas that were previously unidentifiable. In doing so we have provided the first direct estimates of the annual spawning run size since the closure of the fishery over two decades ago. Our current efforts are focused on generating annual run size estimates of Atlantic Sturgeon in both the Delaware and Hudson Rivers which historically supported the largest populations. In the Delaware River, very little is known about the current population status although it is believed to be less than 1% of the virgin stock.

RESULTS

Our abundance estimates will be used to help set and track recovery objectives, a top priority need identified in the recently approved Atlantic States Marine Fisheries

Commission Benchmark Stock Assessment.

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)	
765	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.