2018 Rutgers Combined Research and Extension Annual Report of Accomplishments and Results

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I. Report Overview

1. Executive Summary

The New Jersey Annual Report of Accomplishments and Results is an integrated report reflecting Cooperative Research and Cooperative Extension programs. The report addresses the requirements regarding the use of Hatch Funds and Smith-Lever 3(b) and (c) funds. The report reflects the work of the New Jersey Agricultural Experiment Station (NJAES). The experiment station provides a diverse range of research, extension, and education programs that serve the people of New Jersey and the urban, suburban, and rural communities in which they live. Research at the NJAES and the Rutgers School of Environmental and Biological Sciences spans the biological spectrum, from molecules to ecosystems. Researchers strive to gain a deeper understanding of our physical world, identify the ways in which humans affect our plane, and develop multi-dimensional solutions to address real-world problems. NJAES has a vigorous program of applied research and outreach through its labs, farms, business incubators, and marine stations across the state. Research developments and technologies benefit the public through educational and training programs, technology transfer, policy recommendations, and innovative spin-off companies. Rutgers Cooperative Extension (RCE) helps the diverse population of New Jersey adapt to a rapidly changing society and improve their lives and communities through an educational process that uses science-based knowledge. Through science-based educational programs, RCE truly enhances the quality of life for residents of New Jersey and brings the wealth of knowledge of the state university to local communities. Stakeholders continue to be active partners in identifying critical issues to be addressed. The NJAES highly values the contributions that stakeholders make to ensure that all research and extension projects and programs remain relevant and responsive to the needs of New Jersey residents. Cooperative Extension continues to increase our emphasis on our urban audience base and to deliver programs culturally appropriate to meet the diverse needs. The planned programmatic focus areas reported against include: Climate Change - Water Quality and Quantity; Childhood Obesity - Youth/Adult; 4-H Youth Development; Global Food Security and Hunger - Agricultural Viability; Climate Change - Home, Garden and Environment; Global Food Security and Hunger - Integrated Pest Management; Global Food Security and Hunger - Aquaculture; Food Safety; and Sustainable Energy. NJAES researchers and extension faculty and staff concentrate on these focus areas with relevant, innovative science-based educational programming and research solutions to address critical needs identified by New Jersey residents. NJAES has an organizational commitment to diversity which transcends the work of both Cooperative Research and Cooperative Extension. We strive to meet the needs of agricultural producers farming on the urban fringe, youth challenged by circumstances such as poverty and risks that impeded their success, families faced with workforce employment issues and a growing number of families who are food insecure. We continue to implement RCE educational programs to meet the needs of underserved and underrepresented audiences and reduce any real or perceived barriers to participation.
The NJAES programmatic efforts continue to span the scope of our planned programmatic areas. NJAES researchers are conducting research and providing outreach and education in water quality, quantity, conservation, pollution, prevention and management of runoff. The programs highlighted this year range from minimizing persistent organic pollutants decreasing human exposure, to tracking the short/long-term changes of a salt marsh system due to climate change. Other programs/projects focus on watershed restoration, community bio retention, rain gardens, rain barrels, and native plant naturalization.

Youth and adults in New Jersey, as well as nationally, continue to be at risk for diabetes, high blood pressure, heart disease, and other chronic illnesses. Research on phytochemicals with anti-obesity properties, as well as endocrine disrupting chemicals is highlighted in this report. Extension faculty and staff are offering programs which serve the needs of food insecure children and educating youth, adults, and seniors on food insecurity and the potential impact it has on individuals.
Youth development programs continue to space the scope of 4-H, from life skills to urban gardening and environmental issues, with attention provided to youth from urban communities with lower graduation rates, higher rates of poverty and unemployment, all of which contribute to educational deficiencies. Through 4-H and other youth development programs, participants are provided with leadership and life skill development opportunities, with a key focus on STEM programmatic efforts. Some of the efforts highlighted range from STEM education using LEGOS, research experiences for STEM Ambassadors, experiential programming introducing or deepening rural and urban youths' understanding of the connection between science and their food, animals, and health.
NJAES researchers continue to build upon their research on new and specialty crops, plant products, and the development of ethnic greens and herbs; as well extending and maximizing the post-harvest quality of high value and perishable crops. Due to an increasing number of breweries in New Jersey, NJAES/RCE faculty and staff are working with growers to provide information about pests, fertility management, hopyard establishment and the Rutgers hop quality analysis service. NJAES researchers continue to research cost-effective insect pest management practices and successful IPM programs.
Research continues to focus on insect biology and behavior on key fruit pests, including invasive species and the reduction of insecticide use. In addition, efforts have been aimed at early detection of brown marmorated stink bugs.
NJAES researchers continue to study risk assessment efforts in terms of food safety. Efforts this year have been on listeria in cheese, cold plasma inactivation, and modeling bacteria competition. Technical advice was provided to the industry ranging from the evaluation of microbial contamination and removal from touch screen devices to canned fruit sampling plans.
Base funding from the State of New Jersey and from USDA - NIFA formula funds provides NJAES with a foundation for program development, implementation, and delivery, while competitive grants, contracts, and gifts increase the scope and impact of research and extension programs. "Other" funding includes restricted and unrestricted gifts, income from sales and service activities, and patent and plant licensing income. County appropriations included salaries paid by counties to Rutgers Cooperative Extension (RCE) faculty and staff, research and extension programs. Grant income is the primary source of support for our nutritional assistance programs, national pesticide testing and pest management services and continuing professional educational programs for New Jersey's farmers, businesses, and residents. Grant income in climate change, water quality, and other environmental research as well as basic research into metabolic and other influences on human and animal health and wellbeing.

Total Actual Amount of professional FTEs/SYs for this State

Year: 2018	Extension		Research	
	1862	1890	1862	1890
Plan	130.0	0.0	60.0	0.0
Actual	111.0	0.0	51.1	0.0

II. Merit Review Process

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

- Combined External and Internal University External Non-University Panel
- Expert Peer Review

2. Brief Explanation

The NJAES Research Council, comprised of faculty representatives from several internal departments of the Rutgers School of Environmental and Biological Sciences, assist in selecting reviewers (both internal and external) for formal peer review of research proposals. Appropriate stakeholders play a role in the merit review process as they assess extension programs for relevance in addressing local needs. External peer-review was performed for faculty under consideration for promotion and/or tenure evaluation. Review of scientific merit is also reviewed externally by granting agencies panels, journal editorial boards, and external university panels.

III. Stakeholder Input

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

- Use of media to announce public meetings and listening sessions
- Targeted invitation to traditional stakeholder groups
- Targeted invitation to non-traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals
- Targeted invitation to non-traditional stakeholder individuals
- Targeted invitation to selected individuals from general public
- Survey of traditional stakeholder groups
- Survey of traditional stakeholder individuals
- Other (focus group sessions)

Brief explanation.

Four/five times a year, the NJAES leadership meet with the external advisory NJAES Board of Managers. Discussions and listening sessions focus on staffing, program development, and budgetary decisions. The Board of Managers is comprised of one representative from each county board of agriculture in NJ as well as state-wide members representing Biotechnology, Community Resources, Environment, Food Science, Marine Science, and Public Policy. Also, the NJAES leadership participate in the State Agricultural Convention and the NJ Farm Bureau Convention.

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

1. Method to identify individuals and groups

- Use Advisory Committees
- Use Internal Focus Groups
- Use External Focus Groups
- Open Listening Sessions
- Needs Assessments
- Use Surveys

Brief explanation.

At the county and state levels faculty and staff engage partners and potential clientele in a variety of processes to collect input. Individuals who participate in these processes are those who serve on advisory boards, special research and extension committees, leaders of commodity groups, partners who participate on government and service related boards, and individuals who participate in programs. Opportunities to participate in the process of gathering input are widely publicized through newsletters, websites, mass and social media and word of mouth. Engagement of input from groups and individuals who are underrepresented is proactively done to ensure that extension programs and research initiatives are relevant, responsive and address the diverse needs of our many publics.

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

1. Methods for collecting Stakeholder Input

- Meeting with traditional Stakeholder groups
- Survey of traditional Stakeholder groups
- Meeting with traditional Stakeholder individuals
- Survey of traditional Stakeholder individuals
- Meeting with the general public (open meeting advertised to all)
- Meeting specifically with non-traditional groups
- Survey specifically with non-traditional groups
- Meeting specifically with non-traditional individuals
- Survey specifically with non-traditional individuals
- Meeting with invited selected individuals from the general public
- Survey of selected individuals from the general public

Brief explanation.

NJAES personnel participate in open forums in which current issues and concerns that impact the county are identified. Stakeholders are active participants in strategic planning processes conducted to identify priority needs that guide research and extension programming. Local assessment of program needs are routinely performed by county agents and educators. Diverse audiences are also targeted to gather appropriate needs data. Extension Specialists engage stakeholders, collaborators, commodity groups, public, private and government officials to identify research needs both applied and basic. Participation by field agents with county boards of agriculture and other local interest groups result in the identification of priority needs on the local and state levels that could benefit from Cooperative Extension programs and/or Cooperative Research solutions. Our partners in the educational process are key to helping faculty and staff identify effective methods for providing the research-based information which is the core of the land grant mission of transformation education that impacts individuals, communities, the environment and the quality of life for all.

3. A statement of how the input will be considered

- In the Budget Process
- To Identify Emerging Issues
- Redirect Extension Programs
- Redirect Research Programs

- In the Staff Hiring Process
- In the Action Plans
- To Set Priorities

Brief explanation.

NJAES welcomes and values the input of our stakeholders. We continually strive to create welcoming environments where stakeholders feel comfortable and trust what is shared will be carefully considered as policies are set, programs are developed, research direction is set and budget priorities are identified. Stakeholders are essential and critical partners, and their input is necessary to ensure that the work we engage in is relevant and responsive. The NJAES Board of Managers are stakeholders who are actively engaged in the process of providing input on an ongoing basis throughout the year. They attend regular meetings with Extension and Research Directors to share their knowledge and experience with their local county or special interest areas the represent. They are true representatives of the diversity of research and extension that NJAES extends to the residents of NJ and beyond. Not only do they provide invaluable feedback on issues, but they also function in supportive roles as advocates for our research initiatives and extension educational outreach. Other important sources include: NJ State Board of Agriculture, NJ Farm Bureau, County Boards of Agriculture, county and state health departments, state Department of Environmental Protection, and other relevant public and private agencies and organizations.

Brief Explanation of what you learned from your Stakeholders

Stakeholders provide valuable information that contributes to the prioritization process for staffing decisions and program development.

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	2225066	0	3021847	0
Actual Matching	12858747	0	16693938	0
Actual All Other	1527798	0	8709852	0
Total Actual Expended	16611611	0	28425637	0

3. Amount of Above Actual Formula Dollars Expended which comes from Carryover funds from previous				
Carryover	1202000	0	0	0

V. Planned Program Table of Content

V(A). Planned Program (Summary)

Program # 1

1. Name of the Planned Program

Climate Change - Water Quality & Quantity

☑ 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%	
111	Conservation and Efficient Use of Water	20%		20%	
112	Watershed Protection and Management	40%		40%	
133	Pollution Prevention and Mitigation	20%		20%	
605	Natural Resource and Environmental Economics	10%		10%	
	Total	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	15.0	0.0	6.0	0.0
Actual Paid	1.0	0.0	2.8	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
128389	0	146051	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
672661	0	872037	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
35594	0	288475	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

• Work with municipalities to help them meet their regulatory responsibilities on stormwater management and watershed restoration
• Perform experiments to investigate what the current nutrient loads are in NJ water
• Determine the best methodologies for developing Total Maximum Daily Load (TMDL) values for NJ waterways
• Examine the effectiveness of alternative onsite wastewater treatment systems
• Provide scientifically sound advice to state regulatory bodies on water quality issues
• Math modeling of contamination transport in surface and groundwaters
• Create a program comprising of faculty, staff, volunteers, industry partners and government officials

2. Brief description of the target audience

• Municipalities
• State Department of Environmental Protection
• Staff and students who gain valuable scientific experience
• Industry partners who learn ways to meet water quality standards
• Communities who learn watershed restoration methods
• NJAES Faculty and Staff involved in water research/outreach
• School age youth
• Residents

3. How was eXtension used?

Faculty answered the "Ask the Expert" questions.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	5726	869214	275	58

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	2	14	16

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- A variety of strategies will be implemented to reach target audiences. This will include and not be limited to workshops, field visits, classes, newsletters, media releases, electronic communications,and publications.In addition a trained volunteer teaching base will be developed. Quantitative reports of participation will be collected.

Year	Actual
2018	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Short term - Knowledge of nutrient loads in various NJ waterways. Find the best methodologies for determining TDMLs
2	Medium term - To identify representative pollutants and aquifer systems in New Jersey. To develop equilibrium isotherms to quantify the adsorption/desorption kinetics for the pollutant/soil/water systems. To develop breakthrough and leaching data for the pollutant/soil/water systems.
3	Long Term - A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.
4	Medium Term - Stormwater Education Program for Sustainable Residential Landscapes in New Jersey. To identify representative pollutants and aquifer systems in New Jersey. To develop equilibrium isotherms to quantify the adsorption/desorption kinetics for the pollutant/soil/water systems. To develop breakthrough and leaching data for the pollutant/soil/water systems.
5	Long Term - Engaging Communities on the Importance of Storm-water Management. A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.
6	Long Term - Watershed Restoration for Healthy Ecosystems. A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.
7	Long Term - Watershed Restoration in Central New Jersey. A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.

Outcome #1

1. Outcome Measures

Short term - Knowledge of nutrient loads in various NJ waterways. Find the best methodologies for determining TDMLs

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Medium term - To identify representative pollutants and aquifer systems in New Jersey. To develop equilibrium isotherms to quantify the adsorption/desorption kinetics for the pollutant/soil/water systems. To develop breakthrough and leaching data for the pollutant/soil/water systems.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Using Smart Sewers to Provide Safe Water to New Jersey - In New Jersey, untreated sewage frequently contains on average 64 ng/L of polychlorinated biphenyls (PCBs), which is a thousand times higher than the federal surface water quality standard of 64 pg/L. Wastewater also contains unacceptably high concentrations of dioxins, chlorinated pesticides (such as DDT), brominated flame retardants, and other persistent organic pollutants (POPs). Wastewater and drinking water treatment plants are not designed to remove these POPs. Once they are taken up by organisms, POPs biomagnify, or increase in concentration at higher trophic levels, leading eventually to human exposure when people drink contaminated water or eat contaminated food.

What has been done
NJAES researchers have discovered that sewers already do a fairly good job of destroying many POPs before they reach the wastewater treatment plant, due to microbial action in the anaerobic portions of the sewer. Biological processes occurring in sewers already provide the unintended benefit of waste treatment in the form of reduction of biological oxygen demand (BOD), removal of nitrogen, and total suspended solids (TSS). Researchers discovered that PCBs and

polychlorinated dibenzo-p-dioxins and -dibenzofurans (PCDD/Fs) are also detoxified in sewers. NJAES researchers studied the conditions within the sewer that lead to the detoxification of POPs, so that sewer design and management can be optimized, allowing the sewer to serve as an anaerobic pretreatment zone that destroys POPs. The specific problem addressed was the presence of toxic, persistent organic chemicals in wastewater. NJAES researchers continued their work on three objectives: Determining which environmental contaminants can be detoxified by microbial processes in sewers; determining what factors within the sewer enhance detoxification; developing a set of guidelines as to how to optimize the design, management, and maintenance of sewers to encourage detoxification of dangerous pollutants.

Results
NJAES researchers demonstrated that PCBs and dioxins are dechlorinated by bacteria in sewers and further determined that PCDD/Fs undergo both peri and lateral dechlorination. The lateral dechlorination appears to be preferred and results in complete detoxification of the PCDD/F molecule. They examined the fate of brominated diphenyl ethers in sewers but found no evidence of degradation. They examined the fate of pharmaceuticals, especially antibiotics, but again found no evidence of degradation. They also determined that combined sewers house conditions that enhance the dechlorination of PCBs and PCDD/Fs. They were able to examine the correlations between PCB dechlorination products and factors such as flow rate, total suspended solids, and nutrients. The factors representing other PCB sources were positively correlated with total influent flow, but the dechlorination signal was not, suggesting that the dechlorination signal arises from different locations and/or processes. They found some evidence that the age of the sewer system is important. Older separate sewer systems are more effective than newer ones at promoting dechlorination, presumably because they have built up deeper beds of sewer sediment, and perhaps also because they have worse hydraulics. They also noted that salinity seems to inhibit dechlorination in groundwater, which may affect sewers as well.

4. Associated Knowledge Areas

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

Outcome #3

1. Outcome Measures

Long Term - A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Climate Change Effects on Sustainability of the Tuckerton Peninsula Salt Marsh System: Application of Water-Quality and Meteorological Databases in Ecosystem Assessment - There is a need for comprehensive databases for researchers, coastal managers, and decision-makers to track the short-term variability and long-term changes in the structure and function of the salt marsh system due to climate change.

What has been done
NJAES researchers are leveraging results of ongoing studies of climate change impacts on the Tuckerton Peninsula salt marsh. This research project is measuring water-quality and meteorological conditions affecting the Tuckerton Peninsula salt marsh system, with the resulting comprehensive databases to be made available to researchers assessing climate change impacts on sustainability of the marsh platform. Investigators collected extensive water-quality and meteorological databases. The water-quality parameters included temperature, salinity, DO concentration, DO percent saturation, pH, turbidity, and water depth. They were measured continuously (every 15 minutes year-round) at four long-term sampling stations along the Mullica River-Great Bay estuarine salinity gradient adjacent to the Tuckerton Peninsula salt marsh platform using an integrated system of moored, automated YSI 6-series dataloggers that were deployed and retrieved on regular intervals. Nutrients were measured monthly at these four stations by collecting discrete water samples and analyzing them for nitrogen and phosphorus concentrations along the estuarine salinity gradient. Nutrient samples were also collected every two hours over a 24-hour period each month by an ISCO sampler deployed at Buoy 126. Nitrogen and phosphorus concentrations in these water samples were subsequently determined in Rutgers University chemistry laboratories. In regard to meteorological data acquisition, a Campbell weather station located at the Stockton University Marine Field Station on Nacote Creek was used to obtain a continuous data stream of wind velocity and direction, solar radiation (PAR), barometric pressure, and humidity. Precipitation was also measured at the weather station. This data, collected year-round, are valuable for research and coastal-zone management programs in New Jersey and other coastal states in the Mid-Atlantic region. The Centralized Data Management Office (CDMO) at the University of South Carolina serves as the primary repository of the water-quality and meteorological databases collected in this project. The CDMO is also the secondary source for distribution of the data to the public. The data are likewise stored at the Rutgers University Marine Field Station (RUMFS) in Tuckerton, New Jersey, where it can be disseminated to data users in academic institutions, government agencies, businesses,

industries, and coastal communities. Metadata reports are available on the data collected.

Results

Temporal and spatial trends of water-quality and meteorological data are being examined further to assess the drivers of change in the Mullica River-Great Bay Estuary and Tuckerton Peninsula salt marsh system. This data will enable investigators to determine the status and trends of these important ecosystems. An objective being achieved is to generate habitat trends and baseline data useful for characterizing marsh spatio-temporal structural and composition changes for effective coastal zone management. The databases collected are of value to academic and government researchers who can utilize the data to assess the structure and function of biotic communities and the condition of marsh habitats in the Mullica River Basin and Barnegat Bay Watershed for future restoration efforts. Many academic institutions throughout New Jersey will find useful project data for its research. Government agencies, national estuary programs, as well as K-12 schools can access the meteorological and water-quality databases derived from this project for application in research, education, outreach, and community programs. Municipal, county, state, and national coastal management programs are major potential users of the data being collected in this project. As such, the residents and coastal tourists of the state will benefit. The National Oceanic and Atmospheric Administration (NOAA) and Jacques Cousteau National Estuarine Research Reserve (JCNERR) will gain from the data acquisition in this project because the Tuckerton Peninsula salt marsh system is the sentinel site of the JCNERR. It is used as a research platform for assessing the susceptibility of coastal marsh habitat in the region to coastal storms and other climate change effects.

4. Associated Knowledge Areas

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

Outcome #4

1. Outcome Measures

Medium Term - Stormwater Education Program for Sustainable Residential Landscapes in New Jersey. To identify representative pollutants and aquifer systems in New Jersey. To develop equilibrium isotherms to quantify the adsorption/desorption kinetics for the pollutant/soil/water systems. To develop breakthrough and leaching data for the pollutant/soil/water systems.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
New Jersey is the most densely populated state in the country. Addressing environmental challenges in the state requires informing and motivating leaders, organizations, and residents in the state. Many lakes and streams in the state have been designated as impacted by state regulators. In most cases, the pollution is considered non-point source pollution that comes from home lawns, farms, parking lots, and a variety of other sources. Addressing these concerns necessitates the education of clientele groups not traditionally possessing a high degree of expertise in land management such as homeowners, as well as professionals such as municipal employees and landscapers. Educating paraprofessionals, such as Rutgers Environmental Stewards and Rutgers Master Gardeners, who then educate others multiplies the educational effect is beneficial.

What has been done
Education programs were conducted that included examples of storm-water management practices such as rain gardens and rain barrels conserve potable water and reduce water pollution while engaging the audience with tangible and accessible projects that can be implemented at homes, businesses, and public areas. Conserving potable water and preventing water pollution are essential to preserving water resources for drinking water, business use, recreation, wildlife, and agriculture. Educational workshops were offered addressing storm-water management, water conservation, water pollution prevention, and volunteer stream monitoring. These included events in which participants built rain barrels to install at home and work sessions where participants installed a rain garden in a public area.

Results
This programming successfully resulted in educating participants about the environmental benefits of water conservation and water pollution prevention. The 26 rain barrels built at these workshops are expected to save 36,000 gallons of potable water per year when installed and used at participants' homes. The six rain gardens installed by program participants mitigate the runoff from 9,000 square feet of impervious surfaces, will treat and clean 200,000 gallons of storm-water runoff per year, and prevent 28 lbs. of sediment, 0.3 lbs. of phosphorus, and 3.3 pounds of nitrogen from entering local waterways per year. These workshops also trained volunteers, including Boy Scouts, to maintain rain gardens in public spaces. Survey respondents of one workshop (n =24), increased their knowledge about their watershed, storm-water management, impervious cover, and nonpoint-source water pollution in urban environments. (Overall knowledge 2.49 out of 5.00 before, and 4.72 out of 5.00 after.) They indicated an intention to redirect downspouts to a pervious area such as the lawn or garden (74%), use native plants for landscaping (81%), use soil testing to guide lawn fertilization (76%), install a rain garden (75%) and install a rain barrel or cistern (72%). Youth evaluations of one stream monitoring program (n=27) indicated that 82% learned a lot about water pollution, 93% learned

how to protect water, and 70% learned about rain gardens, 93% wanted to learn more about this topic, and 84% would share what they learned with others.

4. Associated Knowledge Areas

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

Outcome #5

1. Outcome Measures

Long Term - Engaging Communities on the Importance of Storm-water Management. A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Due to the dense population and intense development within New Jersey, stakeholders face many problems with water quantity and quality issues as well as groundwater recharge.

What has been done
This program provides outreach education on small-scale storm-water control techniques (green infrastructure). A Rutgers Cooperative Extension Agriculture and Natural Resource Agent educates community members, citizens, schools, churches, municipal centers, and developers, on watershed management and conservation in order to implement best management practices for sustainable communities.

Results
Highlighting water reuse through rainwater harvesting, 3 rain water reuse workshops were conducted, training 72 participants while constructing 34 rain barrels. In addition, trainings on community bio retention projects, including rain gardens and native plant naturalization projects were conducted. Of the participants 46% installed rain barrel; 85% satisfied with performance of rain barrel; 46% took some other action to reduce storm-water runoff (i.e. redirected or disconnected downspouts, installed a second rain barrel); 23% took some other action to save water (installed low flow toilet or shower head). 'Has installing your rain barrel made you more interested in other environmental actions?' Native plants 64%; Composting 55%; Reduce energy use 55%; Recycle more 46%; Driving less 27%.

4. Associated Knowledge Areas

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

Outcome #6

1. Outcome Measures

Long Term - Watershed Restoration for Healthy Ecosystems. A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Eutrophication (high nutrient/organic loads) in lakes and ponds, along with conditions of warm, calm water, with elevated nutrients, can cause photosynthetic green and blue-green algae

(cyanobacteria) to increase dramatically. These 'blooms' may be visible as floating scum that resembles blue, green or even red paint on the surface of the water. Blooms can spoil water quality producing pungent odors or a thick scum, affecting recreational use, reducing oxygen levels, as well as impacting other plants and animals in the water. At night, respiration from blooms uses oxygen that can alter the balance of the ecosystem to the point of causing fish kills. Decomposition of the bloom also consumes oxygen in the pond. In addition, some species produce toxins that can cause illness in humans, pets or livestock.

What has been done
This program focuses on the basics of stream, lake and pond maintenance and repair with the emphasis on conditions encountered in the urban environment responding to upstream changes in hydrology, sediment, and pollutant transport. Efforts in this program stress watershed restoration methodology, better management of storm-water and construction management. NJAES Agents and researchers are working on a joint project with the New Jersey Department of Environmental Protection along with the Burlington County and Camden County Parks Departments on lake water quality improvement studies. They are looking at source tracking of toxic cyanobacteria in Smithville Lake and Hopkins Pond and comparing the reliability of a relatively inexpensive and quick water toxicity test kit versus a full laboratory ELISA analysis to determine if the test kit is a useful tool for lake managers. Water quality parameters collected via field sampling is being used to determine 'bloom' characteristics of three species of toxic cyanobacteria: Microcystis, Aphanizomenon, and Anabaenopsis. The information will be used to determine if water use activities should be restricted due to the potential toxic effects from the cyanobacteria. Pond turtle 'sunning' platforms (habitat) plans were drawn up and presented to the Parks department for installation in two lakes.

Results
After installation of the aeration system, the pond water column is mixing well, with DO levels only 0.5ppm difference from surface to bottom; zooplankton have had an explosive population growth which will benefit the fishery. Hopkins Pond algal blooms have been greatly reduced.

4. Associated Knowledge Areas

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

Outcome #7

1. Outcome Measures

Long Term - Watershed Restoration in Central New Jersey. A safe and secure water supply for all communities and industries in the state. An effective and efficient nutrient-trading program that meets the needs of industry and meets the standards set by the state regulatory bodies.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Starting in 2012, Rutgers Cooperative Extension of Middlesex County (RCE) has worked with local partners to help implement a watershed restoration and protection plan in the Manalapan Brook Watershed in central New Jersey. The purpose is to implement best management practices (BMPs) needed to reduce rainwater runoff, sediment, and nutrients as identified in the watershed plan. Manalapan lake is the largest impoundment on Manalapan Brook. The lake is highly turbid and can have high density of aquatic plants which causes problems for lake recreation and ecology. The brook that flows into the lake suffers from sediment erosion and deposition. Modeling conducted by a project consultant showed a 64% reduction in total suspended sediment loading was needed (4,527 tons of sediment) in order to meet state surface water quality standards. The project focused on implementing the best management practices identified in the plan that will help reduce sediment loading, while also educating the residents and municipalities in the watershed about best practices for watershed health. The first phase has been spent developing educational videos for each structural BMP so other towns and residents can learn from the work. In addition, sometimes changes to public spaces can cause controversy among the community and these videos will be used to try to get ahead of any issues that arise.

What has been done
RCE Agriculture and Natural Resource Agents focused on: Continuing to develop BMP videos; naturalizing stormwater detention basins, stormwater detention basin maintenance, and shoreline restoration maintenance. B-roll footage of construction was shot in the spring, while a detention basin in the watershed was retrofitted so the viewer sees the steps involved with building the BMP. Interviews were conducted onsite with Extension staff and contracted consultants on the project. Topics covered included: BMP benefits, planning, implementation, considerations for public spaces, plant types, invasive species, and maintenance. Videos are purposely kept short- approximately 6 minutes long so they can be used in a variety of teaching settings and hold short attention spans. Promoting the use of BMPs for watershed restoration by incorporating the videos into Extension education activities. Existing videos include the project overview, floating wetland islands, and lake shoreline restoration.

Results
These videos were viewed 1,654 times on youtube, viewed by 85 audience members at Extension education seminars, as well as shown at the County fair, and Green Fair. A survey conducted with a selection of viewers indicated that 73% (n=22) indicated the videos helped them understand the importance of water resource protection in the Manalapan as well as specific

actions they could take at home to improve water quality and reduce storm-water runoff. The 44,100 sq. ft. basin that was retrofitted to a naturalized basin in the spring. A decrease in storm-water runoff will help reduce sediment and nutrient loading in the watershed.

4. Associated Knowledge Areas

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

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

External factors did not affect outcomes.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

NJAES research and extension outcomes related to this planned program were evaluated utilizing a variety of evaluation methods appropriate for each initiative to determine the effectiveness on both a qualitative and quantitative level. For KASA, and practice change we included the measurement of knowledge gained as measured by pre/post Likert-scale assessment. Surveys were used to measure increase in skills acquired, behavior change and practice adoption. For process evaluation we focused on program delivery, participation, relevance and timeliness. Data was collected at appropriate times for each initiative that supports this planned. IRB approved evaluation instruments were used to collect research and extension data. Data analyses and comparisons relevant to basic and applied research and demonstration were collected and analyzed and reported utilizing a variety of data collection methods appropriate to each research question. The major goal of evaluating is the demonstration of social, economic, behavior, and environmental changes in conditions that contribute to improved quality of life as a result of participation in programs and benefits of research solutions. See state defined outcomes for detailed results for the initiatives.

Key Items of Evaluation

None to report.

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Childhood Obesity - Youth/Adult Obesity

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
701	Nutrient Composition of Food	5%		10%	
702	Requirements and Function of Nutrients and Other Food Components	10%		10%	
703	Nutrition Education and Behavior	25%		25%	
704	Nutrition and Hunger in the Population	15%		15%	
724	Healthy Lifestyle	40%		40%	
801	Individual and Family Resource Management	5%		0%	
	Total	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	10.0	0.0	5.0	0.0
Actual Paid	4.7	0.0	6.6	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
469887	0	405938	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1416176	0	2604366	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
378701	0	2186994	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

• To identify the factors that promote excessive weight gain as well as protect against childhood obesity
• Measure how children born small for age are different with respect to body composition and risk for diabetes prior to developing diabetes or obesity.
• Investigate how perilipin A works in adipocytes to control fat storage and fat breakdown.
• Collect and analyze data on obesity-related measures (i.e., BMI) in adults and children
• Examine how weight loss affects calcium absorption and bone mass
• Create a multidisciplinary program comprising of faculty, staff, the medical community, industry partners and government officials
• Conduct adult/youth education and deliver targeted messages on healthy food choices and increased physical activity education using the following strategies:

Direct Methods:
• Educate Youth
• Educate Parents
• Educate Volunteers
• Food and Fitness Ambassadors
• Educate Child Health Summit Professionals
• Educate Teachers/School Nurses
• Educate Communities

Indirect Methods:
• Website
• Social Marketing

2. Brief description of the target audience

• Clinicians, Physicians and Nurses
• Health Care Professionals
• Hospitals (including teaching hospitals)
• Staff and students who gain valuable scientific experience
• Industry partners that benefit from fundamental and applied research in obesity and related chronic diseases
• Communities that benefit from increased knowledge about the mechanisms involved in obesity
• Other faculty and staff working on similar research
• Health-related organizations and foundations interested in obesity/nutrition issues
• School Age Youth
• Teens
• Teachers
• After School Providers
• Parents
• Volunteers
• Extension Professionals
• State and County Agencies and Organizations
• Schools

3. How was eXtension used?

RCE faculty were active in CoPs, such as Families, Food and Fitness, Community Nutrition Education, Diversity, Equity and Inclusion, etc. Faculty answered the "Ask The Expert" questions, developed collaborative educational products, and conducted professional development sessions.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	29090	135067	19983	485

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	6	45	51

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- A variety of strategies will be implemented to reach target audiences. This will include and not be limited to workshops, field visits, classes, newsletters, media releases, electronic communications,publications. In addition a trained volunteer teaching base will be developed. Quantitative reports of participation will be collected

Year	Actual
2018	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Short Term - Individuals gain awareness, knowledge, skills related to: Attitudes about healthy eating for adults/youth. Healthy food choices for adults/youth. Selection of healthy foods for adults/youth. Benefits of physical activity (reduced overweight and obesity, reduced risk of diabetes, heart disease and cancer.) Physical activity recommendations for health for adults/youth. Identify factors that promote excessive weight gain and protect against childhood obesity.
2	Medium Term - Individuals incorporate skills/change behaviors related to: Increased adoption of healthy food practices. Increased consumption of fruits, vegetables, whole grains and low-fat dairy. Increased participation in family meals. Increased participation in physical activity. Increased participation in family-related physical activity. Increased use of new 'campaign' website. Improved understanding of the relationship between early nutrition and later risk for chronic disease. Understanding the process by which perilipins at the surface of lipid droplets control how much energy is released from the adipocyte at times of need. Understanding how the intestines and body uptake and process dairy fat. Identify genes, their protein product and how the proteins influence the way the body processes fat.
3	Long Term - Individuals experience: Decreased overweight and obesity for youth/adults. Decreased risk factors for nutrition-related health problems and chronic diseases that are affected by diet and physical activity for youth/adults. A clear and comprehensive understanding of the genetic and physiological mechanisms of obesity and related chronic diseases. Pharmacological and/or medical treatments to alleviate the effects of obesity and related diseases.
4	Healthy Living - Medium Term - Individuals incorporate skills/change behaviors related to: Increased adoption of healthy food practices. Increased consumption of fruits, vegetables, whole grains and low-fat dairy. Increased participation in family meals. Increased participation in physical activity. Increased participation in family-related physical activity. Increased use of new 'campaign' website. Improved understanding of the relationship between early nutrition and later risk for chronic disease. Understanding the process by which perilipins at the surface of lipid droplets control how much energy is released from the adipocyte at times of need. Understanding how the intestines and body uptake and process dairy fat. Identify genes, their protein product and how the proteins influence the way the body processes fat.
5	Identification and mechanism of anti-obesity phytochemicals in foods- Medium Term - Individuals incorporate skills/change behaviors related to: Increased adoption of healthy food practices. Increased consumption of fruits, vegetables, whole grains and low-fat dairy. Increased participation in family meals. Increased participation in physical activity. Increased participation in family-related physical activity. Increased use of new 'campaign' website. Improved understanding of the relationship between early nutrition and later risk for chronic disease. Understanding the process by which perilipins at the surface of lipid droplets control how much energy is released from the adipocyte at times of need. Understanding how the intestines and body uptake and process dairy fat. Identify genes, their protein product and how the proteins influence the way the body processes fat.
6	Bountiful Boxes- Long Term - Individuals experience: Decreased overweight and obesity for youth/adults. Decreased risk factors for nutrition-related health problems and chronic diseases that are affected by diet and physical activity for youth/adults. A clear and comprehensive understanding of the genetic and physiological mechanisms of obesity and related chronic diseases. Pharmacological and/or medical treatments to alleviate the effects

	of obesity and related diseases.
7	Breakfast After the Bell - Long Term - Individuals experience: Decreased overweight and obesity for youth/adults. Decreased risk factors for nutrition-related health problems and chronic diseases that are affected by diet and physical activity for youth/adults. A clear and comprehensive understanding of the genetic and physiological mechanisms of obesity and related chronic diseases. Pharmacological and/or medical treatments to alleviate the effects of obesity and related diseases.
8	Union County Senior Meals Program - Long Term - Individuals experience: Decreased overweight and obesity for youth/adults. Decreased risk factors for nutrition-related health problems and chronic diseases that are affected by diet and physical activity for youth/adults. A clear and comprehensive understanding of the genetic and physiological mechanisms of obesity and related chronic diseases. Pharmacological and/or medical treatments to alleviate the effects of obesity and related diseases.
9	Endocrine-disrupting chemicals and female reproduction: Effects of DEHP and its replacement DiNP in the ovary. - Long Term - Individuals experience: Decreased overweight and obesity for youth/adults. Decreased risk factors for nutrition-related health problems and chronic diseases that are affected by diet and physical activity for youth/adults. A clear and comprehensive understanding of the genetic and physiological mechanisms of obesity and related chronic diseases. Pharmacological and/or medical treatments to alleviate the effects of obesity and related diseases.

Outcome #1

1. Outcome Measures

Short Term - Individuals gain awareness, knowledge, skills related to: Attitudes about healthy eating for adults/youth. Healthy food choices for adults/youth. Selection of healthy foods for adults/youth. Benefits of physical activity (reduced overweight and obesity, reduced risk of diabetes, heart disease and cancer.) Physical activity recommendations for health for adults/youth. Identify factors that promote excessive weight gain and protect against childhood obesity.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What has been done

Results

4. Associated Knowledge Areas

KA Code	Knowledge Area
701	Nutrient Composition of Food
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle

Outcome #2

1. Outcome Measures

Medium Term - Individuals incorporate skills/change behaviors related to: Increased adoption of healthy food practices. Increased consumption of fruits, vegetables, whole grains and low-fat dairy. Increased participation in family meals. Increased participation in physical activity. Increased participation in family-related physical activity. Increased use of new 'campaign' website. Improved understanding of the relationship between early nutrition and later risk for chronic disease. Understanding the process by which perilipins at the surface of lipid droplets control how much energy is released from the adipocyte at times of need. Understanding how the intestines and body uptake and process dairy fat. Identify genes, their protein product and how the proteins influence the way the body processes fat.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Get Moving Get Healthy NJ Workforce - Many of today's health problems (obesity, heart disease, diabetes, and cancer) are often exhibited during the long workdays of many professionals. However, several of these ailments can be reduced through good nutrition and a healthy life style.

Research shows that heart disease and obesity are often preventable if efforts are made early on.

What has been done

This program focuses on making health and wellness in the workplace a top priority. The goal of the Get Moving Get Healthy NJ Workforce program is for employees to live longer, be healthier and more productive while reducing their risk of chronic diseases and obesity. This online program aims to encourage healthy lifestyles, healthy eating, reducing stress, improving finances and physical activity. The weekly sessions offer an education on nutritious foods and ways to change eating and exercise habits, along with practical suggestions for adapting lifestyles. In addition, it advises an increase in physical activity, encourages better management of home finances and how wealth is related to overall health. The weekly topics provide concise evidence-based information related to the following health messages: eating certain foods can contribute to healthy lifestyle; lowering stress levels; increase well-being, self-image and self-esteem; strategies for better eating and exercise habits, along with boosting brain health; tips for adapting lifestyle and managing personal finances; management strategies on time; stress and balancing work with family. Organizations may choose between a 12, 24 or 52-week series for their employees.

Results

Follow-up surveys were taken by 275 employees. Results to date are as follows: Participants indicated they made progress in the following areas: 73% increased the number of steps they take per day, 67% increased consumption of vegetables, 62% increased consumption of fruit, 53% improved diet, 56% decreased consumption of sugar, 50% improved level of energy, 48% lost some body weight, 47% decreased their debt, 41% improved physical condition, 40% increased level of exercise, 40% fit better in clothing, 36% decreased consumption of fats, 35% improved sleep, 33% lost some inches around the body, 30% decreased level of stress, 28% increased their personal savings, 23% improved physical appearance, 16% used strategies to prevent disease, and 79% quit smoking.

4. Associated Knowledge Areas

KA Code	Knowledge Area
701	Nutrient Composition of Food
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle

Outcome #3

1. Outcome Measures

Long Term - Individuals experience: Decreased overweight and obesity for youth/adults. Decreased risk factors for nutrition-related health problems and chronic diseases that are affected by diet and physical activity for youth/adults. A clear and comprehensive understanding of the genetic and physiological mechanisms of obesity and related chronic diseases. Pharmacological and/or medical treatments to alleviate the effects of obesity and related diseases.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Flemington Salvation Army Corps Summer Lunch Club - Hunterdon County consistently ranks at the top of the list as the healthiest county in New Jersey, according to the Robert Wood Johnson Foundation County Health Rankings report, ranking #1 each year since 2011. Despite overall high levels of health, several concerns exist for the county. The health status for certain minority racial/ethnic groups indicate worse health status. Significant health disparities may occur even in a county as wealthy as Hunterdon County. For example, according to the 2016 Latino BRFSS for Hunterdon County, only 29.1% of Latinos experience a 'healthy weight/BMI' compared to 44.8% county residents overall. In 2016, 25.2% of Latino residents rated their health as 'fair-poor' compared to 7.8% of all residents. Finally, 73.9% of Latino survey respondents reported not having health insurance, compared to less than 10% of the mainstream population. The median household income for Hunterdon County as of 2016 was $108,177, making it the richest county in New Jersey. Despite being a wealthy county, great disparities in income level exist in the county. As of 2016 data, about 4.5%, or 5,499 individuals, were at the poverty level, and 11,330 individuals were classified as being at or below 185% of the poverty level. It is estimated that in 2017 about 2,633 individuals in Hunterdon County received SNAP benefits (about 23% of those eligible). An estimated 1,729 children were eligible for Free/Reduced (F/R) Lunch, with about an actual participation rate of 70%. One challenge faced in Hunterdon County is the fact that, to date, no single public school has achieved an eligibility rate in which would allow for participation in USDA school nutrition benefits, such as SNAP-Ed and other USDA meal programs, including the Summer Food Service Program. Flemington Borough is the most densely populated subdivision in this county and has the highest rate of poverty (20.7%), affecting 941 people. About 30% of the population of Flemington is made up of newly immigrated residents of Hispanic ethnicity, making it one of the most diverse municipalities in the County.

What has been done

The Hunterdon County Partnership for Health (HCPH), Lifestyle Action Team partnered with the Salvation Army Flemington Corps to offer the first USDA Summer Food Service Program in Hunterdon County, to serve the needs of food insecure children in Flemington Borough. The Salvation Army site contained an operable and certified kitchen, and which already served community meals to its regular program participants 1-2 days per week. They sponsored the summer food service program at their site to reach local children and expand the overall meals

programs to 4 days/week. HCPH provided technical support as needed for the USDA program application, as well as to recruit and organize volunteers to assist with meal preparation and supervision of the children during the meal service. The local neighborhood near the site was determined 'open' meaning participants did not need to show income eligibility. Thus, the program was able to serve any/all children who wanted to attend decreasing potential social stigma associated with participation. Volunteers were assigned roles such as engaging and supervising children before, during, and after the lunch service, meal preparation, and cleanup. Recruitment of program participants was done through local contacts with existing Salvation Army families, as well as through fliers sent home in back packs by local school nurses. The lunch program served meals on Tuesdays, Wednesdays, and Thursdays for 8 weeks, from July to August. Demographics of the participants were estimated to be 85% Hispanic, 4% African American, and 1% White. A Family and Community Health Sciences Educator (FCHS) assisted in the program planning and preparation of USDA required menus, helped with meal preparation, and oversight of food safety and child allergy information. Having completed the ServeSafe Food Handler's training, the FCHS Educator was back-up to the Salvation Army kitchen staff for kitchen food safety issues and engaged the youth at lunchtime in fun and interactive discussions about food, and provided nutrition-focused posters and worksheets for the children to promote healthy eating.

Results

1,089 meals were served to 78 children over an 8-week period. A total of 34 volunteers were recruited (20 youth and 14 adults) who participated in a rotating schedule over the summer, for a total of 212 volunteer hours. Volunteers represented 8 different groups: 4 Community Agencies and 4 local schools, as well as the community at large. Volunteer Testimonials included: Teen Volunteer: "Volunteering at the Salvation Army was a very rewarding experience. I got to meet some great kids and see the impact this valuable program has on their lives. I also got to help out my community in a fun way. The summer lunch club was a very worthwhile experience for both the volunteers and kids, and I am looking forward to next summer." Adult Volunteer: "Prior to being involved in the Summer Lunch Club program, I had limited knowledge of the services offered by The Salvation Army. By participating in this newly developed program, I was able to gain a more in-depth view of the widespread and valuable services the Salvation Army provides to the community. I feel that the Summer Lunch Club program filled an unmet need in our community by offering free and nutritious lunches to our food insecure children. I was glad that I could contribute my time to such a purposeful program." Partnership for Health Representative: "Seeing so many people and organizations come together to help the kids in our community has been a humbling experience. I love that we maintained our mission to serve healthy, well-balanced meals and the kids actually enjoyed them! Most of all the kids had fun- playing, learning & making friends."

4. Associated Knowledge Areas

KA Code	Knowledge Area
701	Nutrient Composition of Food
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle

Outcome #4

1. Outcome Measures

Healthy Living - Medium Term - Individuals incorporate skills/change behaviors related to: Increased adoption of healthy food practices. Increased consumption of fruits, vegetables, whole grains and low-fat dairy. Increased participation in family meals. Increased participation in physical activity. Increased participation in family-related physical activity. Increased use of new 'campaign' website. Improved understanding of the relationship between early nutrition and later risk for chronic disease. Understanding the process by which perilipins at the surface of lipid droplets control how much energy is released from the adipocyte at times of need. Understanding how the intestines and body uptake and process dairy fat. Identify genes, their protein product and how the proteins influence the way the body processes fat.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Overweight, obesity, chronic disease and inactivity put children and adults at risk for a reduced quality of life, premature death and increased health care costs. Many people 'know' the basics of healthy behaviors, but fail to practice them on a regular basis. Others lack the knowledge and skills, such as cooking or food shopping skills, to maintain a healthy life style. Parents and caregivers also need guidance on providing healthy meals and snacks for their children.

What has been done
Some of the programs offered by Educators in Rutgers Cooperative Extension Department of Family and Community Health Sciences include: Parents Academy, a four class series at the Somerville Y providing tips and techniques to parents/caregivers on providing healthy meals and snacks for children, feeding picky eaters, tackling food waste and food budgeting for nine young mothers. 'Parents Academy' empowers parents to be role models for healthy eating. Classes were held once a week for four weeks in October. Participants completed a survey via telephone or email three weeks after the final class. In addition, Senior Center classes were conducted by a FCHS Educator at seven county senior centers, teaching 20 classes for 469 seniors. Topics included: reducing consumption of sugar and salt; reducing food waste; and eating more produce and understanding gluten-free eating. Public or worksite programs were also conducted by FCHS Educators at worksites, organizations or the extension office teaching the public about healthy

eating and lifestyles. FCHS also provided programming for workforce training programs (a series of 1 - 4 classes each month with a new group of participants) and transitional housing sites. Topics included: reducing consumption of sugar and salt; heart healthy living, reducing food waste; eating more produce; gluten-free eating; Mediterranean eating; mealtime in a flash; stretching the food dollar and herbs for flavor. Some classes included demonstration and tasting of food. Building Bridges to Better Health, a Healthier Somerset coalition grant project, is a 4-year grant project focused on Bound Brook and South Bound Brook, two urban/suburban towns. A FCHS Educator serves as one of the project's team leaders. The project, in its third year, has made progress in strengthening school wellness, particularly mental health; reviewing policies and transportation with health in mind; encouraging free and low cost health education in the community and making the public aware of community resources. One town has started installation of a community garden under direction of a local committee with plans to plant in summer of 2019. Farm Market Vouchers with Education, a project in Somerset County provided $15 farm market vouchers in 4 targeted communities with higher low income populations. This is a partnership to provide food and nutrition education prior to distribution of the vouchers. FCHS staff taught at 7 sites with 178 people reached.

Results

In terms of reduce food waste such as meal planning and using shopping lists, 100% of the participants agreed that the series gave them a better understanding of leading by example and plan to encourage children to eat a nutritious diet; 20% have experienced fewer mealtime battles with their picky eaters; 100% plan to use the techniques taught to maximize savings on their grocery bill; 100% plan to cook more often with their children; 100% have or plan on sharing the series materials with at least one other person; Verbal feedback included: "Cooking with my children went well at the Y. We try to do it now on the weekends." "I enjoy involving my kids with meal planning and cooking. It helps me with my busy schedule." "I have shared a recipe with a friend and made copies of the MyPlate handouts for another friend." "Thank you. It was amazing! The helpful tools like the chart with all the foods and how long they are good for is a great resource." "Getting the information from mom is not as fun as getting it in a class, where you get to measure ingredients and cook with your friends." Twenty (20) Senior Center classes were held reaching 466 seniors at 7 centers. Seniors reported learning new information. They planned to read labels more often; pay attention to serving sizes; reduce food waste; drink more water and fewer sugary beverages and use left-overs within 4 days. Fifty (50) public & worksite classes/programs were taught with 593 participant contacts. The classes at the WorkFirst employee training program were taught in a series of 2 to 4 classes each month with most participants attending more than one session. Select evaluation results include: 29 participants increased their knowledge from medium or low to high about using herbs in cooking and reserving them; 7 of 8 participants in a gluten-free class reported increased their knowledge about which foods contain gluten, how to read food labels to find gluten, preventing cross contact and precautions when dining out; 100% of the people in the post evaluation of 'Stretching Your Food Dollar' classes for WorkFirst planned to improve shopping trips by reading circulars and creating lists and budgets in advance and they planned to use moneysaving strategies such as coupons, and shopping the perimeter of the store. Mediterranean Diet & lifestyle: 58 (61%) of 95 participants responded to a post class evaluation. Participants indicated significant changes in eating moving from "never & 1/2 the time" in before class behaviors to "most of the time or always" in planned after class behaviors for the following: eating more vegetables and fruits, eating fish twice a week, eating more whole grains, following a Mediterranean eating pattern and getting 30+ minutes of physical activity/day or 150 minutes/week. Farm Market Vouchers with Education: 178 participants reported learning how to better select fresh produce and the importance of eating more produce for health. They expressed appreciation for the $15 voucher or bag of produce. The distributed vouchers or produce bags of the same value for some groups were worth $2,670.

4. Associated Knowledge Areas

KA Code	Knowledge Area
701	Nutrient Composition of Food
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle

Outcome #5

1. Outcome Measures

Identification and mechanism of anti-obesity phytochemicals in foods- Medium Term - Individuals incorporate skills/change behaviors related to: Increased adoption of healthy food practices. Increased consumption of fruits, vegetables, whole grains and low-fat dairy. Increased participation in family meals. Increased participation in physical activity. Increased participation in family-related physical activity. Increased use of new 'campaign' website. Improved understanding of the relationship between early nutrition and later risk for chronic disease. Understanding the process by which perilipins at the surface of lipid droplets control how much energy is released from the adipocyte at times of need. Understanding how the intestines and body uptake and process dairy fat. Identify genes, their protein product and how the proteins influence the way the body processes fat.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Genetic and environmental factors are both risk factors for obesity whereas environmental factors such as dietary behaviors and lifestyle are recognized to play predominant roles in causing this disease. Adipose tissue is an active endocrine and metabolic organ, which in addition to triacylglycerol (TG) storage, secretes various adipocytokines, cytokines, growth factors and hormones, implicating energy homeostasis and pathological processes. It is believed that a combination of decreased caloric intake and physical exercise is effective for prevention of obesity, but it is difficult to have people change their lifestyle and control their diet. Some anti-obesity drugs have been used to treat overweight or obese patients, however, with less efficacy

and safety concern. Some literature shows that many phytochemicals and natural products are used to treat obesity as metabolic stimulates, appetite suppressants and starch blockers, and by regulation of glucose and lipid metabolism as well as targeting on adipocyte differentiation.

What has been done

NJAES researchers are looking to: (1) to identify phytochemicals which have potential anti-obesity properties; and (2) understand the mechanism of inhibitory effect of polymethoxyflavones and other flavonoids on adipogenesis. The research is seeking novel compounds from fruits and vegetables which have anti-adipogenic and anti-obesity activity and study their mode of actions. This study investigates the chemopreventive effects of garcinol, a polyisoprenylated benzophenone derivative isolated from the fruit rind of Garcinia indica. NJAES researchers sought to delineate how garcinol protects against obesity in high-fat diet (HFD)-induced mice, and determined whether its anti-obesity effects are related to the gut microbiota.

Results

Obesity is associated with low-grade chronic inflammation and intestinal dysbiosis. The gut microbiota is a key player in the pathophysiology of diet-induced obesity. The results showed that garcinol reduced HFDfed mice body weight gain and relative visceral adipose tissue fat weight in a dose-dependent manner. Furthermore, garcinol markedly reduced the serum levels of glutamate pyruvate transaminase, total cholesterol, and triacylglycerol. The 16S rRNA gene sequence data indicated that garcinol not only reversed HFD-induced gut dysbiosis--as indicated by the decreased Firmicutes-to-Bacteroidetes ratios but also controled inflammation by increasing intestinal probiotics, Akkermansia spp. The increased Akkermansia spp. population also affected the AMP-activated protein kinase; signaling pathway in adipocytes adipogenesis. Since promoting browning of white adipose tissue (WAT) helps to maintain energy homeostasis. Previous studies have found that citrus fruit exhibits a number of biological activities. Although most citrus fruit drop has been considered agricultural waste, the ability to use it may be desirable. In another project, NJAES researchers investigated the anti-obesity effects of immature citrus fruits in high-fat diet (HFD)-fed mice. The main phytochemical components of immature Citrus reticulata in water extraction analyzed by HPLC are synephrine, narirutin, hesperidin, nobiletin, and tangeretin. Oral administration of 1% Immature Citrus Reticulata Extract (ICRE) for 11-weeks markedly reduced body weight gain, epididymal fat weight, fasting blood glucose, serum triglyceride, and total cholesterol ($P < 0.05$ for all). In addition, histological analysis revealed that dietary ICRE decreased adipocyte size and hepatic steatosis compared to the HFD group ($P < 0.05$ for both). Furthermore, it was found that mice treated with ICRE have improved cold tolerance during acute cold challenge. These effects were associated with increased expression of uncoupling protein 1 (UCP1) and thermogenic genes in inguinal WAT. Taken together, these results suggest that ICRE can prevent obesity and lipid accumulation through induction of brown-like adipocyte formation.

4. Associated Knowledge Areas

KA Code	Knowledge Area
701	Nutrient Composition of Food
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle

Outcome #6

1. Outcome Measures

Bountiful Boxes- Long Term - Individuals experience: Decreased overweight and obesity for youth/adults. Decreased risk factors for nutrition-related health problems and chronic diseases that are affected by diet and physical activity for youth/adults. A clear and comprehensive understanding of the genetic and physiological mechanisms of obesity and related chronic diseases. Pharmacological and/or medical treatments to alleviate the effects of obesity and related diseases.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The most common health issues in today's society are associated with inadequate nutrition, overweight and obesity and access to health care, many of which are observed in individuals living in food insecure households. The current data shows that 8.5% of resident in Monmouth County are food insecure, meaning that 53,210 individuals living in Monmouth County live in food insecure households. These individuals are at an increased risk for the development of chronic disease and illness, including diabetes, heart disease, high blood pressure, obesity, depression and anxiety. As a result of this, there is a great need to increase awareness of food insecurity in this county and educate youth volunteers on the issues related to food insecurity.

What has been done
This program worked in partnership with Rutgers Against Hunger (RAH) to help educate youth volunteers on the concepts related to food insecurity. The program encouraged community participation and worked to increase food access through the implementation of a food drive activity, in which youth volunteers assembled boxes of non-perishable food items to be donated to the Howell Emergency Food Pantry. The participants received a presentation encouraging participation in the community and education to help increase food access within the county. In order to encourage this community outreach, youth volunteers participated in a self-administered food donation activity, preparation of boxes and tallying the total weight of food items provided. The volunteers sorted and arranged non-perishable food items in the assembled boxes, which was later donated to the local Howell Emergency Food Pantry.

Results

This was the first year that the Rutgers Cooperative Extension Department of Family and Community Health Sciences offered the Bountiful Boxes program to individuals in the community. Incredible feedback was received with 16 students volunteering their time to this program. The program was effective in educating students (and their families) on the concepts related to food insecurity, which is evidenced by the learning outcomes of the program. Before implementing the nutrition education lesson, none (0%) of the students were able to provide an adequate definition of food insecurity. However, comprehension greatly increased after students had received the nutrition education lesson. After implementation of this program, 100% of the students were able to define food insecurity. Similar outcomes were observed on other scales of the post evaluation survey. With majority of the students being able to identify adverse health outcomes associated with food insecurity, nutrition assistance programs that work to increase food access and factors that contribute to food insecurity. At the end of the lesson, 94% of the students received a grade of 80% or higher on the post-evaluation survey further demonstrating increased comprehension and the efficacy of this program. The post-evaluation survey also revealed that 100% of the students pledged to help improve food access in their community in the future through participation in community programs (such as food drives, food pantries and soup kitchens). 100% of the students were sent home with handouts and worksheets, summarizing the information learned and promoting community outreach. This program was successful in donating 188.8 pounds of non-perishable food items to the Howell Emergency Food Pantry.

4. Associated Knowledge Areas

KA Code	Knowledge Area
701	Nutrient Composition of Food
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle

Outcome #7

1. Outcome Measures

Breakfast After the Bell - Long Term - Individuals experience: Decreased overweight and obesity for youth/adults. Decreased risk factors for nutrition-related health problems and chronic diseases that are affected by diet and physical activity for youth/adults. A clear and comprehensive understanding of the genetic and physiological mechanisms of obesity and related chronic diseases. Pharmacological and/or medical treatments to alleviate the effects of obesity and related diseases.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Breakfast After the Bell has become the unofficial gold standard in providing school breakfast, particularly in larger, urban, and/or low-resource school districts. It offers a way to feed much greater numbers of students (than the traditional method of serving breakfast before the school day begins), thereby becoming a reliable method of addressing food insecurity among youth. Research has shown that eating breakfast is linked to student performance and behavior. An understanding of how BATB was working in New Brunswick Public Schools was needed.

What has been done
As part of the evaluation of the breakfast after the bell program in New Brunswick Public Schools, five focus groups with students were conducted in April-May. Students participated in groups as follows: first grade (n=7), and 2-3 graders (n=4), and 4-5 graders, (n=5), and 6-7 graders (n=3), and 7-8 graders (n=6). Common themes among all of these focus groups were general dissatisfaction with the breakfast food quality (food that was still frozen, or expired milk, for example) and fatigue with the food choices, particularly the cereal, which, up to that point, had been served to the students 3-4 times per week. This is reflected in the breakfast participation numbers for the 16-17 school year, which showed a steady decline in participation rates, from a high of over 89% shortly after BATB was implemented (January 2015), down to just under 70% by June 2017. These numbers were reported and the students' opinions to NBPS administration. Data was one of the motivating factors in NBPS changing food service management companies for the following school year. An analysis of breakfast participation data is ongoing for the 2017-18 school year but an increase in breakfast participation rates is highly likely. As part of this same evaluation, a survey was distributed to New Brunswick Middle School students. NBMS had implemented BATB in the beginning of the 2014-15 school year, and immediately saw a significant increase in participation, from under 15% in March 2014, to over 75% in October 2015. In January 2017, the Middle School had switched back to the traditional breakfast before the bell model. The principal stated that his reasons for doing so were his belief (from what he heard students saying) that most students ate at home before school and/or bought food on the way to school to eat, so they didn't need school breakfast. However, on the survey, students reported the following: 55% of students said that they were more likely to eat breakfast when it was served in the classroom (before the bell), and 72% said that they do not buy breakfast on the way to school.

Results
NBPS changed school food service provider after seeing the focus group data that students were unhappy with the quality and repetitiveness of the school breakfast. At some point during the 2017-18 school year, the middle school principal decided to start serving breakfast before the bell, due to his own understanding that most students were eating breakfast at home or on the way to school. However, upon seeing the data, said that he decided to change back to providing breakfast after the bell since our student survey showed that, in fact, very few students reported eating at home, and that the participation data showed that breakfast after the bell increased greatly breakfast participation at the Middle School. As of right now, plans are in place to serve BATB in the Middle School starting in September 2019, with potential to start even sooner

(depending on factors such as budget, availability of food service staff).

4. Associated Knowledge Areas

KA Code	Knowledge Area
701	Nutrient Composition of Food
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle

Outcome #8

1. Outcome Measures

Union County Senior Meals Program - Long Term - Individuals experience: Decreased overweight and obesity for youth/adults. Decreased risk factors for nutrition-related health problems and chronic diseases that are affected by diet and physical activity for youth/adults. A clear and comprehensive understanding of the genetic and physiological mechanisms of obesity and related chronic diseases. Pharmacological and/or medical treatments to alleviate the effects of obesity and related diseases.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
In a continued collaboration with the Union County Division on Aging, a Family and Community Health Sciences (FCHS) Educator worked with the Director of the UC Division on Aging to provide a dietitian to direct the Senior Meals program.

What has been done
The FCHS Educator provided nutrition training for home health aides, provided nutrition screenings for seniors, acted as gerontology program preceptor for dietetic interns and dietetic technicians, taught nutrition, exercise, food safety and health classes at sites, assisted with the

set up of Farmer's Markets to distribute produce vouchers and assisted with setting up food delivery. Over 20 staff were supervised at 24 congregate sites feeding 750 seniors their noon meal each week. Over 2,000 limited resource Union County seniors received vouchers for Farmer's Market produce worth $50,000 distributed at 7 Senior Centers in Union County. Summer nutrition staff assisted the Program Coordinator in delivering the vouchers.

Results
85% of seniors rated lunch meals as satisfactory or better. A new congregate site was opened in Scotch Plains and attendance is the 3rd highest in the Union County Senior Meals Program. 72% of seniors have reduced their salt intake as a result of the nutrition education sessions required by the program. WIC Senior Farmers Market vouchers allowed the purchase of $ 50,000 in fresh produce at four locations in Union County. Twenty-five (25) sites received food safety education through the Senior Meals Coordinator and the FCHS Educator.

4. Associated Knowledge Areas

KA Code	Knowledge Area
701	Nutrient Composition of Food
702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle

Outcome #9

1. Outcome Measures

Endocrine-disrupting chemicals and female reproduction: Effects of DEHP and its replacement DiNP in the ovary. - Long Term - Individuals experience: Decreased overweight and obesity for youth/adults. Decreased risk factors for nutrition-related health problems and chronic diseases that are affected by diet and physical activity for youth/adults. A clear and comprehensive understanding of the genetic and physiological mechanisms of obesity and related chronic diseases. Pharmacological and/or medical treatments to alleviate the effects of obesity and related diseases.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Endocrine-disrupting chemicals or EDCs are a group of environmental chemicals that are common in the environment. EDCs alter the normal function of the endocrine system in the body and cause adverse developmental and reproductive effects. These chemicals are both natural and man-made, and include pharmaceuticals, DDT and other pesticides, and plasticizers, such as bisphenol A and phthalates. Various human populations, including children are exposed to these chemicals daily. When a developing individual is exposed to these chemicals, the effects can be long lasting and manifest as precocious puberty, irregular reproductive cycles, subfertility or infertility, or cancer later in life. There is an increasing prevalence of obesity and metabolic disorders, such as type II diabetes among human populations throughout the world. While factors, such as malnutrition or sedentary life style can play roles in this problem, endocrine disrupting chemicals (EDCs) can also contribute. In addition, EDCs, such as phthalates act through PPAR-signaling, which is known to affect glucose homeostasis and adipogenesis. Thus, it is important to study the developmental effects of phthalates on glucose metabolism and on the expression of genes that can play role in glucose homeostasis.

What has been done

Research by NJAES faculty uses inbred rats as a model animal to study the effects of two phthalates: DEHP and DiNP. DEHP is one of the most commonly used phthalates. Due to DEHP's known adverse effects in males, DiNP has been used as its replacement because DiNP was considered safer. However, studies in males suggest that the safety of DiNP should be questioned more thoroughly. In addition, virtually nothing is known about DiNP's effects in females. Therefore, NJAES researchers exposed pregnant and lactating female rats to DEHP or DiNP at doses that various human populations are exposed. They studied the effects of the exposure in the female offspring, specifically focusing on the ovarian structure and function to assess the effects of these chemicals on female reproduction. The changes in the expression levels of molecules in the ovary and identity any relationship among the structural, functional and molecular changes were analyzed. During this research period, timed-pregnant Fischer CDF rats (F0; N=3-4) were orally treated with oil (Control) and 24, 240, and 500 mg di-iso-nonyl phthalate (DINP) or di(2-ethylhexyl) phthalate (DEHP) per kg BW per day between embryonic day (E) E11 and postnatal day (PND) 7 (sperm positive vaginal smear day= E0; day of birth of litter = PND0). In F1 females, blood glucose levels (mg/dL) were measured before and at 15, 30, 60, 90, and 120 min after oral glucose (2 mg/kg) gavage or after insulin (1.0 U/kg) injection for oral glucose tolerance test (OGTT) or insulin tolerance test (ITT), respectively, between PND130 and 140. OGTT was performed after a 16-hour fasting and ITT was performed after a 4-hour fasting and both values were expressed as area under curve (AUC).

Results

The highest DEHP (500 mg/kg/day) tended to increase ($p = 0.09$) AUC values for ITT, suggesting that developmental treatment with DEHP induces insulin resistance. In contrast, highest dose of DINP (500 mg/kg/day) significantly increased ($p = 0.05$) the AUC values for the OGTT, suggesting that developmental treatment adversely affect glucose clearance from the blood. In addition, since, insulin resistance is associated liver pathologies [8, 9] and adipogenesis [10, 11] in rats and humans, researchers examined the liver weight as well as weight of perimetrical, perirenal, and abdominal fat tissues. Highest doses DINP tended to increase ($p = 0.06$) the liver weight. However, fat accumulation was not significantly affected.

4. Associated Knowledge Areas

KA Code	Knowledge Area
701	Nutrient Composition of Food

702	Requirements and Function of Nutrients and Other Food Components
703	Nutrition Education and Behavior
704	Nutrition and Hunger in the Population
724	Healthy Lifestyle

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

None to report.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

NJAES research and extension outcomes related to this planned program were evaluated utilizing a variety of evaluation methods appropriate for each initiative to determine the effectiveness on both a qualitative and quantitative level. For KASA, and practice change we included the measurement of knowledge gained as measured by pre/post Likert-scale assessment. Surveys were used to measure increase in skills acquired, behavior change and practice adoption. For process evaluation we focused on program delivery, participation, relevance and timeliness. Data was collected at appropriate times for each initiative that supports this planned. IRB approved evaluation instruments were used to collect research and extension data. Data analyses and comparisons relevant to basic and applied research and demonstration were collected and analyzed and reported utilizing a variety of data collection methods appropriate to each research question. The major goal of evaluating is the demonstration of social, economic, behavior, and environmental changes in conditions that contribute to improved quality of life as a result of participation in programs and benefits of research solutions. See state defined outcomes for detailed results for the initiatives.

Key Items of Evaluation

None to report

V(A). Planned Program (Summary)

Program # 3

1. Name of the Planned Program

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
806	Youth Development	100%		100%	
	Total	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	30.0	0.0	0.0	0.0
Actual Paid	3.9	0.0	0.0	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
347271	0	0	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1754730	0	0	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
351997	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Positive Youth Development:

• Employ Essential Elements (belonging, independence, mastery and generosity) as the basis for life skill development and related workforce development skills.

- Utilize Experiential Education Model (Experience, Share, Process, Generalize, Apply).

Provide opportunities for youth to:
- Feel and believe that they are cared about by others (Attachment, Belonging, Connection)
- Feel and believe they are capable and successful (Achievement, Mastery, Competence)
- Know they are able to influence people and events (Autonomy, Power, Confidence)
- Practice helping others through youth's own generosity (Altruism, Purpose, Contribution)

Subject matter:
(USDA/NIFA Mission Mandates)
Science, Engineering, Technology (includes:science literacy, animal science, plant science, environmental science, life sciences, etc) Citizenship (includes youth engagement, community youth development, community service, character development, civic engagement, etc) Healthy Lifestyles (includes chemical health, mental and emotional health, foods & nutrition, physical health and safety, etc).

2. Brief description of the target audience

- School Age Youth (K - 13, one year out of high school) and their Parents
- 4-H Volunteers (adult and youth)
- Teachers/Educators/other Youth Development Educators
- School Age Child Care Providers
- College Students (interns, collegiate 4-H)
- Other Extension Professionals and University Partners
- Communities: Stakeholders and Non-Profit, Social Service, Government Agencies
- Under-served and Under-represented Audiences

Delivery modes:

- 4-H Clubs and Related Activities
- 4-H Afterschool (clubs and short-term programs)
- School Enrichment
- Special Interest
- 4-H Camping (day camps and overnight camping)
- Mentoring and Individual Study

3. How was eXtension used?

Faculty participated in several CoPs, including Program Evaluation, Personal Finance, Community, Local and Regional Food Systems, Volunteer Administration. Faculty answered "Ask the Expert" questions, developed collaborative educational products, and conducted professional development sessions.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	355	984421	35592	299299

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	5	0	5

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- A variety of strategies will be implemented to reach target audiences. This will include and not be limited to workshops, field visits, classes, newsletters, media releases, electronic communications,and publications.In addition a trained volunteer teaching base will be developed. Quantitative reports of participation will be collected.

Year	Actual
2018	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Short Term - Youth increase awareness, knowledge, attitudes, and skills related to essential elements, workforce development, life skill development, and relevant subject matter. Volunteers increase knowledge and awareness of practices fostering positive youth development, including youth/adult partnerships. Youth development professionals and stakeholders increase awareness and knowledge of problems and solutions supporting positive youth development, including: policies that need to be addressed,community resources and support.
2	Medium Term - Youth apply knowledge, attitudes, skills, and behaviors needed to become competent, caring and contributing citizens by: taking on leadership roles in their youth organizations and schools, and working in partnership with adults in a variety of settings. Youth and adults demonstrate effective partnerships through increased youth participation on advisory committees and other governing bodies. Volunteers and youth development professionals apply practices fostering positive youth development.
3	Long Term - Youth demonstrate mastery and competencies needed to become engaged by assuming leadership positions in communities; developing and implementing action plans to address community needs, and becoming productive members of the workforce. 4-H youth are engaged partners in decision making regarding RCE programming including but not limited to 4-H youth development programming. 4-H alumni and volunteers become engaged citizens by assuming leadership positions in communities. Youth development professionals and stakeholders influence decision makers in policy development related to youth development needs and issues.
4	Short Term - NJ 4-H Science Pathways Program (Passaic County). Youth increase awareness, knowledge, attitudes, and skills related to essential elements, workforce development, life skill development, and relevant subject matter. Volunteers increase knowledge and awareness of practices fostering positive youth development, including youth/adult partnerships. Youth development professionals and stakeholders increase awareness and knowledge of problems and solutions supporting positive youth development, including: policies that need to be addressed,community resources and support.
5	Short Term - REAL LIFE Academy. Youth increase awareness, knowledge, attitudes, and skills related to essential elements, workforce development, life skill development, and relevant subject matter. Volunteers increase knowledge and awareness of practices fostering positive youth development, including youth/adult partnerships. Youth development professionals and stakeholders increase awareness and knowledge of problems and solutions supporting positive youth development, including: policies that need to be addressed,community resources and support.
6	Long Term - 4-H Teen Café. Youth demonstrate mastery and competencies needed to become engaged by assuming leadership positions in communities; developing and implementing action plans to address community needs, and becoming productive members of the workforce. 4-H youth are engaged partners in decision making regarding RCE programming including but not limited to 4-H youth development programming. 4-H alumni and volunteers become engaged citizens by assuming leadership positions in communities. Youth development professionals and stakeholders influence decision makers in policy development related to youth development needs and issues.

Outcome #1

1. Outcome Measures

Short Term - Youth increase awareness, knowledge, attitudes, and skills related to essential elements, workforce development, life skill development, and relevant subject matter. Volunteers increase knowledge and awareness of practices fostering positive youth development, including youth/adult partnerships. Youth development professionals and stakeholders increase awareness and knowledge of problems and solutions supporting positive youth development, including: policies that need to be addressed,community resources and support.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
STEM Education Using LEGOS in Somerset 4-H - 4-H is responding to our nation's concern for improving human capacity and workforce abilities in STEM areas by combining non-formal education with hands-on inquiry-based learning in a youth development context. Rutgers Cooperative Extension 4-H Agents are continually working to develop effective partnerships between scientists and education professionals. With so many new adults leading clubs, and new members joining robotics clubs, additional training is needed.

What has been done
LEGO Robotics: 4-H Robotics is a unique opportunity to engage volunteers and corporate employees who can offer science expertise, workforce application, and mentoring to 4-H'ers in local communities. Adult and teen volunteers advise youth members as they learn to build and program robots using LEGO NXT Mindstorms and the EV3 kits. Club members also decide if they want to get involved with local, regional and national robotics competitions like FIRST. LEGO Education Build: Showcase 4-H's commitment to hands-on learning initiatives, provide students and community members the opportunity to build, create, and to inspire children to share and invest in their creativity. Experienced volunteers have invited new volunteers to club meetings and trainings. In addition, they mentor new volunteers on their own time. LEGO Build: This is an 'open build' essentially placing LEGOS throughout designated tables and asking youth to build whatever came to mind. Finished products were placed on display tables with a description of it and why they were inspired to build. Youth were encouraged to build multiple items and to walk around the room to see other youth's builds. The LEGO Build program is available at every event in

Somerset County, including 4-H Family Camp, TOPS day camp, club meetings, and at the Somerset County 4-H Fair. It has even been modified for school enrichment classes and afterschool programs.

Results
Since 2008, LEGO Robotics is an area that has grown significantly in Somerset County 4-H. There are now six standard 4-H robotics clubs, and cloverbud LEGO clubs. While each year the number of LEGO Robotics clubs increases, there is still a waiting list of over 30 youth for these clubs, demonstrating the need to continue to form new 4-H clubs. In addition, this project area now has their own 40'x60' tent at the Somerset County 4-H Fair. It is one of the most popular tents for fairgoers with at least five hands on activities going on at all times. They invite local high school robotics teams into the tent to conduct demos of the FIRST robots the teams have built and used in competition. For the past few years, members from the Somerset County 4-H Robotics Clubs have formed teams that participate in the FIRST LEGO League (FLL). They are a subgroup of the club that starts working in late August for a qualifying tournament that takes place in November. Winners compete at the World Championship in the spring.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #2

1. Outcome Measures

Medium Term - Youth apply knowledge, attitudes, skills, and behaviors needed to become competent, caring and contributing citizens by: taking on leadership roles in their youth organizations and schools, and working in partnership with adults in a variety of settings. Youth and adults demonstrate effective partnerships through increased youth participation on advisory committees and other governing bodies. Volunteers and youth development professionals apply practices fostering positive youth development.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Research Experience for STEM Ambassadors - To offer a more in depth experience for students to understand the process and nature of science.

What has been done
A research program was developed for returning STEM Ambassadors focusing on microplastics in the Raritan River. The 4-H faculty and staff worked with five teens that participated in the STEM Ambassador program in 2017 and returned for a second year of engagement. They were paired with a Rutgers professor and his graduate students to explore a) the distribution of microplastics in the Raritan and Passaic Rivers, b) analysis of data collected from zebrafish that show the toxicity of plastics in the developmental biology of the fish, and c) communication of results in an undergraduate research poster session.

Results
As a result of this program, 100% of the student participants reported having a greater understanding of the scientific process. Students assisted Rutgers graduate students in the development of a community app to help community members collect and report plastics along the rivers. All students produced scientific posters.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #3

1. Outcome Measures

Long Term - Youth demonstrate mastery and competencies needed to become engaged by assuming leadership positions in communities; developing and implementing action plans to address community needs, and becoming productive members of the workforce. 4-H youth are engaged partners in decision making regarding RCE programming including but not limited to 4-H youth development programming. 4-H alumni and volunteers become engaged citizens by assuming leadership positions in communities. Youth development professionals and stakeholders influence decision makers in policy development related to youth development needs and issues.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Science Matters-There exists a need for high-quality experiential programming to rural and urban youth in in order to drive youth to a pathway that deepens their understanding of how science connects to their food, animals and health; sparks their interest in Agri-science careers; and empowers them with the skills and support to show their communities just how much science matters.

What has been done
Essex, Hudson, and Morris County 4-H collaborated with Bayer to inspire young people to become tomorrow's science leaders, positively impacting the health and lives of people, plants and animals. Science Matters is holistic and capable of uniting 4-H's capacities, programs, curriculum and models across science and health relevant to all divisions of Bayer. In this inaugural year, this 4-H partnership with Bayer Crop Science paved the way for other leaders, employees and resources across Bayer to join in expanding Science Matters company-wide. The Science Matters project provided informal educational programs for youth through funding for greater staffing support, curriculum supplies and a connection to Bayer employees. Morris and Essex County 4-H programs reached over 850 youth through hands-on food science related programming. Youth were reached through direct teaching lead by Science Matters teens, 4-H staff and adult volunteers, and through outreach of educators who participated in Science Matters curriculum training. The core of this program involved teams of teenagers who were challenged to recognize community issues, and implement service projects to address local community food related issues.

Results
21 teens participated in Science Matters Program, each committing around 70 hours of service to the program, resulting in a total of 1,470 service hours - 850 youth reached through hands on food science programs - 9 Bayer Employees worked with youth during the program - 45 educators participated in training to lead community food and health programs through the National Agri-Summit Impact in numbers: 16 teens participated in the National Agri-Summit; 21 teens each completed 2 teach-back events to demonstrate and teach their community action plan; each team (3 in total) completed a community service project- GMO Fact Sheet, Building a Compost Bin, and Working at a Soup Kitchen. Science Matters 2017- 2018 Youth Evaluation ' N=21 ' 94% of youth indicated that they feel comfortable being a leader; 76.5% of youth indicated that they feel comfortable speaking up in a group, and 12% indicated they usually feel comfortable speaking up in a group; 94% of youth indicated a strong interest in science; 71% of youth indicated wanting to pursue a career in the science field, 29% of youth indicated maybe wanting to pursue a career in the science field; 100% of youth indicated learning new things about science through 4-H; 82% of youth indicated learning how to use science to solve everyday problems through 4-H; 88% of youth indicated sharing a science-related project with others; 50% of youth indicated they strongly agree that they would like to continue studying science after high school; 44% agree that they would like to continue studying science after high school Comments from teens: I will use the 4-H activities for my garden program. It's just what I needed; from an adult professional development participant - In this program I like the teachers the best and they taught me about food. (Teachers referring to the teens)- from an out-of-school time program participant at Newark Public Schools "I learned that food access is a worldwide issue."- from a Science Matters Team Member who participated in the World Food Prize Research Project "I had a great time at the summit one of my favorite parts was getting to make a Hex bug track to learn how to transport cows. This trip has been one of my best 4-H experiences. I learned a lot and would like to thank Bayer for this opportunity that I probably wouldn't have had otherwise." - from

a Science Matters Team Member "I am doing a workshop at the North Jersey Teen Conference. I would love to be able to do more workshops like this one in the future. They are a great opportunity to teach others all that I have learned from my Science Matters experience. In the future, I hope to continue learning about the world around us and all science topics. I hope to still pursue a career in Medicine, and programs like Science Matters have helped show me all the options available for more science related careers." -from a Science Matters Team Member.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #4

1. Outcome Measures

Short Term - NJ 4-H Science Pathways Program (Passaic County). Youth increase awareness, knowledge, attitudes, and skills related to essential elements, workforce development, life skill development, and relevant subject matter. Volunteers increase knowledge and awareness of practices fostering positive youth development, including youth/adult partnerships. Youth development professionals and stakeholders increase awareness and knowledge of problems and solutions supporting positive youth development, including: policies that need to be addressed,community resources and support.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

A need for the development of leadership, service and life skills in urban teens, while exposing them to the various science, engineering and technology fields that exist. The city of Paterson, which is the 3rd largest city in NJ is plagued with many common urban challenges, making it hard for teens to find future success. 29% of the population in Paterson lives below the poverty line, with the city ranked as the 10th most dangerous place to live in NJ, and 2nd in most heroin treatment cases in NJ, also noted as one of the largest heroin distribution areas in the state.

What has been done

In an effort to provide positive learning, leadership, and service opportunities to teens from Paterson the NJ 4-H Science Pathways Program was developed and consists of hands-on fun science activities in a Makerspace setting. Teens from the urban city of Paterson were recruited to the program prior to freshman year of high school. These teens come from low income families, and/or receive free/reduced lunch at school, and are traditionally underrepresented minorities in the fields of science, technology, engineering, and mathematics. Teens learn about various science fields, participate in hands-on learning in those fields, gain skills and see the enjoyment of those fields. The program also allows them to develop and improve on many life skills, such as critical thinking, teamwork, public speaking, teaching, and program planning and implementation. Additionally, these teens are trained in hands-on science activities and teach these activities to younger youth in their home communities. The Science Pathways program allows for the expansion of science knowledge not only within the teens who participate but also within local communities through the teens' outreach efforts. These teens are exposed to various fields of science and youth development and teaching. The program is designed to continue until senior year. Each year a new group of program participants enters the program. Recruitment is a big part of this program. To begin the recruitment process, the site coordinator met with administration, science teachers, and guidance counselors. Teachers and counselors often identified youth who they felt were a good fit and benefit most from the program. Youth and parents attended a presentation about the program. Interested youth submitted an application and participated in an interview process. Once selected, participants attend a program orientation along with their parents and participants meet twice a week for four hours in a Makerspace environment. Projects during the year include screen printing, movie maker, coding, sewing, soldering, etc. Participants spend weeks on each project building their skills. Participants also conduct hands-on science programming to younger youth throughout their community. Hands-on teaching take place at their local libraries, in after-school/summer camp programming, and other locations. Working together they create program plans, using the skills and activities they learned during the program. At the end of each program year, participants attend an end of the year Summit at Rutgers University, where they meet up with program participants from their sister site in Trenton. At the Summit participants showcase their final projects, receive feedback on their projects, meet with University professionals, and interact with individuals working in various science fields. Participants entering their second through fourth year of programming, work on more advanced science projects, increase their teaching time in the community, and spend more time outside of programming learning about and speaking to professionals in the field. Their opportunity to teach in the community expand to include teaching incoming program participants and younger youth hands-on science programming. Participants also assisted in the planning for the end of year statewide Summit and created a formal presentation focused on leadership development over the years. As the year progresses participants visit NJ/NY businesses that use science and technology, speak with professional in the various science fields, learn more about the many educational fields/paths that exist for the different types of work that utilize science and technology.

Results

Participants include 19 teens taught during 2017-2018 for 61 hours* (*hours taught to younger youth outside of the science pathways program). Feedback from participants during the end of the year shows that teens believe participation in this program has helped them in many different ways. Since participating in this program teens say they are better at public speaking and time management, they feel more comfortable when meeting new people, working with others including younger youth, are more responsible, more patient, are more confident. Knowledge and skills gained include: Improvement of leadership skills and learning how to listen more; learning to accept constructive criticism. Teens have stated that they enjoy this program more than others including school because they feel like they are trusted more, can be more creative, there?s more freedom and less stress, and there's more exposure to different areas in science. "The freedom to

do something you really like to do, as opposed to just being told to do something." Teens feel that this program has helped to improve their leadership skills by giving them opportunities to teach other youth, share what they have learned with others, and participate in various community service events/activities. Teens have said, "It's a different experience." and "It's really fun." Program participants have taken on leadership roles as science instructors to younger youth in the community teaching at the Passaic County Fair, New Jersey Maker Day, Passaic County 4-H Science-Sational Day, and William Paterson University Summer Youth Programs. Participants taught 46, 4th-8th graders, during the Passaic County 4-H Science-Sational Day held at Passaic County Community College. Participants planned and implemented a 12 hour, hands-on science program, during William Paterson University's summer youth programs. A total of 28 youth in grades 4th-8th attended this week long program. These Science Pathways participants are providing valuable and low-cost programming to youth in their own communities. The Science Pathways program offers leadership opportunities for program participants, and also provides role models to younger youth from within their own urban community. 75% of the youth who attended the 4-H Junior Scientist Program at William Paterson University, run by Science Pathways participants said the program was very good or excellent.

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #5

1. Outcome Measures

Short Term - REAL LIFE Academy. Youth increase awareness, knowledge, attitudes, and skills related to essential elements, workforce development, life skill development, and relevant subject matter. Volunteers increase knowledge and awareness of practices fostering positive youth development, including youth/adult partnerships. Youth development professionals and stakeholders increase awareness and knowledge of problems and solutions supporting positive youth development, including: policies that need to be addressed,community resources and support.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Teens will soon be making the transition from living with their parents to living on their own. Are they prepared with the skills they need to make this transition? For instance, a study completed by the Organization for Economic Co-operation and Development indicated that "more than one in six students in the United States does not reach the baseline level of proficiency in financial literacy. At best, these students can recognize the difference between needs and wants, can make simple decisions on everyday spending, and can recognize the purpose of everyday financial documents such as an invoice." In the past, schools provided basic cooking, sewing, and financial management skills through Home Economics programs. These types of programs are rarely offered in schools today. Where are teens learning these skills now? While many skills can be learned in the home, parents can use some help.

What has been done

The REAL LIFE Academy was designed to teach teens basic life skills. The Academy is a week long day camp for teens who had just completed grades 7, 8, and 9 and introduced teens to skills they will need for life on their own including the following: financial management; cooking skills and meal planning (including shopping); consumerism skills; home care and laundry; consumerism skills (grocery store field trip); basic nutrition; basic first aid; clothing care (sew on a button, iron a shirt, remove a stain); basic etiquette -and more! The week included cooking every day with a culinary arts teacher from the Vo-Tech to learn basic culinary skills. Another instructor from the Vo-Tech taught carpentry skills. Financial management was taught each day with guest speakers and by using 'My Financial Future' which is National 4-H curriculum. Additional curriculum regarding etiquette and consumerism decision making came from Florida, Georgia, and Oklahoma 4-H. The Family and Community Health Sciences (FCHS) Senior Program Coordinator taught nutrition lessons each day, conducted a session on the importance of physical activity, and led a field trip to a local grocery store where teens learned about unit pricing. An educator from the County Health Department provided a basic first aid session on hands only CPR. A REAL LIFE Simulation where teens were assigned a career, marital status, number of children, and their credit status. They determined their net monthly income for the month and then needed to visit a dozen stations where they need to make choices for things like transportation, housing, insurance, groceries, child care, and amenities. The FCHS Educator provided a healthy snack in the morning and a brief nutrition lesson each day while leading a session about keeping physical activity a part of your life and guided teens on the field trip to the grocery store. Additional topics taught included: how to understand unit pricing and comparing the nutritional and economic value of fresh, frozen, and canned vegetables.

Results

A retrospective pre-post survey indicated increases in: skills learned and knowledge gained. The greatest increases were seen in: how to do hands only CPR; sewing on a button; setting financial goals; appropriate table settings; writing a check; cost of living on my own; how credit works. When asked one thing they learned, teens indicated the following: "I learned how to get the best food for a cheap price." "I learned that not everything will be the way you want it."

4. Associated Knowledge Areas

KA Code	Knowledge Area
806	Youth Development

Outcome #6

1. Outcome Measures

Long Term - 4-H Teen Café. Youth demonstrate mastery and competencies needed to become engaged by assuming leadership positions in communities; developing and implementing action plans to address community needs, and becoming productive members of the workforce. 4-H youth are engaged partners in decision making regarding RCE programming including but not limited to 4-H youth development programming. 4-H alumni and volunteers become engaged citizens by assuming leadership positions in communities. Youth development professionals and stakeholders influence decision makers in policy development related to youth development needs and issues.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Bringing teens to campus supports the university's commitment to youth outreach and STEM education. The objective is for teens to come to campus to 1) increase their exposure and understanding of what RU has to offer in STEM and 2) to increase their comfort level being on campus and meeting what will hopefully be their future professors for their undergraduate studies.

What has been done
The 4-H Teen Science Café is an out-of-school program that offers teens the opportunity to explore the big advances in science and technology affecting their lives. Teens and STEM experts engage in lively conversations and activities to explore a topic deeply. There is a core group of ~15 teens (grades 9-12) that actively plan and facilitate the cafes. The opportunity to host the café on the main campus of Rutgers, a major research university, is beneficial for the youth. The teens hear short talks from research scientists that represent a multitude of disciplines, and they are immersed in the collegiate atmosphere. The café provides youth with a unique, STEM-based opportunity to complement their 4-H experience.

Results
The Teen Cafe program continues to build momentum in the 4-H program to 1) retain teens that are in 4-H and provide a meaningful outlet to continue their 4-H experience and 2) for those teens who are not in 4-H, it formally introduces them to the program and provides them with a positive experience. Overall the cafe is supporting the teens in development of public speaking skills and

increasing their knowledge of STEM disciplines (e.g. Earth science, biology, and ecology). The program was offered on sea level rise, cancer biology and genetics, and urban ecology.

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.)
- Other (Youth risk factors)

Brief Explanation

None to report.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

NJAES research and extension outcomes related to this planned program were evaluated utilizing a variety of evaluation methods appropriate for each initiative to determine the effectiveness on both a qualitative and quantitative level. For KASA, and practice change we included the measurement of knowledge gained as measured by pre/post Likert-scale assessment. Surveys were used to measure increase in skills acquired, behavior change and practice adoption. For process evaluation we focused on program delivery, participation, relevance and timeliness. Data was collected at appropriate times for each initiative that supports this planned. IRB approved evaluation instruments were used to collect research and extension data. Data analyses and comparisons relevant to basic and applied research and demonstration were collected and analyzed and reported utilizing a variety of data collection methods appropriate to each research question. The major goal of evaluating is the demonstration of social, economic, behavior, and environmental changes in conditions that contribute to improved quality of life as a result of participation in programs and benefits of research solutions. See state defined outcomes for detailed results for the initiatives.

Key Items of Evaluation

None to report.

V(A). Planned Program (Summary)

Program # 4

1. Name of the Planned Program

Global Food Security and Hunger - Agricultural Viability

☑ 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
205	Plant Management Systems	20%		20%	
211	Insects, Mites, and Other Arthropods Affecting Plants	20%		20%	
215	Biological Control of Pests Affecting Plants	20%		20%	
601	Economics of Agricultural Production and Farm Management	20%		20%	
604	Marketing and Distribution Practices	20%		20%	
	Total	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	65.0	0.0	36.0	0.0
Actual Paid	5.7	0.0	14.6	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
695784	0	898378	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
3680123	0	4394014	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
409940	0	3275102	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Identify critical programmatic foci/needs based on Extension and stakeholder assessment. These can be broadly defined under three areas:

- Production BMPs (nutrient, pest, waste/by-products management, water quality and quantity, energy)
- Financial BMPs (marketing, labor, risk management, policy e.g. farmland preservation)
- Ag Systems (sustainable ag, organic ag, new crops and use/alternative)

Develop an inventory of local (county based), regional and statewide programs designed to meet these needs; identify team members and their roles.

Create a multi-task effort to generate and share research-based information with clientele through demonstrations, educational meetings and workshops, certification programs, trainings, development of recommendation and decision making guides, etc.

2. Brief description of the target audience

Stakeholders (broadly defined to include producers, processors, marketers, end-users, policymakers, legislators).

Commercial agriculture producers and end-users (such as marketers, processors, consumers, etc.).

Municipalities and other governmental and non-governmental agencies, etc.

3. How was eXtension used?

Faculty participated in answering "Ask The Expert" questions, participation in CoP, and the development of collaborative educational products.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	28591	91597241	2213	15

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

Patent Applications Submitted

Year:	2018
Actual:	3

Patents listed
62/622,206 - LOW ACID CRANBERRY VARIETIES AND PRODUCTS THEREOF: REDUCING THE NEED FOR ADDED SUGAR IN CRANBERRY PRODUCTS (FILED);
PCT/US18/43259 - APPLICATION OF AN ENDOPHYTIC BACKTERIUM IN GRASSES TO INCREASE PLANT GROWTH, SUPPRESS SOIL BORNE FUNGAL DISEASES, AND REDUCE VIGOR OF WEEDY COMPETITORS (FILED);
PCT/US18/45173 - BACTERIAL MIXTURES FROM NON-CULTIVATED PLANT RELATIVES FOR COTTON (GOSSYPIUM HIRSUTUM) FOR THE RESTORATION OF DAMAGED MICROBIOMES OF CULTIVATED COTTONSEEDS (FILED)

10-7001 - CRANBERRY VARIETY NAMED CNJ95-20-20 "SCARLET KNIGHT' (ISSUED);

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	39	80	119

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- A variety of strategies will be implemented to reach target audiences. This will include and not be limited to workshops, field visits, classes, newsletters, media releases, electronic communications,and publications.In addition a trained volunteer teaching base will be developed. Quantitative reports of participation will be collected.

Year	Actual
2018	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Short Term - Increases in knowledge and skills of agricultural and horticultural industry professionals will occur relating to: Nutrient management Pest management Waste/by-products management and utilization Improving water quality and conserving water Conserving energy Marketing skills Labor management Risk management Policy e.g. farmland preservation Sustainable ag and organic ag production methods New crops and use/alternative crops
2	Medium Term - Productive agricultural land is stabilized to meet the needs of the agricultural industry and the needs of people of NJ. Agriculture remains a relevant and viable economic sector as profits increase (through reduced costs and/or increased or new sales or revenue streams). Measurable reductions in environmental impact (clear and adequate sources of water, reduced waste, reduced soil losses, reductions in non-point source pollution, etc.) will occur through the adoption of improved and sound management practices. Overall state environmental quality will be enhanced by agriculture, such as through the utilization and recycling of biowastes generated by the non-ag sector or the enhancement of air quality. The products of NJ agriculture will add to the nutritional quality of New Jerseyans food supply.
3	Long Term - New Jersey's agriculture will remain a viable and important industry. New Jersey residents will recognize the importance of agriculture's contributions to societal well being (open space, quality of life) and will support the agricultural industry socially, politically and economically.
4	Long Term - Addressing Food Security in Union County. New Jersey's agriculture will remain a viable and important industry. New Jersey residents will recognize the importance of agriculture's contributions to societal well being (open space, quality of life) and will support the agricultural industry socially, politically and economically.
5	Long Term - NJAES Strawberry Breeding Program. New Jersey's agriculture will remain a viable and important industry. New Jersey residents will recognize the importance of agriculture's contributions to societal well being (open space, quality of life) and will support the agricultural industry socially, politically and economically.
6	Long Term - Sustainable Peach Production in New Jersey. New Jersey's agriculture will remain a viable and important industry. New Jersey residents will recognize the importance of agriculture's contributions to societal well being (open space, quality of life) and will support the agricultural industry socially, politically and economically.
7	Long Term - Best Management Practice for New Jersey Vineyard. New Jersey's agriculture will remain a viable and important industry. New Jersey residents will recognize the importance of agriculture's contributions to societal well being (open space, quality of life) and will support the agricultural industry socially, politically and economically.
8	Long Term - Conservation and Utilization of Plant Genetic Resources. New Jersey's agriculture will remain a viable and important industry. New Jersey residents will recognize the importance of agriculture's contributions to societal well being (open space, quality of life) and will support the agricultural industry socially, politically and economically.

Outcome #1

1. Outcome Measures

Short Term - Increases in knowledge and skills of agricultural and horticultural industry professionals will occur relating to: Nutrient management Pest management Waste/by-products management and utilization Improving water quality and conserving water Conserving energy Marketing skills Labor management Risk management Policy e.g. farmland preservation Sustainable ag and organic ag production methods New crops and use/alternative crops

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Extend and Maximize the Post-Harvest Quality of High Value and Perishable Crops - Small fruit and cut flowers are important horticultural commodities in the US. The annual retail trade in floricultural products is a $32 billion industry. Most cut-flowers sold in the US are grown in Columbia and Ecuador and must be shipped to the US for distribution. Cut flowers are a highly perishable commodity and methods to reduce loss due to fungal disease and senescence during shipping is vital. In addition, the small fruit industry is a significant horticultural industry in the US. Strawberries are a $2.3 billion industry. Most fruit are consumed domestically, but are shipped largely from CA and FL throughout the country with a significant export market in Canada. Blueberries are also consumed domestically but with the fresh market industry localized in just a few states (NJ, MI. OR, WA), fruit are shipped nationwide, although there were also 36,000 metric tons exported in 2011. If global export and import markets are to be expanded, shipping and storage of these high value but perishable commodities require new methods to control disease and senescence of fruits and flowers. These losses are estimated as high as 25% in the US and even greater worldwide.

What has been done

NJAES researchers are developing an organic system to control postharvest fungal diseases of fresh fruit and flowers during shipping and storage using the controlled release of natural antifungal volatile compounds from cyclodextrin in a modified atmosphere package to reduce production losses of high value, perishable, organic and conventionally grown horticultural commodities. Herbs such as thyme, oregano, cinnamon and garlic have been used throughout

history to not only add flavor to foods but to preserve their shelf life. The essential oils (EOs) found in herbs has been shown to be responsible for anti-microbial effects. In addition, EOs typically act as growth inhibitors. Monoterpenes from a variety of plants are known to inhibit respiration and act as uncoupling agents for ATP production. This coincides with the two most important factors for increasing postharvest shelf life: reduction in disease and reduced respiration. The major difficulty in using monoterpene EOs for reducing disease and inhibiting the deleterious effects of respiration on shelf life is that the compounds are volatile. Volatility makes the compounds difficult to apply and their effective treatment time is limited, nevertheless; a volatile compound can coat the surface of the plant cuticle much more effectively than a compound dissolved in water. The second component to the research is to use Modified Atmosphere Packaging (MAP) to wrap the clamshell packages. The MAP has microperforations in the packaging to create an atmosphere modified by the amount and type of fruit in the package. During storage, the fruit respires, reducing the oxygen, and increasing the carbon dioxide content of the package. Some water vapor exits the package preventing condensation that can promote disease. The optimal oxygen content of the package for a variety of fruits and vegetables is about 5%, and carbon dioxide from 5-10%. Without the microperforations oxygen content can drop below 1% creating an anaerobic environment resulting in off-flavors and aroma along with fruit deterioration. MAP also maintains water content of the fruit. This is important because strawberry is typically 92% water when ripe. Losses of as little as 2% are significant because they change color and texture of fruit and increase consumer rejection. Treatments. Cooled fruit were added to each package (6 replicates /treatment) and weighed. Strawberry fruit were maintained for 7 days at a temperature between 0-4 C. There were 4 treatments in each experiment. These treatments consisted of some combination of thyme (Thymus vulgaris) EO and MAP in a 2x2 complete factorial experimental design. Two Tyvek sachets containing CD (with /without EO) were taped to the inner bottom of the containers in some experiments, or a coating of the CD-EO complex was prepared with soy protein isolate and glycerol.

Results

'Chandler'strawberries were picked directly into clamshell containers at a commercial farm in NJ. After 7 days, the fruit was evaluated and then again after 1 additional day at 11 C to simulate a retail display. The fruit were evaluated for changes in fresh weight, disease incidence and two quality parameters, firmness and Brix. It was clearly evident that enclosing the clamshell packaging containing fruit in MAP reduced water loss. Treatments without MAP lost 5.4% fresh weight whereas with MAP treatments lost 0.4% or less fresh weight. At $4/lb., this loss of fresh weight translates directly into an economic loss. EO had no effect as expected on fresh weight loss. In contrast, disease incidence was significantly reduced by treatments containing thyme EO. The best treatment was TO:CD +MAP with the lowest percentage of disease fruits. Fruit quality parameters such as firmness and Brix (soluble solids) were in the range for acceptable ripe fruit with all treatments. Fruit firmness slightly increased during storage, whereas mean Brix only increased in the treatments without MAP. This may have been due to the loss of fresh weight. After 7 days in cold storage, the fruit were stored at 11 C for one additional day to simulate retail shelving conditions. All treatments were stored without MAP. The higher temperature resulted in a loss of fresh weight. Treatments without MAP lost an additional 4% of their fresh weight to a total fresh weight loss of 7-8%. Treatments that had been enclosed in MAP now lost a total of 2-3% of their fresh weight. The presence of MAP was a significant factor in reducing total fresh weight loss. Disease increased across all treatments, but disease incidence was lowest with the with the treatments containing thyme EO . Mean firmness and Brix was not significantly different across all treatments from initial harvest values. The results clearly indicate the value of thyme EO for disease control and MAP for reducing weight loss.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
215	Biological Control of Pests Affecting Plants
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices

Outcome #2

1. Outcome Measures

Medium Term - Productive agricultural land is stabilized to meet the needs of the agricultural industry and the needs of people of NJ. Agriculture remains a relevant and viable economic sector as profits increase (through reduced costs and/or increased or new sales or revenue streams). Measurable reductions in environmental impact (clear and adequate sources of water, reduced waste, reduced soil losses, reductions in non-point source pollution, etc.) will occur through the adoption of improved and sound management practices. Overall state environmental quality will be enhanced by agriculture, such as through the utilization and recycling of biowastes generated by the non-ag sector or the enhancement of air quality. The products of NJ agriculture will add to the nutritional quality of New Jerseyans food supply.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Hopyard Establishment, Management, and Post-Harvest Handling - An increasing number of breweries in New Jersey (and the Tri-State Area), combined with the local food movement have contributed to a growth in the number of inquiries on how to establish a hopyard. In addition, one of the most critical aspects of hop farming is encouraging growers to employ the best post-harvest management practices to ensure growers know how to properly handle and store hops.

What has been done
Several individual consultations have been made with growers at the demonstration hopyard located at the Snyder Research and Extension Farm in NJ. These meetings served to inform

growers about pests, fertility management, hopyard establishment and the Rutgers hop quality analysis service. In addition, several formal presentations were made to growers explaining the process of harvesting hops, and emphasizing how quality (value) can be compromised if proper post-harvest guidelines are not adhered to. In addition, these talks served as opportunities to inform growers about the Rutgers hop quality testing services.

Results
As a result of this program nearly 20 hop growers in New Jersey have begun to submit their hops for quality testing to the Rutgers University hop analysis service.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
215	Biological Control of Pests Affecting Plants
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices

Outcome #3

1. Outcome Measures

Long Term - New Jersey's agriculture will remain a viable and important industry. New Jersey residents will recognize the importance of agriculture's contributions to societal well being (open space, quality of life) and will support the agricultural industry socially, politically and economically.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
New Crops and Plant Products for Income, Health, Nutrition and Medicine - Profitability and, subsequently farm viability has been a challenge to produce growers in the eastern United States since the 1980's because of highly volatile market prices. Growers in the east also operate on a relatively small land base with production costs that are generally higher per unit of crop output.

This puts them at a competitive disadvantage against larger commodity growers from other states, where production costs are comparatively lower. Encroachment of farmland by development, coupled with the difficulty to maintain profitability, create a challenge for some farming enterprises, leading to the need to produce higher value crops in New Jersey and the East coast. Future success in commercial farming will depend largely on the commercialization and expansion of high value, specialty crops such as ethnic produce, and plants of interest because of their health and nutritional benefit. Targeting specific niche markets can provide favorable competitive advantages, as does the rise in interest of locally grown produce and leaving a greener footprint with lowered transportation costs.

What has been done

NJAES researchers are building upon their ongoing research on new crops and plant products and the development of ethnic greens and herbs, using a market-first approach. In addition, they are building upon their international models of horticultural commercialization which uses a market-first science-driven approach with fresh and processed vegetables, herbs, spices and medicinal plants which serve as the economic driver for targeted rural African communities in sub-Sahara Africa. Implemented under the Agri-Business in Sustainable Natural African Plant Products (ASNAPP) program, researchers used a sustainable development model for the diversification of valuable agricultural commodities and developed marketing channels. They are exploring scale-up and replicability and continue to develop new crops and new products. Much focus is on good agricultural practices, introduction of high quality germplasm, the nutritional and health promoting properties of the plant that when coupled to quality assurance and quality control systems for collection or cultivation with partnerships with buyers.

Results

Focus continued in plant breeding, with the development of new sweet basil downy mildew tolerant/resistant varieties, with the release of four new Downy Mildew Resistant Sweet Basils, and an improved understanding of the basis for resistance; continued breeding specialty and ornamental basils with DM and Fusarium resistance; began to gene stack multiple resistances into single new basil, continued to identify and develop new plants with aromatic oils that repel insects and other insect and animal pests; the development of additional ethnic greens and herbs. Development of chilling tolerant basil lines continued with an expanded focus on Fusarium wilt resistance. Researchers continued their focus on the genetic basis of DRM and FOB, and in searching for markers associated with resistance and those associated with specific aroma compounds such as methyl chavicol, linalool and 1,8-cineole. They began new work in developing robust regeneration systems for basils.The new catnips, CR9, rich in essential oil and the bioactive isomer of nepetalactone as a potential insect repellant and CR3, with unique chemistry and attributes were studied for their efficacy against a number of insects with promising results. New exotic peppers, including habaneros, poblanos, and African Bird Eye Chili continue to be developed with the release in 2017 of Rutgers Pumpkin Habanero, that has unique taste, flavor and visual appeal to meet the ethnic markets. A new vegetable amaranth is also being developed for high yield and rich iron, Mg and Ca contents. Edible nightshades were extensively studied for the presence of glycoalkaloids in leaves and fruits and researchers found leaves to be safe to consume while the fruits were rich sources of these alkaloids. New analytical protocols for improved quantification of natural plant products was a core focus using a Shimadzu TQ8040 Triple Quad MS for volatiles and an Agilent UPLC-triple quadrupole-MS/S for medicinal compounds. Projects were completed linking chemistry of aromatic volatiles to human sensory responses. Taste tests were conducted on new plant variety releases and the flavor was found to be acceptable to consumers furthering the selection and breeding work to include aroma and flavor as key components. Models for improving food security, nutrition and income generation continue to be developed as part of the international programs and significant focus is on exploring ways in which indigenous vegetables can create income generating opportunities and

improve health and nutrition by increasing dietary diversity. Collaborative work using natural products for human health and disease led to the development of new analytical protocols for the quantitation of difficult to detect levels of microbial generated phenolic acid metabolites derived from grape flavanols and separately also by raspberry ketones. Series of PK studies have identified bioactive compounds that may be associated with the medicinal activity.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
215	Biological Control of Pests Affecting Plants
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices

Outcome #4

1. Outcome Measures

Long Term - Addressing Food Security in Union County. New Jersey's agriculture will remain a viable and important industry. New Jersey residents will recognize the importance of agriculture's contributions to societal well being (open space, quality of life) and will support the agricultural industry socially, politically and economically.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Union County NJ is home to 563,892 residents living in a 103 square mile area, with a population of 5,216 people per square mile. In this densely populated county, 9.3% are living at the poverty level. These approximately 53,100 residents may face the issue of food insecurity.

What has been done
Since 2002, the Rutgers Master Gardeners of Union County have grown vegetables for local food pantries in the county. A 'Sharing Garden' is located in the demonstration garden at Trailside

Nature and Science Center. Master Gardener volunteers learned how to start the plants from seed, transplant, care for and harvest the vegetable plants through hands-on gardening experiences. The Master Gardener course includes classroom lectures on soils, vegetable gardening and integrated pest management strategies for home and community garden vegetable production. The County of Union has a 'Community Gardening' Grant program in which local community garden organizations and schools can receive start up grants to build and plant raised bed gardens and hydroponic units. In 2018, sixty-one (61) community gardens grants were awarded to school and community groups. Union County Agriculture Agents provided lectures on 'Good Bugs vs Bad Bugs' and 'Composting' at the county's Come Grow with Us Community Garden Conference for 106 county grant recipients program. Participants learned proper composting techniques for community garden settings and integrated pest management strategies for preventing/managing insect and disease problems in a vegetable garden, including the use of beneficial insects.

Results
In the 2018 growing season, Master Gardeners produced and donated 1338 pounds of fresh vegetables to local food pantries. The retail value of the produce is $2,515. Fourteen (14) food pantries received the vegetables. Volunteer Master Gardeners provided support by providing technical advice and assisting with growing and harvesting vegetables to various local organization.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
215	Biological Control of Pests Affecting Plants
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices

Outcome #5

1. Outcome Measures

Long Term - NJAES Strawberry Breeding Program. New Jersey's agriculture will remain a viable and important industry. New Jersey residents will recognize the importance of agriculture's contributions to societal well being (open space, quality of life) and will support the agricultural industry socially, politically and economically.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Strawberries are an important crop for many New Jersey farmers that sell directly to consumers through retail operations. A New Jersey Agricultural Experiment Station (NJAES) 2015 survey of 75 of an estimated 130 small fruit growers in NJ revealed that 19% of small fruit growers attributed 25% or more of their income to strawberries. The most important attributes reported by growers when considering selection of strawberry varieties were flavor (93.8%), disease resistance (76.4%); yield (73.3%) and fruit size (72.2%). Growers reported an average retail price of $3.31 per pound and an average wholesale price of $2.20 per pound. Growers produced an average of 15,000 pounds of strawberries per acre. The primary goals for the NJAES breeding program are to produce better tasting strawberries that are disease resistant and better adapted to the challenges of Northeast growing conditions.

What has been done

Utilizing traditional plant breeding, the Rutgers NJAES strawberry team has developed new strawberry varieties which have provided new selections to help farmers enhance local production and marketing. The new strawberry selections were tested at two NJAES research stations in addition to several other University sites and on six farms throughout the state using both organic and conventional production systems. Rutgers NJAES developed partnerships with two commercial strawberry nurseries to produce new NJAES varieties for distribution to farmers throughout the state and nation. Farmers and industry professionals were educated on this research and local strawberry production techniques through state and regional presentations, on-farm meetings and Extension conferences. Consumers were informed about the project through Extension training sessions, newspaper and journal articles and television segments.

Results

In 2017, 365,788 Rutgers Scarlet strawberry plants were sold and distributed via 518 sales to 44 states and four Canadian provinces for an estimated average wholesale production value of $804,733 for 2018 season production. The demand among growers in New Jersey and throughout the USA and Canada to produce and market the new Rutgers ScarletTM strawberry demonstrates a change in behavior and adoption of a new variety to enhance profits for growers. Three hundred and fifty farmers were able to observe and learn about the selections firsthand at educational meetings. An additional 30,000 farmers were made aware of the strawberry selections and their potential through the Nourse catalog, grower newsletters, and other media outlets. Consumer awareness about local strawberry production as well as the NJAES strawberry breeding and release project and new NJAES selections was accomplished through educational tours, TV and radio segments, newspaper articles, educational videos, taste panels and web based press releases that went out to over 300,000 people.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems

211	Insects, Mites, and Other Arthropods Affecting Plants
215	Biological Control of Pests Affecting Plants
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices

Outcome #6

1. Outcome Measures

Long Term - Sustainable Peach Production in New Jersey. New Jersey's agriculture will remain a viable and important industry. New Jersey residents will recognize the importance of agriculture's contributions to societal well being (open space, quality of life) and will support the agricultural industry socially, politically and economically.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The Tree Fruit Industry of South Jersey is more than a century old. Competition from other states and constant retail prices have resulted in a decline of peach production acreage from 45,000 acres in 1980's to 4,800 in 2016. One way to increase the market share is to provide high-quality fruits tailored to the local markets and retail outlets, throughout harvest windows (June to Sept). NJAES is well positioned to fill the gap in providing a high-quality fruit through outreach, education, and demonstration of these advances to the peach industry and will lead to greater success and improved local recognition of this industry and Rutgers products. South Jersey's orchards need to modernize to be more efficient in production, specifically in the area of post-harvest handling of fruits; integrating modern technologies for frost protection, and precision irrigation.

What has been done
Three broad programs have been developed. The multi-model approach was used to reach out to as many growers: presentations at eight growers meetings in NJ and PA; development of a Fact Sheet; and conducted three demonstrations: (1) Peach and Nectarine Varieties Development Program (2) Tree Fruit Integrated Pest Management Program (3) Orchard Modernization Program.

Results
433 growers increased their awareness about new peach and nectarine varieties developed from Rutgers Tree Fruit Breeding Program. 399 growers learned about 'how to protect orchards from the frost damage. Survey after the educational program indicated that 86% of the respondents intend to integrate at least one of the five methods of frost protection in their orchard. 67% of the respondents agreed that the budget and technical details presented will help them in deciding which system to use or implement. These responses indicate that there is a possibility of prevention of substantial loss of crop due to frost damage. 86 growers learned how to use peach bloom and fruit thinner. 66 growers learn how to estimate the pump capacity for irrigating new and existing orchard block. 269 growers received information on how to manage vole damage.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
215	Biological Control of Pests Affecting Plants
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices

Outcome #7

1. Outcome Measures

Long Term - Best Management Practice for New Jersey Vineyard. New Jersey's agriculture will remain a viable and important industry. New Jersey residents will recognize the importance of agriculture's contributions to societal well being (open space, quality of life) and will support the agricultural industry socially, politically and economically.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
New Jersey is uniquely suited to produce high-quality wine grapes. Its varied climates create an

opportunity for producing a rich and varied suite of wines. However, major biotic and abiotic stresses affect the sustainability of this production system. Three main challenges that affect the economic sustainability of the wine industry are: (1) harsh winters leading to cold injuries and subsequent scourge of crown gall disease; (2) high humidity causing high disease pressure and excess precipitation causing excess canopy, and (3) viral diseases, caused by infected planting material sourced from the non-certified nurseries. Considering these factors, there is a need for developing and implementing a Best Management Practices (BMP) program in wine grape production.

What has been done
The Multi-Model approach was used to reach out to as many wine grape growers in NJ and nearby states. Eight educational meetings were conducted and presented at these meeting. Two workshops were organized, one each for pruning workshop and canopy management. Three Factsheets were distributed digitally and hard copies.

Results
In 2018 these three Fact Sheets received additional 2540 views or downloads. 16,000 subscribers of trade magazine 'Fruit Growers News' received information on Techniques for preventing cold injuries to grapevines and 11,000 subscribers of trade magazine Good Fruit Grower received information on how to differentiate between nutritional deficiency and virus symptoms. A plant pest advisory article was read by 101 growers. Due to this education, growers prevented substantial loss of wine grape crops due to cold damage and saved a substantial amount of money. Growers saved a substantial amount of time and efforts in addition to saving money in identifying the nutritional deficiency and virus symptoms. Growers also saved a substantial amount of money in pest management due to efficient canopy management.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
215	Biological Control of Pests Affecting Plants
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices

Outcome #8

1. Outcome Measures

Long Term - Conservation and Utilization of Plant Genetic Resources. New Jersey's agriculture will remain a viable and important industry. New Jersey residents will recognize the importance of agriculture's contributions to societal well being (open space, quality of life) and will support the agricultural industry socially, politically and economically.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
All tree fruit cultivars have defects which reduce fruit quality, marketable yields and/or their ornamental value. Susceptibility to bacterial diseases, small size, lack of fruit firmness, inability for the fruit to store, poor fruit color, and lack of flower bud hardiness are common drawbacks of currently available varieties. The consistent development of a steady stream of new and improved tree fruit varieties is critically important to a long-term agricultural competitiveness.

What has been done
NJAES researchers identified new sources of genetic diversity to develop peach, apricot, and apple cultivars which will be better adapted to northeastern growing conditions. NJAES researchers continued to characterize Prunus and Malus germplasm obtained from the Plant Germplasm Quarantine Program in Beltsville, MD, the National Clonal Repository in Davis, CA and the Plant Genetic Resource Unit in Geneva, NY for its potential use in plant breeding programs in the Mid-Atlantic region and elsewhere in the US.

Results
The conservation of potentially useful germplasm in the field can be challenging when the germplasm is not well adapted to the local growing environment. Germplasm possessing useful traits of interest has been integrated into our breeding program in controlled crosses with superior cultivars and advanced selections. These progenies were grown in NJ, and the group has selected segregants that are better adapted to the local environment. Accessions and elite selections were evaluated for hardiness, bloom date, flower bud set, crop load, fruit size and weight, fruit quality, fruit firmness and disease resistance. Quantitative and qualitative information about each accession/selection was entered into a database, analyzed, and compiled into reports that are disseminated to researchers, nurserymen, and grower cooperators. Although there was a prolonged period of above normal temperature in early February this year, many of the apricot selections had good flower bud survival in early April. During the bloom period, it was very cool and rainy, so fruit set on our controlled crosses was extremely light yielding only six hybrid seed. Researchers harvested an additional 741 open pollinated seed from three apricot selections with excellent fruit set and quality and one of our commercially released cultivars. Similarly, fruit set on our peaches and nectarines [Prunus persica (L.) Batsch] was also negatively impacted by the cool, wet spring. From seventy-one controlled crosses, the group only obtained 506 seeds, and an additional 606 open pollinated seed from twenty advanced selections. Although the peach and nectarine crops were very light, they were able to select peach and nectarine seedlings from the controlled crosses for cold hardiness, bacterial spot resistance and fruit quality in solid seedling

rows. Over the course of this project, many peach, apricot, and apple selections have been made and distributed to researchers, growers, and nurserymen for further testing. Several of these selections were identified as potentially superior to existing cultivars and have been commercialized.

4. Associated Knowledge Areas

KA Code	Knowledge Area
205	Plant Management Systems
211	Insects, Mites, and Other Arthropods Affecting Plants
215	Biological Control of Pests Affecting Plants
601	Economics of Agricultural Production and Farm Management
604	Marketing and Distribution Practices

V(H). Planned Program (External Factors)

External factors which affected outcomes

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

Brief Explanation

None to report.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

NJAES research and extension outcomes related to this planned program were evaluated utilizing a variety of evaluation methods appropriate for each initiative to determine the effectiveness on both a qualitative and quantitative level. For KASA, and practice change we included the measurement of knowledge gained as measured by pre/post Likert-scale assessment. Surveys were used to measure increase in skills acquired, behavior change and practice adoption. For process evaluation we focused on program delivery, participation, relevance and timeliness. Data was collected at appropriate times for each initiative that supports this planned. IRB approved evaluation instruments were used to collect research and extension data. Data analyses and comparisons relevant to basic and applied research and demonstration were collected and analyzed and reported utilizing a variety of data collection methods appropriate to each research question. The major goal of evaluating is the demonstration of social, economic, behavior, and environmental changes in conditions that contribute to improved quality of life as a result of participation in programs and benefits of research solutions. See state defined outcomes for detailed results for the initiatives.

Key Items of Evaluation

None to report.

V(A). Planned Program (Summary)

Program # 5

1. Name of the Planned Program

Climate Change - Home, Garden and Environment

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	20%		20%	
111	Conservation and Efficient Use of Water	20%		20%	
131	Alternative Uses of Land	20%		20%	
205	Plant Management Systems	20%		20%	
721	Insects and Other Pests Affecting Humans	20%		20%	
	Total	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	15.0	0.0	10.0	0.0
Actual Paid	2.1	0.0	11.8	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
261561	0	477801	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
1562389	0	4211582	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
169366	0	1153961	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Identify critical programmatic foci/needs based on Extension and stakeholder assessment broadly defined under two areas:

- Environmentally sound gardening/lawn care
- Home horticulture-lawn, garden and grounds management
- Commercial horticulture - professional management and maintenance
- Environmentally sound household, structural pest control
- Home pest control-termites, carpenter ants,, etc.
- Human-heath related pest control-bed bugs, mosquitoes, ticks, etc.
- A school IPM program will be developed to train end-users sound management techniques,

Develop an inventory of local (county based) and regional and statewide programs designed to meet these needs. Identify team members and their roles. Create a multi-task effort to generate and share research-based information with clientele, including research, demonstrations, educational meetings and workshops, certification programs, trainings, etc. Research on plant cultivars that exhibit increased disease ans insect resistance , as well as reduced need for fertilizer and irrigation water, will lead to reduced dependence on chemical control of pests and disease, lessening the impact on the environment.

2. Brief description of the target audience

Stakeholders:

- Homeowners and residential clientele
- Commercial horticulture professionals (management and maintenance)
- Commercial pest control operators
- Public health officials
- Local environmental commissions or others that have interest in these areas
- Municipalities and other governmental and non-governmental agencies, including Parks Commission, Public Health, Mosquito Commission, schools, etc.
- Volunteers (trained via Master Gardener Program, Environmental Stewards Program), youth and others who can support and benefit from these efforts
- Underserved and underrepresented audiences

3. How was eXtension used?

Faculty participated in the development of collaborative educational products and answering "Ask the Expert" questions.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	41248	237133	982	3153

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

Year:	2018
Actual:	14

Patents listed
15/757,722 - PERSONAL ELECTROSTATIC BIOAEROSOL SAMPLER (PEBS) WITH HIGH SAMPLING FLOWRATE (FILED)
15/997,212 - METHODS AND APPARATUS FOR MANAGEMENT OF MOSQUITO POPULATIONS WITH HABITAT SHARING HETEROSPECIFIC INSECTS CARRYING INSECT GROWTH REGULATOR (FILED)
201800139 - COMPASS II CHEWINGS FESCUE- (FILED)
201800138 - CARDINAL II STRONG CREEPING RED FESCUE- (FILED)
201800420 - WOODALL CHEWINGS FESCUE- (FILED)
201800417 - LEEWARD CHEWINGS FESCUE- (FILED)
201800149 - SHIELD PERENNIAL RYEGRASS- (FILED)
201800150 - SIGNET PERENNIAL RYEGRASS- (FILED)
201800055 - HEIDI KENTUCKY BLUEGRASS- (FILED)
201800068 - MARTHA KENTUCKY BLUEGRASS- (FILED)
201800416 - SR2150 KENTUJCKY BLUEGRASS- (FILED)
201800408 - BLUEBANK KENTUCKY BLUEGRASS- (FILED)
201800008 - TOURPRO CREEPING BENTGRASS- (FILED)
201800147 - 777 (TRIPLE SEVEN) CREEPING BENTGRASS- (FILED)

201600091 - AMITY FALL FESCUE (ISSUED)
201600234 - PARAMOUNT TALL FESCUE (ISSUED)
201600245 - 4TH MILLENNIUM SPP TALL FESCUE (ISSUED)
201600246 - RAMBLER SRP TALL FESCUE (ISSUED)
201600247 - TRAVERSE 2SRP TALL FESCUE (ISSUED)
201600233 - MARVEL STRONG CREEPING FESCUE (ISSUED)
201600301 - MINIMUS HARD FESCUE (ISSUED)
201600015 - BOLT KENTUCKY BLUEGRASS(ISSUED)
201600263 - RUCKUS PERENNIAL RYEGRASS (ISSUED)

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	18	39	57

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- A variety of strategies will be implemented to reach target audiences. This will include and not be limited to workshops, field visits, classes, newsletters, media releases, electronic communications,publications. In addition a trained volunteer teaching base will be developed.Quantitative reports of participation data will be collected.

Year	Actual
2018	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Short Term - Increased knowledge and improved decision making skills of professionals and volunteers (Master Gardeners and Environmental Stewards) working in commercial horticulture professions (management and maintenance), commercial pest control operators, public health officials, municipalities and other governmental and non-governmental agencies. Increased number of trained youth and adult volunteers, and measurable impact of their assistance on clientele. Increased number of certified pest control operators. Increased number of youth and adult clientele utilizing Extension information and service to improve their own and others knowledge and decision making skills.
2	Medium Term - Educated youth and adult clientele, both professional and residential, utilize their newly gained knowledge and skills to implement and make changes such as: Efficient and effective pest control techniques. Proper utilization of fertilizers and other soil amendments as needed based on soil testing. Proper selection of plant materials to reduce need for chemical inputs. Reduction in the damage caused by structural pests. Reduction in health related incidents and costs association with human health vectors (ticks, mosquitoes). Protect health and safety of school children. Enhance or maintain environmental quality.
3	Long Term - New Jersey's residents will reside, work and play in a healthy, safe, and sound environment-in their homes, gardens, schools, parks and workplaces.
4	Medium Term - Biology, Ecology & Management of Emerging Disease Vectors. Educated youth and adult clientele, both professional and residential, utilize their newly gained knowledge and skills to implement and make changes such as: Efficient and effective pest control techniques. Proper utilization of fertilizers and other soil amendments as needed based on soil testing. Proper selection of plant materials to reduce need for chemical inputs. Reduction in the damage caused by structural pests. Reduction in health related incidents and costs association with human health vectors (ticks, mosquitoes). Protect health and safety of school children. Enhance or maintain environmental quality.
5	Long Term - Agrochemical Impacts on Human and Environmental Health: Mechanisms and Mitigation. New Jersey's residents will reside, work and play in a healthy, safe, and sound environment-in their homes, gardens, schools, parks and workplaces.
6	Long Term - Rutgers Environmental Stewards Program. New Jersey's residents will reside, work and play in a healthy, safe, and sound environment-in their homes, gardens, schools, parks and workplaces.

Outcome #1

1. Outcome Measures

Short Term - Increased knowledge and improved decision making skills of professionals and volunteers (Master Gardeners and Environmental Stewards) working in commercial horticulture professions (management and maintenance), commercial pest control operators, public health officials, municipalities and other governmental and non-governmental agencies. Increased number of trained youth and adult volunteers, and measurable impact of their assistance on clientele. Increased number of certified pest control operators. Increased number of youth and adult clientele utilizing Extension information and service to improve their own and others knowledge and decision making skills.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
131	Alternative Uses of Land
205	Plant Management Systems

721 Insects and Other Pests Affecting Humans

Outcome #2

1. Outcome Measures

Medium Term - Educated youth and adult clientele, both professional and residential, utilize their newly gained knowledge and skills to implement and make changes such as: Efficient and effective pest control techniques. Proper utilization of fertilizers and other soil amendments as needed based on soil testing. Proper selection of plant materials to reduce need for chemical inputs. Reduction in the damage caused by structural pests. Reduction in health related incidents and costs association with human health vectors (ticks, mosquitoes). Protect health and safety of school children. Enhance or maintain environmental quality.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Onsite Wastewater Treatment Systems: Assessing the Impact of Climate Variability and Climate Change - Pharmaceuticals and personal care products are chemicals that are commonly used in many American households and contribute to the municipal waste stream. Some of these chemicals may be metabolized by the human body, but a large fraction is released directly into the waste stream. Pharmaceuticals and personal care products may have pharmacological activity, whereas others may interfere with hormonal systems by mimicking estrogen. This has an ecological impact on any animals that may be living in water that receives treated effluent and could contaminate drinking water.

What has been done
NJAES researchers are working to understand the mechanism whereby microorganisms degrade pharmaceutical and personal care products under anaerobic conditions and that increasing temperature extremes resulting from climate change will affect the rate of biodegradation activity, ultimately impacting the amount of these chemicals that can be removed during wastewater treatment and subsequent variability in the concentrations that are released into the environment. To this end, sewage sludge is being used to establish anaerobic enrichment cultures amended with individual pharmaceuticals and personal care products. This creates ideal growth conditions to promote growth of specific organisms that are likely to have pharmaceutical and personal care

product degrading capabilities resulting from continued exposure to household wastes. These chemicals are either washed down the drain or flushed down the toilet and end up as components in waste water. These chemicals must be degraded by the microorganisms in wastewater treatment systems, otherwise they may be released into the environment. NJAES researchers monitor the concentrations of substrate, which will be an indication that biodegradation is occurring. Researchers are studying the microbial community associated with these processes to identify specific metabolites and corresponding genetic markers.

Results
Recent findings indicate that some pharmaceuticals are transformed by microorganisms into products that are slow to degrade. This is important, because these partial transformation products have not yet been examined for pharmaceutical activity or environmental prevalence. Researchers' results provide evidence of metabolites that could be screened for in water samples and biosolids, key modes of pharmaceutical entry into the environment. Researchers continue to monitor enrichment cultures for pharmaceutical and personal care product biodegradation activity. Cultures are periodically transferred to fresh media to maintain activity and further enrich for biodegrading populations. They genetically characterize these enriched microbial communities to gain a better understanding of the types of processes these microorganisms may be involved in. They have transferred the cultures to maintain biodegradation activity. They simplified microbial communities able to degrade pharmaceuticals with diphenhydramine and naproxen were established. Researchers use genetic biomarkers to determine the presence of the benzoyl-CoA pathway in cultures that show degradation of the aromatic ring. They extracted DNA from methylparaben degrading enrichment cultures to screen for genetic functions and used genetic biomarkers for the benzoyl-CoA pathway, which they expect to be present based on the chemical data. They had positive results for these biomarkers. NJAES researchers continue to identify biodegradation products. Two naproxen-degrading consortia were again tested to identify their substrate range. The consortia were found to transform both natural compounds, pharmaceuticals, and personal care products that all contained similar structural characteristics. Some of these products are novel microbial transformation products.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
131	Alternative Uses of Land
205	Plant Management Systems
721	Insects and Other Pests Affecting Humans

Outcome #3

1. Outcome Measures

Long Term - New Jersey's residents will reside, work and play in a healthy, safe, and sound environment-in their homes, gardens, schools, parks and workplaces.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Horticulture for Seniors - Approximately 12% of Essex County residents are senior citizens (> 65 years of age), with senior centers and services are at capacity in the larger urban communities. The county is expanding the number of senior centers to accommodate the demand for lunch programs and activities for its older residents.

What has been done
The Rutgers Master Gardeners of Essex County offer a recreational horticulture program monthly where seniors are provided an educational program about horticulture, nutrition or exercise. The seniors are engaged in "hands on" activity, i.e. making a terrarium, arranging flowers, planting herb boxes) that they take home. Healthy snacks are provided and discussed. The participants are able to socialize with other seniors from across the county, building new friendships and social networks.

Results
Although no formal survey of participants was conducted, Extension faculty and staff interviewed individuals at the monthly sessions and had conversations with the directors of senior centers and assisted living facilities (who have been sending their clients to the program.). In the interviews, it was discovered that seniors are gardening more at home - either with more houseplants in the apartments/rooms or with a community garden space at their senior center. The Master Gardeners reported more requests for help creating gardens at the senior centers.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
131	Alternative Uses of Land
205	Plant Management Systems
721	Insects and Other Pests Affecting Humans

Outcome #4

1. Outcome Measures

Medium Term - Biology, Ecology & Management of Emerging Disease Vectors. Educated youth and adult clientele, both professional and residential, utilize their newly gained knowledge and skills to implement and make changes such as: Efficient and effective pest control techniques. Proper utilization of fertilizers and other soil amendments as needed based on soil testing. Proper selection of plant materials to reduce need for chemical inputs. Reduction in the damage caused by structural pests. Reduction in health related incidents and costs association with human health vectors (ticks, mosquitoes). Protect health and safety of school children. Enhance or maintain environmental quality.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Aside from being a nuisance, mosquitos pose an important public health risk to the U.S. population. Vector viral diseases are harmful to both humans and animals, including West Nile virus, Eastern Equine Encephalitis and, more recently, more exotic diseases such as chikungunya and dengue fever, both of which have arrived in the United States. Since mosquitos frequent shoreline areas with abundant wetlands and coastal salt marshes, effective mosquito control is also crucial to the economic health of those shoreline communities where tourism is an integral part of the local economy. In 1930, the New Jersey Agricultural Experiment Station made the first aerial spray application for mosquito control. Aerial delivery of furnace oil at 8 gallons was ridiculed as 'pie-in-the-sky,' but by 1947 a million acres in New Jersey were being treated annually via aircraft. Today, we are increasingly challenged to diminish pesticide use.

What has been done
NJAES researchers submit that unmanned aerial vehicles (UAV) offer potential to reduce broadcast in favor of highly targeted applications, i.e. precision mosquito control. They have constructed a prototype 6-rotor heavy-lift UAV of carbon fiber for <$5000. The robocopter with mounted sprayer weighs 7.5 kg and is equipped with an array of sensors including sonar, barometer (altitude hold), magnetometer (direction), gyros (stabilization), 2-axis camera (video downlink), accelerometers, optical flow (position hold), long range digital control, GPS, radio telemetry and more. The aircraft is capable of entirely autonomous missions. NJAES researchers

are conducting proof-of-concept field tests on the aircraft's capability to contribute to multiple functions in precision mosquito control including adulticiding, larviciding, larval surveillance, adult surveillance and research. Prototype devices for each of these essential mosquito control functions have been developed for aerial platform and only await field experimentation. Female mosquitoes contaminated with the low-risk insect growth regulator pyriproxyfen can transport lethal concentrations of this substance to additional larval habitats. This offers the promise of effective, economic and environmentally-friendly control for these species. Researchrs have developed an autodissemination station which is highly effective in cage and room studies at attracting and contaminating oviposition-seeking females and releasing lethal concentrations of pyriproxyfen into subsequent containers visited. The prototype has high attraction, exclusion from oviposition, unidirectional design, specialized formulations, extended activity, and is maintenance-free, biodegradable, user-friendly and low-risk. Researchers are extending the concept to additional pest species, assess the effect of field variables on station efficacy, assess field deployment on localized mosquito populations in cryptic habitats, and modify the station to yield a low-cost yet effective product. Prototype stations were tested in field conditions to determine how far the pyriproxyfen can be disseminated, how well it reaches cryptic habitats, and the impact of competing site abundance, size, and water quality. Cage and room tests determine effectiveness of the current design, evaluate oviposition attractants, and assess the impact of our formulations on mosquito fitness. Crucial field trials center on focal points of high mosquito activity (`hot spots'). Field deployed stations were tested over time for structural stability, efficacy duration, and biodegradation. The prototype was modified as necessary to achieve optimal efficacy, cost, and versatility. The final design resulting at the end of this phase will be suitable for large-scale production.

Results

NJAES researchers completed construction and testing of a radical new larval collector designed around the most popular consumer Unmanned Aerial System (UAS) or drone in the world, the Phantom 4. Their new design capitalizes on the ease of use and reliability of the drone to remotely conduct larval surveillance in inaccessible areas. The onboard camera allows the operator to view mosquito larvae in the water in real time. A patent-pending system operates a pump which sucks up live mosquito larvae and delivers them into a collection vial. The design has been preliminarily tested against Aedes albopictus. Researchers previously tested an early design of their ULV (Ultra-Low Volume) unit for adult mosquito control. While the device worked, it had significant technical issues and was difficult to build. Researchers recently completed construction and preliminary testing of a new and improved ULV sprayer. Proper pesticide droplet size is critical to successful adult mosquito control. To guarantee optimal droplet size, they redesigned and modified a proven commercial electric ULV machine to work on their new large autonomous hexacopter. They minimized the size and weight of the unit, designed new housings and mounts, and tied the electronics into our flight control system. They completed calibration of the flow rates and droplet sizes and conducted several successful test flights.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
131	Alternative Uses of Land
205	Plant Management Systems
721	Insects and Other Pests Affecting Humans

Outcome #5

1. Outcome Measures

Long Term - Agrochemical Impacts on Human and Environmental Health: Mechanisms and Mitigation. New Jersey's residents will reside, work and play in a healthy, safe, and sound environment-in their homes, gardens, schools, parks and workplaces.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Heavy metals affect the health and well-being at all nodes on the food chain (including humans); this is especially true for vulnerable, environmental justice communities in New Jersey. There is a need to understand the heavy metal levels in biota (mainly vertebrates) to as sentinels of long-term exposure in coastal New Jersey, and to understand the concerns and perceptions of people to environmental stressors (natural and anthropogenic) in a manner that can lead to mitigation and accommodations.

What has been done
NJAES researchers collected environmental samples and analyzed them for pesticide residues and assessed the levels as to the potential risks to human and ecological health. There are multiple phases of this work, one is measuring metals and other environmental chemicals in fish at different levels in the food chain (biotic and human exposure) in Central and Southern New Jersey. Another is collecting, analyzing and monitoring heavy metal levels in biota as sentinels of long-term exposure in coastal New Jersey. An additional component is understanding the concerns and perceptions of people to environmental stressors (natural and anthropogenic) in a manner that can lead to mitigation and accommodation. Data on intertidal use by shorebirds and data on heavy metals levels of invertebrates, fish and birds that address whether these levels can account for declines in some key species were collected. Both aspects are important for coastal management, species management, and understanding basic scientific mechanisms. There are three major competing claims for intertidal habitat: foraging shorebirds, recreationists, and aquaculture. Since Red Knot (a shorebird) is federal threatened, possible take by any group (including aquaculture) must be considered. The researchers provided key data to consider when deciding whether there should be more or fewer restrictions on rack and bar agriculture with respect to shorebird dependence on the intertidal. During this period, researchers collected

samples (feathers, blood, other tissues) of shorebirds and Pine Snakes to understand the levels of heavy metals in these components of NJ food webs. Using AA equipment, they analyzed mercury, lead, cadmium and other metals to determine where the metals were accumulated. This was possible because blood represents local exposure, and feathers represent chronic exposure. By knowing where birds grew their feathers, it can determine where the birds acquired the metals. Data are analyzed with standard statistics. It is very important to understand the movement of contaminants in food chains, especially in coast environments where fish and shellfish provide important food source for a significant part of the American population. The source of contaminants in coastal and intertidal environments often derives directly from sediment and moves through the food chain. However, the intertidal habitat is also important in and of itself as a spatial element and because of its use by a range of invertebrates, fish and other organisms. NJAES researchers spent considerable time examining different user groups for the intertidal: recreationists, oyster growers, and shorebirds (including the federally endangered Red Knot). This involved a series of observations (natural intertidal areas) and experiments (with and without oyster racks). Field observations were made every day, in different beaches, at different tide times.

Results

Results showed that Red Knots and other shorebirds used the intertidal, including the area rack and bag aquaculture use, and they did so during all tidal phases. Researchers continued examining heavy metals levels in several species of birds, as sentinels of exposure of organisms in coastal waters. Metals come from current and legacy farming and industrial uses. It is essential to understand whether metals levels are high enough to cause adverse effects in the birds (and our data show they are not), might cause adverse effects on their predators (and they were not high enough to cause effects), and to determine whether these levels are acquired in New Jersey or the U.S. This research is continuing, but preliminary data indicates that in some cases metals are coming from Northern Brazil (e.g. selenium). Understanding the movement of chemicals, such as mercury and lead, through our environment allows us to understand the risk to our health, as humans are often at the top of the food chain. Birds that eat fish are thus an indicator of the potential contaminants we ourselves are exposed to. The data indicated that most metal levels in shorebirds were similar in Suriname (wintering location) and Delaware Bay (migratory site). On-going work with shorebirds in Brazil (where they followed the same protocol), showed that selenium levels were significantly higher in shorebird samples collected in Brazil compared to Suriname and New Jersey. Thus, the high levels, which are within the range to cause adverse effects, are not being accumulated in New Jersey. This is significant because it suggests where management is essential and shows that current aquaculture or agriculture in the region of Delaware Bay are not contributing to the high selenium levels. The NJAES researchers demonstrated that the shorebirds use the intertidal habitat, moving out with the receding tide, into and beyond the area normally used by rack and bag aquaculture. However, this research also shows that at present, there is no immediate adverse effects with the current regulations. During this current period, it was determined that the levels of mercury, cadmium and lead in blood of shorebirds did not indicate adverse effects by comparing the levels (both means and highs) with those known to cause adverse effects in laboratory studies. Another environmental study reached out to 10 licensed pest control operators in a small New Jersey pest control company to assess their personal protective equipment use when working with pyrethroid insecticides. Exposure was assessed through the collection of urine and saliva samples and subjects completed a questionnaire to assess their personal protective equipment use (PPE). On a normal work day that involved spraying pyrethroid insecticides, subjects gave a set of one urine sample and one saliva sample before work, and one set after work. This study hopes to find a relationship between PPE use and metabolites of exposure in subjects' urine.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
131	Alternative Uses of Land
205	Plant Management Systems
721	Insects and Other Pests Affecting Humans

Outcome #6

1. Outcome Measures

Long Term - Rutgers Environmental Stewards Program. New Jersey's residents will reside, work and play in a healthy, safe, and sound environment-in their homes, gardens, schools, parks and workplaces.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
New Jersey's history of industrialization combined with the associated problems of high population density leads to scientists and legislators often being first in the nation to address environmental issues. The citizens of New Jersey have also been on the front lines of the environment, forming the first environmental watershed association in 1949, the Stony Brook-Millstone Watershed Association (now the Watershed Institute). In 1959, citizens began the fight to stop a jetport and won, leading to the creation of the Great Swamp National Wildlife Refuge. Educated citizens can provide the best assistance to their communities as they deal with environmental issues.

What has been done
The Rutgers Environmental Steward (RES) Program trains volunteers interested in environmental issues but lacking a science background. The program provides basic information that allows citizens to go into their communities better informed to make environmental decisions, with a network to reach out to for help, and able to implement environmental practices and projects to help change their communities, their state, and their world. In 2018, the RES Program was offered in Atlantic County (15 participants), Burlington County (17 participants), Somerset County

(17 participants) and Union County (16 participants) for a total of 65 participants educated this year. The program offered 3-hour weekly classes for 20 weeks covering geology, soils, environmental chemistry, water resources, green infrastructure, invasive species, climate change, ecology, and many other topics. Additional training was based on county location/need or trending issues, and has included environmental justice issues, Emerald Ash Borer identification, or bat ecology and species identification through hand-held sonar. The program ran 3-5 field trips to environmental locations of interest in New Jersey. Several locations held classes in the evening to allow accessibility to working professionals. The class culminated with Stewards completing a 60-hour+ approved, project-driven internship, which may be either of the Stewards design or developed with the needs of the program or program partners.

Results

The fall 2017 and the winter/spring 2018 Rutgers Environmental Steward (RES) classes offered education to 65 New Jersey residents in Atlantic, Burlington, Somerset and Union Counties. Thirty-two Rutgers Environmental Stewards were certified having completed both the class portion of the program and the 60-hour volunteer internship. Internships were conducted in 12 counties. RES interns volunteered 3,414 hours and the volunteers they gathered to help complete internships volunteered 4,746 hours for a total of 8,160 hours of volunteer time at a total value to $231,091 (Independent Sector, 2018). Stewards raised $19,360 in funds to enable them to complete their internship projects. Examples of projects include: Stewards in Brigantine and Mount Laurel began plastic film recycling in their towns and more than 2,088 lbs. of plastic film were recycled; In the City of Camden, a Combined Sewer Overflow community, 3 Stewards worked on projects that resulted in storm-water runoff reductions by 185,414 gallons of storm-water per year; As songbird populations decrease nationally, 3 Stewards in Middlesex County created a bluebird trail with bluebird boxes. Fifteen bluebirds were fledged in 2018 in these boxes; Five pollinator gardens were designed and installed by Stewards in Washington, Eastampton, North Brunswick, Brookdale, and Rocky Hill Township for a total of 37,205 square feet of new pollinator habitat; Three Stewards assisted with Pine snake tracking in the Pine Barrens, which helped provide critical nesting data. The Stewards worked on re-directing an off-road vehicle race that was scheduled to run directly over a winter den to a more suitable location; Four Stewards helped map 741 Ash trees in priority, high-risk areas of 7 Union County parks to help with the impending Emerald Ash Borer invasion. Some of the unsolicited quotes when a visitor asked whether people thought the class was worth the time commitment include: "The speakers alone are worth the time. I highly recommend it especially if you're on your towns ENV COMM. I've been on Bricks for 4 years and I'm often referring to my RES experience when we vote on projects and organize events." "Oh, this is an amazing program. 20 weeks of the most interesting information about the natural world that you could ever hope to learn." "Learned so much in this class that I am able to talk for confidently about our environment. The first few classes were not as good as the rest of the classes. I loved getting outside and being hands on. So glad I made the time to take this course." "Definitely do it! Highly recommend. I was a 2016 graduate and continue to benefit from things I learned and people I met."

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
131	Alternative Uses of Land
205	Plant Management Systems
721	Insects and Other Pests Affecting Humans

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

None to report.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

NJAES research and extension outcomes related to this planned program were evaluated utilizing a variety of evaluation methods appropriate for each initiative to determine the effectiveness on both a qualitative and quantitative level. For KASA, and practice change we included the measurement of knowledge gained as measured by pre/post Likert-scale assessment. Surveys were used to measure increase in skills acquired, behavior change and practice adoption. For process evaluation we focused on program delivery, participation, relevance and timeliness. Data was collected at appropriate times for each initiative that supports this planned. IRB approved evaluation instruments were used to collect research and extension data. Data analyses and comparisons relevant to basic and applied research and demonstration were collected and analyzed and reported utilizing a variety of data collection methods appropriate to each research question. The major goal of evaluating is the demonstration of social, economic, behavior, and environmental changes in conditions that contribute to improved quality of life as a result of participation in programs and benefits of research solutions. See state defined outcomes for detailed results for the initiatives.

Key Items of Evaluation

None to report.

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Global Food Security and Hunger - Integrated Pest Management

☑ 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
216	Integrated Pest Management Systems	100%		100%	
	Total	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	20.0	0.0	10.0	0.0
Actual Paid	1.2	0.0	6.8	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
161087	0	685889	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
951266	0	1621719	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
55393	0	817125	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research
- Develop new and novel techniques for pest management and pest detection

Delivery

- Provide IPM information to a wide variety of stakeholders
- Employ new methods for delivery IPM information

Education

- Conduct IPM educational programs for stakeholders
- Conduct IPM educational training for university students
- Conduct IPM educational training for Vo-Ag and FFA students
- Conduct IPM public awareness campaign

Extension

- Work with communities, schools, businesses to help them meet their regulatory responsibilities on pesticide application
- Help growers develop scouting programs to identify pest populations before significant plant damage occurs.
- Develop pest management options to be used in an integrated or rotational program.
- Identify indicators to help growers anticipate pest problems.
- Develop monitoring techniques and population damage thresholds for selected pests.
- Provide scientifically sound advice to state regulatory bodies on pest management and pesticide issues
- Create a multidisciplinary program comprising of faculty, staff, volunteers, industry partners and government officials
- Investigate IPM methods to help growers produce top quality crops, limiting or reducing production costs.
- Evaluate all pest and crop management practices into a set of commercially used methods. These include the use of: pesticides, economic/aesthetic threshold levels, resistant cultivars, optimum horticultural practices, environmental monitoring, pest scouting, and fertility monitoring and recommendations.

2. Brief description of the target audience

- Municipalities
- Pesticide applicators and their employers
- Commercial pesticide applicators
- State Dept. of Environmental Protection
- Staff and students who gain valuable scientific experience
- Industry partners in agriculture and related commodities
- Consumers
- NJAES Faculty and Staff involved in pest management research/outreach
- Farmers
- Commodity groups
- New Jersey residents
- School faculty, staff and children
- NJAES researchers
- Secondary and university students
- Governmental agencies
- Environmental organizations
- Agricultural, landscape, fine turf and other related industries

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	11914	79677	350	0

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

Patent Applications Submitted

Year:	2018
Actual:	3

Patents listed

62/656,875 - AGGREGATION OF TERRESTRIAL ENVIRONMENTAL DNA (eDNA)(FILED);
62/716,742 - ENDOPHYTIC MICROBES FOR GROWTH PROMOTION OF CROP PLANTS AND SUPPRESSION OF AGGRESSIVE INVASIVE PLANT SPECIES (FILED);
15/812,968 - DOWNY MILDEW RESISTANT/TOLERANT SWEET BASIL VARIETIES (FILED)

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2018	Extension	Research	Total
Actual	6	52	58

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- A variety of strategies will be implemented to reach target audiences. This will include and not be limited to workshops, field visits, classes, newsletters, media releases, electronic communications,publications. In addition a trained volunteer teaching base will be developed. Quantitative reports of participation will be collected

Year	Actual
2018	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Short Term - Develop improved IPM delivery methods. Develop detection, monitoring and sampling methods that reliably predict pest levels. Develop novel management methods for a wide variety of pests. Develop IPM training for secondary and university students. Improve public awareness about IPM Determine the effectiveness of pheromones for mating disruption of pests. Greater understanding of entomopathogenic nematode species'effects on pests. Evaluation of the effectiveness of natural pesticides and crop management to reduce pests. Determine which types of plants attract pests to be used as a pest control method.
2	Medium Term - Research and educational programs, and public awareness campaign results in increased adoption of IPM in traditional and non-traditional systems. Research findings used to develop new projects. IPM training of students creates new IPM interns, professionals and researchers. Knowledge of various natural insecticides and their effectiveness on pests. Determining the best time and application method for IPM products. Greater understanding of pest biology and ecology. Greater understanding of entomopathogenic species biology and ecology.
3	Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.
4	Short Term - Developing and Evaluating Reduced-Risk Management and Phenology Programs for Fruit Pests. Develop improved IPM delivery methods. Develop detection, monitoring and sampling methods that reliably predict pest levels. Develop novel management methods for a wide variety of pests. Develop IPM training for secondary and university students. Improve public awareness about IPM Determine the effectiveness of pheromones for mating disruption of pests. Greater understanding of entomopathogenic nematode species'effects on pests. Evaluation of the effectiveness of natural pesticides and crop management to reduce pests. Determine which types of plants attract pests to be used as a pest control method.
5	Medium Term - Improving the Efficacy and Sustainability of Peach Disease Management Strategies: Incorporation of Biorational Materials and Refinement of Cover Spray Programs. Research and educational programs, and public awareness campaign results in increased adoption of IPM in traditional and non-traditional systems. Research findings used to develop new projects. IPM training of students creates new IPM interns, professionals and researchers. Knowledge of various natural insecticides and their effectiveness on pests. Determining the best time and application method for IPM products. Greater understanding of pest biology and ecology. Greater understanding of entomopathogenic species biology and ecology.
6	Medium Term - Upland Fruit (Tree Fruit and Grape) Integrated Pest Management Delivery. Research and educational programs, and public awareness campaign results in increased adoption of IPM in traditional and non-traditional systems. Research findings used to develop new projects. IPM training of students creates new IPM interns, professionals and researchers. Knowledge of various natural insecticides and their effectiveness on pests. Determining the best time and application method for IPM products. Greater understanding of pest biology and ecology. Greater understanding of entomopathogenic species biology and ecology.

Outcome #1

1. Outcome Measures

Short Term - Develop improved IPM delivery methods. Develop detection, monitoring and sampling methods that reliably predict pest levels. Develop novel management methods for a wide variety of pests. Develop IPM training for secondary and university students. Improve public awareness about IPM Determine the effectiveness of pheromones for mating disruption of pests. Greater understanding of entomopathogenic nematode species'effects on pests. Evaluation of the effectiveness of natural pesticides and crop management to reduce pests. Determine which types of plants attract pests to be used as a pest control method.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Epidemiology and economic impact of bacterial leaf scorch in New Jersey - Bacterial leaf scorch (BLS) of amenity trees, caused by the bacterium Xylella fastidiosa, has reached epiphytotic proportions throughout the eastern and mid-western US. BLS has had major impact in the urban landscape and has the potential to destroy millions of susceptible trees in the urban forest. In New Jersey, BLS is widespread on oaks in the red oak group and in some communities affects approximately 35% of susceptible trees in the urban forest. With no current cost-effective rescue technology, arborists are forced to remove trees to prevent liabilities that result from declining trees.

What has been done
A long-term study of BLS incidence and severity in two central New Jersey communities found that disease incidence in a population of 700 pin, red, or scarlet oaks increased in from 20 to 35% during a ten-year period. Approximately one-quarter of these street-side oaks were removed by property owners or municipalities, and of these, 15% were identified as trees severely affected by the disease within the previous 5-year period. Of the street-side trees remaining, 20% were severely affected by BLS and an inverse relationship between disease development and tree growth was evident. This disease clearly represents a significant impact to the urban forest in these communities; with no cost-effective rescue technology, arborists are forced to remove trees

to prevent liabilities that result from declining trees. In additional work, to better understand the Xylella strain pathogenic to oak, unique gene repeat regions from X. fastidiosa subsp. multiplex strain NB1, isolated from oak in New Brunswick, NJ were compared to isolates of varying geographical locations and plant hosts. This work serves as a base for further characterization of oak strains unique to New Jersey.

Results
In spite of the widespread distribution of BLS in New Jersey, very little is known of the biology of the disease, its progression and transmission, and effective management. More information regarding the pattern of new infections, the seasonal cycles of insect vectors, and the role of alternative, 'potential-reservoir' hosts on disease development is needed before effective management strategies can be devised. The refined real-time PCR technique is a useful tool for disease diagnosis, which is an essential part of the decision-making process for arborists caring for trees with leaf scorch.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #2

1. Outcome Measures

Medium Term - Research and educational programs, and public awareness campaign results in increased adoption of IPM in traditional and non-traditional systems. Research findings used to develop new projects. IPM training of students creates new IPM interns, professionals and researchers. Knowledge of various natural insecticides and their effectiveness on pests. Determining the best time and application method for IPM products. Greater understanding of pest biology and ecology. Greater understanding of entomopathogenic species biology and ecology.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Protecting Human Health and Urban Environment through Integrated Pest Management Program

- Integrated pest management (IPM) programs have been recognized as more effective to manage urban pests and reduce pesticide use. An effective IPM program takes consideration of pest biology and ecology. By reducing pesticide applications and more effectively controlling urban pests, food contamination and adverse impact to human health from pesticide use and pest infestation can be minimized.

What has been done

Through basic and applied research on pest biology, behavior, ecology, and various control techniques, NJAES researchers have designed, tested, and disseminated new and improved pest management solutions. They developed practical and effective solutions for managing urban pests such as bed bugs, cockroaches, ants, and termites. During this final year of the project, researchers evaluated various tools and strategies for better management of bed bugs. They also studied German cockroach infestations and the relationship between environmental conditions and building occupant behavior. The research group designed and tested integrated pest management programs (IPM) for bed bugs in two counties and evaluated their effectiveness in three communities. These communities enrolled in a 2-year study contained more than 2,000 apartments. Researchers tested a threshold-based bed bug management approach with the goal of achieving elimination with minimal or no insecticide application. Thirty-two bed bug infested apartments were identified. In a second study, researchers analyzed the presence of German cockroaches in relation to environmental conditions, resident demographics, and residents' tolerance of cockroaches. They conducted resident interviews, placed sticky traps to detect the presence of German cockroaches, and assessed apartment conditions.

Results

For the bed bug study, NJAES researchers found consumer grade steamers are as effective as professional steamers as a non-chemical control tool. The consumer grade steamers usually cost 60-150 dollars compared to commercial steamers which cost > $700. Proper use of steamers can kill all life stages of bed bugs. This information can be utilized by consumers to conduct safe and effective treatment. Additionally, IPM programs were more effective in reducing bed bug infestations than traditional pest control services. Residents from buildings enrolled in IPM programs were more satisfied with the bed bug control services than residents from the site which did not adopt IPM. A threshold-based management approach (non-chemical only or non-chemical and chemical) can eliminate bed bugs in a similar amount of time, using little to no pesticide compared to a chemical only approach. Comprehensive pre-treatment preparation of apartments is not necessary for eliminating most of the bed bug infestations. Applying these findings in future bed bug management will help save money and eliminate bed bugs rapidly and safely. Biting arthropods are capable of transmitting human and animal pathogens worldwide. Repellents are a primary tool for reducing the impact of biting arthropods on humans and animals. N,N-Diethyl-meta-toluamide (DEET), the most effective and long-lasting repellent currently available commercially, has long been considered the gold standard in insect repellents, but with reported human health issues, particularly for infants and pregnant women. In the present study, it was found that fatty acids derived from coconut oil which are novel, inexpensive and highly efficacious repellant compounds. These coconut fatty acids are active against a broad array of blood-sucking arthropods including biting flies, ticks, bed bugs and mosquitoes. In laboratory bioassays, these fatty acids repelled biting flies and bed bugs for two weeks after application, and ticks for one week. Repellency was stronger and with longer residual activity than that of DEET. In addition, repellency was also found against mosquitoes. An aqueous starch-based formulation containing natural coconut fatty acids was also prepared and shown to protect pastured cattle from biting flies up to 96-hours in the hot summer, which, to this research group's knowledge, is the longest protection provided by a natural repellent product studied to date. For the cockroach study, a total of 388 apartments from seven low-income apartment buildings, occupied by senior citizens in New Jersey were included. It was found that 30% of the apartments had German cockroaches.

Among interviewed residents whose apartments had existing cockroach infestations, 36% were unaware of the presence of cockroaches. Apartments with a 'poor' sanitation rating in kitchens and bathrooms was 2.7 times more likely to have cockroaches than that in apartments with better sanitation conditions. Residents' tolerance to cockroaches is significantly associated with presence of cockroaches and cockroach population size. These findings will help design future educational efforts in order to reduce high cockroach infestation rates found in similar communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #3

1. Outcome Measures

Long Term - Protect commodities, homes and communities from pests. Increased abundance of high quality food and fiber products. Increased acreage in New Jersey grown under IPM practices. Reduced environmental problems associated with current pest management practices. A comprehensive understanding of best management practices for IPM that are economically viable and environmentally safe.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Development of an eDNA surveillance protocol for detection of brown marmorated stink bugs - The brown marmorated stinkbug (BMSB, Halyomorpha halys), which has become a devastating pest to many northeastern farmers, was first detected in the US in 1996 and is currently still expanding across the continent. As with any biological invasion, the best management practices are often ones that detect the invader early and control it before it can establish within a novel landscape. If such practices had been available for BMSB when it was first detected in Allentown, Pennsylvania in 1996, perhaps spreading populations in the United States could have been detected and controlled sooner. Unfortunately, that was not the case, and the species has spread to 40 US states as well as Canada and several European countries. The BMSB is transported

into novel habitats by hitchhiking on agricultural and horticultural products, or within luggage or household items associated with people's movements. The BMSB causes significant damage both to agricultural crops and ornamental plants, and its economic impact has been devastating. Furthermore, insecticide applications aimed at BMSB control have upset years of carefully optimized integrated pest management strategies and reduced populations of natural insect predators and parasitoids of other important agricultural pests. Because the best way to control an invasive pest is not let it become established, early detection is key.

What has been done

Current efforts aimed at detecting the presence of BMSB require capturing individuals via black light or pheromone traps, followed by visual taxonomic identification. However, surveillance through direct sampling of specimens often does not detect the presence of the target species until it is relatively abundant. Additionally, black light traps are used for large-scale landscape monitoring, which will not inform presence and spread of BMSB at the local scale (e.g., among individual farms). An emerging surveillance tool that has proven highly useful in detecting the presence of aquatic invasive species is environmental DNA (eDNA). As a matter of course, DNA molecules are released into the environment from various biological byproducts such as shed cells, saliva, excreta, and rotting bodies. This abundant source of DNA allows for indirect sampling that can identify the presence of one or more target species. Environmental DNA has a proven track record of detecting critical invasive species in aquatic ecosystems, even when they are at abundances far below what direct monitoring can detect. For these reasons, eDNA has become a standard approach to surveying for the presence of aquatic invasive species, where high sensitivity, early detection and pre-emptive control are key. NJAES researchers have adapted known eDNA techniques to monitor the spread of agricultural pest insects, where there is evident need to have highly sensitive early detection systems in place to optimize integrated pest management programs. They will utilize the BMSB as a test case whereby researchers can prove the utility of the concept for agricultural pests and test the ability of eDNA to detect presence of BMSB at lower abundances than the current direct monitoring can achieve. From prior research, researchers developed a high-sensitivity species-specific real-time PCR (rtPCR) assay for identifying trace amounts of often highly degraded BMSB DNA. For this project, they are field-testing this assay for detecting BMSB eDNA on active farms using a suite of promising field sampling. As end products, they will evaluate the ability of eDNA to detect BMSB, evaluate its ability to detect BMSB presence when traditional direct methods do not, and deliver a practical protocol for eDNA BMSB detection that can inform on-farm pest control decisions.

Results

NJAES researchers have used a genetic tool previously designed for BMSB that is very sensitive to trace amounts of degraded DNA. BMSB are phloem-feeders that remain on the host plant for extended periods of time, potentially leaving a detectable level of DNA. These fruits are harvested by farmers and brought to centralized locations for rinsing to remove soil and other detritus, and for boxing to sell. They posited that rinsing harvested fruits in water then concentrating, extracting and testing existing DNA could be used as a viable surveillance technique. Their time series experiment resulted in positive detections across all time ranges (i.e. two, four, six, and eight hours) indicating that DNA accumulation beyond the minimum of 2 hours tested is not required, at least under cage conditions. They found that all water samples spiked with BMSB were qPCR positive, and all negative controls were negative. They also found that all four peach trees in the New Jersey farm tested for BMSB DNA were positive during both visits. Pheromone traps located next to each of the trees were also positive, and on a few occasions BMSB nymphs were seen crawling on peaches just before the fruit was collected for processing. All negative controls were negative. Finally, they found that the eDNA strategy was both effective in the field and more sensitive to smaller populations than the blacklight and the pheromone traps. At the New Hampshire farm they found evidence of BMSB eDNA over all eight days sampled. Tests of the

wash containers prior to washing harvested crops yielded no positive detections, indicating containers were not pre-contaminated. The blacklight trap, which operated continuously across their eDNA sampling time, collected a number of different insect species, but not BMSB. The pheromone traps caught a few native stink bug species, but only one BMSB, a nymph collected on the last day of sampling. The detection of a BMSB nymph on the last day of sampling in the New Hampshire farm provided a visual confirmation of the presence of BMSB on the farm. It is worth noting that this nymph was found near the end of August, after BMSB populations had the opportunity to grow throughout the season. In contrast to standard surveillance using pheromone traps, they show that a highly sensitive eDNA based surveillance protocol detected BMSB consistently. Their multi-method occupancy model for the surveying efforts conducted on the New Hampshire farm yielded detection probabilities of 0.03 (0.038 standard error) and 1.0 (0.00 standard error) for the pheromone traps and the eDNA method, respectively.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #4

1. Outcome Measures

Short Term - Developing and Evaluating Reduced-Risk Management and Phenology Programs for Fruit Pests. Develop improved IPM delivery methods. Develop detection, monitoring and sampling methods that reliably predict pest levels. Develop novel management methods for a wide variety of pests. Develop IPM training for secondary and university students. Improve public awareness about IPM Determine the effectiveness of pheromones for mating disruption of pests. Greater understanding of entomopathogenic nematode species'effects on pests. Evaluation of the effectiveness of natural pesticides and crop management to reduce pests. Determine which types of plants attract pests to be used as a pest control method.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

For the past 40 or so years, much research in applied entomology has been focused on

developing and refining integrated pest management (IPM) programs. While the eastern tree fruit system still maintains a heavy reliance on synthetic insecticides, they were applied based on degree-day models and trap thresholds, using reduced-risk compounds, with resistance management and conservation of natural enemies in mind and in harmony with non-insecticide tools such as mating disruption. Orchard crops in particular are ideal models for IPM systems because it is a perennial system that permits a systems-level approach. Recently, invasive pests such as brown marmorated stink bug (BMSB) and spotted wing drosophila have disrupted well researched IPM programs, especially in fruit systems. The success in IPM programs lies in a more precise approach to pest management with the integration on non-insecticide management.

What has been done

NJAES researchers conducted research on insect biology and behavior on key fruit pests, including invasive species, to develop or refine IPM programs and reduce insecticide use. Plum curculio (PC) is a top insect pest of peaches and lays its eggs right after fruit set and where there is a second generation (like NJ) adults also lay eggs in ripening fruit which can lead to contamination at harvest. Previous research in Canadian apples suggested that PC move from the woods. This research group investigated this behavior in peaches with bivoltine populations using cheap and safe food-based protein markers. The protein markers are sprayed onto trees throughout the growing season and the insects pick up the protein during natural movement. At five commercial peach orchards, researchers evaluated the application of insecticides to orchard borders for management of BMSB at 5, 10, and 20 acre scales. The border on a 5-acre block constitutes 25% of the total acreage and thus this approach significantly reduces the amount of insecticide applied. They also included an assessment of the compatibility of border sprays with mating disruption for internal worms, beneficial insects, and pollinators.

Results

Most (79%) of the Plum curculio adults were collected on the border while 21% were collected on the interior. Of the adults collected, 14.7% were marked with the egg protein indicating they had visited the edge of the plot while 2% of the PC adults marked with the egg protein were collected on the interior indicating they had traveled from the edge to the interior of the block. Only 1 individual was marked with the second protein and suggested that it had moved from the interior to the edge. These results suggest an edge effect by PC but the low occurrence of marking indicates additional research is needed. NJAES researchers found that stink bug and internal worm damage was equal or less relative to that of grower's standard practices, even up to 20 acres. BMSB pressure was much higher in 2018 in NJ than in previous years and while the border spray approach was effective, a few additional sprays were needed on the entire block, especially for the 20-acre blocks. However, this approach reduces the amount of insecticide applied and benefits beneficial insects such as predators and bees. Previous research using sweep samples and visual observations demonstrated a significant reduction in foraging pollinators in plots with groundcover management. This is expected to reduce exposure of foraging bees to pesticides that they would be exposed to if flowering weeds were present within the orchard. They expect that beneficial insects will benefit long-term from this strategy. They also identified significantly higher numbers of parasitoids within the border spray blocks and the BMSB specialist parasitoid wasp, Trissolcus japonicus on commercial peach farms in NJ.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #5

1. Outcome Measures

Medium Term - Improving the Efficacy and Sustainability of Peach Disease Management Strategies: Incorporation of Biorational Materials and Refinement of Cover Spray Programs. Research and educational programs, and public awareness campaign results in increased adoption of IPM in traditional and non-traditional systems. Research findings used to develop new projects. IPM training of students creates new IPM interns, professionals and researchers. Knowledge of various natural insecticides and their effectiveness on pests. Determining the best time and application method for IPM products. Greater understanding of pest biology and ecology. Greater understanding of entomopathogenic species biology and ecology.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Peach blossom blight, rusty spot, and bacterial spot are three major diseases that need to be controlled by commercial growers. Significant blossom blight results in canker formation which provides inoculum for brown rot later in the season. High levels of bacterial spot results in considerable numbers of fruit lesions and defoliation. In disease-favorable years, 100% of a crop can be lost to brown rot or bacterial spot. Rusty spot can also cause significant yield loss on susceptible cultivars. Unfortunately, resistant peach cultivars are not available for control of blossom blight and not all cultivars have sufficient resistance to rusty spot or bacterial spot. Furthermore, there are no cultural control practices that can effectively manage these diseases. Consequently, disease control is dependent on application of fungicides or bactericides.

What has been done
NJAES researchers determined that biorational materials, many of which are approved for organic production, can be effective for control of peach blossom blight, rusty spot, or bacterial spot. Any biorationals observed to be highly effective can be deployed alone in disease control programs, replacing conventional fungicides or bactericides. Biorationals that provide only partial control can be deployed in combination with conventional fungicides or bactericides. Either approach will result in reductions of conventional fungicide or bactericide usage. Most biorational materials have lower levels of toxicity, which reduces harm to the environment and lessens applicator exposure. Conventional fungicide or bactericide residues on fruit are also reduced by

these programs. Researchers evaluated the efficacy of any new, recently introduced biorational materials for management of peach rusty spot, brown rot blossom blight, or bacterial spot. Additionally, they assessed the efficacy of programs integrating effective biorational materials with current conventional fungicides and bactericides for management of peach rusty spot, brown rot blossom blight, or bacterial spot. Two recently introduced biorational materials, Stargus and Regalia, were examined for their effective integration into peach bacterial spot management programs. The active ingredient in Stargus consists of Bacillus amyloliquefaciens strain 727 cells and spent fermentation media. This rhizobacterium protects plants by colonizing the surface of plant tissues, thereby preventing the establishment of fungal and bacterial plant pathogens. In contrast, the active ingredient in Regalia, an extract of Reynoutria sachalinensis (giant knotweed), protects plants by inducing systemic resistance. The bioactive compounds in this extract stimulates the plant to increase phenolics, antioxidants, and strengthen cell walls.

Results

Both materials were compared to the current standards, copper bactericides and the antibiotic oxytetracyline, on both highly susceptible O'Henry peach and susceptible Suncrest peach. Results showed that neither compound provided adequate control of bacterial spot on highly susceptible O'Henry fruit. However, both biorational materials significantly reduced bacterial spot on susceptible Suncrest, providing control that was equivalent to the copper and antibiotic standards. Total saleable fruit (market grades 1 + 2) for Stargus and Regalia were 90% and 81%, while the copper and antibiotic standards had 95% and 90% saleable fruit, respectively. These results demonstrated that an effective peach bacterial spot control program can be achieved when the biorational materials are used in conjunction with cultivar resistance, and that the level of resistance in the cultivar need not be high. On a scale of 1 to 6, with 1 = highly susceptible and 6 = highly resistant, O'Henry is rated at 1 while the "less" susceptible Suncrest is rated at 2. Highly susceptible cultivars, such as O'Henry, are not recommended to growers.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

Outcome #6

1. Outcome Measures

Medium Term - Upland Fruit (Tree Fruit and Grape) Integrated Pest Management Delivery. Research and educational programs, and public awareness campaign results in increased adoption of IPM in traditional and non-traditional systems. Research findings used to develop new projects. IPM training of students creates new IPM interns, professionals and researchers. Knowledge of various natural insecticides and their effectiveness on pests. Determining the best time and application method for IPM products. Greater understanding of pest biology and ecology. Greater understanding of entomopathogenic species biology and ecology.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

New Jersey tree fruit production is located in both southern and northern counties. According to the latest agricultural statistics, NJ peach production is valued at $30-35 million and apples at $28.5 million. The industry in southern counties is heavily oriented towards wholesale markets and peach production, while the industry in northern counties is heavily dependent on direct markets and apple production. Retail market fruit production in northern counties is valued at approx. $15-20 million. New Jersey fruit growers produce commodities that are susceptible to more than two dozen arthropod and disease pests. Management of this pest complex can cost producers up to $500 or more per acre. Some large NJ growers may spend up to $350,000 for pesticides alone. Fertilizers also represent a major cost impact. Growers can experience depressed prices from foreign and west coast competition, often leading to deficits in the farming operation. Production costs are high due to labor, fertilizer and energy costs, and pesticide costs. Pest management costs have increased due to label restrictions on old products and the introduction of newer more expensive pesticides. The Food Quality Protection Act has led to restrictions and changes in the types of pesticides that may be used to produce many fruits. Many of the new pesticides are narrow spectrum, that control only one or a few pests and must be used with degree day phenology models and other integrated pest management (IPM) practices. While customers continue to demand high quality clean fruit, they are also aware of pesticide use, and want an assurance of safe food with little to no pesticide residues.

What has been done

An IPM delivery program has been delivered to commercial growers, statewide. The New Jersey wine grape industry has doubled since 2002, with at least 50 wineries and over 100 vineyards. NJ is 5th in the U.S. in wine production, producing 1.7 million gal. of wine, valued between $36-$40 million. Since there has been no IPM programming for grapes, and little baseline data, many grape growers tend to either overuse pesticides or not adequately control pests. A pilot IPM program was started in 2010 to focus on pest surveys and grape berry moth timing. New invasive species such as the brown marmorated stink bug and the spotted wing drosophila demand changes in pest management practices and educational and research needs on a regional basis. Key areas that NJAES researchers looked at included: Maintaining or increasing crop quality and yield, and marketing ability through modern integrated pest management practices; Developing new and novel techniques for pest management and pest detection, and employing new methods for tree fruit IPM delivery; Providing IPM information to tree fruit; Reducing the use of OP, carbamate and other toxic pesticides in favor or reduced risk technologies and alternate management strategies; Minimizing non-point source pollution through the reduction of fertilizer and pesticide sources, and enhance water quality through similar means; Reducing farm worker exposure to pesticides; Reducing or minimize production costs. Cooperate with workers in other states to bring IPM information on invasive species, to growers on a regional and national level. An integrated crop management (ICM) program was delivered to commercial fruit growers who

produced apples, peaches, nectarines, and grapes. The program reached both primary and secondary participants. Secondary participants attend extension update meetings, and receive other IPM/ICM information through personal visits, fax broadcasts, articles, newsletters and the Internet. Primary participants are those growers who access all the above information and participate in a field scouting program. While some primary participants do self-scouting, the majority contribute funding through acreage participation fees which fund seasonal field scouts, travel, supplies, and laboratory costs. Weekly field scouting forms the program core and data source for newsletter articles, and from which pest management recommendations were made, with nutrition and nematode management included at specific times of the season. A broadcast fax service was used to advise of timely pest events and supplement the Plant and Pest Advisory Fruit Edition Newsletter. Organized grower meeting contact reached a total of 851 audience members, while on-farm consultations totaled 1,240 visits. The Plant and Pest Advisory Newsletter had a total of 26 weekly articles. Web access in NJ and other states totaled 105,000 views. Acreage impacted by primary participants totaled 80% of all state tree fruit acreage. Over 95% of total state tree fruit acreage was impacted by the program. IPM information reached over 90% of NJ grape growers.

Results

The program demonstrated reduced risk methods that included the use of mating disruption and ground cover management as tools to replace insecticide use for Oriental fruit moth, tarnished plant bug and stink bugs and two species of peach tree borers. Degree-day pest phenology models were updated, and proper use was advised to growers. Demonstrations were conducted on commercial farms to encourage use of alternative practices. Alternative practices include use of mating disruption and reduced risk pesticides. In southern counties, where the bulk of commercial peaches are produced, 75% of growers used alternative, 'reduced risk' insecticides, and 80% of growers used reduced risk fungicides. In total, program participants reduced pesticide use by 26-80% compared to standard spray schedules, depending on the practices used. Other IPM practices included grower use of degree day based pest models, reducing insecticide use by 40% compared to standard calendar spray methods. Laboratory tests where completed in 2018 as part of the fertility component. Over 75% of areas sampled were shown have sufficient to excessive phosphorous levels, which led to decreased phosphorous use on those sites. The invasive insect, brown marmorated stink bug (BMSB) has set pest management programs back 30-40 years. This research and demonstration project showed that growers could treat field edges while using mating disruption and ground cover management to reduce insecticide use by up to 75% compared to most commercial practices now being used for BMSB. Spotted Wing Drosophila (SWD) was found in commercial peach plantings during 2018. While insecticides had to be used to control this pest, the integrated approach resulted in only one third the number of applications used in small fruit crops.

4. Associated Knowledge Areas

KA Code	Knowledge Area
216	Integrated Pest Management Systems

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

No external factors to report.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

NJAES research and extension outcomes related to this planned program were evaluated utilizing a variety of evaluation methods appropriate for each initiative to determine the effectiveness on both a qualitative and quantitative level. For KASA, and practice change we included the measurement of knowledge gained as measured by pre/post Likert-scale assessment. Surveys were used to measure increase in skills acquired, behavior change and practice adoption. For process evaluation we focused on program delivery, participation, relevance and timeliness. Data was collected at appropriate times for each initiative that supports this planned. IRB approved evaluation instruments were used to collect research and extension data. Data analyses and comparisons relevant to basic and applied research and demonstration were collected and analyzed and reported utilizing a variety of data collection methods appropriate to each research question. The major goal of evaluating is the demonstration of social, economic, behavior, and environmental changes in conditions that contribute to improved quality of life as a result of participation in programs and benefits of research solutions. See state defined outcomes for detailed results for the initiatives.

Key Items of Evaluation

None to report.

V(A). Planned Program (Summary)

Program # 7

1. Name of the Planned Program

Global Food Security and Hunger - Aquaculture

☑ 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
135	Aquatic and Terrestrial Wildlife	100%		100%	
	Total	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	3.0	0.0	5.0	0.0
Actual Paid	0.2	0.0	4.0	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
24539	0	163370	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
407242	0	843923	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
72996	0	833778	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

• Investigate the genetic mechanisms for disease resistance and improved quality in economically important shellfish

• Create a dynamic and cooperative partnership with faculty, staff, businesses, regulatory/advisory

councils and the government to research best management practices and discover effective solutions and management practices to address threats to NJ aquaculture as well as investigate opportunities to increase the quality and quantity of the aquaculture harvest.

- Collect and analyze data on how communities and businesses are affected by the aquaculture industry management practices.
- Examine the presence of unhealthy levels of contaminants in aquaculture products.
- Determine best techniques for shellfish hatcheries on and off shore.

2. Brief description of the target audience

- Aquaculture related businesses and employees
- State Department of Environmental Protection
- State Department of Agriculture
- Industry partners who learn ways to improve or protect their harvests
- Communities who depend on aquaculture-related revenue
- NJAES faculty and staff involved in water research/outreach
- Consumers of aquaculture products, including recreational fishing

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	2190	764	101	0

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	1	10	11

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- A variety of strategies will be implemented to reach target audiences. This will include and not be limited to workshops, field visits, classes, newsletters, media releases, electronic communications,publications. In addition a trained volunteer teaching base will be developed. Quantitative reports of participation will be collected.

Year	Actual
2018	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Short Term - Knowledge of seasonal variations for shellfish diseases. Create census data on communities involved in aquaculture. Determine the level of pollutants in economically important fish species. Develop markers and maps of important genetic traits. Knowledge of shellfish hatchery techniques that decrease time for growth to market size.
2	Medium Term - Identify spatial and temporal relationships between patterns of shellfish diseases in NJ and environmental correlates. To develop disease-resistant strains of shellfish. Develop superior disease-resistant and larger genetic lines of shellfish.Measure the impact of communities on the aquaculture industry. Knowledge of the feasibility of off-shore shellfish farming.
3	Long Term - Clear and comprehensive understanding of community, environmental, genetic and physical regulators of aquaculture quality and quantity. A safe and secure aquaculture industry that can meet consumer demands for high-quality products and also be environment friendly and economically viable. Creation of superior aquaculture products that will be of high demand outside NJ.
4	Long Term - Population Connectivity and Long-term Population Dynamics in Shellfisheries. Clear and comprehensive understanding of community, environmental, genetic and physical regulators of aquaculture quality and quantity. A safe and secure aquaculture industry that can meet consumer demands for high-quality products and also be environment friendly and economically viable. Creation of superior aquaculture products that will be of high demand outside NJ.
5	Long Term - Barnegat Bay Shellfish Restoration Program (BBSRP). Clear and comprehensive understanding of community, environmental, genetic and physical regulators of aquaculture quality and quantity. A safe and secure aquaculture industry that can meet consumer demands for high-quality products and also be environment friendly and economically viable. Creation of superior aquaculture products that will be of high demand outside NJ.

Outcome #1

1. Outcome Measures

Short Term - Knowledge of seasonal variations for shellfish diseases. Create census data on communities involved in aquaculture. Determine the level of pollutants in economically important fish species. Develop markers and maps of important genetic traits. Knowledge of shellfish hatchery techniques that decrease time for growth to market size.

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Medium Term - Identify spatial and temporal relationships between patterns of shellfish diseases in NJ and environmental correlates. To develop disease-resistant strains of shellfish. Develop superior disease-resistant and larger genetic lines of shellfish.Measure the impact of communities on the aquaculture industry. Knowledge of the feasibility of off-shore shellfish farming.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Understanding the ecology of shellfish and their pathogens to improve shellfish management and production - Shellfish are important components of estuarine and coastal ecosystems that play significant roles in maintaining healthy ecosystems. Many species provide a renewable resource to local and regional economies through fisheries and aquaculture. A variety of molluscan shellfish such as oysters, hard clams, surf clams, ocean quahogs and scallops are fished and farmed in New Jersey and the surrounding region. Shellfisheries and shellfish aquaculture are dependent upon good water quality and healthy ecosystems. Nationally, molluscan shellfish aquaculture is a 328+ million-dollar industry supporting thousands of small farms and sustainable green jobs in rural areas (USDA 2014). Molluscan shellfish production increased 69% from 2005 to 2013. Farm-raised oyster production is increasing rapidly in the Northeast and mid-Atlantic regions and other species are soon to follow. In comparison, NOAA reports molluscan fisheries landed $904,518 worth of shellfish in 2014 indicating that shellfisheries is likely worth several

billion dollars to the US economy annually. In every case, fished or farmed shellfish are exposed to a plethora of ecological interactions, including parasitism, which can dramatically reduce production or affect human health. Shellfish can filter vast amounts of water which is magnified by the extensive assemblages that they can form in either natural or culture situations. As a result, shellfish contribute to ecosystem functioning by filtering water and providing habitat via the structures/assemblages formed by their shells. As filter feeders, shellfish can accumulate contaminants that are harmful to humans (e.g., Vibrio bacteria). Therefore, understanding shellfish ecology and pathology is of critical importance to the sustainable management of shellfish aquaculture and fisheries while protecting human health. The overarching goal is to improve production, management and regulation of the shellfish to support the shellfish industry and protect the environment.

What has been done

NJAES researchers are studying the life history, population dynamics and ecology of shellfish and their pathogens including spatial and temporal relationships with environmental correlates in order to identify and examine the ecological processes that control human pathogen accumulation in shellfish. They have developed, implemented, and monitored surveillance programs for shellfish, as well as developed and evaluated shellfish restoration and enhancement programs.

Results

Results for monitoring of oyster disease for the Delaware Bay oyster industry were shared at monthly Shellfisheries Council meetings and incorporated into the annual stock assessment to help inform management of the fishery. Analyses of field samples and experiments on a nematode parasitic on sea scallops were completed and reported to the industry directly and via conference presentations. Key findings included: Nematode distribution in the MidAtlantic has neither expanded northward nor contracted southward in the years since initial outbreak in 2015; On average, approximately 29% of observed meat lesions contain a nematode; Larger scallops were more likely to have more lesions and more nematodes; Scallop-to-scallop transmission of the parasite did not occur; Parasite transmission from shucked meats (mimicking discards at sea) to live scallops did not occur; Nematodes die quickly at high temperatures: 37 seconds at 56C, 17 seconds at 75C, and 6 seconds at 95C. At human body temperature (37C) nematodes died within 3 to 7 hours; A preliminary experiment to determine survival rates of infected scallops found that mortality in the laboratory was ~10% higher for infected scallops with highest mortality in heavily infected scallops. The Delaware Bay oyster shell planting program was monitored and is being evaluated to determine its overall success to demonstrate how fishing industry enhancement programs can sustain both fisheries and habitats when managed adaptively for long-term sustainability. Monitoring efforts to evaluate living shoreline projects involving the creations of near shore oyster habitat was completed and additional funding secured by the The Nature Conservancy to continue monitoring of shellfish productivity and habitat use by motile fauna as the structures become ecologically mature. Funding was also obtained to evaluate the performance of a novel subtidal cage culture system to grow oysters on dormant leased oyster grounds in Delaware Bay using hatchery reared lines of oysters selected for disease resistance. Disease and predation have virtually shut down production on these expansive historic leased grounds and developing economically viable aquaculture systems for these grounds is likely to help revitalize the Delaware Bay oyster program.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

Outcome #3

1. Outcome Measures

Long Term - Clear and comprehensive understanding of community, environmental, genetic and physical regulators of aquaculture quality and quantity. A safe and secure aquaculture industry that can meet consumer demands for high-quality products and also be environment friendly and economically viable. Creation of superior aquaculture products that will be of high demand outside NJ.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Agrochemical Impacts on Human and Environmental Health: Mechanisms and Mitigation - The importance of the evaluation of the impact of multiple pesticides entering into surface and groundwater and the effects that these levels have on aquatic species inhabiting these rivers and lakes. Pesticides are designed to inhibit or block pathways that are involved in neurotransmission, and other hormonal related targets that can alter normal development even at low level exposure because of impacts on developing organisms. Recent studies by the USGS have illustrated that a number of commonly used pesticides are present as mixtures in streams and lakes in agricultural, rural and urban environments. Some of these are what are referred to as legacy pesticides or their metabolites that have been not used for many years but are still present and likely impacting aquatic life. Research has shown that in lower vertebrates (finfish, reptiles) and higher vertebrates (rodents, mammals) the embryonic and early development stages are much more sensitive to a large number of toxic compounds than adults.

What has been done
NJAES researchers are conducting research to address the additive or non-additive effects of these pesticides on the embryo, juvenile and adult zebrafish model system. They are using existing computer software (Bench Mark Dose software USEPA) to calculate levels that would be protective based on statistical values. Based on these values, policy decisions can be made as to what if any remedial activities might be needed to protect aquatic species. If highly conserved pathways are involved, then this could be applicable to humans utilizing these water for drinking water or recreational fishing and hunting.

Results
Previous work has shown altered development and impacts on behavior in fish that would impact their survival. In the past year, NJAES researchers have been able to expand their studies into examining the impact of pyrethroid pesticides on the early development of the neurons in the brains of zebrafish. This has been accomplished using a technique that allows for microscopic visualization of the nerves in the brain with fluorescence tagged nerves and cells in living sedated fish. This novel approach allows for examining altered nerve development and damage to specific neurons. They have continued to work on connecting the effects that they are observing in the brain with behavioral effects that they had previously observed following embryonic exposure. The effects from single exposures to embryos and larvae have been shown to continue into adulthood. This area of research is important in understanding pesticide effects on any developing brain across vertebrate species.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

Outcome #4

1. Outcome Measures

Long Term - Population Connectivity and Long-term Population Dynamics in Shellfisheries. Clear and comprehensive understanding of community, environmental, genetic and physical regulators of aquaculture quality and quantity. A safe and secure aquaculture industry that can meet consumer demands for high-quality products and also be environment friendly and economically viable. Creation of superior aquaculture products that will be of high demand outside NJ.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
With a global human population of nearly 6.9 billion, demand for global food is putting pressure on fisheries resources worldwide. The great challenge of managing fisheries is balancing the global need for marine food resources with the long-term sustainability and stability of the populations being fished. Fisheries rely on marine ecosystems for production of the animals that are

harvested; however, the productivity of the natural systems are delicately balanced and can be damaged from human activity on land and at sea and is changing in unexpected ways as the regional and global climate changes. There is a need to understand how patterns of population connectivity can help us understand dynamics in fishery productivity and the capacity of these populations to respond to stressors like fisheries and climate change. In New Jersey, over 85% of all commercial fishery landings are from invertebrate fisheries. The vast clam populations living in the sandy bottom along the Mid-Atlantic continental shelf are not only the basis of a major fishing industry, but also an important part of the marine coastal shelf ecosystem through their high filtration capacity and massive benthic biomass. Also fishing along the Mid-Atlantic shelf, the sea scallop fishery is currently the most valuable fishery in the U.S.; its ex-vessel value in 2011 was over $580 million. In state waters, oysters in Delaware Bay have provided a sustainable fishery resource, critical reef habitat and contributed to the local economy in New Jersey for centuries. For all of these fished populations to sustain themselves, their pelagic offspring have to survive weeks in the water column as developing microscopic larvae and then find suitable habitat miles from their birthplace where they can grow to adulthood.

What has been done
NJAES researchers are investigating the role of larval connectivity in the fishery ecology of New Jersey shellfisheries. Temporal trends in population characteristics such as abundance and gene frequencies influence the ability of a population to support a fishery and to respond to changing climate. Sustainable management of fishery resources rely on understanding and predicting these changes over time. Dynamics in abundance occur in part through changes in the supply of new individuals to a population, a process called larval dispersal. Genetics are likewise shared among populations of shellfish through larval dispersal. In this way larval dispersal is a mechanism that controls important dynamics in shellfishery stocks.

Results
NJAES research efforts have been successful in identifying the possible drivers of climate driven changes in the surfclam fishable stock over the past 3 decades. Model simulations show that larval dispersal is sufficient to maintain the overall stock; however, changes in bottom ocean water temperature over time can lead to shifts in stock distribution and limits to maximum body size. Coupled biological and socio-economic models were used to test what these biological and ecological changes may mean to future alteration in fishery activity and the role individual captains' choices when fishing in fishery resilience.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

Outcome #5

1. Outcome Measures

Long Term - Barnegat Bay Shellfish Restoration Program (BBSRP). Clear and comprehensive understanding of community, environmental, genetic and physical regulators of aquaculture quality and quantity. A safe and secure aquaculture industry that can meet consumer demands for high-quality products and also be environment friendly and economically viable. Creation of superior aquaculture products that will be of high demand outside NJ.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The health of the Barnegat Bay ecosystem has degraded considerably in recent decades due to human impacts and changes in ecosystem dynamics. Concurrently, there have been substantial declines in wild shellfish populations that support valuable coastal fisheries and also provide many ecosystem benefits, including improving water quality and providing habitat for other species. As a result, increased efforts are needed to help restore both wild shellfish populations and the health of the Barnegat Bay ecosystem in order to serve the diverse clientele who work or recreate within the Barnegat Bay ecosystem.

What has been done
The BBSRP annually hosts the Shellfish Gardener course which educates stakeholders about the ecology of the Barnegat Bay ecosystem and promotes positive environmental stewardship of coastal marine resources by using shellfish biology, restoration, and aquaculture as the primary teaching tools. In 2018, the course was offered as a HyFlex course so that registrants from all over New Jersey could participate in the class lectures live from in-class or remote locations via webinar. The Shellfish Gardener course also included field trips and mandatory volunteer time for experiential, hands-on learning to reinforce lessons taught in classroom settings.

Results
The 2018 BBSRP Shellfish Gardener course participants (n=39) primarily included members of the general public, as well as some young professional marine scientists. All of the 21 course evaluation survey respondents agreed both that they were pleased that they participated in the program and that the information presented was valuable. 95% of Shellfish Gardener course evaluation respondents (n=21 total) agreed that they had an improved understanding of the issues impacting the health of the Barnegat Bay ecosystem as a result of taking the class, while the same percentage of respondents also agreed that they are likely to change their own practices to promote more positive environmental stewardship of our marine ecosystems and that they'd share what they have learned with others. As a result of participating in the Shellfish Gardener course, the registrants committed over 800 hours of volunteer time to improving the health of the Barnegat Bay ecosystem, which included assisting in growing 600,000 hard clams and 50,000 oysters that were planted in the wild to help restore shellfish populations.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

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

No external factors to report.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

NJAES research and extension outcomes related to this planned program were evaluated utilizing a variety of evaluation methods appropriate for each initiative to determine the effectiveness on both a qualitative and quantitative level. For KASA, and practice change we included the measurement of knowledge gained as measured by pre/post Likert-scale assessment. Surveys were used to measure increase in skills acquired, behavior change and practice adoption. For process evaluation we focused on program delivery, participation, relevance and timeliness. Data was collected at appropriate times for each initiative that supports this planned. IRB approved evaluation instruments were used to collect research and extension data. Data analyses and comparisons relevant to basic and applied research and demonstration were collected and analyzed and reported utilizing a variety of data collection methods appropriate to each research question. The major goal of evaluating is the demonstration of social, economic, behavior, and environmental changes in conditions that contribute to improved quality of life as a result of participation in programs and benefits of research solutions. See state defined outcomes for detailed results for the initiatives.

Key Items of Evaluation

None to report.

V(A). Planned Program (Summary)

Program # 8

1. Name of the Planned Program

Food Safety

☑ 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	5%		5%	
104	Protect Soil from Harmful Effects of Natural Elements	5%		5%	
311	Animal Diseases	5%		5%	
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals	5%		5%	
404	Instrumentation and Control Systems	5%		5%	
501	New and Improved Food Processing Technologies	10%		10%	
502	New and Improved Food Products	10%		10%	
503	Quality Maintenance in Storing and Marketing Food Products	10%		10%	
504	Home and Commercial Food Service	15%		15%	
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources	10%		10%	
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins	10%		10%	
722	Zoonotic Diseases and Parasites Affecting Humans	5%		5%	
723	Hazards to Human Health and Safety	5%		5%	
	Total	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	3.0	0.0	4.0	0.0
Actual Paid	0.8	0.0	3.7	0.0

Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
124250	0	208199	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
2305331	0	1758494	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
48223	0	116998	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

• Conduct training and certificate programs for growers, producers, food workers, consumers and vendors to increase knowledge of food safety practicies.
• Design strategies, tools and processes to detect and eliminate pathogens, chemical and physical contaminants during production, transportation, processing and preparation of food.
• Invesitgate the ecology of threats to the food supply from microbial and chemical sources
• Develop technologies for the detection of food supply contaminants

2. Brief description of the target audience

• Producers
• Processors
• Retail - restaurants/vendors/supermarkets
• Department of Health
• Consumers, families, youth communites
• NJAES - faculty - staff - students
• Food manufacturers
• Schools - child care providers - food service workers

3. How was eXtension used?

Faculty have participated in answering "ask the expert" questions and provided leadership to CoPs.

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	16473	4235374	6	0

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	15	21	36

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- -New methods in technologies -Educational workshops -Newsletters -Scientific publications -Patents -Website development -Extension publications -Volunteers trained -Agricultural and Industry Certifications -Train the trainer programs -Audits conducted

Year	Actual
2018	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Short Term - Increase knowledge of viable technologies, detection prevention, intervention and control technologies and practices to ensure food safety. Increase understanding of the ecology of threats to food safety from microbial and chemical sources.
2	Medium Term - Adoption of safe food handling practices at the individual, family, community, production and supply system levels.
3	Long Term - A safe food supply resulting from reduced incidence of food-borne illnesses.
4	Medium Term - Survival strategies of foodborne pathogens and commodity contamination in production fields and retail outlets. Adoption of safe food handling practices at the individual, family, community, production and supply system levels.
5	Long Term - Oxidative and Free Radical Reactions in Foods and Biological Systems. A safe food supply resulting from reduced incidence of food-borne illnesses.

Outcome #1

1. Outcome Measures

Short Term - Increase knowledge of viable technologies, detection prevention, intervention and control technologies and practices to ensure food safety. Increase understanding of the ecology of threats to food safety from microbial and chemical sources.

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Medium Term - Adoption of safe food handling practices at the individual, family, community, production and supply system levels.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Enhancing Microbial Food Safety by Risk Analysis - The Centers for Disease Control and Prevention has recently reported that an estimated 48 million cases of foodborne illness, 128,000 hospitalizations, and 3,000 deaths occur each year from foodborne microorganisms. In addition to human suffering, foodborne illnesses also have a substantial economic impact in the United States. The annual cost of foodborne illness in the U.S. is estimated at $89 billion for loss of productivity, other economic losses and medical expenses.

What has been done
The studies being conducted will be the first comprehensive attempt to develop risk-based strategies leading to effective control of pathogens from the farm through to consumption across all food commodities in the US. Additional expected outcomes include the use of microbiological data to develop risk-based models that can be used to better predict microbial contamination and predict the reduction of pathogens in foods due to application of various control strategies. It is expected that the outcomes of this project will contribute to the long-term profitability and sustainability of the food industry as a whole by making accessible a suite of new tools with which

the microbial safety of foods can be enhanced. Risk assessment efforts focus on predictive modeling and quantitative risk assessment. NJAES Researchers efforts in the last year have been on Listeria in cheese, cold plasma inactivation, and modeling bacteria competition. The researchers still have interest in Salmonella, E. coli and norovirus in nuts, and fresh fruits and vegetables and maintain a strong interest in handwashing and cross contamination.

Results

Efforts in risk management primarily consist of the development of predictive models and quantitative data for use by risk managers. Specific results and progress include the following: a series of papers on modeling and risk assessment Listeria in a variety of cheese products. Listeria continues to be an important foodborne pathogen, which recently caused over 200 deaths and 1000 illnesses in South Africa, in an outbreak linked to processed meat; papers on Salmonella in chicken and on cold plasma. Cold plasma is a novel food processing technique that uses the fourth state of matter (plasma) to inactivate microorganisms. This technology uses electricity to convert a gas (e.g. air, oxygen, nitrogen, or helium) into reactive ions that kill microorganisms. The research team provides the processing expertise, and this team provides the microbiology expertise to yield useful research findings. The team showed that it was easier to inactivate microorganisms on smooth surfaces than on rough surfaces, which seem to protect the microorganisms from the reactive ions. Recently, there was a nationwide concern over E coli in romaine lettuce. This research team did discuss E. coli foodborne disease outbreaks several times on their Food Safety Talk podcast. Most notably in these episodes: 143 (I don't want dead water) E. coli in romaine lettuce from fall 2017; 146 (Vegas baby!) the risks posed by E. coli in flour; 150 (Rambunctious Ramble in the Jungle) E. coli in romaine lettuce including a link to a restaurant in New Jersey; 151 (Washing My Own Head) lots of discussion about E. coli and romaine lettuce; 152 (One Hang Up One Hug) and update on the E. coli in romaine lettuce from summer 2018. Risk communication efforts primarily center through information disseminated through the podcast and listenership continues to grow every year and appears to have a wide listener base, including the general public as well as colleagues in academia, industry and government. They combine humor, pop-culture references, and fast-paced discussion to educate our diverse audience about current food safety topics.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
104	Protect Soil from Harmful Effects of Natural Elements
311	Animal Diseases
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals
404	Instrumentation and Control Systems
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
503	Quality Maintenance in Storing and Marketing Food Products
504	Home and Commercial Food Service
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
722	Zoonotic Diseases and Parasites Affecting Humans

723 Hazards to Human Health and Safety

Outcome #3

1. Outcome Measures

Long Term - A safe food supply resulting from reduced incidence of food-borne illnesses.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Improving food safety through predictive models and microbial risk assessment - Food manufacturers are under a variety of regulatory, economic and environmental pressures. Retaining a strong manufacturing base is still an essential component for the state's economic growth.

What has been done
A NJAES researcher provides technical assistance for small and medium-sized companies, helping to keep them in business, while still assuring the safety of the food supply. Short-courses and one-on-one assistance provided specific and direct economic benefit to NJ companies. Technical advice was provided on shelf stable claim regarding salami products. This included discussions of experiments to evaluate microbial contamination and removal from touch screen devices. Technical advice was also provided on canned fruit sampling plans to evaluate the impact of damaged shipments on customer spoilage complaints. Assistance was provided to a New Jersey based testing lab with safety evaluation of cooling deviation and safety evaluation of cooking deviation, in addition to assisting a New Jersey based testing lab with safety evaluation cold holding of vacuum-packed fish. An NJAES researcher also provided technical assistance to other states and internationally, some examples include: California based company with refrigerated hot filled grain-based product pathogen and spoilage inactivation and growth estimates using computer modeling; advice on garlic spread and focaccia bread challenge studies for Wisconsin based company; potato chip food safety risk assistance for Pennsylvania based company; clostridium perfringens process risk evaluation for Colorado based company; process lethality evaluation for FDA colleague in Maryland; assisted Virginia based trade association with quantitative microbial risk assessment of Salmonella in peanuts, etc.

Results
In several cases costly recalls, rework, or product destruction were avoided. In some cases, federal agencies, trade associations or food processing companies were able to use risk-based decision-making to guide them in their policy discussions. The value of the food products in question was estimated to exceed $1 million.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
104	Protect Soil from Harmful Effects of Natural Elements
311	Animal Diseases
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals
404	Instrumentation and Control Systems
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
503	Quality Maintenance in Storing and Marketing Food Products
504	Home and Commercial Food Service
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
722	Zoonotic Diseases and Parasites Affecting Humans
723	Hazards to Human Health and Safety

Outcome #4

1. Outcome Measures

Medium Term - Survival strategies of foodborne pathogens and commodity contamination in production fields and retail outlets. Adoption of safe food handling practices at the individual, family, community, production and supply system levels.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual

2018 0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Bacteria have the ability to adapt to varying environments which has facilitated their existence for millions/billions of years. From a practical food safety and shelf-life position recognizing and understanding how bacteria survive is essential. Studies conducted in the open-environment and in greenhouses suggests that enteric bacterial population of CFU survive for short periods; not detectable on crops by culture or molecular methods. Companies conducting monitoring and test and hold programs indicate that enrichment of samples (water, soil, commodity) is required to detect pathogens of interest. Thus, it would seem that consumers suffer cases of foodborne illness from consuming produce that is apparently contaminated with extremely low levels of the causative agent. This may or may not be the case. Enteric foodborne pathogens may be at much greater levels but in dormant states that impede detection and facilitate contamination. In the present project, experiments that focus on ability of bacteria to undergo desiccation and entry in to a viable but-nonculturable state (VBNC) and subsequent contamination of or recovery on leafy greens is investigated. E. coli is exposed to water, soil, and chicken manure pellets and desiccated or VBNC state determined. Assessment of crop contamination and resuscitation on crops is investigated.

What has been done

For this period, two of the project's main goals were addressed: Assess change in microbial population of crisped and misted products and shelf-life (retail/in-home) and define cross-contamination during crisping focusing on E. coli O157:H7, Salmonella and Listeria monocytogenes and utility of various sanitation processes in preventing cross-contamination. The efficacy of various water antimicrobials in reducing MS2 bacteriophage (serving as a surrogate for human norovirus) on the surface of strawberries was investigated. The water antimicrobial served two purposes, the reduction of MS2 on strawberries and the control of cross-contamination. The study was also conducted with a cocktail of Shiga-toxin producing Escherichia coli.

Results

The shelf-life of fresh produce was evaluated following exposure through immersion to various water antimicrobials. In short, commensal bacteria populations quickly recovered and several days post-exposure populations were similar to those on produce receiving no treatment or treatment with water. Also, evaluation of several "home" or "kitchen" antimicrobials was completed. The studies demonstrated that sodium bicarbonate and sodium chloride have minimal effect on reducing population of commensal bacteria. Foodborne pathogens cannot be effectively removed from fruits and vegetables through washing. Understanding the behavior of foodborne pathogens on fresh fruits and vegetables will aid in developing strategies to identify and inactivate pathogens of concern when present. Research on bacteria that enter a survival state (viable but non-cultural; VBNC) builds on studies previously completed by the PI demonstrating long-term survival of pathogens in water. For instance, VBNC foodborne pathogens on leafy greens may not be detected using biochemical or molecular typing methods. Therefore, testing using those methods may under estimate the risk associated with a particular lot of lettuce. VBNC bacteria may also be less susceptible to the action of antimicrobial agents.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships

104	Protect Soil from Harmful Effects of Natural Elements
311	Animal Diseases
314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals
404	Instrumentation and Control Systems
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
503	Quality Maintenance in Storing and Marketing Food Products
504	Home and Commercial Food Service
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
722	Zoonotic Diseases and Parasites Affecting Humans
723	Hazards to Human Health and Safety

Outcome #5

1. Outcome Measures

Long Term - Oxidative and Free Radical Reactions in Foods and Biological Systems. A safe food supply resulting from reduced incidence of food-borne illnesses.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Microbial safety has commanded the press, regulatory, and research funding spotlights over the past decade. At the same time, problems of chemical degradation of food quality have been largely ignored even while they present significant hurdles to the food industry and also contribute to food safety and healthfulness. Lipid oxidation, commonly known as "rancidity", has long been recognized as the major chemical reaction limiting quality, safety, and stability of foods during processing and storage, but knowledge of oxidation mechanisms stagnated during the no/low fat era. Now, recognition of key roles of lipids in nutrition, health, and disease is forcing reformulation

of foods with high levels of polyunsaturated fatty acid, particularly omega-3 fatty acids, and difficulties in stabilizing these lipids is demonstrating clearly that our understanding of oxidation processes in foods is terribly outdated and incomplete. At the same time, pressure to eliminate use of traditional synthetic antioxidants such as BHT (butylated hydroxytoluene) and to increase utilization of natural phenolic compounds as food antioxidants for enhanced health and increased safety further complicates the challenges facing the food industry for limiting food oxidation. The food industry is under great pressure to replace synthetic antioxidants (e.g. BHT and BHA) with natural antioxidants for "safer" food stabilization. However, lack of information about reactions of natural antioxidants (mostly polyphenols) in foods has limited effective applications of natural antioxidants (mostly polyphenols) in foods.

What has been done
NJAES researchers are working to provide critical missing information about antioxidant chemistry -- radical quenching mechanisms and specificity, solubility and phase partitioning, reactions with proteins and other non-lipid molecules - and then apply that information to develop a) essays that can predict effectiveness of specific natural compounds in foods and b) guidelines for use of natural antioxidants to protect sensory, functional, and nutritional qualities of foods.

Results
Natural antioxidants often show disappointing effectiveness in stabilizing foods, possibly because phenol reactions are diverted from lipid radical quenching to complexation with proteins. To investigate the extent to which antioxidants may depleted by reaction with proteins, eight polyphenols found commonly in foods or natural extracts were reacted with purified a-lactalbumin (ALA) in solutions buffered at pH 7. Chemical analyses showed that phenols differed in their reactivity with protein amine, thiol, disulfide, and tryptophan groups, with gallic acid, pyrogallol, and hydroquinone being generally most reactive. These three phenolic compounds were highly reactive with sulfur amino acids groups, complexing with up to 90% of cysteine free or from reduced cysteine(-SH groups) in ALA. They also formed non-covalent associations with about 25% of unreduced cystine (S-S bonds) and covalent linkages with small amounts of these bonds, with limitations most likely caused by steric inaccessibility in the proteins. Fluorescence analyses showed that hydroquinone, resorcinol, and catechol bind strongly to three tryptophan residues in hydrophobic environments, while pyrogallol and phenolic acids bind more weakly to a single tryptophan near the protein surface. Since tryptophans are all in the protein interior, such reaction suggests that phenols can induce opening of the protein structure with at least partial denaturation. This possibility was verified by circular dichroism, which revealed that all phenols opened the random coil structure of the protein. Gallic acid and pyrogallol (three phenolic groups on the aromatic ring) and phenolic acids altered protein structure by decreasing a-helices but increasing b-sheet structures, while hydroquinone, catechol, and resorcinol (two phenolic groups) did the opposite (increased a-helices, decreased b-sheets). All the phenolic compounds reacted moderately with free amines in the ALA. Although this reaction was less than expected from previous results, it still provides a means by which proteins are protected and system oxidation is reduced by phenols even while antioxidant protection is diverted away from lipids. This complex action of phenols in foods must be recognized and accounted for in designing antioxidant formulations with natural antioxidants.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
104	Protect Soil from Harmful Effects of Natural Elements
311	Animal Diseases

314	Toxic Chemicals, Poisonous Plants, Naturally Occurring Toxins, and Other Hazards Affecting Animals
404	Instrumentation and Control Systems
501	New and Improved Food Processing Technologies
502	New and Improved Food Products
503	Quality Maintenance in Storing and Marketing Food Products
504	Home and Commercial Food Service
711	Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources
712	Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins
722	Zoonotic Diseases and Parasites Affecting Humans
723	Hazards to Human Health and Safety

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

No external factors to report.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

NJAES research and extension outcomes related to this planned program were evaluated utilizing a variety of evaluation methods appropriate for each initiative to determine the effectiveness on both a qualitative and quantitative level. For KASA, and practice change we included the measurement of knowledge gained as measured by pre/post Likert-scale assessment. Surveys were used to measure increase in skills acquired, behavior change and practice adoption. For process evaluation we focused on program delivery, participation, relevance and timeliness. Data was collected at appropriate times for each initiative that supports this planned. IRB approved evaluation instruments were used to collect research and extension data. Data analyses and comparisons relevant to basic and applied research and demonstration were collected and analyzed and reported utilizing a variety of data collection methods appropriate to each research question. The major goal of evaluating is the demonstration of social, economic, behavior, and environmental changes in conditions that contribute to improved quality of life as a result of participation in programs and benefits of research solutions. See state defined outcomes for detailed results for the

initiatives.

Key Items of Evaluation

None to report.

V(A). Planned Program (Summary)

Program # 9

1. Name of the Planned Program

Sustainable Energy

☑ 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
605	Natural Resource and Environmental Economics	100%		100%	
	Total	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	4.0	0.0	2.0	0.0
Actual Paid	0.1	0.0	0.8	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

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

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
12298	0	36221	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
108829	0	387803	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
5588	0	37419	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

- Perform experiments to investigate renewable energy production.

- Develop methodologies and scientifically sound alternatives to fossil fuels
- Educate homeowners, business owners, farmers and agri-related businesses, youth and families about conservation and efficiency practices related to energy use.
- Provide education and training to enhance bio energy related job development and careers.

2. Brief description of the target audience

- University faculty, staff and students
- School aged youth
- Families
- Homeowners
- Farmers
- Agri-businesses
- State agencies and organizations
- Industry partners
- Small businesses
- Entrepernuers
- Policy and decision makers

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2018	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	957	84123100	3	0

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	5	11	16

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- -Scientific publications and patents produced -Participants reach through direct and indeirect education -New methodologies and technologies developed

Year	Actual
2018	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Short Term - Increase knowledge, energy efficiency technologies and conservation practices related to energy use. Explore research strategies to replace fossil fuel consumption.
2	Medium Term - Participants in direct and indirect educational methods will adopt practices to conserve energy use and reliance on fossil fuels. Business owners will create and maintain green jobs/careers as a result of bioenergy development. Newly developed plants and technologies will be adopted to enhance energy independence.
3	Long Term - Fossil fuel consumption will be replaced with biofuels. Economic development will be enhanced through an increase of jobs and careers as a result of bioenergy development. Environment quality enhanced as a result of sustainable biofuel production and utilization.
4	Long Term - Impact Analyses and Decision Strategies for Agricultural Research. Fossil fuel consumption will be replaced with biofuels. Economic development will be enhanced through an increase of jobs and careers as a result of bioenergy development. Environment quality enhanced as a result of sustainable biofuel production and utilization.

Outcome #1

1. Outcome Measures

Short Term - Increase knowledge, energy efficiency technologies and conservation practices related to energy use. Explore research strategies to replace fossil fuel consumption.

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Medium Term - Participants in direct and indirect educational methods will adopt practices to conserve energy use and reliance on fossil fuels. Business owners will create and maintain green jobs/careers as a result of bioenergy development. Newly developed plants and technologies will be adopted to enhance energy independence.

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Long Term - Fossil fuel consumption will be replaced with biofuels. Economic development will be enhanced through an increase of jobs and careers as a result of bioenergy development. Environment quality enhanced as a result of sustainable biofuel production and utilization.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The Science and Engineering for a Biobased Industry and Economy - The new biobased industry, be it for food, fuel, biomaterials or other co-products, is rooted in a sustainable and productive biomass production system. Replacing petroleum products with those originating from biological sources will require significant fundamental and applied research efforts. Reversing the effects of

climate change may only be successful with the implementation of bioenergy with carbon capture and storage. At the national level, manufacturing, agriculture, and energy sectors would benefit from the adoption of this new practice, whilst benefitting the public with cleaner air and cleaner water.

What has been done

NJAES researchers evaluated how the use of technology leads to internalization of the negative externalities, through a combination of fish-farming with hydroponic, namely, aquaponics systems. Because this method internalizes the negative externalities without the need for regulatory intervention, there is a larger output of fish than the regulated outcome and cost-savings in the fish-farming process due to decrease in the need to purchase fertilizers. The aquaponics systems diversify the sources of income of the farmer as well as the resulting "double dividend" from savings in water purification and savings in the purchase of fertilizer for plants growth. The research shows how duckweed can add value to an aquaponics system and how this can benefit the development of a biorefinery that uses duckweeds to produce bioplastics. Duckweed serves as fish feed and a biological filter, as well as feedstock for the bioplastic process.

Results

Preliminary results suggest that the addition of duckweed results in a decrease in feed cost and effluent disposal cost, as well as significantly reduced the area needed to build the integrated system. There is potential for nutrient restoration, ecosystem stabilization, and breeding incrementalism in plant microbiome manipulation technology. Despite information gaps, fundamental studies provide evidence of the beneficial impacts of microbiome-concentrated techniques that change plant functional traits like leaf nutrient levels and plant life longevity; this provides the world with a dependable method to grow certain crops and confident food and energy security. Duckweed may be utilized at different stages of growth and processing for various needs: Food - Chicken feed/fish food. Corn, for example, is normally used to feed livestock but remains low in protein; duckweed can supplement low-protein conventional feeds in a cost-effective manner. Similarly, it is used to feed fish like tilapia and carp. Fish, otherwise, may be placed in duckweed tanks to suppress certain pests, like mosquitos; Human food: Poor populations in Laos, Thailand, Myanmar, India, Pakistan, Bangladesh survive on carbohydrate-rich foods which may be supplemented with duckweed as a protein or fat source. Depending on the strain of duckweed, human diets may be supplemented with different levels of carbohydrates, proteins, fats, minerals, carotenoids, and sterols: Energy - Pelletize for traditional boilers. In comparison to dense wood, pelletizing duckweed would require less energy. The pellets may be burned directly for energy or further processed into fuel. Feedstock for biogas: Upon drying and pelletizing the duckweed, the pellets can be used to produce a biogas. This gas is renewable in comparison to natural gas. After further processing, biofuel once converted into a gas, duckweed may be further processed into methanol, and then converted into gasoline. Due to the low cost of duckweed production and maintenance, duckweed-sourced biofuel may become very cost-competitive with existing oil refineries; Environment - Water contamination measure - The EPA currently uses a strain of duckweed, from the species called Lemena minor, to identify the level of heavy metal contamination in water. Duckweed is also utilized as a sediment toxicity indicator to test the level of nutrients or contaminants in enriched or unenriched soils. This method provides an additional, natural method to test sediment toxicity; Clean water - Duckweed's ability to uptake nitrogen and phosphorus makes it an efficient way to purify water and remove excess contaminants. Finally, the meta-analyses suggest that corn ethanol has minor effects on greenhouse gas emissions and significant yet moderate effects on food and fuel prices. However, corn ethanol has a relatively significant impact on fuel security in terms of reductions in the import of oil to the US and its overall effect on the US balance of trade.

4. Associated Knowledge Areas

KA Code	Knowledge Area
605	Natural Resource and Environmental Economics

Outcome #4

1. Outcome Measures

Long Term - Impact Analyses and Decision Strategies for Agricultural Research. Fossil fuel consumption will be replaced with biofuels. Economic development will be enhanced through an increase of jobs and careers as a result of bioenergy development. Environment quality enhanced as a result of sustainable biofuel production and utilization.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2018	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
The conceptual framework underlying the research does not naively take the availability of new technologies as given. While it is critical to assess current producer demand for new technologies, it is equally important to examine how socio-economic factors affect the supply of innovations and how evolving factors will change these demands. The research will investigate how policies, regulations, and environmental factors affect the size and focus of investments in research and innovation, and the pace and direction of technological change.

What has been done
The researchers have already completed three experiments: one simulating a tilapia-lettuce aquaponic system using data generated at a facility in Australia; the second was a pilot of garra-rufa fish and lettuce at Israel; and the third is a pacu-duckweed benchmark system at Rutgers.

Results
This work has improved the understanding of factor impacting the adoption of aquaculture and aquaponics technologies, and identified possible barriers to the deployment of the technology. The conceptual and empirical results are discussed in recent publications (e.g., "The Synergy between Aquaculture and Hydroponics Technologies: The Case of Lettuce and Tilapia" discussed some of the key findings).
The experience so far shows that the introduction of aquaponics can diversify the farmers' sources of income, yield savings in the cost of water purification and the cost of fertilizer for the

plants' growth, and results in more fish and plant output compared to an unregulated scenario. While deriving these results, they also derive a separation rule for managing live aquatic inventory, which separates expenses (which are affected by the biology of fish) and income. In addition, the combination of fish and duckweed resulted in significant impacts on costs: currently, 30% of the aquaculture costs comes from feed, and this experiment shows they can cut this cost by 50% yet not impact fish growth. The group is currently investigating if they can reduce the cost even further using a pilot that includes two 600 gallon tanks.

4. Associated Knowledge Areas

KA Code	Knowledge Area
605	Natural Resource and Environmental Economics

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Other (Consumption Practices)

Brief Explanation

No external factors to report.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

NJAES research and extension outcomes related to this planned program were evaluated utilizing a variety of evaluation methods appropriate for each initiative to determine the effectiveness on both a qualitative and quantitative level. For KASA, and practice change we included the measurement of knowledge gained as measured by pre/post Likert-scale assessment. Surveys were used to measure increase in skills acquired, behavior change and practice adoption. For process evaluation we focused on program delivery, participation, relevance and timeliness. Data was collected at appropriate times for each initiative that supports this planned. IRB approved evaluation instruments were used to collect research and extension data. Data analyses and comparisons relevant to basic and applied research and demonstration were collected and analyzed and reported utilizing a variety of data collection methods appropriate to each research question. The major goal of evaluating is the demonstration of social, economic, behavior, and environmental changes in conditions that contribute to improved quality of life as a result of participation in programs and benefits of research solutions. See state defined outcomes for detailed results for the initiatives.

Key Items of Evaluation

None to report.

VI. National Outcomes and Indicators

1. NIFA Selected Outcomes and Indicators

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