2019 Annual Report of Accomplishments and Results

Maryland
University of Maryland
University of Maryland Eastern Shore
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I. Report Overview

The NIFA reviewer will refer to the executive summary submitted in your Plan of Work. Use this space to provide updates to your state or institutions as needed.

1. Executive Summary (Optional)

In 2019, the University of Maryland Extension (UME), the Maryland Agricultural Experiment Station (MAES), and both the University of Maryland Eastern Shore (UMES) Agricultural Experiment Station and Extension Program continued to successfully and efficiently collaborate in implementing their joint Plan of Work (2015-2019). However, this will be the last joint annual report of accomplishments for the University of Maryland College Park and the University of Maryland Eastern Shore. The cooperative relationship in research and extension established over many years will continue but starting next year (2021) both institutions will report their accomplishments separately. These institutions are submitting separate Institutional Profiles for their Research and Extension Plan of Work for the period 2020-2014.

II. Merit and Scientific Peer Review Processes

The NIFA reviewer will refer to your Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA's attention.

Process	Updates
1. The Merit Review Process	No change
2. The Scientific Peer Review Process	No change

III. Stakeholder Input

The NIFA reviewer will refer to your Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA's attention.

Stakeholder Input Aspects	Updates
1. Actions taken to seek stakeholder input that encouraged their participation with a brief explanation	Various field events were held throughout Maryland to showcase the work being done by Extension and Research teams at UMD and UMES. In these gatherings, stakeholders interacted with faculty who shared results of their projects and the stakeholders actively shared comments, input and feedback on university activities.
2. Methods to identify individuals and groups and brief explanation.	Extension agents are regularly engaged in activities with stakeholders. Researchers attend and give presentations at the county and specific ag themed meetings. They meet new groups and/or individuals in these venues.
3. Methods for collecting stakeholder input and brief explanation.	No significant update to report. See response on #4.
4. A Statement of how the input will be considered and brief explanation of what you learned from your stakeholders.	Stakeholder inputs are used in setting priorities for research and Extension activities. An extensive input collection process was conducted when UMD's College of Agriculture and Natural Resources embarked on setting its Strategic Initiatives in 2017. The college continues to refine action items under these initiatives and continues to collect input from its stakeholders, including its strategic partner in Maryland, the University of Maryland Eastern Shore.

IV. Planned Program Table of Contents

V. Planned Program Activities and Accomplishments

Please provide information for activities that represent the best work of your institution(s). See Section V of the Guidance for information on what to include in the qualitative outcomes or impact statements. Add additional rows to convey additional accomplishments. You may expand each row as needed.

No.	Title or Activity Description	Outcome/Impact Statement	Planned Program Name/No.
1.	**Women in Agriculture (UME)**	Increase in small, part-time, female, veteran, and limited resource farmers. **Outcome:** Since 2008, Annie's Project has expanded and reached 21 sites educating 692 farm women and acquiring $250,000 of grant and solicited funds. In 2019, one urvey was sent to 972 registrants (324 responses 33% response rate and 16 states represented). Of the participants: 66% were interested in the topic, 37% will use the information to help their clients, and 29% will improve their farm business management. Results concluded a statistically significant increase in knowledge after attending the Webinars.	1.Global Food Security and Hunger
2.	**Agricultural Nutrient Management Program (UME)**	Increase in the amount of agricultural land under best-management practices due to Extension programming efforts **Outcome:** 260,187 acres covered and 1,364 Nutrient Management Plans reviewed.	1.Global Food Security and Hunger
3.	**UME Master Gardener Program (UME)**	Increase in the number of people growing food for health and economic reasons **Outcome:** 112, 788 Master Gardener volunteer hours with a value of $3.23 million.	1.Global Food Security and Hunger
4.	**Internet Resources for Small Ruminant Producers (UME)**	Raising Sheep and Goats for Quality Meat Production **Outcome:** The UME Small Ruminant Facebook page has more than 13000 followers and "likes." In 2019, over 10 million people were reached by the UMES small ruminant program via web sites and social media.	1.Global Food Security and Hunger
5.	**Preventing Outbreaks of Avian Influenza Through Timely Dissemination of Practical Science-Based Information (MAES)**	Avian influenza (AI) affects various species of poultry and outbreaks caused by the H5 and H7 strains have resulted in severe economic losses to the poultry industry worldwide. In 1983, an outbreak of highly pathogenic H5N2 in the Mid-Atlantic region of the U.S. cost the federal government	1.Global Food Security and Hunger

		over 62 million dollars to eradicate the outbreak; producers lost nearly 200 million dollars. Thirty-two years later, the U.S. is facing its worst outbreak of AI with 223 infected poultry premises in 15 states as of June 17, 2015. More than 48 million birds have been lost due to infection caused mainly by a deadly mixed-origin H5N2 strain of highly pathogenic avian influenza (HPAI). While cases have not been reported on the East Coast, poultry growers and workers in major poultry production areas in the U.S. need to know how HPAI is transmitted so they can take the necessary measures to prevent it. To address these needs, the project will develop, enhance, and disseminate practical, credible, science-based information on avian influenza prevention, preparedness, and response. **Outcome:** The team has conducted a series of poultry management workshops over the past four years, focusing on biosecurity measures to prevent outbreaks of avian influenza. They have also given oral and poster presentations on biosecurity and avian influenza prevention at professional and poultry industry meetings. Workshops and presentations were complemented by the short (6-7 minute) videos produced during the first year of the project. These science-based videos show step-by-step biosecurity procedures for various sectors of the poultry industry including commercial poultry growers, technical service personnel, and backyard flock owners. The videos have been translated into Spanish and Mandarin and are also subtitled in Korean and Vietnamese. The surveys conducted following these workshops and other poultry events revealed 75% of participants improved their biosecurity practices after attending UME poultry programs.	
6.	**Honey bee Best Management Practices to Improve Colony Health (MAES)**	Managed honey bee colonies have been dying at high rates in the US for the last 10 years. These high rates of losses are a concern for both beekeepers and the farmers who rely on a healthy honey bee population to pollinate their crops. In the US over $16 billion of produce rely on managed honey bees for pollination. This project aims to reduce the high rate of losses experienced by beekeepers by testing and promoting the adoption of data derived best management practices.	1.Global Food Security and Hunger

		Outcome: In 2019, the team completed the field validation of the economic and colony health effects of adopting regional, operational, and cultural BMPs derived from an analysis of 5 years of management surveys. Two publications are being prepared as a result. A paper was published showing that colony conditions influenced queen brood patterns more than the queen, which is an important finding for beekeepers who tend to blame all problems on the queen, rather than considering that the conditions of their combs (e.g., pesticide residue, pathogen spores) and colony size and health have a greater influence on brood health. Over 100 sideline and backyard beekeepers participated in 2019, more than doubling the number from 2015. They benefit directly from this research by receiving monthly reports outlining their colony health and disease and pathogen levels. Scientists also benefit from Sentinel data collection. All data is public and available for viewing online at beeinformed.org. Other research institutions have initiated similar programs, growing and spreading the idea of beekeeper-mediated data collection. BMP field validation is designed to impact both scientists and beekeepers. Data was collected and presented at many conferences and shared with participating research institutions. Results were also shared monthly on the BeeInformedPartnership (BIP) blogs, webinars, and numerous beekeeper club meetings.	
7.	**Studies leading to animal vaccine development and replacement of antibiotics (MAES)**	Several studies are being conducted by faculty in the Department of Veterinary Medicine that aim to develop novel animal vaccines and replacement of antibiotics. Animal-human interactions are also being studied. Among these projects are: • **A Structure-Based Vaccine for Bovine Respiratory Syncytial Virus using Newcastle Disease Virus Vector** The goal of this project is to develop an effective vaccine against the bovine respiratory syncytial virus (BRSV). BRSV causes severe respiratory disease (including fever, coughing, gasping, and pneumonia) and even death in calves. Respiratory diseases not only cause significant economic losses to cattle farmers but also are a public health concern because of the	1.Global Food Security and Hunger

		risk of developing antibiotic-resistant bacteria from the use of antibiotics to treat secondary bacterial infections. Outcome: BRSV is the major cause of pneumonia in calves. Currently available BRSV are not efficacious. The BRSV fusion protein (BRSV F) is the principal target of BRSV neutralizing antibodies in bovine sera. The F protein is present on the surface of virions in an unstable prefusion form, which upon contact with adjacent cell membranes undergoes a conformational change to the stable post-fusion form. Recently, it was shown that in closely related human respiratory syncytial virus (HRSV) the prefusion form of the F protein is the major neutralizing antigen. The pre-fusion form of the F protein of BRSV was stabilized, expressed, and evaluated using Newcastle disease virus (NDV) as a vaccine vector. The team had constructed, recovered, and characterized recombinant NDVs expressing the wild type and pre-fusion forms of BRSV F protein. Results show that the mutations identified in the F protein of HRSV can be used to stabilize the F protein of BRSV. Work is in progress to characterize the F protein of BRSV in protection. • **Triple-Acting therapeutics for Streptococcus suis** The overall goal of the project is to develop antimicrobials toward Streptococcus suis, a pathogen in pigs that causes swinelymphadenitis. S. suis is also a zoonotic pathogen that has been associated with outbreaks of human disease, mainly in pig farmers. **Outcome:** This antimicrobial approach utilizes peptidoglycan hydrolase (PGH) enzymes that specifically and directly break down the S. suis peptidoglycan, resulting in bacterial death. The team had made multiple double-acting and one triple-acting chimeric enzymes. All have been expressed, purified, and characterized (i.e. host range, biochemical and biophysical characterization, etc.). Despite the creation of these triple acting mutants, nothing was as active as PlySs9, a double-acting enzyme. Biofilm studies were done with this enzyme and it represents the best enzyme to-date. This enzyme for in vivo studies is now being mass-produced and will be shared with collaborators for future animal research.	

		• **Differentiation of infected from vaccinated animals (DIVA) Vaccine Development Against Porcine Reproductive and Respiratory Syndrome Virus** Porcine reproductive and respiratory syndrome (PRRS) has been causing significant economic losses to the swine industry. The causative agent is the PRRS virus (PRRSV). Current strategies are inadequate to control the disease. An improved vaccine is needed. This project aims to identify the genetic source of a PRRSV strain A2MC2 in inducing type I interferons and explore the deletion of the A2MC2-P90 as a negative marker for differentiation of infected from vaccinated animals (DIVA) in vaccine development. **Outcome:** PRRSV A2MC2 is a novel strain as it induces interferon induction. The team characterized this strain to determine the genetic source. Preliminary data suggests that a point mutation at the 3' end of ORF1ab is essential for the interferon induction. Further work is being undertaken to confirm this finding. Training for graduate students and technicians and other scientists were provided in these studies. Results were disseminated at conferences and through publications.	
8.	**Sequence-based big data genomic discovery and application to improve dairy fertility (MAES)**	Dairy fertility has experienced severe declines over the past 50 years. Although dairy fertility has low additive heritability, differences in fertility between breeds and between Holstein cattle unselected for 50 years and contemporary Holsteins, as well as the existence of elite cows in both production and fertility, suggest the existence of substantial genetic contribution to fertility and the possibility of improving fertility without much sacrifice in milk production. Recent efforts in genetic improvement of dairy fertility have achieved some stability in fertility performance but the reversal of the declining trend remains to be a difficult task. The USA has the largest quantity of dairy genomic and fertility data and has a unique group of unselected Holstein for 50 years. The rapidly decreasing sequencing costs and sequence data already available from this team and	1.Global Food Security and Hunger

		collaborators provide an unprecedented powerful tool for genomic discovery and application to improve dairy fertility. The objective is to discover causal/tightly linked genetic variants and apply genomic discoveries to improve dairy fertility. **Outcome:** The team had completed the following - 1) sequence-level imputation to over 27,000 Holstein bulls, 2) Sequence-level testing of transmission ratio distortion, 3) GWAS of additive and non-additive effects in Holstein cows using YD phenotype, 4) Sequence-level GWAS of additive effects in Holstein bull using PTA phenotype, and 5) Fine-mapping of candidate causal SNPs for over 270 QTL regions in the cattle genome. Two Ph.D. students worked in this project and were trained in genetics and bioinformatics related to cattle reproduction. Two postdocs were also heavily involved in the project. The results have been disseminated to communities of interest through oral and poster presentations at annual meetings of the American Dairy Science Association (ADSA) and at the Animal and Plant Genome Meeting, as well as through publications of tens of research articles in high-profile journals in animal genetics and genomics.	
9.	**Genomic and genetic approaches in identifying genes that regulate strawberry fruit development (MAES)**	Strawberry is an important specialty crop in the US. The cultivated strawberry is octoploid (4 pairs of chromosomes for each of the 7 chromosomes) and is thus tremendously complex in its genome. Researchers, who have had preliminary success, is pioneering the CRISPR/Cas9 genome editing method for strawberry. The study seeks to improve this method further by adopting a virus-based delivery method. Gene knockout methods will be employed to study a number of genes previously identified to be specifically expressed in the wild strawberry fleshy fruit (the receptacle). These analyses will shed light on the function of these fruit-specific genes. These combined efforts will provide much needed molecular insights into strawberry fruit development, based on which fruits with desirable traits and yields will be engineered with the CRISPR/Cas9 genome-editing tool. **Outcome:** Results have shown successful genome editing (CRISPR) of strawberry genes in Fragaria vesca. The team has also made several	1.Global Food Security and Hunger

		vectors suitable for CRISPR/Cas9 genome editing in strawberry and have determined the function of ARF8 in fruit development using CRISPR and over-expression. In addition, they have also identified and characterized genes involved in strawberry leaf development using mutant screen and cloning. Two graduate students were trained in strawberry genetics, gene cloning, transformation, and genome editing. One undergraduate student was trained in basic lab skills. Results were disseminated in seminars with other universities and a meeting with a biotech company. Two articles were published in the New Phytologist and the Journal of Integrative Plant Biology.	
10.	**Identification and characterization of viruses infecting soybean (*Glycine max* L.) and lima bean (*Phaseolus lunatus*) using Next Generation Sequencing in the Mid-Atlantic region of the United States (UMES Agricultural Experiment Station)**	Producers of soybean (*Glycine max* L.), and lima bean (*Phaseolus lunatus*) on Delmarva Peninsula (Delaware and Maryland and Virginia) facing new diseases diminishing their yield and quality. Identification of new/emerging diseases is needed to be able to develop successful plant protection strategies. This project aims to provide a comprehensive survey of viruses infecting the two important legume crops using fast and affordable next-generation sequencing (NGS). **Outcome:** 112 samples of diseased plants were collected throughout the Delmarva region, RNA isolated and tested for the presence of assembled virus sequences. Data analysis is underway to identify viruses.	1.Global Food Security and Hunger
11.	**Evaluation of Soil Health Building Practices on Soil Quality and Yield of Specialty Crops Grown on the Delmarva Peninsula (UMES Agricultural Experiment Station)**	Healthy soil is important for agriculture production and ecological wellbeing. The project seeks to evaluate soil health management practices to improve yield and quality of vegetable crops grown by small farmers on the Delmarva Peninsula, and to establish research-based production practices and practical approaches to improve soil health. **Outcome:** A preliminary field study was conducted to evaluate the effects of 3 organic fertilizers and biostimulants (sea salt and sugars) on soil quality and crop yield compared to a chemical fertilizer. Soil health (Solvita Soil Test and soil nutrient analysis) and crop yield were measured and analyzed. Preliminary data suggest little difference between all treatments.	1.Global Food Security and Hunger
12.	**Organic crop management on Delmarva for selected specialty crops (UMES Agricultural Experiment Station)**	Organic use and demand by consumers have steadily increased in recent years, nationally as well as on the Delmarva Peninsula and crop management practices must comply with national and state regulations. **Outcome:** In our region, environmental concerns about phosphorus and nitrogen runoff into the Chesapeake Bay have triggered regulatory	1.Global Food Security and Hunger

		changes related to the use of poultry manure on farm land, which must be incorporated or injected in the soil within 48 hours of application. This study compared poultry litter to non- poultry litter nutrients on selected specialty crops (tomatoes, ginger, carrots, kale) and collected production and food safety data.	
13.	**Potential of Day Neutral Strawberries (DNS) using Nanotechnology on the Delmarva Peninsula (UMES Agricultural Experiment Station)**	Historically the tri-county (Somerset, Worcester, and Wicomico) area, were UMES is located, was the hub for strawberry production on the Eastern Shore of Maryland. However, the current production is negligible and production is seasonal. **Outcome:** The cultivation of June-bearing strawberries is the major source of farm income from this crop and thereafter most of the produce is imported. This study evaluated the potential of several cultivars of day-neutral strawberries (DNS) in terms of growth and development, and yield in the open field and low tunnel conditions. Seven DNS cultivars were planted using a standard strawberry plasticulture system in field/open bed and low tunnels (LT) regimes at UMES. Data showed similar results to those observed during the 2018-2019 season. Portola is the only variety which showed high yield under late planting conditions. Low tunnels improved yield (35-37%) in comparison to open bed regimes. Use of low tunnels also reduced fungal infection by 60- 65%. Varietal differences were observed for number of leaves, plant height, and leaf area.	1.Global Food Security and Hunger
14.	**Biodiversity of Delmarva Agricultural Drainage Ditches: Towards Ecological Intensification by Arthropods (UMES Agricultural Experiment Station)**	Ecological intensification is a new paradigm shift to meet the challenges of food production by reducing inputs while enhancing ecosystem services through management of the agricultural environment. **Outcome:** As an example, agricultural drainage ditches are common, non-cropland habitats on the Delmarva Peninsula that could support populations of arthropods that benefit ecological intensification. This study assessed the biodiversity of ditches to determine their potential for providing ecosystem services. Pollinator populations' activity in ditches near woodlands (cover crops) and field crops (border) were determined. The pollinator species were identified, and their relative richness at the border and cover crop plots were quantified using a diversity index. The most dominating pollinator species were the soldier beetles, *Chauliognathus* spp, and bumblebees, *Bombus pennsylvanicus*. Collectively they accounted for about 43% and 24% in both plots. Anderenid bees and swallowtail butterflies were collected and visualized only in cover crop plots, and white lined hawk moths were recorded only in field border plots. The average two years diversity index value of 0.84 and	1.Global Food Security and Hunger

		0.82, species diversity tended to be higher at cover crop plots than field border plots, respectively. The value of the Simpson diversity index (1-D) ranges between 0 and 1. The higher the value of the diversity index, the greater richness and evenness (abundance) of the species. These findings indicate that drainage ditches contribute to the population richness of the pollinators.	
15.	**Development of *Aronia Mitschurinii* as a specialty crop alternative for the Delmarva Region (UMES Agricultural Experiment Station)**	*Aronia mitschurinii* (also known as back chokeberry) is a potential high-value alternative crop for producers on the Delmarva Peninsula. **Outcome:** A multidisciplinary research project in horticultural phytochemistry focused on the impacts of cultural management (fertility, pest management, etc.) practices along with processing on the phytochemical and nutritional content of the fruit. The fruit of this plant has an antioxidant content up to sixteen times greater than that of the acai berry, which is commonly featured in some television programs, and currently widely present in natural and vitamin shops across US. The aronia harvest of 2018 was processed and analyzed for juice yield, brix, pH, anthocyanins, flavonoids and polyphenol content as a function of Nitrogen fertilization rate; organic vs. traditional growing; and application of mineral bursts. The results were also correlated to degrees days. The level of antioxidants as a function of factors tested followed similar trends as in previous years. The concentration of anthocyanins however varied between years and this could be correlated to temperature during the growing season. Cultural management such as nutrient application, mineral amendments, age of plants during the growing season may influence the quality and quantity of phytochemicals in the fruit. A Nitrogen rate of 3 g/bush/year is optimal to achieve the highest antioxidant content. No significant difference was detected in phytochemical quality of organic fruits vs. regular grown fruit, while mineral burst helped to slightly increase the antioxidant content. Samples from the 2019 harvest were collected, processed and stored for analysis. Fermentation experiments and wine making with aronia juice to preserve a maximum of antioxidants in wine are being conducted. The aronia ripening process, with particular interest on trends for brix and anthocyanins as a function of time, revealed that the peak of anthocyanin concentration (important for medicinal purposes) happens much earlier than the peak of brix (important for food use purposes). Measurements of conductivity were carried out with the aim to construct a simple device for farmers to determine optimal harvesting time as function of application. This device would work for any berries or fruits	1.Global Food Security and Hunger

		containing anthocyanins. More observations are needed before reporting results.	
16.	**Using UAV's to improve nitrogen applications in winter wheat (UMES Agricultural Experiment Station)**	Precision Agriculture has the potential to reduce inputs for crop production while maintaining or increasing yield and quality and, at the same time, reducing the environmental impact. **Outcome:** UMES is collaborating with Virginia Tech and the University of Delaware on this project using remote sensing technologies including UAV (Unmanned Aerial Vehicle) flights with color, color-infrared, and thermal cameras over selected portions of agricultural fields to explore use of remote sensing data to study nutrient levels and irrigation levels on crop yields. Ground based measurements from hand held devices were used to validate the remote sensing data. From the UAV images, whole field maps can be generated to show Normalized Digital Vegetation Index (NDVI) and other vegetation indices across the entire field. The long-term goal is to generate variable rate N prescription maps from UAV platforms which allow a growers in the Delmarva region to apply N in a variable rate based on the crop's need with more precision than before, thereby optimizing nutrient inputs while mitigating potentially harmful water quality effects. In the 2018-2019 winter wheat growing season 9 treatments with 2 replicates (for a total of 18 strips) were conducted at UMES collecting data related to tiller counts, hand held NDVI (Greenseeker) and NDVI data obtained from color-infrared (CIR) aerial imagery from small drones . Due to variety of factors winter wheat yield was lower in the 2018-2019 growing season compared to the winter wheat yield in the previous year, but the harvest data showed similar pattern. The ANOVA analyses indicated a significant difference in yield in the no nitrogen treatment as compared to all others that received 120lbs/acre in average but in 9 different staggered treatments as reported before. Some errors in estimating and documenting tiller counts previously were identified and eliminated. Further analyses of hand held Green Seeker data and corresponding tiller count estimates revealed that there indeed was a strong correlation of the NDVI data with tiller counts for field data. The results of the field studies conducted in the previous years have provided the foundation for the culminating study planned for 2019-2020 winter wheat field trial at UMES that will compare efficacy of variable rate nitrogen application with the selected staggered nitrogen application rates that provided comparatively better yields in the studies conducted in previous years.	1.Global Food Security and Hunger

17.	**Developing environmentally sustainable alternative management practices for kudzu bug in Maryland (UMES Agricultural Experiment Station)**	The invasive kudzu bug (*Megacopta cribraria*) has emerged as the top yield-limiting pest of soybean in the U.S. and has been detected in eight Maryland counties. Maryland is the northern limit of the bug invasion. **Outcome:** The goal of this project is to protect the soybean production from this rapidly invading pest by developing environmentally-friendly, economically-viable, socially-acceptable kudzu bug management strategies. Field-collected entomopathogenic fungal strains, these a fungi that attack kudzu bugs, were isolated from cadavers of kudzu bug. Three strains were identified and two showed significant higher mortality in bugs during laboratory trials compared to the third strain or control. Further tests are underway to identify these pathogens using molecular techniques and to test the effectiveness of the pathogens as a systemic endophyte, thus showing the pathogen is a real candidate as a biological control agent of hemipteran pests and are useful in IPM strategies.	1.Global Food Security and Hunger
18.	**Personal Protective Technologies for Current and Emerging Occupational and Environmental Hazards (UMES Agricultural Experiment Station)**	A number of activities with Personal Protective Equipment (PPE) to protect applicators of pesticides have been conducted, some as part of the NC-170 multi-state project. This work, is part of the UMES International Center for PPE which includes studies on laundering of pesticide-contaminated clothes, decontamination studies of cotton/polyester fabrics using a three-step process, and ISO standards development (18889 for gloves, and 27065:2017 amendment to replace commercial pesticides with a dye test surrogate). **Outcome:** All activities involve close collaborations with organizations in Brazil, France, Spain and Germany, as well as collaborators from Washington State University. UMES is coordinating an inter-laboratory study to develop garment testing methods using spray applications. The knowledge, standards, and methods being created are benefitting applicators of pesticides and re-entry workers.	1.Global Food Security and Hunger
19.	**Small Ruminant Production and Management Program (UMES Extension)**	**Integrated gastrointestinal parasite management in small ruminants** Changes in USA's demographics have increased lamb and chèvon (goat meat) demand. In the last five years more than 80,000 t (metric tons) of lamb were imported every year to USA. **Outcome:** To support this industry, workshops ("*BeSmart – DrenchSmart*"), conferences, telephone consultations and farm visits on integrated gastrointestinal parasite management in small ruminants were conducted. Parasite nematodes reduce sheep and goats' productivity up to 15%.	1.Global Food Security and Hunger

		• **"ALL WORMS, ALL DAY":** The all-day conference focused exclusively on gastrointestinal parasites, which are problematic on small ruminant farms. The program educated stakeholders on up-to-date methods and recommendations for controlling parasites including the use of the FAMACHA Score Card. The speakers in the program were members of the American Consortium for Small Ruminant Parasite Control (ACSRPC). The program was a collaborative effort between Virginia, Maryland and Delaware Cooperative Extension Programs. • Workshops on practical determination of parasite loads: sheep and goat producers learn how to perform fecal egg counts on their farms to effectively plan and implement integrated parasite management using multiple of practices. Performing the determination at the farm saves time and money, and provides a localized information on parasite loads. • Sheep and goat producers who apply the integrated parasite management practices taught, benefit from delaying anthelmintic resistance (AR) in their flocks/herds. AR is a global challenge to ruminant production enterprises which originated from abusing and misusing commercial anthelmintics. **Pasture and grazing/browsing management workshops** Workshops and farm visits on pasture management to plan and implement nutritional strategies for effective utilization of pasture, hay making and identification of plant species which have shown to reduce parasite burdens in sheep and goats. **Outcome:** Sheep and goat producers learn how to plan pasture rotation, multi-species grazing, and unwanted vegetation management for their farms. **Marketing channels for sheep and goats** UMES Extension organized a livestock bus tour for sheep and goat producers to visit the New Holland Stables (Lancaster, PA) Auction Sale...the largest sheep and goat auction in the USA. A production deficit of lamb and chèvon allows for an unprecedented strong demand for sheep and goats. Producers, therefore, need to be informed of the value of sheep and goats to find rewarding marketing avenues. Because marketing sheep and goats is one of the most complex activities, this visit was intended to	

		increase farmers' knowledge of the opportunities available. Additionally, the members of the USDA/Agricultural Marketing Service team explained the trends and other peculiarities of sheep and goat marketing. Parallel to the sheep and goat sale, there were auctions for cattle, pigs, horses, and hay. The visiting farmers group was invited to tour the New Holland Agriculture manufacturing plant.	
20.	**The honeybee apiary at UMES (UMES Extension)**	Pollinators and honeybee colonies are declining in drastic numbers worldwide at an alarming rate. Their decline poses a threat to global agriculture and human food supply and security.. **Outcome:** Beekeepers on the Maryland Eastern Shore will benefit from recommendations for reducing honeybee parasites and disease, identify nutrition schedules and diets, and reduce honeybee mortality by accidental pesticide applicationsThe beekeepers' training focused on designing and implementing multiple workshops, classes and farm visits on the use of hive supplies selection, honeybee colony establishment, colony health monitoring, honey harvesting, etc. Interested farmers have hands-on practices at the UMES Demonstration farm to develop confidence and gain knowledge about honeybees.	1.Global Food Security and Hunger
21.	**Small Farms Program (UMES Extension)**	**Strengthening interest-in and demand for alternative and ethnic crop production among small farmers on Delmarva** To help small-scale producers stay competitive and profitable, it is important for small-scale producers to consider specialty niche crops. UMES Extension's Small Farm Program developed a series of educational projects designed to introduce and educate farmers on specialty ethnic enterprises to include crop production management, good agricultural practices, and value-added opportunities. In 2019, UMES conducted 6 educational crop field demonstrations on the following specialty crops: • Aronia • Hops • High tunnel vegetable production • Specialty ethnic crops, and • Herbs **Outcome:** The projects attracted over 200 producers from along the Delmarva Peninsula. Eighty-three (83%) of the participants increased their knowledge and understanding of Aronia production and growing select crops (i.e., bok choy, specialty Asian greens, etc.) in high tunnel systems. Interestingly, 87% stated they plan to use the information and/or training	1.Global Food Security and Hunger

		received in the future. Fifteen farmers have already begun growing select specialty ethnic crops (herbs, Scotch bonnet peppers, hibiscus, and Jamaican callaloo). **Helping farmers develop marketing plans and strategies** There is an increasing demand for fresh, locally grown produce; however, farmers (particularly those with limited resources or underserved) often lack business and market savvy to take advantage of this growing trend. As a result, they limit customer exposure which unfortunately equates to lower farm sales, inefficient use of resources, and their inability to grow/expand the farm business. **Outcome:** UMES Extension's Small Farm Program educators collaborated with Delaware State University and National Crop Insurance Services to offer a 3-part workshop training series to teach farmers (and aspiring farmers) how to better understand their own operation sufficiently to develop marketing plans and strategies. Workshops consisted of formal instruction, group discussion, hands-on activities, and take-home assignments. A total of 55 farmer participants were introduced to the farm business planning process which they were shown how to: 1) evaluate potential risks the farm faces 2) determine the current wellbeing of the farm business, and 3) understand marketing principles and how each element of the marketing mix (product, price, promotion, place, people/customers) are used to create an effective plan to manage the marketing decisions on the farm. **Outcome:** Participants collectively spent close to 1,800 hours working on classroom/homework exercises which averages about 64 hours per participant. Seventy-five percent of the participants successfully developed their own personal marketing plan for their respective farm business based on the educational materials and resource templates provided. **Sustaining Small Farms 360 Degrees** Despite the growing interest among diverse populations who want to enter into farming on a small-scale, farmers continue to face numerous challenges such as: rising production costs, insufficient farm business management skills, and other uncontrollable factors that make it difficult to make a profit. Consequently, there is a strong need to provide educational programs and training to equip farmers with the knowledge and skills needed to own and operate a farm business successfully. Each year, the	

		UMES Small Farm Program hosts an annual Small Farm Conference for farmers and landowners in Maryland and along the Delmarva Peninsula. The main objective of this two-day event is to equip farmers with tools and strategies to increase farm profitability and promote sustainability. UMES Small Farm Program staff have utilized this event to build program content to appeal and address the regional interests/concerns of limited-resource, new and beginning, and the underserved farmer. As part of the two-day program, participants have access to a variety of seminars and training under the following categories: • alternative agriculture • farm business and marketing, and • beginning farmer resources **Outcome:** This program event has attracted over 600 participants in the past 5 years. Participation in state and USDA government programs has increased among small and beginning farmers. Each year, new partnerships are formed with local/state agencies and community organizations to support small farm programming initiatives. In the areas of general farm business management and direct marketing, over 85% of farmer participants feel the information and training received during the Small Farm Conference is greatly beneficial to their farming operation.	
22.	**Demonstration of apple orchard establishment on the Eastern Shore of Maryland (UMES Extension)**	Historically the tri-county (Wicomico, Somerset, and Worcester) area was known for fruit cultivation on the Eastern Shore of Maryland. The 1925 USDA census of agriculture showed 6.0 million pounds of apple production in this area. However, currently there is no commercial apple production in these counties (USDA, NASS 2012). Moreover, Maryland farms fulfill only 9% of the apple consumption in the state and rest (> 90%) is imported from neighboring states. Despite enormous potential for apple production in this area, agriculture is limited to row crops. **Outcome:** UMES Extension recently established an apple orchard at University of Maryland Eastern Shore to rejuvenate the lost commercial apple industry on the Eastern Shore of Maryland. This multi-variety and multi-rootstock/scion apple orchard is the site for hand-on training for growers, beginner farmers, farm managers, stakeholders, state sustainable agriculture research and education coordinators, small farm program coordinators, nutrient management coordinators, and extension associates to generate human resources to popularize the apple cultivation on the Eastern Shore and adjoining urban areas. This demonstration also empowered US service veterans by providing training for fruit cultivation in	1.Global Food Security and Hunger

		Maryland. This year two workshops were conducted in Baltimore County on apple cultivation to train US service veterans. In 2020, there will be three workshops on apple cultivation at Therapeutic Alternatives of Maryland (TALMAR) to train veterans. In 2019, 4 mini-orchard were established in three counties (Worcester, Somerset, and Wicomico) to provide local fruit to local people with help from Robert Wood Johnson Foundation-Culture of Health Initiative grant. Many growers who participated in the workshops, after learning budding and grafting in apples have ordered rootstocks to propagate apple trees on their farms in a cost-effective manner.	
23.	**Business and legal considerations for beginning, limited-resource and socially disadvantaged, landowners, women and veterans in Maryland and along the Delmarva Peninsula (UMES Extension)**	The Agriculture Law Education Initiative (ALEI) is a collaboration between the University of Maryland Francis King Carey School and College of Agriculture & Natural Resources, University of Maryland, College Park, and University of Maryland Eastern Shore. Through Extension, the statewide, non-formal agriculture education system developed by the University of Maryland Extension (UMD) and UMES Extension Program, extension's environmental and agricultural faculty legal specialists provided instruction on the following: • Farm estate planning • Land purchase and selling transactions • Legal and institutional risks associated with farm ownership • Food safety legal issues (i.e., The Food Safety Modernization Act of 2010) • Ag declaration of intent • Financial documents related to the agricultural enterprise • Insurance for the farm • Farm business organization structures • Marketing **Outcome:** Multiple workshops, conferences and consultations have been conducted during statewide events and regional farmers meetings. After the educational events, farmers have indicated that they knew very few of the risks of farming and that they need to start planning to keep their agricultural enterprises following the legal regulations.	1.Global Food Security and Hunger
24.	**Farm Energy (UME)**	Increase in the number of educational programs offered to consumers **Outcome:** A follow-up survey to an in-service training has indicated the following intentions from its participants: learning to help others implement energy measures (32%), wanting to help educate others (46%), preferring	2.Sustainable Energy

		information via workshops/seminars (29%), and planning to incorporate energy into educational programming (33%).	
25.	**Maryland Master Naturalist Program (UME)**	Increased number of citizens and communities adopting practices of landscape ecology and understanding the relationship among pesticides, poor septic systems, and environmental health **Outcome:** 29,360 Master Naturalist volunteer hours with a value of $841,188.	3.Climate Change
26.	**Training Green Industry Professionals to Provide Woodland Services for Small Acreage Owners (MAES)**	Increase in management and sustainability of forest and wildlife resources **Outcome:** The program is in development but it will ultimately train service providers to work on smaller acreage properties resulting in improved forest health. The program will help interested green industry professionals expand their business model and increase income and jobs in this niche sector.	3.Climate Change
27.	**Agricultural Nutrient Management Program (UME)**	Increase in nutrient management planning, waste management systems, and use of composting technology. **Outcome:** 5,696 total plans for FY2019, of which 5310 were updated from previous plans and 386 were new plans. It covers 260, 187 acres.	3.Climate Change
28.	**Watershed Stewards Academy (UME)**	Increased number of acres of best management practices (stormwater, nutrient management) implemented **Outcome:** Over 400 Master Watershed Stewards and 600 Chesapeake Bay Landscape Professionals have been trained to-date to assist individuals, communities, and towns with their pollution reduction goals through environmentally sound landscaping, stormwater management, and other practices to reduce nutrient and sediment runoff into the Bay. These training and efforts result in the treating of stormwater through the implementation of best management practices that include impervious removal, conservation landscaping, rain gardens, and rain barrels.	3.Climate Change
29.	**Best Management Practices for Mitigating and Adapting to Saltwater Intrusion (MAES)**	The research focuses on the lower eastern shore of the Chesapeake Bay where sea-level rise rates are twice the global average and where centuries of farming have dramatically altered soil chemical and physical properties. The research will test the effects of saltwater intrusion on plant productivity and nutrient release.	3.Climate Change

		Outcome: Data were gathered on crop productivity and survival of soybean, switchgrass, spartina patens, and sorghum. Porewater data collected from lysimeters indicated the potential for large quantities of phosphorous (as soluble reactive phosphorous) and nitrogen (as ammonium) to be released from fields that undergo saltwater intrusion. These preliminary data were crucial for the team in obtaining a $1.2M USDA-NIFA grant to further their studies on the effect of saltwater intrusion on crop productivity and soil nutrient loss. The main objective of the integrated research and extension project is to develop management strategies and policy frameworks that will help balance farmers' needs and environmental health on coastal farms that are affected by saltwater intrusion. One M.S. and one Ph.D. student worked and were trained under this project. Results were disseminated in several stakeholder meetings in Maryland and through digital media, radio, and TV. Journal articles were published in Bioscience and Biogeochemistry.	
30.	**Waste Management and Cover Cropping Systems to Enhance Soil Health, Nutrient Cycling, Waste to Energy, Water Quality and Climate Adaptation (MAES)**	The use of cover crops is a major nutrient management tool used in agriculture to improve soil health and minimize negative environmental impacts, to keep nutrients in the ground so they do not end up in bodies of water such as the Chesapeake Bay. A team of faculty is focused on optimizing the cycling and management of nitrogen (N), phosphorous (P), and other essential nutrients. **Outcome:** The Soil Quality Lab developed an innovative new model of how cover crops interact with the nitrogen cycle to reduce leaching loss of nitrogen during the winter leaching season. Research from several years and the new model shows that the important factor to consider is when the cover crops are planted and how much root growth they can achieve before winter dormancy. Data showed that cover crops must be planted with at least 600 growing degree days left before winter sets in to allow deep-rooted, fast-growing cover crops to clean up most of the nitrates from the soil profile down to 2 meters or more. This ensures that there is very little nitrogen present in the soil profile that can be dissolved and leached to the groundwater.	3.Climate Change

		Another significant outcome from this project is a pending patent that has been issued on an innovative method to remove ammonium from digester effluent as a separate product for better utilization of N input and fewer transportation costs for poultry litter applications. A Maryland Energy Innovation Institute Grant was received to take this process from lab-scale to the pilot-scale, and a manuscript from this work is currently under review. Two M.S. and two Ph.D. students worked and were trained under this project. Results have been disseminated to communities by giving presentations at local meetings and conferences all over Maryland, and national meetings of ASA, CSSA, and SSSA.	
31.	**Mitigation of heat stress in broiler chickens through early-life thermal conditioning (MAES)**	Heat stress in chickens can occur in the summer when temperatures often exceed 95°F in the regions of the United States where most broiler chickens are raised. Notable effects of heat stress on broiler production include increased death of chickens in the flock and reduced feed intake and growth by the birds that survive. In addition to financial costs, heat stress in commercial poultry operations represents a serious issue of animal well-being. **Outcome:** Experiments were conducted and revealed that early life thermal conditioning was found to reduce the mortality of broiler chickens during heat stress under production conditions. No effect of early life thermal conditioning on feed intake, animal growth, or feed efficiency of broiler chickens was found under production conditions. One postdoctoral researcher, one laboratory technician, two graduate students, and an undergraduate student assisted and were trained under this project. Results on the effect of heat stress on gene expression within the hypothalamus and pituitary gland were presented at the annual meeting of the Poultry Science Association.	3.Climate Change
32.	**An Agro-ecosystem Model to Achieve Agricultural Sustainability for Delmarva (UMES Agricultural Experiment Station)**	The Delmarva Peninsula, home to some of the most productive agriculture in the nation, faces numerous environmental challenges that may jeopardize both its productivity and its economic viability. **Outcome:** The Chesapeake Bay Total Maximum Daily Load (TMDL) regulations which call for reductions in nitrogen, phosphorus and sediment	3.Climate Change

		loadings on the order of 30%, and which may considerably constrain production in order to comply. Farmers and other stakeholders need recommendations for how to adapt agricultural production systems to environmental and socio-economic change. An agro-ecosystem model comprised of linked crop, hydrology, livestock/poultry, and economic models for assessing the economic and environmental effects of adaptation practices has been developed for the Manokin watershed in MD. Field monitoring data has been collected, compiled and organized to help improve modeling parameterization in the difficult terrain (very flat) of the Manokin. This framework provides a way to assess physical and economic implications of alternative strategies to reduce nutrient loadings from agriculture. The models can be run under alternative climate scenarios in order to assess the costs and effectiveness of such practices under climate change. Insights gained from these models can be used to assist Delmarva stakeholders in adapting to changing demands imposed by evolving markets and environmental policies. Work is currently underway to use the framework to evaluate alternative poultry feeding strategies including phytase amendments and low N feeding. These results will contribute to improved economic sustainability of Delmarva agriculture.	
33.	**Developing a Cost Effective Activated Gypsum Amendment that Reduces Ammonia Emission from Poultry Litter Bedding (UMES Agricultural Experiment Station)**	Poultry production is the major industry in our region and NH3 produced in the litter is of increasing concern to bird health and air pollution. **Outcome:** The project developed an organic product, based on gypsum, that can be used as an amendment to poultry litter bedding for reducing ammonia emissions in poultry houses and be competitive with sodium bisulfite (PLT®) in terms of effectiveness and cost. Benchtop tests and pen tests showed both treatments to be equally effective in ammonia reduction compared to the control. Bird performance and footpad scores were the same or similar for both products tested.	3.Climate Change
34.	**Healthy FSNE Out of School Time Programs (UME)**	Increase in fruit and vegetable consumption among preschoolers and youth **Outcome:** 1,333 youth reached through face-to-face education. 37% more providers regularly talk about the importance of healthy eating with the youth in their program. 23% more providers use healthy foods as examples	4.Childhood Obesity

		in their educational programs. 12% more providers say that healthy foods, such as fruits and vegetables, are offered to the youth in their program.	
35.	**Securing Food Resources for Families Initiative (UME)** **Healthy Tots, Healthy Families Initiative (UME)**	Increase in school cafeteria workers' awareness, knowledge, and skills regarding healthy eating practices **Outcome:** 50 of the food assistance programs that partnered with FSNE are backpack programs and/or food pantries in schools and Pre-K sites where youth receive nutrition education, and FSNE provides resources, tastings, and training on healthy food offerings. More than 49,000 patrons of food assistance sites received newsletters and recipe cards in their food packages, or during a food tasting or other educational event. More than 92,500 contacts made through the regular (monthly) distribution of print materials to clients at food pantries or food banks. 92% of food assistance sites have established policies or practices that support healthy eating. 61% of food assistance sites implemented new or improved policies or practices that support healthy eating. 364 preschool teachers/staff trained to become healthy role models and to improve the health of their classroom or school environment.	4.Childhood Obesity
36.	**Healthy FSNE Families (UME)**	Increase in preschoolers and youth who include physical activity in daily routine **Outcome:** 45% more parents say that their school-aged children are physically active for at least one hour daily. 17% more parents frequently role model physical activity for their children. 19% more kids understand the importance of being active for at least 45 minutes each day.	4.Childhood Obesity
37.	**Healthy School Communities Initiative (UME)**	Increase in preschoolers and youth who report eating more healthy foods **Outcome:** 127 programs with schools, including preschools, afterschool programs, and food pantries, partnered with FSN to promote healthy school environments. More than 24,000 youths reached through face-to-face education. 19% more parents say that their preschool-aged children eat more than one type of vegetable. 25% more children eat at least three servings of fruit per day. 52% more elementary school parents regularly buy fruits and vegetables at the farmer’s market.	4.Childhood Obesity

38.	**Health Benefits of Patchouli Alcohol (MAES)**	Patchouli essential oils have been used for medicinal applications due to a variety of biological effects including antibacterial, antifungal, anti-influenza, and antioxidant activities. Patchouli is a species of plant from the genus Pogostemon and a major component of patchouli oil. Recently we found that patchouli alcohol possesses anti-inflammatory activity in immune cells. The research aims to study if patchouli alcohol influences the occurrence of metabolic disorders including inflammation, obesity, and cancer, focusing on elucidating the mechanisms and biological targets. This will expand understanding on the health benefits of patchouli in the prevention of human chronic diseases. **Outcome:** Patchouli alcohol is a major component of patchouli essential oil and has been broadly used for diverse health benefits in oriental medicine. Despite its significance, science-based research using in vitro and in vivo disease models has not been documented. In the first year of the study, the researchers observed anti-obesity and anti-diabetic activity of patchouli alcohol using diet-induced obese and diabetic model. During the second year, the team performed in vitro experiments to elucidate the responsible mechanism of anti-obesity and anti-diabetic activity. They also performed an in vivo study to test the hypothesis that patchouli alcohol possesses tumor-suppressive activity in a mouse colon cancer model. The test demonstrated that patchouli alcohol could be used as a novel and is a promising agent to prevent and manage colon cancer. A graduate student worked and was trained under this project. Results were shared at scientific and professional conferences including the American Society for Nutrition (ASN) and the American Society for Biochemistry and Molecular Biology (ASBMB). A journal article was also submitted to the Journal of Medicinal Foods.	4.Childhood Obesity
39.	**Preschool caregivers' perceptions of obesity during their own life course on the Lower Eastern Shore of Maryland - A qualitative study (UMES Extension)**	Previous studies indicated that eating habits are established in early childhood. Consequently, obesity has become a major health concern in America. To better understand human phenomena, such as the growing epidemic of obesity, which is not only a behavioral issue, but also a social, psychological and cultural issue, The Nutrition and Health Programs at UMES collaborated with the Head Start Program on The Eastern Shore to	4.Childhood Obesity

		explore, through qualitative methodologies, how preschool caregivers perceive, identify, and understand obesity, during their own life course (their own childhood and adulthood). **Outcome:** A person-centered methodology was used to allow participants to discuss their experiences in their own terms. Experts in Family Sciences, Sociology, Anthropology, and Psychology conducted focus groups with preschool caregivers at home (parents and guardians) and at school (teachers, teachers' aides, and cafeteria staff) at three Head Start Centers (Princess Anne, Crisfield, and Salisbury) on the Lower Eastern Shore of Maryland. The data analysis was conducted based on the following components of the Food Choice Model: past influences of personal experiences and historical eras, current involvement in trends and transitions, and anticipation of future events. Overall, the results indicate that addressing the health risks related to obesity among preschoolers, practitioners must consider caregivers' cultural norms, expectations, ideals, social, psychological, and physical environments. There is no one-size-fits-all remedy to combatting obesity which is a problem in a complex environment. A single model may not work. Programs development may take into consideration what works best for the population being served.	
40.	**Grow It Eat It (UME)**	Increase in people who gain basic food safety knowledge and skills **Outcome**: 234 GIEI classes to approximately 3,510 residents were taught, which contributed 11.598 hours of service valued at $332,141.	5.Food Safety
41.	**Good Agricultural Practices and Good Handling Practices (UME)**	Increase in fruit and vegetable farmers adopting good agricultural practices **Outcome:** All (100%) participants were certified as completing the program to ensure safe manufacturing/processing, packing, and holding of food products for human consumption in the United States. Participants who attend the workshop should be able to help their employer/owner comply with federal food safety regulations	5.Food Safety
42.	**Maryland Crabmeat Quality Assurance and Inspection Program (MCQAP) (UME)**	Increase in processors using good practices **Outcome:** This program helped all participating crabmeat processors eliminate the dangerous human pathogens E. coli from their crabmeat and processing environments by 100%. The program helped processors to control Listeria monocytogenes in both crabmeat.	5.Food Safety

43.	**Evaluating Food Safety Risk of Toxoplasma gondii in Naturally-Infected Meat Animals (MAES)**	Toxoplasma gondii is a protozoan parasite that infects virtually all warm-blooded animals. The Centers for Disease Control and Prevention (CDC) has reported that it is 1 of 3 pathogens (along with Salmonella and Listeria) that accounts for >70% of all deaths due to foodborne diseases in the United States. Currently, there are no quantitative data available pertaining to the concentration of viable T. gondii in the muscle tissues of naturally-infected meat animals. Thus, the objectives of this project are to collect and test samples from meat animals for T. gondii, over a year, from retail/grocery stores in the Maryland region with the help of serological testing (MAT) and bioassays. Consequently, the project involves isolating and genotyping the isolated T. gondii from positive samples and analyzing the impact of serving size on the burden of toxoplasmosis to the general public. **Outcome:** Hearts and leg carcasses of meat animals such as lambs, goats, and pigs were purchased from local retail/grocery stores in the Maryland region. Among the meat sources of T. gondii, pork is considered important in the epidemiology of toxoplasmosis in the USA. The goal was to determine the early onset of T. gondii tissue cysts formation in experimentally infected pigs and estimate their distribution in pork meat qualitatively. Results demonstrate that T. gondii tissue cysts are formed early in infection and they are unevenly distributed. Additionally, the team investigated the concentration and distribution of viable T. gondii tissue cysts in naturally infected lambs and goats. Hearts and shoulders of lambs and goats were tested for T. gondii infection. The rate of isolation of T. gondii increased with portion size of meat bioassayed and even small portion sizes (5g and 10g) of meat have the potential for T. gondii transmission. This indicates the likelihood of human toxoplasmosis from consuming T. gondii contaminated fresh cut meats. A Ph.D. student worked and was trained under this project. Project results were shared at different annual meetings and conferences including International Association for Food Protection (IAFP) and Society for Risk Analysis (SRA). One peer-reviewed article has been published in the	5.Food Safety

		Journal of Veterinary Parasitology and another manuscript is under preparation.	
44.	**Development of an effective and low toxic silver-based antimicrobial materials (MAES)**	Silver (Ag) and silver-based composites are strong antimicrobial agents for their broad antimicrobial activities to gram positive and negative bacteria strains, fungi, and viruses. These composites have been used as antimicrobial agents for centuries by incorporating into containers, paints, medical devices, wound dressing, food packaging, and so on. However, the current reported silver-based antimicrobial composites to have limitations, such as 1) uncontrolled release of silver could not ensure long-time antimicrobial efficacy; 2) high application dose of silver might diffuse to food systems and are toxic to humans; 3) silver cores might become environment hazards after usage. To meet these challenges, major strategies are undertaken, including 1) development of coreless silver composite, 2) decrease of the application dose of silver to reduce potential toxicity and, 3) controlled release of silver to restrict the diffusion of silver to food systems. **Outcome:** The researchers have developed a novel antimicrobial coating material with alkynyl Ag substituted chitosan (Ag-CS), which possessed high-efficient antimicrobial effect and prolonged release of Ag. Further, by substituting Ag to CS through chemical bonds, this structure was coreless and environmentally friendly. The Ag-CS demonstrated potent antimicrobial efficacy over either AgOAc or AgNO3 with minimum inhibitory concentrations (MIC) of 6.4, 13.4, and 12.8 µg/mL silver equivalents, respectively. A prolonged Ag release was also achieved with a superior release rate of 90% in 5 days. Overall, the study indicated Ag-CS as a promising antimicrobial coating material that is antimicrobial efficient and environmentally friendly. A Ph.D. student worked in this project and was trained in food safety and microbiology. A journal article and conference paper have been submitted for publication in 2020.	5.Food Safety
45.	**Engineering Endolysins to Target Gram-negative**	Bacteriophage are bacterial viruses. In order to complete their replication cycle, they must bust out of the bacterial cell. In order to do this, they	5.Food Safety

	Pathogens for Food Safety Disinfectant Use (MAES)	release enzymes called endolysins that chew up the rigid bacterial cell wall. These endolysins can be exploited to chew up the cell walls of healthy, non-infected bacteria. The result is the death of the bacterial cell. As such, these endolysins kill bacteria on contact and represent an alternative to traditional antibiotics and disinfectants. The objective is to engineer endolysins to work on several Gram-negative bacteria, such as those that cause issues with food safety and food security (i.e., E. coli and Salmonella, to name a few), and then evaluate them in standardized disinfectant tests. **Outcome:** The researchers have cloned and/or synthesized, expressed, and purified half a dozen different endolysin domains and made chimeras of them with various cationic, hydrophobic, or amphipathic peptides that are known to impart properties that allow small proteins, such as endolysins, to transit the bacterial outer membrane and access the subjacent peptidoglycan. They are currently characterizing these enzymes and will assess their antimicrobial properties and host range. A graduate student worked in the project and trained in molecular biology and protein biochemistry techniques.	
46.	**Sonochemical Processes for inactivation of spoilage microorganisms on the surface of fresh produces and food-contact surfaces (MAES)**	Post-harvest spoilage of fresh whole and cut produce is a significant challenge that impacts sustainability, economics, and nutritional aspects of fresh produce. Despite significant advances in hurdle technologies including combinations of produce washing and cooling, chemical sanitation and fumigation, refrigerated storage, and modified atmospheric packaging, currently, over 30% of the fresh produce in North America is wasted and microbial spoilage is one of the leading factors influencing the shelf-life of fresh produce. To address this critical challenge, this project evaluates a synergistic interaction of ultrasound with (a) sonocatalytic materials to develop novel food-contact surfaces that can minimize or eliminate the risk of cross-contamination and biofilm formation, and (b) microbubbles combined with sonocatalytic food-grade materials to improve inactivation of spoilage microorganisms on fresh produce and wash water while maintaining the quality of fresh produce by avoiding mechanical damage.	5.Food Safety

		Outcome: Biofilm found on food-contact and non-food-contact surfaces during processing depicts a challenge to the food industry due to its inherent resistance to disinfection methods. A novel synergistic bacterial inactivation using high-frequency ultrasound (HFUS) (1Mhz) and food additive propyl gallate (PG) was employed to inactive biofilm formed by Listeria innocua on stainless steel surface, a commonly used material in the food industry. The combined HFUS and PG treatment allowed the removal and inactivation of the Listeria innocua bacteria biofilm with a complete bacterial inactivation both on the stainless steel surface and in the solution. Another study looked at the combination of HFUS (1Mhz) and PG to inactivate bacteria in aqueous and clarified apple juice environments. The combined HFUS and PG facilitate the use of ultrasound as a killing step and enables more production of value-added "green label" and organic product that benefits both the food producer the consumers. The team also explored the efficacy of ultrasound in combination with carvacrol as an alternative treatment to decontaminate fresh blueberries and extend their shelf life. The findings showed that washing blueberries with ultrasound combining with carvacrol or carbonated water have the potential to increase the safety and shelf-life of ready-to-eat blueberries. One undergraduate student, four graduate students, and a postdoctoral student received training related to these projects. They are also co-authors on the publications submitted.	
47.	**Your Money Your Goals (UME)**	Individuals who report increased ability to set financial goals, make savings plans, establish emergency funds, and decrease debt **Outcome:** Results of paired surveys show significant increases in confidence for every question. Survey results also indicated that 96% of the participants agreed or strongly agreed that the training was effective and approximately 99% indicated that YMYGs would improve their ability to meet the needs.	6.Family & Consumer Sciences
48.	**Nutrition and Gardening for Families (UME)**	Increase in individuals who report the adoption of healthy eating practices (including eating more fruits and vegetables, choosing high fiber foods, choosing more whole grains)	6.Family & Consumer Sciences

		Outcome: The program made 1,993 nutrition and/or gardening teaching contacts through work with community partners and efforts to reduce food insecurity through education. In an effort to promote school and community gardening, the coordinator installed 16 raised garden beds around the county and used them as teaching tools for school and community gardening. Participant surveys have documented that 81% of youth and 97% of adults reported increased knowledge about making healthy food choices; 84% of youth and 94% of adults reported increased knowledge about gardening's role in growing food and reducing money spent at the grocery store.	
49.	**The Grow It, Eat It, Preserve It program (UME)**	Increase in people reporting the adoption of healthy home practices **Outcome**: Using Paired t-tests, it was determined that participants experienced statistically significant changes after attending the program ($p<0.05$). The results from the food preservation workshops show it is an effective means to assist the community to safely preserve foods and prevent botulism. No foodborne cases related to food preservation and botulism have been reported in Maryland.	6.Family & Consumer Sciences
50.	**Housing Eviction and Foreclosure Prevention Education (UME)**	Increased research findings that contribute to individuals and families well-being and quality of life **Outcome:** 90% of potential rent default tenants who participated in the program actually practiced budgeting. Tenants at risk of eviction from organizations that participate in UME Finance Education dropped from 60% to approximately 40% from 2008 – 2013 and had continued on a decline to 20% in 2019. 96% of the homeless residents found subsidized housing, and 92% found jobs.	6.Family & Consumer Sciences
51.	**Health Literacy Initiative (UME)**	Increase in reported confidence and capability to make smart health insurance decisions **Outcome:** After taking the Smart Choice Basics workshop, participants (N=60) significantly increased their confidence in understanding health insurance terms and applying knowledge and information to make a smart choice health insurance decision ($p<.001$). After taking the Smart Choice Smart Actions workshops, participants (N=33) significantly increased their knowledge and confidence in knowing how to find out what is and is not	6.Family & Consumer Sciences

		covered before receiving a health care service and can apply knowledge and information to be a Smart User of health insurance (p<.001). After taking the Smart Use Essential Health Benefits workshop, participants (N=62) significantly increased their confidence in knowing how to figure out their share of the costs for care, after the health plan pays their share, knowing how to find out what is and is not covered before receiving a health care service, and can apply knowledge to be a Smart User of health insurance (p<.001). After taking the Smart Use Understanding and Estimating Costs workshop, participants (N=31) significantly increased their confidence in estimating their total health care costs (p<.001). After taking the Healthcare in Your Senior Years workshop, participants (N=21) significantly increased their confidence in understanding health insurance options in their senior years and could estimate their total health care costs (p<.001).	
52.	**Kids Growing with Grains (UME)**	Increase in youth reporting adoption of healthy eating behaviors **Outcome:** For students who attended this program, 94% understand that grains are important ingredients in foods that we eat daily. 69% will talk to their family about whole grains being listed on food ingredients lists. 90% understand that animals eat grains to produce things that they can eat and use. These evaluation results indicate that Kids Growing with Grains program develops student's conceptual understanding and knowledge of grains and their importance in our lives, where their food comes from, and the connection between agriculture and their environment. By building this foundational knowledge, students and their families are better able to make informed decisions in order to improve their nutrition, support local agriculture, and protect the environment.	7.4-H Youth Development
53.	**Teen Corps (UME)**	Increase in youth who intend to engage in community projects and community leadership positions **Outcome:** Sixteen Teen Corps members representing 4-H clubs citywide participated in workforce readiness, service-learning, and STEM training, reaching approximately 1,000 youth and community members. One-hundred percent designed sustainable youth-led activities and projects in City Council Districts 6, 7, 9, regionally, and nationally. One graduated from	7.4-H Youth Development

		college in May 2019 and one entered the armed forces to pursue a medical career. Both have continued to support outreach and educational activities of Teen Corps and the Baltimore City 4-H Program.	
54.	**4-H Animal Science (UME)**	Increase in the number of youth and adults adopting animal science practices that demonstrate increased knowledge of raising animals in a responsible, ethical, and ecologically viable manner **Outcome:** Youth, on average, carry about 200 agriculture-related projects each year. Allegany County 4-H youth enrolled in animal science projects have earned over $100,000 annually through the sale of their project animals.	7.4-H Youth Development
55.	**Extension AGsploration program (UME)**	Increase in the number of youth who report aspirations to pursue science-related fields in college **Outcome:** One hundred and twenty-eight new individuals accessed the AGsploration curriculum in 31 states, 1 US territory, and Australia. In Maryland, 39 documented AGsploration lessons were taught to 8,019 program participants and 3 trainings were held to certify 80 new curriculum teachers. $50,000 in funding was secured from USDA-NIFA to expand on the career component entitled "Career AGsperience: Come AGsplore Your Future" to develop agriculture career exploration and workforce preparation curriculum. Trained teen teachers were also surveyed after 3 years of being involved with the program. 85% of them indicated that their participation in AGsploration developed their teaching ability and confidence in teaching agriculture. 77% also indicated the program helped develop planning and organization skills. An additional 62% reported developing agriculture content knowledge and leadership skills. Of the group, 62% major in agriculture, and 73% now have a job in the agriculture industry. Therefore, the AGsploration program has increased the knowledge and appreciation of agriculture in Maryland and created a network of trained individuals to more effectively continue the educational cycle.	7.4-H Youth Development
56.	**Camp Leaders Work-Related Experiences for Social-Emotional Learning (UME)**	Increase in youth who practice environmentally responsible behaviors **Outcome:** A qualitative methodology was utilized to explore camp staff skills and lessons acquired while working at a summer residential camp.	7.4-H Youth Development

		Leaders became aware of the benefits resulting from quality camp relationships and sought to maintain these positive relationships. Several leaders believed their supportive camp network would continue after camp concluded.	
57.	**Extension AGsploration program (UME)**	Increase in youth and families who report becoming more literate in concerns surrounding global hunger and its relationship with agriculture, understanding of food systems, and the relationship of agriculture, food, nutrition, and the economy. **Outcome:** On pre/post tests of students all indicated gaining more knowledge in the topics covered on agriculture and one in four participants indicated wanting to purse a degree or occupation in agriculture science. Trained teen teachers were also surveyed after 3 years of being involved with the program. 85% of them indicated that their participation in AGsploration developed their teaching ability, and confidence in teaching agriculture. 77% also indicated the program helped develop planning and organization skills. An additional 62% reported developing agriculture content knowledge and leadership skills. Of the group 62% major in agriculture and 73% now have a job in the agriculture industry. Therefore the AGsploration program has increased the knowledge and appreciation of agriculture in Maryland and created a network of trained individuals to more effectively continue the educational cycle.	7.4-H Youth Development
58.	**AgriScience Education (UME)**	Education About Careers in Agriculture for High, Middle and Elementary School Students **Outcome:** A total of 313 youth were served. Evaluation data shows 74% of youth would be interested in participating in similar activities in the future. 86% state that they have learned more about what 4-H does in my community from this program. In 2018 42% stated that they believed that Agriculture was important for their future. This preparation for discovery is necessary because the increases in food supply will have to come from advances in agricultural science using technology and methodology not yet engineered. Youth that can make an informed career choice will save money in educational costs and are likely to experience a more fulfilling work life.	7.4-H Youth Development

59.	**4-H STEM and Youth Development (UMES Extension)**	**The Power of People, Soil, & Worms** The National Institute of Food and Agriculture (NIFA) and the Food and Agriculture (FAO) Organization of the United Nations have recognized the need of connecting people with soils and raise awareness on the critical importance of soils in our lives. The opportunity for UMES Extension and specifically 4-H Youth Development is to accommodate the need of educating youth on the links between people, soil and a healthy environment. The developed curriculum uses worms to tap into the innate curiosity of youth. Over time the curriculum morphed into 5-6 lesson plans. The 4-H STEM curriculum *The Power of People, Soil, and Worms* follows: 1) Utilizes the 4-H approach of offering educational hands on, experiential activities to show the importance of healthy soil. 2) Covers Maryland State Education Environmental Education requirements for 2nd grade students. 3) Incorporates the key messages emphasized from the 2015 International Year of Soils: • Healthy soils are the basis for healthy food production. • Soils store and filter water, improving our resilience to floods and droughts. • Soil is a non-renewable resource; its preservation is essential for food security and our sustainable future. 4) Allows for further investigation through setting up and maintaining a worm composting system and using biodegradable waste from lunch. 5) Demonstrates recycling kitchen waste to reduce waste and use the product (worm castings) to increase the health of soil. 6) Introduces and reaffirms the human connection to and impact on the environment **Outcomes:** 4-H youth and teachers/volunteers were introduced to this educational program. Getting the key concepts of (1) soil is not unlimited (2) healthy soil is alive (if not alive…it is dirt) and 3) protecting and maintaining healthy soil is critical to sustainable food production. The development of this program is on-going and the anecdotal response of youth and the increased requests to train teachers has motivated the 4-H STEM Agent Associate to proceed to develop an evaluative tool with the assistance of a 4-H Youth Development Specialist in order to obtain	7.4-H Youth Development

		evidence of the effectiveness of the program other than perceived effectiveness. **Science-TEM (STEM) – Outreach** The majority of youth do not have access to quality STEM programs, and few see such disciplines as a facilitator for their future. Currently only 81 percent of Asian-American and 71 percent of Caucasian high school students attend a high school with a full range of math and science courses. Access for American Indian, Native-Alaskan, African American, and Hispanic is lagging far behind. According to a report from the U.S. Department of Education, only 16 percent of American high school seniors have been found to be proficient in math and interested in pursuing a STEM related career. UMES Extension's 4-H and Youth development Program developed partnerships with schools and camps. Also the 4-H Program planned and implemented special events (fairs, workshops, and festivals) throughout Wicomico County and nearby counties. These partnerships and special events focused on aspects of STEM education including agriculture, environmental science, marine science, climate science, and physics. Sample lesson topics – STEM Challenges, DNA Extraction, Fingerprinting, Projectile Motion etc. **Outcomes:** From October 2018 to September 2019, approximately 1213 youth took part in UMES Extension Science-TEM outreach programming. Many of these youth learned the value of STEM careers and have shown interest in continuing to pursue STEM related topics. Therefore, the UMES Extension STEM outreach programming has contributed to the increased knowledge and interest of STEM subject matter in the state of Maryland. **EnviroMarine Science – Outreach** Policy documents such as *Rising Above the Gathering Storm* (National Academies, 2005) and *Prepare and Inspire* (PCAST, 2010) have called attention to the importance of science, technology, engineering, and mathematics (STEM) jobs to our economy and the continued under-representation of African Americans, Hispanics, and women in many STEM fields. At a time when the US has been overtaken by other countries in the development of STEM expertise (ranking 29th out of 109 countries in the percentage of 24-year-olds with a mathematics or science degree), the fastest growing demographic groups in our population are among those least represented in STEM degree programs (National Academies, 2011).	

		Response: **Outcomes:** UMES Extension's 4-H STEM educators use school enrichment programming as a primary method to reach youth of all ages throughout the lower Eastern Shore. This programming is designed to be single or multi-session hands-on STEM lessons in the area of environmental science which enhance, and foster STEM programming already being conducted in the normal school setting. Lessons are also designed to provide youth with the knowledge needed to pursue STEM related careers and give the youth opportunities to experience activities that are part of different STEM jobs. Sample lesson topics: Marine Chemistry, Dissections, Horticulture, Entomology etc. From October 2018 to September 2019, approximately 904 youth took part in *EnviroMarine Science Outreach* programming. Many of these youth learned the value and importance of Environmental and Marine Science related topics, as well as related careers. Some have shown (by inquiring thru teachers and 4-H Educators) an increased interest in pursuing higher education in careers related to environmental and marine science Therefore, the UMES Extension STEM school enrichment programming has contributed to the increased knowledge and interest of STEM subject matter in the state of Maryland. **Drug Discovery and Biomedical Research Training Program for Underserved Minority Youth.** 4-H is the nation's largest youth development organization with over 6 million youth participating in 4-H annually. In Maryland, over 76,000 youth participated in 4-H programs in 2017. The mission of the Maryland 4-H Youth Development Program is to provide a supportive and inclusive setting for all youth to reach their fullest potential. Through research- based experiential learning programs, youth learn a variety of subjects, including leadership and life skills. In 2013, UMES Extension 4-H Program began with a 4-H STEM (Science, Technology, Engineering, and Mathematics) initiative that focused on enhancing and expanding 4-H STEM programs designed to meet the needs of a diverse, underserved audience in Wicomico, Worcester, and Somerset counties. This UMES 4-H STEM initiative teaches in-school, after-school, clubs, and camp programs as well as train-the-trainer sessions for educators.	

		Outcome: The UMES Extension 4-H STEM Youth Development faculty offered one 8-hour training session to UMES School of Pharmacy faculty and students as part of the NIH SEPA Grant. It was anticipated that such experience enriched by a formal 4-H STEM education and mentoring training enabled them to connect to the high school students and subsequently nurture them to make informed decisions to pursue a college degree and future biomedical/pharmacy career paths.	