Delaware Department of Agriculture

2014 Specialty Crop Block Grant Program- Farm Bill

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Project Title: Food Safety Risks with Watermelons Grown Using Poultry Manure

Project Summary: Agriculture is Delaware's largest single land use, with 41 percent of Delaware's land in farming. Delaware has about 2,500 farms and approximately 500,000 acres of farmland devoted to agriculture. Delaware's agricultural production is valued at over $1.3 billion. Delaware ranks #1 nationally in the value of agricultural products sold per farm at $425,387 and value of agricultural production produced per acre of land in farms at $2,123. Watermelons are an important fresh market crop in Delaware, with 86 farms covering 2,700 acres, and generating $11.7 million in sales. Poultry litter is commonly used as a soil amendment and nutrient source crop production. While foodborne outbreaks of salmonellosis and listeriosis have occurred with melons, the majority have specifically been traced to cantaloupes. There is no current evidence to suggest that watermelons grown using poultry manure are at an increased risk of contamination. However, research has shown that foodborne pathogens can survive long periods in poultry manure. This research project was able to address several aspects of food safety pertaining to watermelons, including transmission of bacteria to melons and persistence of bacteria in amended soils (Tables 1 and 2). These questions are current large data gaps, as identified by the US FDA, who is still continuing data collection in these areas before a final ruling on soil amendments can be added to the FSMA Produce Safety Rule. The information contained in this report also addresses factors that contribute to *Salmonella* persistence in field soil samples in Delaware watermelon plots; including; soil moisture, use of poultry litter (PL), and protection from UV radiation by use of plastic mulch were evaluated.

The main objective of this study was to provide a research basis for informing the risk of using poultry litter to amend soils. An important subsequent objective of this study was to compare factors that contributed to the presence and persistence of *Salmonella* in field soil samples including, soil moisture, use of poultry litter (PL), and protection from UV radiation by use of plastic mulch. As noted above the timeliness of this project is critical, where this information is needed to inform current policy development. We have already had many opportunities to inform growers of our research findings and will continue to do so.

Project Approach: Field trials were conducted in Georgetown, DE at the University of Delaware fields at the Carvel Research and Education Center from May- November over two years, 2015 and 2016. Plot layout was designed and completed, with a total of 12 individual plots per year (Figure 1A and 1B). Poultry litter (PL) (Total Cleanout and Cake in year one, and Total Cleanout in year two) was applied at a rate of 3 tons per acre following industry application rates with 1 row of 10 watermelon plants of 8 seedless and 2 pollinizers planted in each plot. A decision to use only one type of poultry litter in year two was informed by the data collected in year one. We believe that this is also useful information. Soil samples (150 g) soil samples were collected every 7 days, and more frequently at the start of each trial. Soil samples were composites of 6 different spots around each plot. Samples were collected under plastic mulch (Under Plastic, UP) and outside of the black plastic mulch (No Plastic, NP). At harvest, watermelons (n1=120 n2=108) were sampled at random, with each melon surface swabbed in its entirety using environmental sampling sponges.

Prior to being incorporated into the soil, a non-pathogenic, a riframpicin resistant *E. coli* strain TVS 355 was applied to the soil or to the litter at 105 CFU/g. This strain has been studied by many researchers and found to be an environmentally robust organism, well-suited for this study. E. coli cells were detected with direct plate count on MacConkey agar with rifampicin and by most probable number (MPN) analysis in sterile 48-well blocks. Samples were identified as either positive or negative for Salmonella using a modified-BAM method for detection from low initial numbers. Universal Pre-enrichment broth was added to 10g soil samples taken from the original composite 150g samples and incubated at 37°C for 24 hours, followed by selective enrichment in tetrathionate (TT) broth and Rappaport-Vassiladis (RV) broth for 24 hr at 42oC. In year two salmonella positive samples were

quantified using a 48 well MPN method in both TT and RV. *Salmonella* confirmation was performed on XLT-4 xylose lysine agar with tergitol, and 6 isolates per plate were chosen at random and banked at -80°C. PCR confirmation was conducted to verify positive *Salmonella* samples by PCR analysis and confirmation. Stock cultures of Salmonella Newport MDD314 and Bacillus Subtilis UD1022 were used as positive and negative controls. Soil samples (10 g) were placed in a 105 oC for 24 hours and percent moisture content was determined from mass lost. Samples were converted to CFU/gram dry weight. Data were analyzed using JMP Pro (version 13) statistical software and Microsoft Excel.

Significant results from this study include the detection of Salmonella transferred onto watermelons. This is the first field trial to study bacterial transfer under this natural environment using biological soil amendments of animal origin, performed in this way. In the first year 25% of the >100 watermelons sampled were positive for Salmonella and in the second year 33% were positive for Salmonella. The project partners, Kali Kniel and Gordon Johnson worked together on this project. The field trials were arranged and initially designed by Dr. Johnson and Dr. Kniel and many of her students implemented the plot design and performed the weekly biological analysis. Several graduate and undergraduate students were involved in this process due to the extensive sampling and microbiological processing of samples each week.

Goals and Outcomes Achieved: A major successful outcome of this project is the amount of data collected. These data can be used to model bacterial persistence under varying conditions and inform multiple food safety issues regarding bacterial presence in a pre-harvest environment. The ability to recover the two types of bacteria from the whole watermelons is a tremendous outcome and is quite novel, as the majority of researchers are unable to do this type of study from the start to the beginning as was done here.

This grant proposal initially had two goals. The *first goal was to provide a research base to determine the food safety risks with watermelons and poultry manure under Delaware conditions*. This goal was fully met. We are still analyzing the best way to show the data with appropriate statistical analysis and are looking forward to sharing the data with the FDA who will use it in their understanding of use of biological soil amendments in produce safety. This previous statement shows that our second goal was also met; *goal two was to provide research-based information in the risk of using poultry manure near planting on watermelons to regulators and growers in order to make necessary changes to regulations or production.*

An additional outcome of this project that was not in the initial grant proposal was the specific findings that moisture did not significantly aid in the persistence of *E. coli* over time in the fields.
Moisture content in plots inoculated with *E. coli* was not different from those not inoculated with *E. coli*. The change in moisture content in plots over time was significant, but surprisingly, the difference in moisture between day 2 (start of sampling), and day 133 was not significantly different in a cross-comparison. The change in moisture contents over time in samples from under plastic was significantly greater than samples taken from area without plastic.

Beneficiaries: Certainly, the students who contributed to the findings of this research benefited from the extensive experience they received. Produce growers around the world will benefit from the findings here due to the timely and sensitive nature of this subject. This data will fill some important data gaps where policy cannot yet be completed due to lack of knowledge on the specific issues addressed here, persistence of bacteria in poultry litter amended soils and transmission to watermelons.

It is difficult to state the specific number of beneficiaries affected by this project, but certainly this information has been shared with over 50 growers in Delaware and has been shared with at least 100

other people who attended talks where this research was presented. The field design and experimental methods are of great use to other researchers and have already been used by at least ten researchers.

Lessons Learned: Two years of field studies collecting samples every week from a far distance from the laboratory requires organization and team work. We were fortunate to have a great group of researchers able to work on this project at different times over the two years. While we were able to discuss out finding with watermelon growers and visit the facilities of watermelon producers, due to the potential moral and ethical and legal obligations, we did not test retail watermelons or test watermelons on commercial farms. This idea was included in the original grant proposal; however, we were not able to do this in order to ensure the safety of our watermelon growers. We continue to study the bacterial isolates identified during this work and will be able to collaborate with the US FDA on future studies stemming from this original work. The main two goals of the original proposal were met during this study. We had originally hoped to sample watermelons from local growers as well, but decided that due to legal and ethical reasons this would not be a benefit to the community.

Contact Person: The PI of this project was Dr. Kali Kniel, who can be contacted at 302-831-6513 or via email at kniel@udel.edu

Additional Information: Talks and Posters with published abstracts. Please note that manuscripts are currently underway with submission expected in 2018. C. Marik, S. Craighead, S. Gartley, A. Vanore, T Ramos, M. Sharma, G. Johnson, K. Kniel. Factors that contribute to Salmonella Persistence in Field Soil Samples. International Association for Food Protection Annual Meeting, Tampa, FL. 2017.P1-37

T. De Melo Ramos, S. Craighead, P. Spaninger, C. Marik, S. Gartley, A. Vanore, G. Johnson, M. Sharma, K. Kniel. Persistence and Transmission of E. coli and Salmonella spp. in a Watermelon Field Amended with Poultry Litter: Year Two. International Association for Food Protection Annual Meeting,Tampa, FL. 2017. T7—06

T. Ramos, M. Coelho, P. Spanninger, S. Craighead, J. Teichman, G Johnson, M. Sharma, K. Kniel. Food sfatey risks with watermelons gorwn using poultry litter. International Association for Food Protection Annual Meeting, St. Louis, MO. 2016. P2-99

Figure 1. Map of the 12 plots in year one (1A) and in year two (1B) of the two year study.

Table 1. Percent positive Salmonella soil samples over two-year study irrespective of enrichment type.

Table 2. Bacterial transmission to watermelons.

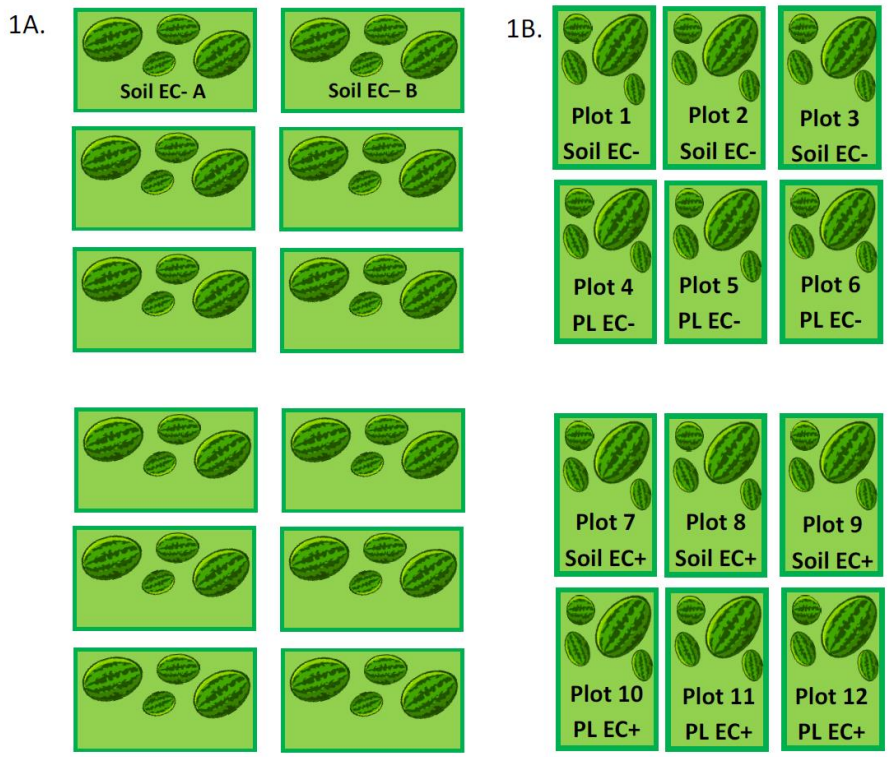

Figure 1. Map of the 12 plots in yea one (1A) and in year two (1B) of th two year study.

Table 1: Percent positive *Salmonella* soil samples over two year study irrespective of enrichment type.

	Total Soil Samples Collected	**Total Soil Samples Positive for *Salmonella***	**Percent Positive**
Year 1	492	178	36.2%
Year 2	348	205	58.9%

Table 2: Bacterial transmission to watermelons.

	***E. coli* 355 log MPN/watermelon n=27**	***Salmonella* spp. log MPN/watermelon**
Plots 1-3: Soil –E.coli	1.28 ± 0.50	2.71 ± 1.07 (n=3)
Plots 4-6 :PL +E.coli	1.56 ± 0.53	2.35 ± 1.38 (n=6)
Plots 7-9: Soil +E.coli	2.01 ± 0.68	1.89 ± 0.94 (n=11)
Plots 10-12: PL+E. coli	1.86 ± 0.98	1.98 ± 1.17 (n=8)

Project Title: Supporting Delaware Growers to Meet Third Party Food Safety Audit Trends

Project Summary: Increasing attention to Microbial foodborne illness outbreaks and produce recalls continues to be an issue for consumers and growers across the country. As a result of food-borne illnesses associated with fresh vegetables, fruits and herbs, the wholesale produce industry is requiring growers to obtain Third Party Food Safety Audits.

In 2008, the Food Product Inspection section, through a Specialty Crop Block award, took measures to implement and provide third party USDA GAP & GHP auditing services at the Department of Agriculture. Prior to that implementation, third party audits in the state of Delaware were only available through the federal government from the USDA, AMS, Specialty Crop Inspection Division located in Washington, DC, or from private companies. The privately based companies were prohibitively expensive for the relatively small farms in Delaware. Between 2010 and 2014, thirteen Third Party Food Safety Audits had been conducted by the Delaware Department of Agriculture/USDA AMS Auditor.

The Food Safety Modernization Act (FMSA), signed into law in 2011, emphasized the need for fresh produce growers to reduce potential exposure of fruits and vegetables to organisms that cause food-borne illness as well as other contaminates. According to the Center for Disease Control and Prevention there are approximately 48 million cases of food borne illness each year in the United States with 128,000 hospitalizations and 3,000 deaths. These outbreaks and recalls have resulted in the wholesale produce industry requiring growers to have food safety programs in place and to obtain third party audit certification. While Delaware produce has not been identified as a source in any food borne illness outbreak, prevention remains the key focus in Food Safety.

The USDA Good Agricultural Practices and Good Handling Practices (GAP & GHP) Audit Verification Program was developed by Specialty Crop Inspection in 2001 at the request of, and in collaboration, with State departments of agriculture. GAP & GHP audits verify that fruits and vegetables are produced, packed, handled, and stored in the safest manner possible to minimize risks of microbial food safety hazards. These Third Party Food Safety Audits verify adherence to the recommendations contained in the U.S. Food and Drug Administration's Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables and industry-recognized food safety practices.

The approximately 150 growers of fresh market vegetables in Delaware are increasingly being required to have independent (third party) audits conducted of their farming operations and food handling as prerequisites to selling to grocery chains, institutional buyers and food service companies. This project was initially intended to continue providing access and awareness of the availability of USDA AMS third party food safety audits for producers, packers and distributors in Delaware, and provide outreach by expanding exposure at local events and reducing the economic barrier of Third Party Audit costs. In addition to USDA audits, some buyers were requiring that growers be audited by commercial firms. Economic barriers to producers, packers, and distributors are the cost of having a food safety plan written and participating in a Third Party Food Safety audit. Technical assistance is being offered at no cost by the Fruit and Vegetable Association of Delaware in partnership with the University of Delaware Cooperative Extension. A portion of this project will focus on reducing barriers to growers by providing a cost share for Third Party Food Safety audits. In Each grower will be eligible to receive an 80% cost share for a USDA AMS or commercial food safety audit up to $1,000.00 per year. The goals of this project are to continue offering GAP/GHP Third Party Audit outreach and to cost share to fruit and vegetable producers to reduce some costs of Third Party Food Safety audits.

Project Approach; This project supported the ability of the Food Products Inspection Administrator and the Food Products Inspection Field Supervisor to host a Food Safety education and outreach booth at Ag Week in 2015, 2016 and 2017. Approximately 154 constituents received Food Safety packets containing information about produce food safety on the farm and availability of USDA Third Party audit services. Bilingual posters were distributed which contained information for field workers about proper hygiene on the farm. Funding allowed for us to reserve the space for the entire length of the event annually (4 days) which was attended by approximately 6,000 agricultural stakeholders. Stakeholders have an opportunity to learn about best practices and new technologies, network with leading industry vendors/experts and meet with other agricultural producers. This venue also provided a means of distributing cost-share applications for Third Party food Safety Audits.

There are economic barriers to producers, packers, and distributors to have a food safety plan written and participating in a Third Party Food Safety audit. Initially, this project was designed to provide cost-share to Delaware farms who successfully completed USDA Third Party audits. In 2017, the project was amended to include cost-share reimbursements to farms that choose to use a commercial audit firm or were required to by buyers. Since the importance of this project is to minimize the burden on growers to develop a food safety plan and participate in food safety audits the scope was changed to include USDA and commercial audits. It is the audit that is most valuable to food safety regardless of the audit source. The change in scope allowed six growers to receive assistance that would not have otherwise.

Goals and Outcomes Achieved: There were 22 audits submitted to the cost-share program from ten growers between September 30, 2014 and September 29, 2017. Out of 22 audits, sixteen were conducted by a USDA auditor and 6 were conducted by a commercial firm. There were 7 audits in Year 1, 4 in Year 2 and 11 in Year 3. The initial objective was to provide a cost-share for 6 USDA audits in Year 1, 8 in Year 2 and 10 in Year 3. The increase in audits seen most noticeably in 2017 can be attributed to expanding the scope of the project to include commercial audits. Thirteen different commodities were evaluated; cabbage, cantaloupe, sweet corn, nectarines, peaches, watermelon, bell peppers, tomatoes, potatoes, apples, asparagus, strawberries and pumpkins. The projected budget for cost share to producers during the 2014 project was $24,000.00 with an actual expenditure was $15,694. The outcome was to achieve provide cost shares for 24 audits and the final results were 91.7% or 22 audits.

The second measureable goal of the project was to increase the number of Food Safety Audit interactions at Ag week and other state programs. Due to the increase in expose time at Ag week by renting the booth from 2 days to 4 and increasing awareness of the implementation of the produce safety rule the distribution of packets was 29 in 2014, 60 in 2015 and 65 in 2016. The target plan was to increase the about of information packets distributed from 29 to 35. This goal was surpassed considerably in 2015 and 2016. Indications are that the 2017 Ag week participation will be even greater due to the implementation of the Produce Safety Rule which becomes effective for large farms in January 2018.

Beneficiaries: The beneficiaries of this project are the estimated 175 growers of fresh market vegetables in Delaware who are increasingly being required to have independent (third party) audits conducted of their farming operations and food handling as prerequisites to selling to grocery chains, institutional buyers and food service companies. Opening the cost-share to include all audit types has been well received by stakeholders. Many growers are required to utilize a specific firm to meet the needs of their buyer. The amount of audits accounted for during this project increased by 27% due to the addition of other audit programs.

While the primary recipients of this project are growers in Delaware who will receive a cost-share for having a Third Party Food Safety Audit, the ultimate beneficiaries are the consumers of Delaware grown produce. The fruit and vegetable growers association, Mar-Del Watermelon Association and Delaware University Fruit and Vegetable Extension also support this project.

Lessons Learned: The project met the objectives as intended. Having increased exposure at Ag week for education and outreach moved the project in a positive direction. If a similar project becomes available again we would schedule more outreach sessions with partners such as the Delaware Farm Bureau, Fruit and Vegetable Growers Association, Potato Growers Association, and Women in Agriculture.

Changing the scope of the project to include cost-shares from successful audits from both USDA and commercial agencies was positive. There was a noted increase in the number of audits and exposure to more stakeholders.

Contact Person: Andrea Jackson, Food Product Inspection Administrator, Phone number 302-698-4545, email Andrea.Jackson@state.de.us

Project Title: Internet Resources, Curriculum Development and Educational Opportunities for Growers That Enhance the Use and Usefulness of the Mid-Atlantic Commercial Vegetable Production Recommendations

Project Summary: The Mid Atlantic Commercial Vegetable Production Recommendations ("Veg Recs") are compiled and edited jointly by Extension specialists and agents, scientists and faculty from Delaware, Maryland, New Jersey, Pennsylvania, Virginia and West Virginia. The Veg Recs contain general information on soil fertility, pesticide use and safety, nutrient management, irrigation, and a diverse array of horticultural management practices. The Veg Recs also contain individual crop-specific sections that document recommended varieties, fertilization requirements, planting, management, harvest and post-harvest considerations and recommended practices and pesticides for weed, pest and disease control for 31 different crops or crop groups. Vegetable growers frequently consult the Veg Recs when making pest management decisions, and are increasingly using the online version of the document. One goal of this project was to enhance the internet version of the Veg Recs with photo galleries and additional information to make it more useful to growers. The second goal of the project was to enhance educational opportunities and resources for new and aspiring vegetable growers in Delaware. Agriculture Agents and Extension Specialists have had frequent interaction with clients interested in starting fruit or vegetable growing enterprises and wanted to organize educational opportunities specifically for this audience.

Project Approach: *Enhance Delaware's Web Version of the Veg Recs*
Emmalea Ernest collected more than 150 digital photographs of vegetable diseases, pests, and physiological disorders from Delaware Extension personnel. These photographs have been organized and labeled by an Extension Vegetable Program miscellaneous wage employee and posted on the Veg Recs Website in galleries organized by crop (https://extension.udel.edu/ag/vegetable-fruit-resources/commercial-vegetable-production-recommendations/index-of-insect-disease-and-disorder-galleries/). Photos of recommended varieties of watermelon, snap bean, muskmelon & specialty melons, and sweet corn have been posted in variety galleries (https://extension.udel.edu/ag/vegetable-fruit-resources/commercial-vegetable-production-recommendations/index-of-vegetable-variety-galleries/).

A program assistant, working with Emmalea Ernest, collected information from processor fieldmen, crop consultants, and agricultural suppliers to update the processing vegetable budgets for peas, lima bean, pickling cucumber, sweet corn, snap bean and spinach. These budgets have been updated and the 2016 versions are linked to the Delaware Veg Recs webpage at: http://extension.udel.edu/ag/vegetable-fruit-resources/vegetable-small-fruits-program/research-reports-fact-sheets/vegetable-crop-budgets-irrigation-cost-calculators/. Emmalea Ernest worked with James Adkins, UD Associate Scientist working with irrigation, to update the Irrigation Cost Calculators for diesel and electric center pivot systems and drip irrigation systems. The updated irrigation cost calculators are also available at the above website. In 2017 the program assistant working with Emmalea Ernest collected information from growers, Extension personnel and Ag suppliers to create new fresh market vegetable budgets for bell pepper, broccoli, cabbage, cantaloupe, potato, seedless watermelon, sweet corn, and tomato, which are also available at the above website. The new vegetable crop budgets were presented to approximately 30 growers and crop consultants at the Mid-Atlantic Crop Management School on November 15, 2017 in a presentation titled: Using Vegetable Crop Budgets for Crop Management Decisions.

Develop a Curriculum Based on the Veg Recs for New Vegetable Growers and Others/ Conduct Educational Meetings and Workshops Using the Veg Recs Curriculum

2015 Workshops

Gordon Johnson worked with County Extension Agents in New Castle County (Carrie Murphy and Dan Severson) and Sussex County (Tracy Wootten) to organize trainings and workshops for a group of beginning fruit and vegetable growers in each county. The classes met for lectures and hands-on workshops or farm tours monthly from February to November of 2015. In some months additional hands on workshops were held. There were 20 participants who completed the Sussex County class and 8 participants who completed the New Castle County class.

2016 Workshops

In 2016 Gordon Johnson worked with County Extension Agents in New Castle (Carrie Murphy and Dan Severson) and Sussex (Tracy Wootten) to organize trainings and workshops for a group of beginning fruit and vegetable growers in the northern and southern part of Delaware. The workshop topics were based on feedback from participants in the 2015 Beginning Farmer trainings and workshops. The following workshops and tours were held:

Workshops for Northern Delaware

New Castle Co. Beginning Farmer Series Fruit Production Workshop
Monday, May 16, 2016 Milburn Orchards
30 participants

Beginning Farmer Workshop Series Oxford Produce Auction Tour
Wednesday, June 21, 2016 Oxford Produce Auction
8 participants

Beginning Farmer Workshop Series: Irrigation Basics
Monday, July 18, 2016 UD Research Farm, Newark
14 participants

Workshops for Southern Delaware

Produce Marketing Workshop – Selling Through the Laurel Farmers' Auction Market
Monday, March 28, 2016 Carvel Research and Education Center
19 participants

Sussex Co. Beginning Farmer Series Fruit Production Workshop
Monday, May 23, 2016 Ernest Fruit Farm, Ellendale
10 participants

Beginning Farmer Workshop Series: Irrigation Basics
Monday, June 27, 2016 Carvel Research and Education Center, Georgetown
13 participants

Beginning Farmer Workshop Series Laurel Farmers Auction Market Tour
Wednesday, July 27, 2016 Laurel Farmers Auction Market, Laurel
15 participants

2017 Workshops

In 2017 Gordon Johnson organized the following educational events for beginning vegetable and fruit growers:

Beginning Farmer Fruit Pruning Workshop
Saturday, March 4, 2017 Ernest Fruit Farm, Ellendale
12 participants

Produce Food Safety Trainings for Direct Marketers and Small Growers
Saturday, March 11, 2017 Carvel Research and Education Center, Georgetown
17 participants

Saturday, March 18, 2017 UD Paradee Center, Dover
8 participants

Saturday, March 25, 2017 Fischer Greenhouse, University of Delaware, Newark
10 participants

In 2017 Carrie Murphy organized the following workshops for beginning vegetable and fruit growers:

High Tunnel Workshop
Thursday, March 23, 2017 University of Delaware, Newark
10 participants

DEUFFC 2017 Urban Ag Tour
Wednesday, September 13, 2017 Tour to Elmer, NJ and various sites in Wilmington, DE
11 participants

Goals and Outcomes Achieved: One goal of the project was increased use of the Veg Recs Website. The benchmark was 100 unique page views per month, which was the amount of traffic the site was receiving before the project began. During the first eleven months of 2017 the Veg Recs Website, including the newly added photo galleries, received 2121 unique page views or 192 views per month, which was close to our target of 200 unique page views per month.

The other goal of the project was increase vegetable production knowledge among beginning farmer workshop participants. Participants in the 2015 workshops were surveyed during the November class meeting to gauge knowledge gained through the classes and how they were using knowledge gained. The majority of those surveyed indicated moderate or significant knowledge gained on the following topics: small fruit production (64%), tree fruit production (64%), vegetable production (100%), cut flower/ornamental production (54%), crop establishment and growing (91%), season extension (100%), providing proper fertility for crops (73%), soil health (82%), tools and equipment (64%), greenhouse production (82%), managing insects and mites (100%), managing diseases (82%), managing weeds (91%), harvesting and postharvest handling (64%), available educational materials for growers (100%), direct marketing opportunities (64%).

Less than half of the respondents indicated moderate or significant knowledge gained for the following topics: community and urban gardening (18%), wholesale market opportunities (36%), practices to reduce risk of foodborne illness from produce (45%), farm business planning (45%), farm business budgeting (36%). The 2016 and 2017 workshops were designed to increase participants knowledge in some of the areas with less knowledge gained: community and urban gardening (Urban Ag Tour), wholesale market opportunities (tours of produce auctions accessible to growers in northern and southern Delaware), and practices to reduce risk of foodborne illness from produce (Produce Food Safety trainings).

Eighty percent of the class participants surveyed indicated that they were already putting into practice knowledge gained as a part of the class in at least one area. Others indicated that they planned to use knowledge gained during next year's growing season.

Beneficiaries: The 2012 Census of Agriculture recorded 222 farms producing vegetables in Delaware. Approximately 225 print copies of the Veg Recs are distributed through Delaware Cooperative Extension and the Fruit and Vegetable Growers Association of Delaware each year, but more growers are also reporting that they use the online version of the Veg Recs. Improvement of the internet version of the Veg Recs has made it easier for growers to access this information online. The photo galleries added to the Veg Recs website have increased traffic to the site and help growers identify insect pests and diseases.

The workshops conducted as a part of this project resulted in more than 200 face to face interactions between beginning fruit and vegetable growers and Extension personnel. The eighty percent of workshop participants reported that they had learned things that they planned to put into practice on their own farms.

Lessons Learned: The Extension personnel working on this project have continued to interact with the beginning farmer class participants individually as they develop fruit and vegetable farm businesses. Because there continue to be people who come to Extension for advice on how to start a fruit or vegetable growing enterprise Carrie Murphy and Dan Severson have applied for (and received) funding for a SARE project to offer workshops for a new cohort of aspiring fruit and vegetable growers beginning in 2018.

There were some difficulties in working on the Veg Recs webpage because of site wide changes to the Extension webpages in 2016. However, now that the photo gallery resource exists, people within Extension have continued to provide additional photos to Emmalea Ernest to add to the site. This is a resource that she plans to maintain and improve.

Updating the vegetable budgets and especially creating new fresh market budgets took more time than anticipated, but now that we have budgets in a desired format for a number of the fresh market crops, future updates will be easier. Gordon Johnson and Emmalea Ernest plan to use the new vegetable crop budgets in additional workshops for farmers in 2018.

CONTACT PERSON

Emmalea Ernest, 302-856-7303, emmalea@udel.edu

Project Title: Developing a Profitable Organic Blueberry Production System in Underserved Communities of Delaware

Project Summary: Delaware is agriculturally rich but underserved communities are still lagging behind to capitalize great opportunity to improve farm income through entering into specialty crop market. Lack of resources and information in the adoption of specialty crops is one of the reasons they are falling behind to other communities in Delaware. Therefore, the overarching goal of this project was to enable 25 underserved farmers to plant 300 blueberry on 0.12 ac in organic production system that results in $900 extra farm income from direct marketing with fresh and value added products. Also, families of the underserved community were expected to consume 10 lb blueberry fruits per year that balances their diet in large extent. Therefore this project was implemented to educate farmers, agriculture producers, extension agents and students. And this project has been able: to make clients aware of economic and nutritional value of blueberry and provide them the profitable organic production system; b) Inform farmers about specialty crop industry with science based results that encourage them to link with industry.

Project Approach: A blueberry demonstration/research cite was established with three varieties of 900 plants in DSU farm located in Smyrna, DE to educate clients about blueberry farming. This allowed clients to gain knowledge from experiential learning. Also, clients were provided technical knowledge and skills through workshops and field days. Well known resource persons were invited from different university to update client's wealth of knowledge.

All the activities were carried out according to this work plan summary table below

Project Activity	Time Line	Responsible
a. Research layout design	2014 April	PC (Project Coordinator)
b. Planting blueberry expt.	2014 April	PC
c. Mowing cover crops and mulching	2015 -017 April-June	Staff in cooperative extension
d. Pruning	2015 Jan- Feb	Students worker
e. Data collection in field research and marketing, consumption and farm income	Round the year	PC, Students worker
f. Three workshops	May and Nov 2015, 16, 17	PC, student worker
g. Three field days	August 2015, 2016, 2017	PC, student worker
h. Research result publication	May 2017	PC
i. Evaluation	Pre and post events Follow up by email , phone and one on one visit	PC and staff in cooperative extension

Goals and Outcomes Achieved: A blueberry production and Marketing workshop was completed on 4/27/2015 (31) to educate our small minorities and other interested growers about blueberry production and marketing. Planting, soil preparation, plant care, and orchard management and marketing were the topics. Speaker was from Rutgers University who is well experienced in blueberry farming. Pruning demonstration was done during May 2015 by Dr. Marsh and 15 participants were volunteered. Organized a workshop and demonstration "science behind the pruning blueberry" held January 11, 2016. The instructor was invited from Rutgers University to train our participants (21). He spoke in class and demonstrated in the field how one needs to manage a blueberry orchard during the winter. This workshop was held from 9:30 am to 4:00 pm. The Cool It Now mobile cooler was demonstrated during the workshop on post-harvest management of fruits and vegetables, held March 22, 2016, from

9:30 am to 2:30 pm. Nineteen (19) participants were there. This workshop was well received by both established and new farmers. Four young farmers who learned more about harvesting and they knew the importance of crop maturity, harvesting time, food safety during and post-harvesting. They knew the ways of handling before and after harvesting. Things to be considered during sorting, grading, packaging, cooling and shipping were discussed in detail. Participants learned produce marketing concepts that will help them increase profitability. A Mobile refrigeration workshop organized on April 13 of 2016 to educate farmers to enable them to build one themselves and 16 participants were participated. Organic Farming of Specialty Crops and Field Day was organized on 06/27/2017 where 25 participants were joined. Two speakers were invited. A breakout session was organized during 2017 small farm conference about some aspects of Blueberry and Strawberry farming in Mid-Atlantic region where 11 clients were participated.

- Short term: participants gained knowledge and skills on plantation and management of blueberry plants, including site selection, and soil management. Also, they learned the skills to harvest and management of fruits after harvest using walking cooler and mobile cooler.
- Long term outcomes: more and more participants will plant blueberry on their land and will be able to harvest high quality blueberry fruits and consume to make health better. Thus, it influences throughout the community and will be able to reduce cost to buy blueberry fruits in future.
- This project expected 25 underserved farmers will plant 300 blueberry on 0.12 ac in organic production system that results in $900 extra farm income from direct marketing with fresh and value added products. As of now, participants are willing to plant and harvest fruits for their family need in future and this project has inspired participants to get all benefits from planting and marketing of blueberry fruits to strengthen their health both physical and economical.

Clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets:

Proposed project activities	Progress made
a. Research layout design	100%
b. Planting blueberry expt.	100%
c. Mowing cover crops and mulching	100%
d. Pruning	100%
e. Data collection in field research and marketing, consumption and farm income	0%
f. Three workshops	100%
g. Three field days	100%
h. Research result publication	ongoing
i. Evaluation	100%

Highlight the major successful outcomes of the project in quantifiable terms: Organized six events (workshops and field days) and educate almost 150 participants participated these events. From these events, participants knew each other and able to shared own experience with each other. They gained knowledge on blueberry farming including site selection, soil management, orchard management (pruning, nutrient management) and marketing. Participants gained knowledge's on post-harvest management of the fruits using mobile cooler "Cool It Now" and walk-in cooler. Also participants learned produce marketing concepts (harvesting, sorting, grading, packaging, cooling and shipping) that might help them increase profitability. The demonstration of a mobile refrigeration unit "cool it now" has been drawn attention from many visitors and many of them expressed desire to build one for their own use for fruits and vegetable post-harvest management.

Beneficiaries: Due to this project almost 150 participants got the knowledge about blueberry production and post-harvest management. It includes all the participants involved during educational events - workshops, field day and field demonstration and some faculty, staffs who are working in the college of agriculture and related sciences. Each year it is expected that new 50-60 visitor will be visiting this blueberry project and they will be benefitted indirectly as well. After 3-4 years later economic impact can be assessed because some of the growers are now start to planting blueberry from their own products. But it looks like there is a very good potential market for blueberry. At least, if the beneficiary of this project (150) start to consume blueberry @ of 2 lbs per month buying from the local market @ of 4 dollars on an average for organic one then there will be $14400 cash will be flowing to the Delaware economy and which can generate more than 100,000 dollars growth within a year due to multiplier effect of each dollar spent. Hence there will be great economic impact resulted due to this educational program in Delaware and beyond.

This project has strengthened the knowledge of DSU Clients including students, research, extension personnel on blue berry farming and marketing. It strengthened the capacity of the college of the agriculture of DSU to hold the events about blueberry farming and marketing. In the long term, whole Delawarean will be beneficiary of this project.

This project has strengthened the knowledge of DSU Clients including farmers, students, research, extension personnel on blue berry farming and marketing. It strengthened the capacity of the college of the agriculture of DSU to hold the events about blueberry farming and marketing. In the long term, whole Delawarean will be beneficiary of this project from physical and economical health point of view.

Lessons Learned:

Before project	After project
-Lack of knowledge on blueberry farming specially organic farming (lack of knowledge on soil pH; weeding without using any chemicals; plot layout; variety selection; winter and summer management of plants , irrigation and fertilization)	-Gained knowledge on organic blueberry farming

Initially we were not much aware about soil ph but it has become a serious concern that blueberry experts said, soil ph must be below or around 5.5. We are still trying to lower from 6 using amendments recommended by OMRI (organic management research institute). Because of higher ph than needed, plants are not well developed.

First one needs to make sure to have soil ph below 5.5 before making any blueberry planting decision. In case of organic farming, there will be very serious weed problem and be mindful if one will have enough hands to pull weeds.

Please contact blueberry extension personnel in any land grant university located anywhere in the northeast USA including (DSU, Rutgers University) for more information about blueberry farming. Regular scouting blueberry plot will help to resolve many problems coming from weeds, insect/pests, and soil pH). Please one need to make sure that one's soil PH is lower than 5.5 before making planting

decision because soil ph is the one and only factor that limit the growth and development of the blueberry plants.

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Project Title: The Georgetown Persimmon Project

Project Summary: Partnering with the University of Delaware Cooperative Extension and 2 other sites, we have established 4 orchards to explore the viability of growing and marketing 2 varieties of Asian Persimmons (Fuyu & Hachiya) in the State of Delaware. The long-term goal and motivation for this project is to evaluate the economic potential of Asian Persimmon orchards in Delaware as a commercial crop. Historical data shows that primary agricultural production in the state of Delaware consists of Corn, Soybeans, Wheat, Sweet Corn and Melons with fruit production ranking very low or non-measureable. This represents a major area for improvement, especially since this project did not build on any previously funded project with the SCBGP.

Project Approach: The overall goal of this project was to establish, monitor and maintain an orchard of Asian Persimmons in Sussex County, Delaware. To this goal, we have prepared suitable property at the Georgetown site with nutrients, fencing and DRIP irrigation system in order to provide for and promote the establishment of an Asian Persimmon orchard consisting of 140 trees in the two varieties. Additional sites at the Thurman Adams Research Farm, University of Delaware, Georgetown; Ernest Fruit Farm; Ellendale; and T. S. Smith Orchards, in Bridgeville, were also prepared and planted. In May of 2015, we planted 35 Fuyu and 35 Hachiya seedlings at the Georgetown location as well as additional specimens at Bridgeville, Ellendale, Georgetown and University of Delaware locations. In May of 2016, an additional 70 trees were planted at Farm Lane, Georgetown under a Budget Amendment thanks to cost savings achieved under the original Grant.

During the first two years of the project, much time was spent in planting and tending to the trees after establishing the limits of the orchards, the well and drip irrigation system as well as the fencing needed for protection from wildlife. The original scope of the project included 70 specimen seedlings at Farm Lane. Sites at the University of Delaware Cooperative Extension, T. S. Smith and Sons in Bridgeville, and Ernest Fruit Farm were also planted. In the third and final year of this project we have replaced winter die-off in the original section of the orchard and at the other locations, while monitoring the seedlings in the new section. In preparation for the winter of 2016/17 all trees were fertilized with manure and straw spread around all seedlings at Farm Lane. Significant contributions made by the Cooperative Extension staff included help in the planting of all trees and guidance with fertilizing needs, suggestions, and wintering advice aside from recordkeeping for the various locations.

Outcomes Achieved:
Accomplishments included, along with the above, are the growth and flourishing of over 50% of the trees planted and well adapted to the locations. The goals of the Grant have been well accomplished. Our goal of 5 additional farms growing Asian Persimmons is off to a good start, with new orchards established at Smith Farms, Earnest Farms and the 2 Georgetown sites and further interest indicated at the annual Agricultural Conventions at Harrington, Delaware in 2015, 2016 and 2017. Progress in the growth of these trees was monitored at a regular rate from planting through season's end by all project partners at all locations. Activities at all locations were monitored by the University of Delaware's Cooperative Extension in Georgetown, Delaware with regular visits. Records kept included plantings, growth tables and fruit production at all sites under the approved project proposal and subsequent amendment to the Georgetown sites.

Beneficiaries: The four established orchards have benefitted all participants, including the University of Delaware's Cooperative Extension in Georgetown, Delaware by gaining a new appreciation for heretofore ignored opportunities to explore specialty crops well established in other regions of the country. The University's orchard, as well as, those in Georgetown, Ellendale and Bridgeville are growing well and producing fruit at an early stage of their development. In short, all parts of Sussex County, and thereby the entire state of Delaware, have benefitted.

Lessons Learned: The only delays in the project have occurred from the shipping of the trees and timing of their planting. Due to previous years weather, specifically temperature and precipitation, (i.e., snowfall) the initial planting of trees was put off from the fall of 2014 to the spring of 2015, with pleasing results. Secondary plantings, in the spring of 2016, and replacement of die-off, due to finding of Termites, were accomplished with direct help from the Cooperative Extension staff. Direct participation by the University of Delaware Cooperative Extension was invaluable in the planting and fertilization of the seedlings to the end that the most beneficial results could be attained. Expectation of crops and the opportunity to invite student tours anticipated in the original Grant proposal were found to have been outside of reality within the Grant term. Nevertheless, a reserve has been maintained to accomplish these activities, as well as Educational opportunities, originally planned in the initial Grant application. Likewise, a publication of findings in paper and electronic forms on the University of Delaware Fruit and Vegetable Program website in the near future is under discussion. Finally, replacement trees for the Georgetown orchard have been ordered at the expense of Mr. Greenblatt. As fruit production at all sites continues to grow, field days and workshops will be promoted at all sites. We expect that promotion of these activities will increase interest in the establishment of additional orchards throughout the region. Thanks and gratitude are expressed to Dr. Gordon Johnson, Emmalee Garver Ernest and the staff of the University of Delaware Co-operative Extension, as well as, Charles Smith of T. S. Smith and Sons and all others involved in this project and to Mrs. JoAnn Walston of the Delaware Department of Agriculture in Dover, Delaware.

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Project Title: Specialty Crops in DE: What Are They, Health Benefits and Where You Can Buy Them

Project Summary: The purpose of this project was to highlight Delaware's specialty crops; highlight overall nutritional values; health benefits and the effects of a good diet on the prevention of various diseases, increase sales of these specialty crops, and to improve sustainability for our farmers. There is a need for this project to show the health benefits of eating fresh locally grown food, highlight what crops are grown in our state, and increase revenue. The best way to reach a large amount of people during our growing season is thru billboards. Just one billboard on I-95 in Wilmington receives 1,100,313 views per month; with that being the yearly average that number is most likely higher during the summer months.

This project was important due to the increases in childhood obesity, the importance of a heart healthy diet and the decreasing number of farms throughout our state. The billboards were set to be put up in June, July and August of 2015, which is during the summer harvest season, and also the time of typical summer vacations which increases travel throughout our state.

All health and nutritional benefits of specialty crops listed coincided with guidelines set forth by the Federal Trade Commission and the U.S. Food and Drug Administration. All nutritional and health claims were truthful.

Project Approach: In October 2014, Laura Simpson went out to see locations of produce stands/farmers markets, and locations of billboards available through Clear Channel for their proximity to available billboards.

ShopRite was the only grocery store highlighted because they had signage and a specific area of the store designated for Delaware Fresh grown produce only

13 Billboards were designed.

In June 2015, Clear Channel installed the following billboards:

I-95 Billboard in June featured asparagus included nutritional facts and highlighted HIGHLAND ORCHARDS and MARINI PRODUCE.

Bridgeville Billboard in June featured peas, included nutritional facts and highlighted LITTLE WAGON PRODUCE and ANDERSON'S PRODUCE.

RT 13 New Castle Billboard in June featured cucumbers, included nutritional facts and highlighted VINCENT'S PRODUCE STAND and SHOP RITE GROCERY STORE.

RT 13 DOVER / CHESWOLD Billboard in June featured strawberries, included nutritional facts and highlighted BOBOLA FARMS and CHESWOLD PRODUCE STAND

In July 2015, Clear Channel installed the following billboards:
I-95 Billboard in July featured blueberries, included nutritional facts and highlighted HIGHLAND ORCHARD and WILMINGTON MARKET AT RODNEY SQUARE

Bridgeville Billboard in July featured cantaloupes, included nutritional Facts and highlighted ADAMS FRUIT MARKET and ANDERSON'S PRODUCE MARKET

RT 13 New Castle Billboard in July featured tomatoes, included nutritional facts and highlighted VINCENT'S PRODUCE STAND and SHOP RITE

RT 13 DOVER / CHESWOLD Billboard in JULY featured green beans, included nutritional facts and highlighted FICNER'S and CHESWOLD PRODUCE STAND

In August 2015, Clear Channel installed the following billboards:

I-95 Billboard in August featured Carrots, included nutritional facts and highlighted WILMINGTON MARKET AT COOL SPRINGS and MARINI PRODUCE

Bridgeville Billboard in August featured tomatoes, included nutritional facts and highlighted MA & PA'S MARKET and SHORT'S BROS.

RT 13 New Castle Billboard in June featured bell peppers, included nutritional facts and highlighted VINCENT'S PRODUCE STAND and SHOP RITE.

RT 13 DOVER / CHESWOLD Billboard in August featured summer squash, included nutritional facts and highlighted BOBOLA FARMS and FICNER'S FARM.

In August 2015, AAA rented the Delaware Farm Bureau their billboard and Signs By Tomorrow installed the following billboard:

Lewes Billboard in August featured sweet corn, included nutritional facts and highlighted Dawn's Country Market and Fresh Connections.

Laura Simpson and Rebecca Urian went out and conducted in person surveys at each of the highlighted produce stands/farmers markets, including the ShopRite grocery store, for June, July and August. In November 2015 Laura Simpson contacted each farm stand/produce stand owner to get input on how much of an increase/decrease of foot traffic and sales percentages they saw from the summer of 2014 versus the summer of 2015 when the billboards were up.

Laura Simpson spent over 150 project hours on this grant. Rebecca Urian spent approximately 100 hours on this grant as well, for a total of 250 project hours combined. The Delaware Farm Bureau paid for these hours and for the billboard located in Lewes, DE and the wrap for the billboard.

Goals and Outcomes Achieved: Of the produce stands/farmers markets owners polled no one saw a decline in foot traffic or sales for the summer 2015 over the summer of 2014, and only one farm stand/produce stand owner said it was about the same. The averages of all produce stands/farmers markets owners increase in sales was 16.5%, with the lowest 2% and the highest being 35%. The average of all farm stands/produce stands foot traffic increase was 17.3%, with the lowest being 5% and the highest being 35%.

Every single owner/manager polled said this was a fantastic idea and welcomed the additional advertising assistance to increase their sales. Most of them mentioned positive feedback from customers as well.

Results from the 128 customer surveys were as follows:

23.7% of people polled knew about the produce stand/farmers market because they lived close by.

21.8% of people polled knew about the produce stand/farmers market because of word of mouth.
42.96% of people polled knew about the produce stand/farmers market because the saw it driving by.
9.2% of people polled knew about the produce stand/farmers market because they saw the billboard.
3.7% of people polled knew about the produce stand/farmers market because of a smart phone app.

85.15% of the people polled said they knew Delaware grew these fruits or vegetables.
14.84% of the people polled said they did not know Delaware grew these fruits or vegetables.

96.87% of the people polled said they planned to come back again.
3.12% of the people polled said they would not come back again.

20.31% of the people polled said they knew some nutritional facts about what they were buying.
79.68% of the people polled said they did not know any nutritional facts about what they were buying.

57.81% of the people polled said they saw our billboards.
42.18% of the people polled said they did not see our billboards.

Based on these findings I would say our billboard project was very successful and came close to the desired intent. 57.81% of the customers polled saw our billboard. Produce stands/farmers market owners said they saw approximately a 16.5% increase in sales over last summer and a 17.3% increase in foot traffic this summer over last summer. At least 60% of the owners polled said they had very positive feedback from their customers on the billboards.

At the end of summer 2016 Laura Simpson took another survey of the owners/managers to see if the produce stands/farmers markets have seen a sustained increase from summer 2015 billboards or a decrease in sales and foot traffic based on the fact that the billboards were not up during summer of 2016. Final results from owner manager surveys were Produce stands/ farmers markets owners said they saw approximately only a 12.7% increase in sales over last summer and a 10.4% increase in foot traffic this summer over last summer. 4 of the 15 managers/owners called in advance to see if we were running the billboard campaign again for summer of 2016 and were told no. They were slightly disappointed, but understood the limitations to the grant and were thankful for the advertising in summer of 2015.

Problems and Delays: Initial problems were, Wayside Terrace was up for auction and no longer open, and the 12th and Brandywine Urban Market no longer held specific hours open to the public, but provided access by appointment only. Those 2 locations were no longer being feasible to include. It was also discovered that Dawns Country Market and Outback Farm were the same place of business, so the 2 separate locations originally listed, now become one. Bellefonte did not get their produce from Delaware so they were also excluded from the campaign.

Also, weather played a role in the Wilmington Market at Cool Springs increase in sales and foot traffic numbers; because they were rained out 9 of the 16 days they were open. This could have played an important role in not reaching the desired 25% increase in sales.

We were also unable to complete the "Text-to-Join" feature, but were still able to collect data by in-person surveys conducting by Laura Simpson and Rebecca Urian.

Only 15 produce stands/farmers markets were able to be highlighted instead of 20 based on 1 closed, 2 being one in the same, 1 no longer open for specific hours and 2 not being within 10 miles of the available billboards.

Beneficiaries:

Highland Orchard Farm Market
Marini Produce
Bellefonte Farmers Market
Wilmington Farmers Market at Cool Spring Park
Wilmington Farmers Market at Rodney Square
Bobola Farm and Florist
Ficners Farm
Farmers Market of Cheswold
Adams Fruit Market
Anderson's Produce Stand
Judy Brothers
Little Wagon Produce
Short's Brothers
Ma & Pa's Market
Dawns Country Market
Freeman's Corn Market
Vince's Produce Stand

Although the above managers and owners would not give me exact sales figures, they did share percentages for summer 2015 and summer 2016.

Results were: 57.81% of the customers polled saw our billboard in summer 2015. Produce stands/farmers market owners said they saw approximately a 16.5% increase in sales over summer 2014 and a 17.3% increase in foot traffic. At least 60% of the owners polled said they had very positive feedback from their customers on the billboards.

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Lessons Learned: Staff members, as well as farmers and produce stand owners/ managers, felt this was an enormously popular and successful idea. Not only did it promote the benefits of eating healthy fresh specialty crop fruits and vegetables, but it highlighted where to purchase them in the state of DE, thus benefitting our local farmers.

There were no major unexpected outcomes, other than a few minor setbacks that caused us to cancel the text program. Originally, we were going to offer a Text-to-Join feature for consumers. Consumers would have been asked to text a keyword (Example: EatDEFresh) to 22828. This would allow us to collect their email addresses and provided us with hard numbers for measurable outcomes. Managers

of the farmers' markets/produce stands did not want to be responsible for having signs on their counter the entire summer due to lack of space or exposure to elements. In-person surveys worked the best because we spent a day surveying customers ourselves. The down side to this was it only reflected the opinions of the customers on that given day.

Probably the most dramatic side effect from this project was the Cheswold farm stand decided not to re-open in summer 2016 because the billboard was not going to be continued.

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Project Title: Promoting the cultivation of wine grapes and wine production in Delaware

Project Summary: Delaware, part of the Vintage American Wine Region, is in the nascent stages of growing its small winery industry. Wineries across the nation have proved to be strong drivers of economic growth and job creation where they have flourished. Delaware wineries must increase their visibility within the region if they are to develop to their full potential.

Additionally, Delaware currently does not grow all the grapes that are needed to serve local wineries. Nearly all Delaware Wineries are forced to purchase grapes from neighboring states to meet their current demand. By illustrating this need and educating local farmers on cultivation strategies and the potential economic benefits of growing wine grapes in Delaware we will be able to significantly increase grape production and reduce our wineries dependence on grapes grown in other states.

Delaware is the central location of the recently formed Vintage American Wine Region, surrounded by more established wine industries in Pennsylvania, Maryland, New Jersey, and Virginia. If Delaware is to both compete with these neighboring states for wine tourism and wine quality we must take an active approach to marketing the quality and variety of wine produced in our state. Because it takes a few years and significant capital investment to increase the number of grapes grown in a state, Delaware needs to move quickly on educating farmers on how and why to grow more grapes to meet current and future demand.

Project Approach: DWA hired a part time Director of Marketing to carry out the grant activities. This person worked .25 FTE and was in charge of supporting all marketing and event efforts of the Delaware Wineries Association related to promoting the growth and consumption of Delaware wines. The DWA website was redesigned to be mobile-friendly by including elements of responsive design. A news section was added to provide content on the industry and DWA members including events and releases. A Social Media Strategy implemented that include both paid and organic components. Paid social media campaigns on Facebook and Instagram were launched to increase followers, lift the DWA brands, and increase DWA event attendance. The pursuit of these goals was enhanced by an organic strategy of posting and sharing social media content on a daily basis. In total, social media advertising reached 1,626,852 people in Delaware during the duration of the grant.

Additional digital tools were implemented to improve marketing and communications. Google Analytics was implemented on the DWA website to allow data collection and analysis of content. Advertising on Google Display Network was added to the marketing plan to allow for hyper-targeted advertising within the state.

Four Annual Harvest Brunch Fundraisers were hosted in October of 2014, 2015, 2016, and 2017. The brunch promoted awareness of Delaware wine and wineries. Attendance ranged from 120 to 150 people each year with members Harvest Ridge Winery, Fenwick Wine Cellars, Painted Stave Distilling, and Liquid Alchemy presenting their products.

The Mid-Atlantic Vintners Roundtable was hosted in February 2016. The conference was for wineries and people interested in opening wineries. Event took place in February 2016 with an attendance of 80 people over two days and featured industry professionals and experts interacting directly with winery and vineyard managers.

Delaware Wineries Association members utilize a number of other agricultural products in addition the grapes. These include Honey, Apples, Corn, Cranberries, Blueberries, Herbs and Spices that are all grown locally. As members have continues to grow their businesses they have also grown in the

consumption of these other local products, which has in turn provided additional markets for these products.

Significant partners in supporting this grant included the Delaware Department of Agriculture, Delaware Office of Tourism, Kent County Tourism, Sussex County Tourism, and the Vintage Atlantic Wine Region. Each of these organizations provided additional marketing support for the activities of DWA members undertaken as part of this grant. This marketing support helped increase attendance at DWA member events and promoted the cultivation of grapes in Delaware.

Goals and Outcomes Achieved: Specific activities that were undertaken as part of this grant that contributed to the completion of the stated goals included the following activities:

• Planning and Execution of a Vintners Roundtable to engage potential grape growers in accessing resources and knowledge to help them get started planting

• Hired a part time marketing director to coordinate all event and marketing activities

• Redesigned and launching of the DWA website to be more focused of promoting events as well as being more mobile friendly

• Planning and Execution of an Annual DWA Fall Brunch to engage with the active local wine consumers in Delaware

• Design and execution of a social media promotions strategy for DWA member events designed to grow attendance and revenue at such events. Implement monthly DWA membership generating posts as well as promotions for DWA member organizations to drive foot traffic to DWA events.

Provide a comparison of actual accomplishments with the goals established for the reporting period.

Goal	Performance Measure	2014 Baseline	2015 Target	2015 Actual	2016 Target	2016 Actual	2017 Target	2017 Actual
1. Increase the yearly sales revenue of Delaware wines by 150% over the next three years	Each year starting in January 2015, DWA members will increase total sales revenue by 50% each year	**$638K**	50% increase on 2014 sales	**$926K** **31.14% Increase from 2014**	100% increase on 2014 sales	**$941K** **47.5% Increase from 2014**	150% increase on 2014 sales	**$1695K** **166% Increase from 2014**
2. Increase attendance at Delaware wine focused events by 100% over the next three years.	Each Year, starting in the fall of 2014, attendance at Delaware wine focused events (festivals, crush parties, etc.) will increase by 33.3% each year.	**6,000**	33.3% increase on 2014 attendance	**10,842** **80.7% Increase from 2014**	66.7% increase on 2014 attendance	**20,860** **247% Increase from 2014**	100% increase on 2014 attendance	**33,250** **454% Increase from 2014**
3. Increase the number of acres of wine grapes planted in Delaware by 75% over the next three years.	Increase the number of acres of wine grapes planted in Delaware by 25% each year	**24**	25% increase on 2014 Acres	**29** **17.24% Increase from 2014**	50% increase on 2014 Acres	**33** **37.5% Increase from 2014**	75% increase on 2014 acres	**33** **37.5% Increase from 2014**

Beneficiaries: DWA Members (2 Operating Wineries, 1 Operating Distillery, 2 Operating Meaderies/Cideries, and 1 Vinyard) were the most immediate beneficiaries from the efforts under this grant. They saw a 166% increase in revenue and a 454% increase in event attendance through the promotion of events associated with Delaware wine production and consumption.

In addition to DWA members numerous non-profit organizations also benefited from the promotion and marketing efforts from this grant as these promotions targeted fundraising events held at DWA member locations as well as fundraising events where DWA members were contributors or sponsors. These organizations include The University of Delaware, the Downtown Dover Partnership, The Food Bank of Delaware, Meals on Wheels Delaware, Hero Hunts, The Delaware Aerospace Education Foundation, Central Delaware Habitat for Humanity, Delaware Technical and Community College, Historic Odessa, Delaware Humane Society, Make a Wish Foundation, March of Dimes, Preston's March, Wounded Warriors, Officer in Distress Fund, Dakiona, and many more.

Lessons Learned: There was significant learning on the part of DWA members on effectively promoting wine focused events. DWA members were especially able to gain significant knowledge as it relates to effective event and organization marketing via social media. This included how to define and target audiences for the greater return on investment of marketing funds, how to design promotional posts for maximum views on varying social media platforms, and how to utilize analytical tools to refine promotional efforts.

One of the major goals of this grant, to increase the amount of grape acres planted by DWA members was not met during the grant period. This is the result of a number of factors, including our inability to recruit new membership from existing wineries as well as the difficulty in finding new potential members interested in cultivating wine grapes in Delaware. Existing wineries were resistant to joining as DWA is seen as supporting competition in the industry which some of the older wineries in Delaware do not see as a good thing for their businesses. The upfront investment to plant and cultivate grapes, for up to three years prior to the first marketable harvest, is seen as the largest obstacle to convincing new potential wineries from being established in Delaware. This is in part to there not being a large and obvious market for Delaware wine at this time. As the existing wineries are able to better establish the presence of an existing market we expect to see this perceived barrier to entry be diminished for future vintners.

One of the efforts that was undertaken to promote Delaware as a good place to grow grapes was the Vintners Roundtable conference held in January 2016. While this event drew wine makers from neighboring states, it failed to draw in farmers in Delaware that might be interested in planting grapes on their property. Outreach was made to some of the local fruit and vegetable growers as part of promoting the roundtable, but the perceived significant investment of the investment and extended turnaround time for wine grapes seemed to lessen potential interest and few non-winery owners attended the roundtable event.

Contact Person

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Project Title: Verifying and Fine-Tuning Mineral Nutrient Recommendations for Selected Vegetables

Project Summary: Current vegetable nutrient recommendations from the University of Delaware Cooperative extension are published in the Commercial Vegetable Production Recommendations for the Mid-Atlantic Region. Recommendations have been questioned for plasticulture drip irrigated vegetables and there are differences in recommendations for coastal plain soils versus upland soils in the region. A wide range of fertilizer programs are being used on the same vegetables across Delaware, often at rates above those recommended. This project evaluated current recommendations for watermelons and tomatoes grown under plasticulture to rectify differences in recommendations in the region. Additional research was conducted to evaluate commonly used foliar programs on watermelons and tomatoes to see if they add any value in improved production or quality.

Project Approach: In 2015, a total of 2 trials on watermelons and one trial on tomatoes with varying nitrogen levels applied through the drip irrigation system were conducted in 2015 to evaluate levels. Data collected in 2015 included yields and quality evaluations, petiole nitrate, and chlorophyll meter readings.

Table 1. Fertilizer Type (Standard and Controlled Release) and Organic Amendment Effects on Yield in Watermelons, University of Delaware, Georgetown, 2015.

Fertilizer or Organic Amendment	Weight per Melon	Number per Acre	Lbs/a
	Lbs	Melons	Average
Standard 125 lbs N	16.3	6396 ab	104698 ab
CRN 150 lbs N	18.3	4782 c	87311 ab
CRN 112.5 lbs N	16.5	4955 bc	82411 b
CRN 75 lbs N	17.8	4955 bc	88451 ab
Standard 150 lbs N	16.4	7087 a	117064 a
Poultry Manure 3 T/a	16.6	5129 bc	85545 ab
Compost 9 T/a	17.3	5762 abc	98506 ab
	NS	*	*
NS Not statistically significant. * Statistically significant at the 5% level – means followed by the same letter are not statistically different by Least Significant Difference.			

Table 2. Fertilizer Type (Standard and Controlled Release) and Organic Amendment Effects on Fruit Quality and Nitrogen Status in Watermelons, University of Delaware, Georgetown, 2015.

Fertilizer or Organic Amendment	Chlorophyll	NO3-N	Hollow Heart	Soluble Solids
	Meter Reading	PPM	Rating	Brix
Standard 125 lbs N	44	2502	1.40	11.3
CRN 150 lbs N	49	3025	1.20	11.1
CRN 112.5 lbs N	48	4400	1.55	10.9
CRN 75 lbs N	48	2875	1.45	11.4
Standard 150 lbs N	45	2878	2.05	11.6
Poultry Manure 3 T/a	46	2025	1.60	10.9
Compost 9 T/a	45	2175	1.85	11.3
	NS	NS	NS	NS
NS Not statistically significant at the 5% level.				

Yields of watermelon were optimized at 125 and 150 lbs of N per acre; however, there were no differences in quality when comparing the different nitrogen rates in the 2015 nitrogen study.

In 2016, a total of 2 trials on watermelons and two trials on tomatoes with varying nitrogen levels applied through the drip irrigation system were conducted to evaluate responses. Two foliar fertilization trials, one on tomato and one on watermelon were also conducted. Data collected in 2016 included yields and quality evaluations, petiole nitrate, and chlorophyll meter readings.

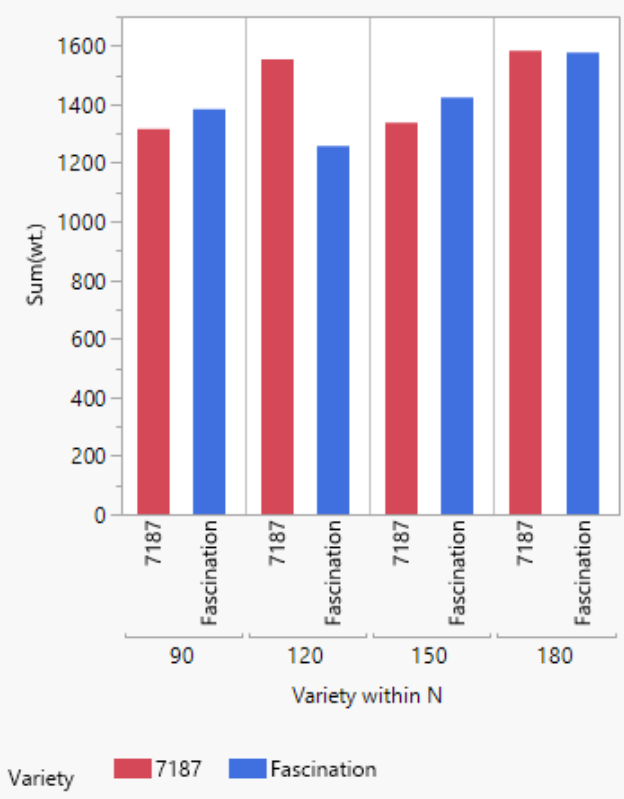

Figure 1. Yields of watermelon by nitrogen rate, Newark, Delaware, 2016

Yields were not statistically different over all nitrogen rates.

Surveys of growers and the industry were done informally at Delaware Agriculture Week in January 2016 and at the MarDel Watermelon Association Meeting in February 2017. Information was obtained from 29 growers and 6 crop consultants.

Overall, the average nitrogen rate being used in watermelons was 142 lbs per acre. 35% of the growers applied more than 150 lbs per acre, 48% of growers applied between 120 and 150 lbs of N per acre and 17% of growers applied between 90 and 120 lbs of N per acre. Rates varied with field, variety. 63% of growers and consultants surveyed also used tissue testing and altered application rates accordingly.

In 2017 a total of 2 watermelon and 2 tomato trials (one foliar and one soil applied) were conducted.

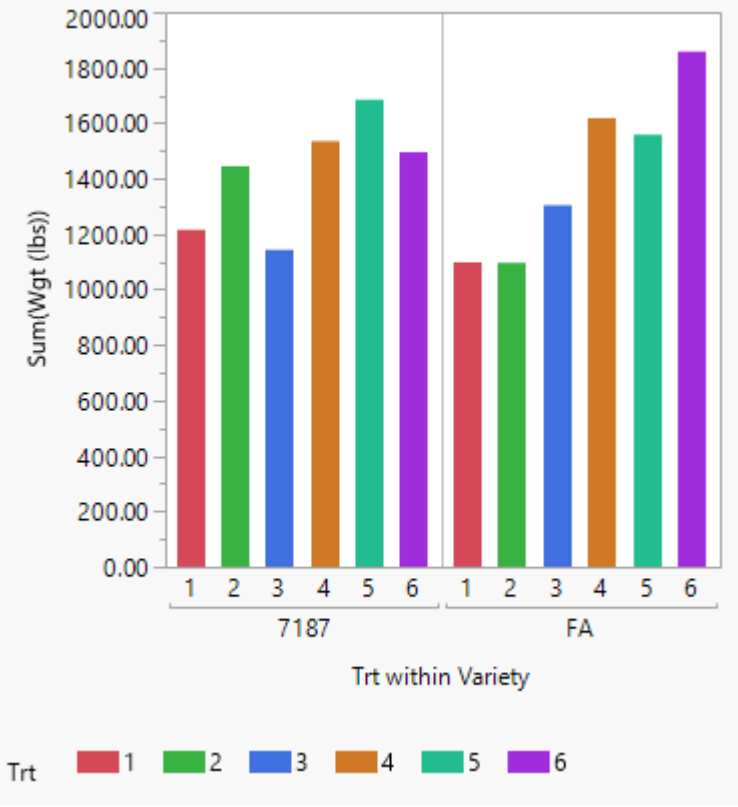

Figure 2. Watermelon yields by nitrogen treatment, Georgetown, Delaware 2017

Treatment 1: 100 lbs of N, 3 applications
Treatment 2: 120 lbs of N, 4 applications
Treatment 3: 120 lbs of N, 3 applications
Treatment 4: 140 lbs of N, 4 applications
Treatment 5: 140 lbs of N, 3 applications
Treatment 6: 160 lbs of N, 4 applications

FA = Fascination

Overall yields of watermelon in 2017 were optimized with 140 lbs of N applied in 4 splits.

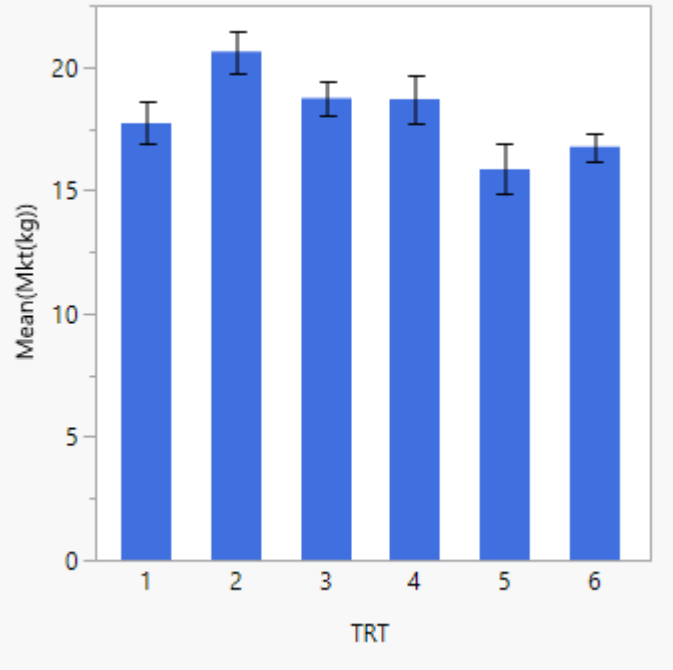

Figure 3. Yields of tomatoes by foliar fertilizer treatment.

Treatment 1 = 30-0-0
Treatment 2 = 23-0-0-7
Treatment 3 = 22-6-22-2
Treatment 4 = 11-8-5
Treatment 5 = 34-4-4-4
Treatment 6 = no foliar

Differences between foliar treatments were evident in tomato production trials. Highest yields were obtained with foliar fertilization and additional sulfur and potassium.

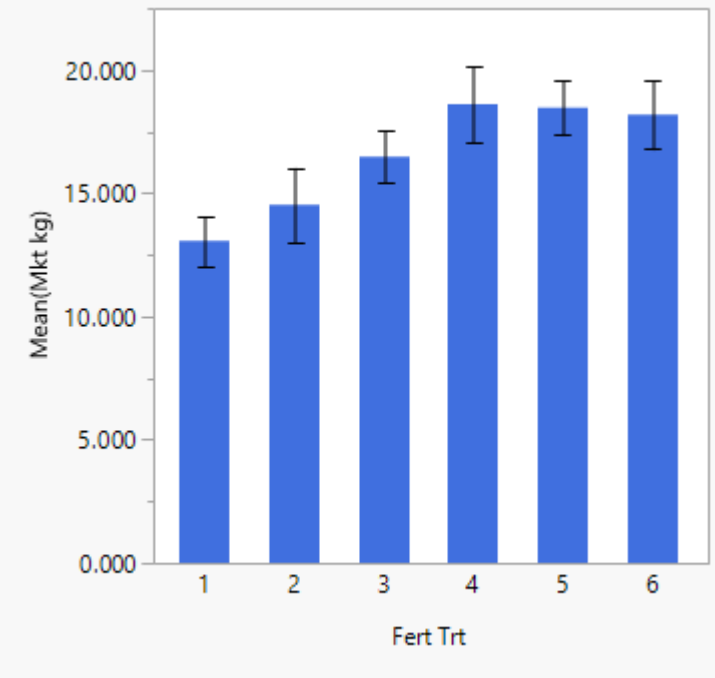

Figure 4. Yields of tomatoes by fertilizer treatment.

Treatment 1 = 30-0-0, 3 applications, 150 N total

Treatment 2 = 23-0-0-7, 4 applications, 180 lbs N total

Treatment 3 = 22-6-22-2, 5 applications, 210 lbs of N total

Treatment 4 = 11-8-5, 5 applications, 210 lbs of N total

Treatment 5 = 34-4-4-4, 5 applications, 210 lbs of N total

Treatment 6 = 22-6-22-2, 5 applications, 210 lbs of N total

Yields were optimized in tomatoes with 210 lbs of N.

Goals and Outcomes Achieved: In 2015, a total of 2 trials on watermelons and one trial on tomatoes with varying nitrogen levels applied through the drip irrigation system were conducted in 2015 to evaluate levels. In 2016, a total of 2 trials on watermelons and two trials on tomatoes with varying nitrogen levels applied through the drip irrigation system were conducted to evaluate reponses. Two foliar fertilization trials, one on tomato and one on watermelon were also conducted. In 2017 a total of 2 watermelon and 2 tomato trials (one foliar and one soil applied) were conducted. Surveys of growers and the industry were done informally at Delaware Agriculture Week in January 2016 and at the

MarDel Watermelon Association Meeting in February 2017. Information was obtained from 29 growers and 6 crop consultants.

Research conducted provided information to verify current recommendations for fertilizing tomatoes and watermelons. This research showed that current recommendations remain viable but that the high end of current recommendations produces the highest yields in both crops.

Foliar fertilization trials indicated that some foliar programs may have a yield benefit in watermelons and tomatoes but more research is needed to verify what programs will optimize production.

Surveys show that some of the acreage is being fertilized above recommended rates but the majority fell within current recommendations.

Information from these trials will be provided to growers and consultants and will be used in recommendations to growers and the industry in the region. Recommendations have been verified and will be used in all states in the region. Recommendations will be published in the 2018 Commercial Vegetable Recommendations and will be used in state and private soil testing laboratories for recommendations given to growers.

Beneficiaries: Currently, there are over 3000 acres of watermelons, and tomatoes grown for fresh market under plasticulture in Delaware with a value over $10,000,000. By verifying current recommendations, growers will be able to make better informed decisions on fertilizer programs to avoid over-fertilization while at the same time maximizing yield and quality. Surveys showed that this work could help reduce applications for over 30% of the growers surveyed. Educational programs and recommendations provided to growers to detail this information will reach over 500 growers, industry representatives, and agricultural professionals with the project.

Lessons Learned Current recommendations are still valid but may need revisiting with higher yielding varieties of watermelons and tomatoes. Additional foliar fertilization research needs to be conducted to provide information to the industry on best materials, timings, and rates.

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Project Title: Fresh Produce Recipes for Delaware Consumers

Project Summary: Far too few Delawareans regularly eat fruits and vegetables. According to the Delaware Department of Health and Social Services, only 14.6 percent of Delaware adults in a 2011 survey reported eating more than two fruits daily, while only 11 percent reported eating more than three vegetables daily. Progress needed to be made to encourage healthy eating, which would lead to increased consumption of Delaware-grown specialty crops.

The Department of Agriculture has previously developed, printed, and distributed recipe cards for promoting fruit and vegetable consumption, not funded by a SCBGP. While these recipe cards were popular, many of the recipes had not been tested prior to printing. This created an issue with recipes not being palatable or difficult to create for the general public, which in turn did not support the goal of increasing consumption. The nutritional information on these older cards only related to the specialty crop in the recipe creating an unsafe environment for people with special dietary needs. Each recipe needed to be fully analyzed with nutritional information published so that the consumer could determine if a serving of any recipe would meet their dietary needs.

One of the chief challenges to eating fruits and vegetables is a lack of knowledge of how to prepare fruits and vegetables and incorporate them into daily diets. Other barriers noted in the academic research include the time involved in cooking fresh foods, the difficulty in persuading children and men to eat vegetables, and access to convenient sources of fresh foods. (Preventing Chronic Disease, 2013; Journal of Extension, 2009; Health Education Research, 2004.) The Delaware Department of Agriculture's new recipe card series used ingredients that were readily available in a home kitchen or could be purchased at a local grocery store for very little money. Specialty crop ingredients could be found at the local farmers' market, farm stand, urban garden, or grocery store. We also recognized that storage and handling would be an important educational piece so that locally grown fruits and vegetables would not be wasted when many Delawareans are watching budgets. We realize that families have multiple obligations and sitting around the dinner table can be hard to do every night and time is a valuable resource. Many of the recipes were developed with this in mind.

This project is important and timely because it meshes with and supplements the State of Delaware's ongoing work to encourage healthy eating and active lifestyles. There is a great deal of energy and effort going into these initiatives, using both public- and private-sector resources. The Division of Public Health, within the Department of Health and Social Services (DHSS), has recently taken over the 5-2-1 Almost None campaign, which encourages consumption of at least five fruits and vegetables daily (vegetables three times and fruits twice).

Project Approach: Even though we had solicited recipes from the public, so few were submitted that we had to identify suitable recipes featuring specialty crops grown in Delaware. The staff set requirements that had to be met in order for a recipe to be accepted for print including: made with fresh, locally grown produce; ingredients that an average household would have in their pantry; when completing a nutritional analysis through Calorie Count, the recipe must meet a grade of A or B; and the recipe must be available for use free of charge. If recipes did not meet these requirements, they were not automatically thrown out. We looked at what we could do to make them healthier and would work to alter the recipe to meet our needs, while maintaining quality and flavor of the recipe. A total of 150 recipes were sent on for design, with 84 recipes making the cut for publication.

Our graphic design staff worked to obtain photographs of the produce that we used on our recipe cards from actual Delaware farmers' markets and farm stands. The photographs serve as the background of each card, giving a visual for our audience. These pictures help the consumer to easily pick out recipes that meet their preferences or accompany what they are purchasing at the market or through a

Community Supported Agriculture (CSA) program. Along with the ingredient list and directions, each card includes handling and storage information to help Delawareans increase food safety in the home. Lastly, nutritional information was determined for a serving size per recipe by using the online website http://www.caloriecount.com. Previous versions of DDA recipes only provided nutritional information on the specialty crop included in the recipe. This was a request from DHSS to utilize in their nutrition education programs and for individuals utilizing SNAP and WIC-FMNP benefits.

We developed two different distribution methods for the recipe cards. We had the printer drill-press 900 sets of recipe cards, each set included a ring, and shrink wrap them for distribution to nutrition education programs and special events focusing on locally grown specialty crops. University of Delaware Cooperative Extension has utilized these sets as a teaching tool during their SNAP-Ed classes with graduates receiving a complete set to use at home. We had the remaining 252,000 individual cards shrink-wrapped into packs of a hundred to distribute to farm stands, farmers' markets, and community supported agriculture programs.

Goals and Outcomes Achieved: A total of 84 different recipes were developed and printed featuring photographs of the actual specialty crop, easy to understand instructions, local and common ingredients, handling and storage guidelines for food safety and nutritional information for the entire recipe. A total of 277,200 cards were printed with two different distribution styles. The original goal was to print 500,000 recipe cards based on an outdated bid received in 2013. We chose to increase the size of the card allowing for more information and to increase readability. By putting all the information on one side, we can now put the recipe online in a .jpg and/or .pdf format when our new website goes live. This means we won't reach as many different outlets, such as service centers and events like Ag Day, but we will be more targeted in our distribution.

When this grant was written, the goal was to make this a two-year project. It has taken longer than that to develop the recipes, have the printer complete his tasks, and deliver to us for distribution. This has delayed our distribution, but will be continued until all cards are out to the public.

The original principal investigator (PI) on this grant left the Delaware Department of Agriculture in January 2017. The PI had several performance measures that were not followed through as outlined in the accepted project proposal, many due to staffing issues which had held up the overall project completion. The PI had also written the grant with the anticipation that the recipes would be published on an "online recipe center." This was not possible as it did not match the State's web protocol. We are currently addressing this through the development of another website that will be housed off the State server, but owned by Delaware Department of Agriculture.

Informal surveys were completed with University of Delaware Cooperative Extension, DHSS, and farmers' market managers on what to include in the recipe cards. These needs were met through the recipe card development. University of Delaware Cooperative Extension's statewide SNAP Educator has distributed all of the complete sets they were provided in 2017. She has requested more sets for upcoming year. Cooperative Extension also hosts a monthly training - in person and on-line – where they prepare a recipe for their recipients using locally grown specialty crops. They had recently run out of recipes to showcase and requested permission to utilize the ones designed by Delaware Department of Agriculture through the Specialty Crop Block Grant.

We have had a request from a farm stand in New Castle County to share our recipes on their website. We have approved them to do that with the agreement that they will acknowledge the Department for the creation of these recipes. They have also agreed to share through social media once we get our secondary website so the information comes directly from us. Delaware Farm Bureau has also utilized the recipes on their website highlighting specialty crops.

Beneficiaries: We have distributed one-third of the complete sets to University of Delaware Cooperative Extension and are still in the process of distributing the individual card sets. DHSS needs a larger quantity than we printed, so they have requested a digital file to do reprints in house as they meet with clients.

It is very difficult to measure distribution once the sets have been delivered to the farm stand, farmers' markets, or community supported agriculture programs. What we do know is that our WIC-FMNP end of season reports are showing 5,722 coupons were redeemed in 2017, more than doubling our numbers from the previous kick-off year. Many of these participants are new to the farmers' markets and are interested in learning how to cook healthy food on a budget for their family. This means the recipe card project is on target and will continue to positively impact Delawareans over the next few seasons. We are also in the preliminary stages of collecting the 2017 farmers' market data, but the forecast is that Delaware will hit a record year with over $3 million in sales, showcasing the commitment that our citizens have for purchasing Delaware Grown specialty crops as a food choice.

Lessons Learned: This project was initially planned as a two-year project and that was not realistic. The reality is you cannot take 150 recipes or even 84 from a generic site and expect them to meet the needs of your consumer. There are cultural expectations and regional differences in how a recipe is prepared that need to be addressed. Our staff worked on recreating local favorites into healthy recipes and creating a lot of recipes from scratch.

The goal is to have the consumer select a recipe that they want to make, purchase the specialty crop ingredients from local farmers, be able to prepare it at home and want to make it again. We also learned from previous recipe card projects, not funded through SCBG funds, that those recipes quite honestly didn't taste very good. When we got the recipe the way we thought it should be we took it to our home kitchens. We tweaked ingredients based upon taste and judged the response of our families. If it was a total flop and no one would eat it again, the recipe got pulled from the project.

While this took a lot of extra time, our staff understands what it takes to prepare a variety of specialty crops that are grown in Delaware and sold at local farmers' markets, farm stands, and grocery stores. This knowledge is beneficial when we are out visiting these sites and interacting with the consumer. We have also targeted our promotional items to cooking in the kitchen with Delaware grown specialty crops. We have found when someone picks up a tool, we can say you could use that to scrub a sweet potato or here is a peeler that you could use on cucumbers and here is a great recipe to make at home. This gives you a way to educate the public without coming across as authoritarian – it's just sharing knowledge from one home cook to another.

In previous versions of DDA recipe cards, the printer would ship a box full of loose recipe cards that quickly became hard to handle, used a lot of staff time to sort and resort, and did not allow us to take stock of what we had. This time we made the decision to have the printer sort, pack and shrink-wrap in manageable quantities. Every box is labeled with what recipe is in it and they were broken into seasonal lots. This took the printer a lot more time to do than they expected causing a delay for us, but the overall ease of handling these cards makes it worth it.

One of our unexpected positive outcomes from this project is the utilization of these recipes for demonstrations at the farmers' markets. Many of our markets will host a cooking demonstration at a specified time for patrons to learn how to cook a recipe with local ingredients sourced right from the farmers' market. Sometimes chefs from the area present and other times volunteers or Extension

nutrition staff will do the cooking demo. The volunteers and Extension educators were starting to run out of recipes to utilize and our project provided them with a whole new resource.

Funding Expended To Date: $15,444

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