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**Project Title:** Investigation of Genetic and Physiological Factors Underlying Heat Tolerance in Lima Bean and Development and Selection of Heat Tolerant Lima Bean Breeding Lines

**Project Summary:** Lima bean (*Phaseolus lunatus*) is Delaware's most widely planted vegetable crop and important for the state's processing vegetable industry. The majority of Delaware lima bean acreage is of the green baby type grown for processing, with approximately 12,000 acres planted in the state annually. One regional processor has also begun growing the Fordhook type, which produces a large plump seed.

In Delaware, the planting window for lima bean is from mid-May through mid-July. Early plantings, those planted before June 20, are often subjected to high temperatures during flowering, which can delay pod set until cooler temperatures prevail or cause split sets, in which some pods are set early and then a second set is initiated a few weeks later when environmental conditions improve, making timing of harvest difficult and causing an overall reduction in yield. Lima bean yields are generally higher in later plantings harvested from early September through frost (mid to late October). These plantings, however, are also subject to more disease pressure under cool fall conditions. Additionally, relying entirely on late plantings diminishes the vegetable processors' harvest window and limits the acreage and production of lima bean in Delaware. At a lima bean forum held on December 11, 2012 in Georgetown, Delaware, growers and processors identified heat and split sets as the top yield limiting factor for lima bean production in Delaware, and heat tolerance as the number one priority trait for improvement in the crop. The second most yield limiting factor identified was drought, and drought tolerance is the second ranked trait for improvement.

Heat tolerance breeding has been one goal of the University of Delaware (UD) Lima breeding program since its initiation in 2004. Experiments done in 2011-2013 through a previous specialty crop block grant, "Lima Bean Cultivar Improvement and Genetics Research for Heat Tolerance and Pest Resistance", have allowed us to test some potential heat tolerance screening methods and identify some lima bean lines that may be heat tolerant. The Lima Bean SCRI grant awarded in 2012 is focused mainly on combating fungal disease of lima bean, however genetic resources generated as a part of that grant can be used to better understand heat tolerance in lima bean. Information and experience gained from the previous SCBG grant and the SCRI grant will be built upon in this project to:

- 1.) Develop heat tolerant breeding material and establish a process by which material in the breeding program is routinely screened for heat tolerance.
- 2.) Determine if heat stress-related delay of pod set in lima bean is caused by effects on vegetative structures and plant growth, effects on reproductive structures, or both.
- 3.) Use genotype data generated thorough the Lima Bean SCRI grant and heat tolerance screening results generated through this grant to determine the underlying genetic basis for heat stress tolerance in lima bean.

The overall goal of the project was to work toward the development of new lima bean varieties with ability to produce economic yields under high temperature conditions.

**Project Approach:** All activities described below have been carried out by Emmalea Ernest with assistance from miscellaneous wage employees of the Extension Vegetable and Fruit Research Program.

*Heat Tolerance Screening of Diverse Lima Bean Germplasm Being Characterized by GBS*  
A set of 255 diverse lima bean lines (diversity panel) has been chosen for characterization using Genotyping by Sequencing (GBS) as a part of the Lima Bean SCRI grant. This set of lines includes commercial varieties, landraces and wild accessions from 18 different countries. The GBS analysis is proceeding as

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a part of the SCRI grant. In 2015, 221 of these lines (for which ample seed was available) were planted in the field in single plots. Fluorometer readings, to assess photosynthetic efficiency under heat stress, were taken on these plants. We did not assess yield or reproductive heat tolerance in this planting, because many of the diverse lines are photoperiod sensitive and do not produce flowers under summer field conditions in Delaware. Twenty five of the diverse lines which had flowered and produced pods under field conditions in 2014 were also planted in a separate replicated field experiments in 2015 and 2016. These lines were evaluated for pollen production and pod set under heat stress and photosynthetic efficiency (using the fluorometer). Several lines produced large amounts of pollen and set pods under heat stress. Also in 2016, 143 of the 255 lines which were determined to be non-photoperiod sensitive were screened for their ability to set pods under high night temperatures in the greenhouse. In screening the diversity panel both in the field and the greenhouse we have identified 28 lines that set and mature pods under high night temperature conditions lines (table below). Crosses are being made with some of these lines to determine if they will be useful in the breeding program as additional sources of heat tolerance.

**Heat Tolerant Lines from the Lima Bean Diversity Panel**

Line #	Name	PI	Source	Country
0002	1102-6	NA	Jim Beaver, University of Puerto Rico	Haiti
0005	Bush Florida Butter	PI 549509	USDA Collection	USA
0011	Dixie Butter pea	PI 549462	USDA Collection	USA
0016	Jackson Wonder	(PI 549467)	Seedway (purchased)	USA
0018	PA German Red Lima	NA	Landis Valley Farm Museum, Heirloom Seed Project	USA
0035	Hopi 13	PI 347779	USDA Collection	USA
0037	Hopi 155	PI 347784	USDA Collection	USA
0038	Hopi 2000	PI 347787	USDA Collection	USA
0041		PI 347826	USDA Collection	USA
0045	Howur	PI 440807	USDA Collection	USA
0066	Henderson Bush	PI 549466	USDA Collection	USA
0070	Baby Potato	PI 549494	USDA Collection	USA
0131	Pat		P. Gepts, UC Davis	USA
0132	Henderson		P. Gepts, UC Davis	USA
0135	UC Haskell		P. Gepts, UC Davis	USA
0138	Wilbur		P. Gepts, UC Davis	USA
0141	Violet's Multicolored Butterbean		Southern Exposure Seed Exchange	USA
0143	Dixie Speckled Butter pea		Baker Creek Heirloom Seeds	USA
0145	L 136	PI 347829	USDA	USA
0158	Bal	PI 180461	USDA	India
0188		PI 257381	USDA	Colombia
0209	Sierra	PI 347798	USDA	USA
0210		PI 347799	USDA	USA
0215		PI 347816	USDA	USA
0246	Easy Shell	PI 549484	USDA	USA
0247	Buttergreen	PI 549485	USDA	USA
0253	Brown Crower Pole 118	PI 550301	USDA	USA
0255	Black and Buff Bush	PI 347822		USA

### *Development of Heat Tolerant Breeding Lines*

We identified several lines heat tolerant lines and have made crosses with those lines in order to develop the heat tolerant germplasm that is one of the Expected Measurable Outcomes of this project. Crosses were made between heat tolerant lines and high yielding commercial lines in December 2013 and 2014. We are currently working with sixteen populations from 2013 crosses and seven populations from 2014 crosses. All populations were grown in the field in 2015 and 2016 and advanced by single seed descent or selections made. A list of the populations and description of how they are being advanced for evaluation in the future is below.

<b>Name</b>	<b>Pedigree</b>	<b>Description of Cross<sup>1</sup></b>	<b># of Lines, Current Generation &amp; Advance Method<sup>2</sup></b>
<b>DE13023</b>	Bridgeton x 1102-6	GBL x heat tolerant	108 F <sub>7</sub> by SSD
<b>DE13040</b>	Sieva x Bridgeton	heat tolerant x GBL	116 F <sub>5</sub> by SSD
<b>DE13050</b>	DE0407905 x 1102-6	GBL elite x heat tolerant	108 F <sub>5</sub> by SSD
<b>DE13051</b>	1102-6 x DE0407905	heat tolerant x GBL elite	95 F <sub>5</sub> by SSD
<b>DE13052</b>	1102-6 x DE0802102B	heat tolerant x GBL elite	2 F <sub>6</sub> pedigree selections
<b>DE13053</b>	DE0505002A x Violet's Multicolored Butterbean	BL yield x heat tolerant	1 F <sub>6</sub> pedigree selection
<b>DE13054</b>	Cypress x Violet's Multicolored Butterbean	GBL elite x heat tolerant	3 F <sub>6</sub> pedigree selections
<b>DE13055</b>	Cypress x UC Luna	GBL elite x heat tolerant	1 F <sub>6</sub> pedigree selection
<b>DE13056</b>	Cypress x Bush FL Butter	GBL elite x heat tolerant	2 F <sub>6</sub> pedigree selections and 81 F <sub>5</sub> by SSD
<b>DE13057</b>	DE0407905 x Violet's Multicolored Butterbean	GBL elite x heat tolerant	15 F <sub>5</sub> bush plants by SSD
<b>DE13059</b>	UC Luna x Violet's Multicolored Butterbean	Heat tolerant x heat tolerant	28 F <sub>5</sub> bush plants by SSD
<b>DE13060</b>	Violet's Multicolored Butterbean x 1102-6	Heat tolerant x heat tolerant	3 F <sub>5</sub> pedigree selections
<b>DE13061</b>	1102-6 x Bush FL Butter	Heat tolerant x heat tolerant	82 F <sub>6</sub> by SSD
<b>DE13062</b>	UC Luna x 1102-6	Heat tolerant x heat tolerant	116 F <sub>5</sub> by SSD
<b>DE13063</b>	1102-6 x Cypress	Heat tolerant x elite GBL	105 F <sub>5</sub> by SSD
<b>DE13064</b>	Bush FL Butter x UC Luna	Heat tolerant x heat tolerant	105 F <sub>5</sub> by SSD
<b>DE14003</b>	Bridgeton x UC Beija Flor	GBL x heat tolerant	147 F <sub>4</sub> by SSD
<b>DE14004</b>	UC Beija Flor x Bridgeton	heat tolerant x GBL	300 F <sub>4</sub> by SSD
<b>DE14005</b>	Bridgeton x Bush Florida Butter	GBL x heat tolerant	79 F <sub>4</sub> by SSD
<b>DE14006</b>	Bush FL Butter x Bridgeton	heat tolerant x GBL	86 F <sub>4</sub> by SSD
<b>DE14007</b>	Bridgeton x AL Blackeye	GBL x heat tolerant (vine)	14 F <sub>4</sub> bush plants by SSD
<b>DE14008</b>	AL Blackeye x Bridgeton	heat tolerant vine x GBL	49 F <sub>4</sub> bush plants by SSD
<b>DE14022</b>	DE0804101A x AL Blackeye	green FH x heat tolerant (vine)	5 F <sub>4</sub> bush plants by SSD

<sup>1</sup> GBL=green baby lima, BL=baby lima, FH=Fordhook

<sup>2</sup> SSD=single seed descent

Seed is being increased of the most advanced selections (F<sub>6</sub> generation of DE13052, DE13053, DE13054, DE13055, DE13056) for replicated yield testing and advanced heat tolerance screening in summer 2017

### *Investigation of Physiological Factors Related to Heat Tolerance in Lima Bean*

#### **Field Experiments**

Field experiments were carried out in summer 2014 to characterize the heat tolerance of several lima bean varieties. Three sequential plantings of nine bush Lima types (six reported heat tolerant and three heat susceptible checks) were planted on May 28, June 12 and June 26. Within each planting, varieties were planted in a randomized complete block design with five replications. Four vining Lima varieties (three reported heat tolerant and one heat susceptible check) were planted in a separate trellis area in a randomized complete block design with three replications. Plants were transplanted into the trellis area on May 22. Data on flowering date, pod set, number and size of aborted flowers and pods, and quantity of pollen shed by anthers was collected once or twice weekly during July and August. Data on yield was collected as pods matured.

Our results from the field experiments suggest that the amount of pollen shed by anthers onto the stigma and style of the flower varies with heat stress and genotype. Significantly less pollen is shed by flowers that develop under heat stress conditions. Genotypes which produce more seeds and pods under heat stress conditions (i.e. Bush Florida Butter, 1102-6) shed more pollen under heat stress conditions than heat susceptible genotypes (i.e. Dr. Martin, Fordhook 242). We developed a method for mounting and staining the stigma and style with pollen onto microscope slides. We then photograph the stigma and style and count pollen grains on the photo with the aid of a tablet computer and stylus running Image J software.

### **Greenhouse Chamber Experiments**

In fall 2014 we constructed two climate controlled chambers inside an existing greenhouse in order to conduct more controlled heat stress experiments. We have conducted five rounds of experiments using the chambers and have found them to be a very useful tool in understanding the physiological effects of heat stress in lima bean. In these experiments we have counted pollen grains shed onto the stilar brush and stigma from flowers produced under high night temperatures (78-80°F) and those produced under cool night temperatures (62-65°F). We also harvested dry pods as they matured and recorded the date of harvest, number of pods and number of seeds per pod. Total yield of dry mature seed was also measured.

The first chamber experiment was planted in November 2014 and harvested in February 2015. The purpose of this experiment was to assess the heat tolerance/susceptibility of six genotypes that had been observed to be either heat tolerant or susceptible in field experiments. Flowers from plants under heat stress flowered earlier but produced lower yields. Flowers from heat stressed plants had fewer pollen grains shed onto the stigma and style. Some genotypes produced higher yields under heat stress than others (indicating heat tolerance).

The second chamber experiment was planted in March 2015 and harvested in May and June 2015. The purpose of this experiment was to assess the heat tolerance/susceptibility of six genotypes (some repeated from the first experiment and some new ones). As in the first experiment flowers from heat stressed plants had fewer pollen grains shed onto the stigma and style. Some genotypes produced higher yields under heat stress than others (indicating heat tolerance) and yield under heat stress was highly correlated with pollen production under heat stress (Pearson Correlation Coefficient is 0.885, p-value is 0.019). For all genotypes there were fewer seeds per pod produced under heat stress. Some genotypes also set fewer pods per plant, but for others (which seem to have more heat tolerance) the number of pods set under hot night temperatures was not significantly different than the number set under cool night temperatures. We also used the chambers to conduct another experiment during this time, in which we grew a vining heat susceptible genotype inside the hot chamber and trained vines out of the chamber into the cool night temperature greenhouse and vice versa. Yield and pollen counts were determined by the location of the flower/pod, either inside the hot chamber or in the cooler greenhouse, not by the location of the pot or main part of the plant. This indicates

that the heat stress response in pollen production is the result of the local conditions experienced by the flower.

The third chamber experiment was planted in June 2015 and harvested in September and October 2015. Originally we had not planned to conduct experiments in the chambers during the summer, but the installation of a donated air conditioner in the cool chamber allowed us to carry on with the project. We were again interested in determining the heat tolerance/susceptibility of several genotypes and pollen count and yield data were collected as in the two previous experiments. Under summer conditions we were able to increase the night temperature in the hot chamber to more than 80°F for an extended period. Daytime temperatures in both the chambers were in the 95-100°F range. Nighttime temperature in the cool chamber was around 65°F. Under these conditions yields were very low in the hot chamber for all genotypes, even those that were somewhat heat tolerant in previous experiments. Plants in the cool chamber produced high yields, despite high daytime temperatures. This experiment demonstrates that night temperatures are most critical when it comes to heat stress response in lima bean.

The fourth chamber experiment was planted in October 2015 and harvested in January and February 2016. The purpose of this experiment is to determine if high night temperatures can induce the abortion of pods that have already been set. Plants were grown under cool night conditions until they set pods. Half of the plants were then being exposed to high night temperatures. For the four genotypes tested there was not a statistically significant difference between plants that matured pods under cool night conditions versus hot night conditions in the number of pods per plant, the number of seeds per plant nor the number of seeds per pod. For some genotypes there was a significant difference in the weight of seeds produced with smaller seeds produced under hot night conditions.

The fifth chamber experiment was planted in March 2016 and harvested in May and June 2016. The purpose of this experiment was to test the effect of hand pollinating flowers grown in heat high night temperature conditions with pollen from plants grown in cool night conditions. Another goal was to look more closely at heat effects on flower morphology and confirm previous effects on yield that were observed. Flowers in the hot chamber which were pollinated with pollen from the cool chamber did develop small pods, however most did not reach maturity. Self-pollinated flowers from the same plants on the same day did not develop pods. These results indicate that there may be some heat effect on stigma receptivity or pollen germination, in addition to the effects on pollen production and release that have already been described. Dry weights of plants (with all pods removed) were measured at the end of this experiment. Plants grown under hot night conditions had significantly higher dry weights, suggesting that heat stress does not inhibit of vegetative growth in lima bean

Experiments using the greenhouse chambers are ongoing in order to answer remaining questions about the physiological effects of heat stress on lima bean.

### *Genetics Studies*

Genotyping of the lima bean diversity panel as a part of the SCRIM grant is not yet completed so planned association mapping with the diversity panel has been delayed, although the phenotyping of this group of germplasm proceeded as described above. Additionally, in summer 2016, 99 F individuals from a cross between Bush Florida Butter (heat tolerant) and C-elite Select were grown under high night temperature conditions in the greenhouse. Data was collected on pod and seed production for each plant. The amount of pollen released onto the style at anthesis was visually evaluated. Pod and seed yield under heat stress had a continuous distribution, with some plants having a yield higher than the heat tolerant parent and some having a yield lower than the heat susceptible parent. Higher yields were generally associated with higher amounts

of pollen visible at anthesis, but some plants with high amounts of pollen did not produce a high yield. Based on these results it seems likely that several genes are involved in the heat tolerance phenotype. Later generations from this population will be evaluated in future years to better understand the inheritance of heat tolerance in order to facilitate breeding.

### *Presentation of Results*

Results of the first three chamber experiments were presented to bean breeders and geneticists at the Bean Improvement Cooperative Meeting on Nov 3, 2015 in Niagara Falls, Ontario, Canada. A similar presentation was presented at the Northeast Regional American Society for Horticultural Science Meeting in Philadelphia, Pennsylvania on January 6, 2016. Results were also presented to lima bean growers at the annual meeting of the Fruit and Vegetable Growers Association of Delaware on January 13, 2016

**Goals and Outcomes Achieved;** By the end of this grant we expected to have identified several heat tolerant lima bean genotypes, made crosses with them in the breeding program, and have advanced heat tolerant breeding lines ready for yield testing. These goals have been achieved. Nine F<sub>6</sub> selections will be yield tested in the field and greenhouse screened for heat tolerance in summer 2017 and other heat tolerant breeding lines are in pipeline for screening in future years. Greenhouse and field heat screening methods have been tested and established as a part of this project and will continue to be used in order to select heat tolerant germplasm in the breeding program.

Another goal of this project was to increase the scientific understanding of the physiological mechanisms for heat tolerance/susceptibility in lima bean. It is clear from our research that high nighttime temperatures (75°F and higher) are detrimental to lima bean yield by inhibiting pod set. Such conditions reduce the amount of pollen that is released by the anthers, causing poor or no pollinations. Pods that have already set are not affected by high night temperatures and high daytime temperatures, when coupled with cool nights, do not decrease yield. The effect of heat is determined by the conditions experienced by the flower structures, not by the plant as a whole. There are differences in yield and pollen production under heat stress between genotypes. High nighttime temperatures do not seem to have a deleterious effect on vegetative growth in lima bean so in the future I plan to focus my research on heat effects on reproductive structures.

The third goal of this project is to characterize the genetic basis for heat tolerance in lima bean. The realization of this goal was hampered by the current lack of genotype data for lima bean. Work to genetically characterize the diversity panel and develop a set of genetic markers that can be used in lima bean is continuing and will hopefully be available within the next year. With mapping populations in development and some phenotyping completed, I hope to be able to make additional progress toward this goal in the near future. From a functional standpoint for the breeding program the most important development is the establishment of reliable heat tolerance screening methods that have been developed as a part of this project.

**Beneficiaries:** The ultimate beneficiaries of this project are the approximately 80+ farms growing lima bean and four Lima processing companies in the Mid-Atlantic region. The value of the 2012 processing Lima crop in Delaware was \$10 million. Heat tolerance is a major yield limiting factor for Lima production in the Mid-Atlantic and in other US production regions. The research and breeding done as a part of the project will expedite the development of heat tolerant lima bean varieties.

**Lessons Learned:** The greenhouse chambers that were built (rather inexpensively) as a part of this project have been a valuable tool in determining the physiological effects of heat on lima bean and I will continue to use them in lima bean heat tolerance experiments.

Characterization of the genetic basis for heat tolerance in lima bean has not been achieved in the way that was anticipated, but I hope to make additional progress in this area in the coming year as more genotype information and genotyping tools become available.

The development of a greenhouse screening method for heat tolerance was valuable in characterizing large amounts of germplasm simultaneously and will be critical to selecting heat tolerant lines from the breeding program in the coming years. Field screening for heat tolerance was useful only in some years of the project, as some years did not have long periods with high night temperatures.

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**Project Title:** Development of enhanced strategies to mitigate Lima Bean Pod Rot caused by *Phytophthora capsici*

**Project Summary:** In recent years, Delaware lima bean growers have reported an increasing incidence of pod rot caused by *Phytophthora capsici*, an emerging pathogen in bean with potential to be a significant threat to lima bean profits. Managing pod rot through cultural means (i.e. crop rotation) is only partially effective because the pathogen has numerous other known hosts and can survive long periods in the soil. Sporangia of *P. capsici* produce zoospores that are transported in water, including irrigation sources, and disease incidence is therefore greater during wet weather. Isolates have also demonstrated the ability to overcome the widely-used fungicide, Ridomil Gold. For these among other reasons, it is therefore urgent to better assess the prevalence and spread of *P. capsici* in lima bean-producing areas in the region as well as to provide risk assessment tools to guide fungicide use.

**Project Approach:** Lima bean are Delaware's most widely planted vegetable crop and important for the state's processing vegetable growers. The majority of the lima bean acreage is green baby lamas grown for processing (13,000 acres planted in 2010). Lima bean is plagued by several pathogens and pests, which pose a tremendous threat not only to Delaware's lima bean industry, but to its vegetable processing industry. One such pathogen is *Phytophthora capsici*, the causal agent of pod rot on lima bean, with an extensive host range. Until 2001, it was believed that lima beans were "immune" to *P. capsici*, until it was isolated from plants in Delaware (Davidson et al., 2002; Hausbeck and Lamour, 2004). The Mid-Atlantic region has reported increasing incidence of pod rot on lima bean, particularly when conducive weather conditions prevail, and it has been described as extremely difficult to manage during climates that favor the pathogen.

One of the chemistries that were widely used to manage pod rot is called mefenoxam (trade name: Ridomil Gold). Incidences of resistance of the pathogen to this fungicide had been reported, prompting us to identify a quick and efficient method of identifying Ridomil-resistant strains in the field. Using two sets of well-defined primers and a PCR program, our post-doctoral associate, Nilwala Abeysekara (funded by this grant) was able to achieve an 80% success rate of accurately detecting Ridomil-resistant isolates, which would inform growers to use other fungicides on label for lima bean, in the field (see below in Outcomes for additional information).

Furthermore, she also over the last two years developed a primer set that accurately differentiates *P. capsici* from the downy mildew pathogen, *P. phaseoli*, whose symptoms and signs can look quite similar in the field. She also was able to complete a third field season of *P. capsici* collections of isolates from water samples from irrigation sources in Delaware, and surprisingly, after having consultations from experts like Dr. Hong at Virginia Tech, and trying different methods, was unable to detect any *P. capsici* from irrigation sources around Delaware after collecting over 200 samples during the course of three field seasons. In future, we could sample from sediments and soils in or near irrigation sources, as this was not attempted during the course of these experiments.

Finally, Nilwala has been working on field level risk assessment for pod rot. In the original proposal from 2014, we thought of generating a risk assessment tool, however it came to light that growers would not really use it, as pod rot in fields is a fairly "known quantity" and growers usually know where and when it will show up, given the right weather conditions. Nonetheless, she continues to work on a risk assessment protocol to be written up as a Fact Sheet, that growers can take under consideration during their field seasons. It is based upon 20 parameters, some of which include drainage, dew point, and crops under rotation, weeds, rainfall, temperatures, field history and humidity. This is being done in conjunction with Dr. Gordon Johnson and Dr. Tom Evans, who have significant experience with this disease and these risk factors. Our specific commodity group impacted were/are the lima bean growers and processors in the state of Delaware and surrounding areas.

Contributions of project partners include access of growers to their irrigation sources (these samples were collected by Heather Baker, a graduate student working with Nilwala on the collection project).

**Goals and Outcomes Achieved:**

**Table 1.** Goals of project and Outcomes achieved. Note: all activities were performed by Niwalwa Abeysekara, with the help of Heather Baker where stated, and under the advisement of Drs. Johnson, Evans and Donofrio. Identification of *P. capsici* was aided by N. Gregory.

Activity	Accomplishment	Outcome
Test <i>P. capsici</i> isolates from 2014 - 2016 seasons for fungicide resistance and on lima bean germplasm	-- ~300 total samples analyzed for positive <i>P. capsici</i> identification, mating type, and Ridomil-resistance -- Data basing completed by Heather Baker -- Primers have been developed	-- manuscript in preparation for <i>Phytopathology</i>
Data basing of weather and field data for risk assessment model was Heather and it was done.		
Development of primers for differentiating isolates; changed slightly to Ridomil sensitivity- that was how we differentiated them.		
Collection of additional <i>P. capsici</i> isolates from water and plant material; tried in 2014 and 2015 but nothing from water, using different methods.	-- collection by Nilwala and Heather -- all isolates from 3 years tested, all virulent on lima bean.	-- no isolates of <i>P. capsici</i> were recovered.
Testing of new isolates for fungicide resistance and on lima bean germplasm		
Testing of primers on new isolates	-- collection of data by Heather Baker, completed -- Risk model assessment in preparation.	-- Factsheet in preparation on risk model
Collection of 2015 field and weather data; yes, Heather—only 2014		
Development of risk assessment model with 2014, 2015 data; Modified to a Field-level risk assessment fact sheet		

Overall, we met the goals of this project. We did not develop a risk model for pod rot in the fields, simply because the growers informed us that it would not be widely used. Instead, we are developing a Factsheet with risk assessment parameters listed for any grower who wishes to access it. It is a much more specific, detailed, and rigorous assessment plan than any currently present. Our primer sets for identification of pod rot in the field and for identification of Ridomil-resistance should prove very helpful for informing growers which fungicide to choose.

Potential Impact: The main beneficiaries will be regional lima bean processors and growers, in the form of improving overall competitiveness of the industry, retaining jobs and improving processing company and grower profits. Decreasing use of fungicide sprays to control an emerging, important lima bean disease – pod rot – will at once improve our growers’ and processors’ environmental footprint, reduce pest control costs, and generate a larger profit margin; furthermore, many of the strategies we propose could also be applied to other vegetable crops in the region, which fall victim to *P. capsici* and several other pathogens and pests that plague lima bean.

At least 20 farms representing four major lima bean production and processing companies will immediately benefit from this project on mitigation, prevention and control of Pod Rot. Over time, our goal is that all roughly 50 – 70 farms that grow lima beans both in Delaware and the eastern shore of Maryland, will adopt our strategies and will benefit.

Expected Measurable Outcomes: The Pod Rot Risk Assessment Tool will be made available to growers, consultants, and processing companies for their use. It will be used by university extension specialists to alert growers and processing company field personnel of the potential for disease initiation and to determine if fungicide use is warranted. This information will be made available to growers and processors via multiple channels. In addition, this assessment tool will provide means to predict which field areas, land features, and microclimates have higher risk of pod rot occurring, aiding growers in making rotational decisions. It also will be useful to help scouts target field areas for increased monitoring, enhancing the ability to find early infections. The genetic typing information will provide information on local populations and how pod blight is spread between fields. Water testing results will be provided to growers to determine if water sources are contaminated and if treatment or alternative irrigation sources should be sought.

Overall Goals:

- (1) Pod Rot Risk Assessment Tool (PPRAT): This tool will allow growers to plug data into a user-friendly web-based interface, and see a resultant “risk” number that will be well-defined on the site, and will indicate whether their risk is low, medium or high based on specific weather parameters, field histories and inoculum sources. This project is well-underway, and the post-doctoral associate will contribute additional important information on inoculum sources.

Ultimately, we have generated a pod rot fact sheet. The PPRAT will not be fully developed, in the sense of developing a model, because some of the advisory board members suggested it would not be widely used, but that a Factsheet stating the risk factors for pod rot would be much more helpful. This is underway and will be completely in March 2017.

- (2) Rapid identification of isolates: These tools are being developed by the post-doctoral associate, and will be tested on this year’s field collections, which is one reason why it is so pivotal that she remain working for another year. The rapid identification measures will consist of robust primer sets to be used in conjunction with PCR, in order to rapidly determine what is in the grower fields, and most importantly, whether it is changing.

We are successfully using PC1 and PC2 primers, from another groups' publication to rapidly identify *P. capsici* amongst other fungi and oomycetes. Our post-doc, importantly, have developed 2 sets of primers when used in conjunction predict fungicide sensitivity to a major fungicide, Ridomil Gold, to an accuracy of 80%. A manuscript is underway.

Performance Measure (number of people who will actively participate in the risk assessment):

- (1) Four lima bean processing company fieldmen, one consultant, and 40 growers will use the PPRAT risk assessment tool representing 8000 acres. We will host a field school in late summer to widely introduce this tool, and other aspects of the project, to the associated lima bean cooperators above.

We had a field school in January of 2016 and these people were present, however due to the reasons listed above, we did not generate the full risk model tool, which we were told by our Advisory board would not be widely used. We instead are generating a Factsheet on PPRAT for growers to access that defines the major risk factors to look for when preparing for pod rot. This Factsheet will be available in April. We will hold one more field school in 2017, and we will educate on all aspects of pod rot.

- (2) PCR-based markers will be used by University of Delaware, Delaware State University, and University of Maryland researchers, extension specialists, graduate students, and professionals (>8 total)

These primers are currently being used by two labs at University of Delaware (right now about 3 or 4 people across two labs).

Benchmark and Target: In 2015, the PPRAT will be tested on 4 farms as designated by the processing companies. In 2016 the PPRAT will be tested on at least 20 farms. DNA based detection and characterizations will be done on a minimum of 20 samples in 2015 and 40 samples in 2016.

One thing that is important to note here, is that due to timing, we did not receive the DDA funds until the summer of 2015, so implementing any of these tools for this field season would have been difficult as they were developed in the fall of 2015 and the winter of 2016. The PPRAT Factsheet will be widely disseminated in April 2017.

Data Collection Plan: Information will be collected at cooperator meetings and field schools in 2015 and 2016 using oral, paper, and electronic surveys. These surveys and the pending field schools will also help us monitor the progress made towards our measurable outcomes.

We have had one field school last year, and we have run surveys at the last field school, and the lima bean forum in 2014. This data is being processed for a final report. In 2017, we will have another field school, and we will perform "output mapping", which we are developing now for the coming field season. We will be able to better assess how the growers are using not only the PPRAT Factsheet, but also the other tools we have developed in the lima bean project.

Project Dissemination & Measuring Participants: As mentioned above, we will utilize a field school in 2015 and 2016 to introduce our new tools, and provide some hands-on experience with them. Information will also be presented at lima bean specific meetings each year and at the processing crop educational sessions at Delaware Agricultural Week. We will continue to utilize paper, oral, and electronic surveys to not only track participation and utilization of our tools by lima bean cooperators, but also to continue to help guide our research. Publications will also be a means of measurement, as well, and we have one manuscript on Task (b), already underway. Information will also be distributed in electronic form via a web site specific for the lima bean project. The number of persons and organizations reached will be measured by attendance at the sessions listed above, website visits, and publication downloads, and personal communications.

Along with the response above, our post-doc funded on this grant has generated a manuscript that will be submitted for publication in the next few weeks on rapid identification of *P. capsici* and utilization of the primer combination. This manuscript is targeted for Phytopathology.

**Beneficiaries:** There are roughly 300 lima bean growers in Delaware, and we hope that they will all benefit from the Factsheet on risk assessment parameters. In the long-term, we will use our primer set to make positive identifications on *P. capsici* and on Ridomil-resistant isolates. It is difficult to predict how many people this will benefit, but we hope to be of use to all 300!

At least 20 farms representing four major lima bean production and processing companies will immediately benefit from this project on mitigation, prevention and control of Pod Rot. Over time, our goal is that all roughly 50 – 70 farms that grow lima beans both in Delaware and the eastern shore of Maryland, will adopt our strategies and will benefit.

**Lessons Learned:** It is important to mention that some aspects of this project did have a delayed start because of some issues with our research office in getting the proper forms completed in a timely manner!

These were described in the above-sections, but to re-iterate, we were surprised to get no *P. capsici* isolates from the water samples, given all of the locations we queried, the techniques we used, and the experts (Dr. Hong, VA Tech) we consulted. It is possible our method simply did not work, or it is possible that the pathogen is located more in the sediments, which we did not extensively test.

Also, it was helpful to learn from the growers that an actual risk assessment model for pod rot would not be very useful to them, but rather an extensive set of risk assessment parameters, which we are in the process of completing.

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**Project Title:** Laurel Farmer’s Auction Market Promotions and Marketing

**Project Partner:** Southern Delaware Truck Growers Association, Inc. - Laurel Farmers’ Auction Market

**Project Summary:** The Laurel Farmers’ Auction Market was created by a group of Delmarva Peninsula

farmers in the 1940's. It is known as "The Block" and from July to September operates six days a week selling specialty crops. This project helped to promote specialty crops by allowing us to continue to advertise and to promote the specialty crops by means such as social media and our website in order to gain new buyers and sellers for our locally grown specialty produce. The project was to help with labeling to identify the specialty crops being sold and purchased and signage to the pavilion to help consumers better understand the procedures for selling and purchasing specialty crops. The market also needed to upgrade the specialty crop transport system for buyer and seller convenience to load and unload their specialty crops. We are located in a central area to reach the large cities, such as Philadelphia, Baltimore, Washington, Norfolk and even New York City.

**Project Approach:** We set up signage at the pavilion to inform buyers and sellers the procedures for using the market. We procured carts to make it easier for sellers to unload and display their specialty crops and for sellers to transport the specialty crops to their vehicles for loading. New labels are being used to better identify the specialty crops including the date they were brought in as well as the buyer who purchased them. We were able to advertise and promote the market and specialty crops better on Facebook and our website along with making sure consumers knew the procedures for using the market.

**Goals and Outcomes Achieved:** Unfortunately, due to the weather this season we did not reach our goals. We had sales of \$350,000 which did not reach our goal of \$500,000 and the amount of sellers decreased from 212 to 192 for the 2016 season. We did, however, increase the number of buyers from 277 to 385 this year.

The signs at the pavilion were a huge help in making the consumer, old and new, aware of the procedures for buying and selling specialty crops at the market. This aided in making sure everyone understood the rules and helped to enforce the quality of specialty crops brought in.

The carts for the specialty crop transport system increased the efficiency of unloading, moving, and loading of the specialty crops by an average of 10 mins per seller, buyer, and employee. This made it easier and less time consuming for the seller to drop the specialty crops off at the market. They aided the employees in setting up the auction for each sale. Having more carts with the specialty crops already on them drastically helped the buyers with transporting the specialty crops to be loaded. All in all it benefitted everyone involved by having easier access to move the specialty crops from one area to another and saved on damage from mishandling of the produce.

The labels improved the market by making it easier to see what the specialty crop was to buyers including less knowledgeable consumers. They aided in making sure the employees knew what the specialty crops were and when they were brought to the market. They also helped the buyer by making it easier for them to locate the produce they had purchased.

Being able to promote the market more on the website and Facebook aided in making consumers more aware of what the market has to offer. We were able to update the website with the rules and procedures of the market and efficiently upload auction details on the website which helped increase the number of buyers to 385. Advertising on Facebook allowed us reach the social media consumer and again make more consumers aware of the specialty crops the market has to offer and increased pages likes by 111 for a total of 792.

**Beneficiaries:** This project was helpful to the specialty markets in this area. It also increased the awareness of the specialty crops we have in this area and help to put more of these foods on family tables.

The Food Bank of Delaware was able to purchase produce from the auction which aided in helping 56 low income families in the area eat healthier. The Laurel School District increased the amount of specialty crops they were able to serve in their Summer Feeding Program for 78 children. One of the biggest beneficiaries were 5 local farmers markets and 18 produce stands, who were able to increase the amount and type of specialty crops they could offer to local families. This also aided in bringing more money into the community as some of their customers are weekend travelers to the ocean resorts.

Employees of the market were also a beneficiary of the project due to the increased efficiency of the carts and less time spent on handling the produce. The signs that were posted also resulted in less time by employees explaining the rules and procedures as they are now clearly stated and posted for everyone to read.

**Lessons Learned:** Some of the lessons learned were that to make new changes you need proper equipment along with proper rules and procedures. You also need to ensure that the consumers are aware of the rules and procedures and the proper and efficient way to utilize any equipment the market provides. Changes are hard for people who have done the same thing year after year and don't like change.

It will be an ongoing task to continue to increase the awareness of the specialty crops at the Laurel Farmers Auction Market. We need to keep changing with the growing times to ensure that we not only keep existing consumers, but also that we can attract the newer generations of consumers.

**Contact Person:**

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**Project Title:** “Marketing Campaign for Developing Grower Business Relationships with Retailers, and Promoting Existing Relationships to the Community”

**Project Summary:** With 11,000 acres of fresh market produce grown in Delaware annually, and a value of approximately \$35 million, farmers of specialty crops utilize a variety of avenues to move that produce for consumption including the numerous retailers/grocers in Delaware that actively desire locally grown, fresh

produce in their respective stores. This project targeted those retail markets and growers, driving traffic to the grocery store chains and major price clubs that offer locally grown produce. The project also aided in farmers making the right connections within the retail industry so as to heighten the probability of successful, repetitive and increased sales.

Overall, the project was very successful in meeting all of the amended, stated key objectives, as outlined in the grant memorandum to Carly Borgmeier in 2015.

**Project Approach:** The approach was multi-faceted, but focused on relationships, between growers and retailers/buyers, and growers to the community. The executed plan, using \$25,000 in funding, was three-fold. First, bus tours were conducted that brought Shop-Rite grocery store consumers directly to the farm fields of specialty crop growers in Kent and Sussex Counties (Delaware) consecutive summers. Consumers were educated on farm history, growing seasons, crops and yields and even how to prepare tasty recipes that utilized the farm's vegetables/fruits. Shop-Rite has several stores in northern Delaware where farmland is scarce, and the tours were quite successful, based on feedback. Funding helped with bus rentals.

Secondly, advertising was purchased to promote the annual 'First Rate-First State Summit' which is a growers/buyers expo the Delaware Department of Agriculture (DDA) hosts every February in Dover, DE. The summit allows all specialty crop growers in the state to meet with the purchasing agents for every major grocery store chain doing business in the state, as well as smaller independent grocers. A banner was also designed for the event. Advertising was placed in The Produce News featuring some of Delaware's top growers of specialty crops in an effort to market and promote the farms to the readership that includes produce buyers.

Finally, funding allowed for the successful trip of three farmers of specialty crops to attend the largest produce marketing expo in North America, Produce Marketing Association's (PMA) "Fresh Summit" in Atlanta, Georgia during October 2015. The grant also allowed DDA to exhibit at the event, set up meetings between the growers and produce buyers representing major grocery store chains and price clubs, network and distribute a booklet featuring major wholesale produce growers in the state.

**Goals & Outcomes Achieved:** Observable goals were met satisfactorily, but measurable, sales-oriented goals were more challenging to document. Polled farmers, particularly those who attended the PMA 'Fresh Summit' Expo in Atlanta, stated that they obtained new leads and contacts, but didn't share any specific increase of sales data. The same statement would apply for the results at the 'First Rate-First State Summit' in 2015. Approximately 130 attendees were present with a mix of growers, buyers, value-added producers and special guests from local government agencies and universities. Many of the farmers met with most if not all of the buyers who attended and contact information exchanged. Feedback again was very positive after the show concluded and several farms stated they had new leads and were thankful.

Several of the farmers who attended PMA then participated in a panel discussion at Delaware Agriculture Week, January 2016, in Harrington, DE, as part of DDA's Direct Marketing session. They shared their experiences in Atlanta and pledged to return to the PMA show in Orlando, October 2016 based on their successes while in Atlanta. In addition to meeting buyers they also gained contacts in the packaging and shipping aspects of the industry.

Print advertising also produced results as several farmers, smaller growers of specialty crops, contacted DDA to attend based on the Delmarva Farmers ads. These individuals had previously not been invited since DDA did not have their contact info in our database when invitations went out via email and letter. Also,

the two ads in 'The Produce News' generated some interest by produce buyers, as well as bringing attention to Delaware farming, most specifically to the highlighted, featured farmers.

Finally, feedback from key management members from Shop-Rite (Wakefern) was positive concerning the bus tours they conducted, often with DDA as a partner, to various specialty crop growing farms in Delaware. The popular tours quickly filled up and often many consumers had to be turned away due to no space on the buses remaining. Attendees learned about these crops and often purchased some to take home while on the tour at the farmers' various farm stands/markets, although that was not the central objective. As consumers learned more about the farms and what they grew, the consensus was they would return to their homes to purchase additional quantities of local cabbage, sweet corn, peaches, apples, tomatoes, peppers and other fruits and vegetables now that they had seen the people responsible for the produce in their favorite grocery store during the spring and summer weeks.

The original measurable outcomes (increases of 10%-2014 and an additional 5% in 2015) became unrealistic to collect after interest in traveling to grocery store chains declined and the grant was amended in 2015 to better center on what could be accomplished since the original goals were unattainable. Additionally, at that time, the grant was reduced in half to \$25,000 to better match the updated objectives. Please see memorandum to Carly Borgmeier for specific details about the new objectives. Baseline figures were not established due to lack of input from both growers and retailers polled. Feedback, when provided, was always observable, not detailed or documented.

Polling retailers/grocery produce buyers was unsuccessful (via email, phone and letter) despite various attempts of inquiry. Buyers often change positions within their company, or leave for a new position with a competitor, or simply, as was the case with Acme and others, refuse to return inquiries/calls. Retailers are also very reluctant to share any sales results. Only Shop-Rite in New Castle County provided a very high level response regarding the sales of locally grown produce from Delaware, that the fruits and vegetables sold, particularly after the farm tours (enhanced interest in the local crops by the consumers who visited the farms), were excellent. Additionally, efforts to poll growers who attended PMA or sell locally to Shop-Rite and other retailers, including Redner Markets, Harris Teeter, Giant, and others, did not generally respond to inquiries. Two farms (Evans Farms and Coastal Growers) did state that local sales with grocery stores were good, but no statistical data was supplied to support those statements.

Although major successes were attained, they are not measurable, quantifiable in nature. Farmers attending PMA shared that they had made many contacts in the industry, new leads and business connections, in the grocery store and wholesale produce buying markets. But no specific sales data was shared, nor do we know if all of these leads, or only a few of them, came to fruition. Successes were observable (great participation in farm tours, more local produce at grocery store chains in Delaware, participation at PMA produce expo {whereas in the past no farmers ever attended this show with DDA}).

**Beneficiaries:** There were two major beneficiaries to this project. First, the produce farmers of Delaware benefited from the grant, or in other words those who grow qualified, specialty crops, and two, the consumers who shopped for these same crops at nearby grocery stores and markets. The farmers, through increased sales to grocers, were able to plant and grow larger quantities of fruits and vegetables. Relationships were birthed at the annual First Rate-First State Summit and at the PMA expo that will be long lasting, season after season. The consumer benefitted from healthier eating while contributing to the local agricultural economy, thus aiding the state's top industry, farming.

The beneficiaries of more local specialty crops being sold at various retailers/grocers in Delaware clearly include: the growers who sell the produce; the consumers, both native and visitors (since Delaware is a popular tourism state); and the grocers who purchase wholesale then sell retail to the public. Although it's not been quantifiable (see previous comments) the economic impact is favorable based on observable and high level commentary by the retailers and growers alike.

Measuring the number of consumers who benefited from this grant project is impossible to detail, but certainly the participants of the Shop-Rite bus tours, totaling over 300 customers, benefited by meeting the growers and purchasing at their store of choice (Shop-Rite). As to the number of growers who benefited, a minimum of ten Delaware farms can be identified as having experienced an increase of produce sales to the local grocery store chains. This includes participants at the annual First Rate-First State Summit, the farms included on the Shop-Rite farm tours (T.S. Smith & Sons, Papen Farms, Fifer Orchards, Vincent Farms and Evans Farms) and those who attended the PMA Fresh Summit expo in Georgia.

**Lessons Learned:** First, the grant was amended after the first year since the original objectives proved to be difficult and unachievable. Farmers simply didn't have the time or interest in traveling to visit grocery store produce buyers. However, after the rewrite and approval, the three main new objectives were attained and fulfilled. Lessons learned included: consumers care about locally grown produce for a variety of reasons, as shared during the Shop-Rite farm tours and conversations with grocery store produce managers. First, they want to support the local growers of specialty crops, families they often know personally and respect, and they desire fresh, local produce on their plates at home. Although they can find produce at local farm stands and farmers markets, most consumers shop regularly at their grocery store of choice. To have locally grown fruits and vegetables available there, with full knowledge of what farm these crops were grown, was a major benefit to consumers, and quite convenient.

We also learned that grocery store chains, unlike in the past for most of the major names, desire and seek the locally grown product. This contributed to our success stories in that both buyer and grower wanted to work together, get local specialty crops placed into the Delaware grocery stores. All chains operating in Delaware buy from a minimum of two farms, often more. Finally, it was obvious that growers enjoy having another reliable avenue for sales of their specialty crops. Grocery stores can receive either larger shipments to distribution centers (tractor trailer loads) or smaller direct store deliveries from the farm.

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**Project Title:** Planting Hope in Delaware – Community Expansion and Engagement

**Project Summary:** Planting Hope proposes to expand access to fresh fruits, vegetables and herbs in communities surrounding the Herman Holloway Campus by developing a CSA and accessible demonstration gardens. The CSA will be tailored to the needs, interests, and limitations of the communities, and be coupled with a "Garden to Table" program. An Enabling demonstration garden will be installed, for

education, vegetable production and season extension. We will work with a high school FFA chapter in forming the CSA, to encourage their interest in business development and contribute to their view of agriculture career options.

Located in an area defined by the USDA as a Food Desert, Planting Hope Urban Farm (PHUF) planned to expand the existing gardens and Market, to increase underserved populations' access to and consumption of fresh fruits, vegetables and herbs. Located in the vicinity of the Herman Holloway Campus, these populations include low income individuals, the elderly, and people with disabilities. Individuals in these populations may not have access to the Campus Market or other Farmers Market, or store with fresh produce. Individuals may be unfamiliar with a number of vegetables, their preparation, and their role in a healthy diet. In addition, they may face limitations in the preparation of simple, healthy meals. This project was geared towards increasing the consumption of specialty crops by increasing their availability for underserved populations, by increasing people's knowledge of the nutritional value of specialty crops, and providing information and demonstration gardens for people to grow vegetable plants for their home setting or living circumstances.

**Project Approach:** In 2014, a CSA was test marketed with 10 shares. During 2015, year 2 of the CSA, membership expanded to 11, and included Campus employees and New Castle County residents. In 2015 a total of 708 lb. fresh vegetables and herbs were distributed, along with 50 recipes and nutrition information handouts. A survey was conducted at the end of the year. In 2016, another CSA member was added, making a total of 12 members. From June-October, we initiated a trial of a Bi-Weekly program, with 3 share members. This was somewhat successful, and we will revise this in 2017 to a ½ share for monthly distribution, based on survey information. For the monthly CSA, 778 lb. of fresh vegetables distributed and 498 lb. in bi-weekly shares (1,276 lb. total). There were 45 recipes distributed. A year end survey was conducted.

**Expanded Community Garden plots** -Due to demand, in 2014 the number of plots was expanded from 7 to 13, and in 2015 the number of plots was expanded from 13 to 17. In 2016 the area layout was reconfigured to produce 18 plots. All growing space must be fenced in, due to wildlife in the vicinity of the Urban Farm. In 2016 there were two Community Garden work days, which included a meal, and two workshops were presented. Twenty five growing guides were distributed, along with other resource materials. An end of year survey was conducted.

**Increased production and Campus Market offerings** - An additional 1600 ft<sup>2</sup> growing space was prepared, and Market Garden II was established. Planting Hope partnered with a local Delaware farm, Filasky's, to source highly desired produce items that we don't have resources to produce. Two cold frames were constructed and added to the Urban Farm to harden off seedlings and to be used for season extension. In 2015, over 80 varieties of 48 different vegetables were selected for production, based on taste, visual appeal, and wherever possible, disease resistance. A total of 2093 lb. fresh produce was harvested from both market gardens and sold at the weekly Campus Market to more than 40 regular customers. To help introduce customers to a variety of produce, tastings were instituted at the Campus Market. There were 14 tastings and 12 cooking demonstrations offered, and 70 recipes and nutrition information distributed.

In 2016 a new Market Garden layout was implemented to accommodate a cutting garden. Spring, summer and fall vegetables were planted. A new lima bean production area was installed in Market Garden II, consisting of 4x4 posts with wire anchors. Lima bean production began in May with transplants from the greenhouse. A total of 54.56 lbs. were produced in a 30-ft. row of a combination of pole and bush lima beans. The varieties planted were Fordhook, Burpee's Best Pole, and Jackson Wonder. There was some

disease resistance and minimal pest damage. There was one small early harvest, with bush beans producing earlier than pole and one large harvest at end of season. Limas were distributed to CSA members and sold at market. For the year, 2,137 lb. were produced, combining Market Gardens I and II, and sold through the Campus Market and CSA shares.

To address the issue of produce available to sell outside of the times of regularly scheduled Campus Markets, “Pop Up” markets were initiated. These were well received, always sold out, and will be continued in 2017.

**Newsletter** - A monthly newsletter, “the Planting Hope Gazette” was initiated in 2014. Nine editions of the newsletter have been issued, and the distribution list has 91 individuals. Topics include What’s happening at PHUF, recipes and gardening tips.

**Developed a “Garden to Table” curriculum for Terry Children’s Psychiatric Center** - A Community Garden plot was first maintained for the Terry Center, and then raised beds were built in the Outdoor Classroom. In 2015, the children planted watermelons and pumpkins in Market Garden II. Cooking and tasting activities were conducted both on Planting Hope Urban Farm and in the Terry Center’s classroom and kitchen. Activities were designed to meet the specific needs of the children, and included topics like healthy soil care and maintenance, plant and insect life cycles, vegetable growing and nutrition information. Worm bin was created, hands on education provided, bin left in classroom for students to manage and learn from throughout the year. A scavenger hunt was held on Planting Hope, with the theme of sustainability. The children planted red tulip bulbs on PHUF, as part of the Red Ribbon Campaign, to plant a promise to remain drug free for a year. A total of 36 children from the Terry Center participated throughout the year.

**Planting Hope with Honey Bees – Planting Hope Apiary** - With support from the Delaware Beekeepers Association, University of Delaware, Delaware State Apiarist and Brushy Mountain Bee Supply, an apiary was established adjacent to the Planting Hope Gardens. Beekeeper Ronnie Hazlett II is a veteran of the U.S. Marines, and was chosen after advertisement for the position and an interview. He began with 4 hives, and has turned them into 6 full hives plus 5 nuclear colonies (nucs). In late November 2015, the Delaware Center for Horticulture donated two bee hives to Planting Hope. A total of 35 lb. honey was harvested and sold in 2015.

Spring 2016 started with 11 hives, which were turned into several more. Twenty five nucs were sold, and the apiary is going into winter with 20 hives. Thus over the course of the summer 45 hives were managed. From the 9-10 hives used for honey production, almost 1000 lb. of honey was collected. This was sold to 4 local farmers markets. While working to make queens for use in the apiary, Planting Hope Apiary began offering extra queens to other beekeepers in the area.

Using some funds from the honey sales and the beekeeper’s own funds, 100 beeswax candle molds were purchased. Wax from Planting Hope Apiary, along with wax from other local beekeepers, a beeswax candle business has been started. Candles are sold at farmers markets, and an Etsy store is in the process of being established. In addition, a foundation press was purchased, with the intent of selling wax foundation in the future.

To help support the bee colonies, a 4000ft<sup>2</sup> bee pasture was installed on PHUF in the fall of 2015. It was seeded with “Mid Atlantic Pollinator Mix” from Ernst Seeds, which is a recommended mix of wildflowers and grasses. Seed was covered with jute mesh, which helped to keep moisture in and stabilize the soil. Germination was very good, and a variety of flowers was in bloom by mid-summer. The bee pasture attracted a variety of bees, wasps, grasshoppers and butterflies.

### **Goals and Outcomes Achieved:**

Goal #1 – Increase the consumption of fresh vegetables by Campus Market and CSA customers by increasing the following: availability of produce, nutrition information, options for preparation, and thereby people’s motivation to modify their diet. Performance Measures: (1) Number of servings of fruits and vegetables that respondents report eating per day, and (2) Number of individuals that have tried at least one new vegetable. Benchmark – 75% of Delawareans report eating fewer than 5 servings of fruits and vegetables per day. Target – By the end of the 2015 growing season, we expect that a majority of those surveyed will report eating at least one additional serving of fruits and vegetables per day.

Of the CSA customers who responded to the survey, 40% report eating 2-3 servings of fruits and vegetables each day, and 60% reported consuming 4-5 servings per day. All respondents agreed that as a result of participating in the program, they tried some new foods, ate a more balanced diet and felt that they improved their overall well-being.

Goal #2 - Increase options for people with disabilities to grow vegetables for their own consumption. Performance Measures: Number of people who visit the Demonstration Garden, attended “Garden to Table” sessions, and/or asked about designs for raised beds and recommended plants. Benchmark: Currently there are no public vegetable gardens that have been designed for and are accessible to people with disabilities. Target – we anticipate that by the end of the 2015 growing season, we will have inquiries from private and public organizations about enabling gardens and garden design for people with disabilities.

Inquiries and Invited Presentations about accessible gardens:

- Governor Bacon Center, one of the State’s long term health care facilities, to assist with garden design for Center residents. Consulted with the Center’s Director and Activity Therapists, and provided a series of raised bed plans and recommended activities.
- University of Delaware, Landscape Architecture class. Four students are creating a scaled drawing and providing designs for possible accessible garden areas
- National Plant Board (approx. 100 people) toured gardens and given a presentation about programs and partnerships
- Silverside Church toured PHUF to view options for therapeutic gardening
- Presentation given to a Veteran’s group at the VA Medical Facility in Wilmington
- Clients at the Delaware Psychiatric Center plant and maintain a raised bed of vegetables, flowers and herbs. They are given instruction about growing the plants, and harvest them to taste.
- Division for the Visually Impaired. At their request, workshops, tours of PHUF, cooking demonstrations, and tastings were presented to their “Independent Living Garden Group”
- Hospitality School Culinary Students and Youth Culinary Students Summer Camp were given Power Point presentations and hands-on demonstrations about growing and harvesting vegetables. They were also introduced to GAP/GHP practices.
- The Department of Health and Social Services paved a parking lot at the entrance to PHUF, and installed a handicap parking space and access ramp.

Goal #3 – This was revised from the initial Goal 3. Planting Hope will offer instruction in vegetable production, beekeeping, good agricultural and handling practices, and marketing to Victory Village and other interested Veterans. Veterans will have the opportunity to sell their produce at Planting Hope’s Campus Market.

Performance Measure: Number of Veterans who gain experience with vegetable production and/or beekeeping and participate in aspects of specialty crop marketing.

Benchmark: Will assess Veteran's knowledge of vegetable production and beekeeping. Veterans will keep a journal to chart progress

Target: At least two Veterans who gain experience with vegetable production and/or beekeeping will seek opportunities in agricultural industries.

One Veteran has established a successful beekeeping operation, Planting Hope Apiary. Through one of his mentors, he became interested in operating the apiary according to the principles of natural beekeeping, and obtaining a "Certified Naturally Grown" certification. (<http://www.cngfarming.org/apiary>). This was obtained in 2015, and all Planting Hope Apiary honey is sold in jars with the "Certified Naturally Grown" label affixed. Due to a number of delays in obtaining their occupancy permit, plus facility issues, Victory Village did not receive its occupancy permit until August 2016. This negatively impacted our target in Goal 3, thus effort was focused on Planting Hope Apiary. In November 2016 the Delaware Department of Agriculture issued another call for veterans interested in learning beekeeping, and we intend to continue with this program, albeit on an extended time frame.

The beekeeper established Facebook (356 followers) and Instagram accounts to track the progress of the Apiary and expand the customer base. He gave a talk at the New Castle County Detention Center (juveniles) and hosted Visit from local school kids to the apiary (Lego Team). He also organized a one day class on Natural Beekeeping (30 participants).

**Beneficiaries:**

- Clients, Delaware Psychiatric Center (30+), planting and maintaining raised vegetable bed.
- Nemours Health Prevention Specialists (12)
- Peer Support Recover Academy (15), hands-on vegetable garden instruction, harvesting and food preparation
- Campus market customers, regularly reach 30+ customers
- Culinary students, the Hospitality School and Youth Culinary Camp, 30+ students
- Terry Center children, 90
- Community garden groups (National Guard Gardens, Delaware Autism, Delaware State Ethnic vegetables, Delaware Division for the Visually Impaired)
- Facebook followers (333) – 850+ posts, featuring planting information, vegetable varieties, perennials, pollination, soil preparation, plant pests and diseases, events, recipes and nutritional information.

**Lessons Learned:** We have learned the following:

- Many of our customers have limited familiarity with the wide diversity of specialty crops available. They have never seen or tasted these items, and are thus not likely to purchase them unless they become better acquainted. "Tastings" and cooking demonstrations at the Campus Market were helpful in overcoming this barrier.
- We tried to experiment with unusual varieties of basic vegetables, such as beans and peas, however these were not readily accepted by Campus Market and CSA customers.
- Recipes should be based on the following criteria – less than ½ hour preparation time, affordable, and can be made with basic kitchen equipment

- Local honey is a very popular item. People are interested in the health benefits, and were amazed at how wonderful it tastes vs. what they might purchase off the shelf.
- Our customers prefer produce grown without the use of pesticides.

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**Additional Information:**

Participated in the following events with a display about Planting Hope Urban Farm:

- DHSS, Division of Substance Abuse and Mental Health’s Annual Review, 2014-2016
- Delaware Agriculture Week and Urban Agriculture 2014-2016
- Earth Day, DHSS 2016
- LEAD Delaware, a training program for the next generation of agriculture leaders toured PHUF
- A Taste of Summer, 2015, partnership with the Hospitality School’s culinary students, using local sources to prepare a healthy lunch.
- Healthy Halloween, 2014-2016, including “Meet the Beekeeper”
- Planting Hope Apiary participated in the Philadelphia Honey Festival and Farm and the Chef (to benefit the March of Dimes)
- Healthy Food Mini Fair, March 2015
- Visit by Astrid Jakobs de Padua, Minister Counselor of Food and Agriculture, Germany, Embassy of the Federal Republic of Germany
- A monarch waystation was established on PHUF. It was initially designed and installed by Thomas McKean High School FFA. It was later re-designed by a University of Delaware Landscape Architecture student, and moved to another location on the farm.

Winner, Delaware Center for Horticulture Garden Contest, Best Vegetable Garden, 2015 and Honorable Mention 2014

New logos were created for Planting Hope Urban Farm and Planting Hope Apiary. They use elements of Planting Hope’s original logo, and show the connection between these two projects. Note, in the Planting Hope logo, the dots spell out “hope” in Braille. This emphasizes the connection to people with disabilities.



**Project Title:** Advancing Specialty Crops in Urban Wilmington, Delaware

**Project Summary:** The Delaware Department of Agriculture (DDA) awarded Specialty Crop Block grant (SCBG) # 12-25-B-1661 to the Delaware Center for Horticulture (TheDCH), for the project, “Advancing Specialty Crops in Urban Wilmington,” in November 2013. This final report describes TheDCH’s activities for the duration of the project. The project was proposed for Specialty Crop Block Grant (SCBG) funding from the Delaware Department of Agriculture in order to: (1) improve sales of organically grown produce from the 12th & Brandywine Urban Farm (Urban Farm) to residents of the Farm’s neighborhoods which are USDA-designated food deserts; and, (2) support the work of the stakeholder-based Delaware Urban Farm and Food Coalition (DEUFFC)<sup>1</sup> to efficiently and effectively facilitate the production, marketing, and sales of specialty crops in nearby food deserts.

**Project Approach:** Much of the eastern half of the City of Wilmington, and surrounding areas of New Castle County, is classified as a food desert by the USDA. Project approach was to:

- (1) Expand distribution of produce grown at the Urban Farm at 12th & Brandywine Streets to residents of nearby neighborhoods, designated by the USDA as food deserts, through marketing and education efforts;
- (2) Support the work of the DEUFFC to improve the efficiency and effectiveness of the Wilmington area's distribution system for specialty crops.

Comprised of volunteers, the DEUFFC was formed in 2008 to support the Delaware Center for Horticulture's (TheDCH) efforts to develop the Urban Farm. The Urban Farm exists to meet the fresh produce needs of nearby residents. Having completed its fifth growing season at the time of the SCBG proposal, the Urban Farm annually produces 1,200 to 1,300 pounds of specialty crops that include blackberries, blueberries, green beans, beets, carrots, cucumbers, eggplant, garlic, okra, peppers, radish, spinach, and tomatoes. TheDCH targets discount sales of this produce to neighboring residents, most of whom are food insecure since they live more than two miles from the nearest grocery store or any other outlet for fresh food. Not all of the Farm's produce is purchased by residents of these neighborhoods. SCBG funds were used to conduct marketing, outreach and nutritional education to nearby residents to increase demand for the Urban Farm's produce within its 'foodshed' and therefore, increased sales of specialty crops to residents who don't otherwise have easy access to these crops. In addition to the Urban Farm, the DEUFFC has supported numerous community gardens by providing resources and technical assistance in a collaborative approach. Its multi-talented members have donated materials, built growing beds, and raised funds. DEUFFC members represent medical, health, agriculture, funding, and advocacy interests, such as: Christiana Hospital; City of Wilmington; Delaware Department of Agriculture; Delaware Department of Health and Social Services; Delaware Department of Natural Resources and Environmental Control; Delaware Farm to School Collaborative; Delaware Greenways; Delaware State University; Food Bank of Delaware; Habitat for Humanity; Healthy Food for Healthy Kids; Nemours Health and Prevention Services; New Castle County; USDA/First State RC&D Council; USDA/NRCS; University of Delaware; YMCA; citizen advocates; community development organizations; and farmers. Through collaborations, partnerships, and other forms of technical assistance between and among members, the work of DEUFFC members efficiently and effectively increases sales of specialty crops through growing, distribution, education, and/or marketing. Further, the DEUFFC represents the urban specialty crop industry in New Castle County, and the organization's overall mission is to serve the food insecure through production, marketing, and sales.

The DEUFFC recognizes that specialty crop production, in urban settings, is sustainable because food miles traveled are minimized. However, the DEUFFC also recognizes that the Wilmington area's needs for specialty crops cannot be fully met by what is grown in and near the city, especially with more and more education efforts whose collective goal is to increase specialty crop demand. Accordingly, there is a need to fully understand, describe, and assess Wilmington's distribution system for specialty crops. The goals of this project support broader efforts to build the local food economy of Wilmington through a basis of research and baseline documentation of current conditions.

**Goals and Outcomes Achieved:** Goals. The overall goals of TheDCH's SCBG project were to: (1) conduct outreach to the residents of the 12th & Brandywine Urban Farm's foodshed; and, (2) support the stakeholder-based DE Urban Farm and Food Coalition (DEUFFC). These goals were developed to efficiently and effectively facilitate the production, marketing, and sales of specialty crops in urban Wilmington. Specific tasks were planned to result in achievement of the established goals.

Activities - These tasks were undertaken, and/or overseen, by staff of TheDCH; i.e., Director of Programs, Urban Agriculture Manager, Urban Farmer, and Communications Coordinator. In addition, SCBG funds were used to hire an intern, as proposed in the grant application, who undertook much of the outreach and research described herein. The final status of each task is described as follows in italic font.

## 1. Tasks to Support the Outreach Goal

1a. Create flyer: *As proposed in our application, we developed a flyer advertising the specialty crops for sale at the 12th & Brandywine Urban Farm, starting with the 2014 growing season. This flyer highlighted the option to use Supplemental Nutrition Assistance Program (SNAP) benefits and included a redeemable coupon to incentivize purchases. Consistent with our established measurable outcome to track marketing tool dissemination, and with assistance from partners of both TheDCH and the DEUFFC (e.g., Food Bank of Delaware), the flyer was distributed door-to-door within a 4 – 6-block radius of the 12th & Brandywine Urban Farm. Consistent with our established measurable outcome to track 12th & Brandywine Urban Farm’s production of specialty crops, we tabulated that a total of 1,412 pounds of specialty crops were produced at the 12th & Brandywine Urban Farm for sale during the 2014 growing season. Almost 60 percent of the specialty crops sold were purchased by residents of the three zip codes that comprise the Urban Farm’s ‘foodshed;’ i.e., those food-insecure areas closest to the Urban Farm.*

1b. Additional outreach methods and tools: *Consistent with our work plan, we researched various categories of facilities and organizations to which the flyers could be distributed. This is a task that had not yet been done, so no baseline tabulation of our community partners existed. In total, almost 100 potential partner sites were identified in categories such as medical, educational, community, churches, and “other” (e.g., laundromats, convenience stores, day care, etc.). Approximately half of these sites were provided a supply of flyers in a cardboard sleeve for countertop display. Further, we designed and printed interchangeable magnetized fruit and vegetable labels for the two (previously purchased) market signs that are placed outside the 12th & Brandywine Urban Farm each market day.*

1c. Organization and dissemination of outreach methods and tools: *Periodically throughout the 2015 growing season, efforts to disseminate outreach methods and tools were communicated and utilized as community engagement exercises by staff of TheDCH, including various staff leadership roles including Director of Programs, Urban Agriculture Manager, Community-Based Education Coordinator, Urban Farmer and SCBG Intern. In February 2015, TheDCH held an urban farm kickoff and engagement event at Urban Promise in Wilmington’s Northeast community. This event engaged residents and community members in dialogue on what methods for outreach had/had not been effective, what tools could be used to engage more families and youth, and ways to get visitors and gardeners at the farm on a repeated basis. This event was followed in the spring by an organized community day in May, which highlighted the farm as a neighborhood resource, safe haven, and opportunity for involvement. As the growing season came to an end, outreach methods and tools were incorporated into a community garden tour hosted by the DEUFFC, which highlighted the urban farm’s community engagement efforts.*

## 2. Tasks to Support the DEUFFC-related Goal

2a. Track and assess current specialty crop distribution projects; analyze other facets of Wilmington’s specialty crop distribution system: *In accordance with our grant application, we researched demographic data for northern New Castle County (i.e., the area north of the Chesapeake & Delaware Canal), with particular foci on those areas whose residents have limited access to fresh fruits and vegetables as well as*

*on the residents of this area who may face economic or other challenges. Consistent with our established measurable outcome to document and assess the system for accessing specialty crops in northern New Castle County, we learned that about half of Delaware's residents live in the 10 percent of the state situated north of the Chesapeake & Delaware Canal. A significant number of these families face challenges such as low access to specialty crops; receive SNAP benefits; living at or below the poverty line; and/or do not have a vehicle. A summary of this research to date was distributed to the DEUFFC at their July, 2014 quarterly meeting. In 2015, the SCBG project intern placed a focus on the analysis of supply and demand data in order to identify gaps in areas of need. This research and analysis was completed in November 2015, with a final report (attached) available for distribution and pending publication on DCH's website and distribution to coalition members.*

2b. Support DEUFFC's Political Economy committee with research and analysis on topics such as water use, soil toxicity, insurance, land acquisition, etc.: *As indicated by our grant application, access to a reliable, reasonably priced water source is essential to the successful production of specialty crops by community gardens and urban farms. Accordingly, we measured how all the community gardens and urban farms located within the City of Wilmington access water for use in growing operations. Specific measurements assessed whether a direct connection is made to a public water supply; the cost of that connection if a fee was charged; whether an outside contractor or City staff did the work; and, if and how much usage fee is charged. A report incorporating the research results was submitted to the DEUFFC's Political Economy committee, which used it to develop a draft water access framework that was recently proposed to City officials. There was no prior tabulated baseline of the water access framework and urban farms.*

*The SCBG grant also supported the travel and tuition for TheDCH's Urban Agriculture Manager to attend the three-day Chesapeake Food Policy Leadership Institute (CFPLI) in October, 2014. The CFPLI addressed the organizational development, policy intervention/strategy, and communication needs of food policy councils, such as the DEUFFC, in close alignment with our SCBG grant proposal. As noted in the original grant proposal, "Advancing Specialty Crops in Urban Wilmington" was developed to support the work of the DEUFFC to improve the efficiency and effectiveness of the Wilmington area's distribution system for specialty crops. Specifically, as a stakeholder-based, volunteer organization, DEUFFC leaders needed this training to facilitate the production, marketing, and sales of specialty crops in areas of low food security. As such, a shift of approximately 2 percent of the grant's funds from the Personnel line to the Travel & Other lines was approved by the DE Department of Agriculture via email and phone between June and October, 2014 for Tara Tracy, TheDCH's Urban Agriculture Manager and Co-Chair of the DEUFFC, to participate as one of approximately 45 invitees in the CFPLI (October 5 – 7, 2014). The DEUFFC's other Co-Chair also attended the CFPLI.*

**Beneficiaries:** The principal beneficiaries of the project have been Wilmington and Wilmington-area residents whose neighborhoods are designated as food deserts, specifically the 11th Street Bridge community in the vicinity of the Urban Farm at 12th and Brandywine Streets. The residents of many of these same neighborhoods disproportionately represent those Delaware populations which have experienced triple or greater obesity rates in the past three decades; similar increases in the rates of diabetes have been documented in Delaware residents. A well-documented means to curb diet-related diseases is through consumption of fruits and vegetables. Accordingly, the work funded by the SCBG grant sought to increase the production, marketing, and sales of specialty crops in and near Wilmington, benefiting all food desert residents, especially those who are experiencing diet-related disease.

At the Urban Farm at 12<sup>th</sup> and Brandywine, the community garden beds support (8) community gardeners each season. These beds vary in activity from year to year, resulting in (19) individuals and families served

through growing their own produce at the site for the grant period. The farm market supports both a regular clientele and sporadic sales, averaging 42 different individuals per season over the course of the grant program. Urban farm sales to community food businesses also support distribution of local produce across the neighborhood in which it was produced, adding another 25 (average) customers at distribution points within Wilmington's East Side. As a seasonal average, this results in the direct access for (86) individuals that would otherwise not have a local access point for fresh produce. This figure does not represent an extrapolated number for household members served. At an estimate of 4.2 members per household, the project served over 360 individuals locally.

The beneficiaries of TheDCH's and DEUFFC's efforts through this project were largely African American and Hispanic communities located within the City of Wilmington's east side neighborhoods, and within nearby challenged communities in northern New Castle County. Residents in these areas are subject to higher rates of diet-related diseases (i.e., obesity and diabetes, as previously documented), environmental contamination, and poor access to healthy foods. This project also served as an initial form of baseline documentation for initial research on Delaware's local, urban food economy.

The research and analysis component of this project indirectly served the greater audience of northern New Castle County residents. Based on the access gap analysis, the various communities identified as lacking direct access using the model developed by the project include: Claymont, DE (8,253), Elsmere, DE (6,164), and Newark, DE (32,549). As a result, the gap analysis research supported by this project supports future planning and development of local produce access points for urban populations numbering 46,966.

**Lessons Learned:** Overall, we are very pleased with the accomplishments and outcomes of the project. The principal challenge continued to be consistency of staffing in the second year. In year one, the first intern hired left TheDCH for full-time work in August 2014. However, she fully and accurately completed the demographic research for the assessment of Wilmington's system for distributing and accessing specialty crops; she also facilitated development and distribution of the 12th & Brandywine Urban Farm's flyer. In October 2014, her successor was hired to complete the project – a University of Delaware senior who committed to working part-time through graduation in May, 2015, and then at a full-time level (as grant funding permits) to complete the assessment project and other tasks outlined in our work plan, as planned through the end of the grant period. However, in July 2015, project oversight provided by Tara Tracy, Urban Agriculture Manager, was impacted when Tara left the organization for part-time work elsewhere. In her absence, oversight of the project and supervision of the project intern was provided by Vikram Krishnamurthy, then Director of Programs, since promoted to the position of Executive Director. Mr. Krishnamurthy worked directly with DCH's intern (Meghan Sobott) with hands-on GIS analysis support, to finalize the writing and editing of the supply/demand/gap analysis, and with new Director of Programs, Ann Mattingly, throughout 2016 to finalize the draft report.

In terms of positive lessons learned related to outreach, we gained a much better knowledge of the 11th Street Bridge neighborhood in dealing with food insecurity, access to fresh produce, and affordability based especially on the door-to-door canvassing of the neighborhood and ensuing conversations and input/feedback sessions with community members and the civic association. Regarding the urban farm itself, we gained valuable feedback on crop recommendations, sales analysis, pricing, willingness to pay, opportunities for wholesale sales, and customer preferences for market hours.

Regarding the gap analysis performed and completed by intern(s), the project findings confirmed some assumptions concerning geographic areas and communities that align with transportation access, access to

fresh produce (retail), and household income. However, there were areas identified through this analysis that previously were not necessarily known as priority areas for increased access. These include areas surrounding the City of Newark, as well as communities further north in New Castle County.

The findings of this project also identified some areas for further research and refinement. The notion that community gardens, school gardens, and urban farms provide access to fresh produce must be balanced with the acknowledgement that these efforts are primarily seasonal, and therefore do not provide year-round access. Furthermore, school gardens may be active during the school year, but during the summer months, they rely on community support to sustain efforts for harvesting, distribution, sales (if applicable), planning for the fall season, and coordination with schools and active teachers.

### **Funding Expended to Date**

As of this final report, all grant funds have been expended as of 9/28/2016. As noted previously, some approved budget adjustments were made in order to accommodate some unanticipated training opportunities (regional conferences). Otherwise, expenditures for staff resources (project completion, outreach and communications, printing and copying, travel, research and analysis, and project oversight) were consistent with budget guidelines.

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### **Project Title:** Wilmington Healthy Corner Store Network

**Project Summary:** The city of Wilmington, Delaware has over 60 corner stores throughout the city, selling mostly processed, packaged food with little or no fresh fruits or vegetables. Without adequate access to healthy, affordable food, residents in these communities suffer from high rates of obesity and diet-related health problems.

During the first report period, the project team laid the groundwork to establish a new Healthy Corner Store Network in Wilmington, with a focus on equipping corner store owners with the skills and capacity to stock and promote locally grown fruits and vegetables. During the second report period, The Food Trust continued to provide comprehensive store owner trainings, healthy food marketing materials, and resources to build store owners' capacity to source, stock, and promote Delaware-grown fruits and vegetables.

Of note, this grant also helped to lay the groundwork for the launch of a separate and subsequent SCBGP grant (SCBGP-FB-15-07), which is a distribution pilot project aimed to further enhance stocking and marketing of Delaware-grown produce in Wilmington corner stores.

**Project Approach:** The activities performed to achieve the grant objectives are included below, organized by the specific area of the proposed work plan for this grant.

**Work Plan #1:** Hire project manager to coordinate recruitment and marketing efforts.

**Activities Performed:** The Food Trust hired a full-time project manager (David Palmer) to coordinate recruitment, intake, and marketing efforts toward the launch of the Healthy Wilmington Corner Store Network. Approximately halfway through the grant year, that manager resigned to enroll in graduate school. The Food Trust recruited and hired a new project manager (Regina Ginyard) who continues to lead recruitment and marketing efforts in the Wilmington Corner Store Network. Throughout the grant period, project staff provided specialized training and technical assistance to build store owners' capacity to stock, promote, and sell Delaware grown produce.

**Work Plan #2:** Recruit corner stores in target communities, with at least 20 enrolled to conduct an initial pilot.

**Activities Performed:** The Food Trust successfully recruited 18 corner stores in target communities in Wilmington, DE. Community stakeholders and project staff identified corner stores throughout Wilmington, and visited each business at least once to assess stores' eligibility to participate in the Healthy Corner Store Program.

The Food Trust, in conjunction with local partners, analyzed data compiled from GIS mapping, standardized store owner eligibility criteria forms, and input from local stakeholders. These analyses determined areas of greatest need, in terms of low income areas and lack of healthy food retail, and potential capacity for small stores to stock and market fresh local produce, and helped the team target specific corner stores for consideration in the Wilmington Healthy Corner Store Network.

Project staff and local stakeholders conducted recruitment visits in high-need neighborhoods and explained to the store owner the benefits and requirements of participation. If the owner was unavailable, staff asked the store's employees about the owner's likely availability. Store owners who agreed signed a memorandum of understanding that described the program requirements, and committed to introducing at least four new healthy products.

**Work Plan #3:** Collect baseline data on local fruit and vegetable inventory and other store information.

**Activities Performed:** For this project, staff developed a new, more innovative store assessment form and inventory form, and included these data collection changes to the corner store database. Specifically, the store assessment form was modified to assess conditions of the store as well as store owner knowledge related to the store's capacity to stock local produce. The inventory form was also modified to capture not only the presence of produce, but delineate between local Delaware grown vs. out of state produce, and assess its price and quality.

**Work Plan #4:** Collaborate with store owners to prepare for introducing local fruits and vegetables, through providing training and support, planning quantities and types to introduce, and coordinating distribution logistics with store owners.

**Activities Performed:** In preparation for selling Delaware-grown produce, The Food Trust provided specialized training geared toward the handling of locally sourced produce, hands-on support, and technical assistance to store owners enrolled in the network. The project staff also provided store owners with commercial-grade equipment, including baskets and shelving units that were selected in order to help display produce including locally sourced produce in a more eye-catching, efficient manner. In addition, store owners also received business owner training around topics including "Produce Display" and "Converting

Fruits and Vegetables to Added Value Products” in an effort to build store owners’ knowledge around consumer shopping habits and help increase sales of Delaware grown produce.

**Work Plan #5:** Train owners on the marketing and promotional materials and how to use them in order to engage customer purchases.

**Activities Performed:** Once a store was fully enrolled in the program, the project staff worked with the store owner to install in-store marketing and promotional materials. The healthy food identification marketing materials helped to draw attention to the various, healthy food sections of store. Customers were able to quickly identify “healthy hubs” within the corner store as a result of the healthy food identification marketing materials. Healthy marketing materials consisted of shelf “talkers”, or attractive cards with nutrition information and serving suggestions that would help customers make more informed decisions around their food purchase. Shelf talkers were placed near healthy products, providing information for customers to identify the most healthful choice within different product categories. Marketing materials also promoted fruit and vegetables consumption, particularly fresh fruit and vegetables, in order to build demand for fresh produce, and enable all produce including locally grown produce to sell well. Stores also received a decal, applied to their front entrance, to identify the store to the larger community as having committed to sell more healthy foods.

**Work Plan # 6 & #7:** Develop marketing materials to promote local fruits and vegetables in stores. Order promotional materials such as specials boards and exterior signage to promote local fruits and vegetables in stores.

**Activities Performed:** The Food Trust worked with the corner stores to create a packaging and promotion strategy for Delaware grown produce, including containers suitable for a corner store environment. The team developed, printed, and distributed three types of marketing materials: external advertising, internal promotion, and healthy recipe cards for shoppers. External advertising consisted of weatherproof banners that highlighted the healthy, local produce options offered in the stores. Internal advertising consisted of “Delaware Grown” produce tags and labels that highlighted which healthy produce items were locally sourced. The Food Trust also worked with corner stores to create recipe cards that helped families prepare healthy meals with the locally grown, in-season produce available in the stores.

**Work Plan #8 & 9:** After produce is introduced, provide additional training and support on stocking and properly managing produce to ensure profitability and support display of local produce.

**Activities Performed:** Food Trust staff provided store owner trainings for 16 stores to profitably sell more fresh fruits and vegetables with a focus on how to merchandise and promote Delaware grown items.

The project team spent an average of 15 hours and 20 minutes in training visits with each store that helped store owners understand consumer habits and use them to their advantage. The project team also facilitated store owner trainings around identifying consumer preferences and becoming aware of healthy retail marketing trends to drive produce offerings. All sixteen stores that successfully introduced produce received special training on using displays such as coolers and tiered baskets to display fresh produce, with specific emphasis on optimally merchandising Delaware grown items, including using behavioral economics techniques to place these items optimally on shelf (e.g., eye level) and within the store (e.g., visible at entry) to encourage the purchase and profitability of local produce.

**Work Plan #10:** Collect owner feedback on the overall local produce distribution process and adjust model with partners as needed.

**Activities Performed:** The Food Trust conducted periodic interviews with store owners to collect feedback on stocking and marketing local produce. Some store owners expressed frustration with procuring affordable

produce without traveling long distances to wholesalers outside the state. Based on this feedback, The Food Trust connected store owners with local wholesalers and distributors to better streamline local produce sourcing efforts in their stores.

### **Other Project Activities**

The Food Trust conducted a nutrition education pre-intervention assessment with local stakeholders and community groups to best gauge consumer knowledge and shopping habits as they pertain to healthy food purchases in corner stores. The pre-intervention assessment provided baseline information about types of produce consumers would purchase if they had access, how customers consume fresh fruits and vegetables and what forms of healthy foods customer had experience preparing at home. This grant helped to build the framework for nutrition education lessons conducted in corner stores.

The project team conducted a total of **52** lessons across **7** stores averaging about 8 customers per lesson (**410** total participants / **52** lessons total). These lessons included nutritional information about seasonal products, demonstration of preparation techniques, taste tests, and serving suggestions paired to other healthy foods. Nutrition lessons featured taste tests and cook demonstrations of recipes featuring Delaware-Grown fruits and vegetables. Recipe cards were adapted to inform customers when specialty crop fruits and vegetables are in season in Delaware. Upon completion of these nutrition lessons, the project team used consumer reactions and assessments to adapt the recipe cards and make the adoption of healthy cooking practices more convenient for customers.

The Food Trust also partnered with the Police Athletic League of Wilmington to coordinate the “Big Apple Fest,” which worked to increase demand for locally-grown apples and promote neighborhood corner stores as trusted, reliable sources of fresh local produce and other healthy foods. The outdoor community engagement event provided fun, family-centered activities, including nutrition education lessons that highlighted the benefits of fresh local produce, healthy smoothies using Delaware produce via a “blender bike,” swag bags filled with nutritional materials including recipe cards featuring Delaware produce, and Delaware-grown apples. The community event was held outside of the Grab-N-Go Market, one of the Wilmington Network's corner stores. Over 50 community members participated in the event, taking home information to their families and helping to change the perception of local corner stores.

### **Goals and Outcomes Achieved**

- **Enrollment:** The project team anticipated 20 enrolled stores into the network. Upon completion of the project, 18 corner stores enrolled in the Wilmington Healthy Corner Store Network over the course of the project period.
- **Local Produce Choices:** The project team anticipated that 60% of participating corner stores would introduce at least two forms of local produce during the project period. Upon completion of the project, 83% of the stores introduced at least two local produce items per store.
- **Store Owner Training:** The project team anticipated involving 100% of enrolled stores in in-store training to drive demand for locally-grown produce and healthy food options. Of those stores, 75% of the store owners were expected to show an increase in knowledge of effective marketing practices. Fifteen out of the eighteen store owners (83%) participated in store owner trainings and demonstrated an increased knowledge of produce display knowledge. The remaining three stores have not yet received this training but the stores will likely be ready for this training in December 2016 / January 2017.
- **Locally Grown Produce Marketing Materials:** The project team anticipated that each enrolled store would receive marketing materials for healthy food options, such as recipe cards featuring Delaware-

grown fruits and vegetables, with 75% of owners adopting them. All enrolled stores received and installed these healthy food marketing materials. Along with the introduction of produce, store owners hosted educational events and health screenings to help drive demand of the produce and help them to continue increasing varieties of produce.

**Beneficiaries:** Corner store owners contributed significantly to the implementation of the project, collaborating both on the promotion of Delaware grown produce within their stores and participating in training and technical assistance to stock and merchandize these items. In addition, 410 local residents participated in store-based nutrition education lessons featuring Delaware-grown produce, gaining skills and knowledge to shop for and produce fresh fruits and vegetables, and another 50 community members attended the Apple Fest event to promote Delaware-grown apples. In addition, many more community members were exposed to the promotion of Delaware grown produce in the corner stores through in-store displays and promotion.

**Lessons Learned:** Many store owners in Wilmington do not live in the region or travel abroad for extended periods throughout the year. This created a challenge for recruiting stores into the Network. As a result, project staff began collecting contact information along with dates and times that store owners would likely be available throughout the year. By focusing on the owners who delegate decisions to store staff, the project team had greater success ensuring solid collaboration, even in the owners' absence.

Store owners reported difficulty procuring fresh fruits and vegetables, with many stores traveling to Philadelphia to purchase inventory. The Food Trust has developed many relationships with Philadelphia vendors and distributors as part of our agency's separately managed and funded Philadelphia and Camden Healthy Corner Store Initiatives. Through this network of business relationships, we were able to connect Wilmington corner store owners with local distributors who stocked Delaware-grown products-to create a more convenient supply chain so corner stores could more easily stimulate consumer demand for local produce.

Changes in staffing structure during the spring of 2016 impacted the recruitment and enrollment of corner stores into the project. This staffing change delayed the beginning of in-store training for three of the 18 stores, and The Food Trust is continuing to offer training to these stores.

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