FY 2014 SPECIALTY CROP BLOCK GRANT PROGRAM – FARM BILL
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Project Coordinator:
Melissa Ball, Division of Marketing
Phone: (804)786-5448
Email: Melissa.ball@vdacs.virginia.gov

Final Report

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A. VARGO
LOCAL FOOD HUB
Final Report

PROJECT TITLE
Local Food Hub Multi-Tiered Quality Assurance and Cost-Share Program to Advance GAP Implementation on Small Farms

NAME OF ORGANIZATION
Local Food Hub

PROJECT SUMMARY
Local Food Hub created a multi-tiered approach to on-farm safety and technical support for small farms, resulting in 15 farms successfully passing the Good Agricultural Practices audit.

PROJECT PURPOSE
The purpose of this project was to address the need for on-farm safety and technical support due to increased pressure from the marketplace for food safety assurances beyond what regulations require, and the lack of capacity that small farms entering the wholesale marketplace have to achieve full GAP certification. The program was designed to help farmers move more quickly and cost-effectively through the GAP certification process.

This project was important to helping farms throughout Virginia overcome barriers associated with increasingly high food safety standards. As food safety standards continue to rise, an ability to understand and meet those standards is critical to success. Also important is a clear understanding of FSMA guidelines, and their impact on each farm.

This project built on work on previous funding from the SCBGP, which allowed Local Food Hub to offer Sustainable Agriculture Workshop Series and Grower Services outreach. This program sought to address gaps in previous services offered to go further in helping farms improve food-safety practices and achieve GAP certification.

Please note that this program was targeted at the producers of specialty crops, and therefore did not benefit other commodities.

PROJECT APPROACH

All project objectives and goals were completed, resulting in the creation of a robust multi-tiered approach to on-farm food safety training and technical support, including administrative procedures, resources and manuals, one-on-one targeted technical assistance, group training opportunities, and the administration of a cost-share program for GAP audit and water testing expenses.

An internal management system was developed to manage the technical assistance work with participating growers, along with administrative procedures related to the GAP audit and water

testing cost-share program. Each specialty crop producer in Local Food Hub's network was evaluated through farm visits, phone calls, and in-person meetings to identify where their operation and experience in on-farm food safety practices fell with LFH's three-tiered quality assurance system. For the farms that were not maintaining GAP certifications (i.e. Tier 1 and 2) much of this work was accomplished by progressing through a series of risk assessment exercises that were developed by Local Food Hub. In addition to the risk assessment forms and templates for an introductory On-farm Food Safety Plan further discussed below, Local Food Hub developed a comprehensive growers' manual and crop specifications to assist growers in meeting compliance for safe growing and handling practices.

Five farms seeking first time certification in 2016 received extensive one-on-one assistance to develop customized food safety plans, evaluate and implement necessary changes to infrastructure, and prepare for their audits. Each of these farms received a minimum of 3 farm visits, in addition to help with developing their written plans and record keeping systems. The 10 farms that had achieved GAP certification in 2015 also received assistance as they evaluated and updated plans, and went through the audit renewal process. We are excited to report that all 15 farms pursuing USDA GAP certification through the course of this project, with technical assistance from Local Food, have successfully passed their audits.

Local Food Hub's Quality Assurance Training was conducted on 3 occasions in a small group setting. The class was taught by Local Food Hub staff, and attendees received LFH food safety manual templates that were designed to be in line with the GAP program, but scale-appropriate for smaller farms. The core of this manual consists of a series of risk assessment exercises, developed by LFH, which farms complete to identify current good practices and areas in need of improvement. These exercises have been well received by state and regional training partners as an accessible resource for small farms.

In addition to trainings on Local Food Hub's Quality Assurance Program and creating a food safety plan, growers had the opportunity to learn about FSMA and receive a technical training on post-harvest handling and use of sanitizers from Dr. Laura Srawn, Virginia Tech Extension Specialist in Produce Safety, at our annual growers' meeting in February. In November, 24 growers participated in the first Produce Safety Alliance Grower Training in Virginia, hosted by Local Food Hub in Charlottesville, in collaboration with Virginia Cooperative Extension. To provide this training, Local Food Hub's Director of Grower Services attended a Train the Trainer course beforehand.

Administrative procedures for the cost-share program were refined during this period and informational sheets and forms were distributed to all partner farms working with Local Food Hub. Cost-share funding for both water testing and audit costs has been accessed smoothly and consistently.

The following provides specifics related to each area of the work plan:

Developing a management framework/criteria for Three-tiered Quality Assurance Program: the attached power point describes this framework.

Developing and implementing a cost share program for audit expenses and water quality testing. Since the interim report, the following farms took part in the cost share program:

- **Malcom's Market Garden**
- **Schuyler Greens**
- **Wenger Grape Farm**
- **Riverside Produce Farm**
- **Sunnyfield Farm**
- **Planet Earth Diversified**
- **Church Hill Produce**

Evaluating and assigning LFH partner farms to the appropriate tier: all farms were assigned to a tier.

Creating a custom work plan for each partner farm: custom work plans were created for several farms in each of the tiers, though not for all 70 partner farms (see lessons learned below).

Creating a formalized intake process for new partner producers: sample intake documents are attached.

Hosting GAP introductory and advanced trainings through VCE: as discussed above, growers had dozens of opportunities to engage in food safety and supplemental trainings with Local Food Hub and VCE staff, including GAP-specific trainings, producer meetings, on-farm visits.

Developing a comprehensive manual for LFH producers: Manuals were developed and distributed, and can be made available upon request.

Developing and distributing a marketing plan and materials for LFH buyers: as described below, Local Food Hub engaged with all of its institutional buyers to provide information about and access to food-safety certified products.

GOALS AND OUTCOMES ACHIEVED

Target: 3-8 new Gap Certifications a year for 2 years, 5 additional "Transitioning to GAP" each year for two years, and an increase of 10% attendance at trainings and seeking technical assistance.

Results:

- 15 farms have attained GAP certification throughout this project.
- Workshop attendance increased 45% from 2014 to 2015, and 17% from 2015 to 2016

Target: 10% increase in institutional purchasing, additional 5 institutional accounts per year that correlate with enhanced food safety assurance program.

Results:

- Institutional sales for 2015 totaled $168,951.14. While institutional sales outside of the local school system increased more than 10% from 2014, changes in school system buying practices brought the overall number down.
- Institutional sales for 2016 totaled $186,906.88, an increase of more than 10%.
- Most institutional buyers are now requiring GAP-certified products. Without this quality assurance program Local Food Hub would not have been able to serve these customers, specifically:
    - **Eight K12 school systems (50+ schools total)**
    - **Two private K12 schools**
    - **University of Virginia Hospital**
    - **University of Virginia dining (four locations)**
    - **James Madison University (five locations)**
    - **Bridgewater College**
    - **Darden School of Business**
    - **Two retirement communities**
    - **Six wholesale distributors, including Sysco**

Target: Framework document, grower manual and buyer materials distributed to all of Local Food Hub's network of growers and buyers.

- Results:
  The following methods were used to ensure that all growers and buyers in its network have access to the resources developed during this project:
    - annual partner producer meeting
    - trainings
    - password-protected resource page for growers on web site
    - grower newsletters
    - weekly emails to all buyers

BENEFICIARIES

The beneficiaries of this project include the 15 partner farms who achieved GAP certification from the program, and the 330 individuals who attended workshops. It also benefited partner buyers, **particularly those who can only purchase GAP certified products, including eight K12 school systems (50+ schools total), two private K12 schools, University of Virginia Hospital, University of Virginia dining (four locations), James Madison University dining (five locations), Bridgewater College, Darden School of Business, two retirement communities, and six wholesale distributors**. Farms that participated in the program benefited from comprehensive assistance to improve food safety standards, which leads to more success in the wholesale market. Likewise, partner buyers benefitted from a wider range of farms that meet rigorous food safety standards.

LESSONS LEARNED

Technical assistance needed by the farms pursuing GAP certification was greater than anticipated. Each farm had unique situations to factor in, and their capacity to develop regulatory compliant written plans and record keeping systems differed as well. Because establishing record-keeping practices appeared to be particularly challenging for participants, a companion

records manual was developed and provided to better organize the record-keeping aspects of certification.

CONTACT PERSON
Portia Boggs, Local Food Hub
434-244-3276, Portia@localfoodhub.org

ADDITIONAL INFORMATION
N/A

2
J. SAMTANI / J. DERR
VIRGINIA TECH
FINAL

PROJECT TITLE: Developing Organic and Integrated Management Strategies for Pest Control in Annual Strawberry Production

NAME OF ORGANIZATION: Virginia Polytechnic Institute and State University

PROJECT SUMMARY

A study evaluating preplant treatments for strawberry production was initiated in the 2013-14 and 2014-15 growing seasons at the Hampton Roads Agricultural Research and Extension Center (HRAREC) in the City of Virginia Beach, VA. The objective of this study was to evaluate the potential of soil solarization (SS) treatments in coastal Virginia climatic conditions for their efficacy on weed control and crop yields and to compare SS to 1,3-dichloropropene (1,3-D) + chloropicrin (Pic) fumigation. Treatments included 1,3-D + Pic 39:60 by weight, shank fumigated at broadcast rate of 220 kg ha^{-1}, 6 wk and 4 wk SS treatments, 4 wk SS treatment replaced with Virtually Impermeable Film (VIF) tarp at the time of transplanting, and a nontreated control. SS treatments were covered with 1 mil clear polyethylene tarp and non-solarization treatments were covered with 1.25 mil VIF tarp. In both growing seasons, following completion of the preplant treatments, 'Chandler' strawberry was planted in two rows at a 36 cm in-row spacing in plots that were 4.6 m long by 0.8 m wide on bed top, in the first wk of October. Over two growing seasons, only the 6 wk SS treatment consistently lowered the weed density count compared to the nontreated control. The weed density count in the 6 wk SS treatment was not statistically different from the 4 wk SS and 4 wk SS replaced by VIF tarp treatments in the 2013-14 growing season. In both seasons, crop yield in the 4 wk SS was significantly lower than other treatments. Lack of improved yield from 1,3-D + Pic treatment over nontreated plots suggests that either the weed and disease infestations at the site were not high enough to adversely impact yield, or a higher fumigant rate would be needed to have a positive impact on crop yield.

PROJECT PURPOSE

There has been an increasing demand for strawberry consumption nationwide. In Virginia, farmers are seeking to diversify their crops to those that offer higher value and cater to the rapidly increasing urban and sub-urban population. Virginia is experiencing a growth in acreage under strawberry production as well as increasing consumer demand for berry consumption. Virginia Beach is the largest strawberry-growing area in Virginia and has an annual production value estimated at $750,000 to $1,000,000. Growers typically pre-plant fumigate their strawberry fields with methyl bromide:chloropicrin (MBPic) formulations to control diseases and weeds. Methyl bromide use is being discontinued, which can result in yield losses 10 to 15%, along with increased hand weeding costs. Although there are alternative fumigants available, they do not provide the complete spectrum of pest control as MBPic and could negatively affect human health. For example, chloropicrin effectively controls pathogens but not weeds, and it can have negative health

effects on humans at low doses. Another fumigant, 1,3-dichloropropene, provides good control of soilborne diseases and nematodes, but is known to increase the risk of cancer. Growers using fumigants have to comply with regulations such as maintaining buffer zones and re-entry periods. Many growers complain that fumigation is becoming too expensive. It is imperative that we identify pest control tools that do not involve fumigants.

Weed control has been listed by organic producers as the number one impediment to organic crop production. Soil solarization, a potential non-chemical replacement for toxic fumigants, is achieved by covering moist soil with clear impermeable polyethylene tarp for the required time period. Soil temperatures will reach much higher than air temperatures, and there is a linear relationship between soil temperature and the time needed to kill most pathogens and weed seed. The potential of soil solarization for pest control in strawberry production in Virginia has not been investigated until recently.

One product supplementary to optimize soil solarization is mustard seed meal (MSM), a byproduct obtained after oil is extracted from mustard plants. The high cost of MSM (currently available to purchase in VA at $1.50/lb.) prohibits incorporation of high rates of MSM. In Spain, strawberry plants subject to pre-plant treatment of *Brassica carinata* (10 kg/m^2) + solarization had higher growth and berry yield compared with solarization or biofumigation alone (Porras et al., 2009). Contrary to that, a study in Florida in tomato fields found no benefit of adding cabbage residue @ 6.6 to 8.9 kg/m^2 to soil solarization (Coelho et al, 1999). To date, however, there are limited studies that look at integrating crucifer-based biofumigant products with soil solarization and additional studies are warranted.

The objectives of this study were to optimize soil solarization treatments for their effects on pest-control in strawberry production. We determined i) weed control efficacy of pre-plant soil solarization, and enhanced soil solarization, ii) crop yields in solarization and enhanced solarization plots in comparison to an untreated control. iii) to disseminate the findings of this research to growers, extension personnel, and others involved in strawberry production.

PROJECT ACTIVITIES

A field study was established at the Hampton Roads Agricultural Research and Extension Center starting August 15, 2014. The study utilized a randomized complete block design with 4 replications and six treatments plus a nontreated control.

Pre-plant treatments in the study initiated in 2014 included i) Pic-Clor 60 that was shank fumigated at 220 kg/ha on August 30, ii) Soil solarization (SS) for 6 week duration initiated on August 21 iii) SS for 4 week duration initiated on September 3, iv) SS 4 week treatment initiated on September 3, and replaced with black tarp on October 1, 2014, v) SS 4 week treatment + Mustard seed meal (MSM) applied at 1,000 lbs/A and vi) 4 week SS initiated on September 3 with black tarp added on October 1 to form a two layer tarp, and vii) a nontreated control. Following completion of the pre-plant treatments, the strawberry cultivar 'Chandler' was planted at a 14 inch in-row spacing on October 3, 2014 on 15 linear foot beds. SS treatments were covered with 1 mL clear polyethylene tarp and non-solarization treatments were covered

with 1.25 mL virtually impermeable black film tarp. Trials were repeated in the fall of 2015 using the same methods listed above.

Weed data on the plots was collected by establishing a 5 feet clear tarp window soon after planting. This meant replacing black tarp on the bed top with clear tarp in a 5 linear foot row for treatments that had the black polyethylene tarp. Naturally-emerged weed populations in the strawberry beds were monitored periodically through the growing season and data was recorded by weed species on November 4, 2014, December 10, 2014, and March 9, 2015. After each evaluation period, the emerged weed species in the strawberry beds were hand weeded. Data on weed control efficacy of these treatments was collected periodically through the growing season.

Plant stand count data was collected on a monthly basis starting November 2014 and continued throughout the growing season, and plant vigor was evaluated using a scale of 0 = dead plant to 10 = extremely vigorous. Disease incidences were monitored on a similar interval, looking especially for symptoms of disease problems such as crown rots caused by *Phytophthora cactorum* or *C. gloeosporioides*, fruit rots caused by *Botrytis cinerea*, *C. acutatum*, and *P. cactorum*, and potential virus-related problems such as Strawberry Mottle Virus and Strawberry Mild Yellow Edge Virus. Strawberry plant development was monitored later in the season by measuring plant canopy diameter on April 7, 2015. Field plots were harvested in the 10 linear feet plots (~16 plants/replicate) twice per week by project personnel starting May 2, 2015, and each harvested fruit was categorized as marketable versus non-marketable, in order to calculate yields in these categories by harvest date, and then cumulatively for the entire season. Additionally, data on fruit size was recorded once per week by measuring five fruits per replicate. Harvesting continued till June.

II. Problems and Delays

Implementation of SS treatment in Virginia can be a challenge as wet soils and rain events can delay initiating SS in a timely manner. In our study, in the first season, our intent was to initiate 8 wk SS period instead of a 6 wk SS period, but wet soils and rainfall during initiation time, delayed bed formation. Canada geese (*Branta canadensis* L.) can disturb the process of SS by pecking on clear tarp, as was evidenced in our trial. To remedy this initial damage, clear tape was used to seal any holes caused by geese in clear tarp. Fencing of study site and scare-eye balloons (Bird-X Chicago, IL 60612) subsequently kept geese away from beds in the conducted trials.

GOALS AND OUTCOMES ACHIEVED

Results:

Table 1. Soil temperature collected at a 5 cm depth during the 6 wk and 4 wk soil solarization (SS) treatment periods, in a bed with no tarp or a clear tarp. Trials were conducted at the research station in Virginia Beach, VA

Duration of measurement[a]	Tarp	Year 1 High temperature	Year 2 High temperature	Year 1 Mean temperature	Year 2 Mean temperature	Year 1 Time > 40 C	Year 2 Time > 40 C
		--------°C-------		---------°C---------		----------h----------	
6 wk	None	37.2	37.4	25.0	23.7	0.0	0.0
6 wk	Clear	45.6	43.9	30.0	27.7	95.7	41.5
4 wk	None	36.7	36.0	24.4	22.5	0.0	0.0
4 wk	Clear	45.6	43.4	28.9	26.2	41.8	12.0

Table 2. Weed densities counts in 1.5 m lengths of bed for the two growing seasons as affected by preplant treatments. . Trials were conducted at the research station in Virginia Beach, VA

Treatment	Common chickweed [b]		Cudweed		*Lamium* spp.	Wild garlic		Total weed density	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 1	Year 2	Year 1	Year 2
	----------(plants/3.7 m^2)----------								
Nontreated control	54.8 a [c]	72.3 a	50.0 a	28.0 a	51.1 a	13.8 bc	4.5 ab	272.3 a	303.5 b
1,3-dichloroprone + chloropicrin [a]	32.8 a	24.8 b	21.5 b	18.5 ab	34.3 ab	25.0 ab	4.0 b	243.5 ab	231.0 b
4 wk soil solarization	15.8 b	67.0 a	10.0 bc	21.0 a	36.7 ab	38.5 a	7.3 ab	198.6 bc	462.0 a
4 wk soil solarization replaced by black tarp	12.3 b	67.8 a	5.0 bc	31.0 a	42.3 a	15.3 bc	5.5 ab	192.6 bc	317.3 b
6 wk soil solarization	14.3 b	9.0 b	2.5 c	1.0 b	14.0 b	10.3 c	9.3 a	168.3 c	138.8 c
Pr > F	0.0015		0.0431		0.0390	0.0399		<0.0001	

[a] 1,3-dichloropropene plus chloropicrin (39:60 by weight) was shank fumigated at 220 kg ha^{-1} on broadcast basis.

Table 3. Cumulative marketable and total yields for the strawberry trials conducted at the research station in Virginia Beach, VA. Data were averaged over growing seasons.

Treatment	Marketable yield	Total yield
	----------(g/plant)----------	
Nontreated control	484.8 a [b]	716.6 a
1,3-dichloroprone + chloropicrin [a]	438.0 a	664.6 a
4 wk soil solarization	360.9 b	543.9 b
4 wk soil solarization replaced by black tarp	486.2 a	709.9 a
6 wk soil solarization	431.0 a	642.7 a
Pr > F Treatment	0.0035	0.0024

[a] 1,3-dichloropropene plus chloropicrin (39:60 by weight) was shank fumigated at 220 kg ha^{-1} on broadcast basis.

[b] Means with the same letter within a column are not significantly different using least significance difference at $P \leq 0.05$.

GOAL: Have strawberry growers see the benefits of this non-chemical pest management technology. through field days as well as information posted on a Virginia Tech website.

A total of 102 strawberry growers leaned about the benefits of this research through attendance at grower meetings in Charlottesville, Richmond, and Virginia Beach. Research results documenting the effectiveness of soil solarization and the use of mustard seed meal were presented at these meetings

GOAL: Replace the use of fumigants with non-chemical alternatives

Common chickweed [(*Stellaria media* (L.) Vill.], cudweed (*Gnaphalium* spp.), henbit (*Lamium amplexicaule* L.), purple deadnettle (*Lamium purpureum* L.), wild garlic (*Allium vineale* L.) and white clover (*Trifolium repens* L.) were the predominant weed species in both growing seasons. In the first growing season, all plots treated with soil solarization had lower common chickweed density count than nontreated and 1,3-D + Pic fumigant- treated plots. In the second, common chickweed density count was lower in the 6 week soil solarization and 1,3-D + Pic fumigant plots compared to the nontreated and 4 wk SS treatments. It appears that a 6 week or longer soil solarization treatment may be comparable to fumigant application in strawberry production.

BENEFICIARIES

This project benefited growers currently producing strawberries in Virginia, as well as others considering growing this crop. Extension personnel and growers were able to learn the outcome and conclusions from the conducted trials at grower meetings.

2015 Strawberry grower meetings

July 2015. Southeast Virginia and Northeast North Carolina Strawberry Pre-plant Meeting, Virginia Beach, VA, July 27, 2015. Audience Size: 23. Hours of Instruction: 2.0.

Strawberry Meeting, Charlottesville, VA, July 30, 2015. Audience Size: 34. Hours of Instruction: 2.0.

2016 Strawberry grower meetings

Findings of the study were presented at the preplant meetings in Charlottesville, Richmond and Virginia Beach held on July 18, July 19, and July 22, 2016, respectively. Meeting in Charlottesville was attended by 17 growers and 5 industry members. In Richmond, meeting was attended by 12 growers and 5 industry members. In Virginia Beach, meeting was attended by 16 growers and 4 industry members.

LESSONS LEARNED

In our study, 6 wk SS was more effective at providing weed control over 4 wk SS. Canada geese (*Branta canadensis* L.) can disturb the process of SS by pecking on clear tarp, as was evidenced in our trial. To remedy this initial damage, clear tape was used to seal any holes caused by geese in clear tarp. Fencing of the study site and scare-eye balloons subsequently kept geese away from beds in the conducted trials. Performance of SS treatment can be improved by subjecting the raised beds to a longer 8 wk or 10 wk duration beginning in mid-July or early August. Enhancing SS process with other bioamendments or a preemergence herbicide may have improved performance on weed control and crop yield. For SS treatments, having a tarp designed with black shoulders and a clear top would further reduce hand weeding costs. SS could be a useful pest control tool for organic growers, limited resource growers, or growers that need to address pest issues in buffer areas prior to strawberry transplanting.

CONTACT PERSON

Jeffrey Derr

Phone: 757/363-3912

Email: jderr@vt.edu

ADDITIONAL INFORMATION

The following paper contains detailed data tables for this research.

Jayesh B. Samtani, Jeffrey Derr, Mikel A. Conway and Roy D. Flanagan III. 2017. Evaluating Soil Solarization for Weed Control and Strawberry (*Fragaria xananassa* Duch.) Yield in Annual Plasticulture Production. Weed Technology (in press).

3
A. VALLOTTON
Virginia Tech
Progress Report

PROJECT TITLE
Increasing Capacity to Provide Comprehensive Fresh Produce Food Safety Education from Farm to Fork

NAME OF ORGANIZATION
Virginia Polytechnic Institute and State University

PROJECT SUMMARY
Providing comprehensive food safety education from farm to fork is crucial to decrease the risk of outbreaks caused by fresh produce contamination, since increased awareness, knowledge, and skills can lead to changes in better handling practices and thereby reduce occurrences of contamination. Virginia Cooperative Extension's Fresh Produce Food Safety Team used a multi-pronged approach to achieve this over-arching objective by targeting extension agents, growers, and consumers. We conducted introductory and advanced level agent/ grower trainings statewide to increase agent capacity and the number of growers implementing on-farm food safety principles (37 agents, 361 growers). Additionally, agents and growers were mentored in the Good Agricultural Practices (GAP) certification process (26 agents, 34 growers). Further, we created a Facebook page (295 page likes, 9,875 views), as well as a comprehensive fresh produce food safety website, housing a wealth of resources for agents, growers, and consumers (imminently to be launched). To guide our consumer resource development, we conducted a consumer phone survey on fresh produce food safety perceptions and purchasing behavior (636 responses).

This project did not build on a previously funded project with SCBGP.

PROJECT PURPOSE
The potential for food contamination to impact fresh produce food safety is a significant concern regardless of the produce grown, production system used, size of farm, or market outlet. Outbreaks significantly impact not only a particular grower, but the fresh produce industry as a whole. To address the ever-changing food safety requirements and regulatory environment for Virginia growers, especially in light of the passage of the Food Safety Modernization Act (FSMA) Produce Safety Rule, Virginia Cooperative Extension (VCE) created the Fresh Produce Food Safety (FPFS) Team in 2013 to spearhead statewide VCE efforts in providing comprehensive food safety education. While VCE has a proven track record in making research-based information available to citizens of the Commonwealth, VCE on-farm food safety teaching resources were limited. There was a need for educational resources that were more place-based and that recognized the varied scales, production systems, and market outlets of produce operations in Virginia. In the wake of the passage of the FSMA Produce Safety Rule, the need for providing Virginia produce growers easy-to-understand information and training on GAP principles and how to implement GAPs on farm has been crucial for growers to maneuver through the changing regulatory environment and ultimately provide a safer food supply.

One of the major objectives of this project was to **increase capacity within VCE to address fresh produce food safety education and varied training needs for growers**. To accomplish this objective, we proposed developing multiple educational resources that would be housed on a comprehensive website, aimed towards agents, growers, and consumers. The website would house several other new

resources including a blog, a GAP decision-making tool, USDA and Harmonized GAP Plan of Action manual templates, webinars, on-farm factsheets pertaining to pre- and post-harvest handling practices, YouTube videos, and a consumer-oriented materials (discussed below). To strengthen agent capacity, we also proposed agent trainings in our four VCE districts. As detailed below, agents attended 'mixed' grower/agent trainings, then, subsequently, assisted teaching similar trainings elsewhere, thereby learning by doing.

A **second major goal** of this project was to **increase the number of growers implementing on-farm food safety practices and/or obtaining GAP certification**. In addition to the resources provided on the website, we proposed conducting introductory and advanced level grower trainings in each of the four VCE districts. Our programmatic approach with growers was to encourage a risk-based approach and the implementation of GAPs, whether or not a farm chose to become certified, since our experience has shown that growers working through the entire complex certification process and becoming GAP-certified are primarily motivated by market requirements imposed by specific buyers.

For those growers further pursuing GAP certification, we provided **mentoring** through a hands-on preparation process. This process included initial email or phone calls with the local agent and grower to discuss market food safety requirements and pertinence of obtaining a GAP audit; site visit to the grower's farm; a risk assessment of their entire production, harvest, and post-harvest handling process; discussion of targeted GAPs and ways to implement them; on-going guidance on preparing the Plan of Action manual, incorporating GAPs, a thorough recordkeeping system, and expectations for the actual audit; and performing a mock audit prior to the actual audit to make sure everything was in place.

A **third main objective** was to **provide resources to educate consumers on fresh produce food safety**. We proposed conducting a consumer preference survey, to determine the specific terms or practices, which consumers associate with high quality and safety of fresh produce. Using the key words or phrases identified in the survey, we planned to develop on-line resources and other relevant materials.

This project was not been submitted or funded by another State or Federal grant program. One of the greatest benefits is that this project has dovetailed nicely with other funded projects, especially in terms of the website developed here. Given that the website houses a wealth of resources, materials that were or are being developed as part of other projects, will also be housed on our comprehensive site. Additionally, we are very well poised as a state since we are part of the Southern Regional Training Center (for the PSR and Preventive Controls Rule), as well as a subcontractor on a VDACS project related to implementation of the FSMA PSR and PCR (2017-2021). The many accomplishments of this project and the synergy of this work with other related projects positions us very well to provide support at many levels to the fresh produce industry in Virginia.

PROJECT ACTIVITIES

- ***Project Team Meetings/Calls/Email communication*** were on-going throughout the project
- ***Educational Resources Development***
    - Developed a basic marketing plan for social media and website content
    - The Project Team felt it was prudent to make sure our materials aligned well with the Produce Safety Alliance (PSA) curriculum in terms of primary topic themes and emphases. To this end, some of the Project Team have attended PSA training for trainers (using other funds) so as to be in keeping with the PSA guidance. In keeping with this guidance, we developed materials accordingly. Additionally, given revisions to the USDA HGAP audit, we made changes to our manual templates.
    - Facebook Page launched
        - https://www.facebook.com/VirginiaFreshProduceFoodSafetyTeam

        - To date, we have had 295 page likes and 9875 views
    - Created Virginia Fresh Produce Food Safety Team YouTube channel
        - https://www.youtube.com/channel/UC_yVOBlU3X1T-ntRLUpiNdQ
    - Virginia Fresh Produce Food Safety Website planned and developed (launch is imminent)
        - http://www.hort.vt.edu/producesafety/index.html
        - This comprehensive site has general information about the Fresh Produce Food Safety Team's mission and team members, research projects, and an outreach tab with calendar, news, and other relevant links, as well as agent-, producer-, and consumer-oriented sections.
        - Agent section of the website is password-protected and offers many additional resources that agents can utilize for their educational programming:
            - Agent Competencies with resources for agent professional development
            - Determining Training Needs Tool to help agents focus on specific teaching needs of different audiences
            - Training Resources cover on-farm, risk-based food safety principles and GAPs; direct market food safety; food safety plan writing; GAP certification and recertification; FSMA compliance; accessing Virginia markets; other relevant resources. These annotated pages include slide sets, videos, image library, and other web-based resources.
        - Producer section of the website includes:
            - Accessing Markets looking at various characteristics, requirements, and hurdles to accessing Virginia markets (based on a market assessment project we conducted); provides food safety recommendations
            - Producer Decision Tree to help growers determine specific educational resources they should access based on their food safety needs
            - Producer FAQs on a variety of topics
            - Producer Resources provide a wealth of info and links to materials producers can access covering same topics as agent resources
        - Consumer section of the website focuses on consumer-friendly topics:
            - Food Safety for Home and School/Community Gardening provides guidance on non-commercial production of fruits and vegetables
            - Considerations for Purchasing Safe Produce looks at characteristics to help consumers select and purchase safe produce, and also discusses some common misperceptions
            - Consumer Safe Food Handling, Preservation, and Storage provides links to info related to these topics
            - Consumer FAQs explores general questions about foodborne illness and produce outbreaks
        - The website has represented a huge amount of effort and teamwork, yet well worth the investment of time and resources given the reach we will have. The website provides a single location for Virginia-based producers to find relevant information on fresh produce food safety. Further, it also help us to streamline our efforts by strategically including answers to many frequently asked questions. The content developed for the website is also being re-tooled into factsheets and other resources when possible.
        - We do see the website as a work in progress and will be making regular updates as we develop more resources. The calendar page (also serving as a blog) will be a huge help to have a place where agents and growers can see upcoming meetings across many different fresh produce safety areas.

- Decision Tools created (housed on website)
  - Created tree graphic to help agents understand competencies needed for various grower training levels
  - Created interactive agent decision tool for determining grower training needs (also available as static PDF)
  - Created interactive grower decision tool for determining specific training and resources a grower needs (also available as static PDF)
- USDA GAP manual revisions, 4th edition (housed on website)
  - Updated checklist template (agents, growers)
  - SOPs and record sheets (agents)
  - We had hoped to create a user guidebook but that is still a work in progress. We did create a factsheet on the GAP certification process, and there is also guidance provided on the website.
- USDA HGAP manual creation (housed on website)
  - Created checklist template (agents, growers)
  - Developed a list of what agent helpers would need to do and what producers would need to have appropriate records and documentation. This will form basis for the guidebook not yet completed.
  - There is guidance provided on the website.
- Video Production (housed on YouTube and links on website)
  - Developed scripts and obtained footage from around state on various themes including risk assessment, field GAP, greenhouse GAP, packinghouse GAP, and Urban Farm GAP
  - Fresh Produce Food Safety Risk Assessment YouTube video (102 views) https://www.youtube.com/watch?v=-zwIJg0JCjs&list=PL7v9_-Pdw-QfrgdCTYzVUubU1tCkBcGOe
  - Greenhouse GAPs YouTube video (580 views) https://www.youtube.com/watch?v=ia_vbyloyaw
  - As time allows, we will be following up with additional videos using the footage we obtained.
- Webinar development
  - Conducted FSMA 411 webinar (for agents)
  - Given the changing regulatory environment, we plan to create additional videos, and are already planning webinars for inclusion on the agent part of the website.
- Factsheets developed and written
  - A Guide to the Good Agricultural Practices (GAP) Certification Process (HORT-252NP)
  - Guide to Identifying Food Safety Hazards in Greenhouse Systems (HORT-254NP)
  - Guide to Identifying Hazards in Packinghouse Environments (FST-279NP)
  - Overview of the Food Safety Modernization Act Produce Safety Rule (FST-270NP)
  - Food Safety Modernization Act Produce Safety Rule: Agricultural Water (FST-271NP)
  - FSMA Produce Safety Rule: Wildlife and Domesticated Animals (FST-272NP)
  - Food Safety Modernization Act Produce Safety Rule: Worker Health, Hygiene and Training (FST-278NP)
  - GAPs and FSMA – an Overview for Hop Growers in Virginia (HORT-237NP)
  - Assessing On-Farm Produce Safety Risks (in press)

- ***Agent and Grower Trainings***
  - Workshops (basic and advanced levels)

- On-farm risk assessment twilight or half-day GAP workshops were held:
    - Bellair Farm Twilight Talk (Albemarle Co) (21 growers)
    - Farmers Market Talk (Danville) (3 agents, 38 growers)
    - Dayspring Farm Twilight Talk and Walk (King & Queen Co) (3 agents, 16 growers)
    - Floyd, Franklin, and Halifax Co trainings (3 agents, 16 growers)
    - Richmond City (collaborating with Tricycle Urban Agriculture) (1 agent, 15 growers)
    - Small Farm Outreach Symposium (Danville) (5 agents, 84 growers)
- Collaborating with local agents in each locale, the following all-day trainings were held:
    - GAP Produce Safety Workshop (Spotsylvania Co) (2 agents, 41 growers)
    - Food Safety Best Practices for Farmers Market Growers Workshops (Wytheville, Roanoke, Abingdon) (5 agents, 55 growers)
    - FreshFarm Markets and Conservation Fund Workshop (Leesburg) (1 agent, 23 growers)
    - Packinghouse Best Practices: A Hands-on Workshop Using a Risk-based Framework to Increase Fresh Produce Food Safety (Dayton and Hillsville) (8 agents, 51 growers)
    - Production and Risk assessment/ food safety practices in Hydroponic Greenhouses (in Charlottesville/Scottsville) (2 agents, 33 growers)
- Across all trainings, evaluations indicated increased knowledge in assessing risks and implementing GAPs. Agent participants valued the participant mix and practical lessons learned.
    - "*I learned some great ideas to incorporate into future trainings and had a chance to meet/network with VCE and non-VCE folks*".
    - *"Great training…best thing is all the hands-on and networking."*
    - *"It was very nice to have a group of producers and specialists that all had their own advice to give based on where they are in the process…it was great to attend because it really pulled the class and the manuals together and the whole process..."*
    - *"We are so lucky to work with Specialists like you (Amber) and Renee that are willing to assist with teaching workshops and interact with producers/growers/market managers. You guys add a wealth of value and expertise. I'm thrilled to be part of the team. I was excited to see the response from the audience and the invitation to work with other communities to offer similar workshops."*
    - *"I'm visiting a grower today who is thinking about building a vegetable packinghouse. I am so happy I attended your packinghouse workshop last November! The information is so, so helpful! Thank you!!"*
- Growers also agreed:
    - *"Very knowledgeable [speakers] giving great ideas for low cost 'engineering' for good farm practices."*
    - *"Very well done training…I appreciated the activities…"*
    - *"Can't wait to apply what I've learned today to my work from here on out!"*
    - *"We learned so much and have been applying what we learned since then!"*
- Growers also said they intended to incorporate the following practices to reduce

contamination risks:

- Provide more food safety training for workers
- Test quality of water used for irrigation
- Improve handwashing and toilet facilities for workers
- Improve cleaning and sanitizing methods on the farm or packing house
- Incorporate ways to control/monitor animals on the farm/packing/storage areas.
- Use safe methods (temperature control, sanitation etc.) for storage and transport of product to marketplace
- Document food safety practices

- GAP Certification Preparation Mentoring
  - 26 agents were mentored over the course of the project, with 34 people assisted with GAP certification preparation
  - All growers have implemented a risk-based approach and GAPs, with at least 10 farms obtaining GAP certification or recertification as a result of these efforts. In cases where farms were not certified, it was either an issue of growers still in the process of preparing to become certified, or else deciding to wait until a later indefinite point in time, given other constraints. Most important is the increased capacitation of agents to assist growers with less input from the specialists.
  - Comments from agents and growers have been very favorable with the mentoring approach:
    - *"Thank you so, so much for your help! You are the BEST. I was feeling overwhelmed with this process, and you made it much more approachable."* (Maria Sohail, agent mentee)
    - *"Amber Vallotton [mentor] has been a big help to me as well as other agents concerning the GAP process. One of the local farmer's here have been working towards having their operation GAP-certified for a while. Amber has walked us through the process along the way. I am happy to say that the grower passed with 100%. He was overjoyed and needlessly to say thanked us many times over. This has been a real learning experience and one that I most welcome."* (Carol Haynes, agent mentee)
    - *"It was a pleasure meeting with you and we appreciate it very much. It was a great help…The manual you left was awesome."* (Aquaponics grower)
    - *"I passed all the sections of GAP with flying colors. Thank you SO MUCH for all of your help and support over the last year."* (Hydroponic greenhouse grower)
    - *"Wanted to share that we had our GAP Audit and passed! Thanks for the mock audit at the garden. Know it helped me be more prepared and make some changes prior to the audit, including installing our produce sinks inside the garage."* (College farm grower)

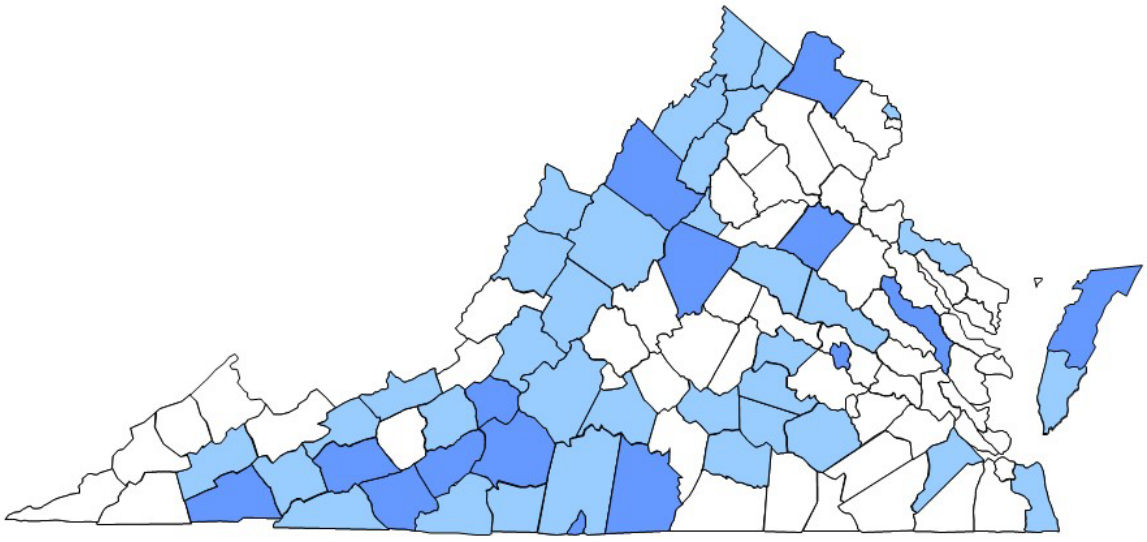


Figure 1. Project Agent and Growing Trainings. Dark blue locations are sites where workshops were held. Light blue counties show localities served by VCE agents trained in on-farm risk assessment, GAP, and GAP certification mentoring (light blue).

- ***Consumer Preference Survey***
  - Working with Michigan State University (subcontractor) and Lightspeed Research, LLC, as a contractual service, conducted phone survey throughout Virginia, with 636 "completes"
  - The survey targeted three areas in Virginia, avoiding major metropolitan areas; 27% self-identified themselves as living in a metropolitan area, 34.0% lived in a suburban region, and 33.2% lived in a rural region.
  - Key findings included the following:
    - Participants were asked to respond to questions about their perceptions of food safety issues using a 5 point Likert scale where 1=strongly disagree and 5=strongly agree.
      - Most (89.8%) disagreed that "I do not have time to worry about food safety."
      - More than 80% of the sample had heard of some food safety concerns, so a majority of the respondents were aware of the topic.
      - Most agreed or strongly agreed (85.9%) that "Consumers assume the produce they buy is safe to eat" and "I am confident that the produce I buy is safe to eat" (81.2%).
      - Most (88.2%) wash all of their produce at home to be sure it is safe.
      - We found that slightly more than half (58.7%) relied on the USDA to insure their produce is safe.
    - Purchase source was the most important product characteristic for subjects to assess food safety, followed closely by the produce itself.
      - Among the four options for retail source, the perceived safest place was a natural food store/cooperative. The supermarket and farmers market were perceived to be similar and slightly safer purchase locations and compared to the roadside stand, which was perceived to be the least safe place among the four retail types listed.

        - Among the four types of produce, the perceived safest was the grape tomato, followed by the mixed berries, and leafy greens. Sprouts were perceived to be the most risky.
        - Production method (organic vs. conventional) accounted for only 17% of the decision on how safe the food was perceived to be.
    - To investigate information sources more deeply, respondents were asked to "indicate the sources of information you trust about food safety."
        - The USDA had the greatest number of survey participants indicated they trusted that source (66%), followed by "organizations that certify produce" (49.8%), Virginia Cooperative Extension Service (37.9%), friends (26.9%), the Internet (19.2%), and YouTube (4.7%).
        - Not surprisingly, the most widely recognized logo was that of USDA Certified Organic produce; and, about a third of those respondents felt moderately to very knowledgeable about that program. The program "Food Safety Begins on the Farm" had the lowest level of awareness and knowledge.
    - When asked to rank how they would prefer to obtain information about food safety, consumers ranked in person first (25.2%), followed by email (20.3%), electronic copies (16.7%), website (10.8%), printed copies (5.8%), Facebook (4.1%), telephone (2.5%), a listserv (1.3%), workshop (2.3%), YouTube (0.3%), videos (0.2%), and Twitter (0.2%).
- Our initial method of addressing consumer misconceptions and needs regarding fresh produce food safety was to develop a website of online (downloadable) resources.
- Our findings will also be communicated with agents and specialists in consumer education to enhance education in consumer skills in recognizing and practicing fresh produce food safety in their purchasing, preparation and handling of fresh produce. We will assist in the development of publications and other online resources to address consumer concerns and misconceptions regarding fresh produce food safety.
- Results of the survey were presented at the 2016 American Society for Horticultural Science Conference in a talk entitled, "Virginian's Perceptions of Fresh Produce Food Safety"
- Additionally, we have drafted "Virginians' Perceptions of Food Safety" manuscript to be submitted to *Food Control* in November 2017

GOALS AND OUTCOMES ACHIEVED

Goal 1: Increase capacity within Virginia Cooperative Extension to meet fresh produce food safety education and/or training needs of agents, growers and consumers. (Achieved)

Performance Measures 1: 1) Number trained agents using knowledge gained and accessing resources provided to subsequently train growers in on-farm food safety within their local region (measured by pre- and post-training surveys immediately before and after training, then one year after initial agent training). 2) Number of website hits, DVD/video views, resource downloads/ distribution of new educational resources using Google analytics or other tracking tool.

Benchmark 1: 1) Baseline—Number agents currently proficient to deliver comprehensive on-farm food safety education, and 2) number of existing Virginia-based web, video or print VCE fresh produce food safety resources for agents, growers, and consumers.

Target 1: 1) 75% of trained agents utilizing that training at local level with grower groups or individuals. 2) 15 new resources geared to each unique audience with average website hits/month (9/15 to 9/16) by audience: 30 by agents, 50 by growers, 100 by consumers; average video views/month by audience: 20 by agents, 20 by growers, 50 by consumers; average resource hit/download per month by audience: 50 by agents, 50 by growers, 100 by consumers.

In considering the overall capacity at the start of the project versus where we are now, the baseline number of agents who were proficient in teaching basic on-farm food safety and GAPs was only five people. There had been some professional development training for agents prior to this time, but that training was minimal. The trainings also did not reflect most current regulations and the broad spectrum of training levels needed, especially as related to GAP certification and the finalization of the FSMA Produce Safety Rule (in late 2015). As a result of the project work, workshop materials were developed, such as slide talks, break-out session activities, and hands-on stations. Thirty-seven agents attended workshops, with 26 of these agents additionally mentored individually in the GAP certification process. Workshops and mentoring were held across all four districts (see Figure 1, p7). Thus, our agent capacity grew more than 7-fold, and more than 70% of agents trained were also mentored in the GAP certification preparation process with growers.

The project was a vital impetus for resource development on many fronts. While there were some publications and web-based resources available for growers prior to the project start, these resources were mostly focused on food safety for direct market growers and consumer home food handling practices. Given the continuum of grower training needs ranging from on-farm risk assessment to direct market to food safety plan writing to GAP certification to FSMA compliance training, the resources were lacking in several areas. Resources that were available (externally) needed vetting and organization into a comprehensive clearinghouse that was easily accessible and usable.

We began our work by creating a simple communications plan for social media and the website content. We then launched our Facebook page to offer a presence on social media. Since its inception, our Facebook page has had 295 page likes with 9,875 views. Unfortunately, since the website has not yet launched, we have no metrics for it at this point. However, once we make sure all the kinks are out, we anticipate the site to launch within the next few weeks. In sharing the unfinished website link with agents and specialists, all have said it is fantastic and will be instrumental in providing excellent information to agents, specialists, producers, and consumers. In addition to creating new tools, such as the decision tool of training needs for agents and producers, the website content is organized around the many levels of training described previously. The tree graphic in Figure 2 below represents the primary grower training areas of the website. The website will serve as an excellent platform for continued resource sharing. We will be using an analytics tool for capturing this data on a daily basis. We have also planned a series of agent webinars to provide guidance on using the website. Also linked to the website are our videos. The *On-farm risk assessment* and *Greenhouse GAPs* videos have been viewed 102 and 580 times, respectively. We have also utilized the videos at trainings, and they have been well received. We also created 9 factsheets, with more in the developmental phases--as mentioned earlier, much of the written content and graphics developed for the website is being re-tooled into factsheets and other resources where possible. One thing we have witnessed is that using a multi-pronged approach to resources development and training is the best way to conduct educational outreach, since people learn in different manners. By using a variety of delivery modes, we believe we will be able to reach a larger amount of producers and other clientele.

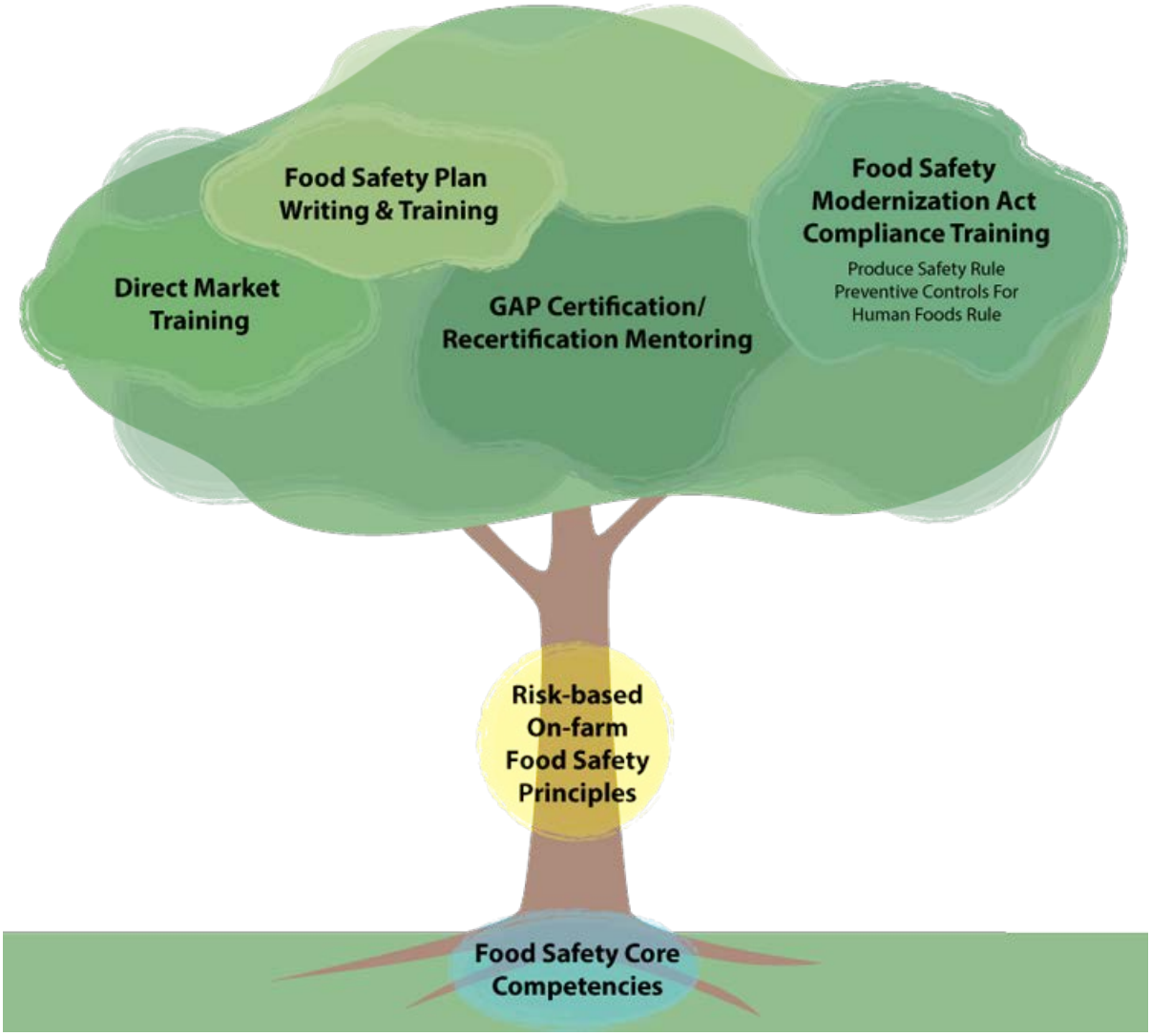


Figure 2. Agent Competencies. Food Safety Core Competencies and on-farm, risk-based food safety principles provide the structure needed to teach various levels of on-farm food safety training.

Goal 2: Increase the number of growers implementing on-farm food safety principles and/or obtaining GAP certification. (Achieved)

Performance Measure 2: 1) Number of new growers who incorporate GAP principles as a result of attending introductory level grower food safety trainings and utilizing various resources (measured using a pre- and post-training questionnaire immediately before and one year after training). 2) Number of new growers who become GAP certified through the process of attending advanced level grower food safety trainings, individual consults, and utilizing our various resources developed (measured using number of USDA GAP and HGAP farms certified at time of project grower trainings, and one and two years after training as posted on the USDA AMS website for certified farms in Virginia).

Benchmark 2: 1) Baseline-Number of farms participating in introductory or advanced trainings which currently incorporate on-farm GAPs, and 2) current number of USDA GAP or HGAP-certified farms in Virginia.

Target 2: 1) 75% increase in number of farms implementing GAP principles into their produce operation. 2) 10% increase in number of farms that become GAP certified.

We were very pleased with the level of participation we had from growers. 361 growers participated in our 16 trainings/workshops. While some workshops were geared to direct market producers, not requiring GAP certification, the level of interest and excitement was still strong, and there was indication most growers planned to implement GAPs on-the-farm and also in the marketplace. Of the growers attending advanced workshops, there were only about 5% that were already GAP-certified. While several training participants expressed interest in wanting follow-up for becoming GAP certified, many inquiries for mentoring came directly from growers and/or agents for support and guidance (who had not attended a training). During the project 34 growers and 26 agents were mentored. Of the growers mentored, we estimate 9 growers were certified, with a few more waiting until next year to follow through.

In terms of evaluating Goal 2 efforts, we have long realized that the effectiveness of our educational programming to growers should not be measured strictly by the number of growers who become GAP-certified, since ultimately pursuing certification is a market-driven decision. Even those growers who do pursue the certification process do not always complete the process for a variety of reasons. Sometimes, growers decide to pursue alternative markets (not requiring GAP certification); other times, they decide to wait given other more pressing demands. And, those growers becoming certified, don't always remain certified after their initial certification—again for many different reasons.

Thus, looking at the number of Virginia GAP-certified farms listed on the USDA AMS website does not really demonstrate the total number of farms in Virginia following best practices on-the-farm. There are hundreds of trained growers, who now are aware, knowledgeable, and committed to incorporating GAPs, even when they may not pursue certification. Most importantly, our primary guiding principle for success is to help growers understand on-farm, food safety, contamination risks and, subsequently, implement specific on-farm GAPs, regardless of whether or not they pursue certification. When growers do complete the audit process, we have had a 100% successful passing rate, and firmly believe the mentoring model is the ideal means to assist produce growers in Virginia. Ultimately, we are working to create a stronger food safety culture and mindset amongst our agents and growers!

BENEFICIARIES

The beneficiaries of this project are Virginia Cooperative Extension educators (agents) and the fresh produce growers, consumers of fresh produce, and the general public they serve. Agents had programming responsibilities in agricultural-related areas, as well as in family & consumer sciences. Growers ranged from small, urban- to greenhouse- to field and orchard production-farms. Markets they were tapping into were direct-to-consumer, restaurants, retailers, schools, institutions, and wholesale buyers. As mentioned previously, 44 agents and 361 growers benefitted from the project by raising their awareness, knowledge, and skills in performing on-farm risk assessments and implementing GAPs. Overall capacity and resource availability has been increased for both agents and growers. Additionally, results obtained from our consumer survey provided important guidance for further developing resources not only for consumers, but also for educators, who will work with these clientele.

LESSONS LEARNED

- As the project lead, I have learned so very much, and I know my cohorts have equally learned a lot as a result of this project! The first lesson learned is how important it is to have a great project team. ***Without team-work and everyone's contributions, we would not have been successful!*** Further, ***partnering with agents and grower collaborators on-the-ground was very important***. For all of the workshops, we always partnered with the local agents, and, when possible, held part of the workshop at a farm facility (i.e. packing house, greenhouse, farm site).
- Trainings, using a ***hands-on approach***, were far more effective than only using the typical Powerpoint lecture format. In many of our trainings, we provided risk assessment scenario break-outs and hands-on stations, which were well received, especially for workshops held during the off-season. The stations included sanitizer products, concentration calculation methods, and sanitation basics; measuring sanitizer strength and pH; temperature calibration; labels; weights and measures; and three-compartment sinks. This approach is a must, and when possible, training on-farm is the best training environment!
- In our project, we found that being flexible with what we originally proposed, in terms of ***training structure***, was important. Although we had originally proposed separate agent and grower trainings, we found that having 'mixed' trainings, consisting of both agents and growers, provided a wonderful opportunity for agents to mingle and learn first-hand of grower needs, perceptions, and challenges. It also was a great way to minimize costs by reducing travel expenses.
- For those growers needing GAP certification preparation support, ***mentoring agents and growers simultaneously*** was a very effective method (versus training the agent alone). Although it was more time consuming from the mentor standpoint, ultimately it helped the agent-in-training to gain greater confidence and apply themselves to a real world situation. Further, it fostered relationship building with the specialist mentor, agents, and growers, thereby strengthening important networks. In the long-run, this model is the most effective way to teach the GAP certification process. It also meant that the only travel expense was for the mentor traveling to the agent/grower location (vs several agents traveling to an in-service training).
- Further, as the mentor trainer, this approach provided a great opportunity for me to become familiar with many on-the-ground needs in different Virginia locations. My work in the field greatly enhanced the direction I felt was needed for the website content development.
- Developing and creating a comprehensive website is an amazing avenue for information dissemination, and we know it will serve us well into the future. It does require a ***tremendous level of effort***, requiring solid teamwork and support for developing content, as well as necessitating access to IT expertise. Because of the complexity of the website we developed, it took far more time than anticipated. The ***biggest challenge has been the focused time to write the content given so many other project demands***, not only on this current project's foci but on other closely related work. A big part of getting the content written was setting aside solid large blocks of time and writing. Delegating specific parts of the website to different people also helped to share the load and draw on the strengths of others. The project team has contributed much effort and significant time to this work, and we are eager to finally see this very important clearinghouse of resources launched!
- Because of the ***impact of the changing regulatory environment*** on food safety standards, especially during the time when our project began, we were somewhat in a holding pattern on some of the FSMA-related content. We wanted to make sure all materials were well aligned with the FSMA Produce Safety Rule (PSR) and language, so as to not cause confusion to growers and agents. Fortunately, several of us on the core project team are part of the Southern Regional Training Center (grant project), and were trained as trainers of the Produce Safety Rule and Preventive Controls Rule, so as to be better equipped to build capacity in VA. We are pleased with how we could integrate the regulation into the resources we have developed. Given our work

on other FSMA projects, the website will be an outstanding place for agents and producers to find the relevant resources they need.

- I think one of the best things about creating the website, is that it really helped me to organize and strategize with the rest of the project team on making the work we do be cohesive, and to identify gaps in information that we needed to address.
- ***Videos*** are excellent teaching tools, but they ***take a tremendous amount of effort and work to create***. While we took a lot of hours of footage all across the state, creating two excellent videos, we were unable to complete some of the other videos. A big part of this was the lack of time to write the scripts, as well as having proficient funds to edit the footage. In the future, we would hire professional videographers versus using student help; I would also allot more dollars towards this work. Incidentally we still plan on creating these other videos and using the footage we have since it is well done.
- In the proposal we discussed making webinars. Based on agent and grower feedback, we decided that ***videos would be more effective teaching tools***. While webinars can be effective, agents often do not have sufficient time to spend watching and listening to them. Shorter videos can be very effective in conveying lessons, especially when the videos are augmented with supplemental factsheets (like what we did with the Greenhouse GAPs video). Factsheet supplements can provide the necessary detail that is difficult to capture in a 5 minute video.
- We had originally proposed DVDs for sharing the videos, but given the changing technology we opted to instead purchase thumb drives which can hold the videos *and* other content. We think this will be a better use of the grant money. We plan to make thumb drives available for agents with web content and any other needed files.
- The ***consumer survey was well worth the effort*** and we feel we gleaned a lot of useful information. Working with MSU was a wonderful experience, and we believe we can build upon what we learned with the survey.
- The ***project proposal was ambitious to say the least***, so some of the resources we had hoped to finish like the manual guidebooks were not completed (yet). Given all the trainings and other resources we proposed, especially the website and videos, it was a lot to tackle!
- As ***project lead, I think the greatest challenge was time management and having to juggle too many different projects at once***. This was especially true since I was also one of the key trainers and the sole GAP certification mentor for the project. Having to travel a lot meant not being able to focus on content development, BUT being in the field kept me in tune with agent and grower needs, and also the opportunity to run ideas past them!
- Given the enormity of this work, and the fact that everyone has many responsibilities on different fronts, I found that ***setting aside face-to-face meeting times*** and creating to-do lists together greatly helped to accomplish many of the tasks at hand. Follow-through was slow at times, so I would suggest building in more than enough time to get what is needed, and make sure to have regular check-ins.
- I did and do have an amazing IT person. ***If anyone is endeavoring to create a website, having a skilled and easy-to-work-with IT person is imperative***. That person should be well funded through the budget.

CONTACT PERSON

Amber D. Vallotton, M.S., Extension Specialist, Department of Horticulture, Virginia Tech
540-231-5655
avallott@vt.edu

ADDITIONAL INFORMATION

Virginia Fresh Produce Food Safety Website

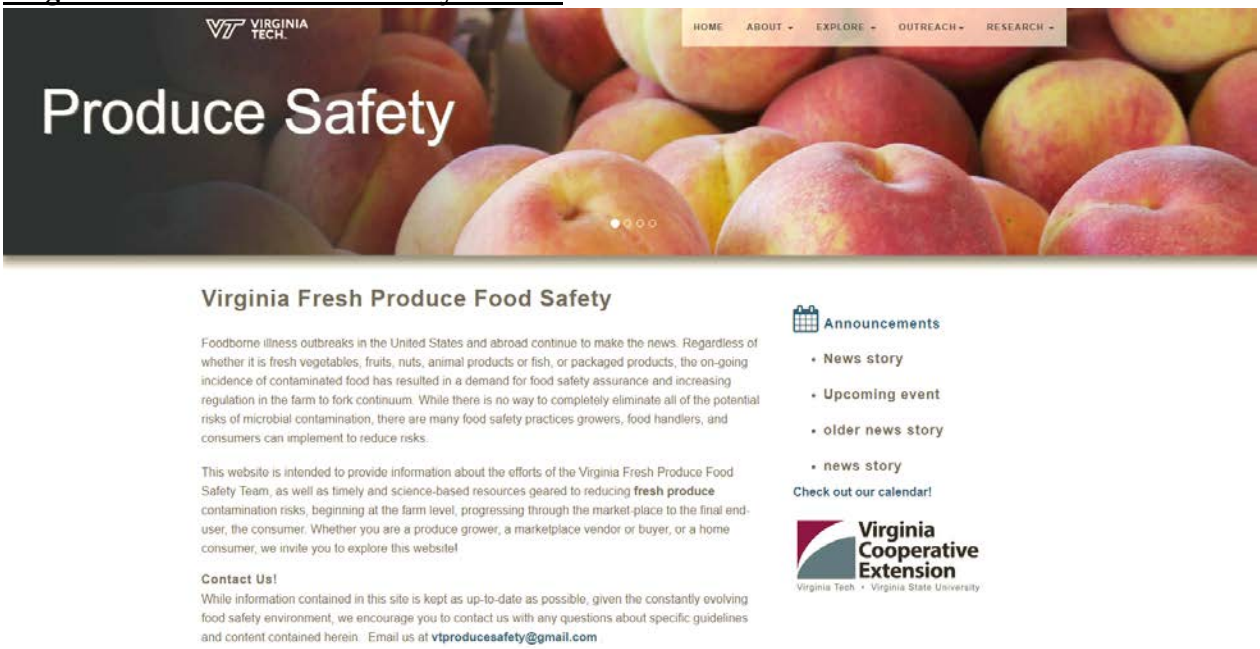


Figure 3. Home Page of the Website.

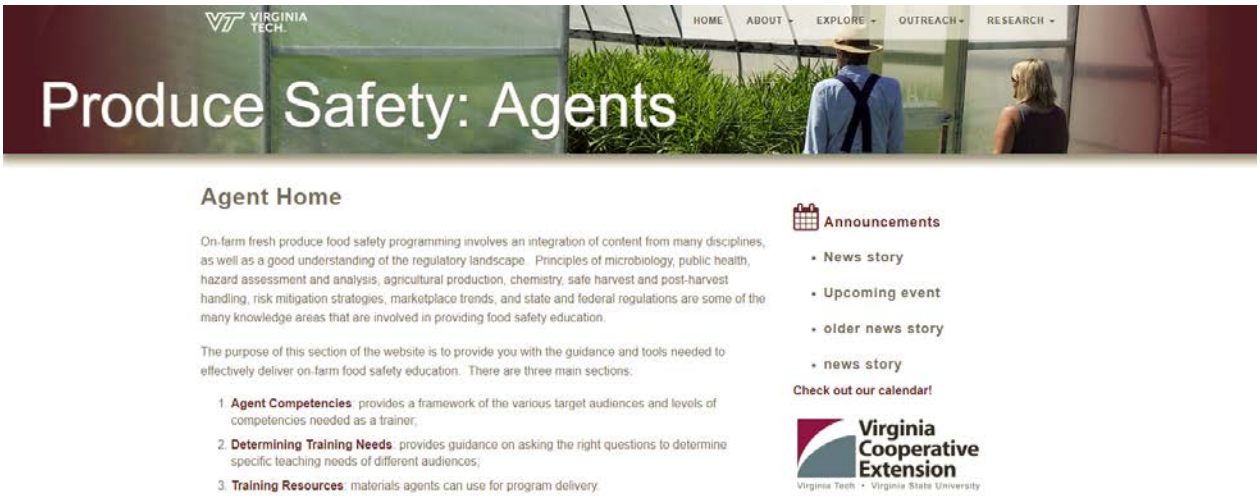


Figure 4. Agent Section of the Website. This portion of the website is password-protected and provides information for agents related to their personal professional development ("Agent Competencies"), determining specific grower and consumer needs ("Determining Training Needs"), and a wealth of resources they can use for program delivery ("Training Resources").

Figure 5. Producer Section of the Website. This portion of the website provides information for producers related to understanding marketplace food safety requirements and hurdles ("Accessing Markets"), helping growers determine specific educational resources they should access based on their food safety needs ("Producer Decision Tree"), input on a variety of topics ("Producer FAQs"), and a wealth of info and links to materials producers can access covering same topics as agent resources ("Producer Resources").

Figure 6. Consumer Section of the website. This portion of the website provides consumers guidance on non-commercial production of fruits and vegetables ("Food Safety for Home and School/Community Gardening"), characteristics to help consumers select and purchase safe produce ("Considerations for Purchasing Safe Produce"), links to information ("Consumer Safe Food Handling, Preservation, and Storage"), and general questions about foodborne illness and produce outbreaks (Consumer FAQs).

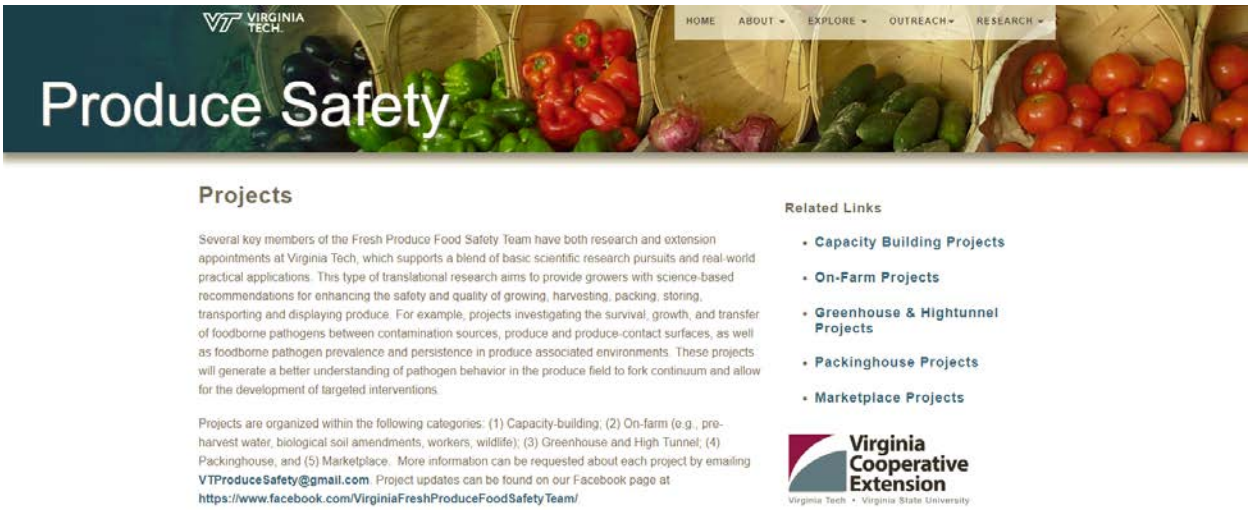
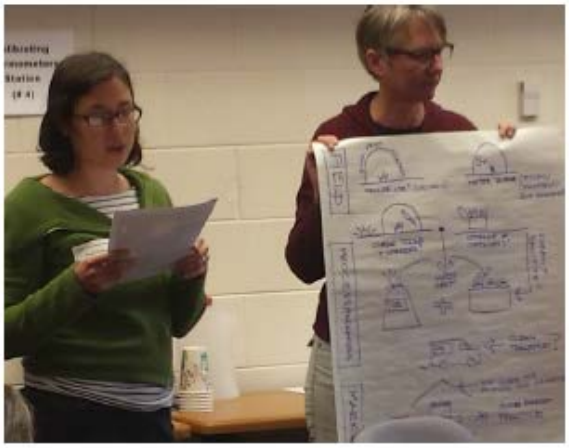


Figure 7. Research section of the website. This portion of the website highlights several of the various research projects of the members of the Fresh Produce Food Safety Team. Projects are organized into the following categories: capacity building, on-farm, greenhouse and hightunnel, packinghouse, and marketplace projects.

Training Workshop Photos







GAP Certification Preparation Mentoring Photos








Other Information Provided as Attachments

- Decision Trees
  - Agent decision tool for determining grower training needs (jpg)
  - Grower decision tool for determining specific training and resources a grower needs (jpg)
- USDA GAP Manual Checklist Templates (pdf)
- USDA HGAP Manual Checklist Templates (pdf)
- Factsheets (pdfs)
  - A Guide to the Good Agricultural Practices (GAP) Certification Process (HORT-252NP)
  - Guide to Identifying Food Safety Hazards in Greenhouse Systems (HORT-254NP)
  - Guide to Identifying Hazards in Packinghouse Environments (FST-279NP)
  - Overview of the Food Safety Modernization Act Produce Safety Rule (FST-270NP)
  - Food Safety Modernization Act Produce Safety Rule: Agricultural Water (FST-271NP)
  - FSMA Produce Safety Rule: Wildlife and Domesticated Animals (FST-271NP)
  - Food Safety Modernization Act Produce Safety Rule: Worker Health, Hygiene and Training (FST-278NP)
  - GAPs and FSMA – an Overview for Hop Growers in Virginia (HORT-237NP)
  - Assessing On-Farm Produce Safety Risks (in press)
- Consumer Survey
  - Questionnaire (pdf)
  - "Virginian's Perceptions of Fresh Produce Food Safety" Talk (pdf)

4
A. Stewart
Virginia Tech
Final

PROJECT TITLE

Cider Production from Virginia-grown Apples: Development of Research-Based Fermentation Strategies

NAME OF ORGANIZATION

Virginia Tech, Department of Food Science & Technology

PROJECT SUMMARY

With the increasing number of cider producers in Virginia and throughout the US, there is an immediate need for research and extension programs that will allow Virginia's cidermakers to be at the forefront of this burgeoning industry. Sulfur off-odors are a persistent problem in cider production, often associated with failure to optimize yeast assimilable nitrogen (YAN) pre-fermentation. This project provided evidence that apples are lower in YAN on average, as compared to wine grapes, however wine fermentation practices are currently directly applied to cider fermentation. Through this project, we also evaluated amino acid composition in Virginia-grown apples, and observed marked differences compared to grape. By boosting the methionine concentration in apple juice pre-fermentation, decreased hydrogen sulfide production was achieved, resulting in differences in cider aroma. This project concluded with an Extension workshop organized by Virginia Tech Research and Extension faculty. Results of this applied research project were communicated to the Virginia cider industry within the context of cider fermentation best practices. The workshop proved to be a useful resource for current and prospective cider makers in Virginia. The successful expansion of the cider industry will lead to increased sale of and value for specialty crops in the Commonwealth.

PROJECT PURPOSE

The long-term objectives of this research program are to develop research-based cider making strategies, optimized for high-quality cider production from Virginia-grown apples, and to provide effective and accessible training opportunities to Virginia cider makers. Research and extension in this area will increase the value of Virginia-grown apples.

With the recent exponential increase in the number of cider producers in Virginia and around the US, there is an immediate need to develop research and extension programs that will allow the State's cider makers to be at the forefront of this burgeoning industry. Nationally, cider production more than doubled between 2008 and 2011, when the Alcohol and Tobacco Tax and Trade Bureau reported that there were 1.1 million gallons of hard cider produced in the U.S (Matson Consulting, 2012). Market reports from third-party firms have estimated that cider sales have been increasing 50% per year since 2010 (Canadean, 2013). Virginia currently has eight licensed commercial cideries, all

of whom use Virginia-grown apples. As part of a VDACS Specialty Crop Block Grant (SCBG), Virginia Tech researchers surveyed commercial cider makers in 2012 and found that on average they expected their production to increase three-fold over the next five years, and at least two new cideries are slated to open within the next year. Virginia cider industry is similar to the scale of the Virginia wine industry just 30 years ago, but it may not take nearly that long for cider production to equal or surpass the volume and economic impact of Virginia wine.

The expansion of cider production supports existing farmers by providing additional value-added outlets for specialty crops grown in the Commonwealth. However, there is a lack of reliable research-based information to provide to these clients. Competition for retail shelf space and brand loyalty is likely to increase from regional, national, and international cider brands as cider claims increasing market share in the alcoholic beverage sector. **The outcomes of this project will make Virginia's cider producers and apple growers more competitive by providing research-based fermentation strategies for production of consistent, high quality cider from Virginia-grown apples.**

Hard cider production is a viable means of value-added processing for Virginia apples, a specialty crop in need of additional market outlets. Hard cider production involves cultivar selection, orchard management, fruit maturity assessment and the post-harvest operations of milling, pressing, fermentation, clarification, filtration, and bottling. Whereas most of the post-harvest processes involved in cider production are physical and chemical in nature, fermentation is a complex microbiological process whereby living organisms (yeast) convert sugar into ethanol, carbon dioxide, and flavor-impacting secondary metabolites. As such, development of a defined fermentation management strategy is required for consistently successful cider production, without the production of off-aromas during fermentation. Many factors directly affect the fermentation process including temperature, acidity, yeast strain, microorganisms from the apple juice, sulfur dioxide dosage, nitrogen management, yeast nutrition, aeration, and mixing.

In commercial cideries, fermentation strategies are mostly based upon standard winemaking practices. However, while there are some similarities between grape wine and apple cider, there are enough differences that cidermakers will greatly benefit from fermentation strategies developed specifically for their production conditions. For example, wine grapes generally contain 1.5 to 2 times more sugar than apples and the acidity of cider is more variable than it is for grapes. Moreover, traditional cider fermentation temperatures are often very low compared to wine fermentation, resulting in slow fermentation rate and much longer duration of the fermentation process than in wine production. These factors can lead to unwanted microbial growth during fermentation and defective products with acetic acid (vinegar) and sulfur off-odors. These negative sensory characters greatly reduce the value of hard cider, and can even lead to batches that must be discarded. Virginia apple growers work diligently year in and year out to produce high quality fruit. By improving fermentation success rate and reducing the incidence of sensory faults in cider, Virginia apples will be consistently transformed into world-class cider. This two-year project contributed to the development of reliable, optimized fermentation management strategies for cider production and will thus increase the value of Virginia-grown apples.

There were **three main objectives** for this project:

1. Survey yeast assimilable nitrogen concentration in Virginia cider apples, and determine pre-fermentation amino acid profiles in juice from apple cultivars used for cider production.

2. Establish research-based, optimized fermentation strategies for cider production from Virginia-grown apples, and publish an Extension fact sheet on the role of yeast assimilable nitrogen in cider fermentation.

3. Communicate the results of this research within a framework of cider fermentation best-practices to Virginia cidermakers through an Extension workshop on Cider Fermentation organized by Virginia Tech research and extension faculty from Food Science & Technology and Horticulture Departments in Spring 2016.

The VDACS-SCBG program has previously funded projects that show the cideries and cider apple orchards are economically feasible, provided support to establish more than 30 acres of new orchards for cider, and helped establish horticulturally-focused projects, including two variety trials. This project built upon the prior SCBG-funded work to develop downstream cider-specific fermentation management strategies so that cidermakers can systematically produce a reliable value-added specialty crop product, thus maximizing the investment made into this research area.

PROJECT ACTIVITIES

The project activities will be summarized by Objective (Objectives 1-3 were identified in the Project Purpose section above).

Objective 1: ***Survey yeast assimilable nitrogen concentration in Virginia cider apples, and determine pre-fermentation amino acid profiles in juice from apple cultivars used for cider production***.

Yeast assimilable nitrogen (YAN) is essential for yeast growth and metabolism during apple (*Malus* x *domestica* Borkh.) cider fermentation. YAN concentration and composition can impact cider fermentation kinetics and the formation of volatile aroma compounds by yeast. The YAN concentration and composition of 12 apple cultivars grown in Virginia, USA over the course of two seasons were determined through enzymatic assay of both free amino nitrogen (FAN) and ammonium ion concentration. YAN concentration ranged from 9 to 249 mg N L^{-1} among cultivars, with a mean value of 59 mg N L^{-1}. FAN was the largest fraction of YAN, with a mean value of 51 mg N L^{-1} as compared to 8 mg N L^{-1} of ammonium. Ninety-four percent of all samples analyzed in this study contained less than 140 mg N L^{-1} YAN, a concentration generally considered the minimum sufficient to complete fermentation. Over the two years of this study, only one cultivar in one year had a mean YAN concentration exceeding 140 mg N L^{-1}. FAN and YAN concentrations were correlated, but neither

YAN nor PAN values were correlated to ammonium concentrations. We have submitted a manuscript reporting these results to the Journal of the Institute of Brewing, and it is currently under review.

Amino acid analysis was performed 15 cultivars grown in the same research plots in the 2014 growing season. The amino acid profile in apples with potential for cider making is substantially different than that reported in wine grapes. *Vitis vinifera* wine grapes are rich in proline and arginine, while the apple cultivars included in this survey are richer in asparagine and glutamine. We are currently preparing a manuscript to report these results and plan to submit this manuscript to the Journal of Food Composition and Analysis in early 2017. The impact of these differences on yeast metabolism during fermentation warrants further research and we began to address these questions in response to Objective 2 of this project.

Objective 2: ***Establish research-based, optimized fermentation strategies for cider production from Virginia-grown apples, and publish an Extension fact sheet on the role of yeast assimilable nitrogen in cider fermentation.*** Apple juices with modified amino acid profiles were fermented and H_2S production during fermentation was monitored. H_2S is a volatile off-aroma produced during yeast metabolism, and many yeast nutrition regimes aim to prevent production of this off-aroma. A thorough review of the literature revealed that a lack of methionine in juice pre-fermentation can lead to production of H_2S by certain yeast strains during fermentation. Our amino acid profiling results in Objective 1 indicated that apple juice is lower in methionine than grape juice, and that supplementation with methionine could be a good strategy to address the prevalence of H_2S production in cider fermentation. Indeed we observed that supplementing apple juice with methionine to levels observed in grape juice led to decreased production of the off-aroma H_2S during cider fermentation. A manuscript reporting the results of this study has been submitted to the Journal of the Institute of Brewing and is currently under review.

Objective 3: ***Communicate the results of this research within a framework of cider fermentation best-practices to Virginia cidermakers through an Extension workshop on Cider Fermentation organized by Virginia Tech research and extension faculty from Food Science & Technology and Horticulture Departments in Spring 2016***. This workshop was held at the Alson H. Smith, Jr. Agricultural Research and Experiment Station at Winchester, VA, in conjunction with the Frederick Co. Extension Office (Mark Sutphin). Dr. Stewart, Dr. Peck and graduate student Brianna Ewing provided original research updates based on findings in this project, as well as educational

presentations on fermentation management and sensory faults detection (with samples prepared by Dr. Molly Kelly, VT FST). Progress on objectives 1 and 2 allowed us to make cutting edge research-based recommendations for improved cider fermentation, specifically with regards to pre-fermentation nitrogen analysis and adjustment. Increase in cidermakers' knowledge of cider fermentation management was assessed via pre- and post-surveys at this workshop, and results of this evaluation are attached to the present report.

GOALS AND OUTCOMES ACHIEVED

The key measureable outcome of this project was to realize a 50% improvement in cidermakers knowledge of prevention of common pitfalls in cider fermentation. Our workshop evaluation of pre- and post- knowledge (attached to this report) indicated the following quantitative increases in knowledge on the topics listed (self-reported by workshop attendees):

TOPIC	INCREASE IN KNOWLEDGE
Cider Fermentation	42%
Yeast Assimilable Nitrogen	103%
Sensory Faults in Cider	78%
Chemical Constituents of Cider Apples	62%

A >50% increase in knowledge was achieved for 3 of the 4 topics related to cider fermentation and cider production best practices.

BENEFICIARIES

Virginia's cider makers, prospective cidermakers, and apple growers directly benefited from the workshop described in Objective #3, which aimed to disseminate the results of research conducted through this project in the context of cider fermentation best practices. This workshop filled to capacity weeks before the deadline for registration, with 48 attendees registered, and several extra showing up the day of the workshop. Based on results of our evaluation survey (attached), attendees reported knowledge gained on the following topics, through workshop participation: Cider Fermentation, Yeast Assimilable Nitrogen (YAN), Sensory Faults, Chemical Constituents of Cider Apples, How Apple Varieties Influence Cider Quality, Harvest Maturity and Post Harvest Storage, Apple Varieties to Grow

for Cider. Cidermakers listed the following planned changes in practice, based on knowledge gained through the workshop:

"Pay more attention to YAN levels."
"Pay more attention to apple storage."
"Continue to learn and research as much as possible."
"Sanitize."
"Think about sulfur residue."
"Build a better budget, make partnerships"
"Remain aware of the science going on that can help you."

The national cider industry has also benefitted from the results of this research through our group's oral and poster presentations at the national cider industry conference, Cider Con, in Feb. 2015 (Chicago, IL) and Feb 2016 (Portland, OR). Approximately 500 stakeholders attended each of these national meetings. Presentations given at Cider Con were as follows:

Stewart, A.C. Cider Apple Polyphenols: Fruit Production and Processing Factors, Flavor, and Human Health Impacts. CiderCon. Chicago, IL, 2/5/15.

Boudreau, T.F*., Peck, G.M.; Stewart, A.C. 2015. Survey of Yeast Assimilable Nitrogen Concentration and Composition in Fifteen Virginia Cider Apple Cultivars. CiderCon. Chicago, IL, 2/6/2015. *Poster.*

McGuire, M.N*., Boudreau, T.F.*, Stewart, A.C., Peck, G.M. 2015. Crop Load Impacts Total Polyphenol and YAN Concentration in York Apples. CiderCon, Chicago, IL, 2/6/2015. *Poster.*

A poster was also presented at the World Brewing Congress in August 2016 (Denver, CO) to approximately 2000 attendees, as follows:

Boudreau, T.F.*, Ma, S.; Patrick, N.; Peck, G.M; Duncan, S.; O'Keefe, S.; Stewart, A.C. The Impact of Yeast Assimilable Nitrogen Concentration and Composition on Fermentation Kinetics and Hydrogen Sulfide Production during Cider Fermentation. World Brewing Congress, Denver, CO, USA. 8/14/16. *Poster.*

A poster was presented at the American Chemical Society annual conference (over 10,000 attendees annually), in 2016. Citation follows:

Ma,S.*; Peck, G.M.; Stewart, A.C. Survey of amino acid composition in cider apples grown in Virginia by UPLC-PDA. 251st American Chemical Society National Meeting and Exposition. San Diego, CA 3/13/2016. *Poster*.

A poster was also presented at the 2015 Institute of Food Technologists meeting (>10,000 attendees, national meeting), citation follows:

Boudreau, T.F*., Peck, G.M.; Stewart, A.C. 2015. Survey of Yeast Assimilable Nitrogen Concentration and Composition in Fifteen Virginia Cider Apple Cultivars. Institute of Food Technologists Annual Conference, Chicago, IL. 7/12/2015. *Poster.*

A poster was also presented at the 2015 American Society for Enology and Viticulture meeting on 6/16/2015 in Portland, OR, to approximately 400 wine industry stakeholders; citation follows:

Boudreau, T.F.* McGuire, M.*, Peck, G.M., Stewart A.C. Impact of Cultivar and Crop Load on Yeast Assimilable Nitrogen in Cider Apples Grown in Virginia. 2nd International Symposium on Nitrogen in Grapes and Wine and ASEV National Conference, Portland, OR. 6/16/2015 and 6/17/2015. *Poster.*

LESSONS LEARNED

The workshop held to fulfill Objective #3 of this project was over-subscribed. Due to space limitations in the workshop venue, we could not accommodate all interested parties. Several County Extension Agents from Northern and Central Virginia attended the workshop and have offered to help host future workshops in their regions. In the future, we will make a strong effort to keep County Extension personnel abreast of our research projects and any associated training opportunities. In addition, the Extension fact sheets that were to be generated to fulfill the second part of Objective #2 are still in progress. Personnel changes during the course of the project (Extension Pomologist, Dr. Peck, leaving Virginia Tech in 2015), resulted in delays in writing Virginia Tech Extension materials. Dr. Stewart will follow through on this in 2017, as there is currently no Extension Pomologist on staff at VT. We are currently in the process of interviewing and hiring for this position.

CONTACT PERSON

Amanda Stewart, Department of Food Science & Technology, Virginia Tech

Phone: 540.231.0868

Email: amanda.stewart@vt.edu

ADDITIONAL INFORMATION

In addition to fulfilling the objectives of this project, Dr. Stewart leveraged startup funds (Virginia Agricultural Experiment Station and Hatch funds) to conduct additional research on apple fermentation not originally described in this project proposal, but utilizing a similar experimental approach as that developed for this project. This work resulted in a peer-reviewed publication in the Journal of the Science of Food and Agriculture entitled "The interactive effect of fungicide residues and yeast assimilable nitrogen on fermentation kinetics and hydrogen sulfide production during cider fermentation." This additional project was made possible by the experimental apparatus developed and tested through this SCBG-funded project. This is only one example of many planned projects that will utilize similar approaches to those developed in this SCBG-funded project to address emerging challenges in cider fermentation.

5
C. Cook
VAFAIRS
Final

PROJECT TITLE
Chestnut Production and Marketing Feasibility Study

NAME OF ORGANIZATION
Virginia Foundation for Agriculture, Innovation and Rural Sustainability

PROJECT SUMMARY
This study comprehensively analyzes and substantiates the growth of Virginia's chestnut industry. The study is composed of two parts, along with a series of accompanying short videos. This report acts as a how-to guide for producing organic chestnuts in Virginia. The first part discusses steps and tips for establishing, maintaining, harvesting, and marketing chestnuts and chestnut orchards. The authors also provide recommendations based on interviews with growers and visits to existing orchards. Additional resources for growers are also available in this portion. The analysis portion of the document focuses on the economic viability of selling fresh chestnuts. The study discusses the current chestnut industry within the United States and Virginia, including sales and uses for chestnuts, general operating procedures, and cooperative organization. The document also presents a model cooperative which aggregates and stores chestnuts from producers statewide, selling the fresh chestnuts to wholesale clients within the state. A baseline financial analysis determined the amount of supply and sales needed for the venture to break even. The consultants also created scenarios to view the effects certain financial changes would have on the business. Overall observations and recommendations are included.

PROJECT PURPOSE
The purpose of the project is to evaluate and support the expansion of the chestnut industry in Virginia. Virginia FAIRS and partners identified a specific need to help address gaps in the available information for chestnut farmers in the state. The objective of this study is to improve the understanding of market demand for chestnuts, explore the economics of producing chestnuts, and compile valuable technical information related to producing chestnuts.

This project was conducted at a time when many groups are looking at how to grow the chestnut industry within Virginia. Chestnut farmers are exploring more collaborative ways to increase their production and find new markets for their products.

The U.S. chestnut industry is fairly insignificant on an international scale, accounting for less than 1% of chestnut production worldwide. The United States produced about 1,300 metric tons of chestnuts in 2012, while U.S. demand stands at about 4,000 metric tons per year, with international markets meeting the majority of that demand. This level of demand has remained steady for years and is anticipated to continue until a major industry change occurs. Virginia currently ranks 7th among chestnut producing states, with average farm size at about 4.3 acres. This number reflects an average of 2.9 bearing-age acres per farm and production of about 2,200 pounds of chestnuts per farm each year.

Many Virginia chestnut farmers produce chestnuts out of personal interest in preservation and promotion of chestnuts for the sake of their unique, historical value. Many growers produce chestnuts as more of a hobby or side venture than a profitable business model. The income of most (88%) chestnut farmers in the state consists of only 0-10% revenue from chestnuts, with the remainder of their income sourced through other farming efforts or non-farm businesses.

PROJECT ACTIVITIES

Chris Cook and Stephen Versen sought a consultant to complete the feasibility study work in November 2014. Matson Consulting was selected to complete the work due to their previous experience providing this type of document. The consultants communicated and exchanged information with VA FAIRS and the Virginia Tech team. They submitted drafts for review in July and August 2015. Matson Consulting submitted the study to Chris Cook in Oct. 2015 for inclusion in the overall document. The study found that the current chestnut industry would not support a full scale chestnut cooperative. The consultants recommend coordinating with other states for supply. With industry growth, a cooperative, combined with marketing campaigns to increase potential producer and customer awareness, would help grow the state's industry.

Concurrently with the creation of the feasibility study, Katie Commender and John Munsell from Virginia Tech conducted interviews and research to gather the necessary data for a chestnut production report and to also help inform the feasibility study. The production data report was completed and submitted to Chris Cook to be compiled in the final document. Along with this report, production videos were also produced and shared with the project team before publication.

In November and December 2015, VA FAIRS compiled the feasibility study and production data report into one overall document and completed final editing. The production videos were uploaded to the VA FAIRS Youtube channel.

GOALS AND OUTCOMES ACHIEVED

Goal 1: Create third party independent feasibility study for the production and marketing of chestnuts

This goal was achieved and the final feasibility study was shared and made publicly available online.

GOAL 2: Disseminate the feasibility study, production fact sheet, you tube video series and other key findings to interested parties

The feasibility study and videos were shared with all interested parties including chestnut growers and other organizations. The study was posted to the VA FAIRS website and the videos are uploaded to the VA FAIRS Youtube page. The study has been viewed by numerous parties and continues to be viewed on our website. The target views for the site were 100 visits; we have had 1,389 visits to the site since we shared the document. The videos have combined over 2,500

views since they have been uploaded. These views continue to grow as more people discover the site and feasibility study.

We have concluded that there is a growing interest in chestnut production and marketing in the state and surrounding areas. We will continue to share this information with interested parties to continue the impact of the project.

BENEFICIARIES

This information is shared online on the VA FAIRS website, as well as the VA FAIRS Youtube channel. The document is available for any interested parties to view. It has been specifically shared with chestnut farmers in the state, the Virginia Department of Agriculture and Consumer Services, and multiple other outside organizations.

Multiple groups and individuals benefitted from this project. We estimate that this project had approximately 50 beneficiaries.

These groups benefitted from the project by gaining expanded knowledge about the best practices for chestnut production and the potential for working collaboratively to increase the industry overall. The project also provided the information necessary for groups to determine whether or not a chestnut cooperative in the state would be a viable opportunity for growing production and sales.

LESSONS LEARNED

During the project, it became necessary to share large amounts of data and information between parties. Typically this information would be shared via email, but many times the document size or volume of information was difficult to share and keep organized. To address this issue we implemented a shared file through Drop Box so that each member of the project team could easily share information and make contributions. It also allowed us to keep track of what information we had and what we still needed.

During project development, we learned that the chestnut industry is continuing to grow and it looks promising for future growth. A key aspect of the project was the interviews with chestnut farmers on the ground. This allowed us to have a better understanding of the industry needs.

CONTACT PERSON

Chris Cook
• Telephone Number- (804) 290-1111
• Email Address- Chris.Cook@vafb.com

ADDITIONAL INFORMATION

Organic Chinese chestnut Production in Virginia – available for download on www.vafairs.com
Feasibility Analysis of a Prototypical chestnut Cooperative - available for download on www.vafairs.com
Video series: Bringing back the chestnut - available for viewing on www.vafairs.com and on Youtube

6
G. Peck
Virginia Tech
Final Report

PROJECT TITLE
Advancing Organic Apple Production in Virginia (*Memorandum of Understanding Agreement # FFY 2014-571*)

NAME OF ORGANIZATION
Virginia Tech

PROJECT SUMMARY
Growing apples organically in Virginia can be very challenging due to the intense insect, disease, and weed pressure in the mid-Atlantic region. Some of these challenges are unique to organic production, and for that reason, may not have been the main focus of university research and extension programs. However, as the demand for organic products remains high and new tools and techniques become available for organic growers, there is a need to conduct research specifically for organic production. Through the work conducted for this SCBG, we targeted some of the key barriers that have prevented Virginia growers from adopting organic apple production methods. Our project has led to the development of more reliable organic crop load and disease management practices. Additionally, we held a one-day workshop and taught 50 growers about organic apple production techniques. Ultimately, we hope that our work will increase the number of organic growers and the acreage of organic apple orchards in the Commonwealth.

PROJECT PURPOSE
The purpose of this project was to increase the ability of beginning and existing apple producers to effectively use organic orchard management practices. We aimed to do this by targeting several key barriers that have historically prevented Virginia growers from adopting organic production methods. Dr. Peck's previous research experience in New York State demonstrated that there were significant limitations to growing organic apples in humid conditions. His work was summarized in the popular extension book, "A Grower's Guide to Organic Apples" (http://nysipm.cornell.edu/organic_guide/apples.pdf). Among the greatest limitations in organic apple production are: obtaining a desirable number of apples so that neither the current year's fruit size nor developing flowers for next year's crop are reduced (known as managing crop load) and managing the more than one dozen diseases that affect apples and apple trees. This SCBGP-funded project aimed to overcome these issues for Virginia's growers.

Well-managed apple trees typically produce about ten times more blossoms than are needed to produce a full crop of acceptably-sized fruit in Virginia. In order to minimize tree damage from over-cropping, improve fruit size, and ensure that the trees produce an adequate number of fruiting buds for the following year, the flower and/or fruit load must be reduced or "thinned". Drs. Yoder and Peck, and Mr. Combs, have been addressing the bloom thinning of organic apples in a project funded by the Washington Tree Fruit Research Commission. From this work, we have developed a model that accurately predicts the ideal application timing of bloom thinning chemicals. While growers in Washington State have readily applied this model

information in their orchards, it has only been in the last couple years that Virginia growers have shown an interest in bloom thinning. This is largely because of concerns that spring frosts may further damage blossoms and result in too few fruit to harvest. However, more and more Virginia apple farmers are transitioning from growing fruit for processing to the more competitive fresh fruit market where annual production of large fruit is essential, and as they do, the benefits of bloom thinning are now becoming better recognized in the State.

Additionally, our previous research has shown that the fungicide, lime sulfur, is a reliable apple bloom thinner. Among the many fungal diseases that need to be managed in Virginia, cedar-apple rust and quince rust are formidable barriers to organic apple producers. The materials of interest for bloom thinning [namely liquid lime sulfur, JMS Stylet-Oil, and Regalia (a knotweed extract)] are also approved for disease control in organic production systems, and recent tests at the Winchester fruit research lab indicate that the control of rusts by a combination of Regalia and JMS Stylet-Oil is unique among the limited organic options.

Our project sought to integrate bloom-thinning applications with early season disease control, including rusts. Our goal was to more adequately manage apple crop load while reducing the number of fungicide applications that are needed. The approach explored the use of registered rates of the fungicides, such as lime sulfur and Regalia, to bloom thin apples. The project therefore created valuable information for organic apple growers in the mid-Atlantic region, and resulted in a potential reduction of pesticide use and disease incidence for these growers.

PROJECT ACTIVITIES

1) Organic Apple Workshop: On 25 Aug 2015, over 50 people attended the "Commercial Apple Production Field Day" at the Alson H. Smith, Jr. AREC. Below is the agenda from the Field Day:

Topic	Speaker
Organic Certification Requirements	Beth Sastre (VCE) & Sue Ellen Johnson (Virginia Association for Biological Farming)
Site Selection/Orchard designs	Mark Sutphin (VCE) & Greg Peck (VT)
Cultivar and Rootstock Selection	Greg Peck (VT)
Soil and Fertility Management	Ashley Thompson (VT)
Crop Load Management and Bloom Thinning in Organic Orchards	Candace DeLong (VT), Leon Combs (VT), & Greg Peck (VT)
Disease Management	Keith Yoder (VT)
Arthropod Management	Chris Bergh (VT)

2) Bloom thinning tests: A replicated trial was conducted at the Alson H. Smith, Jr. AREC in 2015. In this study, applications of bloom thinning chemicals were evaluated for their early season disease control of powdery mildew [*Podosphaera leucotricha* (Ellis & Everh.) E. S. Salmon] and cedar-apple rust (*Gymnosporangium juniperi-virginiana* Schwein.) in an organically managed 'Honeycrisp'/'MM.111' orchard. Labeled rates of lime sulfur or Regalia® were both applied with JMS Stylet-Oil as flower thinning agents with application timing based

on a ‘Honeycrisp’-specific, temperature-based pollen tube growth model. There were four flower thinning treatments, each of which consisted of two separate applications—lime sulfur followed by lime sulfur or Regalia, and Regalia followed by lime sulfur or Regalia. There was also an untreated control, a hand-thinned control, and a “grower’s standard” control of lime sulfur applied when fruitlet size was on average 10 mm dia.

3) Graduate student to present preliminary results at professional meeting in New Orleans, LA: Candace DeLong presented a paper at the American Society for Horticultural Science Annual Meeting in July 2015. The citation for her talk is:

DeLong, C., K. Yoder, L. Combs, and G. Peck. 2015. Evaluating the Pollen Tube Growth Characteristics of Different Crabapple Cultivars. HortScience 50(9):S178 (Abstr.).

4) Complete bloom thinning data analyses and communicate results as extension and peer-reviewed publications: The following papers have been direct outputs from this grant.

Peck, G.M., C.N. DeLong, L.D. Combs, and K.S. Yoder. 2016. Managing Crop Load and Diseases with Bloom Thinning Applications in an Organically Managed ‘Honeycrisp’/‘MM.111’ Orchard. HortScience (submitted).

DeLong, C.N., K.S. Yoder, L. Combs, R.E. Veilleux, and G.M. Peck. 2016. Apple Pollen Tube Growth Rates Are Regulated by Parentage and Environment. Journal of the American Society for Horticultural Science. (In press).

Peck, G., C. DeLong, and K. Yoder. 2016. Integrating crop load management with disease control in an organically managed apple orchard. HortScience. (Abstr. in press).

Peck, G.M., L.D. Combs, C. DeLong*, and K.S. Yoder. 2016. Precision Apple Flower Thinning using Organically Approved Chemicals. Acta Hortic. 1137: 47-52.

Peck, G., K. Yoder, C. DeLong, A. Cochran II, L. Combs, D. Carbaugh, A. Kowalski, W. Royston, Jr., S. Kilmer, M. Borden, J. Repass, S. Athey, and T. Mackintosh. 2015. Managing Crop Load and Diseases with Bloom Thinning Applications in an Organically Managed ‘Honeycrisp’/‘MM.111’ Orchard. Great Lakes Fruit Workers’ Meeting. Geneva, NY. 2 pp.

This project only focused on apple production.

GOALS AND OUTCOMES ACHIEVED

1) Organic Apple Workshop: We asked the participants to rate their level of knowledge on a scale of 1 to 5, where 1 means “a very low level of knowledge” and 5 means “a very high level of knowledge” before and after the meeting.

BEFORE					TOPIC	AFTER				
1	2	3	4	5		1	2	3	4	5
13%	26%	30%	26%	5%	1. Organic Certification			17%	66%	17%
	27%	46%	18%	9%	2. Site Selection and Orchard Design			23%	68%	9%

9%	26%	38%	22%	5%	3. Cultivar and Rootstock Selection		5%	36%	54%	5%
	13%	44%	39%	4%	4. Soil and Fertility Management			21%	67%	12%
14%	41%	27%	14%	4%	5. Crop Load Management and Bloom Thinning			27%	55%	18%
4%	39%	35%	13%	9%	6. Disease Management		4%	35%	52%	9%
9%	32%	36%	9%	14%	7. Arthropod Management		10%	24%	52%	14%
14%	36%	27%	18%	5%	8. Resources for Organic Apple Production		5%	14%	67%	14%

We also asked the participants the following questions:

Do you currently commercially grow apples? **YES:** 52% **NO:** 48%

If yes, number of acres of apples: 1A=1; 2A=3; 4A=1; 5A=3; 6A=1; 8A=2; 12A=1; Planning=1

Do you currently commercially grow apples organically? **YES:** 23% **NO:** 77%

If yes, number of acres of organic apples: 2A=2; 4A=1; 8A=1; 12A=1; Planning=1

On a scale of 1-5, how likely are you to try to produce apples organically within the next two years.

(1 being not very likely and 5 being very likely.)

1	**2**	**3**	**4**	**5**
33%	8%	13%	4%	42%

2) Bloom thinning tests: All thinning treatments reduced crop load compared to the non-treated control, and after one application of lime sulfur or Regalia®, the number of fertilized king blooms was reduced and zero percent of side blooms had been fertilized. All chemical thinning treatments resulted in fruit russeting. Russeting was more severe when lime sulfur was used as one of the bloom thinning applications. All treatments had fewer leaves with cedar-apple rust infection than the untreated control. These results suggest that bloom thinning sprays of lime sulfur and Regalia® could reduce crop loads and decrease cedar-apple rust infection. Additionally, bloom thinning applications could take the place of one or more fungicide sprays, leading to an overall reduction in the amount of fungicides used for organic apple production.

BENEFICIARIES

The primary beneficiaries of this project were commercial apple growers in VA. More than 50 stakeholders attended the workshop we hosted in Aug 2015. In addition, five Virginia Cooperative Extension personnel gained expertise in organic apple production through either developing presentations for or attending the organic apple workshop. Lastly, a graduate student

received her master's degree, in part, based upon the work outlined within this SCBGP-funded project.

LESSONS LEARNED
This grant provided funding to further the production of organic apples in Virginia. The applied nature of the project and the funding support to host the workshop were of great benefit to our project and allowed us to directly disseminate our research results to our stakeholders. The workshop also allowed us to show the research blocks to stakeholders so that they could learn about experimental design and implementation.

CONTACT PERSON
• Name the Contact Person for the Project
Gregory Peck, Ph.D.

• Telephone Number
607-255-7122

• Email Address
gmp32@cornell.edu

ADDITIONAL INFORMATION
n/a

7
K. Tignor
VDACS
Final Report

PROJECT TITLE
Low Cost Protection from Pesticide Damage for Honey Bee Colonies

Virginia Department of Agriculture and Consumer Services

PROJECT SUMMARY
Protecting beehives and foraging bees from exposure to pesticides presents many challenges to beekeepers. Beehives must either be removed from areas where pesticides are being applied or worker bees confined within their beehives. The former is costly requiring alternative apiary locations, available equipment for moving beehives and disorientation of bees. The latter can be equally costly restricting pollination and honey production and may result to colony loss from overheating.

Insect flight is known to cease during periods of rainfall. An irrigation spray and mist cooling systems were used to simulate rainfall to reduce internal beehive temperatures and restrict honey bee flight. Internal temperatures were reduced by as much as 12°F (6°C) from ambient temperatures for both watering systems. The irrigation spray system simulated rainfall sufficiently to prevent foraging flight from a beehive. Closure of a beehive entrance with screening or other breathable material with the mist systems is recommended to prevent bee flight. High water volume requirement in the irrigation system limits its use to ready sources of water. Lower water volume requirements for the mist system offers beekeepers a method low cost automated method for confine honey bees while cooling beehives in remote locations.

PROJECT PURPOSE
Pollinator exposure to pesticides is a growing concern of the general public and government agencies. Pesticides, particularly insecticides, are potentially harmful to honey bees and other pollinators. In 2014 President Barrack Obama issued an executive order establishing the Pollinator Health Task Force directing Federal agencies to take steps to reverse pollinator losses and help restore pollinator populations to healthy levels. The Environmental Protection Agency was directed to assess the effect of pesticides on bee and other pollinator health and take action, as appropriate, to protect pollinators. In response, State agricultural agencies, including the Virginia Department of Agriculture and Consumer Services, developed pollinator protection plans to mitigate the risk of pesticides to managed pollinators.

Honey bee exposure to pesticides may occur through several pathways. First, pesticides may be sprayed or otherwise applied directly to or on a beehive. Exposure of this type would have the most immediate and greatest impact on a honey bee colony as beehive occupants in all live stages and social status would be exposed to a potential toxin. Second, foraging worker honey bees may be exposed to toxic material while alighted in or flying through target areas where pesticides are being applied. The toxicity of the active ingredient in a pesticide, level of exposure and pesticide formulation determine the impact to beehive occupants. For example, exposure to liquid formulations of highly toxic pesticides would likely be lethal when applied directly on

foraging worker honey bees resulting in little or no pesticides transported back to a beehive. Non-lethal exposure could allow worker bees to transport a pesticide to a beehive exposing honey bee adults and larvae to sub-lethal levels. Chronic effects resulting from the latter situation could adversely impact colony productivity and survival. Third, worker honey bees may come into contact with treated materials after a pesticide application is completed. Risk from pesticide damage to beehive occupants following an application is dependent on distance from the beehive which diminishes with time as pesticides degrade. Confining worker bees in a beehive during and immediately following pesticide application is a procedure commonly used by beekeepers to minimize the risk of worker bee exposure to potential toxins. The proposed watering systems are intended to minimize risk of pesticide exposure to beehives and foraging bees during pesticide application through confinement of foraging workers and rinsing contaminates from surface of beehives.

Overheating is a common concern of beekeepers when confining worker bees during transport of a beehive or as a precaution against pesticide exposure. Internal beehive temperature is related to ambient temperature and other weather conditions such as cloud cover and rain occurrence. Temperature inside a beehive is also affected by the worker bees. Metabolic body functions in worker populations inside a beehive can increase the internal temperature of a beehive by 90°F (50°C). Immature growth rate and survival is impacted by even slight variations in beehive internal temperatures. During the winter months, maintenance of proper internal beehive temperatures is important to maintain survival of the colony and development of immature stages of honey bees. Excessive temperatures during summer months are avoided by honey bee fanning behavior and water evaporation to lower internal beehive temperature for continued immature development. Worker confinement, particularly on warm days, inhibits normal temperature regulation in a beehive adversely impacting egg, larvae, and pupae development time and mortality. The proposed watering systems is intended to simulate rain conditions that confine worker bees to the beehive while cooling the beehive to minimize the risk of overheating.

ACTIVITIES PERFORMED

Hive management was the focus of activities during the 2015 season. Populations of honey bees in four surviving colonies from the 2014-15 winter season were divided and managed to provided sufficient colony numbers to conduct testing of watering systems for confining honey bee populations in their beehive. Purchase of equipment for conducting the proposed methodology for confining honey bee colonies and monitoring impact of watering systems on honey bee populations were undertaken during 2016 and 2017 seasons.

Hives for the project consisted of a single deep and single medium 10 frame Langstroth style boxes with 9 frames of comb in each box. Colony populations consisted of a minimum of 30,000 adult workers, queen, and brood in various stages of development. Each beehive contained sufficient honey and pollen to sustain worker and brood populations. A thermocouple was placed in the medium super of each beehive beneath the top bar of the 8th frame. Additional thermocouples were placed on the bottom board and outside of the beehives, the latter to obtain ambient temperature.

Two watering systems, a low volume mist and higher volume spray, were tested for confining honey bee workers. The systems were constructed using pvc framing and water from the local

public utility system. A preassembled cooling system was purchased for use as the mist system (Orbit Mist Cooling Kit) (figure 1). The brass and stainless steel nozzles in the kit produced a fine mist at a rate of approximately 70 ml per minute (figure 2). The spray system for each beehive was constructed from ½ inch SCH-40 pvc tubing (Silver Line PVC 1120), two fan spray nozzles (Mister Landscaper MLM-404) (figure 3) and 1/2 inch garden hosing (figure 4). An inline 25 psi regulator (Orbit 25 psi FHT x MHT Regulator) was used to regulate pressure in the

Figure 1: Mist System beehive Setup

Figure 2: Mist System Nozzle

Figure 3: Spray System beehive Setup

Figure 4: Spray System Nozzle

watering systems. Water flow was regulated in the spray system to limit spray volume to 350 ml per minute. An automatic garden hose timer (Orbit 1-Outlet Hose Faucet Timer) was used to initiate the watering systems 30 minutes prior to sunrise and continue for 12 hours (approximate time of sunset). Initial testing was conducted with beehive entrances left open permitting free flight during the test period. Subsequent testing was completed by confining worker bees throughout the day by placing 8 mesh (8 strands per inch) hardware cloth over the beehive entrance. Additional testing was conducted at midday to determine efficacy of systems in confining worker bees during periods of ongoing flight activity.

The efficacy of the watering systems was determined through monitoring of worker activity, internal beehive temperature, beehive weight, and queen reproductive rate. Adult flight activity was recorded for video analysis. Internal beehive temperatures were obtained through use of thermocouples in beehives as described above. Individual beehive weight was monitored throughout the testing period with a digital scale. Colony reproductive rates were monitored through photographic records. Images for the latter were acquired for each frame of comb to document the amount of brood, e.g. egg, larvae, and pupae, in test and control hives prior to and upon completion of testing. Software developed by the National Institute of Health, ImageJ, was acquired for measuring the number of cells in honey comb containing brood. The software was used to determine the number of pupating larvae in each test and control hive.

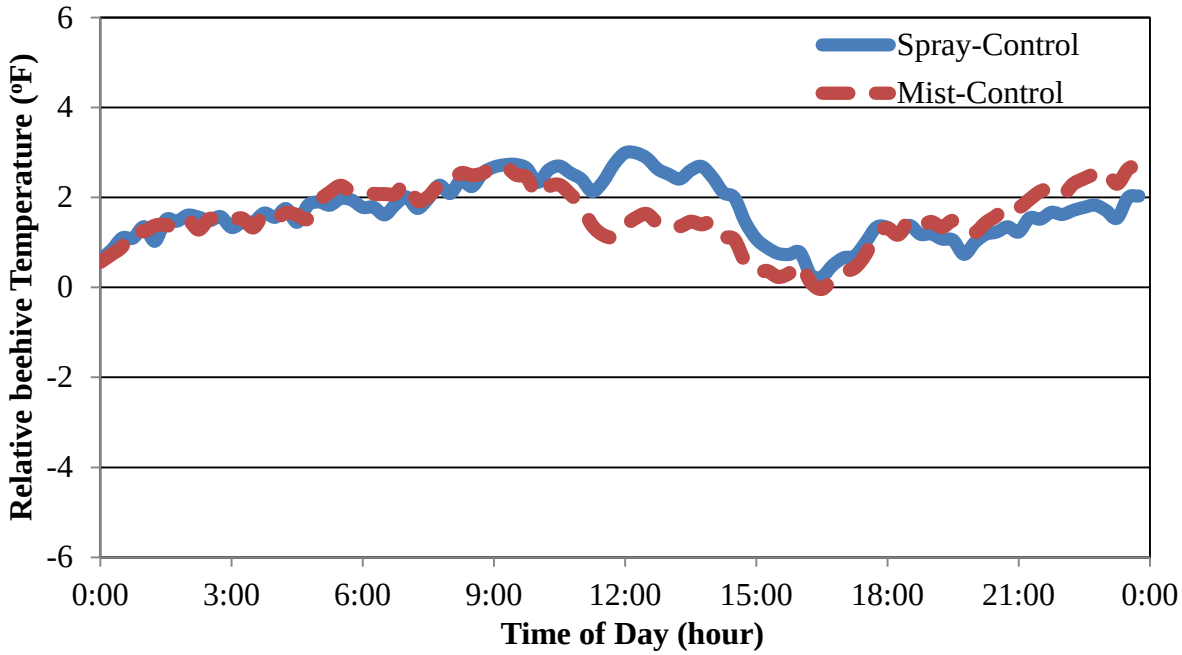
Both watering systems appeared to suppress honey bee flight during the testing period. Worker flight from control hives displayed little change averaging 32 and 31 bees per minute prior to the test and during the testing period, respectively. No difference adult flight activity from the test beehives compared to control was noted prior to water treatments. Egress flights from the spray system hives decreased by 85.7% to 4 bees per minute during the testing period. Mist treated beehives were less affected with only a 62.8% decline in adult flight activity during the treatment period. Midday treatments demonstrated further differences in the two watering systems. Returning foragers were observed hovering above the spray treatment hives after attempting to enter the water treatment (figure 5). The mist water system demonstrated little impediment to foragers returning to their beehive as returning foragers readily return to their beehive.

Figure 5: Foragers Hovering above Spray Hives

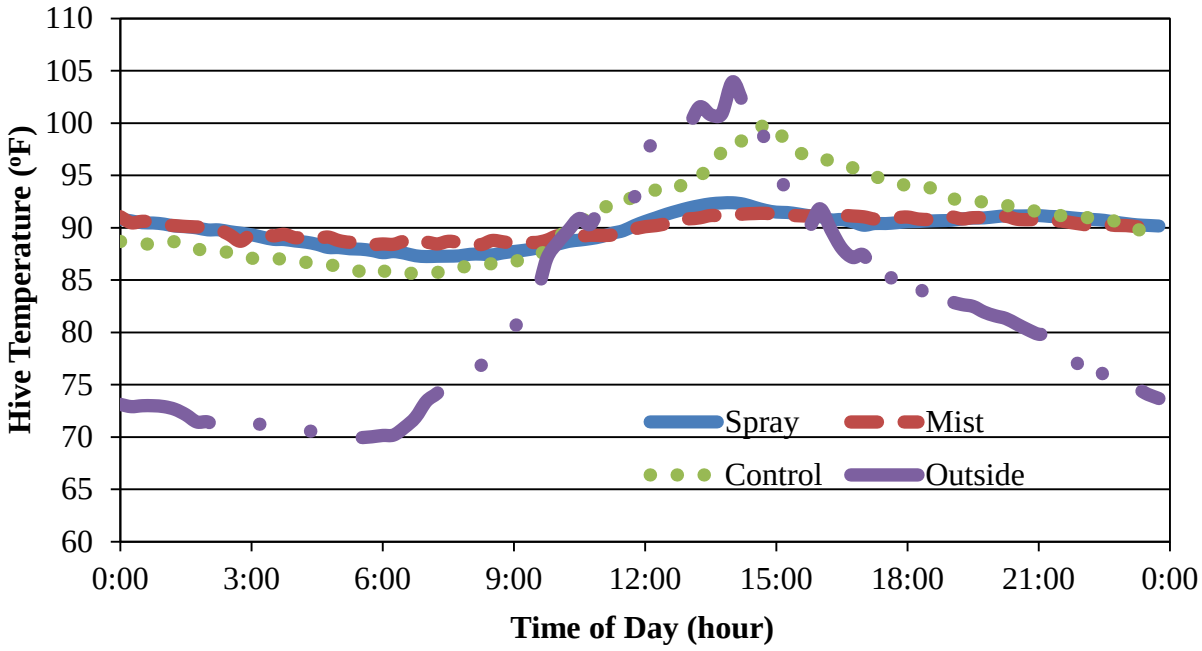
Ambient temperatures peaked at 104.0 °F (40 °C) at approximately 14:30 hours on days when watering systems were active. Surface temperatures of beehive covers reached a temperature of 139.5 °F (59.7 °C). Temperatures in the upper, medium, box of the control beehives reached 100.0 °F (37.8 °C) at approximately the same time. Under normal conditions the internal temperature of test beehives remained consistently similar to the internal temperature in control beehives (graph 1). Temperatures in beehives subjected to spray and mist applications remained within normal brood development temperatures of 93 °F (33.9 °C) throughout the period in which the watering systems were activated peaking at 92.4 °F (33.5 °C) and 91.4 °F (33.0 °F), respectively. graph 2 illustrates the consistent temperatures in test hives and fluctuation in control beehive temperatures over 24 hours including the testing period. Monitoring of internal temperatures demonstrated that both watering systems cooled test hives by as much as 8 °F (4.5 °C) during the warmest period of the day (graph 3) protecting confined workers and brood from overheating.

There was little difference brood production indicating no differences in the reproduction rates of either test group, i.e. mist or spray, and control colonies. beehive weights demonstrated a general decline of 2 to 3 percent the first two weeks following testing. Little differences were noted in the test and control beehive weights during this time period (graph 4).

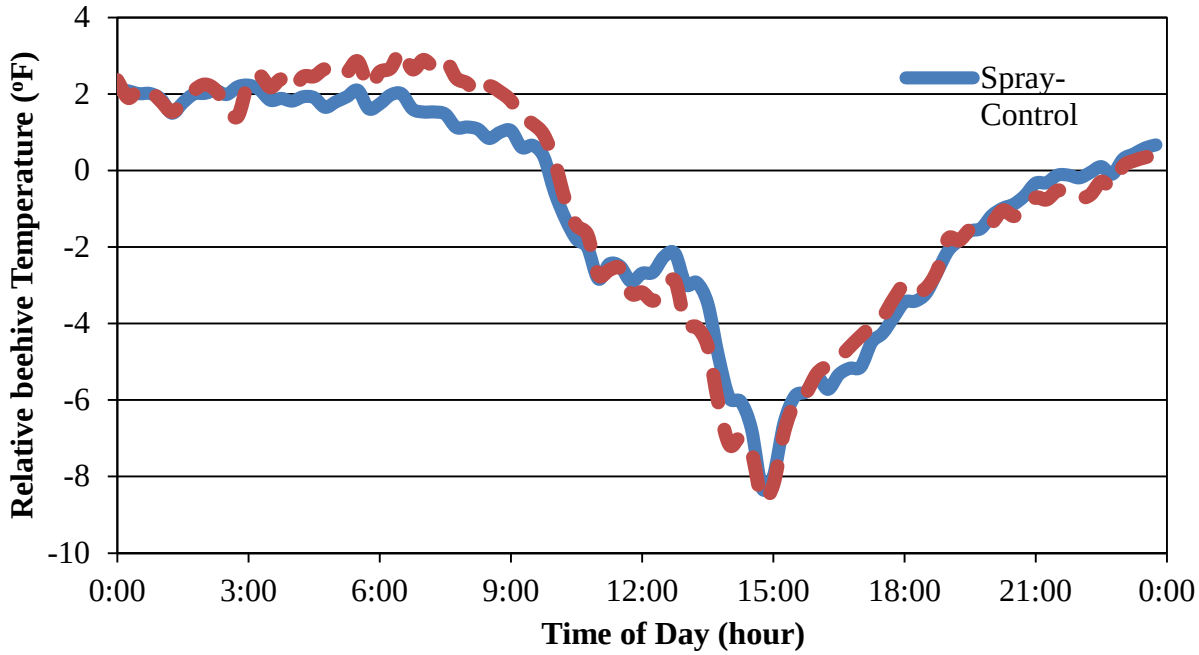
Graph 1: Average Normal Internal Temperature in Test Hives Relative to Control Hives.



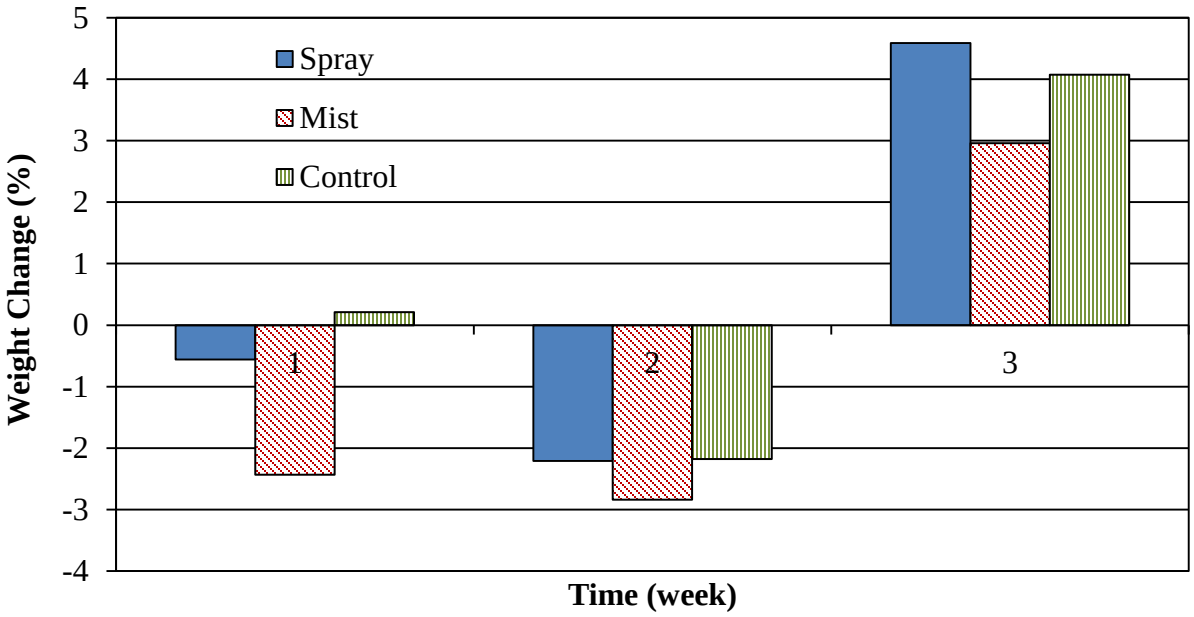
Graph 2: Average Internal Temperature in Beehives When Using Watering Systems to Confine Workers Honey Bees.



Graph 3: Average Internal Temperature Relative to Control Hives When Using Watering Systems to Confine Workers Honey Bees in Their Hive.



Graph 4: Average Weekly Percentage of beehive Weight Change Following Usage of Watering Systems to Confine Workers Honey Bees in Their beehive.



GOALS AND OUTCOMES ACHIEVED

The primary goal of the project was to provide an affordable method for reducing honey bee exposure to pesticides. An added benefit of the water systems is prevention of pesticide contamination in beehives. Pesticides applied in the immediate vicinity may drift onto beehives or accidentally applied onto beehive. In addition, fanning behavior of worker bees may draw

such pesticides into the beehive subjecting adult and immature bees to toxic levels of such chemicals. Returning foraging bees exposed to pesticides, particularly in dust formulations, are known to contaminate beehives. The water systems rinse beehive surfaces and worker bodies lessening the potential for pesticides inadvertently contaminating the interior of a beehive. Lower of temperatures displayed in the water system tests reduced fanning behavior further reducing introduction of contaminates into a beehive.

Results from testing of the watering systems were presented at the 2016 Fall and 2017 Spring meetings of Virginia State Beekeepers' Association. The information was also presented to local beekeeping organizations throughout Virginia in late 2016 through the fall of 2017. The benefits and disadvantages of the watering systems were presented for inclusion in the Pollinator Protection Strategy. The Strategy, to be presented to the Virginia General Assembly in July, 2018, provides voluntary best management practices for beekeepers and pesticide users and supports efforts to reduce risks from pesticides, increase habitat, and take other steps to protect pollinators.

A performance measure for the project was a 5 percent reduction in pesticide related reports of bee kill incidents confirmed to be pesticide related. The Office of Pesticide Services received 4 reports of pesticide related bee losses in 2017. At this time none of the investigations into these reported incidents are confirmed misuse of pesticides that resulted in the loss of the bees. In cooperation with these investigations, the Office of Plant Industry Services identified pest infestations and diseases in the affected honey bee colonies.

BENEFICIARIES

The primary beneficiaries of the project are beekeepers in the Commonwealth of Virginia. More than 400 individuals received information regarding the project through presentations at the Virginia State Beekeepers' Association meetings. Other beneficiaries include farmers and general public relying on honey bees for pollination of agricultural crops and other plants. While pesticides are one of many factors adversely impacting populations of honey bees and other pollinators it is one of few that can be mitigated through the actions of beekeepers. Common protective responses to threats of pesticides are costly and time consuming for beekeepers. The project provides a low cost, automated system to minimize exposure of pesticides to beehives and foraging bees while preventing overheating of immature and adult populations confined to a beehive. Minimal disruption to colony activities ensured sustainable pollinator populations with continual pollination of crops and plants in the vicinity of beehives.

LESSONS LEARNED

Monitoring of insect activity requires specialized equipment of limited demand. Consequently, sources for insect monitoring devices are limited. Prior to undertaking this project, two suppliers of a device for monitoring honey bee egress from a hive were identified. Prior to starting the project one supplier went out of business. The second supplier discontinued distribution in the United States and subsequently discontinued manufacture of the monitoring unit. The lesson learned in this situation is to provide for alternative methods of monitoring insect behavior. The video recording capability of the camera obtained for recording brood patterns also allowed for recording flight from the experimental beehives. This provided documentation for the watering systems' suppression of flight activity minimizing exposure of foraging bees to pesticides.

A second lesson resulted from the performance measure used for the project. During the project several initiatives involving pesticides and pollinators were undertaken. In late 2014 U.S. Environmental Protection Agency engaged State and tribal environmental, agricultural, and wildlife agencies in the development of pollinator protection plans to reduce pollinator exposure to pesticides. In addition, the Commonwealth of Virginia began developing a Pollinator Protection Strategy that included efforts to reduce risks from pesticides. Meetings with stakeholders and publicity related to the state plan and strategy may have influenced beekeeper assumptions that pesticide exposure lead to the demise of their colonies. A less subjective performance measure than reports of pesticide related bee kills may provide a more useful determination of the project outcome.

CONTACT PERSON

Keith Tignor
Telephone Number: 804-786-3515
Email Address: keith.tignor@vdacs.virginia.gov

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K. Terry
Appalachian Sustainable Development
Final Report

PROJECT TITLE
Making Food Safety Certification Available and Affordable for Virginia Farmers

PROJECT SUMMARY

Most wholesale produce buyers insist that the farmers who supply them hold some form of food safety certification. Good Agricultural Practices (GAP) certification is currently available from several sources (USDA GAP, GLOBAL GAP, Global Food Safety Initiative (GFSI) to name a few). A compromise effort between these many paths, the Harmonized Food Safety Audit, is gaining traction with many produce buyers.

Appalachian Sustainable Development (ASD), along with Virginia Cooperative Extension, has been at the forefront of working with wholesale buyers to accept GAP certification plans that are friendly to smaller-scale farmers. We have also worked with farmers to provide training in food safety principles and actions and assisted them with obtaining their GAP certifications so that they can have continued access to quality wholesale markets.

ASD, through this grant, continued to spearhead these efforts throughout the State, providing:

1) Training and consultation to farmers to prepare them to be USDA GAP or Harmonized GAP certification-ready.
2) Expanded training to include direct-market farmers who may need the certification to sell to restaurants and/or institutions.

PROJECT PURPOSE

ASD is a not-for-profit organization working in the Appalachian region of Virginia and Tennessee. Formed in 1995, ASD focuses on developing healthy, diverse and ecologically sound economic opportunities through education, training, and the development of cooperative networks and marketing systems. ASD has been a regional leader in following food safety legislation which directly impacts many producers of fresh produce in southwest Virginia.

The primary purpose of this project was to ensure that farmers in Virginia can continue to sell to quality wholesale and retail markets by assisting them in obtaining the Good Agricultural Practices (GAP) certification(s) needed to access those markets. Most grocery and wholesale buyers already demand that their producers hold USDA GAP certification. Many of the larger restaurants and institutional buyers are following that lead. For the average Virginia farmer, obtaining GAP certification on their own can be confusing, costly and, in many cases, so discouraging that it means the end of their farming business.

In 2011, ASD partnered with Virginia Cooperative Extension to explore ways to assist farmers selling through the Appalachian Harvest wholesale network to meet the food safety standards which were just starting to be required by wholesale buyers. Over the years, food safety certification has become mandatory for nearly all wholesale buyers and the ASD/Cooperative Extension partnership has helped hundreds of farmers across the State to learn more about food safety standards, to prepare their own farms for food safety audits and to assist many of these farmers in reaching GAP certification for their operations.

In that time, the food safety picture has grown more confusing as a global food safety certifier (Global Food Safety Initiative or GFSI) has attracted the attention of several large produce buyers. GFSI is both more rigorous and much more expensive than the USDA GAP program, making many Virginia farmers fear that they will be priced out of business by having to certify GFSI. In response, the Harmonized food safety certification has been developed as a more affordable alternative, taking from both the USDA GAP and the GFSI to develop a certification program that can be accepted by all buyers.

While it is unclear exactly how the food safety certification confusion will settle out, the fact remains that farmers in Virginia need assistance with understanding and meeting the GAP requirements in order to access quality wholesale and institutional markets. ASD and Cooperative Extension have developed a training course that helps farmers meet their current food safety needs and prepares them for future developments. Currently all of the Appalachian Harvest buyers accept the USDA GAP certification to meet their food safety needs, but it is becoming clear that the future of food safety is closer to the Harmonized model. In recognition of that trend, all farmers participating in the ASD/Cooperative Extension program were trained to a level that prepares them for certification for both USDA GAP and the Harmonized GAP audits. This gives each grower the flexibility to respond to changes in the food safety landscape, and certify according to the demands of their markets. Regardless of farm size, scale of production, and or production methodology (conventional or organic) this training is essential to keep the Commonwealth's food system educated, prepared, and qualified to participate in the wholesale market arenas that are necessary for Virginia's family farms' survival.

PROJECT ACTIVITIES & RESULTS

- Appalachian Harvest conducted 16 training sessions, 50% large group, and 50% small group settings. Appalachian Harvest also conducted one-on-one on the farm visits and manual reviews to ensure that new and beginning farmers and/or farmers with SOP challenges had detailed and scientific based, hands on learning opportunities with supportive and compliant GAP manual documentation.
- A hands-on manual for understanding GAP regulations and developing solid practices and SOP's to meet them was utilized with direct classroom instruction to help Virginia specialty crop growers make changes to their farm plans to address food safety and access markets that demand GAP certification. Free manuals were provided to farmers participating in the training programs organized by ASD and Cooperative Extension. Manuals were also made available to others for free (or at minimal cost, if necessary) to assist additional farmers in Virginia and elsewhere.
- 183 Virginia farmers were fully trained in USDA and Harmonized GAP requirements; 91 of these have completed an on-farm visit and/or mock audit with ASD or Cooperative Extension staff (or a trained contractor). These farmers will be certification-ready should their markets require certification.
- 100 direct marketing farmers participated in training sessions. Although most direct markets for specialty crops do not require GAP certification, the habits and procedures implemented by these farmers will increase the safety of Virginia's food supply. If these farmers wish to sell to a restaurant or institution that does require GAP certification, they will be well-educated and in a position to obtain certification to access those markets.
- A specific clarification that Appalachian Harvest must continue to reinforce at every training session is the requirement of Virginia Pesticide Licenses. Conventional farmers, organic farmers, and farmers that don't utilize any field sprays, fertilizers or inputs, MUST obtain a Pesticide License in order to handle 100 ppm chlorine bleach and/or Sanidate as their "kill step" when washing products for human consumption, and/or 10% chlorine bleach to sanitize all contact surfaces. This vital piece of information is explained at all training sessions and reinforced during manual reviews and one-on-one farm visits. Our experience has shown us that farmers, especially organic farmers, often interpret this requirement inaccurately, making it vital that they have a complete and accurate understanding that safe handling of

any input by the farmer and/or by his or her labor force is essential for full compliance with Good Agriculture Practices.

GOALS AND OUTCOMES

Goal: Increase Virginia farmers' knowledge of GAP certification as a result of training. Increase the number of Virginia USDA GAP and Harmonized GAP certified farmers.
Performance Measure: Administer tests before and after training to measure increase in farmer knowledge. Number of farmers obtaining USDA GAP and/or Harmonized GAP training or number of farmers successfully completing a mock audit without corrective measures.
Benchmark: Pretest before training.
Target: 200 growers receive training and gain a 90% increased understanding of farm support and/or access to new technologies and material to help them comply with GAP standards.
Results: 183 growers were fully trained in USDA and Harmonized GAP requirements; 91 of these completed an on-farm visit and/or mock audit with ASD or Cooperative Extension staff (or a trained contractor).
Pre and post-tests were created and administered to wholesale farmers. However, the first time pre-tests were administered they were not well-received by the farmers. The general feeling was that participants were there to learn and requiring that they measure and then turn in tests that showed they did not understand the topics came across as being a bit insulting. Therefore we changed our process and asked farmers to complete the pre and post-tests and grade their own increase in knowledge. At the end of the training sessions we asked farmers how many had scored a 100%. Of the 183 wholesale farmers trained, 159 (or 87%) of them scored a 100, with the remaining participants scorning a 90% minimum.
The 103 direct market producers were not given the pre and post-tests due to our lessons learned from our experiences with wholesale market farmers. 100% of the direct market farmers participated at an "end of session" survey demonstrating that 100% of the participants had gained what they considered at least a 90% increase in knowledge of GAP certification processes and requirements from the education opportunities supported by this grant.

SUPPORTING ACTIVITIES AND OUTPUTS

Objective: Train at least 100 farmers in Virginia to be GAP certification-ready in 2015 in both the USDA GAP and the Harmonized GAP program. The expectation is that 2/3 of these will obtain certification in 2015. Train at least 100 direct market farmers on USDA GAP processes.
Output 1: Appalachian Sustainable Development/Appalachian Harvest trained and prepared 183 Virginia wholesale to retail farmers and 6 packinghouse facilities for the wholesale market arena GAP certification and/or Harmonized GAP. Ten of the farmer participants took their training one step further and, with the support of this grant, were able to obtain their Harmonized GAP with Global addendum certification, thus broadening their markets and increasing their income streams. Three packinghouse facilities obtaining Harmonized GAP certification, and three (3) packinghouse facilities successfully obtained their GAP certification.
Output 2: Appalachian Sustainable Development/Appalachian Harvest trained and prepared 103 direct market Virginia farmers in all aspects of Food Safety. Appalachian Harvest utilized the following "on site" training examples to demonstrate small scale farmer's compliance with food safety regulations: pest management, hand washing stations, product flow, post-harvest handling station (pre-rinse, kill-step, rinse process), affordable and compliant spill kits, safe transport, safe storage, and all relevant SOP's to meet the very small farmer's needs for GAP

compliance should they chose that path and/or should their market requirement shift to require farmer GAP certification.

BENEFICIARIES

Farmers

- 183 Virginia farmers were classroom trained in USDA and Harmonized GAP requirements, with 91 receiving an additional on-farm visit and mock audit with ASD or Cooperative Extension staff (or a trained contractor). These farmers will be certification-ready should their markets require certification.
- 103 direct marketing farmers participated in training sessions. Although most direct markets for specialty crops do not require GAP certification, the habits and procedures implemented by these farmers will increase the safety of Virginia's food supply and if these growers wish to sell to a restaurant or institution that does require GAP certification, they will be in a good position to obtain certification in order to access those markets.

Buyers

- Wholesale buyers have access to a wider diversity of growers and products as a result of the training, on-farm auditing and certification of additional Virginia farmers. This has lead to greater sales of Virginia grown products and stronger, more vibrant rural communities in rural Virginia.
- **Consumers**

Consumers are beneficiaries from this project because the integrity of food safety has improved and will continue to improve in both wholesale and direct market outlets and a local product stream of Virginia grown specialty crops will continue to be available in local and regional markets

LESSONS LEARNED

Measurable goals for this project were fully achieved thanks to the continued support of the Virginia Department of Agriculture and Consumer Services. Appalachian Sustainable Development and Appalachian Harvest strives to be a Food Safety leader for the Commonwealth's agriculture system since we know firsthand what type of negative impacts can transpire if farmers are not ready for market transitions in the areas of buyer's Food Safety requirements. Three and a half years ago, Appalachian Harvest would have dropped from 13 active buyers to only 2 (resulting in a negative impact of over $850,000) if the resources had not been provided for our organization to create curriculum, classroom training, on the farm training, grower manuals and compliance support systems for Virginia's farmers.

An additional lesson learned is that many surrounding states in the Appalachian Mountain region do not have a support system in place the assists small scale farmers with achieving Food Safety training, support, and certification. This became apparent to ASD during several meetings with organizations such as Central Appalachian Network, Appalachian Regional Commission and the Southern Sustainable Agriculture Working Group, to name a few. From this learning, ASD received a small grant from a partner in Durham, NC to host a multi-state Food Safety 3 day training. Twenty-four (24) disadvantaged farmers from West Virginia, Mississippi and Alabama attended this 3 day training session at Appalachian Harvest in Duffield, Virginia. All evaluations of the training were extremely positive and four of these farmers have already accomplished GAP certification after receiving our training.

CONTACT PERSON

Kathlyn Terry/Executive Director/Appalachian Sustainable Development
276-623-1121
kterry@asdevelop.org

Robin Robbins/General Manager/Appalachian Harvest
276-608-8547
rrobbins@asdevelop.org & ahmrkt@yahoo.com

ADDITIONAL INFORMATION

According to a 2013 economic impact study conducted by the Weldon Cooper Center for Public Service at the University of Virginia, agriculture and forestry are Virginia's two largest industries with a combined economic impact of $70 billion annually. Agriculture generates more than $52 billion per annum. The industries also provide more than 400,000 jobs in the Commonwealth. The work of making Food Safety Certification attainable and affordable for Virginia farmers is essential for the successful continuation and growth of Virginia's agriculture and food systems.

By working with Appalachian Harvest to help facilitate their training, audit readiness, request for audit process, and on site USDA GAP or Harmonized audit, many rural/remote family farmers saved approximately $500 on the actual audit process. The closest USDA GAP inspector is 5 hours from many of our rural/remote family farmers. For an inspector to drive directly to a single farm and return to his or her office, the travel cost alone is $920 for one farm, plus a minimum of 4 additional hours (at $92 per hour = $368) for pre, during and post inspection documentation. This would total $1,288 in GAP costs for one small rural/remote family farm to be inspected. With the training, mock audits, and networking opportunities provided by this grant, small rural and remote farmers' costs were lowered by a minimum of $600, and some lowered as much as $788. This can be attributed to farmers being well prepared through intensive education, mock audited and provided with fluid and accurate information for inspections. It can also be attributed to Appalachian Harvest working with inspectors to group farms together based on their geographic location, and having 4-5 inspections conducted on one travel trip by the inspectors with he or she spending several consecutive days conducting logistically friendly GAP inspections. This allows the grouped farmers to share in the $920/travel costs of the inspector. This effort also demonstrates the willingness of the USDA to utilize collaborative efforts to help make GAP certification more affordable for small and medium scale family farmers and packinghouses.

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E. Deal
Mount Rogers Area Christmas Tree Growers Association, Inc
Final Report

Project Title
Mount Roger Area Christmas Tree Growers Association Genetically Improved Fraser Fir Seed Orchard

Project Summary
The Mount Rogers Area Christmas Tree Growers Association (MRACTGA) has been working since 2010 to establish a genetically superior Fraser fir Seed Orchard at the Old Flat State Forest on Mount Rogers. The purpose of the effort was to replace the declining Grayson Highlands Orchard that was established in 1980.

An initial grant from the Virginia Department of Agriculture and Consumer Services (VDACS) was used for the survey, initial preparation of a site, orchard design implementation, and root stock establishment on Mount Rogers. This site is a part of the Mount Rogers State Forest managed by the Virginia Department of Forestry. A 2011 grant from a USDA Specialty Crop Competitive Grant funded the selection and grafting of 25 genetically superior Mount Rogers Fraser fir families into the Old Flat Orchard. In addition, wildlife fencing, planting of a native groundcover, fertility improvements, and planting of a red spruce wind break around the Old Flat Orchard has been accomplished.

The Mount Rogers Area Christmas Tree Growers Association received a Specialty Crop Block Grant from the Virginia Department of Agriculture and Consumer Services in the amount of $22,692 to continue MRACTGA's work in establishing the Old Flat seed orchard. This grant has helped support the only work now underway in Virginia to help preserve the unique Fraser fir/red spruce ecosystem that once flourished in the Southern Virginia Highlands.

The Old Flat Fraser Fir/Red Spruce Orchard now includes 54 genetically superior Mount Rogers Fraser fir parent tree families replicated with over 850 grafts. The framework of the Orchard is complete; the base parent trees are grafted, the red spruce border is in place, the soil fertility, weed and wildlife management program has been implemented. An additional 150 grafted trees will be planted in the spring of 2018 by the association at its cost.

Project Purpose
Establishment of the Old Flat Orchard has multiple purposes.

1. Preserving the Mount Rogers Strain of Fraser fir that has been decimated by the Balsam wooly adelgid.
2. Providing an improved seed bank of Mount Rogers Strain Fraser fir for Christmas tree producers in the Mount Rogers and surrounding areas. This will contribute to the stability of the Christmas Tree Industry. The growing of Christmas trees is the largest employer and economic driver for agriculture in the region.
3. Recreating the high elevation Appalachian Spruce/Fir habitat that is being lost in the unmanaged areas across the Southern Mountains because of the Balsam wooly adelgid.

4. Establishing Best Management Practices to provide habitat for monarch butterflies, bees, wild ponies, deer, and numerous other flora and fauna.

Project Activities

In February of 2017, the newest rootstock to be bench grafted was placed into a greenhouse to awaken the root system for spring grafting. On April 14-15 Fraser fir scion was collected and grafted on 100 Fraser fir rootstock trees using Superior Mount Rogers Fraser fir selections.

Regular spring maintenance was done in the orchard including; herbicide application, fertilizer, and tree removal. The entire area was also bush hogged by the association.

In September 2017, regular maintenance work took place at the Old Flat Orchard including; fertilizer application, herbicide application, fence maintenance, and the releasing of the spring planted grafts. Soil and tissue samples were pulled and sent to North Carolina State University to ensure optimal nutrition for the Old Flat Orchard. 150 Fraser fir seedlings were up-potted into 1 gallon containers for optimal spring 2018 grafting.

Goals and Outcomes Achieved

The Old Flat Orchard has been established and is heading towards seed production in 2025-2028.

The Old Flat Fraser Fir/Red Spruce Orchard includes 54 genetically superior Mount Rogers Fraser fir parent trees replicated over 850 grafts within the Old Flat Orchard. The framework of the Orchard is complete; the base parent trees are grafted, the red spruce border is in place, the soil fertility, weed and wildlife management program has been implemented. An additional 150 grafted trees will be planted in the spring of 2018. Several new families will be a part of these additions to the orchard.

The hard work and enthusiasm in creating the Old Flat Orchard by the Mount Rogers Area Christmas Tree Growers Association has been recognized by the American Chestnut Foundation. In 2016 the Chestnut Foundation planted a research orchard of improved American chestnut on the land adjoining the Fraser fir/Red Spruce Orchard within the Old Flat State Forest. This Chestnut planting will be used to evaluate high altitude attributes of several families of Blight Resistant American Chestnut families that have been developed by that foundation. Both of these Orchards will allow access for education purposes as well as wildlife management opportunities.

Beneficiaries

The Virginia Forest Service and the State of Virginia is a direct beneficiary of the Old Flat Orchard as the orchard falls directly into their mission to “protect and develop healthy, sustainable forest resources for Virginians.” The establishment of the Fraser fir orchard has also provided the avenue for the American Chestnut Society to establish their research orchard. This orchard is a major method of preserving the Mount Rogers strain of Fraser fir.
Christmas tree farmers are also a direct beneficiary of the Old Flat orchard. The genetic material in this orchard represents the best Mount Rogers strain of Fraser fir with selections made for needle retention, color, bud set, and vigor. As with any agricultural commodity, improvement in genetics decreases input costs and increases profitability.

The Cooperative Extension Programs in both Virginia and North Carolina are also beneficiaries of the Old Flat Orchard. The Orchard provides opportunities for educational programs and research in an orchard environment.

The Mount Rogers Area Christmas Tree Growers Association is one direct beneficiary of the seed that will be collected from the Old Flat Orchard as it comes to maturity. Seed sales provides income to maintain the 1980 Grayson Orchard, future expenses for the Old Flat Orchard and allow the Association to provide educational programs for members and college scholarships for area students.

Lessons Learned

The initial scion collection was done in early spring over a 50 mile radius of the Old Flat orchard. This wide range of tree locations created problems such as finding the tagged "super" trees at a later date, having field access in inclement weather, and accidental harvest of selected parent trees. In order to preserve the parent trees laminated tags in English and Spanish and multi-colored ribbons that said do not cut, do not trim were placed in each tree and updated yearly. As the initial material has grown within the Old Flat Orchard we are now able to cut scion material from the Orchard.

The first several years of grafting took place at the Old Flat site on rootstock planted the year before. The weather at this elevation is so variable that the grafts had very mixed success. Over the past several years the ungrafted rootstock has been removed and the scion has been grafted onto rootstock in a controlled environment. After a year of care in a nursery, these plants are then placed into the orchard.

Wildlife continues to be a problem in the Orchard. In order to reduce the damage from deer, bear, and wild horses the Fraser fir trees have been individually fenced. The fencing has greatly improved the viability of the orchard trees however, the fence must be maintained due to the wild horses pushing and scratching themselves on the fence posts and structures.
The obstacles that have occurred during the establishment of the Orchard have found a solution within the group comprised of Christmas tree growers, Extension personal, Forest Service staff and Rangers from the Grayson Highland Park. The best lesson learned is that a great team can solve any problem.

The addition of selected "super trees" will continue throughout the life of the Old Flat Orchard. It is our goal to create an orchard that will provide viable Fraser fir and red spruce seed for multiple decades and perpetuate the Southern Appalachian Spruce / Fir ecosystem that has been decimated by the exotic balsam wooly adelgid, climate changes and habitat destruction. We are also committed to providing educational and research opportunities for University, Cooperative Extension and Forest Service Personnel.

Contact Person

Earl Deal, Jr. Secretary/Treasurer
Mount Rogers Christmas Tree Growers Association
PO Box 127

Whitetop, VA 24292
336-372-2756 ph.
336-372-7006 fax
info@smokeyhollertreefarm.com

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L. Aldrich
Virginia Wineries Association
Final Report

PROJECT TITLE
Commonwealth Quality Alliance Education 2014-575

NAME OF ORGANIZATION
Virginia Wineries Association

PROJECT SUMMARY
The Commonwealth Quality Alliance (CQA) is a quality standards initiative of the Virginia Wineries Association that works to reward and promote Virginia-grown wines. The three primary objectives of the CQA are to:

1) Assist wineries to continuously improve the quality of Virginia wines by employing "best practices" in wine testing and evaluation.
2) Enhance Virginia wines' competiveness nationally and internationally.
3) Increase individual producer's income and ensure the sustainability of the Virginia wine industry.

With Specialty Crop Funding through VDACS, the Virginia Wineries Association established the CQA in 2011 and has now completed its first two years of awarding CQA certification. The initial results were the CQA program is working. In 2013, 16 Virginia wineries participated in the CQA program and 50 wines were awarded CQA certification. Of those CQA participating wineries, two wineries, Horton Vineyards and Rockbridge Vineyard had wines named to the 2014 Governor's Case, a distinction achieved by only 12 wines of the over 400 entrants into the 2014 Governor's Cup annual wine competition. In addition to these Governor's Case winners, 13 CQA participating wineries were awarded Silver Medals and 10 participating wineries were awarded Bronze medals for their entered wines. The CQA is identifying and certifying Virginia's quality wines.

In order to reach timely and sustainable scale of the CQA program, it was necessary to educate wine consumers, producers and sellers about the benefits of the program. Virginia Wineries Association intended to ensure long-term sustainability of the program through three objectives:

1) Educate consumers to equate the CQA Seal with quality, well priced Virginia wines.
2) Educate wine producers about CQA participation and the benefits of submitting wines for CQA approval.
3) Educate wine sellers, particularly restaurants, retailers and wholesalers, on the CQA brand and its certification of quality Virginia wines at appropriate price points.

Each of these objectives was intended to expand Virginia wine sales regionally, nationally and internationally by educating consumers on the quality of Virginia wines, expanding the amount of Virginia wine sold through restaurants and retailers and increasing winery participation in the CQA program.

PROJECT PURPOSE

Fiscal Year 2013 marked another year of increased sales for the Virginia wine industry. Following record high sales in 2012, industry sales for 2013 were up by an additional 6%, selling 511,000 cases. Of equal importance to overall sales, Virginia's wine distribution is also growing. Wine sales outside Virginia grew more than 60 percent from 2012 to 2013. Virginia wines are now sold in Maryland, North Carolina, South Carolina, New York, Illinois, Pennsylvania, Florida and Washington, D.C. In FY 2013, international sales of Virginia wine grew more than 74 percent to more than 5,800 cases of wine with China and Great Britain as the primary export destinations.

While these are exceptional benchmarks for the Virginia industry, other national and international wine producing regions have gained much greater market shares. Since the beginning of Virginia's modern wine industry, the following other wine regions have been developed and surpassed the Commonwealth: Oregon, Washington, New York, Canada, Australia, South Africa, Chile, Argentina, and New Zealand. Like Virginia, these wine industries were in their infancies in the 1970's. However the other regions surpassed the Virginia industry through various means including: quality assurance programs, sustainability programs, funding local educational institutes, specializing in best varietals for the region, etc. All of these regions have not only taken a stronger market share than Virginia nationally and internationally, but most of them have surpassed our local market share.

Moving forward, the Virginia Wine industry must prove itself by having not only a great sense of history, but also showcasing itself as a world leader in quality wines at appropriate price points.

The Commonwealth Quality Alliance was started with the support of SCBGF funding in 2011. Two issues hinder the long-term sustainability of the Virginia wine industry. The first issue is the perception of wine quality. In a consumer survey completed by the industry, 26.4% of respondents believed that more than half of Virginia-produced wines were "flawed or faulted." The second stumbling block is price. Because the majority of Virginia wines are produced from small artisanal wineries, it is a necessity that Virginia wines be priced in the "premium" range (over $12.00 per bottle). The CQA program addresses each of these issues directly. The CQA seal will give consumers confidence in the quality and appropriate pricing of Virginia wines. As US wine sales are increasing, Virginia must work now to realize the marketing opportunity of the CQA. The CQA Seal on approved wine bottles will build consumer confidence that choosing a Virginia wine is making a good choice.

With this grant the objectives were to:

1) Educate consumers to equate the CQA Seal with quality, well priced Virginia wines.

2) Educate wine producers about CQA participation and the benefits of submitting wines for CQA approval.
3) Educate wine sellers, particularly restaurants, retailers and wholesalers, on the CQA brand and its certification of quality Virginia wines at appropriate price points.

Each of these objectives was intended to expand Virginia wine sales regionally, nationally and internationally by educating consumers on the quality of Virginia wines, expanding the amount of Virginia wine sold through restaurants and retailers and increasing winery participation in the CQA program.

PROJECT ACTIVITIES

Benchmark Survey:

- Prepared survey for benchmark and follow up against benchmark – requesting number of tastings sold, cases sold and the number of CQA-approved wine sold in a specified month in early 2015 and again with follow up in early 2017.

Winery Education:

- Held a marketing seminar in February 2016 which touched on the importance of quality assurance programs such as CQA.
- Had an educational segment on "Why CQA?" At Virginia Wineries Association Annual Meeting last November with winery owners and personnel about the "best practice" of CQA participation. Produced and used additional print and electronic education tools.
- Had a booth at the last 2 VWA Annual Meetings with over 400 attendees total all from Virginia wine industry.
- Promoting CQA program in all Governor's Cup promotions and additional industry gatherings in late 2014, late 2015 and starting for 2016.
- Collateral Materials
    - Updating existing materials to include newly approved wines
    - Creation and printing of new materials for "CQA Lately?" Campaign to increase awareness of the CQA program among Virginia wineries and winery staff
    - Shipping of tool kits to CQA wineries which contain – personalized posters, table tents, pocket maps, brochures and "CQA Approved" point of sale crystal.
- Winery recruitment continued with the Governor's Cup competition in November and December each year in addition to regular recruitment.

Restaurant & Retail Education:

- We initiated the "Quality in your Backyard" campaign to reach retailers and restauranteurs to increase awareness of the CQA program among retail establishments and restaurants in close proximity to CQA wineries with the creation of a postcard aimed at introducing the CQA program, targeted wineries and wines
    - Developed database list of retails through survey to wineries and other research

initiatives
    - Printing and postage of postcard
    - Follow up by email, mail or in person visits
- Continued working with participating CQA wineries and VA Wine Distributing Company to educate wine sellers to equate the CQA seal with quality, appropriately priced Virginia wine.
- **VA Wine Month:** Promoted CQA educational materials for use by restaurants and retailers; reach consumers through restaurants and retailers

Consumer Education:

- **Street Teams:**
    - Created and manage street teams to attend Vintage Virginia, where pocket map brochures were distributed to increase awareness of the CQA program, wineries and wines.
    - Created and managed street teams to attend a new festival in the relatively untapped market of Virginia Beach on December 3rd, where pocket map brochures will be distributed to increase awareness of the CQA program, wineries and wines.

- **Social Media** – Development & regular posts
    - Initial survey to CQA wineries for photos of CQA wines in tasting rooms and at festivals; festival schedules; special event schedules; interesting facts about the winery and staff members to use throughout our social media campaign.
    - Creation of social media accounts
    - Regular posts across social media platforms to increase awareness of the CQA program, CQA wineries and CQA approved wines

GOALS AND OUTCOMES ACHIEVED

- Goal: To expand Virginia wine sales regionally, nationally and internationally by educating consumers on the quality of Virginia wines, expanding the amount of Virginia wine sold through restaurants and retailers.
- Performance Measure: Conduct annual surveys of participating vineyards and wineries of sales and customer traffic.
- Benchmark: This survey has not previously been conducted; however, we will establish a benchmark during the project.
- Target: It is expect that 40 percent of wineries indicate an increase in sales and consumer traffic.

The Goal to expand wine sales by educating consumers on the quality of Virginia wines, expanding the amount of Virginia wine sold was achieved. Through marketing and education to

consumers using the pocket maps, point of sale materials, Facebook and other social media outlets, an awareness of the quality of Virginia wine sold was created. With 72 percent of wineries indicating an increase in sales and consumer traffic, the target was achieved. From our baseline survey and subsequent follow up survey, we found consumer traffic on average increased 29% from March 2015 to March 2017. During this same time period we found overall sales increased 8%.

BENEFICIARIES

Direct beneficiaries are the 29 participating wineries receiving all the direct benefits of the program. The Virginia wine industry as a whole - 260+ wineries and over 300 growers - benefits because the program caught flaws in wines that were submitted through the program that then were able to be corrected before consumed by the public. These wines typically would have gone to market flawed pulling the down the Virginia wine industry with it. One flawed wine to a consumer can turn that consumer off from all other wine from the region. This program was intended to help raise the bar for Virginia wines and a “rising tides raises all ships”.

Retailers benefited as we promoted these wines through the Virginia Wine Distribution Company. This enabled retailers to sort by CQA-approved wines on the purchasing website which created awareness to retailers while providing education.

We also believe the consumer benefits from drinking better wine and becoming educated on the Virginia wine brand. We know we educated over 15,000 consumers each year just with the pocket maps and Facebook. Thousands more have seen the crystal plaques in the tasting rooms of participating wineries, and still more the articles written in the press as well as our other social media platforms. This ultimately leads to more Virginia wine sales which benefits all the associated business to the industry from the growers to the bottle manufacturers to the mobile bottling line businesses to the Commonwealth which benefits in more revenue from tax dollars.

LESSONS LEARNED

We were disappointed in the lack of participation in the program from the onset to the end. We received consistent feedback that the industry needed it and that the CQA program was valuable. Yet, if not mandated, similar to the successful Canadian program, participation would be lacking, which proved to be the case. The biggest objection once we overcame price, was that there was a perception from the consumer that wines not CQA approved were lesser is quality, when some wines were not able to receive the designation due to not being made from Virginia fruit. This obstacle became amplified when there was crop damaged as more and more wines were no longer even eligible for the program as they needed out of state fruit.

It was determined that the only way to make the program work was to mandate a wine go through the program to enter the Governor’s Cup competition. This Virginia Wineries Association competition also requires 100% Virginia fruit, like the program. This mandate was explored by the CQA committee and the VWA board both agreed, while this would help support

the program it would likely harm the competition by making it cost prohibitive to enter. All agreed that continuing to the offer free entry to the competition with a CQA approved wine was a positive, but to mandate it with the same arrangement would be diverting funds.

CONTACT PERSON
Laurie Aldrich, VWA Executive Director
• 804-592-3196
• info@VAWine.org

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P. Hess / M. Mulder
Arcadia Food
Progress Report

PROJECT TITLE
Transitioning Farms to Sustainable Practices for Economic Viability and Environmental Health

NAME OF ORGANIZATION
Arcadia Food, Inc.

PROJECT SUMMARY
The Arcadia Center for Sustainable Food & Agriculture offered technical assistance, training, consultation, and a wholesale purchase contract to conventional farmers who would designate a portion of their acreage to growing specialty crops using sustainable methods. Arcadia guaranteed a market for the specialty crops produced by contracting to purchase the crops at competitive wholesale prices. Arcadia partnered with The Farmers Market.co to provide technical assistance and market the crops as "Sustainably Grown in Virginia." This brand was designed to help farmers increase their market share and profits for specialty crops. This was a new project that did not build on a previously funded project with the SCBGP.

PROJECT PURPOSE
This project was designed to help conventional farmers transition to sustainable growing practices for specialty crops in order to meet an identified demand for organic and naturally grown foods central Virginia farmers markets.

The Farmers Market.co in Fredericksburg had frequently heard customer requests for organic and naturally grown foods that were not met by the 45 produce farmers represented at Fredericksburg-area farmers markets. It found the unmet demand particularly acute at a new farmers market on the Quantico Marine Base.

The market for organic and sustainably grown foods is growing nationally at an annual rate of about 20%. Organic food sales in the United States have more than doubled in the last eight years, from $11 billion in 2004 to an estimated $27 billion in 2012. Central Virginia's specialty crop farms are among the largest and most productive in the state, yet they are leaving "money on the table" by failing to capitalize on the explosion in demand for organic and sustainable produce in the Washington, D.C. area.

Arcadia's goals for this project were to:

- Increase the income and wealth of specialty crop farmers in Central Virginia by helping them transition their farms, in whole or in part, to sustainable growing practices**.**
- Improve the efficiency of specialty crop distribution by providing a single aggregation point and delivery system for the crops grown under this program, saving farmers the expense and trouble of moving their products to market in Washington, D.C.
- Provide extensive technical assistance to the five participating farmers through direct planning and consultations, and offer larger training workshops for a wider selection of local farmers.

- Increase the diversity of sustainable, specialty crop farmers by engaging with the network of Latino farmers who currently work with The Farmers Market.co.
- Increase the supply of sustainably grown specialty crops for the regional food system for which consumers have expressed unmet demand and are willing to pay a premium.
- Increase the sales of sustainably grown produce from Central Virginia to high-end restaurants in Washington, D.C. and Northern Virginia.
- Increase access by low-income communities in Northern Virginia and Washington, D.C., to affordable, locally and sustainably grown specialty crops via the Arcadia Center for Sustainable Food & Agriculture's Mobile Market.
- Create and provide a financial safety net to farmers who adopt these practices by committing to purchasing a portion or all of the specialty crops produced under the program for resale in Washington, D.C. and Northern Virginia.
- Provide a path to organic certification and/or Certified Naturally Grown for farmers who
- Increase Central Virginia's farmers understanding and practice of ecologically sound sustainable farm practices, which will improve the water, soil, and air quality in Central Virginia as a result.
- Identify and share solid sustainable practices for the farmers to implement at a measured pace to allow for the learning curve this transition will take.
- Demonstrate the process of transitioning to more profitable and ecologically sound farming practices. Share that information through an online blog that tracks the process of participating farmers, and through a handbook detailing the expenses, revenues, agricultural methods, and marketing practices of that transition. This will expand the reach of the project, and provide other Virginia farmers with the information they need to replicate that transition.

PROJECT ACTIVITIES

Arcadia staff participated with The Farmers Market.co in three growers meetings in Central Virginia from November 2014 to February 2015. Two meetings were organized by the Farmers Market.co and the other was organized by the Northern Neck Vegetable Growers Association. In all, Arcadia staff spoke with over 40 farmers about the program and described the program approach and the benefits.

After those meetings, we developed a recruitment list of 13 farmers for the project. From that recruitment list, Arcadia staff conducted farm consultation visits with 5 farmers, and continued to work to recruit 3 with whom we have an existing relationship into the program. Stephen Corrigan provided consultation and technical assistance to 4 farmers to develop a transition plan to sustainable practices. Unfortunately, only one of the farm, Pleitz Produce, participated in the program in 2015, and did so on a small scale (approximately 1 acre of land). Benjamin Bartley conducted aggregation runs with Pleitz Produce ($8,647 in sales) throughout the 2015 season. Due to staff turnover at Arcadia, and production pressures at Pleitz Produce, Pleitz did not continue in the program in 2016.

Arcadia and The Farmers Market.co participated in farmers meetings in the winter of 2015-2016, but no new farmers were identified for the program, and the farmers originally engaged by Stephen Corrigan were not interested in implementing the new sustainable growing practices due various reasons ranging from issues of cost, tradition, or disagreements within the family members managing the farm. Subsequent attempts to restart the project and engage more farmers were unsuccessful.

In 2014-2015, Arcadia and the project partners developed the program's sustainability standards and created a marketing plan for the program. A logo was also developed for the Sustainably Grown in Virginia brand. The brand and marketing efforts were not implemented due to the lack of participation by farmers at the local level. Arcadia engaged a number of existing suppliers for the Mobile Market program, but no one utilized the new brand or marketing support.

We faced a number of impediments to performing the work on this project which led to limited progress, low program participation, and an inability to meet our proposed deliverables. Our proposed anchor farmer, C&T Produce, had family issues that prevented their participation in the program. Arcadia had been working with C&T prior to the grant as a source for food for our programs, and was planning to launch the program with 5 acres in production and to host cold storage on their farm. The lack of participation by C&T was a tremendous setback for the project, and we were unable to identify a farmer who was willing to fill that void.

The inability to communicate with farmers leading up to and during the growing season was also a major challenge for this project. The reduced role of The Farmers Market.co from the original project proposal limited the ability to maintain open lines of communication with the farmers with whom we had engaged. Once the growing seasons began, the only way to communicate with the farmers was to visit the farm in person, and we were unable to do so on a regular enough basis to maintain effective communication.

Arcadia staff turnover also negative impacted the project, both through the inability to carry out project tasks, and through the loss of continuity of communication with the farmers we had engaged at the beginning of the project. Mr. Corrigan was the farmers' primary point of contact, and he had developed good working relationships with several of the farmers who had the potential to transition larger acreage. Those farmers may have been more willing to work with us if Mr. Corrigan had stayed on throughout the project. Additionally, the change in staff, and lack of participation by farmers, led to an inability to conduct the technical assistance training we had been hoping to provide in the area.

GOALS AND OUTCOMES

As identified above, a number of challenges led to a lack of success on this project. Below are the original goals of the project and any progress that was made on the goal.

- GOAL: Increase the total acreage of sustainable specialty crop land in Central Virginia by assisting farmers to transition from conventional to sustainable practices.
    - PERFORMANCE MEASURE: Number of acres transitioned from conventional to sustainable practices.
    - BENCHMARK: None of the farmers we will work with have any acreage in sustainable production.
    - TARGET: At least 10 and up to 20 acres of new, sustainably grown specialty crop production per year, over two years.

  1 acre of land was transitioned to sustainable growing practices as part of this project. No other farmers with whom we worked transitioned any acreage to production that would follow our sustainability standards. Our expected anchor partner, C&T Produce, had personal issues that led them to not participate in the project.

- GOAL: Increase the profitability of participating farmers by increasing the market rate for their specialty crops, and through developing new market opportunities.
    - PERFORMANCE MEASURE: Gross and Net sales; per-acre sales figures.
    - BENCHMARK: Current gross and net sales figures for each farmer.
    - TARGET: Increased per-acre sales by 10-20% for each participating farmer. Increase total farm sales (percentage will vary due to size of participating operations).

  Due to a lack of participation in the program, we did not collect this data, and did not see an increase in market rates for the specialty crops. We do not have this data for Pleitz Produce.
- GOAL: Increase the total sales of sustainably-grown specialty crops from Central Virginia in Northern Virginia and Washington, D.C.
    - PERFORMANCE MEASURE: Gross sales by participating farmers to Arcadia's Mobile Market, and tracked sales through Arcadia, The Farmers Market.co, and through direct market options.
    - BENCHMARK: These farmers do not currently offer sustainably grown produce, and Arcadia does not work with farms in this area.
    - TARGET: A minimum of $120,000 in sustainably grown specialty crops sold to Arcadia Mobile Market and retail per year of the grant.

Due to a lack of participation in the program, sales of sustainably grown specialty crops by Central Virginia farmers only increased by $8,647 during the project. That includes all sales by Pleitz Produce as identified above.

More details about the reasons the EMOs were not met by the project are explained in the Project Activities and Lessons Learned Sections.

<u>Project Accomplishments</u>

- Arcadia provided technical assistance to four farmers through direct planning and on-farm consultations to transition to sustainable growing practices.
- Arcadia worked with Pleitz Produce to increase their sales of sustainably grown produce from to markets in Northern Virginia and Washington, DC.
- Arcadia increased access by low-income communities in Northern Virginia and Washington, D.C., to affordable, locally and sustainably grown specialty crops via the Arcadia Center for Sustainable Food & Agriculture's Mobile Market.
- Arcadia identified and shared solid, sustainable practices for the farmers to implement at a measured pace to allow for the learning curve this transition will take.
- Arcadia did conduct training in sustainable agriculture with new and beginning farmers throughout the project period, but was unable to convert any additional existing farmers to those practices.

BENEFICIARIES

Due to the lack of participation in the project, and our inability to meet the goals of the project there were limited beneficiaries of this project. Pleitz Produce continues to supply food to DC markets, but we do not believe they have expanded to more acres in sustainable production as originally planned. Follow up with other farmers who received sustainability transition plans has indicated that none have transitioned any of their acreage in a way that would meet our standards. Some have implemented a few sustainable practices identified in the plans, but in general most continue to operate as they did before the consultation.

The creation of sustainability standards and the engagement with the farmers in central Virginia and the northern neck has been positive for The Farmers Market.co and Arcadia, but the impact of the efforts to transition those farmers to sustainable practices has been minimal.

Number of beneficiaries affected by the project: 1 Farm, Pleitz Produce, and as identified above, this benefit is limited. As the project was wholly unsuccessful, and did not continue, some farmers may benefit from the sustainability planning that occurred on their farms (4 farmers other than Pleitz), but we cannot claim these beneficiaries as none have actually transitioned to date as we understand it.

LESSONS LEARNED
We acknowledge that we underestimated the readiness, and potential interest, of farmers to transition to sustainable practices. While there is ongoing market demand for sustainably grown produce, the farmers with whom we have worked seem reluctant to adopt the additional practices and associated costs necessary to meet the standards of the program. We believe this may be due to the fact that there is not sufficient market pressure to develop a cost benefit in the areas where the farmers are direct-marketing their food. We continue to believe that there are some farmers who will be willing to make the leap, but it may just take time to reach the point where there is enough incentive to reach a larger number of growers.

We also believe that in order to help create the transition, we may need to engage financially with the farmers using their current practices before encouraging them to adopt new practices. That existing business relationship would be helpful in regard to developing trust and a working commitment. Unfortunately, we are currently unable to accept produce from those the farmers due to our internal sustainability standards, so we need to continue to evaluate the best opportunity both engage the farmers while adhering to our own mission and standards.

CONTACT PERSON
Matt Mulder
Director of Operations
202-365-0158
Matt@Arcadiafood.org

ADDITIONAL INFORMATION
N/A

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A. Hill
Virginia Food Works
Final Report

PROJECT TITLE
Development of Commercial Shelf-Stable Recipes for Specialty Crops

NAME OF ORGANIZATION
Virginia Food Works

PROJECT SUMMARY
Many specialty crop farmers are forced into profit loss either from accidental overplanting or due to crops not meeting grade standards of wholesalers and retailers. Processing produce into shelf-stable products allows farmers to profit from otherwise unsellable fruits and vegetables. Virginia Food Works (VFW) is a nonprofit organization that assists Virginia food producers as they enter and succeed in the value-added food market. With support from the Virginia Specialty Crop Block Grant program, VFW successfully implemented the Development of Commercial Shelf-Stable Recipes for Specialty Crops Project and now offers an expanded selection of recipes and an array of cost-effective co-packing/production services that enable local farmers to make the most of their seasonal harvest. Each recipe developed has undergone regulatory review and testing to ensure compliance with state and federal regulations, and tasting samples of all food products developed are available to local farmers at no charge.
The success of this project has contributed to VFW managing the creation over 50,000 products for 32 different farms and food businesses in Virginia. In 2015, we began tabulating the estimated retail value of foods created through VFW and the value is over $300,000.

PROJECT PURPOSE
The objectives and purpose of the Development of Commercial Shelf-Stable Recipes for Specialty Crops Project were to remove three key barriers to entry for Virginia farmers and food entrepreneurs who want to create value-added product from Virginia-grown ingredients:

1) Lack of capacity to develop, test, scale, and brand recipes that utilized the crops they were growing;
2) Lack of capacity to manage the regulatory requirements necessary to manufacture a food product for resale, including appropriately scaled commercial kitchen space;
3) Lack of capacity to work off-farm to process locally-grown fruits and vegetables during harvest season.

The importance and timeliness of this work was demonstrated by the results of a feasibility study conducted in partnership with the Virginia Federation for Agriculture, Innovation & Rural Sustainability (VAFAIRS). On behalf of Virginia Food Works, VAFAIRS applied to the Specialty Crop Competitive Grant Program in 2011 and was awarded funds to determine the feasibility of constructing and/or operating a commercial food processing facility in Central Virginia. The study identified underutilized regional resources such as the Prince Edward County Cannery. In 2013, Virginia Food Works was awarded a contract to operate the Prince Edward County Cannery and Commercial Kitchen, providing hands-on commercial food production and assistance to Virginia farmers and residents. This partnership enables VFW to connect farmers

and food entrepreneurs with the appropriate scale of equipment to provide critical production efficiencies to small-scale food producers trying to build successful businesses.
Virginia Food Works assists clients with every step of production including planning, interpreting regulations and requirements, scaling and production. All consultation services are free. Fees charged only include the cannery rental rate and these are kept at cost to encourage use. Hourly rates vary between $10 to $25 per hour and a $5 per hour discount is given if a cannery client uses as least one locally-grown ingredient.

PROJECT ACTIVITIES

Research and hire chef for recipe development.

Based on the result of farmer surveys and market assessment, VFW worked with a number of local chefs and experienced food product developers to design ten recipes over the project period including Chef Loretta Lane-Montana in Powhatan, VA; Patricia Gulick in Prospect, VA; William Gray in Richmond, VA, and Maggie Murphy in Charlottesville, VA. The target recipes were selected to ensure that new co-packing opportunities aligned with the specialty crops that participating farmers were looking to process. The final selections reflect the abundance of tomatoes, berries, apples, grapes, cucumbers, sweet and spicy peppers, and mushrooms available for further processing. Ultimately, VFW completed recipe development for the following products:

Peach salsa	Mushroom vinaigrette	Blackberry applesauce	Fruit syrups	Pizza sauce
Pepper jelly	Garlic and dill pickles	Tomato soup	Marinara sauce	Wine jelly

Recipe testing and refinement.

Once the recipes were completed, VFW staff developed manufacturing processes that utilized the Prince Edward County Cannery's equipment and met regulatory requirements and best practices for manufacturing. Along the way, VFW worked through a number of challenges, including:

1) Changing regulations from the Alcoholic Beverage Control (ABC). VFW had identified significant market interest from Virginia wineries that wanted jams, jellies, and spreads that combined local produce with Virginia wine. However, in 2017, Virginia ABC rolled out new regulations requiring the alcoholic content of food products (like wine jelly) to be incredibly low, with a residual Alcohol By Volume (ABV) of less than 0.5%.
VFW completed the *recipe development* and 50 jar *test batch* of a Chardonnay Spread Wine Jelly in 2015, before the updated ABV regulations in 2017. In fact, it was VFW's questioning of the ABV regulations that ultimately led to the updated formal regulations in 2017.
In the end, the resultant ABV of VFW's Chardonnay Spread was higher than the allowed 0.5% and the recipe and test batch jars cannot be used. To meet the new requirements, a minimal (token) amount of wine would be included in the product, not enough to impart a desired wine flavor. Wineries had hoped to sell food products that included their wines, increasing their tasting room sales. If the final products do not have a wine flavor, there is not an impetus to create the food products for resale. Additionally, the Alcoholic Beverage Commission now requires a lab test verification for each batch of food products made including wine. This testing requirement is intended to verify the ABV of each run of products. This additional testing adds

to the final cost of each batch, making the production costs high. Ultimately VFW ended development of wine jelly as a new product.

Only 9 of the 10 recipes originally planned to be completed during the grant time period are currently available to food producers. Significant time and grant funding was spent in the process of developing the wine jelly which is ultimately not able to move forward.

2) Processing stone fruit. Peach salsa – among other recipes using Virginia peaches – was an early priority for the project as up to 30% of a peach crop is blemished. However, VFW production staff found that the Prince Edward County Cannery's equipment is ill-suited for processing stone fruit. Any product that utilizes diced peaches requires the staff to prep the fruit using only hand labor. This includes steaming to remove the skin, cutting the peach in half by hand and carefully removing the pit as to not leave the sharp tip that is part of the stone. This hand work causes the cost of peach salsa to be too expensive for small-farm co-packing. VFW is exploring new equipment that would make the processes more efficient with new equipment cost estimates around $25,000.

3) Navigating the regulations around water bath pickling. Cucumber pickles were another value-added product that was a high priority for VFW during this project. While pickling for personal consumption is a common practice, pickling for resale carries with it a set of very specific regulatory guidelines to ensure that the process protects the end consumer from microbial threats under the "worst case scenario."

At VFW, commercial pickling is performed using the "hot water bath" method in the Cannery's retorts. In 2014, before the start of this grant project, VFW worked with retort manufacturer Allpax to conduct tests on the cannery's retorts. The intent was to "map" the temperature distribution during the water bath process and find the hot and cold spots in the vessel. This mapping process is necessary to determine the worst-case scenario during the water bath. The result is a specific set of processing instructions called a Process Approval, written by a food scientist called a Process Authority.

When VFW began development of our Garlic-Dill Pickle recipe for this grant project, we did so with the understanding that the results our Allpax testing would satisfy the requirements for this new process approval. However, after further discussion with Virginia Tech and VDACS Food Inspection Services, we determined that an additional retort mapping process was necessary for *each* pickle recipe. This ensures that any variation in packing or ingredient blend didn't adversely affect the manufacturing process.
In May and June of 2017, VFW partnered with Virginia Tech to conduct an additional analysis of the cannery's retorts, this time to ensure the safety and quality of our new Garlic-Dill Pickle. The resulting product is now approved for resale and available to farmers as a co-packing option. One continuing challenge is that any variation on that recipe – to make zucchini pickles instead of cucumber, or to make a bread and butter brine instead of a dill brine – will require additional testing and retort mapping.

Any pickle manufacturer selling pickles wholesale in Virginia must go through this mapping process. Virginia Tech does not perform this test for home-based commercial kitchens and

rarely does this for production kitchens. Given the Cannery and Virginia Food Works' relationship with farmers and food entrepreneurs, Virginia Tech was willing to complete this testing. This means that any producer wishing to manufacture our Garlic-Dill Pickle recipe may now utilize the cannery without having to repeat the mapping process, saving significant time and money.

Apply for process approvals.
VFW worked closely with Joell Eifert, Director of the Virginia Tech Food Innovations Program, to develop manufacturing processes for the recipes developed under this grant project. Process Approvals were issued by Virginia Tech, NCSU or Van Ness Food Technologies.
Due to the regulatory issues around alcohol content detailed above, VFW did not seek process approval for Wine Jelly. Our most recent development – Pizza Sauce – was completed but not submitted before the end of the grant period. However, we will receive the Process Approval on that product before the end of calendar 2017.

Design product labels and review product information with VDACS and/or FDA.
VFW partnered with graphic designer Jenna Obermiller of Icandothat Design to develop two versions of food product labels for each new recipe. One label version has a full-color background and only requires the name of the farm to be shelf-ready. The other label has a plain white background for easy customization by new clients. For reference, the labels are attached to this report.

All labels received an authorized UPC code and include all ingredient and production source information required by VDACS and FDA regulations. To save money, VFW opted to purchases UPC codes from a barcode reseller instead of through GS1.

Conduct bulk recipe trials and distribute samples to prospective clients.
VFW conducted bulk recipe trials in partnership with Homegrown Virginia to produce approximately (50) units of each new recipe for distribution to prospective clients. Each recipe was created at the Prince Edward County Cannery in Farmville, VA using Virginia-grown specialty crops. Over the course of the project, VFW was able to source local ingredients from a number of growers in Central Virginia, including:

CROP	PRODUCER	LOCATION IN VIRGINIA
APPLES	Albemarle Ciderworks	North Garden
TOMATOES	Bellair Farm	Charlottesville
	Local Food Hub	Charlottesville
	Whisper Hill Farm	Scottsville
PEPPERS	Bellair Farm	Charlottesville
BERRIES	Westmoreland Berry Farm	Chantilly
MUSHROOMS	Sharondale Farm	Charlottesville
CUCUMBERS	Loving's Produce	Richmond
PEACHES	Gross' Orchard	Bedford

Once recipes were selected and test batches completed, VFW focused on outreach and engagement with local growers and farm business owners in the state. To support these outreach

efforts, we worked with a Longwood University intern to scour VDACS' farmer lists to identify prospective cannery clients. The intern collected farm names and addresses for over 500 small and large farms, categorizing them by produce type (mushroom farm, apple orchard, berry farm, etc.). VFW then worked with a graphic designer to develop a set of produce-specific postcards to be mailed to perspective clients.

Each postcard advertises at least one of the specialty crops featured in the new recipes developed under this project. Postcards are cross-referenced with a list of crops produced by each grower in our campaign so that the messaging is as targeted as possible for each recipient. Postcard recipients who are interested in value-added processing can respond to the mailing and VFW will then mail the relevant test batch samples through the mail. Other ways to advertise and distribute the test batch samples is at face-to-face meetings and cannery tours, farmer conferences and through partnerships with local farmers markets and cooperative extension services.

GOALS AND OUTCOMES ACHIEVED

During the project period, the Development of Commercial Shelf-Stable Recipes for Specialty Crops Project has been successful in achieving each of the performance goals and measurable outcomes identified in the approval project proposal:

Goal	Performance Measure	Benchmark	Project Target	Actual
Increase the number of farmers and food producers creating foods from Virginia-grown produce.	# of farmers and food producers registered as active clients at the Prince Edward County Cannery	As of 2013: 13 clients	75% increase over benchmark: 23 clients served	**146% increase over benchmark:** 32 clients served
Increase the number of value-added food products in the commercial marketplace that use Virginia-grown ingredients.	# of value-added food products created at the Cannery	As of 2013: 13,820 products created	50% increase over benchmark: 20,730 products created	**119% increase over benchmark:** 30,286 products created

BENEFICIARIES

The major beneficiaries of this project are specialty crop farmers and food businesses in Virginia manufacturing value-added products from tomatoes, apples, berries, mushrooms, cucumbers, and other prevalent crops in Virginia.

During the project period, Virginia Food Works managed the processing of 51,996 lbs. of locally-grown produce into value-added products. These products are now on the shelves of grocery stores and farm stands throughout the region, and describe an estimated total retail value of $308,500 that can now be captured by the 32 different clients served during the grant period.

LESSONS LEARNED

Engaging regulators around small-batch processing

During the course of this project, we discovered regulatory "gray areas" that made it difficult to know how to proceed. Two examples included the Alcohol By Volume (ABV) requirement for food products and the mandatory mapping of the retorts used for processing pickles (discussed above). We struggled to obtain answers from our regulatory agencies on both of these issues as there was not a current policy relating to our questions. We found that with persistence and patience, we were able to obtain our answers while the regulatory agencies simultaneously updated their policies. Another aspect of the lesson is that the regulatory agencies do not always have the answers and they may need information from organizations like Virginia Food Works to learn what is actually happening within the realm of small scale food production. Don't assume that regulatory agencies are inflexible of change.

Determining optimal batch sizes for test production

This project was to primarily develop recipes that utilize Virginia crops to simplify the process for farmers. The goal of the test batches was to make tasting samples of the recipes to share with the farmers, helping to convince them to expand into value-added food production. The test batches had the added benefit of practicing the recipe on the cannery's equipment to improve production efficiency while learning tricks and tips that can be used during larger batch productions. The lesson learned is that by only making 50 jars of one recipe, it is hard to determine the final cost of the products when made at a larger scale. Affordable food processing is a numbers game where one tries to maximize the output with the fewest number of production hours. For example, we often find at the cannery that creating 300 jars of jam takes a similar time as 500 jars of jam. The lesson we have learned is that we cannot easily extrapolate the production costs for a 500 jar batch of salsa based on a 50 jar test batch made as part of this project. If a tomato farmer reaches out to VFW and inquires what the cost will be for creating a 500 jar batch of SCBG new salsa recipe, we cannot state an accurate price as we do not have the experience creating that new recipe on a large scale. This is particularly troubling to us as every farmer wants to know the cost before attempting a new venture like creating value-added foods. We completed the grant as written. The lesson learned is that it may have been best to create a large, full size batch of each recipe instead of a test batch as to generate larger batch pricing data that would be relevant to the farmers.

CONTACT PERSON

Name: Allison M. Hill, Project Director
Telephone Number: 434-960-8958
Email Address: info@virginiafoodworks.org

ADDITIONAL INFORMATION

- N/A

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Virginia Food System Council (VFSC)
Final Report

PROJECT TITLE

"Enhancing Market Opportunities for Virginia's Specialty Crops and Small to Mid-size Farms through 10 Percent Marketing and Education Campaign"

ORGANIZATION

Virginia Food System Council (VFSC)

PROJECT SUMMARY

Under this grant, the VFSC worked to gain an understanding of farm to institution across the state and encourage institutions, such as universities and hospitals, to increase or begin initial investigation into using a portion of their annual food budget for purchasing specialty crops grown in Virginia. The VFSC has compiled research from around the country and created a farm to institution repository on our newly redesigned website. In addition, we have developed a logo, tagline of "Virginia Flavor from Farm to Plate", and marketing materials that can be customized by institutions wishing to advertise their use of Virginia product in meals prepared and served in their cafeterias and dining halls. Lastly, we worked with the Sustainable Food Strategy Task Force and Aramark at the University of Virginia to create a video that addresses the significance institutions can have when purchasing locally from small and mid-size farms and some of the ways that Aramark overcame barriers associated with farm to institution purchasing. This video is also featured on the VFSC website along with other farm to institution resources and a pledge form to track and showcase institutions purchasing Virginia specialty crops.

PROJECT ACTIVITIES

Project Activity	Who	Final Report
Hold six regional roundtable discussions with institutional purchasers and vendors, service providers and distributors to identify barriers and brainstorm solutions.	VFSC, VCE, Virginia FAIRS, Virginia Farm Bureau	Several meetings were held early on in the grant with several institutions (i.e., Mary Baldwin College, James Madison University, Eastern Mennonite University, Washington & Lee University, Harrisonburg City Public Schools, Shenandoah Valley Produce Auction, Shenandoah Foods, Friendly City Food Cooperative). At that point, liability insurance and Good Agricultural Practices, price point, consistent volumes, and size appropriate distribution were seen as roadblocks, along with issues of scale and whether demand was real. Virginia Tech's

		Fresh Produce Safety Team was also just gearing up to conduct a survey on the opportunities and challenges to institutional markets. The report is being finalized by Virginia Cooperative Extension's Fresh Produce Safety Team. A link to the final report will be available soon. We contributed to survey questions and the formatting.
Hold a statewide conference for organizations, institutions, businesses, service providers, vendors, and distributors.	VFSC, VCE, Virginia FAIRS, Virginia Farm Bureau	The annual Virginia Farm-to-Table conference has consistently featured a Farm-to-Institution theme, and we have had panels and sessions with chefs, nutrition directors, producers, and distributors over the life of the grant.
Approach vendors, service providers and Food Service Directors of organizations, institutions, businesses re: interests and barriers to purchasing more local.	VFSC Coordinator, VCE (c/o Eric Bendfeldt), Lynda Fanning (VDA)	Outreach was done early on in the grant cycle and at the annual Virginia Farm-to-Table conference. Information and resources on how other areas have addressed interests and barriers to institutions purchasing more local food are available on the VFSC website.
Maintain newsletters and website. Track pledgers; Write and publish case studies and best practices; Distribute seasonal press releases; Announce Campaign drawings and events	Farmers' Market Managers, VFSC Coordinator and VFSC	The VFSC website was completely redesigned under this grant to better serve the needs of the Council, visitors to the website, and to feature work done under this grant, such as tracking pledges, publishing case studies, and providing data and resources to institutions and producers. We found that a Google group was a better way than a traditional email newsletter to maintain communications so we have used this method to send out news and updates. Events are featured on the VFSC event calendar on our website, and visitors to the VFSC website can also submit their own events to be included on the calendar. Staff at VDACS have handled the $10/week punchcard drawings.
Partner with Virginia Tech and the North Carolina 10% Campaign to create a working database to manage a large cross-state, multiple stakeholder campaign.	NC State Center for Environmental Farming Systems, VTech, VCE (Eric Bendfeldt and others)	In talking with NC State and University of Connecticut, we were advised to look at other options for promoting local foods to universities and hospitals. Part of the advice was based on cost, personnel, and glitches with software platform.

Develop educational materials for farmers' market managers. Develop campaign materials for institutions to utilize in their facilities and on their websites to advertise their long-term commitment to source local food. Develop resources to support connections/relationship among consumers, institutions and local producers of Virginia's specialty crops.	VFSC Education and Outreach Committee, VFSC Coordinator and Interns.	Educational materials are available under the Farm to Institution section on our redesigned website.
Recognize participating institutions/organizations on our website; provide them with 10% Campaign materials for their own in-house advertising campaigns.	VFSC Coordinator in cooperation with participating organizations	Institutions that are purchasing locally have the ability to be featured on our website and on a mapping feature on our website. In addition, the VFSC worked with the University of Virginia and Aramark to create a video highlighting Aramark's commitment to sustainable food purchasing. This video is featured on our website and in Aramark/UVA social media and outreach.
Database tracking: Increases in acreage for specialty crops from beginning of 10/14 – 9/16.	VCE, Virginia Farm Bureau, VDACS/VASS	Over the course of this grant, we have seen growth in aggregation and distribution businesses, such as the Shenandoah Valley Produce Auction, the Local Food Hub, the Southside Produce Auction, Shenandoah Foods, Wadel's Farm Wagon. This growth would suggest a growth in acreage for specialty crops or improvement in market access.

GOALS AND OUTCOMES ACHIEVED

GOAL I: Expand Virginia's $10 a Week Challenge to include a broader 10% Campaign that encourages organizations, institutions, and businesses to pledge 10% of their annual food budget to buy Virginia grown foods, emphasizing specialty crops, in support of local farmers, local food startups/distributors/entrepreneurs, and communities.

PERFORMANCE MEASURE: Tracking of 10% pledges on Virginia Food System Council website.

BENCHMARK: With the $10 a Week Challenge that began in 2012, Virginia households (n = 1072) and businesses (n = 32) pledged to spend at least $755,768 from their annual food budgets on locally grown Virginia.

TARGET: Over the 3-year period of the grant, the Council's target would be to reach 2,500 households and 375 businesses/institutions and secure pledges of local food purchases totaling $5M, with specialty crops as part of their total support for local food.

PROGRESS: Working with The Ivy Group, a marketing agency in Charlottesville, VA, the VFSC developed a logo, tagline, and rack cards in the fall of 2016 and early 2017. These materials were designed so that institutions that have made a commitment to purchasing Virginia specialty crops can customize their own marketing materials with our logo. These materials are available for download on the VFSC website (www.virginiafoodsystemcouncil.org), and have been used on marketing materials, such as tote bags given out to farmers market patrons, and in advertisements about the 10% Campaign and $10 A Week Pledge in Buy Fresh, Buy Local guides and Edible Blue Ridge Magazine.
The VFSC also assisted with the Farm-to-Table conference on December 6, 7, and 8, 2016 at the Blue Ridge Community College in Weyers Cave, Virginia. This conference featured a session on "Local Food For All: Improving Connections and Access" and a panel discussion on "Reconnecting Food and Culture" with speakers from the Virginia Mennonite Retirement Community, George Mason University, the Virginia Sustainable Foods Coalition, the Rodale Institute, and St. Luke's Hospital Project. Headquartered in Bethlehem, Pennsylvania the St. Luke's Rodale Institute Organic Farm grows organic produce that is served to patients, visitors, and employees of St. Luke's Hospital Anderson Campus. Excess produce is sold to staff and the surrounding community, an effort to increase overall health and wellness in and around the hospital. The Virginia Mennonite Retirement Community meanwhile sources much of their food from their own on-campus farm (i.e., Farm at Willow Run) and local Harrisonburg-area farmers, unlike many retirement communities. In addition to these farm-to-institution themed sessions, the VFSC had information on both the $10 a week and 10% campaigns to share with the 186 conference attendees.

The VFSC also advertised the 10% Campaign and $10 A Week Pledge through Buy Fresh, Buy Local guides and Edible Blue Ridge Magazine. In addition to the various Buy Fresh, Buy Local guides across the state, the VFSC also advertised in *Edible Blue Ridge*, a magazine "celebrating the food culture of Central Virginia" and part of the *Edible* family of publications across the country. This magazine has a circulation of approximately 11,000. Advertisements for the 10% Campaign were run in both the Spring 2017 and Summer 2017 issues.

The estimated number of households and businesses reached through this advertising is outlined below:

Publication	Household Circulation	Business Circulation	Total
BFBL Charlottesville, Northern Piedmont, and Loudon	275,000	16,000	291,000
BFBL Hampton Roads	50,000	250	50,250

BFBL Shenandoah Valley	110,000*		110,000
Edible Blue Ridge		11,000	
			462,250

*Note: The Shenandoah Valley circulation includes 60,000 guides to households and businesses, plus inserts in the *Winchester Star*, *Northern Daily*, and *Daily News Record*, which is approximately 50,000 newspapers total.

The $10 a Week pledge and 10% Campaign were also advertised through the Virginia Grown Farmers Market Punch Card Program and with Virginia Flavor tote bags, stickers, and rack cards for Farmers Market Week events during August 2-12, 2017. Although we do not have specific numbers for how many individuals received this advertising, the VFSC provided 100 tote bags and 100 rack cards for Farmers Market Week events, in addition to email advertising that went to market managers at the over 240 farmers markets throughout Virginia.

GOAL II: Enhance the sales to and consumption of specialty fruits and vegetables by these Virginia households, businesses, and institutions

PERFORMANCE MEASURE: To track what percent of the 10% pledge is specifically for fruits and vegetables.

BENCHMARK: The Council's starting point would be to request the current Virginia households (n = 1072) and businesses (n = 32) who have already pledged to spend at least $755,768 of their annual food budgets on locally grown foods, to specify amounts for their fruit and vegetable purchases.

TARGET: Over the 2-year period of the grant, the Council's target would be to reach 2,500 households and 375 businesses/institutions and secure pledges of $1M to $2M worth of fruits and vegetables as part of their total support for local food.

PROGRESS:

Through the VDACS Farm Fresh Pledge Promotion program total dollar purchases at farmers markets across the state are being tracked. Punch cards are distributed to participating markets, and patrons receive one punch for every $10 spent at the market on Virginia Grown products. When completed (a total of $140 spent), punch cards are turned into market managers, and final numbers are reported to VDACS. This program has been running since 2013, and punch cards are tracked for June, July, August, and starting in 2016, September during market season.

The following numbers are the total spent on punch cards for 2014 through 2017:

Year	Number of Markets	June	July	August	September	Total
2014	22	$6,580	$18,620	$28,980		$54,940
2015	21	$19,040	$19,600	$30,380		$69,020
2016	28	$8,540	$19,880	$22,400	$18,620	$69,440
2017	32	$12,880	$8,120	$26,460	$19,040	$66,920

For purposes of this specialty crop block grant, we attempted to distill these numbers down to the portion representing purchases of Virginia specialty crops only. Products falling under the Virginia Grown umbrella include fruits and vegetables in addition to: aquaculture and marine products; Christmas trees, horticulture, and nursery items; dairy and eggs; feed, seed, and non-food items; meat poultry and livestock; peanuts; small grains, cottons, and fibers; and specialty products. Any of these products purchased at a participating farmers market could count towards the Farm Fresh Pledge Promotion punch card completion. Therefore, the total dollar amounts spent in this program do not reflect total dollar amounts spent on only Virginia specialty crops.

We estimate that approximately 70% of purchases reported under the Farm Fresh Pledge Promotion program went towards fruits and vegetables. By these calculations, we are starting with the following numbers:

Year	Total Farm Fresh Pledge Program	Total Specialty Crops
2014	$54,940	$38,458
2015	$69,020	$48,314
2016	$69,449	$48,614
2017	$66,920	$46,844
Total		$182,230

In addition, the VFSC website underwent a large update during 2016-2017, and the functionality to track and map both 10% Campaign and $10 a Week Pledges is now active. We hope that with continuing advertising and Council activity, there will be more households, businesses, and dollars spent on Virginia specialty crops that we can track.

GOAL III: Provide educational resources and community support to help consumers and institutions connect and build relationships with local producers of Virginia's specialty crops

PERFORMANCE MEASURE: Track the number of households, businesses, institutions, and communities reached with our marketing and educational efforts. Distribute surveys after workshops and conferences to measure if there is an increased understanding among participants

BENCHMARK: The Council's starting point would be 1,072 Virginia households (n = 1072) and 32 businesses.

TARGET: Over the 2-year period of the grant, through regional workshops, farm-to-institution forums and conferences; the development marketing materials, press releases, public service announcements and launch events; the Council's target would be to reach 600,000 households and 1,500 businesses/institutions.

PROGRESS: As mentioned above, the Council developed a logo and marketing materials with help from The Ivy Group to promote both the $10/week and 10% campaigns to households, businesses, and institutions. These materials have been used on the website, advertised in Buy Fresh, Buy Local guides and Edible Blue Ridge magazine, and sent out for distribution to

farmers market patrons. In addition, the 2016 Farm-to-Table conference served as a venue for further discussion on farm to institutional purchasing in the state.

In addition, the Council hosted a statewide networking event, titled "Cultivate, Catalyze, Connect: A Gathering of Virginia Food System Councils and Networks," on October 6, 2016 in Lynchburg, VA. This was an opportunity for the Council to connect with other statewide organizations and food policy councils and share our work. The VFSC used this event to learn how we can best be helpful to other state food policy councils and networks as well as discuss our work with the 10% and $10 a week campaigns and how other groups can use our materials to promote these initiatives. There were 65 attendees at this event.

As reported earlier, the VFSC also advertised in the Buy Fresh Buy Local guides throughout the state and the Edible Blue Ridge magazine to promote both the $10 a week pledge and pledges from institutions to purchase specialty crops. These advertisements reached over 460,000 households and businesses.

GOAL IV: Assist and collaborate with consumers, businesses, and institutions to efficiently communicate their commitment to Virginia's specialty crops, farms and local food businesses.

PERFORMANCE MEASURE: Number of businesses, organizations and institutions actively pursuing a local food purchasing plan.

BENCHMARK: The Council's starting point would be the number of institutions that currently engage in a local food-sourcing program. Success and at what percentage, as well as what percentage for fruits and vegetables.

TARGET: Over the two-year period for each pledging organization, institution or business to either initiate a local food purchasing plan or to increase the current percentage of local food and/or specialty crop purchases.

PROGRESS: During the course of the grant, the Council communicated with the 4-VA Virginia Sustainable Food Coalition, which is comprised of George Mason University, James Madison University, Virginia Tech, and the University of Virginia. Through this communication and interaction, the Council learned of the commitment of the University of Virginia and Aramark's contractual obligation to achieve 50% sustainable food purchases by 2034, using AASHE STARS metrics, which includes an emphasis on local and regional procurement.

The VFSC worked with the University of Virginia Sustainability Office and Aramark to produce a video highlighting how UVA has addressed some of the challenges to farm to institution purchasing in the hopes that this will be helpful to other institutions hoping to pursue their own farm to institution initiatives. The video features interviews with:

- Eric Bendfeldt, Chair, Virginia Food System Council
- Andrea Trimble, Director, UVA Sustainability
- Samantha Jameson, Sustainability Coordinator, UVA Dining

This video is featured on the VFSC website, www.virginiafoodsystemcouncil.org.

GOAL V: To continue to collaborate with USDA and VDACS to gauge increased acreage of specialty crops in Virginia.

PROGRESS: This is still a goal. The Council continues to coordinate with NASS, VDACS, the Virginia Beginning Farmer and Rancher Coalition to get a handle on growth in acreage and improved market channels.

BENEFICIARIES

The VFSC learned a lot about farm-to-institution initiatives through this work, and we believe it is important that Virginia be seen as a player in the farm-to-institution field. Although our goal of getting institutions to commit to the 10% pledge is ongoing, we believe we have created a useful repository of information that will benefit institutions, such as universities and hospitals that are beginning to explore how they can source their food more locally and sustainably. The VFSC has a database of universities and hospitals that either have already received notification of this project and the resources available to them on our website, or they will be receiving notification of this information. This database includes 72 universities and 89 hospitals, which we would consider beneficiaries of this project.

In addition, attendees at the Virginia Farm-to-Table and Cultivate, Catalyze, Connect: A Gathering of Virginia Food System Councils and Networks benefitted from this work by learning more about farm to institution efforts, particularly as these apply to Virginia's specialty crops.

LESSONS LEARNED

The VFSC learned many lessons and faced challenges throughout this grant cycle. The biggest challenge was staffing and engaging board members in the work of this grant. As stated in previous progress reports, there was a lag in the transition from one Program Coordinator to the next, which caused significant delay, as there was a lapse in progress being made on this work for approximately 8 months. In addition, the VFSC has been in conversations about how best to fulfill our mission, determine if there is still a need for the VFSC in Virginia, what is the best structure for the board and VFSC as a whole, and what sort of staffing we need to be successful. This was an ambitious project carried out with help from a few board members and a part-time coordinator. For future work, the lesson learned is to create a master work plan with action items, a detailed schedule, and an understanding from all involved as to their responsibilities. Goals under this grant likely would have been met more fully or exceeded had the VFSC been functioning with one consistent Program Coordinator, a full board, and engaged stakeholders.

CONTACT PERSON

Allison Spain

401-374-0019

allisonspain@virginiafoodsystemcouncil.org

Eric Bendfeldt

540-432-6029

ebendfel@vt.edu

ADDITIONAL INFORMATION

The VFSC worked with The Ivy Group in Charlottesville, VA to design a logo that can be used by institutions to advertise that they have made a commitment to purchasing Virginia specialty crops. Many versions of this logo were created so that institutions may customize its use (such as on flyers, tote bags, banners, etc.), and a sampling of this work is included below. More versions can be found on the VFSC website or by contacting the VFSC.

In addition to these logos, The Ivy Group also helped us to create rack cards that have been used to advertise the 10% Campaign and the farm to institution resources available through the VFSC for Virginia institutions, businesses, and producers.

Lastly, the VFSC created a brief report on the 10% Campaign and $10 a Week Pledge as well as barriers to farm to institution purchasing, resources available to institutions and farmers in Virginia, and some examples of best practices in farm to institution purchasing from other states and regions.

14
C. Mei
Institute for Advanced Learning & Research
Final Report

PROJECT TITLE

Beneficial Bacterial Endophytes Improve Grape Vine Growth and Cold Tolerance to Strengthen the Virginia Wine Industry

NAME OF ORGANIZATION

The Institute for Advanced Learning and Research

PROJECT SUMMARY

The Virginia wine industry was recently ranked as the 5th largest in the country and continues to expand. However, this sector, like other agricultural producers, is in need of sustainable solutions to increase yield while reducing the use of synthetic fertilizers. Beneficial bacterial endophytes, residing inside plants, have been proven to promote growth and enhance stress tolerance in many plants. Based on scientific reports from French studies that *Burkholderia phytofimans* strain PsJN was shown to significantly increase biomass of grapevine, enhance cold tolerance, and inhibit the disease development, we have conducted field trials with two cultivars (Cabernet and Chardonnay) of grapevine inoculated with PsJN bacterial culture in four differently environmental vineyards in Southern Virginia. From pruning biomass, we found promising growth promotion by bacterial endophyte PsJN for Cabernet at Ayer's Vineyard in 2015 and at Sandy River Vineyard in 2016. After winter, we observed overwinter survival rate and found that more PsJN inoculated plants survived the cold winter than control plants did at Patrick Henry Community College and there were not much differences in other vineyards. In addition, we tested some bacterial endophytes for powdery mildew disease inhibition in vitro and found that one showed positive results. This project was not built on a previously funded project with the SCBGP.

PROJECT PURPOSE

Sustainable agriculture in the 21st century aims to reduce inputs, such as synthetically produced fertilizers and pesticides, while increasing yields on a per acre basis. To achieve these goals, natural alternatives to the most heavily used chemicals need to be developed and tested scientifically. This project is important and timely because the use of microorganisms to promote plant growth has achieved wide recognition as an alternative to traditional methods such as fertilizer and pesticide application, much of which is not utilized by plants and thereby pollutes the surrounding ecosystem through runoff. At IALR, we have developed a strong research program, which focuses on utilizing microorganisms to benefit agricultural production naturally. In addition, strain PsJN has been shown to increase growth, cold tolerance, and disease resistance in grapevine in European studies.

Due to its proven benefits in grapevine, driven by its ability to reduce the plant stress hormone, ethylene and the production of IAA, a growth promoting hormone, this bacterium will be the focus of this two-year evaluation of grapevine performance at various field sites. Vineyards in Virginia are often subject to below freezing temperatures during early and late seasons. It has been demonstrated that PsJN inoculation of *Vitis vinifera* L. cv. Chardonnay resulted in increased grapevine growth and physiological activities at low temperature. Like the previous study, the inoculated plants had

significantly higher levels of starch and other important plant protective compounds. While cold tolerance and growth promotion are important benefits of PsJN inoculation to grapevine, PsJN has also demonstrated an antagonistic effect on *Botrytis cinerea*, a gray mold which commonly affects grape production in temperate climates like Virginia.

Given the proven benefits mentioned above, the objective of this project was to evaluate performance of grapevine varieties grown in Southern Virginia after PsJN inoculation. Regionally appropriate varieties and rootstocks were first identified with input from Virginia Cooperative Extension. In year one, we purchased 500 saplings (Chardonnay and Cabernet grafted with rootstock #3309), developed methods for bacterium inoculation, and established field experiments in four vineyards. Then we observed plant growth vigor based on pruning weight and winter survival rates. In year two, we continued to monitor plant performance in the field, including chlorophyll contents, pruning weight and winter survival rates by comparing PsJN inoculated plants with non-inoculated controls.

We experienced unexpected challenges when three of the growers who originally supported the project were unable to work with us due to unforeseen conflicts. However, we were able to secure alternate growers in our footprint, but experienced additional delays in getting the vines transplanted. Partners of Ayer's Vineyard, Sandy River Vineyard, Bright Meadows Vineyard and Patrick Henry Community College played important roles in our field experiments by providing enough land and some technical instructions, such as information about soil types, site-specific disease pressure, water needs, and pruning style.

PROJECT ACTIVITIES

During the grant period, we have conducted the following activities:

1. Recruited four vine growers
2. Purchased two vine cultivars: Cabernet and Chardonnay for experiments
3. Developed protocol for bacterial inoculation
4. Observed plant growth and overwinter survival
5. Measured chlorophyll contents
6. Tested bacterial endophytes against powdery mildew disease in vitro

GOALS AND OUTCOMES ACHIEVED

1. We planned to have five vine growers in different geographic areas. We experienced unexpected challenges when three of the growers who originally supported the project were unable to work with us due to unforeseen conflicts. However, we were able to secure 4 alternative growers in our footprint, but experienced additional delays in getting the vines transplanted.
2. We obtained 100% survival rate after inoculated vines were planted.
3. Overwinter survival rate was improved at Patrick Henry Community College. But we experienced unforeseen early spring frost cold weather and disease outbreak, such as powdery mildew and downy mildew in Bright Meadows Farm in Nathalie, VA, which is nestled among the rolling hills of historic Halifax County. Shirley Archer, owner of Bright Meadows Vineyard, said that "this was the worst year in 15 years" in regard to grape production due to the wet, warm winter and hard late freezes. Both Cabernet and Chardonnay could not survive in this vineyard.

4. From pruning biomass, we found promising growth promotion by bacterial endophyte PsJN for Cabernet at Ayer's Vineyard in 2015 and at Sandy River Vineyard in 2016.
5. We found that Cabernet was a more rigorously growing cultivar in Southern Virginia compared to Chardonnay.
6. In addition, the preliminary results showed that some bacterial endophytes could inhibit growth of powdery mildew pathogen in vitro.

Our Target was not met because we did not see 100% increase in biomass. Typical site differences were observed, with some sites performing well and some poorly. We observed 22.5% increase in pruning weight at Sandy River Vineyard. We conducted our field experiments in four geographically different areas and obtained some positive results from plants inoculated with bacteria, such as growth promotion and winter survival. We measured chlorophyll contents but did not find significant differences. Small differences in normalized difference vegetative index (NDVI) were found at Ayer's Vineyard but the differences did not reach significance. We did not measure photosynthesis rates in the field because the outside condition was not stable. Greenhouse studies were unsuccessful because greenhouse conditions were too hot in the summer and not suitable for grapevine growth, and pests were a big problem. The cost for inoculating saplings was minimal, only additional a couple of hours labor.

In conclusion, Cabernet was a hardier growing vine in Southern Virginia compared to Chardonnay. Bacterial endophyte PsJN improved plant growth in Cabernet in some areas and slightly enhanced cold tolerance. More research is needed to further confirm the application of bacterial endophyte PsJN in the field.

BENEFICIARIES

Four vineyard owners benefited from this research project, each receiving 100 vines of inoculated and control plants. If effects of bacterial endophytes on growth promotion and cold tolerance are further confirmed, new vine growers will benefit from the project in growth promotion and cold tolerance.

LESSONS LEARNED

It is very important for grant applicants to find out suitable growers who are willing to accept new technologies and do scientific experiments in their land. In addition, the participating growers should have enough land to conduct the field design. In additions, when doing experiments with grapevines, it is important to place the orders the year before the experimental period is predicted to begin as supplies could be in short supply of the most desirable vine/rootstock combination.

CONTACT PERSON

Dr. Chuansheng Mei
434-766-6704
chuansheng.mei@ialr.org

Additional information

PRESS RELEASE

May 5, 2015

Scientists Working with Local Grape Industry

Patrick Henry Community College's Viticulture Program to Benefit from IALR Research

The Institute for Advanced Learning and Research (IALR) was awarded a grant from the Virginia Department of Agriculture and Consumer Services (VDACS) to facilitate a project designed to help local grape growers.

The proposal, "Beneficial Bacterial Endophytes Improve Grape Vine Growth and Cold Tolerance to Strengthen the Virginia Wine Industry," was awarded $39,798 in October 2014 to complete the project.

According to the proposal, the Virginia wine industry was recently ranked the fifth largest in the country and is continuing to expand. However, this sector like other agriculture producers is in need of sustainable solutions to increase the yield of the grape while at the same time, reduce the use of synthetic fertilizers.

"The goal of the project is to improve performance of the grapevine by increasing growth and cold tolerance by using a natural bacterial endophyte (that resides in the plants),"Scott Lowman, PhD, project manager said.

Two wineries from Martinsville and Henry County have committed to work with IALR on the project, Hamlet Vineyards and the viticulture program at Patrick Henry Community College (PHCC). Since the fall of 2014, scientists inoculated half of the project's grapevine plantlets with the beneficial bacterial endophytes in IALR's lab and greenhouse (photograph). The other plantlets were not altered and will serve as the control group. The plantlets will be transplanted and planted this week to PHCC (May 6) and to Ayers Vineyard (May 11). The wineries and IALR scientists will compare the performance of the inoculated plants versus the non-inoculated plants for the next two growing seasons.

IALR researchers have intensively studied plant-endophyte interactions in a variety of plants and have several publications in peer reviewed scientific journals.

"We already have a lot of previous experience and over seven years of background research related to beneficial bacterial endophytes," Chuansheng Mei, PhD, principal investigator of the project said. Because of this strong research background, Mei and Lowman feel confident this technique will have a positive effect on the grapevine as well.

The project has potential economic impact as well. "This is a perfect example of applied research," Lowman stated.

The Virginia wine industry now consists of more than 200 wineries and contributes $750 million annually to the state economy. If the research is successful, not only could Virginia's vineyards improve the sustainability of their product but also enjoy lower production costs.

For more information on IALR's research visit: http://www.ialr.org/index.php/applied-research

Article from Martinsville Bulletin, Thursday, May 7, 2015

Research aims to aid grape production

By MICKEY POWELL
Bulletin Staff Writer

A research project getting started in Henry County is intended to help wine makers grow stronger, more resilient grape vines, which ultimately could help them reduce production costs.

The project is led by the Institute for Advanced Learning and Research (IALR) in Danville — a partnership of Virginia Tech and other educational institutions, including Patrick Henry Community College (PHCC), the New College Institute and the Piedmont Governor's School.

PHCC, which has a grape-growing and wine-making program, and Hamlet Vineyards of Bassett are participating in the research.

According to the project's proposal, the state's wine industry is the fifth largest in the nation and expanding, and it needs sustainable measures to increase the yield of grapes while reducing use of synthetic fertilizers.

More than 200 wineries statewide contribute $750 million to the state's economy each year, information provided by the institute shows.

The research project's goal, according to its manager, IALR scientist Scott Lowman, is to increase grape vines' growth and tolerance to cold by using a natural endophyte that already is in the plants. An endophyte is a beneficial bacteria that Lowman compared to so-called "good bacteria" in people's stomachs that help with digestion and protect against disease.

Institute for Advanced Learning and Research scientists Scott Lowman (left) and Chuansheng Mei plant grape vines Wednesday at Patrick Henry Community College as part of a research project to improve grape production. The project also involves Hamlet Vineyards of Bassett. (Bulletin photo by Mickey Powell)

Although grape-growing and wine-making are becoming more popular in the region, grapes grown in the eastern United States have "a lot of potential maladies" due to heat and humidity, which contribute to diseased plants, according to PHCC viticulture professor John Ayers. Wet conditions caused by afternoon thunderstorms in the late summer also can lead to diseased plants, said Butch Hamlet, who runs Hamlet Vineyards.

IALR scientists have inoculated half of the grape vine plantlets that will be used in the research project with endophytes. Inoculations were done by dipping the plants into a solution containing endophytes, Lowman said.

The other half will be used as the

See GRAPES, Page 2-A

MARTINSVILLE BULLET

Grapes

(Continued from Page 1-A)

control group. They were dipped into a solution that did not contain endophytes, said Lowman.

One hundred plantlets were planted in PHCC's vineyard on Wednesday. The rest will be planted at Hamlet Vineyards on Friday. They will be monitored over the next two grape-growing seasons, institute officials said.

"It's going to be interesting," Ayers said, to watch how the inoculated ones grow in comparison to those that were not inoculated.

Researchers believe the endophyte inoculation will prove worthwhile based on more than seven years of research, said Chuansheng Mei, another IALR scientist who is the research project's principal investigator.

Lowman mentioned research in France that showed endophyte inoculation helped grapes grow better in cooler climates and resist diseases.

Similar research done in the U.S. with switchgrass, potatoes and tomatoes showed those crops did better when they were inoculated, he said.

Hamlet indicated that if the grape vine research proves fruitful, he might plant inoculated vines in the future if a decision is made to expand the vineyard.

Charges

(Continued from Page 1-A)

• Stafford Darnell Redd, 35, 907 Palace Court, Martinsville, one count each use of firearm in a felony, discharge firearm in a city street without resulting in bodily injury to another person and possession of marijuana, Dec. 19.

• Jocelyn Demetrica Turner, 31, 1114 Sylvan Ave., Martinsville, one count each felony shoplifting and conspiracy to commit felony shoplifting, Dec. 7.

abc 13 WSET.com LYNCHBURG DANVILLE ROANOKE

Scientists Conducting Experiment At Local Vineyards To Promote Natural Growth
by Tola Adamson, Monday, May 11th 2015

Stuart, VA-- Not many people really scorching hot humid summers, and that includes those in the wine industry.
That's why some vineyards on the Southside are taking part in an experiment conducted by scientists at the Institute for Advanced Learning and Research to see how they can protect their grapevines in the humid summers.
It's around that time of the year, spring time, when grape growers are either pruning the vines or planting new ones to prepare for the fall harvest.
"You never finish," said John Ayers, owner of Ayers Orchard and PHCC Viticulture Professor. "There's always something to do."
Ayers said summertime is tough.
"We're primarily concerned with fungus infections that will affect the foliage and eventually the grapes," Ayers said.
To combat that, Ayers, just like others in viticulture, spends many hours spraying each grapevine with an anti-fungal chemical.
"We would normally spray plus or minus 15 times a year," Ayers said.
Now these scientists are working to change that at both the vineyards he manages, and promote a more natural growth process. They inoculated 50 grapevines with a beneficial bacterial endophyte called PSJN. It's been known to help chardonnay and cabernet grapes grow more naturally in France. These scientists hope it will translate to Virginia.
"It helps with cold tolerance and helps with disease resistance," said Dr. Scott Lowman, a scientist at IALR. "It makes the grapevines larger and possibility establish themselves faster."
Then the hard work begins, planting the controlled and the inoculated plants side by side at the vineyards.
"We're hoping to see by the end of the summer some increased growth," said Dr. Lowman. "We're also looking for increased plant health."
"We would have fewer sprays, fewer chemicals, and reduce our cost in the long run," Ayers said.

The scientists have found this experiment successful in a bio energy crop called switchgrass. They said three other vineyards will also be participating in this experiment.

15
M. Reiter
Virginia Tech
Final Report

PROJECT TITLE
Cover Crops and Nutrient Cycling for Vegetable Production in Virginia.

NAME OF ORGANIZATION
Virginia Polytechnic Institute and State University

PROJECT SUMMARY
High-residue cover crops (killed late in growth to provide optimal biomass) add organic matter to soil for tilth improvement and reduce pollution; however, may impact nitrogen management. Objectives for this study include: 1. Determine appropriate nitrogen fertilizer application rates for sweet corn and tomatoes in systems that are utilizing high residue cover crops; 2. Quantify soil health improvement from conversion of conventional tilled vegetable land to land with incorporation of cover crops (tomato and sweet corn) and conservation tillage (sweet corn), 3. Determine nitrogen supply from cover crops, and 4. Disseminate information to farming audiences. For both tomato and sweet corn, we compared their perspective nitrogen fertilizer needs for each system utilizing no cover crops (control), hairy vetch, cereal rye, and mustard. For sweet corn, an additional comparison was utilized that compared no-tilled systems to conventional systems to monitor nitrogen use over conversion years. Overall, we demonstrated that considerable changes need to occur for successful incorporation of high-residue cover crops to vegetable systems. Over the two years, the no cover crop treatments generally had the highest yields and best fruit and ear quality. More work needs to be done on these systems before farmer implementation.

PROJECT PURPOSE
Due to disease pressures, land workability, water management, and timing necessary to grow vegetable crops, vegetable production systems typically employ cover crops that are terminated early in their lifecycle if they use cover crops at all. Early cover crop termination reduces overall biomass production (for example: 500 vs. 5,000 lbs. of biomass per acre for cereal rye); which inhibits beneficial additions of organic matter to the soil profile that assists with soil tilth improvement and nutrient cycling. Extension personnel is consistently asked what cover crops work best in conventional and organic production systems, but little work has been done in Virginia for vegetable systems.

Nitrogen fertilizer is difficult to manage in all vegetable production systems as numerous pathways are readily available to “lose” nitrogen; which decreases a farmer’s overall fertilizer use efficiency. Reduced fertilizer use efficiency is especially problematic in systems that are in conversion from conventional tillage to no-tillage (sweet corn) and if farmers begin to utilize high-residue cover crops (sweet corn and/or tomatoes). No-till and high residue cover crops (such as cereal rye) are excellent farming practices for overall reduction of sediments and nutrients from agricultural fields; however, by adding more carbon and organic matter to the soil the farmer changes the overall carbon:nitrogen ratio of the soil system. Increasing carbon and

organic matter significantly increases overall soil health and tilth but more nitrogen is needed to bring the soil's carbon:nitrogen ratio back to equilibrium (10 parts carbon to 1 part nitrogen). The project investigator demonstrated this phenomenon with row crops and found that 60% more nitrogen was actually needed when high-residue cover crops were incorporated into the farming system (Reiter et. al., 2008a). Also, the project investigator used a nitrogen tracer (N15) to track amounts of nitrogen fertilizer added to rye cover crops that would be available to the following cash crop. Reiter and coworkers (2008b) determined that cover crops could be fertilized with nitrogen fertilizer to increase biomass to build organic matter and that fertilizer would supply up to 30% of the nitrogen needs for the following cash crop through natural nitrogen cycling for up to 3 years.

Current Virginia Cooperative Extension recommendations were based on conventional crop production systems and offer no guidance for farmers utilizing no-tillage or cover crops (Reiter et. al., 2014). Secondly, little data is currently available to Virginia growers wishing to utilize in-situ petiole sap nitrate tests using hand-held nitrate meters and limited data is available for growers wishing to send their leaves to a laboratory for total N concentration for in-season nitrogen management. Nitrogen management tools are necessary for growers to feel comfortable to reduce nitrogen application up-front in the season without in-season guidance for future nitrogen applications. Results from this study will be incorporated with previous SCBGP funds that we received for tomatoes and pumpkins to develop a guideline for Virginia growers wishing to utilize petiole nitrate meters for in-season nitrogen management for vegetable crops. We will develop an Extension publication that gives cover crop guidance for all vegetables grown in Virginia regarding petiole nitrate meter monitoring with data from current varieties and crops grown in our Mid-Atlantic climate (similar to the publication currently available for Florida growers; Hochmuth, 1994).

Particular objectives for this study include: 1. Determine appropriate nitrogen fertilizer application rates for sweet corn and tomatoes in systems that are utilizing high residue cover crops; 2. Quantify soil health improvement from conversion of conventional tilled vegetable land to land with incorporation of cover crops (tomato and sweet corn) and conservation tillage (sweet corn), 3. Determine nitrogen supply from cover crops, and 4. Disseminate information to farming audiences.

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PROJECT ACTIVITIES

In Fall 2014 and 2015, we planted the brassica (Caliente 199 Mustard), legume (hairy vetch), and grass (cereal wheat) cover crops, along with leaving a control section fallow for the winter for conventional tillage with no-cover crop additions. The cover crops were replicated 4 times and in two separate locations at the Virginia Tech Eastern Shore AREC on sandy loam soils (Bojac sandy loam; 65% sand in the upper horizon). In all cases, insignificant amounts of soil nitrate were available (<5 ppm NO_3-N) and soil nitrogen would provide little confounding nitrogen to the experiment. One location was used for fresh market tomatoes and an adjacent location was used for sweet corn. We collected background soil samples for nitrogen and other nutrient quantification from three different depths to monitor the nutrient status within the soil profile. Prior to cover crop desiccation; which was at-heading for wheat and full bloom for mustard and hairy vetch, we harvested 1/4 m^2 areas of aerial biomass to determine cover crop total biomass production. These tissue samples were dried, weighed, ground and analyzed for total nitrogen, carbon, and sulfur concentration. In 2015, both tomato and sweet corn were planted at their locations, both as no-till operations. In 2016, tomato plots had residue incorporated using a disk harrow prior to plastic mulch establishment, while sweet corn was no-tilled directly into the cover crop plots. Overall, sweet corn cover crop biomass ranged from 4,836 to 10,907 lbs. residue/acre. Tomato cover crop biomass plots ranged from 5,299 to 10,806 lbs. residue/acre so high-residue status was reached with these plots. Sweet corn plots were fertilized with N treatments (at-planting and sidedress) along with phosphorus, potassium, and boron as recommended by the soil testing lab. Tomato plots had fertilizer incorporated under the plastic and N treatments were applied via fertigation over the growing season using drip irrigation. Plant tissue (corn ear leaf and upper fully most developed leaf for tomato) was collected and analyzed for leaf tissue N status. Corn ear and tomato fruit were graded for size when yield was collected. Preliminary data was presented to farmers at the Eastern Shore Research Field Day in 2015 and 2016 and at the Eastern Shore Ag Conference and Trade Show. Overall, tomato and sweet corn systems are the only systems that benefited from this research since they are so unique in their varieties, fertility regimes, tillage, and timing.

GOALS AND OUTCOMES ACHIEVED

Introducing high-residue cover crops into the production system is one of the best ways to increase overall soil quality and health; however, presents several challenges regarding overall production and nutrient management. Our results for both tomato and sweet corn clearly demonstrate that considerable management alternations to the production system need to be made for optimal yield and marketability of these two important Virginia vegetable crops. Careful planning and consideration needs to be made to the production system before and after inclusion of high-residue cover crops.

In 2015, we originally planned to plant tomatoes directly in the residue no-till instead of incorporated and installation of polyethylene mulch. The project was established, but a combination of disease, insect, and irrigation issues compromised plots and we decided to eventually abandon the study as too many issues were confounding to demonstrate meaningful results. Although quantifiable results were not obtained, we did learn many lessons that we then implemented for year 2. In 2016 tomatoes, quadratic regression models were the best fit for the cover crop × N rate interaction (Fig. 1). Overall, conventional tilled tomatoes with no cover crops consistently had higher yields than any plots with cover crops incorporated. It is interesting

to note that hairy vetch and Caliente mustard had lower tomato yields at higher N rates than wheat. We speculate that higher N rates sped degradation of brassica residue; which may have increased release of isocyanates under the polyethylene mulch. Brassica degradation and fumigation release should be further investigated to determine if incorporated brassica with plastic mulch systems may cause plant injury and yield reduction for fresh market tomatoes. Brassica are an important and popular cover crop and are more commonly being considered for plastic mulch systems due to their fumigation capabilities. Marketable fruit turnout was not impacted by cover crop treatment (Table 1), but conventional tilled plots with no cover crops had larger fruit than the possibly injured mustard plots (147.7 vs. 136.4 g/fruit, respectively). Averaged across cover crop treatment, fruit size was not impacted with N rate and applying 75 to 225 lbs. N/acre produced the most marketable fruit as a percentage of total yield basis (Table 2).

In 2015 and 2016, conventional tilled sweet corn clearly demonstrated higher yields than plots containing cover crops (Figs. 2 and 3). As expected, the legume hairy vetch cover crop yielded more than the mustard and grass cover crops as more N was available from the cover crop system for growth. Due to C:N ratios and N immobilization, all cover crop treatments in 2016 required more N for optimal yields than the conventional tilled treatments. Overall, N rates for high-residue cover crops with high C:N ratios, such as wheat or rye, will need to be increased for optimal yields and may need to be increased for brassicas. We overall achieved our benchmark on numerous plot treatments and have actually surpassed our target in both years. Regarding overall marketability, conventional treatments also had higher percentages of ears that met consumer expectations compared to cover crop plots in 2015 (Table 3). In 2016, additional N availability from hairy vetch produced a higher marketable turnout than any other treatment (Table 5). Wheat and mustard plots had 50% or less of ears being marketable. We largely contribute smaller and less desirable ears to a lack of available fertility; which was documented by hairy vetch having acceptable ears being produced in 2016. Regarding N rate, averaged across all cover crop treatments, maximum yield was achieved with 100 lbs. N/acre applied at sidedress in both 2015 and 2016 (Tables 4 and 6). However, amount of N fertilizer necessary varied and was dependent on cover crop species used (Figs. 2 and 3). Likewise, highest marketable percentages of ears was produced with 100 lbs. N/acre in 2015 and 150 lbs. N/acre in 2016.

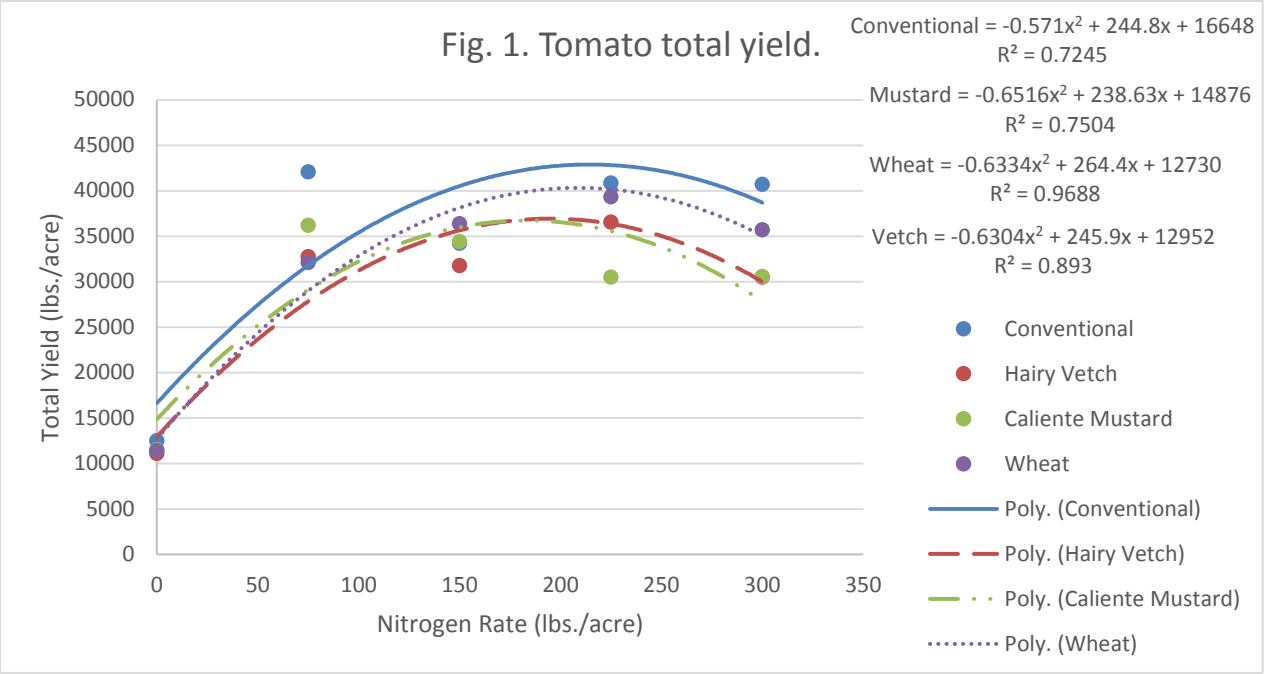

Table 1. Total tomato yield, marketable yield, percent marketable fruit turnout, and average fruit size cover crop main effect for polyethylene mulched tomatoes grown using different high-residue cover crop systems on sandy loam soils in Virginia, averaged across N rates.

Cover Crop	Total Yield	Market Yield	Turnout	Size
	---lbs./acre---	---lbs./acre---	---%---	---g/fruit---
Conventional	34,098 a†	21,608 a	62.3	147.7 a
Hairy Vetch	28,562 b	18,344 ab	62.5	140.2 ab
Caliente Mustard	28,677 b	17,693 b	61.5	136.4 b
Wheat	31,012 b	18,937 ab	58.2	138.7 ab
$LSD_{0.10}$	4,121	3,393	5.1	11.1
Mean	30,587	19,145	61.1	140.7

†Means with a column with different letters are significantly different at p=0.10.

Table 2. Total tomato yield, marketable yield, percent marketable fruit turnout, and average fruit size N rate main effect for polyethylene mulched tomatoes grown using different high-residue cover crop systems on sandy loam soils in Virginia, averaged across cover crop treatments.

N Rate	Total Yield	Market Yield	Turnout	Size
---lbs./acre---	---lbs./acre---	---lbs./acre---	---%---	---g/fruit---
0	11,673 b†	6,640 c	53.6 c	139.1
75	35,816 a	22,979 ab	65.2 a	144.9
150	34,217 a	20,646 b	61.2 ab	140.1
225	36,837 a	24,635 a	66.5 a	140.3
300	34,394 a	20,827 b	59.2 bc	139.1
$LSD_{0.10}$	4,607	3,793	5.7	12.4
Mean	30,587	19,145	61.1	140.7

†Means with a column with different letters are significantly different at p=0.10.

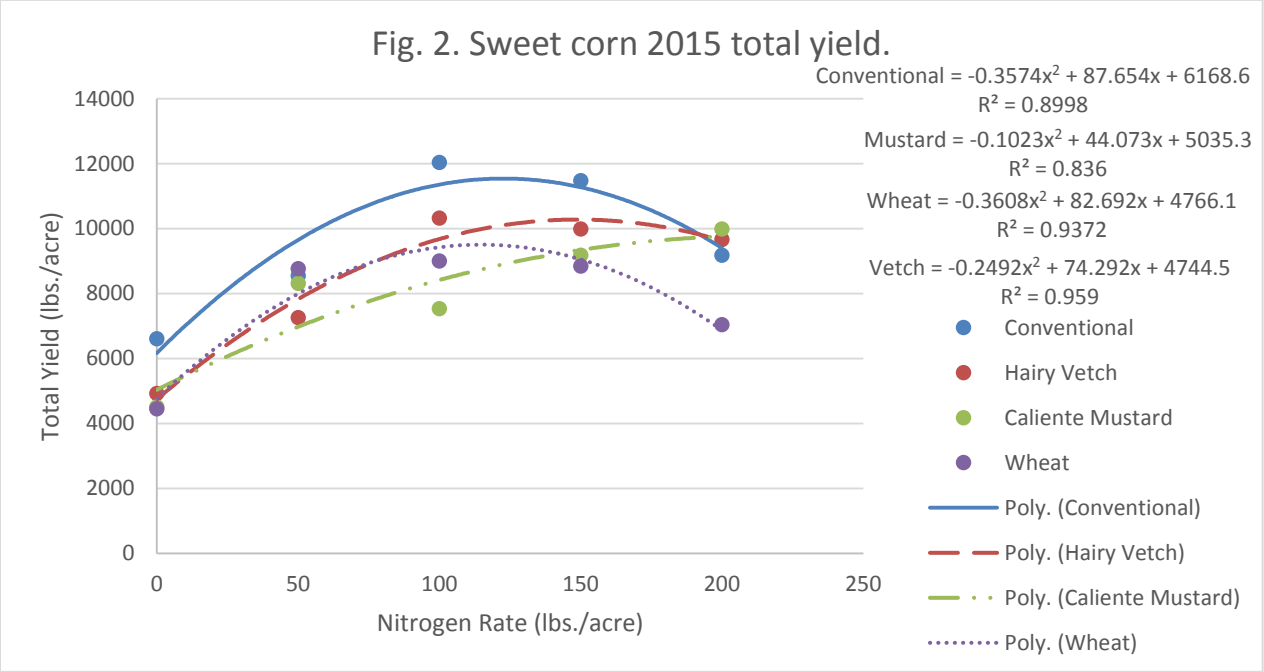
Fig. 2. Sweet corn 2015 total yield.
Conventional = -0.3574x² + 87.654x + 6168.6
R² = 0.8998
Mustard = -0.1023x² + 44.073x + 5035.3
R² = 0.836
Wheat = -0.3608x² + 82.692x + 4766.1
R² = 0.9372
Vetch = -0.2492x² + 74.292x + 4744.5
R² = 0.959
Total Yield (lbs./acre)
14000
12000
10000
8000
6000
4000
2000
0
0
50
100
150
200
250
Nitrogen Rate (lbs./acre)
Conventional
Hairy Vetch
Caliente Mustard
Wheat
Poly. (Conventional)
Poly. (Hairy Vetch)
Poly. (Caliente Mustard)
Poly. (Wheat)

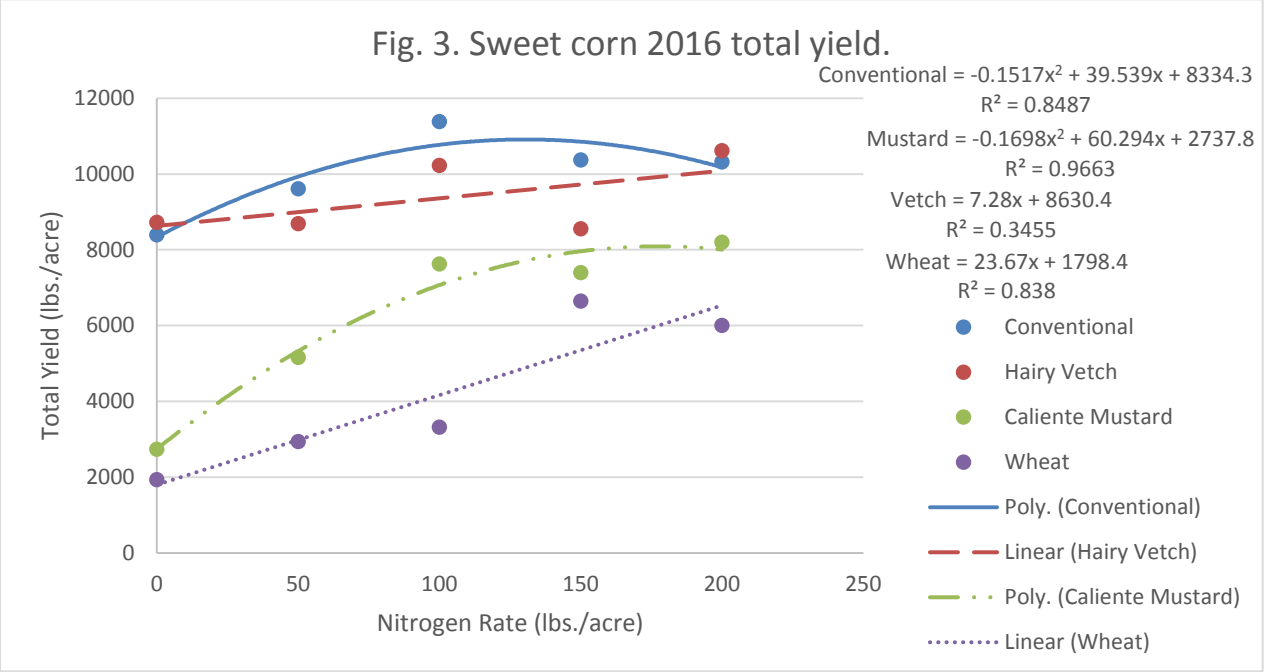

Table 3. The 2015 total sweet corn yield, marketable yield, percent marketable turnout, and average ear size cover crop main effect for sweet corn grown using different high-residue cover crop systems on sandy loam soils in Virginia, averaged across N rates.

Cover Crop	Total Yield	Market Yield	Turnout	Size
	---lbs./acre---	---lbs./acre---	---%---	---g/ear---
Conventional	9,573 a	7,279 a	73.6 a	278.7 a
Hairy Vetch	8,435 b	5,987 b	66.3 b	258.3 bc
Caliente Mustard	7,909 b	5,214 b	61.6 b	260.4 b
Wheat	7,624 b	5,102 b	63.0 b	240.9 c
$LSD_{0.10}$	936	948	5.9	17.8
Mean	8,385	5,896	66.1	259.5

†Means with a column with different letters are significantly different at p=0.10.

Table 4. The 2015 total sweet corn yield, marketable yield, percent marketable turnout, and average ear size N rate main effect for sweet corn grown using different high-residue cover crop systems on sandy loam soils in Virginia, averaged across N rates.

N Rate	Total Yield	Market Yield	Turnout	Size
---lbs./acre---	---lbs./acre---	---lbs./acre---	---%---	---g/ear---
0	5,125 c	2,855 c	50.7 c	241.9 b
50	8,225 b	5,214 b	62.5 b	256.1 ab
100	9,726 a	7,107 a	71.4 a	270.8 a
150	9,877 a	7,464 a	73.1 a	257.8 ab
200	8,973 ab	6,839 a	73.0 a	271.1 a
$LSD_{0.10}$	1,047	1,060	6.7	19.9
Mean	8,385	5,896	66.1	259.5

†Means with a column with different letters are significantly different at p=0.10.

Table 5. The 2016 total sweet corn yield, marketable yield, percent marketable turnout, and average ear size cover crop main effect for sweet corn grown using different high-residue cover crop systems on sandy loam soils in Virginia, averaged across N rates.

Cover Crop	Total Yield	Market Yield	Turnout	Size
	---lbs./acre---	---lbs./acre---	---%---	---g/ear---
Conventional	10,013 a†	8,353 a	83.3 b	283.7 b
Hairy Vetch	9,358 a	8,676 a	92.1 a	356.9 a
Caliente Mustard	6,220 b	3,735 b	50.2 c	234.0 c
Wheat	4,165 c	1,864 c	33.0 d	172.5 d
$LSD_{0.10}$	1,315	1,380	8.5	25.4
Mean	7,439	5,657	64.6	261.8

†Means with a column with different letters are significantly different at p=0.10.

Table 6. Total 2016 sweet corn yield, marketable yield, percent marketable turnout, and average ear size N rate main effect for sweet corn grown using different high-residue cover crop systems on sandy loam soils in Virginia, averaged across cover crop treatments.

N Rate	Total Yield	Market Yield	Turnout	Size
---lbs./acre---	---lbs./acre---	---lbs./acre---	---%---	---g/ear---
0	5,445 b	3,680 c	45.7 d	200.1 c
50	6,598 b	4,819 bc	58.7 c	272.2 ab
100	8,136 a	6,337 ab	65.9 bc	264.8 b
150	8,238 a	6,532 a	77.6 a	277.0 ab
200	8,780 a	6,917 a	75.4 ab	294.7 a
$LSD_{0.10}$	1,471	1,543	9.5	28.4
Mean	7,439	5,657	64.6	261.8

†Means with a column with different letters are significantly different at p=0.10.

BENEFICIARIES

Development and refinement of current Extension fertilizer recommendations for tomato and sweet corn growers that desire to use no-tillage or to incorporate high-residue cover crops will be greatly utilized and have far reaching impacts across the Commonwealth and beyond. The Commercial Vegetable Production Recommendations is the one-stop resource for all vegetable growers in Virginia. Updating Extension recommendations in this document will impact all acres annually grown in Virginia. New varieties, incorporation of high-residue cover crops, utilizing no-tillage, and other management practice changes have significantly changed since these recommendations were originally made. Another possible benefit of this research is the increased use of high-residue cover crops to reduce pollution to our waterways and to build soil organic matter and tilthe; which is difficult to quantify on a monetary basis.

LESSONS LEARNED

Overall, the project was successful in investigating new nitrogen fertilizer rate parameters that need to be established for farmers utilizing high-residue cover crops in a no-tillage situation. Switching to no-till has consistently impacted nitrogen dynamics and new fertilizer guidelines need to be established for the increasing number of producers utilizing no-tillage methodology. In most cases, overall sidedress nitrogen rates were higher than current extension recommendations as we hypothesized. Several production issues occurred with tomatoes in the

first year, and we changed the system to more closely match a plasticulture production system in year 2. Incorporation of the residue assisted with disease, insect, and irrigation problems that plagued us in year 1.

CONTACT PERSON

Mark S. Reiter, Ph.D.
Associate Professor of Soil and Nutrient Management/Extension Specialist
757.414.0724 ext. 16
mreiter@vt.edu

16
B. Zhang
Virginia Tech
Final Report

PROJECT TITLE

Development of Soybean Varieties for Sprouts as a Profitable Vegetable Crop

NAME OF ORGANIZATION

Virginia Tech

PROJECT SUMMARY

Soybean sprouts, a traditional year-round vegetable in Asia, are gaining popularity in the U.S. due to their high digestible energy, bioavailable vitamins, minerals, amino acids, and phytochemicals. To fulfill the purposes of exportation and domestic consumption, superior soybean seeds are required to secure profit of both growers and sprout manufacturers through high production yield and high quality of seeds and sprouts. However, breeding effort of sprouting soybeans is very limited in the U.S. since most soybean breeders focus on commodity soybean variety development. We have made effort to establish breeding criteria of sprout characters of soybean seeds and to develop sprouting soybean breeding lines adapted to Virginia. The breeding criteria include white flower color, clear hilum color, <11 g/ 100 seeds, high quality sprout (HQS) % > 45.04%, HQS fresh weight > 91.23 g, yield > 5.3 g/ g seed, middle quality sprout (MQS) % < 35%, hypocotyl length > 13 cm, hypocotyl thickness > 1.57 mm and mold incidence < 75%. A total of nineteen sprout lines have been intensively tested in eight environments in the past two year. The soybean line V12-1789 has great potential to be released as a sprout variety with very good sprout characters and competitive agronomic traits.

PROJECT PURPOSE

- Specific issue: The breeding effort of sprouting soybean in the U.S. is very limited. No soybean cultivars are specifically developed for sprouts.
- Objectives: The objectives are to develop breeding criteria of sprout characters of soybean seeds and develop premium sprouting soybean cultivars. Once the breeding standards are established, all breeding effort on sprouting soybeans will be placed under the right guidance.

- The importance: Legume seed sprouts are traditional nutritive vegetables in East Asia, and they are also the most popular sprout products in the US market due to their enhanced nutritional value. Soybean sprouts as one important kind of legume sprouts, are commonly used in salad and also add flavor and crunchy texture into stir-fried dishes and soups. Recently, South Korea started to import non-genetically engineered sprouting soybeans from the U.S. 'Goldkim', a Minnesota soybean variety for natto beans (a traditional Japanese soyfood), is now used as sprouting soybean varieties to export to South Korea because it has a 97% germination rate that make high sprout yield. In March 2014, Governor Terry McAuliffe granted $14,100 to expand Windsor processing plant to enable Montague Farms to break into the South Korea soybean sprout market. Virginia soybean growers are expected to "put about $7 million into the pockets" if they grow sprouting soybeans. Although the sprout export market is apparently expanding, and more producers are taking advantage of emerging markets through novel and specialized agricultural products, no breeding programs are currently developing soybeans specifically for sprouts. All sprouting soybeans exported are natto soybeans, but sprout beans and natto beans only share small seed size, round seed shape, yellow seed coat and clear hilum color. Breeding criteria of natto soybeans is not suitable for sprouting soybeans.
- Timeline:

Project Activity	**Who**	**Timeline (Month / Year)**
Plant research materials	PI and the team	5-6/2014
Manage the field and collect agronomic data	PI and the team	7-9/2014
Harvest seeds and collect seed data	PI and the team	10-11/2014
Conduct sprouting studies and establish sprout standards	PI and the team	12-4/2015
Plant sprout breeding lines	PI and the team	5-6/2015
Manage the field and collect agronomic data	PI and the team	7-9/2015
Harvest seeds and collect seed data, and present (Objective 1) at ASA-CSSA-SSSA annual conference	PI and the team	10-11/2015

Evaluate sprout characteristics of breeding lines using new standards, and present (Objective 1) at VT CSES graduate symposium	PI and the team	12-4/2016
Plant elite sprout breeding lines selected in 2015	PI and the team	5-6/2016
Manage the field and collect agronomic data, present (Objective 1) at Southern Soybean Breeder's Tour, and submit the manuscript to Euphytica journal	PI and the team	7-9/2016
Harvest seeds and collect seed data	PI and the team	10-11/2016
Evaluate sprout characteristics of elite breeding lines using new standards	PI and the team	12-1/2017

PROJECT ACTIVITIES

Breeding criteria for development of sprout soybeans has been established. A total of 15 soybean genotypes were evaluated for sprout characteristics including seed-born fungus presence, hypocotyl length, hypocotyl thickness, percentage and fresh weight of high-, mid- and low- quality sprouts, sprout yield seed size and water absorption rate. 'MFS-561', a commercial sprout cultivar, and 'Glenn', a commercial cultivar, were used as checks. Results showed that five fungus genera, *Penicillium sp.*, *Epicoccum sp.*, *Fusarium sp.*, *Alternaria sp.* and *Mucor sp*,were widely distributed among genotypes. Hypocotyl length ranged from 12.7 to 16.2 cm, and most genotypes had longer hypocotyl than 'MFS-561'. All genotypes produced thicker hypocotyl than MFS-561, and more fresh-sprout yield than 'MFS-561' except for V12-1764 and 'Glenn'. Cracking cotyledons and abnormal seedlings could be considered the two main constraints affecting soybean sprout quality. Correlation coefficient among all traits indicated that water absorption, seed size, hypocotyl length and hypocotyl thickness were independent variables. We suggested that good sprout characteristics should include white flower color, clear hilum color, <11 g/ 100 seeds, HQS% >45.04%, HQS fresh weight > 91.23 g, yield > 5.3 g/ g seed, MQS% <35%, hypocotyl length >13 cm, hypocotyl thickness> 1.57 mm and molds <75%.

A total of 83 sprout breeding lines in maturity 4, early 5 and late 5 were tested in 2014 at two locations. Fifty lines, selected from 2014 crop based on agronomic traits, were tested in 2015 at four locations. Nineteen of them were selected based on yield trial and sprout traits and are being tested in 2016 at four locations. V12-1789 is a late 5 variety, and it had the highest percentage (57.5%) of high quality sprouts and the least percentage middle quality sprouts among all sprout lines, and a very small amount of low quality sprouts. It also had very low mold incidence. V12-1789 has very competitive yield. In 2014, it produced 62.5 bu/ac across at two locations, only 2.6 bu/ac lower than 'Glenn'commercial yield check, but 8.5 bu/ac higher than 'MFS-561', food-grade soybean check. In 2015, V12-1789 had 0.2 bu/ac higher yield than 'Glenn' and 2 bu/ac higher than 'MFS-561'. Therefore, V12-1789 will have great potential to be released as a soybean sprout variety.

GOALS AND OUTCOMES ACHIEVED

The goal was to develop sprout soybean varieties using established sprout soybean selection criteria. The targets of the project are to define sprouting soybean standard for breeding selection, and to select one or two superior sprouting soybean varieties. The criteria have been clearly defined including 8 quantitative traits and 2 quality traits. One superior sprout variety, V12-1789, had been selected with 97.8% seed yield of 'Glenn' and 10.8% higher yield than 'MF-561'. The sprout yield produced by V12-1789 was 6.1 g/ g seeds, 7% higher than that produced by 'MFS-561' (5.7 g/g seeds). Therefore, the goal of the project has been perfectly achieved.

It is recommended that the breeding criteria for soybean sprout should include white flower color, clear hilum color, <11 g/ 100 seeds, high quality sprout (HQS) % > 45.04%, HQS fresh weight > 91.23 g, yield > 5.3 g/ g seed, middle quality sprout (MQS) % < 35%, hypocotyl length > 13 cm, hypocotyl thickness > 1.57 mm and mold incidence < 75%.

BENEFICIARIES

- For the international soybean sprout supply system:

This project will directly benefit Virginia producers on no less than 4,000 acres of field in the near future because they will receive better premium than commodity soybeans. Montague Farms, Inc. (Letter of Support 1) will purchase 4,000 metric tons of sprouting soybeans from local growers in the next three years, so growers will receive $7 million by producing sprouting soybeans exported

to South Korea (Murphy, 2014). Our elite sprouting soybean varieties will be selected and applied for PVP at the end of the project. They will be grown as the special sprouting soybean cultivars in Virginia with competitive seed yield and high-quality sprouts, which will ensure yield/premium for sprouting soybean producers.

- For the Virginia "farm to table" supply system:

Growers can produce sprout seeds and supply sprout companies in Virginia and neighbor states such as Henrys Farm Inc. in Woodford, VA. Vegetable growers can produce sprout seeds and make high-quality sprouts easily using sprouters to deliver them to consumers through farmers' markets, grocery stores, and restaurants as local produces (Letter of Support 2).

☐ How many benefited from the project?

The number of impacted farmers are expected to be 30 to 50, but the planting acerage of sprouting soybeans will be no less than 4,000 acers in the next three years, which will make sprouting soybeans become a profitable cash crop in Virginia. In 2009, 26,265 acers were grown for vegetables, potatoes and melons. Potato, an important vegetable crop in Virginia typically is grown between 3,000 to 4,000 acers (Dimartino, 2013). Sprouting soybeans has the potential to become the top ten vegetable crops in Virginia in five years based on planting acerage.

☐ How did they benefit from the project?

- Raise farming income by increasing yield of sprouting soybean seeds and sprouts at small- (home gardens, community gardens, etc) and large- scale farming levels.

Small growers: Small growers can make soybean sprouts by themselves. If the sprout yield increases 10% by sprouting a high-germinating variety, which is very possible, their income will increase by 10%. For example, if they sell sprouts to restaurants weekly to make $500, they will make $550 each week.

Large growers: If the yield of sprout seeds is increased by 5%, profit of 5% more yield will be added into the farming income. For example, $7 million will be $7.35 million, so extra $0.35 million will be made by Virginia growers through growing superior sprouting soybean varieties.

- Increase the awareness of sprouting soybeans as a cash crop

The steady demand for soyfood certainly ensures great soyfood profit, which also secures the economic potential of food-type soybean production in the US. In addition, soybean farmers who

grow specialty soybeans such as food-grade, identity preserved and conventional beans make more profit. For example, $3.40 per bushel premium was paid for conventional soybeans in 2011. Some farmers also comment that the cost of growing conventional soybeans was in fact less than growing GMOs due to increased weed problems and herbicide price (Delta Farm Press, 2009).

LESSONS LEARNED

☐ If goals or outcome measures were not achieved, identify and share the lessons learned to help others expedite problem-solving.

N/A

☐ Describe any lessons you learned in the administration of the project that might be helpful for others who would want to implement a similar project.

N/A

☐ Lessons learned should draw on positive experiences (i.e., good ideas that improve project efficiency or save money) and negative experiences (i.e., lessons learned about what did not go well and what needs to be changed).

N/A

CONTACT PERSON

☐ Name the Contact Person for the Project

Bo Zhang, (570) 231-1731, bozhang@vt.edu

ADDITIONAL INFORMATION

☐ Provide additional information available (i.e., publications, websites, photographs) that is not applicable to any of the prior sections.

- Manuscript entitled “Establishment of Selection Criteria for Breeding Sprout Soybeans” was under review by Euphytica journal.
- The poster entitled ““Establishment of Selection Criteria for Breeding Sprout Soybeans” was presented in 2015 ASA-CSSA-SSSA annual conference and 2016 Virginia Tech CSES graduate symposium.
- The poster entitled “Establishment of Breeding Criteria and Quality Improvement of Soybean Sprouts” was presented in 2016 Southern Soybean Breeder’s Tour.