FY 2013 SPECIALTY CROP BLOCK GRANT PROGRAM – FARM BILL
AMS Agreement: 12-25-B-1703

Virginia Department of Agriculture & Consumer Services

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1. G. Peck
Virginia Tech
Final

I. PROJECT TITLE

Developing Research-based Resources on Hard Cider Apples for Virginia's Commercial Orchards and Cider Makers

II. PROJECT SUMMARY

The purpose of the proposed project was to develop resources that will further increase the quantity and quality of hard cider produced in Virginia. Many hard cider producers believe specialized hard cider cultivars are essential to the quality and branding of their products. With little to no information available on how these specialized cultivars might perform in Virginia, there is a critical need to generate reliable information through replicated research trials. There were four primary objectives of this project: 1) to establish a replicated field trial to evaluate potential apple cultivars specifically for hard cider production, 2) to provide training sessions to commercial orchardists, cider makers, and associated professionals on the horticultural and economic feasibility of growing hard cider cultivars, 3) to analyze the economic drivers for the current expansion of the cider industry, including market conditions and future trends, and 4) to conduct preliminary studies of the juice and hard cider chemical characteristics of potential hard cider cultivars. Data generated from the projects funded by this grant will benefit commercial apple growers and cider makers by identifying the top performing hard cider-specific cultivars.

Over the past five years, cider production has increased by 75% per annum throughout the US, and Virginia is no exception. This significant increase in cider production has created a need for the development of more research and extension resources from land grant universities. At the start of this project, Virginia had eight licensed commercial cideries. In just two years, that number has doubled to 16, with several more slated to open within the next few years.

The work conducted within this project builds upon two previously funded SCGB projects. In 2011, a grant was awarded to the Nelson County Department of Economic Development and Tourism entitled, "Cider Apple and Cider Production Feasibility Study", which had several outcomes, including: a 154-page study by the Matson Consulting group entitled, "Feasibility Study for a Small Farm Cidery in Nelson County, VA", two orchard budget workbooks, a Virginia Cooperative Extension numbered publication entitled, "Assessing the Economic Feasibility of Growing Specialized Apple Cultivars for Sale to Commercial Hard Cider Producers" (accepted for publication), and an informational website to house these and other resources published by Dr. Peck (http://www.arec.vaes.vt.edu/alson-h-smith/treefruit/horticulture/hard-cider/). Dr. Peck was a part of the original submission team and worked with Dr. Gordon Groover on developing the orchard budget workbooks. Information from the two feasibility studies were presented to stakeholders during a two-day hard cider workshop that was partially funded by this current grant and held in Blacksburg on November 6-7, 2014.
In 2012, a second SCBG was awarded to the Nelson County Department of Economic Development and Tourism entitled, "Specialty Hard Cider Apple Varieties Planting Cost-Share Program" with the goal of providing a cost share to commercial apple growers in order to increase the planted acreage of the specialized hard cider apple varieties used to produce high quality hard cider. Approximately 32 acres of hard cider apple trees were planted as a direct result of this grant. As these acres come into bearing, it will be absolutely critical to generate research-based information on appropriate cultural needs of the hard cider cultivars.

III. PROJECT APPROACH

Project Activity	Who	Significant results, accomplishments, conclusions and recommendations
Update Dr. Peck's website to highlight current project status and completed deliverables.	Peck	Website has been updated to include a new extension publication. Additional publications from this grant will be posted to the site over the next year.
Collect apple samples for cider making analysis.	Peck and Stewart	This task has been completed
Ferment apple samples and send finished product to Virginia Tech Enology Service Lab for analysis.	Peck and Stewart	This task has been completed.
Design and plant hard cider cultivar trial at the Alson H. Smith, Jr. AREC	Peck	A hard cider cultivar trial was established in spring 2013. Trees for a second trial were grafted in August 2013 at the Mackintosh tree-fruit nursery in Berryville, VA and then planted at the orchard of Taylor Mackintosh, also in Berryville, VA.
Analyze current demographic, market, and economic trends to help define markets for Virginia's hard cider industry and its ability to compete in the traditional apple markets.	Ferreira	Data collection for 2014 has been completed. Further data will be gathered in 2015.
Complete economic analysis and publish as Virginia Cooperative Extension Publication	Ferreira and Peck	This publication is in press.

While cideries, like wineries, breweries, and other agritourism venues provide considerable economic benefit to rural communities, no funds were used to benefit commodities other than apples and the value added to apples through hard cider production.

See above table for each project partners contribution to specific tasks. Dr. Gregory Peck provided overall project leadership, including the research, outreach, and financial aspects. He also organized and led the hard cider workshop that took place in Blacksburg, VA. All project partners contributed to the hard cider workshop that was held in Blacksburg.

Soon after this grant was awarded, Virginia Tech hired Dr. Amanda Stewart as a fermentation scientist. Dr. Stewart replaced and far exceeded the work that was originally assigned to the unnamed "contracted cider maker". With Dr. Stewart's assistance, we developed a more in-depth research project than was originally proposed and contributed to the training of a post-doctoral research associate (Dr. Katherine Thompson-Witrick). We also collaborated with Dr. Andrew Neilson in Virginia Tech's Food Science and Technology Department to conduct detailed polyphenol composition and concentration analyses of apple peel and flesh, apple juice, and hard cider samples from 20 cultivars of apples grown in Virginia with potential for hard cider production. Additional funding for the polyphenol analyses was provided by Drs. Stewart and Neilson.

Dr. Gustavo Ferreira oversaw the survey work that was funded by this SCBG. This included the hiring and management of Matthew Russell, an undergraduate student in the Department of Agricultural and Applied Economics, who made a very significant contribution in gathering data and information used in

the hard cider market analysis for the mid-Atlantic and New England regions. Dr. Gordon Groover was also involved in this process and shed light on farm management issues within the hard cider industry.

IV. GOALS AND OUTCOMES ACHIEVED

Our project had four goals, as listed below. We have completed all of the proposed deliverables.

GOAL 1: To identify high yielding hard cider apple cultivars that are not currently grown in Virginia but will grow well under its climatic conditions and withstand the pest and disease pressure found in the region.

PERFORMANCE MEASURE: The number of apple cultivars identified for their potential to produce high yields for high-quality cider production in Virginia.

BENCHMARK: Currently, Virginia Tech has not systematically evaluated apple cultivars for their use in producing hard cider in Virginia, and therefore no recommendations exist.

TARGET: Within three years, at least five apple cultivars will be identified for their potential to make high-quality cider and recommended by Virginia Tech to apple growers.

PROGRESS: Two cider cultivar research trials were established in Virginia. The first trial included mostly American cider cultivars and was established in 2013 at the Alson H. Smith, Jr. AREC. This trial was planted as a completely randomized design with five replicated blocks (each of which included a two-tree set of each cultivar). The cultivars in this trial include: Ashmead's Kernel, Bramley's Seedling, Chestnut Crab, Cox's Orange Pippin, Ellis Bitter, Golden Russet, GoldRush, Harrison, Hewe's Crab, Hudson's Golden Gem, Kingston Black, Liberty, Newtown (Albemarle) Pippin, Puget Spice (WSU AxP Crab), Roxbury Russet, Spitzenburg Esopus, and Winesap. The trees were trained as a tall-spindle, which allowed us to obtain a small harvest in 2014. Data is still being analyzed from the 2015 harvest. The second trial was planted in spring 2015 at Taylor Mackintosh's orchard in Berryville, VA and included the following European cider apple cultivars: Binet Rougue, Brown Snout, Brown's Apple, Chisel Jersey, Dabinet, Ellis Bitter, Harry Master's Jersey, Porter's Perfection, Stoke Red, Tremlet's Bitter, Vilberie, and Yarlington Mill.

GOAL 2: To educate current and future producers on the highest quality and most economically viable hard cider cultivars that will grow well in Virginia.

PERFORMANCE MEASURE: The number of current and future producers reached via workshops (held in Nelson or Albemarle County and Winchester).

BENCHMARK: Currently, there are no Virginia Tech-led educational workshops for commercial hard cider producers.

TARGET: At least 20 individuals will participate at each training session (40 total) who represent existing or soon-to-be established commercial orchards and cideries, Virginia Cooperative Extension agents and specialists, and other associated industry personnel.

PROGRESS: We organized a two-day workshop for 6-7 Nov 2014 in Blacksburg, entitled: Cider Production Short Course: From Tree to Bottle. The full schedule of the workshop can be found online at: http://blogs.ext.vt.edu/tree-fruit-horticulture/2014/09/03/cider-production-short-course-from-tree-to-bottle/. The forty-two registered participants learned about the complete supply chain for cider production. The grant PI's presented the following lectures at the meeting:

1. Peck, G. Influence of Orchard Design and Management on Cider Apples: Site Selection,

Rootstocks, Cultivars, Training Systems, and Yields.
2. Groover, G. The Economics of Growing Hard Cider Apples.
3. Groover, G. and G. Peck. Demonstration of Cost-of-Production Worksheets.
4. Ferreira, G. The Emerging Hard Cider Industry: A Market Analysis of the Mid-Atlantic Region.
5. Stewart, A., Neilson, A., and G. Peck. Chemical Composition of Cider Apples in Virginia.
6. Ferreira, G. Strategies for a Profitable Tasting Room.
7. Stewart, A. Nitrogen in Fermentations.

The short course sold out nearly a month before it was held. There were clear gains in knowledge on a large number of cider-related topics, as can be seen from the below post-workshop survey results.

Post-Workshop Survey Results: (Ratings Before/After: 1 = a very low level of knowledge; 5 = a very high level of knowledge).
1. Cider Styles in Virginia and Around the World 3.1/3.8
2. Influence of Site Selection on Cider Apples 2.6/3.8
3. Influence of Rootstocks on Cider Apples 2.3/3.5
4. Influence of Cultivars on Cider Quality 2.7/3.6
5. Influence of Horticultural Practices on Cider Quality 2.4/3.5
6. The Economics of Growing Hard Cider Apples 2.2/3.5
7. Knowledge of National and Regional Hard Cider Markets 2.9/3.8
8. Hands-on Cidery Laboratory Procedures: Brix and Specific Gravity 2.8/3.7
9. Hands-on Cidery Laboratory Procedures: pH 2.5/3.6
10. Hands-on Cidery Laboratory Procedures: Titratable Acidity: 2.1/3.5
11. Management of a Cidery Tasting Room 2.8/3.8
12. Chemistry of Cider Apples 2.1/3.5
13. Governmental Regulations for Cideries 2.5/3.9
14. Strategies for a Profitable Tasting Room 2.7/3.8
15. Nitrogen Management in Cider Fermentations 1.7/3.6
16. Importance of Measuring YAN 1.7/3.8
17. Recognizing Cider Faults 2.2/3.6
18. Services Offered by the Virginia Tech Wine Lab 2.0/3.9
19. Use of an Ebulliometer 1.3/3.8
20. How to Measure Sulfites (SO2) 1.7/3.4
21. How to Measure Apple Maturity 2.3/4.1
22. Processing and Fermentation Equipment 2.8/3.7

One participant stated that, "The facilities and event organizers were incredible, as well as the networking opportunities. It was an excellent opportunity to get together, everyone has chatted through email but making a face-to-face connection was very valuable. Existing cideries feel very supported by VT and would love to see this continue."

The investigators involved in this grant have also been very active in presenting research related to this project in Virginia, and elsewhere.
1. Peck, G., Groover, G. and J. Farris. 2014. Is it Worth it to Grow Hard Cider Apples? User-Friendly Cost of Production Worksheets Can Help Answer that Question. CiderCon. Chicago, IL. 6 Feb. 2014.
2. Peck, G., Kelly, M., Ferreira, G., Groover, G. Stewart, A., and M. LaChance. 2014. Redeveloping Commercial Hard Cider Production in Virginia. Virginia Cooperative Extension In-Service Training. Blacksburg, VA. 27 Feb 2014.
3. Groover, G. Farris, J., and G. Peck. 2014. Cider Apple Economics. Virginia Cooperative Extension In-Service Training. Blacksburg, VA. 27 Feb 2014.

4. Ferreira, G. 2014. Marketing of Hard Cider: Current Projects. Virginia Cooperative Extension In-Service Training. Blacksburg, VA. 27 Feb 2014.
5. Peck, G. 2014. What Does it Take to Grow a Bushel of Cider Apples. Albemarle Ciderworks CiderMakers' Forum. North Garden, VA. 12 Apr 2014.
6. Stewart, A. 2014. Polyphenols in Virginia-grown Cider Apples. Albemarle Ciderworks CiderMakers' Forum. North Garden, VA. 12 Apr 2014.
7. Peck, G. 2015 Developing Research and Extension Programs for Hard Cider Producers. Cumberland-Shenandoah Fruit Workers Conference. Winchester, VA. 4 Dec 2014.
8. Ferreira, G. 2015. Assessment of Cider Market Potential in the Eastern U.S. Introduction to Hard Cider Production (Penn State Extension Workshop). Biglerville, PA. 13 Jan 2015.
9. Gordon, G. 2015. Cider Apple Budget Tools. Introduction to Hard Cider Production (Penn State Extension). Biglerville, PA. 13 Jan 2015.
10. Peck, G. 2015. Design and Establishment of a Hard Cider Orchard. Introduction to Hard Cider Production (Penn State Extension Workshop). Biglerville, PA. 13 Jan 2015.
11. Ferreira, G. 2015. Strategies for a Profitable Tasting Room. CiderCon 2015 – Invited Sessions. Chicago, IL. 4-6 Feb 2015.
12. Ferreira, G. 2015. An Overview of the Cider Market in the U. S. Eastern Coast. CiderCon 2015 – Invited Sessions. Chicago, IL. 4-6 Feb 2015.
13. Stewart, A. 2015. Cider Apple Polyphenols: Origin and Influence on Cider Sensory Characteristics. CiderCon 2015 – Invited Sessions. Chicago, IL. 4-6 Feb 2015.
14. Peck, G. 2015. Cider Orcharding 101: Strategies for Success. CiderCon 2015 – Invited Sessions. Chicago, IL. 4-6 Feb 2015.
15. Peck, G. 2015. Opportunities and Resources for Hard Cider Production. Five locations throughout Virginia. 10-13 Feb 2015.

GOAL 3: To create outreach resources that detail the supply and demand for hard cider production in Virginia.

PERFORMANCE MEASURE: The number of downloads for a published peer-reviewed Virginia Cooperative Extension numbered publication on the hard cider market for new and existing hard cider makers and apple growers.

BENCHMARK: Currently, we reach approximately 25 new visitors and have 125 page views per month through the Virginia Tech hard cider website, http://www.arec.vaes.vt.edu/alson-h-smith/treefruit/horticulture/hard-cider/. However, the website lacks content about the future growth of the cider industry.

TARGET: A new publication analyzing the hard cider market is available free-of-charge online and downloaded 120 times over the course of the 12 months following publication.

PROGRESS: In 2014, PI Ferreira lead a research group comprised of faculty and an undergraduate student from the Department of Agricultural & Applied Economics. This research initiative analyzes market conditions of the hard cider industries in the Mid-Atlantic (including Virginia) and New England regions. The findings from this study will help to better understand the regional hard cider industry by looking primarily at characteristics such as: number and location of current producers, presence of tasting rooms, tasting fees, legislation, distribution, product characteristics (container, size, price), and inputs procurement. Results from this work will be published as a peer-reviewed Extension publication during the winter of 2014-15. This publication will be available online and free-of-charge through the Virginia Cooperative Extension website.

Extension Publication:

1. Ferreira, G., Matthew, R., Groover, G., and G. Peck. 2015. The Mid Atlantic and New England Hard Cider Industries: A Market Overview. VCE Publication (In Progress).

Over the past year, Virginia Tech's Hard Cider Website has been viewed 2,435 times. Of those views, 75% were new visitors to the site. Visitors spent an average of four and a half minutes viewing the page.
GOAL 4: To identify apple cultivars that are currently grown in Virginia for their potential to produce high-quality cider.

PERFORMANCE MEASURE: The number of identified apple cultivars. Establish a standard set of procedures for evaluating hard cider cultivars and fermented ciders. Ferment at least 10 hard cider cultivars in small batches (e.g., 5 gallons) and have the finished product evaluated by the Virginia Tech Enology Service Laboratory for standard chemical analysis (e.g., titratable acidity, pH, tannins, residual sugars, etc.).

BENCHMARK: No Virginia Tech recommendations exist for choosing apple varieties for hard cider production. Cider makers often go through extensive trial and error to determine which cultivars to use when developing their products.

TARGET: Within three years, identify five currently grown commercial varieties that cider makers can use for producing high quality cider.

PROGRESS: In 2013, PIs Peck and Stewart evaluated 33 apple cultivars for maturity, fruit and juice quality. From that group, 20 apple cultivars were analyzed for polyphenol content in both the peel and flesh tissue. Results from this work was published in a peer-reviewed journal:

1. Thompson-Witrick, K.A, Goodrich, K.M., Neilson, A.P., Hurley, E.K., Peck, G.M, and A.S. Stewart. 2014. Characterization of the Polyphenol Composition of 20 Cultivars of Cider, Processing, and Dessert Apples (*Malus X domestica* Borkh.) Grown in Virginia. J. Agric. Food Chem. 62: 10181-10191.

V. BENEFICIARIES

Beneficiaries from this project primarily include commercial apple growers and cider producers. Through our workshop and other outreach activities, we have been able to interact with the vast majorities of these stakeholders. By out estimates, this includes 50 individual orchard operations and over 250 individuals who own, operate, or are employed by a commercial orchard; 16 cideries and over 50 individuals who own, operate, or are employed by a commercial cidery; and at least 15 individual and/or operations who are in the process of establishing a commercial hard cider orchard or cidery.

VI. LESSONS LEARNED

Through this project we have gained considerable knowledge about the strengths and weaknesses of growing cider apples and producing cider in Virginia. We have published one peer-reviewed journal article, two extension publications (in press), and a website. We have trained one post-doctoral researcher, one undergraduate research assistant, and numerous technicians to be knowledgeable about the cider industry, as well as cider-specific laboratory techniques. Additionally, we have built a strong knowledge base about cider at Virginia Tech and throughout the Virginia Cooperative Extension System so that there are now many individuals who are able to expertly answer stakeholder questions about hard cider.

VII. CONTACT PERSON

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VIII. ADDITIONAL INFORMATION

n/a

2. L. Aldrich
Virginia Wineries Association
Final

I. PROJECT TITLE: Virginia Wineries Association: Commonwealth Quality Alliance Marketing

II. 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 previous Specialty Crop Funding through VDACS, the Virginia Wineries Association established the CQA program structure and legal framework, designed a marketing strategy and began design and production of marketing materials. 2013 Specialty Crop funding has been used to meet three objectives: 1) Continue winery and consumer marketing efforts, 2) Expand marketing efforts directed to restaurants, retailers and wholesalers, and 3) Increase the number of CQA participating wineries and the number of CQA Approved wines through the creation and implementation of a wineries incentives program. Each of these objectives was designed to ensure the long-term viability and effectiveness of the CQA program.

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 addresses each of these issues directly. The CQA seal will give consumers confidence in the quality and appropriate pricing of Virginia wines.

III. PROJECT APPROACH:

Based on work plan the following activities have been performed:

- The CQA program was promoted in all Governor's Cup Promotions. This increased submittals into CQA due to the fact that entry was free for the competition with an approved CQA wine.
- Wineries were encouraged to submit their wine in for testing into CQA to increase both the number of participating wineries and the number of submitted wines. We did this in a multitude of ways with different mediums.
- Promoted wineries marketing toolkit and program through electronic and print communications and at VWA meetings. We promoted the program with a display table and marketing materials and the toolkit at 5 events of the association.
- Street Teams distributed promotional materials more specifically the pocket maps to consumers at the VA Wine Expo and Vintage Virginia reaching over 12,000 attendees interested in Virginia wine.
- We have continued doing outreach through social media and it is creating an expanded awareness to consumers of the wines, wineries and the program. This has been very successful.

- We marketed and promoted CQA at Wineries Unlimited in March at a manned booth to promoting the program to wineries and other related to the industry in Virginia and beyond.
- We planned a restaurant and retailer campaign using "Quality in your Backyard"
- Held an educational event on CQA at the Annual Meeting to get over some hurdles related to perception.

IV. GOALS AND OUTCOMES ACHIEVED

Goal 1: Increase the number of Virginia wineries using the CQA wine analysis from the
Performance Measure: Number of VA Wineries using CQA wine analysis.
Benchmark: 14 wineries in 2013
Target: At least 30 participating wineries by December 31, 2015.

We are at 27 wineries and hope this will continue to expand. We expect more to come in this month and next as we approach the time for competition submittals. VWA has the Governor's Cup ® competition, which they allow free entry into (an $80 value) if the wine is CQA approved.

Goal 2: Increase consumer awareness of CQA.
Performance Measure: Number of Facebook "likes."
Benchmark: 306 likes as of August, 2013
Target: Increase of 50% by December 31, 2015.

This goal has been met and exceeded at our last progress report, however we continued to stretch this goal and made it 3046 likes! That is nearly a 1000% increase. We have handed out pocket maps to tens of thousands of people at several targeted festivals. We do regular posts incorporating fun elements to keep followers interest. Clearly, we have expanded the awareness of Virginia wines and the CQA wineries.

V. BENEFICIARIES

Direct beneficiaries are the 27 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.

VI. LESSONS LEARNED

We have not been pleased with the response to marketing by retailers and restaurants; we worked to find alternate ways for retailers and restaurants to promote the program to them and ultimately the consumers. We developed some new and different ways to get in front of them including a campaign around the "Quality in your Backyard" slogan was developed for use in marketing to local retailers and restaurants. However, these portions of our work plan were not fully executed. The full plan will be executed through another Specialty Crop received.

We continue to struggle to get wines entered for various reasons. One is cost versus proven return on investment, another is fear of failure and yet another is overcoming the perception that not all of the wineries wines are quality because not all of them are approved. Some is education to the wineries and providing tools to overcome some of these perceptions. We revamped the program messaging and the value proposition to overcome some of this. We also did CQA education from current wineries using the program – with how they are using it to justify higher priced wines and also to promote their winery overall, while receiving the valuable and necessary sensory and lab analysis. Education about the value of testing and addressing the cold stability of the wine was done at the Annual Membership meeting to help overcome some of our obstacles for participation.

The main lesson learned is that the industry, while clearly believing in the necessity of having a quality program, is reluctant to commit to participating in a program which they perceive as costly. We are showing real value for their dollar and hope to this will catch onto further expand the program. We changed our marketing strategy and are carrying those elements out in the continuation specialty crop grant.

The current economy has also made many wineries more cautious in investing. Additionally, some have a shortage of wine to sell therefore making the investment in CQA a perceived unnecessary expense. In order to facilitate participation, and because of the expressed concern of the cost of the program as established, the VWA will continue to waive the membership fee designed to cover the cost of administration. We believe that this continues to help by removing an objection and with the current push through December we will still meet the goal of 30 wineries.

VII. CONTACT PERSON:

Laurie Aldrich, Executive Director of Virginia Wineries Association
• Telephone Number: 804-592-3196
• Email Address: Info@vawine.org

VIII. ADDITIONAL INFORMATION:

The program has a website www.cqa.org, Facebook page, is on Pinterest and twitter. Included are some of the marketing materials created.

3. K. Semones
Southwest Virginia Farmers Market
Final

PROJECT TITLE
"Primus Trainings and Consultations"

PROJECT SUMMARY

With issues stemming from imported food and food borne illness outbreaks on the rise in the US, food safety regulation has become a necessity. Since 2010 when the Southwest Virginia Farmers Market (SWVFM) received its first USDA GAP Certification, it has been understood by market staff and regional growers that food safety would have both positive and negative effects on the production and economic impacts of specialty crops in Virginia.

The increasing focus on healthier eating and nutrition is raising awareness of agriculture and its importance to consumers. On the positive side, all "Buy Local" programs have succeeded in instilling a sense of food security among consumers while giving an economic boost to the local farmers in the direct-to-consumer marketplace. Organic products are also an up-and-coming market opportunity for many growers due to food safety concerns. While Virginians think you can't get anything better than a Virginia Grown product, to anyone outside the state lines, we have to prove it!

The timing of this project is of vital importance to Virginia fruit and vegetable producers. The negative effects of food safety can be felt each time a regional grower's product is rejected due to insufficient certification or when a viable marketing opportunity arises that cannot be accessed because our producer network or the SWVFM are not on a GFSI level. Virginia specialty crop farmers will be at great risk of losing markets if we do not keep pace with the ever changing food safety landscape. It is the goal of the SWVFM to assist the specialty crop farmers of this region in remaining competitive while developing the best practices for food safety and sustaining economic growth. Finding an agency willing to provide on-site detailed training at a reasonable cost prevented the initial timeline from being executed, therefore we submitted a request for an extension to this grant to ensure all project activities could be executed at the highest level of integrity and in a format that would be understandable for our farmers.

If the project built on a previously funded project with the SCBGP or SCBGP-FB describe how this project complemented and enhanced previously completed work. ***N/A***

PROJECT APPROACH

The start of this project was delayed due to the limited availability of GFSI equivalent training organizations that provide on-site training in a group setting that is both comprehensive and cost effective. Once a suitable GFSI equivalent was identified and an agreement reached regarding the scope of work and proposal objectives, we revised the timeline of the work plan and were able to execute the components of our initial proposal.

In April of 2016, a GLOBAL GAP large group training session was conducted which was open to all regional growers interested in obtaining a GFSI equivalent certification. Each farmer was provided on-site consultant training and a binder containing the 107 page GLOBAL GAP audit scheme and criteria. Each section of the GLOBAL GAP audit was introduced and open discussions were allowed after each section with farmers making notes in their GLOBAL GAP binders.

After the opportunity to review the GLOBAL GAP materials, SWVFM provided 3 small group training sessions to drill deeper into each component of the 107 page GLOBAL AUDIT. SWVFM staff then attended two GLOBAL GAP training sessions based on the 107 page GLOBAL GAP audit and what steps and duties would be required to transition SWVFM from the Harmonized Audit certification to a GFSI equivalent certification. Though the additional workload required of SWVFM staff was not particularly well received (especially given the inability to change compensation accordingly) this project enabled them to understand the necessity of moving forward with this effort.

Ten farmers who were unable to attend the small group sessions were provided with on-the-farm assessments conducted by Ag-Con. During the 6 hour on-the-farm GLOBAL GAP transition sessions, a narrative was written for each farm detailing "where they are now" and "where they want to be." Ag-Con completed a 5 page checklist for each farmer, for SWVFM and for Appalachian Harvest, demonstrating each transitionary need that would have to be met before each farm would be educated, prepared, and ready for a GLOBAL GAP audit. It is notable that the expense of a GLOBAL GAP audit, plus labor and farm restructuring would be prohibitively expensive for 95% of the operations that had requested this assessment.

During this grant period, meetings were conducted with Dr. Allen Straw, Kevin Semones, SWVFM Market Manager and Tammy Hall, Market Food Safety Coordinator to first understand HACCP plans and how to write compliant HACCP plans for SWVFM and for participating farmers who operate their own packinghouses, as they are considered "food facilities" under the FDA regulations. Upon completion of said meetings Tammy Hall created a draft HACCP plan for SWVFM and presented the plan to Dr. Allen Straw and Kevin Semones for input and revisions and arrived at a final FDA compliant HACCP plan. Two training sessions were conducted with SWVFM staff to ensure ownership of duties, required documentation, and HACCP compliant expectations.

Appalachian Harvest conducted two organic training sessions with interested farmers to highlight this additional market opportunity and the supporting logistical systems, and training and tracking systems. These sessions included the overlapping requirement of sustainable agriculture practices that are also included in GLOBAL GAP, and other GFSI equivalent audits. Appalachian Harvest reviewed the organic application in great detail with farmers and shared clear examples of documentation required for organic certification, that were identical to documentation required by food safety audits. This training created a high level of interest in several farmers to analyze their current practices, inputs, processes, and documentation and consider transitioning part of their operations to certified organic production. The overlap of NOP and OMRI approved products that certified organic farmers use that are also used by conventional farmers was a welcome surprise to the farmer audience. As of this date, 4 farmers from this session have already reached out to Appalachian Harvest to get part of their farmland certified organic for 2017's growing season. Prior to SWVFM pursuing a GLOBAL GAP certification (and to ensure that training and processes were compliant) one announced mock audit was conducted. From this on-site audit, a list of corrective and/or transitionary measures was provided to Kevin Semones and Tammy Hall.

Tammy Hall met with SWVFM staff and conducted an on-site training walk through to share in great detail the corrective measures needed to be GLOBAL GAP and HACCP compliant. Once changes were executed, an in-house mock audit was conducted demonstrating both GLOBAL GAP and HACCP complaint processes and procedures. An unannounced mock audit was later conducted by Dr. Allen Straw and SWVFM passed each component of both GLOBAL GAP and HACCP.

GOALS AND OUTCOMES ACHIEVED

Fifty attendees capitalized on the GLOBAL GAP training opportunity and received pertinent information about the requirements of GFSI equivalent audits such as the GLOBAL GAP training this grant provided. Twenty farmers utilized this grant opportunity to receive small group and/or one-on-one training to better understand transitioning their farm operations to GFSI equivalent certification. SWVFM was able to achieve a FDA compliant HACCP plan that can be used as a guide and model to share with farmers who are of the scale to operate their own packinghouses. Ten of our 58 farmers are now educated in NOP compliant organic practices and the market opportunities they have with their current USDA GAP certification by becoming certified organic. Four of the 10 farmers have already made their first steps toward becoming certified organic by 2017's growing season.

The long term outcomes from this grant opportunity include a HACCP model to be shared with farmers and other partners who are required to comply with this FDA regulation and Harmonized audit readiness with even higher level processes that farmers were educated on during the GLOBAL GAP training sessions and one-on-one site assessments.

The the goals established for the reporting period are different than expected. Once the 107 page GLOBAL GAP audit was presented, dissected and discussed it was discovered that the transition expenses for many of our small and medium sized farmers were prohibitively expensive given the production scale and revenue of their farming operations. Once the organic certification processes were explained in comprehensible and basic language and a comparison presented between organic and conventional pricing, a surprising number of farmers expressed interest in taking advantage of the opportunity and support system to consider an organic transition compared to a GLOBAL GAP transition.

The outcomes demonstrate the importance of this grant. First, on-site education and hands on instruction gave 50 participants deeper knowledge of a GFSI equivalent audit. Prior to this opportunity no other educational opportunities for this level of food safety certificate had been provided to the farmers we serve. SWVFM is now HACCP complaint and can readily assist partners and farmers with executing HACCP plans without the inflated costs of hiring consultants. The 20 farmers receiving intensive training now have the opportunity to weigh the cost of processes and GFSI equivalent certification against the revenue generated by their specialty crops.

Highlighting the major successful outcomes of the project in quantifiable terms is difficult at this time because of the tremendous amount of opportunities and options offered to farmers provided by this grant. The GLOBAL GAP, HACCP and certified organic training opportunities have shown some of the early positive mindset changes as farmers consider their abilities (labor, financial, and time) to do well on a GFSI equivalent audit. This grant opportunity has provided them with better numbers than was first perceived, but how large of a revenue impact that will have is not yet quantified. Some farmers are weighing their options, comparing the time and costs of a 107 page GFSI equivalent audit such as the GLOBAL GAP versus their current USDA GAP and/or Harmonized audit. Included in this assessment is the opportunity to become a certified organic producer which requires only an Organic System's Plan, organic application and inspection for 1/10 of the cost of GLOBAL GAP. Farmers were presented with a comparison of organic vs. conventional pricing for summer squash, bell peppers, winter squash, and a variety of other specialty crops. In many cases certified organic local product prices were double that of conventional prices. An additional appeal of the organic option versus a GFSI audit and/or GFSI equivalent audit was a 32 page organic application combined with the implementation of a non-commingling process, versus a 107 page audit requiring greater process revisions, additions, staffing, purchases, etc. Of the original 50 farmers that attended the GLOBAL GAP/GFSI

equivalent training, 20 followed up to have small group and or one-on-one training. After learning about the organic option, 4 of the 20 opted to become certified organic, maintain their USDA GAP or Harmonized audit and diversify their markets with organic production rather than pursuing a GLOBAL GAP audit or GFSI equivalent.

BENEFICIARIES

The groups and operations that benefited from this project's opportunities are the 58 farmers we serve at SWVFM, the 65 farmers served by Appalachian Harvest's food hub, and Appalachian Harvest because of the increase of organic farmers into their existing markets and logistical pathways.

The number of beneficiaries affected by the project's opportunity and/or the potential economic impact can be demonstrated with the data collected from Appalachian Harvest regarding the conversion of one GAP conventional farmer who committed to 2 acres of certified organic green bell peppers for 2016's growing season. Without any additional food safety certification, he became certified organic using the support system provided by Appalachian Harvest. As of October 18, 2016, this farmer's gross income from 2 acres of certified organic green bell peppers was $72,829. During this same season, had this same acreage been conventional, his gross revenue would have ranged from a low of $26,440 to a conventional end of season market high of $42,304. This small acreage of USDA GAP certified organic produce provided this farmer with a positive range of additional income of $30,525 to $46,389. To duplicate this effort across the 4 farmers that have reached out to Appalachian Harvest could result in a gross revenue increase of $120,000 to $160,000 for only 4 small to medium scale farmers. This is a significant amount of economic impact on only 8 acres of the hundreds of agriculture acres in our region could be tremendous.

LESSONS LEARNED

Lessons learned from this project have been both positive and negative. With SWVFM having a compliant HACCP plan, we can serve as a model and template for others seeking the same requirements with no cost to the farmers and or partner organizations.

The jolt of seeing a 107 page GFSI equivalent audit format was overwhelming for our small and medium farmers who have restricted funds and a limited amount of labor available to dedicate to a transition plan.

Unexpectedly, once introduced and educated on the certified organic opportunities, allowable inputs list, and streamlined documentation with "close to home" ready-made markets provided by Appalachian Harvest, there has been tremendous interest in farmers converting portions of the operations to certified organic production. Some have expressed interest in the Appalachian Harvest Grower Group certification avenue, while others have expressed interest in becoming independently certified organic with technical support being provided by Appalachian Harvest.

Some of the lessons learned are clearly demonstrated with the narratives completed during our one-on-one on-the-farm visits. Farmers do not have the funds and/or labor available to scale up their operations to GFSI, and/or GFSI equivalent audits such as the GLOBAL GAP, but this does not mean they do not produce safe foods under their current USDA GAP and/or Harmonized certifications. Some farmers would rather remain USDA GAP and/or Harmonized and focus on market diversity and increased quality and production with a broader range of crops. Other farmers expressed very intense concerns that a GFSI audit and/or GFSI equivalent audits such as the GLOBAL GAP are solely intended to muscle the small and medium scale family farms out of the industry and create a corporate model agriculture landscape using GFSI audits and/or GFSI

equivalent criteria food safety as a marketing weapon. It should be noted that just because a farm obtains a GFSI certification or a GFSI equivalent certification such as GLOBAL GAP, it doesn't mean that his or her practices are safer and/or more honorable than a farmer who has achieved compliance with the FSMA, USDA GAP certification and/or Harmonized certification.

CONTACT PERSON
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ADDITIONAL INFORMATION
We have no additional information to provide at this time.

4. K. Terry
Assisting Virginia Farmers to Access Quality Markets through USDA GAP and Harmonized GAP Training, Assistance and Certification.
Appalachian Sustainable Development
Final

Project Summary
Background: The purpose of this project was to ensure that family farmers in Virginia are not forced out of their markets by an inability to obtain the Good Agricultural Practices (GAP) certification necessary to access the large grocery store chain wholesale markets. ASD's work has been at the forefront of both working with wholesale buyers to accept USDA GAP certification plans that are more farmer friendly to smaller-scale farmers and working with Virginia family farms to meet their specific market requirements. Over the last three years our concentration has been focused on making the complicated requirements of GAP certification more understandable and accessible to farmers in the region. We have worked with farmers to provide training in food safety principles and on the farm practices, including guiding them through the process and conducting on-farm training, technical assistance, and mock audits of their written farm plans and practices.

Motivation The original purpose of the Harmonized Audit was to allow farmers to obtain one audit that would be good for all buyers. ASD and Extension partnered to create a transition plan for moving from USDA GAP audits to the Harmonized Audit in hopes that large volume wholesale buyers would accept this food safety program - since its original purpose was one audit fits all. There are a multitude of food safety audits - GFSI, Global GAP, Primus, USDA, Davis Fresh, etc. - and some farmers were paying for as many as 3 different audits to meet the requirements of their farm's specific buyers. The Harmonized Audit was created by comparing all of the food safety audits, side-by-side. The findings noted that collectively the audits were 90% alike with only a 10% difference. The Harmonized Audit's intent is to prevent farmers from having to undergo numerous third party audits to maintain markets, therefore, the USDA, Davis Fresh, Primus, etc. could conduct the Harmonized Audit and it would be accepted across the industry.

By educating industry leaders the larger percentage of wholesale buyers currently accept the USDA GAP certification. ASD continues to support both the USDA GAP and USDA Harmonized models educating both farmers and buyers on the detailed curriculums that we utilize that address each line item of both audits. While some very large scale wholesale buyers persist in requiring the USDA Harmonized audit with the global addendum, they have become supportive of the USDA conducting these audits which are at a much more reasonable cost when compared to other third party auditing businesses. Currently all of the Appalachian Harvest buyers accept the USDA GAP certification to meet their food safety needs. One large scale buyer who previously accepted only Primus audits provided an exception for Appalachian Harvest growers to utilize their USDA GAP certification since we were the only produce organization who had ever provided them with a curriculum and training program. ASD also worked with two additional buyers on a specific list of crops for them to purchase without a certification component. They agreed to purchase local farmer's produce by accepting "mock audits" in lieu of a USDA GAP certificate. While these very small scale producers had the same training requirements and on the farm practices to meet GAP criteria, they were not required to undergo or pay for an audit by an inspector. They were required to pass a "mock audit" conducted by either VA Cooperative Extension or Appalachian Harvest staff.

While it continues to be uncertain how buyer's food safety criteria will evolve, the fact remains that Virginia's farmers need assistance with understanding and meeting the GAP requirements and Harmonized readiness in order to access wholesale and institutional markets. The trend appears to be toward the Harmonized model; therefore all farmers participating in the ASD/Cooperative Extension program receive training to a level that will prepare them for both USDA GAP and the Harmonized GAP audits.

The ultimate motivation for this project was to support the integrity of the USDA GAP and Harmonized audits, leverage additional resources, educate buyers, consumers, and farmers, while reducing the time it takes farmers to become market-ready in the arena of food safety. Educating farmers on both audits, assisting them to become USDA GAP certified and well prepared to transition quickly to the Harmonized Audit if their specific markets change their food safety criteria will continue to be a necessary motivation for all stakeholders and support service organizations.

Project Approach

Summary of Activities and Tasks Performed During Grant Period

The following steps were taken to create a transition plan for moving from USDA GAP audits to the Harmonized Audit.

1. ASD and Extension created a training curriculum isolating USDA GAP and the Harmonized Audit criteria and revisit curriculum monthly to ensure comprehensiveness and updates are provided.
2. 262 VA family farmers received classroom training
3. 75 on the farm consulting sessions and/or mock audits were conducted, with ongoing TA via telephone, farm follow up, and/or email.
4. After meeting with several industry buyers, USDA GAP certification remained the primary requirement for the industry. However, several buyers strongly encouraged harmonized audit readiness, while two buyers were in agreement to accept "USDA GAP mock audits." With such a broad range of industry requirements it was determined to be the best use of all available resources for farmers to receive USDA GAP and harmonized training, then fashion their specific 1:1 training to each farmer's specific market requirements.

Role and Significant Contributions of Project Partners

ASD assumed the leadership role in this project, but accomplishments and farmer assistance could not have been completed without the solid partnership of Virginia Cooperative Extension. Appalachian Harvest buyers also partnered with ASD to help identify Virginia family farmers in need of assistance, and helped to classify farmers so that ASD could prioritize this work. Classifications: lower level need – mock audit and GAP training needing Harmonization TA only; medium level – GAP certified and harmonized ready; high level need – GAP certified and 1:1 needed for Harmonized Audit, including Global addendum.

Goals and Outcomes Achieved

Activities completed in order to achieve the performance goals and measurable outcomes

Goal 1: Train at least 75 farmers in Virginia to be GAP certification-ready in 2014 in both the USDA GAP and the Harmonized GAP program. The expectation is that 2/3 of these will obtain certification in 2014.
Results: 262 family farmers received USDA GAP and Harmonized audit training with over 60 farmers being USDA GAP certified and harmonized audit ready, and 6 family farmers executing the Harmonized Audit with Global addendum.

Activities completed: Buyer visits and buyer telephone calls were made to gain direct industry updates from the wholesale arena regarding a range of expectations of food safety requirements and potential forecasted changes. Buyers such as Ingles Supermarkets, Whole Foods, Food City, Produce Source Partners, Lancaster Foods, Horton Fruit Company, Lipman's Produce, Albert's Organics and General Produce continued to accept the USDA GAP for 2014's growing season. Three buyers strongly encouraged Harmonized readiness, forecasting industry changes; two buyers accepted mock audits from farmers; and the remaining four buyers supported continued USDA GAP training and certification. ASD also called farmers who had previously attended GAP training and additional Virginia aggregators to arrive at a list of farmers willing to participate and/or needing assistance. USDA GAP training, USDA GAP to Harmonized Audit Training, USDA Harmonized with the Global Addendum and 1:1 sessions all required scheduling of Technical Assistance visits, training sessions, revisions to project plans, and ongoing calendar adjustments.

ASD conducted 12 group training sessions with 262 attendees, 33 1:1 training T/A sessions and 75 on the farm manual reviews with mock audits. If the farmer's specific wholesale markets accepted the USDA GAP audit, farmers still received classroom training and 1:1 training to meet their criteria and were given training in Harmonized audit readiness. All farmers were provided both USDA GAP and Harmonized training in both classroom setting and 1:1 on the farm training to ensure transition readiness. Once TA providers arrived on the farms, an assessment of the farmer's current food safety status was made: GAP status and market requirements, paperwork, on the farm processes, and on the farm supplies. The Harmonized Audit was then explained to farmers and the revisions, additions and/or deletions that would be necessary for their farm to become Harmonized Audit ready. From the 8 hour classroom training and 1:1 on the farm training, consultants and staff maintained contact with 103 farmers participating in the comprehensive process. Consultants and staff addressed any "corrective measurers" that were noted from individual farming operation perspectives. More often than not, the corrective measure was solely a matter of farmer interpretation of the training provided and a matter of scale appropriateness.

Comparison of actual accomplishments with goals established for reporting period
ASD, in partnership with Virginia Cooperative Extension and trained consultants, accomplished the goals established for this grant reporting period. Several operations required more than one TA consulting visit and additional manual reviews. ASD and trained consultants provided an additional focus on farmer's comprehension of water quality requirements and processes to eliminate additional risk factors and better prepare farmers for potential industry changes. It is vital for ASD to stay at the forefront of the industry's discussion of food safety. The changes in the complexion of the food safety debate continue to require the attention of ASD, Virginia Cooperative Extension, and other partners in order to keep farmers well informed, trained, and prepared for their market's requirements. Harmonized Audit readiness training was accomplished with all 262 attendees and 75 family farming operations being visited with more intense training and assistance. There were 12 small family farms that passed "mock audits" and could have easily passed a USDA GAP inspection, however these farms opted to sell the majority products to the buyers who accepted mock audits and/or to their direct markets that do not currently have food safety requirements.

Beneficiaries
Groups and other operations benefiting from the completion of this project's accomplishments
ASD in partnership with Virginia Cooperative Extension and trained consultants, benefited partners such as the Hillsville Farmers Market, Produce Source Partners, Custom Pak, 3 local and 3 regional packing facilities, and 103 Virginia Family Farmers.

Quantitative Data concerning beneficiaries or the potential economic impact of the project.
Appalachian Harvest increased markets for Virginia farmers by offering a diverse range of training and detailed discussions with key buyers of local produce. ASD created an awareness of buyer's requirements and industry forecast, assisting farmers in their decision making process and potential economic impacts to their family farms. From January 1, 2014 to October 28, 2014 the economic impact for Appalachian Harvest farmers alone was $804,655 in sales that required USDA GAP certification. The 12 very small family farms that were provided with markets that accepted mock audits grossed $78,000 in sales from July 2014 till October 28, 2014. ASD has conducted detailed meetings with farmers regarding scale appropriate markets, market requirements as related to food safety and the impact on the farmer's bottom line. For example, a couple of family farmers who appreciated the education and support of our food safety efforts, realized greater profits from diversifying their markets and crop selection while not endangering the integrity of food safety. If these farmers were only going to make $2,000 in supplemental income from farming, and an estimated $500-600 (1/4 of their gross sales) was going to be spent on a USDA GAP audit, it was a better business decision to transition to crops and buyers that accepted a mock audit. While these farmers complied with all aspects of the USDA GAP audit, they were given the opportunity to retain the previously mentioned $500-600 while maintaining the integrity of food safety compliance.

Lessons Learned

Insights from project staff into positive and negative lessons learned.
ASD, buyers, and farmers learned many valuable lessons from the implementation and execution of this project. Many Virginia farmers have made tremendous progress in the area of food safety written principles and practices while streamlining their on-the-farm processes. The on-the-farm assistance continues to be extremely helpful for many farmers to finalize their USDA GAP documents and processes and become fully confident to be GAP audited. The 6 farmers that accomplished the USDA Harmonized Audit with the Global addendum required greater than expected 1:1 training and numerous follow up telephone conversations and emails. While ASD truly understands that family farmers are suffering from training and audit fatigue, we also recognize the extreme need for ongoing food safety supports in order for Virginia family farmers to maintain their markets and continue to produce fresh fruits and vegetable for the wholesale to retail markets.

ASD also learned that there continue to be many extremes in the realm of food safety. Farmer's Market farmers and direct market farmers do not have the stringent food safety requirements the farmers who choose wholesale and institutional markets face. Maintaining close relationships and ongoing discussion with many of Virginia farmer's key buyers is vital to keep both buyers and farmers well informed. Our work to continually stay abreast and aware of food safety changes is a significant need in order to keep our farmers prepared and in their markets, in the same vein it's also necessary for buyers to have a comprehensive understanding of training and audit integrity, rather than submitting to the pressures of other audit "brand names" that claim they are safer than the USDA GAP and/or the USDA Harmonized audits.

Unexpected outcomes or results
During this grant cycle, ASD, learned that one of the buyers driving the past three years' of food safety "wave of change" had given consent for individual store level produce managers to downsize their own food safety requirements. This effort was done in order to source local produce from nearby farmers. The need for this specific buyer to validate their actual support of local family farms took priority over the "claimed safer audit" and the USDA GAP certification was accepted. Initially, this specific buyer was on the GFSI certification bandwagon; however, when GFSI certified product was not available locally, they were willing to accept USDA Harmonized audit with the Global addendum. When local farmers held USDA GAP certifications with Harmonized training, the buyer was willing to accept local farmer's USDA GAP certifications and permitted those farmers to deliver store direct. This example is considered to be a huge success for our continued support of the USDA GAP and Harmonized audits. Not only was a "close to home" farmer provided for this specific buyer, but the farmers participating in this example experienced huge savings in transportation costs, and gained additional markets from this specific grocery chain.

ASD will continue to be leaders with ongoing discussions across diverse retail buyers, wholesale distributors, local food supporters, and agriculture industry leaders sharing the potential impacts of food safety radicalism and how this would negatively impact Virginia's agriculture landscapes, the Commonwealth's overall economy. In order to maintain the economic sustainability of Virginia's family farmers, clear and detailed conversations with all stakeholders need to remain a high level priority for ASD. Historically and currently, these insightful discussions and numerous successes have been made with many retail buyers to accept the USDA GAP or the USDA Harmonized audit. With curriculums being updated and presented to buyers, farmer's burden of costs explained in great detail with science based risk factors being addressed, many buyers are becoming more realistic intheir "local" produce programs, which continues to be great news for Virginia's family farmers.

Additional Information
All funds, $29,896.00, were spent by 12/30/14.

5. K. Terry
Appalachian Sustainable Development
Final

I. PROJECT TITLE

Exploring Brussel Sprouts as a Profitable Crop for Southwest Virginia Farmers

II. PROJECT SUMMARY

Background

The wholesale produce industry is a highly competitive and limited market meaning that any competitive advantage a grower can muster greatly increases his/her chances of a successful season. Appalachian Harvest has a long history of helping growers find a secure foothold in wholesale produce by offering buyers a wide range of options for locally grown produce: certified organic, local conventional, specialty items and custom packaging to name a few. Regular and clear communication with our buyers allows Appalachian Harvest to respond to their needs and work with our growers to do farm planning to meet those needs. In 2013, two Appalachian Harvest buyers inquired about the possibility of on-the-stem Brussels sprouts as a future item for which there would be a strong demand at an excellent price point. This grant enabled Appalachian Harvest to conduct on-farm trials of Brussels sprouts as a potential market crop for our growers.

Importance and Timeliness

This project was important for two reasons. First, partnering with buyers to identify crops to be grown specifically for buyer demand, strengthens relationships with those buyers and enables them to see value in working with small scale specialty crop farmers. Second, it is important for farmers in southwest VA to be able to find competitive niche products that enable them to succeed in the large wholesale marketplace by growing high value crops.

The project was timely because there was no production of on-the-stem Brussels sprouts in southwest VA, making it possible for SWVA farmers to capture that demand.

III. PROJECT APPROACH

Activities and Tasks Performed

The project approach was to recruit 3 farmers who were both willing to trial Brussels sprouts and had proven records of success as wholesale growers. Since one of the requesting buyers preferred certified organic product, we made an effort to have at least one of these on-farm trials on a certified organic farm operation. The participating farmers were provided with transplants, instruction, and support in return for sharing information with ASD and Extension.

In the first year of this project, 3 growers were recruited for on-farm trials of Brussels sprouts on-the-stem. Materials and seeds were purchased and transplant production coordinated. The project team created production and marketing plans which were provided to all growers and the supporting information reviewed with participating farmers. (Please see attached.)

The targeted date for setting the transplants in the fields was the beginning of July. One of the three initial growers backed out of the trials (after transplants had already been produced) and another was identified to take his place.

In year one 5000 transplants were set to field for two on-farm trials. Unfortunately, an unusually rainy June and July prevented the third farmer from setting his plants to field.

Though the recommended plant spacing was 18-24" centers, both farmers used a 12" setter (the only one available to them). These farmers also expressed that they wished to maximize growing space and were interested in the smaller plant spacing.

Farmers were provided with on-farm and on-phone support during the long growing season. Extension agents provided a total of 25 hours of assistance in outreach, recommendations and farm visits in year 1. Fertility recommendations were made by Extension based on soil test results. Farmers each estimated 80-100 hours of labor including: preparing fields, planting to field, cultivating, fertilizing, and managing pests and diseases. Farmers reported implementing pest, disease and weed management to the degree that they felt they could afford for the potential return on investment.

The first harvest of Brussels sprouts on-the-stem was received at the Appalachian Harvest food hub in October 2014.

In year 2 of the trial (2015), 2 farmers chose to participate in the trial. One planted two phases with two different varieties of Brussels sprouts. The other suffered a total loss of his crop to deer and groundhogs shortly after they were set.

In year 3 of the trial (2016), only 1 farmer chose to participate. He planted 15,000 transplants. Unfortunately, his crop was a total loss when an unexpected and heavy rain washed the herbicide he had recently applied onto his transplants.

During the project period 277 cases of Brussels sprouts on-the-stem were sold to wholesale markets. Buyers were extremely pleased with the product. However, farmers did not find this to be a crop they wished to continue to grow.

<u>Contributions and Roles of Project Partners</u>
ASD recruited farmers and worked with Extension to create a plan and production outline for participating farmers. They also provided transplants, wholesale demand plans and proper post-harvest handling and packaging instruction.
VA Cooperative Extension assisted ASD with variety and production plans including soil test analysis and recommendations on weed, pest and disease management. They also provided farmer support and guidance.

IV. GOALS AND OUTCOMES ACHIEVED

The primary goal of this project was to determine whether Brussels sprouts on-the-stem could be a successful and profitable wholesale crop for SWVA farmers. The project team concluded that while Brussels sprouts on-the-stem can command a high price per case, it does not compare favorably to other alternatives.

During the time period of this grant, the Cornell Eastern Broccoli Project was occurring (which ASD participated in). This trial demonstrated that broccoli was a more favorable crop for SWVA farmers given the following analysis:

Crop	***Crop Length***	***Duration of Harvest***	***Buyer WEEKLY Demand. Based on 3 primary AH buyers***	***Weeks for Demand***	***Average Market Pricing***	***Annual Demand (cases) 3 solid buyers***	***Total Potential Local Revenue***
Broccoli	60-65 days	May 1-Dec 1	976	32	$15/cs	31,232	$468,480
Brussels Sprouts	90-105 days	Oct 20-Dec 1	750	Nov 1-Dec 23 (8 weeks)	$28/cs	6,000	$168,000

Broccoli Harvest Labor	***Brussels sprout Harvest labor***	***Cost comparison for limited resource farmers***
75 man hours per ac.	326 man hour per ac.	251 hours more labor hours for Brussels sprouts
Broccoli Box Costs	***Brussels sprout 12 stalks per box, box costs***	***Cost comparison for limited resource farmers***
$1.50	$2.25	.75 cents more cost per box for Brussels sprouts

The extremely long growing season required for Brussels sprouts allows for only one planting per season as compared to two plantings of broccoli. The long growing season also means that the crop is at greater risk for negative impacts from diseases and pests (as was experienced by participating farmers). Additionally, post-harvest handling of Brussels sprouts on-the-steam is extremely labor intensive. The above chart shows that Brussels sprouts required 251 more labor hours/acre than broccoli, resulting in $.75/case more labor expenditure.

Ultimately, the participating farmers found that they would choose to not grow Brussels sprouts in the future for the above stated reasons. Their decisions were also influenced by the current reality in our region that there are other crops that are easier to grow, manage and handle for which there is significant demand. The positive of having a niche market for Brussels sprouts was outweighed by the production and post-harvest expenses and challenges.

The project team's assessment of whether this is a good crop for SWVA farmers:

Pro's	Con's
Large, secure market High price point	This crop does not hold well. Therefore they need to be sold and shipped ASAP. Requires delicate handling, as it is very fragile Plant in June/July and harvest in Oct/Nov – a long time to have a crop in the field Costly post-harvest handling

Additional Observations from the Project

Appalachian Harvest's first harvest of conventional Brussels sprouts was a huge success and of high quality. Once Food City received their first shipment, they ordered 3 subsequent deliveries at exceptional pricing. Once Giant Martin and Harris Teeter received their sample boxes, they too ordered back to back deliveries of the Brussels sprouts. Fresh Market received pictures of the product and they too ordered Brussels sprouts. Unfortunately, the supply of this product was significantly less than the demand.

The organic trial was a complete failure which the project team did not find too surprising given the need to keep this high risk crop in the field for over 100 days. The management of weeds for that period of time is particularly difficult (and quite labor intensive) for organic production.

Brussels sprouts on-the-stem are ordered in a 12-14 count box – which is both a pro and a con. The bulk pack of 12 -14 units per box @ $28-$35 per box provides the farmer with an exceptionally high unit value specialty crop with huge demand. However the attention to detail and the need to remove all of the leaves by hand from each stalk is very time consuming and tedious work on a crop that has a very low tolerance for time from "harvest to store shelf." Post-harvest conditions must be better than just optimum, they must be almost perfect to maintain the crops much needed retail quality. Transporting and storing this crop requires (a) already meeting ideal post-harvest conditions, and (b) micromanaging temperatures and humidity during the transportation and storage processes. This distance of time between harvest and shipping to a market must be less than 3 days. Timing of harvest, markets, logistics, and all details in-between are vital to the success of this crop. The variable that will be extremely diverse across producers is the availability of labor that is educated in agriculture, individual farmer's time for managing the transplant phase, proper weed and pest controls, as well as post-harvest handling and the value that an individual farmer may or may not place on his or her time to hand pluck leaves from stalks. (12-14 count boxes @ 100 boxes equates to 1,400 Brussels sprout stalks of 20-24" in height to handle in optimum post- harvest conditions.)

V. BENEFICIARIES

There were 3 categories of beneficiaries on this project:

Farmers: The 3 farmers who participated in the trial benefited from the opportunity to experiment with a high value crop without incurring the cost of seeds or transplants. Farmers in Southwest VA also benefitted from the results of this project. Though currently, the high demand (and lack of supply) for other, less risky crops, does not make Brussels sprouts an ideal choice for SWVA farmers, it is possible that this might change in the future, as markets and supply and demand

change. Should future farmers be interested in growing Brussels sprouts on-the-stem, they will be provided with the objective information obtained through this project. They will also know the challenges of producing and handling this crop.
Buyers: Though buyers did not receive the quantity of Brussels sprouts on-the-stem they desired, they did have an opportunity to move 277 cases of locally produced product.
Project Team: ASD and Extension benefitted from this project by becoming better informed so that the hundreds of farmers who participate in training and support services through this team will be able to leverage the knowledge gained through this project. ASD's Appalachian Harvest food hub regularly works with 60-70 farmers who access its wholesale markets. The knowledge gained from this project will be shared with this group of farmers as we work with them to create pre-season production plans.

VI. LESSONS LEARNED

The maturity level of the farmer is vital as well as understanding the current workload of the farmer for any trial. A mature grower with fine-tuned time management and pest management is ideal, but not always the case. Hayden Lyons, an ideal grower who committed to the project, lost his only brother at age 22 in early June, but stayed committed to the project. Unfortunately, with this sad situation he didn't practice his usual level of time management and did not have labor in place to execute the best conditions for growing Brussel sprouts. He utilized a pre-emergent herbicide, then planted his transplants. Unfortunately an unusually random heavy rain storm allowed a pathway for the herbicide to leach into his transplants, and he had an entire crop failure.

There are unavoidable risk factors in Brussels sprouts on large wholesale production level. First, the very tender transplants are planted during the hottest part of the growing season, and being such a long-term crop they fight beating a heavy freeze during their expected harvest time. Bare ground production due to extreme summer temperatures is a positive choice, however, the herbicide application must be timed perfectly to avoid rain from saturating the ground to such a degree where the herbicide leaches into the crop. A learning from this season would be to utilize white plastic mulch and drip irrigation to assist in not burning the young transplants in June on black plastic mulch and to avoid the potential of unexpected heavy rains to leach herbicide into the growing areas.

VII. CONTACT PERSON

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VIII. ADDITIONAL INFORMATION

6. S. Rideout
Enhancing Food Safety o Virginia Grown Tomatoes
Virginia Tech
Final

PROJECT TITLE
Enhancing Food Safety of Virginia-Grown Tomatoes

PROJECT SUMMARY
Outbreaks of human diseases caused by foodborne pathogens have increasingly been associated with fresh vegetables and fruits. *Salmonella enterica* has been reported to be the leading cause of these outbreaks in the United States. CDC's studies indicated it causes 1.4 million cases of illness and 500 deaths in the United States every year, with total estimated costs of $3.4 billion/year. According to CDC's reports, there have been at least three outbreaks of salmonellosis resulting from contaminated tomato fruit that were determined to have originated from the Eastern Shore of Virginia (ESV). *Salmonella* contamination on tomatoes also raised questions about the safety of the water used for irrigating these products in this region. Typhimurium and Newport are the two main *Salmonella* serovars associated with tomato outbreaks. There are indications of different serovar-cultivar interactions for *Salmonella* contamination on tomatoes. However, the susceptibility of commercial tomato types and cultivars to *Salmonella* has not been investigated. In addition, although the original contamination has been proposed to be during pre-harvest stage, little is known about the effects of agricultural production practices, like pesticide, fumigant and sanitizing agent applications, on the decontamination of *Salmonella*. The objectives of this project are as follows:

1. Investigate the spatial and temporal incidence of *Salmonella* spp. in irrigation pond water during major production seasons (spring and fall seasons) on the Eastern Shore of Virginia.
2. Evaluate the impacts of agricultural production practices on the decontamination of *Salmonella* Typhimurium and Newport:
    a) effect of fumigation on the decontamination of *Salmonella* Typhimurium and Newport in soils;
    b) effect of bactericide application on the decontamination of *Salmonella* Typhimurium and Newport on/in tomato plants;
    c) effect of sanitizing agent treatment on *Salmonella* contaminated irrigation water.
3. Determine the susceptibility of different tomato types and cultivars to *Salmonella* Typhimurium and Newport.

The population and distribution of *Salmonella* spp. in irrigation pond water on ESV has been detected, which will provide produce growers with information about potential contamination risks. The impact of fumigant, pesticide, sanitizer application on *Salmonella* decontamination was also investigated in this study, which would benefit stakeholders especially vegetable and fruit industries to reduce the contamination risks of foodborne pathogens during the production and achieve the new requirements of FSMA on produce safety.

PROJECT APPROACH

Objective 1: Investigate the spatial and temporal incidence of *Salmonella* spp. in irrigation pond water during major production seasons on the Eastern Shore of Virginia.

Irrigation pond water of four vegetable farms on the Eastern Shore of Virginia was sampled weekly for *Salmonella* detection since October 2013. At each sampling time, about 4 L pond water was collected from each pond near pumps. Collection vessels were sanitized with 70% ethanol and rinsed with sterile water. Collected water samples were stored on ice in the field and transported to lab refrigerators for analysis in Dr. Rideout's lab. The presence/absence of *Salmonella* and quantification in positive samples were detected by the improved MPN method using 4 tubes x 3 dilutions. Isolated *Salmonella* colonies will be stored in 20% glycerol at a -80 °C freezer.

Objective 2: Evaluate the impacts of agricultural production practices on the decontamination of *Salmonella* Typhimurium and Newport:

a) effect of fumigation on the decontamination of *Salmonella* Typhimurium and Newport in soils;

To assess the fumigation effect, sandy loam soils were inoculated with *Salmonella* Newport strain J1892 or Typhimurium strain ATCC 14028 to reach a population density of 10^6 CFU/g, and treated with fumigants (chloropicrin, metam sodium, dimethyl disulfide, or 1,3-dichloropropene). Fumigants were applied at equivalent maximum application levels in fields. Sterile water was used as control. *Salmonella* population was measured by plate counting method.

b) effect of bactericide application on the decontamination of *Salmonella* Typhimurium and Newport on/in tomato plants;

To investigate pesticide effect, 8-week tomato plants were inoculated with the same *Salmonella* strains by dipping tomato leaves in bacterial solution of 10^8 CFU/ml. Inoculated plants were treated with four pesticides with different action mode (Kocide 3000, Actigard 50WG, Firewall 22.4WP and Oxidate 27L). Bactericides were applied at equivalent maximum application levels in fields. Sterile water was used as control. *Salmonella* population was measured by plate counting method.

c) effect of sanitizing agent treatment on *Salmonella* contaminated irrigation water.

In this study, well and pond irrigation water were collected from different vegetable farms on ESV. Three initial levels of *Salmonella* Newport (10^8, 10^6 and 10^4 CFU/mL) and two application levels of disinfectants (1:1,000 or 1:50,000 dilution) were tested in this study (Table 1). Bacterial concentration was measured 30 min after treatment.

Trade Name	**Active Ingredients (AI)**	**AI Concentration (mg/L)**	
		At 1: 1000 dilution level	**At 1: 50,000 dilution level**
Clorox® Regular-Bleach	6 % sodium hypochlorite	60	12
Oxidate 2.0*	27 % hydrogen peroxide,	27.1	0.54
Sanidate 12.0**	18.5 % hydrogen peroxide, 12 % peroxyacetic acid	18.5 12	0.37 0.24
Control	Sterilized tap water	/	/

Table 1. List of disinfectants and active ingredients. * approved by EPA for foliage application in fields; * approved by EPA and the Organic Materials Review Institute for use in irrigation water.

Objective 3: Determine the susceptibility of different tomato types and cultivars to *Salmonella* Typhimurium and Newport.

Three types of tomatoes (Grape/cherry, Roma, and Round) with 5 cultivars per type and 15 cultivars (Table 2) in total were grown on the farm at Virginia Tech Eastern Shore AREC. Mature fruits of each cultivar were harvested and inoculated with *Salmonella* by both surface and vacuum inoculation methods. *Salmonella* concentration in tomatoes 0, 1, 7 and 15 days after inoculation was measured by serial dilution and plating method.

Grape:	Smarty	Jolly Elf	BHN 268	Camelia	BHN 785
Roma:	Picus	Mariana	BHN 685	Sunoma	Plum Regal
Round:	FL 47	BHN 602	Mountain fresh Plus	Red Bounty	BHN 589

Table 2. List of tomato cultivars for susceptibility test to *Salmonella* growth.

Tomato is the specialty crop that benefited from this research project. The main goals of this project were to evaluate the irrigation pond water quality on the Eastern Shore of Virginia for vegetable (tomato) production, screen resistant tomato cultivars and investigate production practices that can reduce the chance for a foodborne disease outbreak (particularly salmonellosis) on tomatoes.

Dr. Rideout provided overall oversight of project and quality control for microbiological assays. Dr. Gu conducted sample collection, agricultural practice evaluation, and tomato cultivar comparison analyses. The Virginia Vegetable Growers Association arranged the irrigation water sampling during this study. Virginia faculty and staff assisted with data presentation to producers and preparation of research and extension publications.

GOALS AND OUTCOMES ACHIEVED

Objective 1:

Salmonella population (Most probable number (MPN) values) in irrigation ponds varies in different months and locations (Fig. 1).

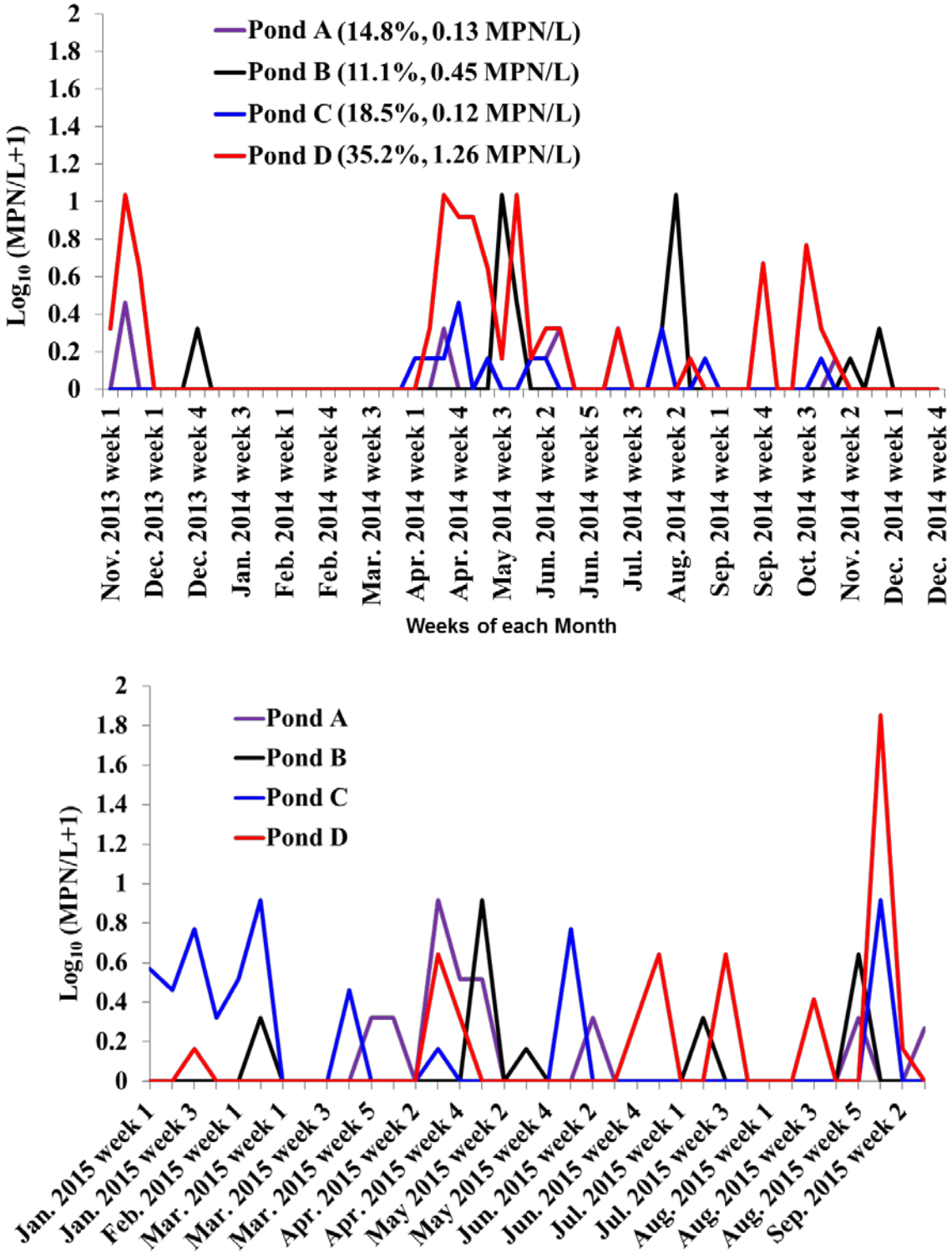

Figure 1. *Salmonella* spp. most probable number values (MPN) in Irrigation Pond Water. The detection limit of this test is 0.42 MPN/L.

There were spatial (pond) and temporal (monthly) differences for *Salmonella* occurrence and population in irrigation pond water (Fig. 1). The prevalence of *Salmonella* spp. in tested four ponds of farm A, B, C and D are 14.8%, 11.1%, 18.5% and 35.2%, respectively. The average MPN

values of *Salmonella* in the four ponds during the study were 0.13, 0.45, 0.12 and 1.26 MPN/L, respectively. *Salmonella* levels in spring and fall was significantly higher compare to winter (P<0.05). The top three serovars isolated from pond water were Newport, Larochelle, and Bareilly.

Objective 2:

a) effect of fumigation on the decontamination of *Salmonella* Typhimurium and Newport in soils;

The original *Salmonella* population in inoculated soil samples before fumigation were not significantly different among various treatments (Se serovar × fumigant application), with an average population density of 5.86 ± 0.25 log CFU/g (P > 0.05). There was no significant interaction between fumigant treatment and *Salmonella* serovar for the fumigation reduction values (P=0.2215). One day after the 2-week fumigation, the average population of SeN (4.78 ± 0.11 log CFU/g) was significantly higher than that of SeT (4.44 ± 0.15 log CFU/g; P=0.0153; Fig. 2A). The deduction of *Salmonella* population in soil is significantly higher after 1,3-dichloropropene and dimethyl disulfide treatments compare to control (P < 0.05), while the deduction values of chloropropin and meta sodium were similar to control samples (Fig. 2B). Soil pH was not changed after fumigation (P<0.05). There was no significant difference among fumigant treatments as well as control samples for soil pH.

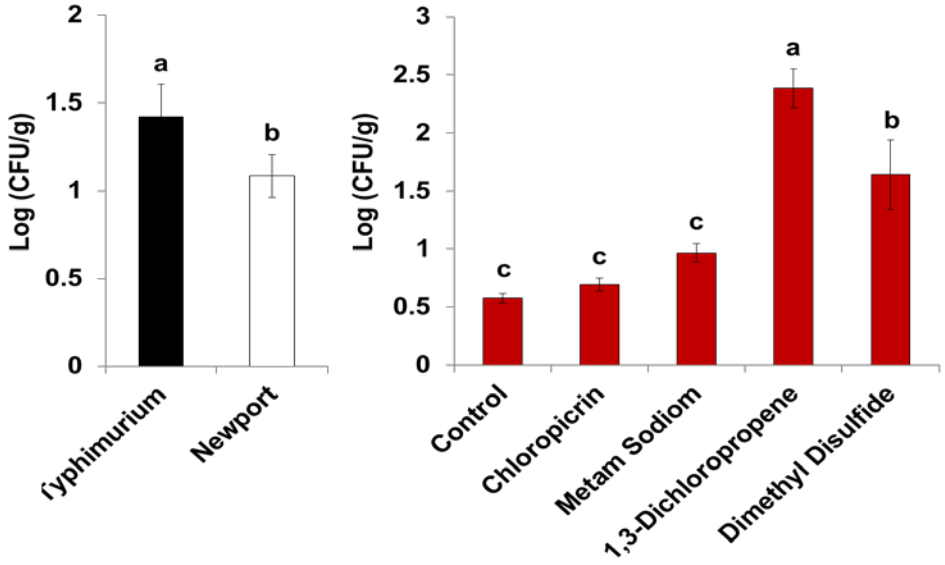

Figure 2. Reduction of *Salmonella* populations in inoculated soils 15 days after fumigation.

b) effect of bactericide application on the decontamination of *Salmonella* Typhimurium and Newport on/in tomato plants;

For both surface and internal detection, *Salmonella* levels on and in tomato leaves of the two inoculated serovars Newport and Typhimurium at each sampling point were not significantly different (P>0.05). The initial *Salmonella* concentration in wash off solution and surface disinfected leaves, 3 h after inoculation, were 6.87 ± 0.14 log CFU/mL and 6.35 ± 0.13 log CFU/g, respectively. One day after Oxidate and Firewall application, the decrease in *Salmonella* concentration in wash off solution of inoculated leaves was significantly higher compared to the control (Oxidate: 0.70 ± 0.24 log CFU/mL; Firewall: 0.59 ± 0.06 log CFU/mL; Fig. 3A). However, Actigard and Kocide treatments did not significantly lower *Salmonella* concentration compared to the control (P>0.05). The reduction of *Salmonella* concentration in surface disinfected leaves was significantly higher for

Kocide application compared to the control (Kocide: 0.79 ± 0.16 log CFU/g; Fig. 3B). All other treatments did not effectively reduce *Salmonella* population inside inoculated leaves.

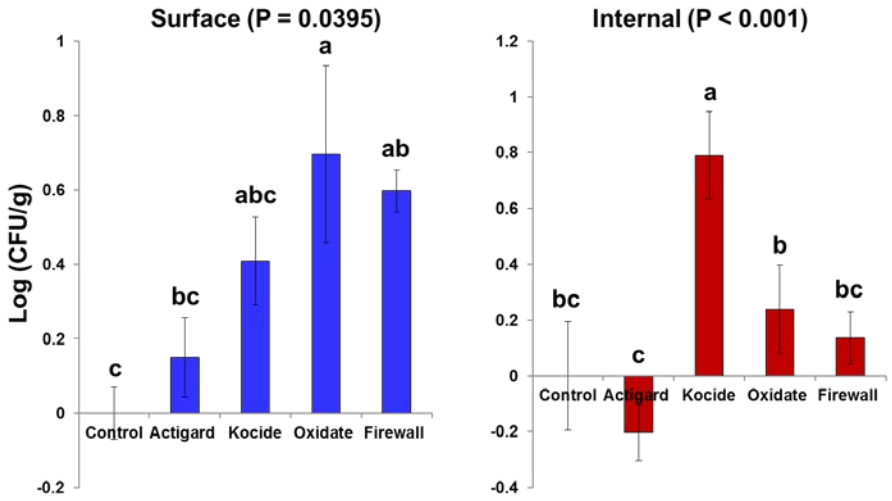

Figure 3. Reduction of *Salmonella* on/in the inoculated tomato leaves after bactericide application.

c) effect of sanitizing agent treatment on *Salmonella* contaminated irrigation water.

Application of the three disinfectants (Clorox Regular-Bleach, Oxidate Broad Spectrum Bactericide Fungicideand Sanidate 12.0) could significantly reduce *Salmonella* Newport population in irrigation water under the conditions with high application level (1:1000 times dilution) or low bacterial initial concentrations (10^6 and 10^4 CFU/mL; Figs. 4 and 5). Sanidate would be the most efficient disinfectant for *Salmonella* decontamination in irrigation well and pond water, especially at higher bacterial population density (10^8 CFU/mL) and lower disinfectant application level (1:50,000 times dilution). In addition, SaniDate 12.0 is approved by the Organic Materials Review Institute for use in irrigation water, which would be allowable for both conventional and organic production.

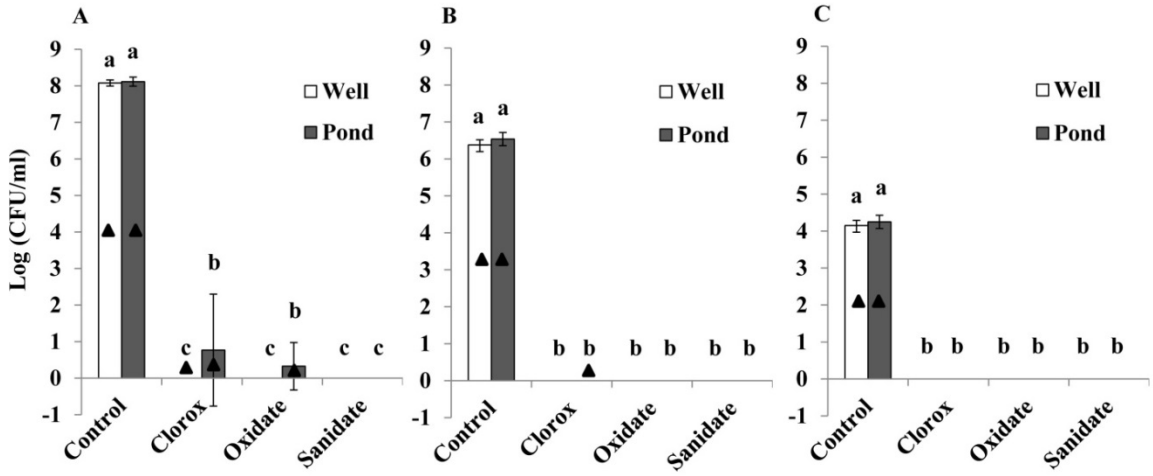

Figure 4. *Salmonella* populations in irrigation well and pond water 30 min after disinfectant treatment at 1:1000 dilution application level. Initial *Salmonella* inoculation level of 10^8 CFU/mL (A), 10^6 CFU/mL (B), and 10^4 CFU/mL (C). Bars present the standard deviations. Solid triangles indicate positive results for *Salmonella* detection after enrichment.

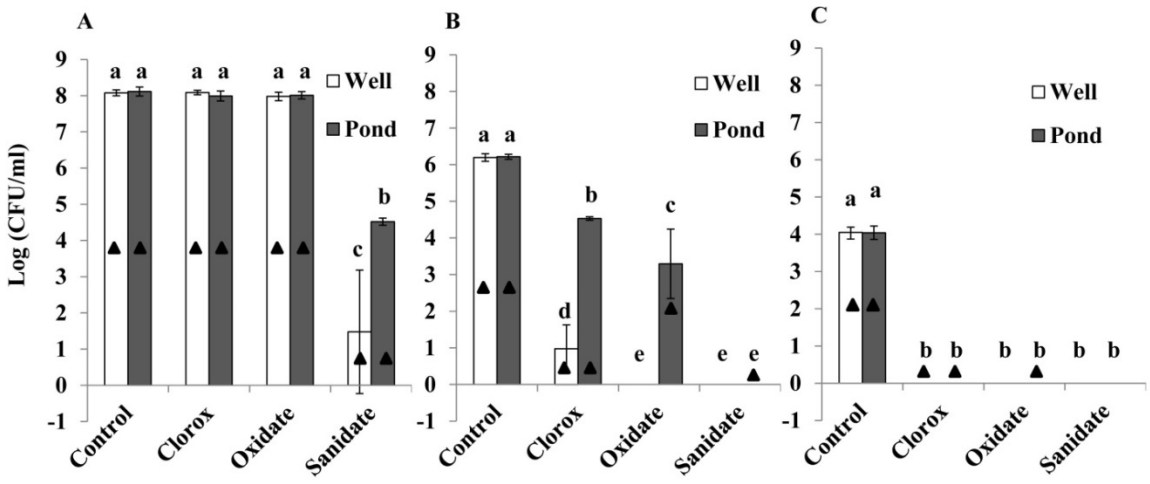

Figure 5. *Salmonella* populations in irrigation well and pond water 30 min after disinfectant treatment at 1:50,000 dilution application level. A: at initial *Salmonella* inoculation level of 10^8 CFU/mL; B: at initial *Salmonella* inoculation level of 10^6 CFU/mL; C: at initial *Salmonella* inoculation level of 10^4 CFU/mL. Bars present the standard deviations. Solid triangles indicate positive results for *Salmonella* detection after enrichment.

Objective 3:

After surface inoculation, *Salmonella* survival on tomato fruits of various types and cultivars were not significantly different (Fig. 6).

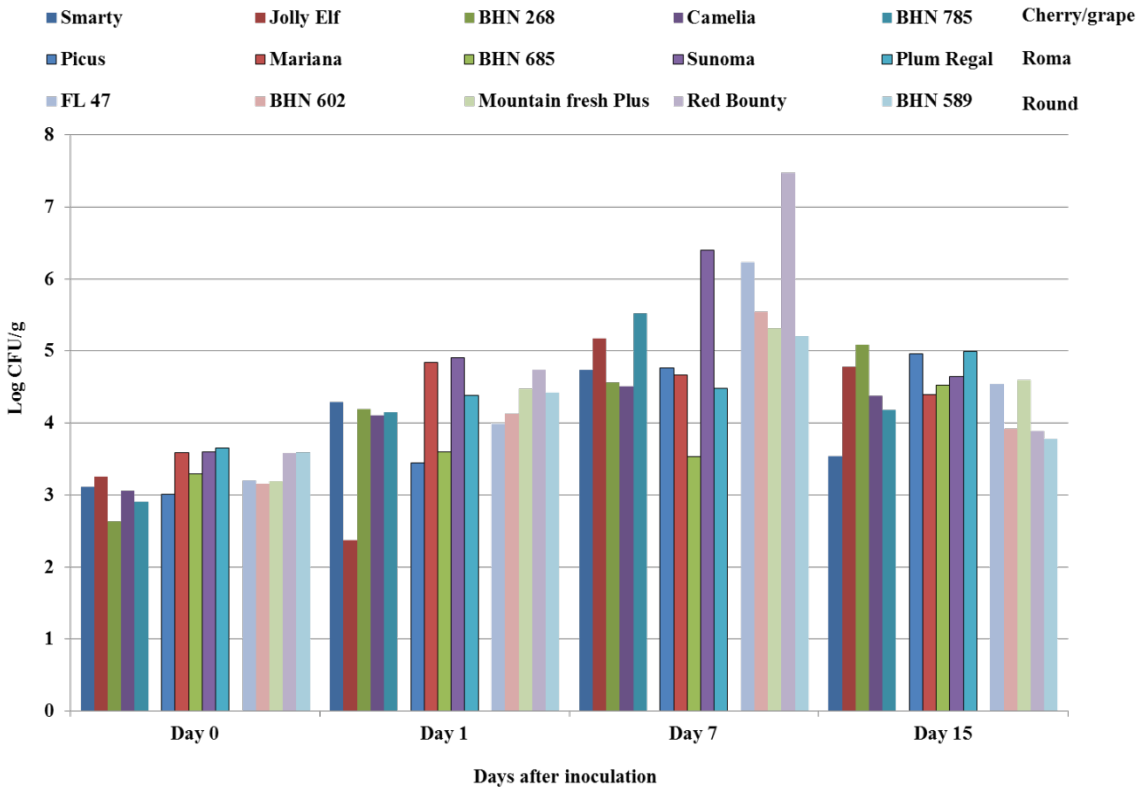

Figure 6. *Salmonella* population of tomatoes after surface inoculation.

Similarly, after vacuum filtration inoculation, *Salmonella* survival on tomato fruits of various types and cultivars were not significantly different (Fig. 7).

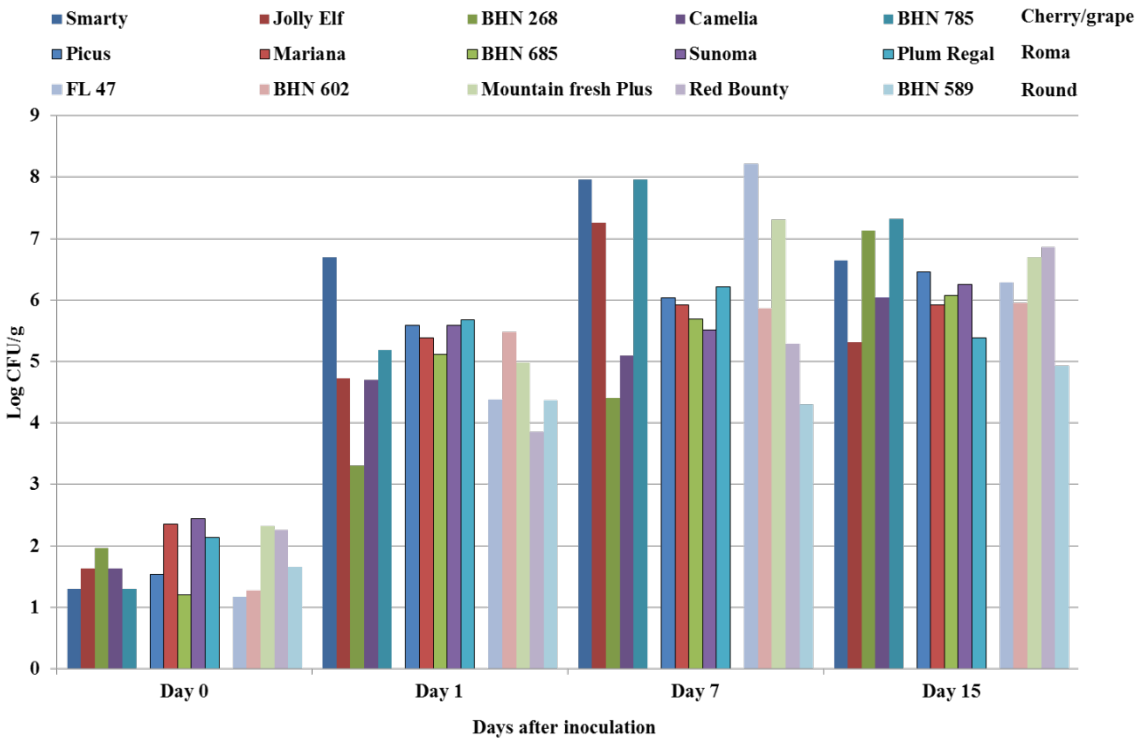

Figure 7. *Salmonella* population of tomatoes after vacuum filtration inoculation.

All funds have been spent as specified in the grant notification letter and project budget.

BENEFICIARIES

Salmonella enterica is the leading cause of bacterial food-borne illnesses and accounts for approximately 42,000 cases of infections annually in the US. Recent salmonellosis outbreaks indicate that environmental transmission of *Salmonella* to produce can lead to human illness. According to CDC's reports, at least three outbreaks of salmonellosis associated with contaminated tomatoes have been traced back to ESV from 2002 to 2010. *Salmonella* contamination on tomatoes also raised questions about the safety of the water used for irrigating these products in this region. Producers are frequently asked by retailers to certify product quality. In this study, we detected the dynamics of *Salmonella* population and distribution in irrigation ponds on ESV. The results provide growers with information that is necessary for them to determine if a contamination problem exists. This information is vital as the FDA intends to begin mandating uniform regulations for food safety, inclusive of irrigation water standards, in the upcoming year. In addition, the efficacy of major fumigants, bactericides, and sanitizers used for tomato production on *Salmonella* deduction in soil, plant, and irrigation water has been evaluated. Relevant results derived from this study have been shared with vegetable growers and other stakeholders through extension talks, field days, and scientific meetings. The outcomes of this research will benefit stakeholders especially vegetable and fruit industries to reduce the contamination risks of foodborne pathogens during irrigation and achieve the impending requirements of FSMA on produce safety. After the education about food safety and good agricultural practices on produce

production in this project, no outbreaks of salmonellosis have been linked to the tomatoes produced in Virginia in recent years.

LESSONS LEARNED

Overall, the project was successful in investigating the distribution and population of *Salmonella enterica* spp. in irrigation pond water and evaluating the impact of fumigant, pesticide, and sanitizer application on *Salmonella* decontamination. Tested sanitizers could significantly reduce *Salmonella* population in irrigation water under the conditions with high application level (1:1000 times dilution) or low bacterial initial concentrations (10^6 and 10^4 CFU/mL). Further studies will be conducted to investigate the mechanism and find optimal application dose for the decontamination of different pond irrigation water, especially from the water sources with high organic matter concentration. Fumigation using 1,3-dichloropropene and dimethyl disulfide which labelled for plant pathogen management can also benefit the decontamination of *Salmonella* in agricultural soil. Future research is needed to evaluate the efficacy of other MrB alterntive chemicals, like Dazomet, or the combination of fumigants, like 1,3-dichloropropene and dimethyl disulfide, on the decontamination of *Salmonella* in soil to reduce potential contamination risks. For bactericide evaluation, even though results of each trial showed significant differences compared with control for certain-bactericide treatments, the rate of *Salmonella* decrease observed on or in tomato leaf was less than a 1 log CFU/ml or log CFU/g, respectively. These data indicate that a single application of bactericides (specifically the ones tested in this study) cannot sufficiently mitigate the contamination of *Salmonella* on and in tomato plants.
High variation of *Salmonella* concentration in tomatoes after inoculation was observed in the cultivar trial. The large standard error values of each treatment result in none significant difference among tested tomato cultivars for *Salmonella* population analysis. The variance of individual fruits of each selected cultivar and/or limited sample size for each test may contribute to the high variation. Further studies of testing other tomato cultivars and larger sample amount would benefit the comparison of susceptibility of different types of tomatoes to foodborne pathogens.

IX. CONTACT PERSON

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ADDITIONAL INFORMATION

Training workshops/schools:

Gu, G., and S. Rideout. Produce food safety research update. Eastern Shore AREC's Annual Field Day, Painter, VA. July 15, 2015.

Gu, G., and S. Rideout. Prevalence and survival of *Salmonella enterica* spp. in irrigation water, poultry litter and amended soils on the Eastern Shore of Virginia. The 26th Eastern Shore Ag Conference and Trade Show. February 11, 2015

Rideout, S., and G. Gu. Parameterizing a Quantitative Predictive Risk Assessment Model (QPRAM) with Data from *Salmonella enterica* Contamination of Tomatoes. FDA webinar. December, 2014

Reiter, M., G. Gu and Jenrette J. Getting excited about agriculture! Watershed Festival. Eastern Shore Soil and Water Conservation District Environmental Education Council, Onancock, VA. October 22, 2014.

Gu, G., and S. Rideout. Produce food safety research update. Eastern Shore AREC's Annual Field Day, Painter, VA. July 9, 2014.

Gu, G., and S. Rideout. The requirements of impending Food Safety Modernization Acts related to potato production. The 2014 Virginia Irish Potato Board annual meeting. March 6, 2014

Published meeting abstracts:

Gu, G., J. Zheng, M. Reiter, L. Strawn, and S. L. Rideout. 2015. Prevalence and survival of *Salmonella enterica* spp. in irrigation water, poultry litter and amended soils on the Eastern Shore of Virginia. International Association of Food Protection (IAFP) annual meeting abstracts, 104: T7-12.

Gu, G., L. Yang, R. Boyer, R. Williams, and S. L. Rideout. 2014. Survival of virulent and mutated *Salmonella enterica* Newport and Typhimurium strains on tomato plants and in soils. IAFP annual meeting abstracts, 103: P1-120.

Rideout, S., G. Gu, M. Reiter, R. Boyer, and E. Brown. 2014. Effects of disinfectants on decontamination of *Salmonella* Newport in irrigation well and pond water. IAFP annual meeting abstracts, 103: P3-144.

Luo, Z., G. Gu, M. C. Giurcanu, M. Adams, G. Vellidis, A. H.C. van Bruggen and A. Wright. 2014. Development of a novel cross-streaking method for isolation, confirmation, and enumeration of *Salmonella* from irrigation ponds. IAFP annual meeting abstracts, 103: T8-09.

Rideout, S., G. Gu, M. Reiter, J. Zheng, and E. Brown. 2014. *Salmonella* contamination and persistence in tomato fields as affected by irrigation, fertilization and cultivation practices. Phytopathology, 104: S225.

Gu, G., J. Zheng, C. Waldenmaier, M. S. Reiter, and S. L. Rideout. 2013. Effects of agricultural practices on *Salmonella* contamination in tomato fields. IAFP annual meeting abstracts, 102: T6-05.

Luo, Z., G. Gu, M. Adams, G. Vellidis A. H.C. van Bruggen, M Danyluk, and A. Wright. 2013. Distribution and genetic diversity of *Salmonella enterica* isolated from irrigation water in the Suwannee River watershed. IAFP annual meeting abstracts, 102: P1-112.

Rideout, S. L., G. Gu, M. S. Reiter, J. H. Freeman, R. R. Boyer, C. Waldenmaier, and K. Fiedler. 2013. Effects of fumigation and bactericide application on the decontamination of *Salmonella enterica*. Phytopathology, 103: S120.

Extension Publication

Rideout, S., M. Reither, G. Gu, et al. 2015. Commercial vegetable production recommendation – Virginia, 2015. Publ. 456-420. (Food safety section) Virginia Cooperative Extension, Blacksburg.

7. G. Moody-Milteer
VDACS
Final

I. PROJECT TITLE

"Advancing Virginia's Strawberry Production and Industry"

II. PROJECT SUMMARY

The proposal was to provide all strawberry growers in the state with the opportunity to take plant tissue samples analysis to improve the health of the plants and to increase plant yields for more sellable product. A tissue sample program helps achieve the best yield and most profit for the crop. With this grant opportunity growers learned why tissue sample analyses are important, how to take tissue samples and how to utilize the analysis to increase plant production. Secondly, the grant allowed assistance to the newly formed Virginia Strawberry Association in their formative stage.

Growing strawberries is a very expensive plasticulture type of farming. To remain in business growers need to use good management practices to have healthy plants to produce the most possible quality yields. By offering tissue sample analysis it provided a nutrient management tool to achieve these goals, a tool that most growers had not used in their farming practice.

The newly formed VSA needed guidance and support to gain interested members, select a Board of Directors, form the by-laws, and get the Association started. The grant helped the Association to begin offering workshops and reach out to growers in Virginia helping them to be better strawberry growers, as well as gain members in the Association.

Many small family farms struggle to keep the farm and many are looking for crops to grow on small acreage. Strawberries are one of the first crops they consider so it is important to assist them in becoming knowledgeable and produce the best crop possible.

III. PROJECT APPROACH

The largest grant objective was to introduce tissue sample analysis to strawberry growers, helping them understand the benefits of taking tissue samples, how to properly take tissue samples and to use the lab results to fine tune the fertilization program for healthier plants and better yields. The grant covered the lab fee cost for both years and postage for the samples during year one. Sixty five producers participated in this grant segment over the two year, with 230 acres of plants, where over 300 samples were submitted. The growers indicated they did see plant health improvements when following the recommendations. But perhaps just as important, the tissue samples even saved growers money. Rather than fertilizing on a regular schedule the growers followed the tissue sample analysis reports and fertilized accordingly. Some weeks no application was needed, other weeks fertigation was recommended. Growers surveyed indicated that by using tissue sample recommendations they increased their profits by $1000 an acre, often by not wasting money on unneeded fertigation. Others that did not have a good fertigation program better understood the needs of the plants.

The Virginia Strawberry Association, VSA, was formed in 2013. The grant provided funding for four Board members to attend the Southeast Strawberry Expo to experience one of the largest strawberry state meetings and to gain knowledge on association duties as well an increase their strawberry knowledge while considering programs and grower assistance for Virginia. The grant provided startup money for the VSA Board to meet in a central location to conduct business including writing by-laws, organizing the new association, and planning needed outreach programs to strawberry growers. The association has 35 members to date and continues to reach out to the other growers in the state.

The grant provided funding to offset the costs of two pre-plant meetings attended by growers and to provide speakers for the Winter Strawberry School. Additionally a special GAP Food Safety workshop for strawberry growers was held where each grower received a GAP manual for use on their farm. Additional monies were earmarked for one-on-one GAP assistance on farms but at the close of the grant year no one had requested this assistance. A session on Value Added Strawberries was attended by 65 people.

A How to Pick Strawberries vinyl poster was developed, printed and distributed to each u-pick strawberry farm in Virginia that requested one for use at the farm stand. This poster is used to educate first time strawberry pickers and to gently remind seasoned pickers the "does and don'ts" of strawberry picking. The banners are vinyl so they can be used for multiple seasons. The banners were purchased and delivered to the strawberry farms by staff.

Funds also provided all strawberry growers in the state an opportunity to sign up for a no cost strawberry weather service which provides weather reports specifically for the grower's location which allows growers to better manage weather risk. The weather service proved to be a very important risk management tool especially during heavy frost and freeze warnings.

Lastly, the grant provided some travel funds for one staff member with strawberry responsibilities to attend strawberry meetings.

IV. GOALS AND OUTCOMES ACHIEVED

Staff updated the strawberry grower list for the 2014 and 2015 season. Seventy (70) strawberry growers were contacted about participating in the Plant Tissue Analysis program where growers had the opportunity to send at no charge to the North Carolina Department of Agriculture lab strawberry tissue samples for analysis. After testing the petioles and leaves, the lab provides the grower with an emailed/online report on what "foods" the plant needs to be of optimum health to produce beautiful and plentiful strawberries.

Each year 30-35 growers accepted the challenge to learn the what, why, and how of tissue sample analysis. To educate the growers on how to take tissue samples and how to read their reports, strawberry growers attending the winter strawberry field walk were provided a hands-on demonstration. At the winter strawberry school an extension specialist provided a brief talk to the growers on how to take a tissue sample. Also a Power Point presentation provided by the lab on the How's and Why's to Tissue Sample was sent to growers that had never taken a tissue sample so they could learn the proper way to select the leaf and petiole for analysis. And staff was available to assist growers needing help.

Out of the 70 growers that were identified in the state only 33% indicated they had ever taken tissue samples. Only 15 growers had ever taken tissue samples regularly just prior to bloom and during the critical time. Other growers indicated they only took a sample if they had a major problem with the plants, likely a disease, and then didn't follow up with another sample at a later date to see if the problem was being helped. With growers participating in the specialty crop grant program taking samples during the critical time every two weeks this was an increase of over 200%. The grant target was a 50% increase use of tissue sample analysis.

One grower summed up his grant participation as, "By far the best grant I have ever participated in. The results were timely and allowed me to make wise management decisions in feeding the plants. I saved money on my fertigation program and had very healthy plants that produced unbelievable berries. Thank you for this opportunity".

The second portion of the grant was to assist and guide a group of growers forming the Virginia Strawberry Association. The group pulled in a few growers from all areas of the state to begin the association. Board members were selected, officers appointed, and they began working on by-laws, filing Articles of Incorporation, and reaching out to potential members. Thirty five joined the newly formed Association on

year one. Four Board members attended the Southeast Strawberry Expo to experience one of the largest strawberry meetings in the US, to gain knowledge on Association duties as well an increase their strawberry knowledge while considering programs and grower assistance for Virginia.

The Board agreed to co-sponsor two pre plant meetings attended by 74 growers and industry representatives, two winter vegetable schools attended by 135, and two winter field walks attracting 86 growers and industry personnel. Board members continue outreach to potential new members and strive to offer timely educational opportunities to growers across the state.

A How to Pick Strawberries vinyl poster was developed, printed and distributed to about 70 u-pick strawberry farms in Virginia that requested one, for use at the farm stand. Some farms have more than one location so some received multiple posters. This poster is used to educate first time strawberry pickers and to gently remind seasoned pickers the "does and don'ts" of strawberry picking.

A Good Agricultural Practice, GAP, class was attended by 28 where attendees received 4 hours of an overview on GAP requirements especially for a strawberry farm. A notebook manual was given to each attendee and used during the class. This manual is set up for the GAP audits so will allow those interested in becoming GAP certified a book to use in the process.

During the duration of the grant over 70 growers participated in the weather service partially funded by the grant. The service provided very timely weather emails to strawberry growers from January 1- June 1 in addition to satellite weather conditions and advisors for each participating field. The weather service proved to be a very important risk management tool especially during heavy frost and freeze warnings. Growers found this type of risk management tool to be much more accurate than the TV or radio station forecast.

The grant provided some travel funds for one staff member with strawberry responsibilities to attend strawberry meetings across Virginia and the SE Strawberry Expo held in North Carolina.

V. BENEFICIARIES

Beneficiaries of the grant were the strawberry growers in Virginia. Every known grower in the state was given the opportunity to participate in each phase of the grant at no cost to the grower.

Each year over 30 growers participated in the tissue sample analysis program with an additional of four new growers on year two. Over 300 samples were sent to the North Carolina Department of Agriculture lab at no charge to be analyzed. Test results were available online. Growers used the tissue sample analysis results to fertigate the strawberry plants to produce healthier and better yielding plants. Data from the analysis makes it possible to fine-tune nitrogen and other nutrients to maximize fruit yield and quality.

The newly formed Virginia Strawberry Association was also a beneficiary of the grant. Monies from the grant assisted with the first Board meetings and allowed four Board members and an advisor to the Board to attend the SE Strawberry Expo gaining strawberry knowledge as well as a better understanding of the role of an association and its operational methods. The grant also allowed the Association to sponsor and co-sponsor varies meetings across the state for strawberry growers.

135 growers and industry personnel attended the two Winter Strawberry Schools. Eighty one braved the cold weather and participated in the winter field walks. Sixty five attended a Strawberry Value Added class and 28 strawberry growers attended a Good Agriculture Practices, GAP, class where they learned valuable information to put into practice on their farms even if they decide not to be GAP certified. The growers attending the GAP certification class were given a manual to use on their farm to reduce food safety risk and/or use for becoming GAP certified.

The How to Pick Strawberries vinyl poster was designed and developed. 125 posters were purchased with 75 being distributed to growers. Growers with more than one pick your own location received a poster for each farm site. The remaining posters will be used for new growers or to replace damaged posters. Favorable comments were received on the new How to Pick Strawberries poster.

A weather service was available to each grower in the state where the farm location was used to provide the grower with the most accurate information for the location providing forecasts for risk protection.

Overall this grant greatly benefited Virginia growers by allowing them to experience various risk management tools to produce a better crop. Likewise the grant opened many educational doors allowing growers to expand their strawberry production knowledge.

VI. LESSONS LEARNED

Taking tissue samples is very important to improve health quality and to improve yields thus increasing on farm profits. Unfortunately it is difficult for all growers to see the need to do so. Even with free tissue sample analysis lab fees and free postage during year one of the grant many growers would not participate. The savvier grower and the new grower jumped on the band wagon and participated. The older grower who really needed to work on improving their production yields and berry quality choose not to participate. Roughly 15 growers had at some time used a lab for a tissue sample analysis before this grant began. The grant allowed many more growers to see the need and the benefits of taking samples. Growers have learned the value of taking tissue samples and have indicated they will continue to do so which is encouraging. Some growers agreed that when taking tissue samples and following the recommendations they had increased their per acre income by $1000. More growers should have taken advantage of this opportunity.

In starting a new association it is challenging for growers to see a need to join a new association and at first difficult to see the value a good association can bring to an industry. With the producers so spread out across the state and with small growers scattered across the state finding meeting places that groups of growers might drive to a meeting has also been a challenge. The Virginia Strawberry Association Board has been dedicated and the Association has done good work over the last two years with more exciting educational outreach to come.

Soil testing, healthy plant stock, tissue sample analysis, and farm weather services are all very important to a healthy and profitable strawberry crop.

VII. CONTACT PERSON

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VIII. ADDITIONAL INFORMATION

N/A

8. L. Aldrich
Virginia Wineries Association Cooperative
Final

PROJECT TITLE
VWA Cooperative: Collective Purchasing Program

PROJECT SUMMARY
For this phase of establishing cooperative operations, VWAC requested funding to establish a Collective Purchasing Program. The objective of the VWAC Collective Purchasing program is to reduce grape growing and wine production costs through collective purchasing of products and services including fencing, bottles, shipping containers, barrels, corks, wine glasses, etc. These savings can ensure economic sustainability for individual producers, the rural communities of Virginia and the overall Virginia wine industry. Collective Purchasing will be particularly effective in assisting small- to medium-sized farm wineries (those producing between 2,000 and 15,000 cases annually) to increase individual producer income. The concentration of wineries and vineyards within Virginia produces an emerging market of purchasers of vineyard and winery equipment, supplies and services through a producer cooperative. No other collective purchasing arrangement is currently available to Virginia wineries.

PROJECT APPROACH

Based on work plan the following activities have been performed:

- The Vine to Wine Co-op surveyed wineries in person, by phone, mail and online, to provide direction to the purchasing agent related to the specifics on the items purchased, vendors, providers and amounts that are ordinarily purchased.
- Research began based on feedback from members and other sources to find appropriate Virginia, regional and national manufacturers and wholesalers with the capacity to supply needed products and supplies. Services, terms, timelines
- An annual ordering calendar was developed with quarterly items for purchase; order and payment schedules; delivery dates; etc.
- Legal review of Collective Purchasing Program; development of all required legal documents has been completed.
- We have designed, produced and continue to disseminate marketing materials to increase winery participation and involvement. This process will be ongoing.
- We contracted with MAE Consulting to develop purchasing systems for VWAC and to be our Purchasing Agent.
- Determination of initial purchase parameters; specific items, quantities, shipping/delivery requirements, etc. was completed with the first and consecutive orders done.
- We did this draft and dissemination of initial purchasing solicitation and have done a second one for annual figures to be shopped to maximize savings.
- Initial bidding process opens - completed
- Supplier registration; capturing responses – completed and created vendor profiles with data
- Evaluating responses and bids - completed
- Supplier(s) chosen - completed
- Order placed - completed
- Order delivered - completed
- Tracking Supplier Performance; review process; issuing corrective actions; determine next steps - completed
- Demonstrated savings highlighted; additional winery sign up – ongoing, but not to targets

GOALS AND OUTCOMES ACHIEVED

Goal 1: To increase participation in VWAC
Performance Measure: Number of wineries/vineyards using the cooperative for procurement
Benchmark: In 2013, 0 wineries/vineyards are using the cooperative for procurement
Target: To have 30 wineries/vineyards using the cooperative for procurement by 2015

The co-op has 25 members currently and recruitment is stalled as they reorganize the program. This goal was not met. We had many obstacles with this recruitment these will hopefully be addressed with a future grant.

Goal 2: Reduce individual winery costs for fungicide
Performance Measure: Percent reduction of costs between collective purchase and individual winery purchase of fungicide
Benchmark: Fungicide application currently costs individual vineyards $413 per acre per year
Target: To reduce the cost of fungicide for participating vineyards 10% by 2015

The co-op prepared the opportunity for purchase, yet not enough used the program to make such a purchase to reach a discount. This goal was not met.

Goal 3: Reduce individual winery costs for bottle
Performance Measure: Percent reduction of costs between collective purchase and individual winery purchase of bottles
Benchmark: Bottles currently cost wineries between $7 and $15 per case of 12.
Target: Reduce the cost of bottles by 10% for participating wineries by 2015.

The co-op members have not begun to see maximum savings but the co-op was able to obtain a 5% savings. This will grow as participation does.

BENEFICIARIES
The VWAC Collective Purchasing Program could impact the State's 230 farm wineries and 300 grape growers. This industry represents approximately $750 million to the Virginia economy on an annual basis. In order to ensure individual farmer income and the sustainability of this growing industry, the VWAC Collective Purchasing Program estimates that it will realize individual winery and vineyard savings of between 15 and 25% on purchased goods. However, they have to participate to benefit from it. Therefore, the 25 participating wineries and vineyards benefitted from the savings, and for some they used those saving as they expanded their farm.

LESSONS LEARNED
There have been many lessons learned along the way. Ordering started sooner than expected, this was good and bad. It allowed it to work through our systems, find some flaws and make improvements. Maximum savings have not been realized and will not until we reach a more critical mass. We learned the importance of vendor profiles and terms as well. Mostly, we have experienced growing pains of going from a start up to an evolving operation.

Our way of receiving orders and purchasing was too labor intensive to be sustainable. The board is working on a new process of possibly having members place orders and pay directly to the supplier that the co-op negotiated better rates with based on expected volume. Then the supplier would provide a rebate back to the cooperative for marketing and promoting. This process will entail much less staff time, less processing costs for credit cards fees, and orders placed direct with supplier means delivery can also be arranged direct, cutting back on logistics time and costs. In addition, it is being explored to have the cooperative buy large orders of bottles and glasses based on what we have determined the need to be, then sell and ship.

The warehouse still has potential, but has generated little interest. The little it has generated has been good (large) but slow to transition.

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ADDITIONAL INFORMATION
The Cooperative website is http://www.vinewine.coop/

9. A. Niemiera
Virginia Tech
Final

I. Project Title
Edible Landscape Demonstration Gardens in Virginia

II. Project Summary
The goal of this project was to introduce and educate homeowners on the numerous edible species that can be used in residential landscapes and home gardens. Using edible species in residential landscapes/gardens is relevant for two main reasons: 1) Edible landscaping is currently a very popular trend amongst U.S. gardeners. As such, there is a significant and very positive economic impact of producing and selling edible landscape species by wholesale and retail nurseries and by the installation of these plants by landscape contracting companies. 2) The "local" food production trend has greatly impacted the U.S. food-buying culture. This trend has spurred home gardeners to take part in this trend by incorporating edible plant species in their landscapes and home gardens.

III. Project Approach
Three botanical gardens 1) Lewis Ginter Botanical Garden (LGBG; Richmond, VA), 2) Norfolk Botanical Garden (NBG; Norfolk, VA), and 3) Green Springs (GS; Alexandria, VA) participated in the two-year project. Each of these gardens developed an area devoted to displaying edible landscape species. Each of the gardens was granted $8,300 dollars to develop the area (e.g., soil and bed preparation, plant purchasing and planting, signage, and irrigation). A survey, developed by the principal investigator (A. Niemiera), was to be conducted at each of the gardens to gauge the success and impact of the gardens.

Results, Accomplishments, Conclusions, and Recommendations
Each of the three botanical gardens was successful in developing a very attractive edible landscape demonstration garden. An accompanying PowerPoint file (in Section VIII) to this report includes photographs of each demonstration garden. The educational goal of the gardens was certainly accomplished since all gardens developed a dedicated area for their demonstration gardens. All plants were professionally labelled (see example in PowerPoint) with common and scientific names. A plant list for each garden for each garden can be found in Section VIII of this report. The visual and educational impact of these gardens will increase over time as many of the plants will become larger and bear more fruit. The horticultural expertise of the three garden staffs was critical in having the gardens be well designed and expertly planted and labelled. Edible species were selected that were appropriate for the local area.

Since NBG incorporated their demonstration garden in their existing children's garden, they did not have to "break ground" to establish a garden area. Thus, their garden was mostly established in the first year of the project. The other two gardens had to develop a new garden area in year one and then plant in year two. Thus, NBG was able to conduct surveys in year one while the other gardens did not. The year one NBG surveys were statistically analyzed and used to improve the survey questions for the year two surveys (included in Section VIII). Year two surveys were conducted by NBG (89 respondents) and by LGBG (50 respondents) and recently sent to the principal investigator; GS has not yet submitted completed surveys and has not responded to emails requesting surveys. Twelve $50 gift certificates were purchased from the Edible Landscape Nursery (Afton, VA); gift certificates were used as an incentive for garden visitors to fill out

surveys. The original plan was to randomly award certificates to two randomly selected survey respondents per garden per year. This plan was modified to accommodate for the fact that no surveys were conducted in two of the gardens in the first year of the project. Surveys results will be transcribed into a spreadsheet form and data will be statistically analyzed. The recent project extension (October 2015) of the grant funding will allow this work to be done. Once survey data are statistically analyzed, data interpretation and conclusions can be made on the project's success and impact can be made. From an anecdotal standpoint, the horticulturists of each garden were proud of their demonstration gardens and noted garden visitor interest in the garden area and plants. The principle investigator visited all three garden projects in mid-July 2015 and was very pleased with the quality of demonstration gardens; he also noted significant visitor interest.

IV. Goals and Outcomes Achieved

The three goals, as outlined in the proposal, and the success of these goal are described below.

1) to educate botanical garden visitors on the fruit species, culture, and benefits of an edible landscape

This goal, for the most part, was achieved. As noted above, each garden developed a well-designed and attractive edible landscape demonstration garden with a wide array of edible plant species. Only one of the gardens (NBG) produced a brochure that outlined the specific culture and benefits of the species.

The original estimation of 300 survey respondents per garden for the two year period was a gross overestimation. Once survey data are transcribed, statistically analyzed and interpreted, quantitative conclusions on the success and impact of the gardens can be made.

2) to persuade botanical garden visitors to purchase edible garden fruit species for their landscape.

The proposed benchmark was an expectation that at least 25% of survey respondents will respond that they are likely to purchase edible landscape species. Survey data will determine if that benchmark was attained.

3) to author a consumer-oriented peer-reviewed Virginia Cooperative Extension (VCE) edible landscape plant publication (posted as a pdf file and in an e-book format) and a technical peer-reviewed journal article (Hort Technology) on the efficacy of edible landscape demonstration gardens.

The VCE edible landscape plant publication has not been started. The initial plan was to photograph edible plants (including fruit) at the three gardens and use these photos for the publication. Since two of the three gardens were started in the second year of the project and many of the plants did not have fruit on them, I am still in the process of obtaining the requisite photos. The quality and impact of the publication is greatly photo-driven. Thus, once a significant quantity of photos is taken, then the publication can be started.

The technical peer-reviewed journal article can be started once survey data from the three gardens are statistically analyzed.

The major successful outcomes of the project are the three professionally-designed edible landscape demonstration gardens that are populated with numerous edible plant species; these gardens and their educational value will persist for decades. The educational impact of these gardens will increase over time as plants mature and fruit harvest increase.

V. Beneficiaries

The beneficiaries of this project are 1) the hundreds (and thousands within the next few years) of botanical garden visitors who view the edible landscape gardens and get ideas about planting edible species in their home landscapes/gardens; 2) the wholesale and retail nurseries that produce edible plant species; and 3) the landscape contracting industry who install and manage edible plant species.

VI. Lessons Learned

The major lessons learned from this project are:

1) The implementation of the demonstration gardens within botanical gardens is not an immediate process. NBG was able to initiate their garden in year one since they installed the garden in an existing garden. The other two gardens had to take all the necessary steps to design, develop, and plant the gardens; these steps had to be taken in conjunction with all other botanical garden work obligations which resulted in delayed start times.

2) There was a gross overestimation of the number of garden surveys that were acquired. A more conservative estimate should have been made. Also, survey data and plant photos took longer to acquire than anticipated. A longer time period should have been anticipated. One of the gardens (GS) has not yet submitted their surveys (despite several requests) and I do not know if surveys were not conducted or if they are tardy in submitting them. If they did not take them, then I will request that surveys be conducted next year; having data from three gardens will make the project findings more meaningful, as well as much more robust and publishable for the refereed journal publication.

VII. Contact Person

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VIII. Additional Information

A. Final Edible Landscape Demonstration Garden Visitor Survey

The Edible Landscape Demonstration Garden is quite young, however, we want to get your feedback on the effectiveness of this garden.

Please circle your answers:

1. **Age:** *Under 18* *18-30* *31-50* *50+*

Gender: M F

2. **How would you describe your gardening experience?**

   Beginner *Moderate experience* *Avid gardener* *I do not have a garden*

3. **Did you read the sign at the entrance of the demonstration garden?**

   Yes *No*

   The amount of information on the demonstration garden sign was:

   Less than OK *OK* *Better than OK*

4. **The information contained in the individual plant signs was:**

   Less than OK *OK* *Better than OK*

5. **The number of edible plants in the garden was:**

   Less than OK *OK* *Better than OK*

6. **After seeing this garden, how likely are you to purchase edible plants for your home garden landscape?**

   Unlikely *Likely* *Certainly* *I do not have a garden*

7. **BEFORE visiting this Garden, how would you rate your knowledge of edible plants that can be used in** landscapes?

   None/Limited Some Moderate Extensive

8. **AFTER visiting this Garden, how would you rate your knowledge of edible plants that can be used in landscapes?**

   None/Limited *Some* *Moderate* *Extensive*

9. **How important is it for you to grow your own food?**

   Not important *Somewhat important* *Very important*

10. What plant(s) did you particularly like?

11. How many times have you visited the demonstration garden?

One *Two* *Three or more*

12. **What was your overall impression of the edible demonstration garden?**

Poor *Fair* *Good* *Excellent*

Other Feedback:

13.To be eligible for the $50 drawing, please give your email address.

Email address _____

Thank you for taking the time to complete this questionnaire!

B. See Additional PowerPoint File for Demonstration Garden Photos

C. Edible Plant Species Lists for the Three Demonstration Gardens

Lewis Ginter Botanical Garden Richmond, V
Asimina triloba
Cornus mas
Corylus avellana 'Contorta'
Corylus avellana 'Red Dragon'
Gaylussacia baccata
Mespilus germanica 'Dutch'
Morus alba 'Chaparral'
Prunus takesimensis
Prunus ussuriensis
Pseudocydonia sinensis
Ribes odoratum
Ribes speciosum
Rubus fruiticosus 'Chester'
Rubus idaeus 'NR7'
Sambucus canadensis 'Nova'

Vaccinium angustifolium
Vaccinium corymbosum
Vaccinium x 'Pink Lemonade'
Ziziphus jujuba 'Ming Tsao'

Norfolk Botanica Garden, Norfolk VA
Malus ‘UEB 3727-7’
Lycium barbatum ‘Phoenix Tears’
Prunus persica ‘Redhaven’
Prunus salicina ‘Methley’
Gaultheria procumbens
Actinidia deliciosa ‘Elmwood’
Camelia sinensis
Sambucus Canadensis ‘Nova’
Rubus idaeus ‘Heritage’
Punica granatum ‘ Salavatski’
Pyrus pyrifolia ‘Hostii’
Malus ‘Mullens’
Malus ‘UEB 3449-1’
Actinidia arguta ‘Ananasnaya’
Diospyrus kaki ‘Maru’
Ficus carica ‘ Celeste’
Laurus nobilis
Olea europea ‘Arbequina’
Vaccinium corymbosum ‘Bluejay’
Vaccinium macrocarpum
Vaccinium ‘Top Hat’
Vitis aestivalis ‘Norton’
Acca sellowiana
Rubus idaeus ‘NRR7’

Green Springs – Alexandria, VA
Castanea mollissima
Ficus carica 'Brown Turkey'
Ziziphus jujuba 'Li'
Ziziphus jujuba 'So'
Ficus carica 'Violette de Bordeaux
Lycium barbarum
Morus alba 'Issai'
Ribes rubrum 'Primus'
Vaccinium corymbosum 'Duke'
Rubus idaeus Raspberry Shortcake
Diospyros kaki ‘Fuya’
Punica granatum
Ribes uva-crispa x R. nigrum

Vaccinium corymbosum ‘Bluecrop’
Asimina triloba ‘Mango’
Asimina triloba Shenandoah
Asimina triloba Susquehanna
Diospyros kaki ‘Fuyugaki’
Diospyros kaki ‘Great Wall’
Maclura tricuspidata
Cydonia oblonga ‘Aromatnaya’
Ficus carica ‘Celeste’
Hippophae rhamnoides
Hippophae rhamnoides ‘Botanica’
Hippophae rhamnoides ‘Garden’s Gift’
Punica granatum ‘Angel Red’
Rheum rhabarbarum ‘Victoria’
Vaccinium ‘Pink Lemonade’
Vaccinium ‘Top Hat’
Ziziphus jujube

10. J. Derr
Virginia Tech
Final

Project Title.

Developing Soil Solarization and Microwaves for Pest Management in Annual Plasticulture Strawberry Production.

Project Summary.

Virginia is one of the top 14 strawberry-producing states in the U.S. and additional growers are interested in producing this high-value crop for diversification. Virginia Beach is the largest strawberry-producing area in Virginia, with an annual production value at $750,000 to $1,000,000. Two of the most important production challenges in Virginia include management of diseases and weeds. Conventional growers in Virginia typically pre-plant fumigate their strawberry fields with methyl bromide: chloropicrin (MBPic) for control of devastating diseases such as *Verticillium dahliae* and *Phytopthora* spp., as well as for weed control. Methyl bromide use is being phased out as it depletes the ozone layer. Although there are alternative fumigants available, they do not provide the complete spectrum of pest control as MBPic. Increased regulations on fumigant use means leaving more buffer areas, especially for those fields that surround sensitive sites such as residential homes, schools and hospitals. Organic producers have few options for disease and weed control and therefore research on organic methods of pest management is a high priority. Due to increased health safety and the paper work involved with fumigating at farms, many farm managers and workers no longer wish to fumigate.

The objective of this study was to compare strawberry production using conventional fumigation to non-chemical approaches utilizing soil solarization and microwave treatments. 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 Virginia has not been investigated.

The use of microwave energy has been proposed as an alternative method for controlling pests such as weeds, weed seeds, insects, and soil-borne plant pathogens. A major advantage of using thermal methods such as microwave energy is that no chemical residues are left in the soil, and hence there are no adverse effects on the environment. Microwave radiation treatment of soil for preemergence weed control or of emerged weeds for postemergence control provides new opportunities for higher crop productivity. Compared to other conventional thermal methods such as flaming or use of steam, use of microwave radiation has advantages, including rapid penetration to all plant parts. Microwave radiation is not affected by wind, thus extending the application window compared to conventional chemical spraying methods.

Project Approach.

A field study was established at the Hampton Roads Agricultural Research and Extension Center starting August 14, 2013. The study utilized a randomized complete block design with 4 replications and six treatments.
Weed seed species in the study included common chickweed (*Stellaria media*), southern crabgrass (*Digitaria ciliaris*), henbit (*Lamium amplexicaule*), curly dock (*Rumex crispus*), and common purslane (*Portulaca oleracea*). Weed seeds were enclosed in permeable nylon mesh bags, which were buried at 2 and 6 in. depths, at 2 locations in a plot, with a total of 4 samples per replication. These samples were exposed to the respective treatments and then subsequently removed from the soil 2 weeks after treatment. Viability post-treatment was determined with a tetrazolium test.

Pre-plant treatments in the study initiated in 2013 included i) Pic-Clor 60 that was shank fumigated at 220 kg/ha on August 30, ii) soil solarization for 6 week duration initiated on 15 Aug. iii) soil solarization for 4 week duration initiated on September 9, iv) soil solarization 4 week treatment initiated on September 9, and replaced with black tarp on October 4, 2013, v) microwave treatment was applied on October 2 to 3, and vi) an untreated control. Strawberry beds in iv, v, and vi were covered on October 4 with black plastic. Following completion of the pre-plant treatments, the strawberry cultivar 'Chandler' was planted at a 14 inch in-row spacing on October 4, 2013 on 15 linear foot beds. Soil solarization treatments were covered with 1 mL clear polyethylene tarp and non-solarization treatments were covered with 1.25 mL virtually impermeable film tarp at both sites.

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 tarp. The naturally-emerged weed population in the strawberry beds was monitored periodically through the growing season and data was recorded by weed species on November 15, 2013, February 2, 2014 and April 21, 2014. After each evaluation period, the emerged weed species in the strawberry beds were hand weeded. Data on the efficacy of these treatments on weed species was collected periodically through the growing season.

Plant stand count data was collected on a monthly basis starting November 2013 and continued throughout the growing season, and vigor of the plant 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 *P. 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 by measuring plant canopy diameter early in the growing season, at mid-season, and towards the end of harvest season. Field plots were harvested in the 10 linear feet plots (~16 plants/replicate) twice per week by project personnel starting May 2, 2014, 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 13, 2014.

Goals and Outcomes Achieved.

Data was collected and analyzed using SAS (Statistical Analytical Software) v. 9.3. The primary data i.e. total weed density data and marketable crop yield are presented below.

Table 1. Cumulative total weed density during the 2013-14 growing season at Virginia Beach, VA.

Treatment	Total Weed Density[a]
Untreated Control	272.3 a
Pic-Clor 60	243.5 ab
Microwave	202.3 bc
Pre-plant 4 wk. soil solar (clear tarp used)	198.6 bc
Solarization 4 wk. PP replaced with black tarp	192.6 bc

Pre-plant 6 wk. soil solar (clear tarp used)	168.3 c
Pr>F = 0.0341	

[a] Means with the same letter within a column are not significantly different from each other using LSD at P = 0.05.

Table 2. Total marketable yield for the 2013-14 growing season at Virginia Beach, VA.

Treatment	Marketable Yield (g/plant)
Solarization 4wk PP replaced with black tarp	483.9 a
Pic-Clor 60	483.2 a
Microwave	481.8 a
Untreated Control	462.1 ab
Solarization 6wk PP	418.9 ab
Solarization 4wk PP	376.0 b
Pr > F 0.1513	

Plots treated with 6 week pre-plant soil solarization had the numerically lowest weed density, but was not significantly different from the 4 week solar treatment or the microwave treatment. There was no significant difference in crop yield among treatments at both sites, suggesting that pest populations may not have been high enough to impact crop yield. Results from the study were presented at the strawberry pre-plant meetings held on July 21, 2014 in Virginia Beach, on July 22, 2014 in Charlottesville, and on December 5., 2014 at Montross, to 132 people in total. Additional studies are being conducted with soil solarization in the 2014-15 growing season at different sites in Virginia to obtain more data on performance of soil solarization.

Beneficiaries.

At the meetings, growers learned about the study and the science behind the use of soil solarization and microwaves for pest control in strawberry. About 98% of the audience indicated the need to do research on methyl bromide fumigant alternatives, and 8% of the audience indicated interest in trying soil solarization at their farms. Growers that showed interest in soil solarization treatments included some organic growers, but also conventional growers - those who no longer wish to fumigate or are constrained by buffer zone requirements. Continued research on methyl bromide alternatives is needed due to lack of a complete, pre-plant pest control tool to date. The lack of a good tool can have a severe detrimental impact on the $5 million Virginia strawberry industry.

Lessons Learned.

Getting the land cultivated and beds prepared in time for the desired duration of soil solarization can be a problem, due to the frequent summer rains in the southeast United States. However, the same is true for any pre-plant treatment. Damage from Canadian geese can occur in pre-plant, clear tarp beds, and precaution to keep geese away is needed in geographic areas of the state where geese are dominant. Unnecessary holes in solar treated beds can reduce the efficacy of solarization. Efficacy of soil solarization could be improved by integrating soil solarization with other bio-based pesticides or an herbicides.

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ADDITIONAL INFORMATION
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11. J. Derr

Virginia Tech
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I. PROJECT TITLE: Cover Crop Evaluation for Weed Suppression, Erosion Control and Nutrient Management in Newly Planted Vineyards

II. PROJECT SUMMARY: Grape production is expanding in Virginia due to a suitable climate combined with a demand for locally-produced wines. The Virginia viticulture industry ranked 7th nationally in 2007. State Secretary of Agriculture, Todd Haymore, stated in February 2013 that Virginia wine sales are increasing annually by 8%. Utilizing cover crops in Virginia's wet climate is an important management tool; not only do cover crops out-compete harmful weeds, but they also decrease soil erosion, provide beneficial insect habitat, and improve overall soil health. Maintaining row middles are difficult in steep slopes. Ever increasing fuel and labor costs decrease grower profits. An ideal cover crop would require less mowing, tolerate traffic, be quick to establish, and persist throughout the year.

In hilly regions, soil erosion not only depletes vital topsoil rich in nitrogen and phosphorus as well as other essential nutrients and soil fauna necessary for newly-planted vines, but it also contributes to an increased sediment load in Chesapeake Bay tributaries. Cover crops have been proven very profitable in vegetable production by decreasing herbicide use and soil erosion. Decreasing weed populations in row middles can reduce the need for herbicide treatment within the row since the row middles are one source of weed infestations. Cover crops are very region/climate specific. What works for the arid climate of California will not necessarily work for the wet and humid climate of Virginia.

Mowing between rows is dangerous on steep slopes. Besides loss of valuable topsoil, soil erosion leads to sediment discharged into streams and rivers, damaging water quality. Decreasing chemical dependence and increasing soil health is demanded by growers and the public alike. The goal of this project was to decrease maintenance costs of row middles, reduce herbicide and reduce soil and nutrient loss, while improving vine growth. Although this trial focused on grapes, these results will be beneficial to producers of other specialty crops, including tree fruit and nursery producers.

Previous research evaluated potential cover crops or improved vine floor management. Over 25 cover crops were evaluated; from those research results five cool season and two warm season cover crops were selected for further investigation in the current research.

Planting dwarf tall fescue reduced mowing needs by greater than 50% in both the 2014 and 2015 research trials, which also has the lowest maximum growth at 22 cm. 'Companion' and 'Rough and Ready' mixtures both achieved a 38% reduction in mowing for 2014 and 36% to 45% in 2015. Planting creeping red fescue resulted in a 25% and 27% reduction in mowing costs in 2014 and 2015. Plugged bermudagrass reduced erosion by 100 percent throughout the study, while plugged zoysia reduced erosion by 95%. Seeded bermudagrass plots reduced erosion by 63%. Seeded zoysia plots were not successful at reducing erosion compared to the bareground control. Seeded bermudagrass had greater turf cover after the second season compared to zoysia plugs; most of the erosion could have occurred after the establishment period in 2014. Creeping red fescue reduced weed populations by >95%. In July 2015 'Companion' and 'Rough and Ready' and dwarf tall fescue displayed weed control at 11%, 19% and 22% respectively.

Depending on the grass species planted, we were able to reduce mowing requirements by over 50%. Soil erosion was dramatically reduced through planting warm-season grasses. Weed populations were reduced in a number of the groundcovers evaluated. These benefits would result in a cost savings to growers as well as contribute to the long term sustainability of the grape industry.

III. PROJECT APPROACH: Three research trials were established to determine weed control, turf establishment rate, mowing requirements, and erosion for selected cover crops. These trials were conducted

at Virginia Tech's Glade Road Research Center, Blacksburg, Virginia and Giles Mountain Vineyard and Winery, Staffordsville, Virginia.

Cool season cover crop research-Giles Mountain Vineyard and Winery, Staffordsville, VA
The following cover crops were evaluated: creeping red fescue, Southern State's Tall fescue with Eco Green (dwarf tall fescue), 'Rough and Ready' microclover mix (34% Quatro Sheep Fescue, 30% Eureka II Hard Fescue, 30% PR8821 Perennial Ryegrass, 5 % Microclover), and 'Companion Grass' (80% PR8821 Perennial Ryegrass, 20% Creeping Red Fescue) mix. These four cool season cover crops were seeded on September 30, 2013 at Giles Mountain Vineyard and Winery site to determine suitability on a 30% slope. Plot size was 9 feet by 20 feet, with four plots per treatment. At the time of seeding Scotts Turf Builder Starter® (25-25-4) was applied with a drop spreader at 12.5 lbs per 1000 ft^2. In March and June, 2014, carfentrazone was applied to all plots for broadleaf weed control. Mowing requirements, establishment rate, and weed suppression data were evaluated for this trial (Tables 1, 2, and 3).

Reducing weed populations through cover crops is a primary goal of this project. This vineyard is located in an old horse pasture, which is primarily composed of tall fescue, orchardgrass, timothy, and annual and perennial weeds. The unmanaged pasture grass was the untreated control. In the cover crop research plots, broadleaf weeds were controlled by the carfentrazone application with the exception of musk thistle. Creeping red fescue and dwarf tall fescue had slower establishments rate, 55% turf cover, compared to 'Companion' grass mix and 'Rough and Ready' microclover mix, with 88% and 83% turf cover 9 weeks after treatment (WAT). Dwarf tall fescue had the greatest musk thistle population at 47% cover, compared to the 'Companion' grass mix which only had 13% thistle cover 47 days after treatment (DAT). On November 17 and 25, 2014; and again on March 2, and March 9, 2015, 2,4 D was applied at a rate of 2 lb ae/A to control musk thistle. Weed pressure was much less in the 2015 growing season, despite the increased precipitation. Creeping red fescue afforded the greatest weed control at ≥95% in 2015. In July 2015 'Companion' and 'Rough and Ready' and dwarf tall fescue displayed weed control at 11%, 19% and 22% respectively. The native pasture grass on which the vineyard was planted had considerable weed pressure from early season hairy bittercress, carpetweed, dandelion; midsummer weeds comprised of burdock, ragweed, common cocklebur; late season weeds consisted of lambsquarters, jimsonweed, field bindweed, and smooth pigweed. Musk thistle was not commonly found in the unmanaged pasture grass, germination must have occurred after raking plots, which would have brought weed seed to the surface prior to seeding cover crops in 2014.

One of the goals of this project was to determine mowing requirements for select cover crops. Plots were allowed to grow to a height of 6 in (15 m), then mowed. Number of mowings per treatment was tallied for each cover crop from May to September 2014 and 2015. Table 3 reflects maximum growing height after not mowing for 6 weeks as well as the number of required mowings. Dwarf tall fescue required only 4 cuttings, while the unmanaged pasture grass control plots required 8 cuttings in 2014. Increased rainfall in 2015 resulted in a greater number of mowings overall, with dwarf tall fescue requiring the least number of cuttings at 5, followed by 'Rough and Ready', 'Companion', and 'Silverlawn' requiring 6, 7, and 8 cuttings respectively. The native pasture grass required 11 cuttings in 2015.

Cool plus warm season cover crop research-Glade Road Research Center, Blacksburg
On October 21, 2013, a warm season plus cool season trail was seeded at Glade Road Research Center. Treatments included: dwarf tall fescue, dwarf tall fescue + 'Riviera' bermudagrass, dwarf tall fescue + creeping red fescue, dwarf tall fescue + 'Zenith' zoysiagrass, 'Rough and Ready' microclover mix, 'Companion Grass' mix, and bareground control. Plot size was 7 feet by 10 feet, with 4 plots per treatment. However during the summer of 2014 less than 5% of the warm season grasses germinated, and the study was ended. During the winter of 2014, Blacksburg temperatures were below average; Glade Road had > 5 days below 0 F during the January/February 2014 time period, which may have contributed to low germination of the warm season grasses.

Warm season cover crop research trial for under trellis weed and erosion control-Giles Mountain Vineyard and Winery, Staffordsville, VA

A third trial was conducted at Giles Mountain Vineyard to determine weed suppression and erosion control of warm season cover crops under the vine row on a 30% slope. On June 6, 2014, 'Riviera' bermudagrass plugs and 'Zenith' zoysiagrass plugs were planted under the vine row as a comparison with broadcast seed. A bareground control was also used for comparison. This vineyard was planted in 2013. Plot size was approximately 18 feet by 18 inches. Each plot contained three 'Vidal Blanc' grape vines. Plots were initially sprayed with glufosinate at 5 qts/A and raked clean. Turf plug initial size was 1 in^2, 90 plugs were planted per plot. Seeding rate was 2 lbs/1000 ft^2. All plots were hand weeded and the bareground control was sprayed with glufosinate and pendimethalin for weed control.

Cover crop effect on soil erosion, under the vine row, was also evaluated with a warm season turf trial. Six erosion spikes were driven in each plot on June 6, 2014. Spikes were driven to designated initial depth which was predetermined with a painted band on each spike. Digital calipers were used to measure distance between initial soil and later soil depths. In 2014, rainfall amounts for the months of June, July, August and Sept were as follows: 1.72, 1.80, 5.21, 1.39 inches, respectively. In 2015, rainfall amounts more than doubled in June, and July 4.00 and 4.26 inches; August was more average with 3.59 inches. A soil moisture probe was used to record monthly soil moisture at a 7 inch depth below the soil surface (data not shown) for each treatment. This data was not significant; no conclusions can be made between soil moisture and cover crop species at this time.

Soil erosion was negatively correlated with turf cover; plots with lower turf cover had higher soil erosion. Plugged bermudagrass had 75% turf cover and no erosion was recorded for this treatment 12 WAT. In 2015 plugged bermudagrass filled in 90% of the test plots area, while plugged zoysia only comprised 59%; Seeded bermudagrass turf cover was 78% and seeded zoysia turf cover was 29%. Crabgrass pressure was considerable during both 2014 and 2015 summer months, all plots were hand weeded every two weeks. The greatest erosion occurred in the bareground-control plots, and seeded zoysia plots; with total soil loss 2.37 mm and 2.45 mm respectively. No erosion occurred in the plugged bermudagrass plots during the 2014 and 2015 growing seasons.

At Giles Mountain Vineyard four Herbicide applications of Rely at 1.5 lbs/A were required to maintain bareground plots in 2015, plots with seeded or plugged bermudagrass required no herbicide treatment. Vine vigor was a considerable problem at this vineyard in 2015, due to extensive rainfall. Hedge pruning occurred three times before verasion on Vidal Blanc vines, except for the vines under bermudagrass which required only one hedge pruning. Vidal Blanc harvest took place on October 4, 2015. Also harvest weights for vines under bermudagrass and bareground/herbicide maintained plots were similar, however cluster weight was greater for vines under bermudagrass cover crop (Table 5). The wine maker at Giles Mountain Vineyard and Winery provided Brix data and pH for randomly sampled grapes, sampled 1 hr prior to harvest. The Brix was significantly higher in the cover cropped vines than for herbicide only plots. No difference was noted for pH.

IV: GOALS AND OUTCOMES ACHIEVED:

GOAL 1: *Reduce mowing by 50%.*

Planting dwarf tall fescue reduced mowing needs by greater than 50% in both 2014 and 2015 research trials, which also has the lowest maximum growth at 22 cm. 'Companion' and 'Rough and Ready' mixtures both achieved a 38% reduction in mowing for 2014 and 36% to 45% in 2015. Planting creeping red fescue resulted in a 25% and 27% reduction in mowing costs in 2014 and 2015.

GOAL 2. Estimate erosion control will be reduced up to 30% on 10% slopes, and by 50% on hillsides > 20% .

At the Giles Mountain Vineyard and Winery site; Vidal Blanc research plots were situated on a 30% slope, with rows planted parallel with the contour of the land. Plugged bermudagrass reduced erosion by 100 percent throughout the study, while plugged zoysia reduced erosion by 95%. Seeded bermudagrass plots reduced erosion by 63%. Seeded zoysia plots were not successful at reducing erosion compared to the bareground control. Seeded bermudagrass had greater turf cover after the second season compared to zoysia plugs; most of the erosion could have occurred after the establishment period in 2014.

GOAL 3: *Determine which cover crop affords the greatest reduction in weed populations*.
Creeping red fescue reduced weed populations by >95%. In July 2015 'Companion' and 'Rough and Ready' and dwarf tall fescue displayed weed control at 11%, 19% and 22% respectively.

While creeping red fescue displayed excellent weed control it also required the greatest number of annual cuttings. Dwarf tall fescue had the slowest establishment rates, however it had superior low growing characteristics, making it ideal for steep sloped hill sides. It is important to note that dwarf tall fescue may require several application of broadleaf weed control during the first growing season. 'Companion' and 'Rough and Ready' mixes displayed comparable weed control characteristics and growth rates.

V. BENEFFICIARIES:

The grape industry will benefit from the reductions in mowings, soil erosion, and weed density achieved through use of the tested cover crops. Although this trial focused on grapes, these results will be beneficial to producers of other specialty crops, including tree fruit and nursery producers. Homeowners can also benefit from this research when planting lawns on steep slopes.

VI. LESSONS LEARNED:

Use of dwarf tall fescue resulted in greater than a 50% reduction in mowing requirements, which would be a significant cost savings for growers. We achieved significant reduction in soil erosion through use of plugged bermudagrass or zoysia, or seeded bermudagrass. This is an important achievement for long term sustainability of grape production. Planting creeping red fescue resulted in significant control of weeds, which would reduce the number of herbicide applications, resulting in a cost savings to growers. Bermudagrass planted under the vine row resulted in bigger grape clusters, higher brix concentration, and decreased overall vine vigor, desirable benefits. Further investigation into grape quality under cover crop vs. no cover crop is necessary. How do cover crops effect grape phenolics profile? Does type of cover crop influence wine grape profile? What role can cover crops play in improving wine quality in Virginia? These questions need to be answered through additional research.

VII. CONTACT PERSON

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Table 1. Percent green turf recorded at Giles Mountain Vineyard, Staffordsville, VA for select cover crops seeded on September 30, 2013.

		% green turf cover						
Treatment	**Seeding Rate (lb/1000 ft^2)**	**5 WAT Nov 2013**	**9 WAT Dec 2013**	**23 WAT April 2014**	**31 WAT June 2014**	**35 WAT July 2014**	**39 WAT Aug 2014**	**42 WAT Sept 2014**
Dwarf Tall Fescue[1]	2	47	55	85	72	51	55	53

‘Rough and Ready’	5	62	83	91	74	38	55	62
Microclover Mixture[2]								
‘Companion Grass ‘ Cov	1	83	88	94	79	42	85	87
Crop Mixture[3]								
‘Silverlawn’ Creeping	2	18	55	82	75	45	59	78
Red Fescue								
Pasture Grass (control)	0	85	83	85	82	75	78	74
LSD (p=0.05)		18	11	12	10	11	17	13

[1] Southern States Tall Fescue with Eco Green
[2] 34% Quatro Sheep Fescue, 30% Eureka II Hard Fescue, 30% PR8821 Perennial Ryegrass, 5 % Microclover
[3] 80% PR8821 Perennial Ryegrass, 20% Creeping Red Fescue

Table 2a. Percent weed cover in cover crop plots at Giles Mountain Vineyard, Staffordsville, VA seeded on September 30, 2013.

		% weed cover						
Treatment	**Seeding Rate (lb/1000 ft^2)**	**5 WAT Nov 2013**	**9 WAT Dec 2013**	**23 WAT April 2014**	**31 WAT June 2014**	**35 WAT July 2014**	**39 WAT Aug 2014**	**42 WAT Sept 2014**
Dwarf Tall Fescue[1]	2	10	15	15	28	31	45	47
'Rough and Ready' Microclover Mixture[2]	5	5	7	9	15	19	40	38
'Companion Grass ' Cover Crop Mixture[3]	1	3	3	6	10	21	15	13
'Silverlawn' Creeping Red Fescue	2	8	10	18	12	20	41	22
Pasture Grass (control)	0	15	17	15	18	10	22	26
LSD (p=0.05)		10	11	9	9	10	7	12

[1] Southern States Tall Fescue with Eco Green
[2] 34% Quatro Sheep Fescue, 30% Eureka II Hard Fescue, 30% PR8821 Perennial Ryegrass, 5 % Microclover
[3] 80% PR8821 Perennial Ryegrass, 20% Creeping Red Fescue

Table 2b. Percent weed cover in cover crop plots at Giles Mountain Vineyard, Staffordsville, VA seeded on September 30, 2013.

		% weed cover						
Treatment	**Seeding Rate (lb/1000 ft^2)**	**70 WAT March 2015**	**74 WAT April 2015**	**78 WAT May 2015**	**82 WAT June 2015**	**86 WAT July 2015**	**90 WAT Aug 2015**	**93 WAT Sept 2015**
Dwarf Tall Fescue[1]	2	15	19	20	21	22	18	15
'Rough and Ready' Microclover Mixture[2]	5	8	15	14	24	19	20	11
'Companion Grass ' Cover Crop Mixture[3]	1	9	13	12	14	11	12	10
'Silverlawn' Creeping Red Fescue	2	1	5	4	2	4	1	3
Pasture Grass (control)	0	22	28	30	35	50	38	33
LSD (p=0.05)		7	5	7	11	6	9	10

[1] Southern States Tall Fescue with Eco Green
[2] 34% Quatro Sheep Fescue, 30% Eureka II Hard Fescue, 30% PR8821 Perennial Ryegrass, 5 % Microclover
[3] 80% PR8821 Perennial Ryegrass, 20% Creeping Red Fescue

Table 3. Total number of grass cutting during 2014 and 2015 growing season and maximum grass height after no mowing for 6 weeks from select cover crops between the vine rows located at Giles Mountain Vineyard, Staffordsville Va.

Treatment	Maximum Ave. Turf Ht. (cm) after 6 Weeks *	Total No. of Turf Cuttings 2014**	Total No. of Turf Cuttings 2015**
Dwarf Tall Fescue	22	4	5
'Rough and Ready' Microclover mix*	24	5	6
'Companion Grass ' Cover Crop Mixture**	25	5	7
'Silverlawn' Creeping Red Fescue	27	6	8
Pasture Grass (control)	39	8	11

*All plots had a final mowing on Sept 12, 2014, and October 12, 2015

*Grass height was from May to September.maintained at a 6 in (15 cm) mowing height

Table 4. Turf establishment and erosion control of warm season cover crops planted under the vine row. Trial initiated on June 6, 2014.

	% turf cover						erosion, mm	
Treatment	**4 WAT July 2014**	**8 WAT Aug 2014**	**12 WAT Sept 2014**	**53 WAT June 2015**	**56 WAT July 2015**	**61 WAT Aug 2015**	**12 WAT Sept 2014**	**64 WAT Sept 2015**
Bermudagrass plugs	35	63	75	80	85	89	0	0
Zoysia plugs	35	18	49	45	60	59	0	0.12
Bermuda seed	0	58	64	71	72	78	0.70	0.88
Zoysia seed	0	6	25	18	24	29	1.08	2.45
Bareground (control)	0	0	0	0	0	0	1.26	2.37
LSD (p=0.05)	-	11	15	19	14	18	0.40	0.71

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Table 5. 2015 harvest weight and cluster weight of three year old-Vidal Blanc grapes with and without cover crop.

treatment	no. grape clusters	vine harvest weight lb	cluster wt lb	mean brix	Mean pH
bermuda (plugs and seeded)	8	3.7	0.46	21.3	3.12
bareground/herbicide	13	4.1	0.31	20.5	3.05
LSD (p=p0.05)	3	0.3	0.11	0.4	0.2

12. J. Miller
VCTGA
Final

PROJECT TITLE: Increasing the Competitiveness of Virginia Christmas Tree Growers

PROJECT SUMMARY

The VCTGA wanted to build upon our successes as we implemented the actions described in the FY 2010, FY 2011 and FY 2012 USDA Specialty Crop Competitive Grants. Beyond those actions addressed in the past three grants, we worked to strengthen our presence at local agritourism festivals, along with aggressively participating in similar state and regional events in order to expand our presentation to wholesale and retail customers alike.

PROJECT APPROACH

This project worked by mutually supporting activities that expanded the relationships between growers and all buyers, educated both groups and promoted the sales of, not only Christmas trees, but other Virginia grown and/or produced specialty products.

In addition to our annual meetings, we intended to sustain the winter meetings in order to share marketing experiences from the most recent holiday season. Secondly, we refined our upgraded website, added a mobile website, and increased our participation into social networking, as a means to both communicate among the membership and market our trees. And lastly, we maintained an inventory of promotional items (stickers, pencils, pens, refrigerator magnets, key rings) that identified and promoted our trees and greens at public agritourism events, industry meetings and trade shows

The initial purpose of the project was to increase the competitiveness of Virginia Christmas Tree Growers by holding winter meetings to provide an opportunity to critique the results of the previous selling season, educate growers on new marketing strategies; changes in techniques; maximize the buying and selling potential between wholesale and chose-and-cut growers; and constructively plan and build a better strategy for the next selling season. A winter meeting would also afford an opportunity to engage speakers who would not normally be available during the summer meeting time.

The size of Christmas tree farms ranges from less than an acre to as large as several hundred acres, with a few growers having a thousand or more acres; and all are in competition with large, non-agricultural retailers, many of which feature trees grown beyond our borders. In terms of marketing, one opportunity to “level the playing field” lies with the power of the internet and social networking.

VCTGA has owned a website for over 10 years years. http://www.virginiachristmastrees.org/ Like many other businesses, our growers have attracted new customers and sold our products as a direct result of the Association’s site and the included mini-pages that feature each member’s farm. We developed a mobile version of our website in order to expand our marketing to work on all mobile devices. We have been active on Facebook to promote our farms and to communicate, on an informal basis among ourselves, a forum to discuss lessons learned, and as a medium to post classified advertisements. Also, Facebook has provided an outlet to post tips to consumers and to promote our mobile website which will direct them to the nearest Choose-and-Cut Farm or retailer. Our membership required training on current and emerging social media which we had training session at our conferences. to locate, visit and shop at a Virginia Christmas tree farm. https://www.facebook.com/VCTGA/ (data listed in section IV)

Since many Christmas trees purchased in Virginia are bought from sources outside of Virginia we partnered our marketing efforts with the Virginia Department of Agriculture and Consumer Services (VDACS) to change this trend, to increase overall competitiveness and to build pride in our Virginia Grown products. We worked to narrow the gap between our growers and Virginia buyers to increase overall sales and provide Virginia consumers with a locally grown, freshest tree possible. We maintained an inventory of promotional that identified and promoted our trees and greens.

Below is a list of promotional material which was distributed at the following events	
	
1,000 Value Grocery Tote Bags (15”x13” with color imprint (walking billboards at events)	1,000 Ink pens 1,000 Pine Tree Soft Key Tag 1,000 Keep-it 4” clips 1,000 Postit® Notes 3x4” 2,500 Business Card Magnets (Stickers and pencils from previous grants)

Mid-Atlantic Nursery Trade Show (MANTS) – We exhibited at 3-day trade show at the Baltimore Convention Center, with an average of 10,807 attendees in early January 2014, 2015, 2016. The exhibit was staffed by VCTGA members and VDACS marketing representatives and received 32 serious contacts looking for sources of Virginia Grown Christmas trees.

Mid-Atlantic Horticulture Short Course (MAHSC) This exhibit, in late January 2014, 2015, 2016 was a 1-day consumer program (attendance over 75) and 3-day commercial program with potential tree buyers. (Attendance over 700 each year). The exhibit was staffed by the VCTGA executive secretary.

Virginia Nursery & Landscape Association (VNLA) Field Day – A 1-day event in early August in 2015 with

140 attendees of potential Christmas tree buyers, and it was staffed by a VCTGA member.

VNLA Guide to Virginia Growers – placed ½ page ads in the 2014, 2015, 2016 issues, which was distributed to over 3,000 potential tree buyers in the mid-Atlantic region.

State Fair of Virginia – Held each year in late September, early October in 2014, 2015, 2016 for 10 days, it is staffed by VCTGA members and VDACS marketing representatives distributing promotional materials, helping consumers locate the nearest choose-and-cut farm or retailers using the Virginia Christmas Tree Directory, and links to the mobile-friendly VCTGA website to look up of locations.

Virginia Tech College of Agriculture Fall Open House – exhibit by the executive secretary for consumer contacts.

Northern Virginia Nursery & Landscape Association – display at their annual educational program with an attendance of 75-100 consumers and Christmas tree retailers in 2014, 2015 and 2016.

Significant contributions were provided by project partnership with the Virginia Department of Agriculture and Consumer Services (VDACS) by providing 12,000 copies of their directory of Virginia Christmas Tree Growers and Retailers. Their "Virginia Grown" http://www.vdacs.virginia.gov/vagrown/index.shtml program was complimentary to our marketing to promote "Experience a Real Tree".

GOALS AND OUTCOMES ACHIEVED

Our overall goal in applying for the USDA Specialty Crop Competitive Grant was to increase the competitiveness of Virginia Christmas tree growers. We planned to sustain our program of winter meetings in order to share marketing experiences from the most recent holiday season; refine our website, add a mobile website and delve into social networking; and maintain our inventory of promotional items in order to promote our products at public agritourism events.

At the beginning or the grant period, our only benchmark was NASS data based upon the 2007 Census with a report date of 2009. Clearly, this information was dated and of marginal utility in meeting our goal. Now, however, the database has been updated and results are favorable. The number of Virginia-grown Christmas trees harvested in 2007 totaled 313,710. Five years later, that number increased to 478,069 trees. And in 2014, the number of Christmas trees harvested again increased to 544,000. We cannot credit our actions relative to the grant expenditures as singularly responsible for this positive trend. But when adding the results of our own survey and the subjective comments of our members, it's logical to conclude that our actions contributed to the increasing trend in Virginia Christmas tree production.

In reviewing our own surveys, our baseline was the 75 member owned farms that are current with their dues. The rate of return for both 2013 and 2014 was 21%. In 2015, that rate increased to 24% which is in line with national average for all surveys. Our surveys are not terribly scientific and include a great number of variables, yet in 2015, the majority of our respondents reported either constant or increasing sales, and their general comments support the NASS trend.

General comments in 2015 included:

- "Good year for choose and cut."
- "Business increasing."
- "Most customers found us on the internet."
- "Numerous (customers) mentioned our website."

A number of respondents specifically credited a website or the "internet" with their increase in sales. They didn't mention if the website was the VCTGA site, a site published by the farm or a third party hosted site. Without regard to the source of the site, we do know that many customers did refer to our farm locator feature, available on both the VCTGA mobile and full websites, to refine their search and find the tree(s) they were seeking. Further, we consider the term "internet" includes social media activities such as Facebook, Twitter, etc. VCTGA does host a Facebook page and many of our member farms host both Facebook pages and Twitter accounts. Over the 2015 holiday season, the association's Facebook page received 37 posts and 160 "likes." From Nov 19 – Dec 13, posts on average reached 150 Facebook clients with a high of 800.

We continue to use Google analytics to measure activity on our website. Comparing November 15, 2013 – December 15, 2013 to the same time frame in 2014, we enjoyed a 47% increase in visits to www.VirginiaChristmasTrees.org. In hard numbers, 10,409 sessions were recorded in 2014 as compared to 7,091 in 2013. Only 31% of the site visitors left after viewing the opening page, the others went on to view 2 or more pages. And, as might be expected, the heaviest traffic was recorded over Thanksgiving weekend with the first weekend in December a close second. In third place was the weekend of November 22-23, 2014.

For the same period in 2015, over 9600 sessions were recorded between Nov. 13 and Dec. 21, 2015, from 8215 different people. Of those visitors, 84% were new to our website and 24,400

different page views were recorded for an average of 2.54 pages viewed per session. Once again, the heaviest web traffic occurred over Thanksgiving weekend, in second place was the first weekend in December and the third busiest time for our website was the weekend prior to Thanksgiving. We continue to be convinced that the maintenance of our websites, both the full version and the mobile makes good business sense.
Our membership, and the Board of Directors, expressed a preference to abandon the scheduling of winter meetings and return to a format of a three-day event annually in August. While we believe our reasoning to add winter meetings to our schedule remains sound, the membership expressed a preference to avoid winter travel and have more time available for program and fellowship. Our meeting was held in Staunton from August 4-6, included two panel discussions which we had not been able to accommodate with the previous format of a two-day summer meeting and one day winter meeting. We were able to schedule Dr. Jeff Owen of North Carolina State University for two presentations and enjoyed the comments Commissioner Sandy Adams, Virginia Department of Agriculture and Consumer Services as our keynote speaker. We had a good attendance and professionally stimulating meeting.

Utilizing grant funds, we again hosted a booth at the State Fair of Virginia and exhausted our supply of promotional items. We enjoyed a substantial increase in visitors, due to change in the layout of the fair which positioned our display along a major traffic pattern. As a result, many more people took home an item (key ring, scratch pad, post-it note pad, shopping list, pencil, pen, etc.) that advertised our logo and promoted our website.

We firmly believe we have achieved our goal of increasing the competitiveness of the Virginia Christmas tree growers through our attendance at the State Fair of Virginia, VNLA field days, the Virginia Christmas Market; scheduling of marketing topics at our annual and winter meetings; the volume of promotional materials distributed and aggressively maintaining our presence of the internet and social media. NASS data, our own survey results and Google analytics all support that belief and we look forward to continuing along a path of increasing success.

BENEFICIARIES

Members of the Virginia Christmas Tree Growers Association and the Mount Rogers Christmas Tree Growers Association, and non-members benefited by increased sales. Through personal calls and emails, members reported that they were closing the choose-and-cut farm sales and retail sales lots early because they were sold out. The VCTGA office has received numerous calls from Christmas tree retailers in large metropolitan areas 7-10 days before Christmas looking for additional trailer loads of trees.

LESSONS LEARNED

One of our more nagging challenges continues to be involving member volunteers to help setup and staff the various exhibits around the state. Many of the events fell during time periods when producers are busy with farm maintenance or the retail season. A second was in obtaining a higher return in the annual surveys.

Another significant lesson learned was to avoid the temptation of taking the lead in scheduling marketing events and thereby incurring a whole range of collateral activities (site selection, facilities, meals, parking, etc.) We found it much more productive to attend, as vendors,

professionally hosted events so that we could focus on our goal of increasing our customers and sales.

We were initially disappointed that the membership preferred to eliminate winter meetings from our annual schedule in favor of returning to a three-day summer meeting. The attendance, quality of the program, and inclusion of the membership into the program (panel discussions) were all well received and re-establish our annual meeting format.

A fourth lesson learned was the very positive reception of our membership to the marketing presentations at our annual and winter meetings. The members were interested, participative and welcoming to our guest speakers. They were involved in discussions as well as question and answer sessions, especially in the social media sessions.

CONTACT PERSON

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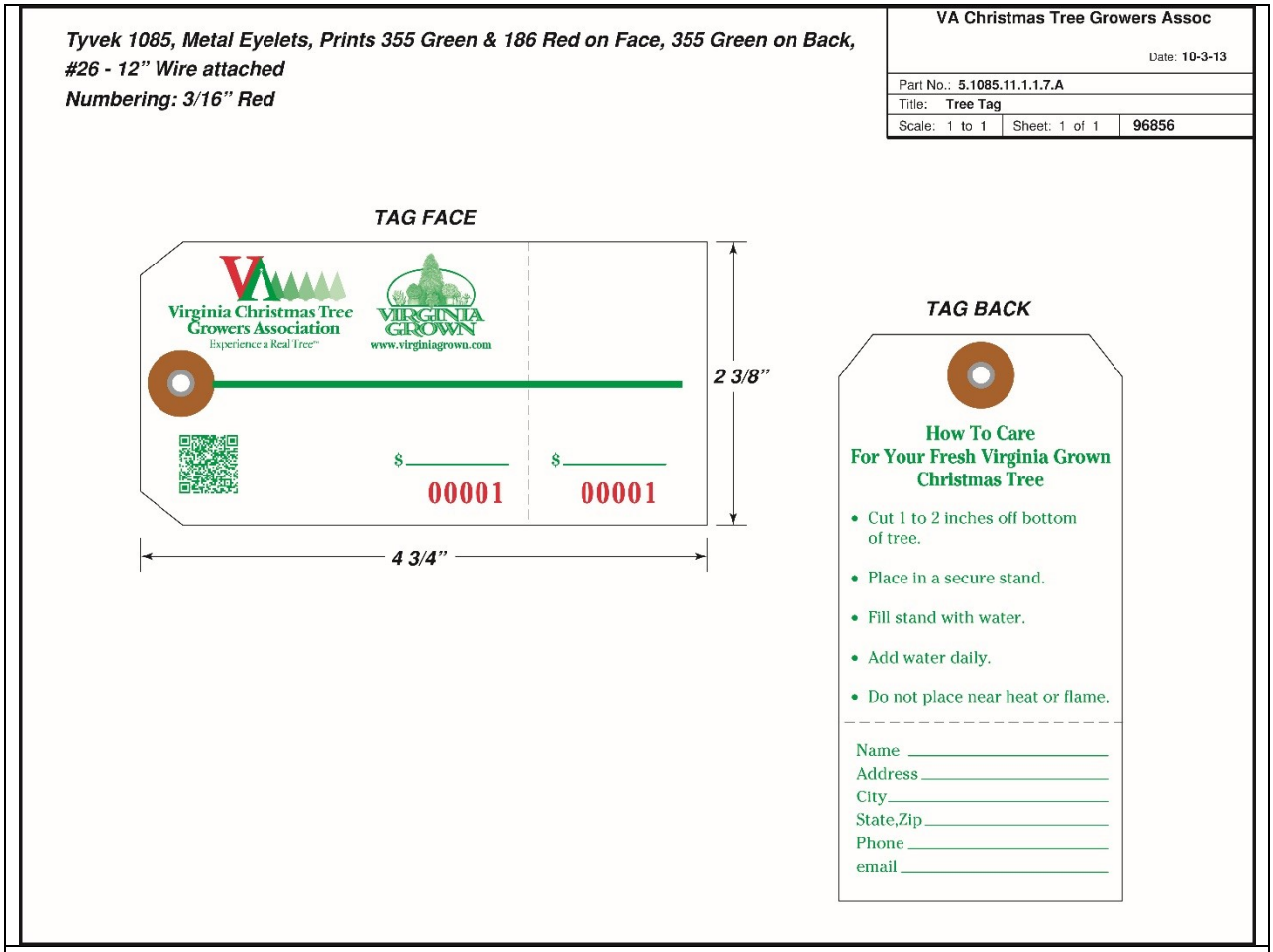
ADDITIONAL INFORMATION

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



35,000 Marketing tags available to members (no grant funds were used for these) The QR code takes the end consumer to the Christmas tree care tips on the VCTGA website.

13. Y. Xu
Virginia State University
Final

Project Title: Building a Bridge between Farmers and Food Industry: Setting Standard Criteria for Chickpea Physicochemical and Functional Properties for Hummus Preparation

Principal investigator (PI)

Yixiang Xu, Associate Professor of Food Processing and Engineering, Agriculture Research Station, Virginia State University, Petersburg, VA, 23806, Phone: 804-524-5668; Email address: yixu@vsu.edu

Project Summary:

Hummus is a Middle Eastern and Arabic food dip or spread made from cooked and mashed chickpeas blended with tahini (sesame paste), olive oil, lemon juice, salt and garlic, and is becoming increasingly popular in the United States. SABRA Dipping Company, a joint venture of Pepsi and Straus and a fast growing international company, manufactures hummus for worldwide distribution. In 2010, SABRA relocated to Chesterfield County, Virginia. As a major ingredient in hummus, the annual utilization of chickpea by SABRA equates to approximately 50,000 acres. The company currently imports their chickpea from Pacific North West region of the United States, since there is no commercial chickpea production in Virginia. Extensive research at Virginia State University has been conducted to identify and develop chickpea varieties as a specialty crop for Virginia's farmers to support this nascent local food industry. The current project further enhance these efforts by evaluating the potential of chickpea varieties grown in Virginia for food development.

The nutritional quality, physical properties, and functional characteristics of chickpea seed substantially influence the final quality and performance of the manufactured hummus products. These properties differ among chickpea cultivars and processing methods. Such information is currently lacking and is needed by agronomists, plant breeders, farmers, and food industry for making appropriate selections of chickpea varieties for planting and for utilization. Therefore, it is very necessary to set standard criteria for chickpea nutritional, physicochemical, and functional properties for food preparation, especially hummus production.

Project Approach:

1. Methods

During 2013-2014 (the first year), six kabuli chickpea varieties were provided by Sabra Dipping Company. The particular varieties were those already used in their processing facility and they are interested in research to find out if they can grow under Virginia conditions. The physicochemical and functional properties were determined for the six chickpeas varieties with the aim of providing baseline information.

After the seeds were received, they were cleaned and dried, and a portion of each sample are used to directly evaluate physical parameters. The remainder was ground using a micro-mill grinder (Bell-Art Products, Wayne, NJ) to pass through a size-40 mesh sieve prior to determining chemical composition and functional properties. Physical parameters include seed weight, volume, density, hardness, hydration and swelling capacity, while chemical composition analyses

include crude protein, lipid, ash, carbohydrate, fiber, and individual sugars. Water and oil absorption and holding capacities were determined as functional properties.

During 2014-2015, two kabuli chickpea varieties, which were planted at two counties (Essex County and Halifax County) in Virginia, were provided by Sabra Dipping Company and Virginia State University Small Farm Outreach program. In addition, one particular variety which was already used in Sabra's processing facility was used as a control. The nutritional quality and protein in-vitro digestibility and stability of two Virginia-grown varieties and control were determined with the aim of comparing the effect of environment conditions. After the seeds were received, they were cleaned, dried, and ground using a micro-mill grinder (Bell-Art Products, Wayne, NJ) to pass through a size-40 mesh sieve prior to determining the nutritional quality. Nutritional quality include proximate composition (protein, ash, lipid, carbohydrate), amino acid, minerals, anti-nutrients (tannins and phytate). Protein in-vitro digestibility was determined after the samples were defatted, while protein stability was measured using centrifugation method.

During 2015-2016, the effects of different processing methods, soaking and non-soaking followed by moist heating (pressure cooking and microwave cooking) and dry heating (roasting), on chemical composition, amino acid profile, mineral concentration, anti-nutritional factors, protein solubility and in-vitro digestibility of chickpeas were investigated.

2. Results

The results from this first year showed that carbohydrate and protein were the two major components in all varieties, ranging from 66.7 to 72.6%, and 19.7 to 24.5%, respectively. Sucrose, raffinose and stachyose were the three major sugars in all varieties, while fructose and glucose were present in smaller concentrations. One variety (#3) had the largest seeds and greatest hardness compared to other varieties, while variety #5 had the highest hydration capacity. Water absorption and holding capacities were different between varieties, while there were no significant differences between varieties in oil absorption and holding capacity. From this study, hydration capacity and water holding capacity were found to be key functional properties for chickpea to be utilized in imparting desirable qualities and functionalities to diverse food products.

The results from the second year showed that carbohydrate and protein were the two major components. Proximate composition, amino acid compositions and anti-nutrients (tannins and phytate) were not significantly different among three varieties. Compared to the control, the chickpea sample grown in Essex County had higher MN, Fe and Zn contents, while the sample from Halifax County had higher Fe content. Protein in-vitro digestibility ranged from 78.8% to 85.9%. Two Virginia -grown varieties had relatively lower digestibility. Three samples had the soluble protein from 26.5 g/g protein to 31.9 g/g protein, and the sample from Halifax County had the lowest soluble protein.

The results from the third year showed that oil content significantly ($P<0.05$) increased in all processed samples, except soaked/microwave cooked sample. All processing methods improved amino acid profile, with the greatest increase caused by soaking/microwave cooking. There was a significant reduction in mineral content after processing except in soaked sample that showed the highest level of mineral retention. All processes significantly reduced tannin and phytate

concentrations. The soaked/ microwave cooked sample had the largest reduction of tannins, while soaking/pressure cooking caused the highest reduction in phytate. Compared to raw counterpart, protein solubility in all processed samples significantly decreased, while in-vitro protein digestibility significantly improved, with the highest values for soaked/pressure cooked and soaked/microwave cooked samples. In-vitro protein digestibility showed a positive correlation with both total amino acids (r=0.774) and total essential amino acids (r=0.838), but a negative correlation with total macroelements (r=-0.925), tannins (r=-0.847) and phytate (r=- 0.818). Soaking/microwave cooking seems to the best method for improving the nutritional quality of chickpea samples analyzed in the present study.

Goals and Outcomes Achieved:

We achieved our goals to characterize physicochemical and functional properties of high yielding chickpea varieties that are readily usable for the food industry. Currently, identifying and developing chickpea varieties adapted to Virginia climate and to be used as a specialty crop for Virginia's farmers still face changeling. However, the progress has been made on this project is very critical and important to achieve long term outcome measures for project. The results provide the useful scientific information to help food industry choose appropriate chickpea varies and processing methods during product development, and will help set standard criteria for chickpea physicochemical and functional properties for hummus preparation.

Beneficiaries:

First, Farmers who are interested in growing chickpea and Food Industries which uses chickpea as a major ingredient for their products will benefit from reading about the results.

Further, two manuscripts have been published in a peer-reviewed journal. Therefore, the whole scientific community which works on legume will be impacted.

Lessons Learned

None

Contact Information:

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Additional Information:

- Two Journal publications are generated from this project

1. Xu, Y.X., Thomas. M., Bhardwaj, H.L. (2014). Chemical composition, functional properties, and microstructural characteristics of chickpea (Cicer arietinum L.) seed as affected by varieties and thermal processing. International Journal of Food Science and Technology,49, 1215-1223.

2. Xu, Y.X., Cartier, A., Obielodan, M., Jordan, K., Hairston, T., Shannon, A., Sismour, E. (2016). Nutritional and anti-nutritional composition, and in-vitro protein digestibility of Kabuli chickpea (Cicer arietinum L.) as affected by differential processing methods. Journal of Food Measurement and Characterization, 10, 625-633.

- Other Products

Three undergraduate students and two dietetic interns have been recruited to obtain hand-on training, and one master student was conducting her thesis in the line with the objectives of the project.

14. J. Fields
PHCC
Final

I. Project Title:

Phase II, Commercial Green Production in Underused Industrial Sites in Martinsville, Va.

II. Project Summary:

The Martinsville Virginia area has been adversely affected by the loss of several major industries resulting in high unemployment and a number of underused manufacturing structures that have been vacated by the loss of these industries. The Phase I and II of the Commercial Green Production project was initiated to investigate the feasibility of using these structures to grow hydroponic commercial greens using LED lighting.

The Commercial Greens project could provide an opportunity for the use of the underused structures provide employment for individuals in an area with one of the highest unemployment rates in Virginia, and to develop a source of fresh salad greens 12 months a year.

III. Project Approach:

Phase I of this project was done to evaluate several LED lightning units and to determine which varieties of Lettuce were best suited to our growing system. The initial tests were conducted using a 14 hour light cycle with a 10 hour dark period. It was determined that 4 varieties of leaf lettuce were best suited to this type of production by providing a quality marketable lettuce product in 30 days from seeding into our system.

In Phase II of the study, we looked to evaluate different lightning patterns by looking at a 7 hour light—5 hour dark—7 hour light—5 hour dark and a continuous 24 light pattern. We continued all other conditions as they were in the initial tests. We selected two commercial LED lights to evaluate in these tests because of more consistent light quality and light dependability.

IV. Goals and Outcomes Achieved:

The plants were evaluated (measured) every 2 to 3 days to determine and evaluate growth. Phase I produced a marketable Lettuce in about 30 to 31 days. Phase II studies reduced the "Growing Period" to 26 to 28 days dependent upon variety evaluated. Light intensity and light quality created some growth differences that were not anticipated. Plants in the lower light areas were weaker and exhibited slower growth. In the tests using a continuous light pattern, we had problems with algae growth on the surface of our growing media and it caused some problems with uniform plant growth. Areas that exhibited these problems were

eliminated from the study and all areas were cleaned before the next planting. Some plants under the continuous lightning exhibited a "Marginal Tip" burn that could have been caused by excessive light or the lack of adequate air movement. The over-all quality of all lettuce was superior to that grown in a field planting making it a more desirable product to market.

Plants were harvested when they reached maturity and handled in a manner that would be acceptable for commercial lettuce production. Good Agricultural Practices were used to insure the sanitation and safety. Lettuces were packaged in "Zip-Lock" bags and stored in a 38 degree refrigerator. The quality of the harvested lettuces were evaluated and found to be a marketable product after 10 days storage, with an additional 8 to 10 days of acceptable consumer quality.

Changes in our production facility reduced the volume of lettuce that was produced. We failed to produce sufficient volume to begin establish potential market opportunities. We did provide a "Salad Lunch" for a group of college personnel that was well received and the quality was found to be acceptable and met quality standards desired by those that tested the product.

Our plans to offer our lettuce production to the PHCC Café have not been fruitful as we failed to have sufficient volume on a consistent basis for them to use in their salad offerings. We would like to continue this production system and work with the culinary arts program at PHCC to provide "Fresh Greens" as a salad item to be used as a portion of their instruction.

Based upon production from our system, and since this system was a vertical design made up of four layers, we able to produce 4.8 plants per square foot of production area. This level of production when extrapolated to a per acre basis would yield a yield of approximately 9,000 plants per acre grown in a 30 day period. With this system, a grower could crop the system for 10 harvests per year creating an annual yield of 90,000 plants per year on an annual basis. If we compare this to a field production of a similar lettuce type using a cropping system of two crops per year an average yield of 54,000 plants per acre would be comparable. The vertical indoor hydroponic system would gain favor from the "Organic" element as there are no chemicals applied to control insects or diseases. It is a much more sanitary system than a field production of greens. Working from a clean temperature controlled environment will have advantages over "Outdoor" weather conditions that add to plant stresses.

V. Beneficiaries:

The beneficiaries of this project have been the Horticulture and Agribusiness students at Patrick Henry Community College, Henry County Governor's school students, Henry County Extension personnel, Henry County Economic Development, Franklin County Horticulture students and interested local Agriculture producers.

VI. Lessons Learned:

We have gained knowledge of the production of various salad greens using LED lights in a vertical hydroponic system. The system used provided a commercially desirable fresh clean

product that met the standards of a “Buying Public”. The yield achieved on a yearly basis was approximately 150 % of that of a field grow production in comfortable clean conditions.

VII. Contact Information:

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15. A. Vargo
Local Food Hub
Final

I. Project Title: *Assisting Growers to Meet New Demands for Food Safety, GAP Certification, and Best Practices in Wholesale Crop Production*

II. Project Summary

While specialty crop producers continue to enter wholesale market channels, they are often unprepared for associated requirements for consistency in supply, quality, packaging specifications, and food safety assurances. Through this project, Local Food Hub worked to address these issues through a workshop series focused on farming topics that address wholesale needs, with an emphasis on quality assurance and food safety. In addition, regular communications, newsletters, and technical assistance provided support to a network of over 70 specialty crop growers to adopt best practices for on-farm food safety and gain a better understand of how their operations relate to FSMA and changing market demands. A small, pilot group of 3 farms enabled the development of a robust technical assistance program for GAP certification that came to fruition in 2015. Consistent funding through the Specialty Crop Block Grant Program has allowed Local Food Hub to continually refine and improve the way in which it provides continuing education opportunities to specialty crop growers through both formal training and in person technical assistance. It has also helped to position LFH as an active and collaborative partner with other state and regional service providers for the ongoing work of advancing on-farm food safety practices and assisting small-scale farms to successfully transition to the implementation of the FDA's Food Safety Modernization Act.

III. Project Approach

Farm visits and GAP technical assistance were focused on 3 primary farms of varying scales, but each with a commitment to pursue GAP certification. Assistance included farm visits and manual preparation and review. While GAP compliant practices and record-keeping is in place on these farms, the farm owners have decided to postpone certification until next season when cost-share funds will be available through SCBGP FY2014 funding. Additional assistance was offered to all participating farms through the creation of additional LFH Grower Guides, our Grower Services Newsletter, farm visits, as well as email, phone, and in-person communications.

Local Food Hub has continued to offer high quality training opportunities to area producers on a range of topics (see below), while adding a more in-depth "working group" approach with a select group of growers on the topics of food safety and season extension – both critical to success in the wholesale marketplace.

This year has been pivotal in our approach to GAP and food safety training with our network of 70 plus specialty crop farmers. In close collaboration with Virginia Cooperative Extension and the new Fresh Produce Food Safety Team, led by Amber Vallotton, we have begun a major redesign of our food safety training and overall approach to assisting small farms adapt to FSMA while promoting a robust food safety culture in Virginia. Local Food Hub is developing a multi-tiered quality assurance program to provide a scale-appropriate food safety framework for small farms that can stand alone or be used as a stepping stone to full GAP certification as needed. Throughout the year, LFH's Director of Grower Services has met frequently with members of

the Fresh Produce Food Safety Team, and key food safety players within USDA AMS and FDA, in order to develop a new approach that would be more realistic and attainable for small farms.

IV. Goals and Outcomes Achieved

Project Activity	# of participants	Project Staff/Partners	Date
Succession Planting: Providing for the Whole Season	53	*LFH Staff:* Adrianna Vargo *Contractor:* Pam Dawling (Twin Oaks)	December 2013
Wholesale Success Training: Harvest and Post-Harvest Handling	59	*LFH Staff*: Adrianna Vargo *Contractor:* Allen Straw (VCE) & Rob Williams (VT)	January 2014
Ag Marketing for Small Farms	25	*LFH Staff:* Adrianna Vargo *Contractor:* Theresa Nartea (VSU) & Gustavo Ferreira (VT)	February 2014
Value-Added Processing	26	*LFH Staff*: Adrianna Vargo *Contractor*: Allie Hill (Virginia Food Works, Homegrown Virginia) & Ian Pasquerelli (VCE)	March 2014
Farm Visits / GAP Technical Assistance	Hill Farm (Louisa Co) Hollands (Rockbridge Co) Walnut Winds (Pittsylvania Co)	*LFH Staff:* Adrianna Vargo	March – April 2014
Workshop: Soil Fertility Management	19	*LFH Staff:* Adrianna Vargo *Contractor:* Todd Niemeier (UACC)	April 2014
Organic Orcharding	16	*LFH Staff:* Adrianna Vargo *Contractor:* Vintage Virginia Apples	May 2014
Workgroup for GAP and High Tunnel Production	14	*LFH Staff:* Adrianna Vargo *Contractor*: Pam Dawling (Twin Oaks)	June 2014

Disease and Insect Pest Management	31	*LFH Staff:* Adrianna Vargo *Contractor:* Jim Hankins VSU, Anton Baudoin VT, Ellen Polishuk	July 2014
Tractor Maintenance and Safety	28	*LFH Staff:* Adrianna Vargo *Contractor*: Todd Anderson (James River Equipment)	October 2014
Pilot: LFH Quality Assurance Program and On-Farm Food Safety Plan	15	*LFH Staff:* Adrianna Vargo *Contractor*: Amber Vallotton (VA Fresh produce Food Safety Team Coordinator)	February 2015

Due in part to our work on food safety issues, Local Food Hub has strengthened its relationship with SYSCO Virginia, translating to a significant increase in sales. New institutional accounts have also been opened at James Madison University, Washington and Lee, University of Richmond, and Bridgewater College. The fact that Local Food Hub is working proactively on food safety with its growers, and now maintains a GAP certified warehouse facility is essential for these relationships to establish and expand.

V. Beneficiaries

The workshops offered through this project in 2014 (excluding the Wholesale Success Training at our annual growers meeting with 59 participants) were attended by 82 distinct participants who described themselves as 46% small-scale producers, 12% established farmers, and 37% aspiring farmers. In addition, the 70+ specialty crop growers in Local Food Hub's network received regular communication and updates on FSMA and food safety related issues. Intensive technical assistance was focused on 3 specialty crop farms to achieve "GAP ready" status, and each of these farms achieved certification the following year. The pilot work done with this mini-group enabled us to effectively work with a larger group in 2015.

VI. Lessons Learned

Adjusting to the frequent and complex revisions, and lengthy rule making process for the Food Safety Modernization Act (FSMA) made it challenging to provide growers with training that we felt accurately reflected the shifts taking place and what the final rules would look like. In essence, we were handicapped to some extent by our proactive approach in that we did not want to put our growers through extensive GAP and FSMA related training that would not reflect the final rules. By stepping back, we were able to focus on a broader risk-based approach to on-farm food safety and begin the development of an internal Quality Assurance Framework which carried over to a project funded in the FY2014 SCBG cycle. We also focused on making sure our partner farms stayed up to date on FSMA through grower newsletters and meetings. In hindsight, while delaying the formal FSMA and GAP training was frustrating, we are now better positioned

to provide growers with a curriculum that will be recognized by the FDA through the Produce Safety Alliance (PSA). Our proactive approach has also enabled us to strengthen ties with state partners, including our participation as an NGO partner in a new NIFA funded grant to establish a regional training center to help farms transition to FSMA compliance.

An additional lesson learned included the reluctance on the part of growers to undertake the financial risk of pursuing GAP certification. While we worked with three farms intensively to become "GAP ready," these growers opted to delay an audit until cost-share funding was available through our FY2014 SCBG funding. It also became apparent that successfully navigating the GAP certification process required extensive one-on-one technical assistance and multiple farm visits, which was also reflected in our FY2014 project.

Our network of producers has come to rely on Local Food Hub to keep them informed and on target to maintain a competitive advantage in the wholesale market and ultimately comply with FSMA. This is a multi-year process, and we continue to build strategic relationships at the state and federal level to ensure we can provide the most accurate and highest quality support possible to specialty crop growers in Virginia.

VII. Contact Person

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VIII. Additional Information

Available on request:

- LFH Quality Assurance Program info sheet
- 2014 Workshop Series Summary & Evaluation Report

16. S. Johnson / L. O'Neill
VABF
Final

Project Summary

Between October 1, 2013 and October 4, 2015, the Virginia Association for Biological Farming (VABF) jump started an annual farm tour weekend. The activities performed included farmer recruitment and selection, farmer training, sponsor recruitment-development, event promotion, materials creation and event management. The first year was extremely successful. Unfortunately, a hurricane threatened and at 2 pm the Friday before the second year tour the decision was made to cancel the tour because of the forecast and the reality of flooded farms, fields and saturated soils. Rescheduling was not practical as numerous farms could not participate on either of the following two weekends. Despite this cancellation, all the farms received advertising and publicity, which continues to positively impact their businesses.

Farmer Recruitment & Selection. VABF extended invitations to area farmers to apply by circulating information about the tour to its members and annual conference attendees, area farmer's market managers, restaurants, farm related list serves, partner organizations and by contacting farmers directly. Interested farmers completed the farm tour confirmation form with information on their growing practices, commercial sales channels, crops in production and other factors needed to assess their suitability for hosting tours (facilities, parking space, insurance coverage). Twenty -five farms had a conversation, eighteen farms ultimately moved forward with participating the 2015 tour a 50% increase in participation over our first year.

Farmer Training. Both years, VABF coordinated a pre-tour training workshop for tour farmers. Farms got to meet one another, and clarify the rationale and goals of the tour. They collected necessary farm tour materials. The workshop also addressed insurance and liability issues, safety concerns, planning activities and tours for visitors, on site marketing and signage, tour marketing, planning for on-site sales, value added products, recruiting volunteers and other relevant topics raised by the farmers. Training also reviewed both bio-security management and a new agreement with Virginia Department of Health on farm Sales and sampling.

Each year extension specialists, Dr. Martha Walker, and our staff, plus others lead the training discussion. 12 farms attended the first year and Sixteen farms attended the second year. Training materials and farm tour educational signage was provided to all farmers, including those who were unable to attend.

Sponsor Recruitment. Ellwood Thompson's Local Market expanded its role as a sponsor and partner for the 2015 tour. The local grocer secured ad space in three Richmond publications and committed to covering design and printing for promotional materials. Ellwood Thompson's involvement appears to increase the potential for long-term viability of the tour. We also had conversations with 19 local restaurants about being promoting their business through sponsoring the tour. Seven restaurants intended to participate, but timing of restaurant outreach and serious weather precluded finalization/confirmation of their participation.
At our pre-tour meeting/training, two farms, both new to the tour this year, both with independent agritourism ventures offered to partner more substantially in term of advice and organization, on the 2016 tour.

Event Promotion. VABF promoted the tour via an extensive marketing plan that included the VABF website and newsletters, local e-calendars, the Ellwood Thompson's Local Market web site and newsletters, local events calendars, social media, farm and food related email discussion groups, extension agents, partner organizations, press releases, advertising in local media, as well as poster and postcard distribution throughout area farmers markets, foodie events, restaurants, garden centers, schools, community areas, churches and stores. A large feature article in the Richmond Times Dispatch informed many people about the tour and biological farms in the region.

Event Management. VABF recruited and trained a diverse group of volunteers to staff the registration tables at each farm on the tour. VABF supplied each volunteer with a detailed set of instructions. Each farm received all the supplies needed for the registration table at the training/meeting the week prior to the tour.

A 6 page 8 ½ x 11 guide to the tour was created that included a map of the tour area, descriptions and contact information for each farm, directions to farms, tips for taking the tour, promotion of other upcoming events. Brochures were distributed at the Farmer pre-tour meeting. Tour directional signs were printed to help guide tour goers to the farms and when they were actually on the farm. Tickets were sold online, and at Ellwood Thompson's Local Market.

Farmer Follow Up & Networking
Each year a follow up meeting was held. The first year was a potluck and farm tour and the second was hosted by Ellwood Thompson's. Farmers and sponsors were encouraged by the continued interest in connecting people to the farms where they buy their food and seeing first hand, the hard work and dedication that goes into it.

Tour Weekend Results. The tour advertising, outreach and press coverage (print, online and radio) increased the awareness of the many biological and local farms in the Richmond Food shed. This should help as the Farm Tour continues into the future. Farm Tour sponsor Ellwood Thompson's is dedicated to continuing to promote local farms and local farm tours.

Goals and Outcomes Achieved
The Virginia Association for Biological Farming (VABF) jump started an annual Farm Tour weekend in 2014 and again in 2015 (though the actual tour had to be cancelled due to a hurricane, the farms did benefit from advertising throughout the Richmond community). The activities performed included farmer recruitment and selection, farmer training, sponsor recruitment, event promotion, event management, and farmer follow up and support.
Long term goals were to increase the awareness and sales of small scale organic farmers in the Richmond Area by getting consumers on the local farms and learning about organic agriculture. Based on reported figures, annual sales of all participating producers increased. Participating producers experienced an average of 17% overall farm revenue increase in the year after the first tour/program year as compared to the year prior to initiation of the Farm Tour. This exceeded the program goal of 10%.

Many organizations benefited from the Richmond Farm Tour. All the local farms involved got increased visibility within the farming community. Richmond Farmer's Markets also got increased visibility in the news, radio, and internet, which results in higher sales for all vendors at a farmer's market (not just tour participants). Ellwood Thompson's is recognized in the local food movement as an advocate of local, small scale, biological farmers. This positive associate increases their sales as consumers seek them out for their grocery needs. Virginia Cooperative Extension involvement continues the alliance among small farms and extension. Slow Food RVA continues to work with local farmers, who appreciate their dedication to sharing the importance of slow food made with local, biological ingredients. Virginia State University continues to benefit from the partnerships created from the farm tour in the programing they do in the future and for their student body. Over 30 farms and 20 institutions and businesses benefitted from their involvement in the Richmond Virginia Farm Tour. As small businesses grow it is these connections that make their businesses viable in a competitive market.

Beneficiaries

Various groups benefited from the completion of the Richmond Farm Tour. First and foremost, the many local farms that participated got publicity and recognition through advertising, as well as through having visitors to their farms, who will hopefully return to their various marketing outlets. The many sponsors, also got advertising and recognition that they are supporting local farms, which helps boost their image in the eyes of their consumers. VABF benefits through helping support our mission to educate about, advocate for, and promote organic and biological farming and gardening. Other area groups that benefitted are Slow Food RVA, Richmond Area Farmers Markets, and VSU Small Farm Outreach. These organizations helped recruit volunteers at area farms for the event. They benefitted through using the opportunity to educate the public about their organization and the work they do. Ellwood Thompson's, as primary sponsor, benefited by demonstrating their support to local sustainable farmers and their commitment to helping educate the consumer public. The Chesapeake Bay Foundation also benefited by utilizing the event to educate about the watershed and the importance of agricultural practices on watershed health. Beginning and aspiring farmers benefited by having the chance to tour multiple established farms, learning best practices and seeing first-hand real-life examples from working farms. Field visits such as these tours provided are invaluable by training and advancing new farmers in our state. Finally, the consumer public of the greater Richmond area and beyond benefited by seeing these farms, meeting these farmers, and learning about what makes sustainable farming unique and critical to a healthy food system.

Lessons Learned (bad weather besides)

Busy farmers. A preplanning meeting over the winter or in early spring is helpful in getting information from farmers, as well as commitment. The meeting pre-tour was an efficient way to distribute materials and answer questions.

Tour paradigm: "why are we doing this" was high on many farms and organizers conversational agenda. We've clarified that the farm tour is primarily to benefit farmers and increase citizen awareness of our local foodshed. Farmer engagement with the tour has had a positive increase.

Recruiting volunteers: Volunteer recruitment is essential for a successful tour. Reaching out to dedicated farmer's market customers or local food advocates and organizations is helpful.

Sponsors are invaluable: Each year our sponsors really pulled through in helping to promote the event and to carry some of the responsibilities.

Competing events. A busy time of year, autumn is a popular time in Virginia for outdoor events. Finding the best date can be the trick and not overlapping with other large events. Choosing a "rain date" months ahead that works for all involved is encouraged. While everyone is not likely to be able to be involved, a higher number is more likely to be.

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17. A. Straw
VA Pumpkin Growers Association
Final

PROJECT TITLE

2013-4B8 Evaluating High Tunnel Strawberry Production

PROJECT SUMMARY

The purpose of this study was to statistically determine if strawberries grown in a substrate system in a high tunnel environment will produce enough yields to justify the additional cost or economic feasibility of the substrate system and the high tunnel in more rural areas of Virginia. The trial evaluated four different day-neutral varieties (compared to Chandler) at three specific plant densities 6", 9" and 12" apart in a double row configuration. To date this data has not been collected or measured and could determine a specific growing system capable of doubling and possibly tripling strawberry yields per acre.
High tunnels are increasing in popularity among growers. However, in more rural areas, is the production and price enough to justify the investment. In Europe, some growers have moved to a substrate system to increase production. The substrate system is placed inside the high tunnel; there will be three rows that are approximately 100' by 3' and approximately 4' above the ground with rocker arms that hold a 10'' gutter system that holds the organic socks with an irrigation tube running through the middle of the sock. The primary question this study answered was; "Can strawberries grown in a substrate system in a high tunnel be cost effective?

PROBLEMS APPROACH

Michael Richard ordered the substrate system, Filtrexx sock matrial and COIR fiber. The substrate system had to be shipped from England. It was to have been in the U.S. in the spring of 2014. However, due to delays in shipping and failure to send some of the parts, it was fall of 2014 before the systems could be completely installed. The substrate system was installed by Michael Richard inside an existing high tunnel that measured 30 feet wide by 96 feet long. A total of 7 gutters were installed approximately 4 feet apart. R. Allen Straw and Michael Richard filled Filtrexx socks 85 feet long with COIR fiber along with a drip irrigation tubing and placed in each gutter. This system provided almost 600 linear feet of row in the 30 foot by 96 foot high tunnel.

The plants had to be shipped in late summer when plant suppliers were shutting down their storage coolers. We tried to store the plants at 32 to 34 degrees F. However, because of all of the delays, the plants rotted in the cooler and had to be reordered. The plants were set by Michael Richard late in the fall of 2014. Supplemental heat was used to imitate where they should be at that time of year. Plants of Sweet Anne, Albion, Seascape, San Andreas and Chandler were planted at spacings of 6, 9 and 12 inches.

A drip irrigation system was installed by R. Allen Straw to provide water and nutrients to the plants in the sock. Three injectors were installed to provide acid to adjust the pH of the water, complete fertilizer and calcium nitrate.

Michael Richard began harvest began in early April and continued every few days all of the way through December. The data were lumped into Spring (April through June), Summer (July through September) and Fall (October through December) seasons. Yield data were averaged across the six replications to identify the optimum variety spacing combination. Data analysis was conducted by R. Allen Straw.

GOALS AND OUTCOUMES ACHIEVED

Harvest began in early April and extended through the end of December during 2015. Berries were picked and weighed every few days. Picking frequency was based on how fast the ripened which was influenced by the weather. Yield data were then combined into Spring (April through June), Summer (July through September) and Fall (October through December) sets. The highest yields in the spring came from Chandler at the 6 inch spacing (1,785 pounds of fruit per 600 linear feet of row), while the best day-neutral variety was Seascape at the 6 inch spacing (1,133 pounds of fruit per 600 linear feet of row). During the summer months, Seascape at 6 the 6 inch spacing produced the most fruit (879 pounds). Sweet Anne at the 6 inch spacing produced the most fruit in the fall (682 pounds). Over the entire season, Seascape at the 6 inch spacing produced 2,616 pounds of fruit per 600 linear foot of row.

Income

Assuming 2,500 lb of fruit could be harvested over a 9 month period and that the average price received per pound was $3.00 per pound a grower could achieve $7,500 in gross sales from a 30 foot by 96 foot high tunnel. In areas other than the Southern Appalachian Mountains, one might receive more than $3.00 per pound.

Expenses (30’ x 96’)

Infrastructure

High Tunnel and construction	$10,000
Substrate System	$6,000
Filtrexx Sock ($1.00/foot)	$600
COIR ($1.70/foot)	$1,020
Irrigation / Injector System	$1,000
Other Misc. Expenses	$1,380
Total	$20,000

Operating

We are still trying to identify our actual operating expenses. Based on some previous budgets for greenhouse strawberry production we are assuming $2,500 to $3,000; although, it could be as high as $4,000 depending on labor costs.

I am using $3,500 in operating expenses for this study (until we identify more specifically our expenses).

Bottom Line:

Gross Sales	$7,500
Operating Cost	- $3,500
	$4,000

If all of the money were paid toward the investment, then the infrastructure could be paid off in about 5 years. However, many of us need some of that money to make a living. It could take as many as 10 years to pay off the original investment. It would be feasible to install a substrate system in a high tunnel for strawberry production in the Southern Appalachians. This system appears to be slightly more productive and profitable than field production of annual plasticulture strawberries. This preliminary study would suggest 10 to 20% higher yields net profits.

BENEFICIARIES

The beneficiaries of this project are existing strawberry growers that are looking at season extension of strawberry production. This should help them make sound decisions regarding the adoption of the substrate system for high tunnel strawberry production.

Another group of beneficiaries are prospective growers. Again, this data should help them be able to determine is the use of a substrate system in a high tunnel would be economically feasible.

LESSONS LEARNED

Always allow extra time for shipments coming from overseas. This was a major issue in getting this project under way.

The substrate production system in the high tunnel produced yields comparable to those in the standard field production system. For the day-neutral varieties, yields were comparable. However, for the June bearing variety, Chandler, yields were 25 to 50% higher than for annual plasticulture production in the fields of Southern Appalachia..

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18. L. Horth
Old Dominion University
Final

PROJECT TITLE
Improving Strawberry Production Through the Use of Native Bees

PROJECT SUMMARY
Colony Collapse Disorder is devastating honey bee colonies impacting farmers. Our goal, was to attempt to use a native bee species, the mason bee, *Osmia lignaria* to supplement honey bees, *Apis mellifera*, on small, family owned farms to improve production of the specialty crop, strawberries. This native bee species has never been used on fruit crops and has only been used in orchards and for almond groves. We wanted to see if the use of this bee was even possible on small farms, given the health of honeybees and to see if they would improve pollination.

Colony Collapse Disorder is impacting about 30% of farmers each year in Virginia and throughout the country. A new solution for crop pollination is needed, particularly given that honey bees are not even native to our country. This project was very timely in that it intends to relieve economic distress to farmers associated with bee losses.

PROJECT APPROACH
This work was a major success and all major goals were accomplished. We have just completed the statistics and there was significant growth of berries with mason bee additions to farms when compared to the same farm (a different section of the farm) where no mason bees supplemented the honey bees. This proves that these bees can pollinate on the ground crops. We saw them visit the crops and even create the next generation of bees in our bee homes. A master's degree student will graduate based upon her work on this project. Berry volumes were measured and shown to differ (be larger) statistically, with the treatment (addition of mason bees). Symmetry was quantified in berries and mason bee addition berries were more symmetric than control berries.

Multiple presentations were given on this work at scientific meetings and a publication is being submitted in October to a professional journal. The general public was educated in Pungo at a booth of educational information on mason bees and strawberry pollination for two years. A before and after educational quiz was given at the booth and over 30 individuals took the quiz. All farmers were mailed by US Postal Service and via email an interim report and a final repot.\. This work was featured in the Virginian Pilot twice, on television, in ODU news twice, and most recently on public radio. Here is the NPR link:
http://withgoodreasonradio.org/episode/millennials-as-spiritual-not-religious/
Note: the first feature is on religion; Horth is second

GOALS AND OUTCOMES ACHIEVED
Activities and Accomplishments: A large number of activities were performed at a fairly large scale and many goals were achieved during this period. Some tasks will be completed in both years, as well. Each task is listed below as outlined in the grant. Results, accomplishments, conclusions and recommendations are discussed below the table of goals and whether they were met.

Comparison of actual accomplishments with the goals established for the reporting period.

Activity	*Goal Accomplished*
Meet with farmers and provide starter information	Yes, in the winter 2013
Construct and purchase bee houses	Yes, in the winter 2013 and spring 2014
Set up houses on farms	Yes, in the spring 2014
Monitor pollination and berry traits (a 2 yr activity)	Yes, in the spring and summer 2014
Crop yield analysis, pollen analysis	Yes completed 2015
Data analysis	Yes, recently completed 2016
Discuss with farmers Yr 1 and Yr 2 outcomes	Completed Aug 2016
Outreach on nutritional education at Pungo Festival	Yes, in the spring 2014
Publication	To be submitted Oct 2016

Results, Accomplishments and Conclusions:

Note: This section addresses the above activities in the order in which they are listed.

We discussed our plans for mason bee addition to farms with the farmers prior to the inception of the work. Farmers seemed excited and cooperative during this interaction. We then constructed over 100 bee homes over a six month period. This was a very labor intensive project. The houses were deployed to the field in the spring of 2014. Spring had some unseasonably cold weather for longer than is typical but the native mason bees were added to the farms by placing cocoons in the deployed houses. Flowering of berry plants occurred later than in some years due to the late cool weather but as flowers emerged we began monitoring flower to berry data. Some issues (discussed below), such as berries being picked, impacted complete data for many of our flower to berry marked individuals. To compensate for this we marked additional flowers.

All data was collected for this work. This did however result in the data set occurring for a much longer period over the season than we had originally anticipated. Data had to then be transferred from field data sheets to computer databases and proof read for transcription errors. This has all occurred and data analysis has recently been completed and results mailed to farmers.

The outreach component of this work outlined in the grant was completed by having a booth at the Pungo Festival and was an overwhelming success. We had folks record whether they learned anything about mason bees and strawberry nutrition and if they did they received a post card with a mason bee. Additionally, I gave an educational talk to the public about bees, which included a large commentary on mason bees, native bee pollination and this work. The talk was held at St Patricks School (Norfolk, VA) in the Evening Lecture Series in the winter 2013-2014 entitled The Exciting World of Bees. Adults got to try their hand at making mason bee homes. This led to us deploying two mason bee homes at St. Patrick's School, as well, where the science teacher became involved in educating children about mason bees. Then we had additional, unanticipated publicity from media (described above)

I also discussed this work at an invited seminar for the Cape Henry Audobon Society in Norfolk in April 2014 and at Blandy Farm, the Virginia State Arboreteum, in June 2014. A blog was established to show progress on this work (horthlab.com). I was able to discuss our work with other scientists involved in pollination and I presented work at the North American Pollinator

Protection Campaign in October this year. Finally, the Virginian Pilot published an article about this project on April 22, 2014 entitled, “These bees cause a buzz”.

Significant contributions and role of project partners in the project.
The contributions largely followed the “events and responsible parties” laid out in the grant. Graduate student Campbell, and I are responsible for the work on this project and all of the above work was completed by us. We ‘collaborate’ with the Pungo strawberry farmers who generously provide their farms as a location for us to deploy native bees and monitor pollination. The initial discussion with farmers occurred with all stake holders (farmers and scientists). Then Horth and Campbell established bee houses on farms, with some assistance from another graduate student, Becky Walawender. Campbell (with Horth’s oversight as stated in the grant but also with additional help in the field by Horth and Walawender and an undergraduate volunteer) monitored pollination events. Data analysis will be completed this fall by Horth. Nutritional education was completed by Campbell and additional outreach was conducted by Horth. In sum, Horth participated in a hands-on fashion more than was originally anticipated, and some additional help was needed, but the work was completed successfully.

Expected measurable outcomes:
Our first goal was to establish a grid for conducting measurements and measure a series of berry plants on the control and experimental sides of each farm. Statistical tests were performed based on these measures to evaluate our treatment effect.

Our second goal was to measure pollination rate and berry quality (symmetry) which we have done and recorded the data. Statistical analyses has been completed and we hope to do more oft his with a second method, which may result in the use of a mathematical software used for this purpose for the first time (and thus may result in a “Methods” publication).

Educational goals included discussions with farmers about the work. We have talked to them as the project was underway and have sent a final commentary to them explaining our results. Another educational goal included writing this work up for publication which we are almost done Educational information was provided at the Pungo Festival as planned this past year. Additionally, our booth was next to one of the strawberry farmer’s booths and this farm group was very helpful in sending folks over to our booth, suggesting good will between farmers and our science team.

BENEFICIARIES
Farmers involved clearly benefitted from larger berries on farms.
We benefitted from the knowledge gained for future work. The scientific community will benefit from the publication of the work and the general community has benefitted from several talks and the publicity garnered that was for the public. A student will graduate with a graduate degree from this work.

☐ Clearly state the number of beneficiaries affected by the project’s accomplishments and/or the potential economic impact of the project. 15-100 (15 directly, plus all those that learned something about pollination from the publicity and press).

LESSONS LEARNED

We had a number of unanticipated impediments, all of which we worked through, several of which were weather-related and therefore not really under anyone's control. Winter months turned out unseasonably warm for a long spell at the end of December and into early January, when we wanted the bees that we had purchased to be shipped to us. Many days were over 60 degrees somewhere in the travel commute (usually here) between Oregon (one location from which bees were ordered and shipped) and Virginia. Eventually we were able to have our purchased bees shipped but we will certainly be looking ahead for week long periods of weather with zero days in the 60s this coming season when we purchase bees. We have a small fridge at our end now exclusively for shipped bees so that we can be sure to monitor temperature and humidity carefully.

Another impediment was the unseasonable cool weather in the spring when we wanted to deploy bees but when the weather just remained too cold. When bees emerge from cocoons they need to have access to pollen and nectar imminently, especially when they have been in their cocoons for long winters (as was the case for these bees since spring remained too cool to emerge for a long period). The cool weather also delayed strawberry flowering and was a concern for us. This may mean we deploy a greater number of bees next season to compensate for weather-related losses. The primary target date that this impacts is being able to analyze data in the fall, which could be pushed to winter so as not to rush analysis.

Our final impediment was the fact that there were less berries at the primary time of the U-pick season, so this resulted in a fair number of our marked berries being picked by consumers. Since we don't want to have any negative impact on the farmer's ability to generate income, we would remark a new flower and start our data collection again. This meant that there was much more time in the field than originally anticipated and our volunteer accrued more hours than anticipated. It also meant that instead of a moderate sample size of complete data on flower to berry we ended up with a number of floral measures, then loss of a berry so no complete data for that flower. This meant lots of incomplete data and lots of unanticipated 'newly started compensatory' data making data collection, collation and analysis more complex than originally anticipated.

One additional factor that we had to address was the unanticipated need for the farmers to move our bee nest boxes or to spray with pesticide once the bees were deployed because of higher amounts of problematic organisms on crops that the farmers had not expected. This likely resulted in excessive death of bees on one transect, and possibly two.

This work was amazingly time consuming. If we were to do this work over, we would need to request additional salary because of the inordinate amount of time this work took. Once the weather warms, berries are covered by plant leaves and some farmers do not mow, so finding a single berry could take several minutes.

☐ Describe unexpected outcomes or results that were an effect of implementing this project. The amount of work was large; we needed more people and more bees!

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

☐ 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). Weather is important for bees and trying to predict spring weather is hard. Knowing when to release cocoons is a tough issue and one worth further consideration. Similarly, knowing whether the bees pollinate other crops would be helpful and whether the bees could transmit or carry disease.

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

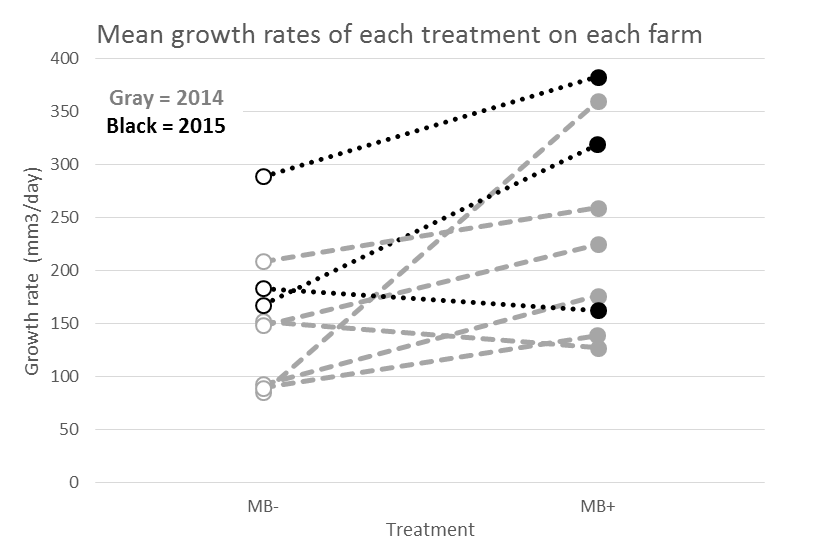
1. Thesis

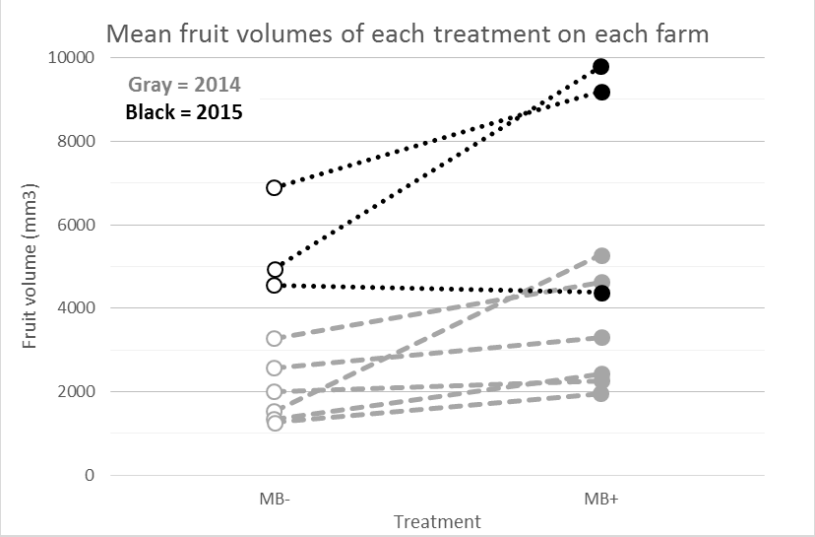
Title page of Laura Campbell's thesis:
Strawberries (Frag X anan) are bigger when native mason bees (*Osmia lignaria*) are experimentally added to small farms
Master of Science---Biology (Defense Fall 2016)

2. Abstract of Publication:

Abstract
Agriculture is a cornerstone of many national economies. Insect pollination is essential or helpful for the pollination of nearly all non-wind pollinated crops and most farmers currently utilize European Honey Bees (*Apis mellifera*) for this work. In the last decade however, Colony Collapse Disorder has had a profound impact on the efficiency of honey bee pollination and consequently fruit set. Honey bee populations are declining still, creating a critical need for alternative or supplementary pollination plans. Native mason bees (*Osmia lignaria*) have recently been used successfully in the pollination of almonds and apples. However, there has been no work on farms with non-tree produce. In this study we conducted mason bee additions on small family farms to
assess these bees effectiveness as a strawberry pollinators. Fruit size was compared on nine farm plots each split in half (one half had mason bee additions, one half did not and remained a control). The addition of mason bees significantly increased berry size demonstrating that a) these bees can be used to pollinate ground crops, b) they are effective pollinators, and c) they can supplement honeybees successfully. This is the first work to employ mason bees for pollination of strawberries on farms.

3. Images showing difference in berry growth rate and berry volume for control (no mason bees, MB-) and experimental (mason bee additions, MB+) farm plots. These data differ significantly as evaluated by non parametric statistics ($P<0.05$)


Mean growth rates of each treatment on each farm
Gray = 2014
Black = 2015
Growth rate (mm3/day)
400
350
300
250
200
150
100
50
0
MB-
MB+
Treatment


Mean fruit volumes of each treatment on each farm
Gray = 2014
Black = 2015
Fruit volume (mm3)
10000
8000
6000
4000
2000
0
MB-
MB+
Treatment

19. L. Cawood
VDH
Final

PROJECT TITLE
Virginia Urban Agriculture Summit

PROJECT SUMMARY
The proposal for the establishment of an annual Virginia Urban Agriculture Summit grew from legislation introduced in the Virginia 2013 General Assembly Session, when 25 delegates and two senators were patrons of HJ758. HJ758, which successfully passed both houses, designated October of 2013 and each succeeding year as Urban Agriculture Month in Virginia.
The legislation pointed out that urban agriculture is important to Virginia's economy and in local communities, with farmer's markets, community gardens, and other urban agriculture education programs, including those that bring together rural producers with urban consumers. It also highlighted that recent natural events demonstrate the importance of food security and showed if every family in Virginia spent $10 per week on fresh, local food and farm-based Virginia products, more than $1.65 billion in economic impact would be generated.
The multiple partners in this project committed to hosting an annual summit every year through which they could leverage the designation of Urban Agriculture Month and use both events as a springboard to develop and expand current and new programs throughout Virginia's urban communities. The 1.5 days of workshops, planned to be low-cost to ensure access by a broad demographic across the commonwealth, focused on urban agriculture practices including: local food system development, community-supported agriculture (including rural/urban linkages), healthy meals, composting and healthy soils, irrigation and garden management, green roofs, and small farm partnerships. The intent of VUAS was to highlight programs that work well and to learn from other localities' successes and challenges in developing urban agriculture infrastructure and programs.
VUAS was not only an important topic but a timely one as well, as urban agriculture is an emerging powerful economic development strategy. Local food is a critical piece in developing strong, livable communities due to job creation and influx of tax revenue, meaning no loss of these dollars outside the local economy, when the $1.65 billion per year is captured for new farming enterprises and food networks. Urban agriculture is also ecologically sustainable. Farmers are great stewards of the land, which means growing and processing food in urban environments is environmentally sensitive and reduces pollutants. Civic engagement is higher when urban consumers easily connect with urban and rural farmers and growers to learn from and develop relationships with one another, a key purpose of the summits. Urban agriculture has the potential to confront distributional inefficiencies of food, rising energy prices, local finance challenges, and others. Small-scale agricultural production is essential to eliminating food deserts and encouraging home and neighborhood gardening.

PROJECT APPROACH
The majority of the tasks and activities identified in the work plan were completed. For promotion of the event, partner organizations issued press releases; verbally announced the summit at meetings, conferences, and other events; publicized it on social media; and issued announcements in newsletters. Other activities, including planning the agenda and recruiting speakers (1/15 and onward), opening registration (8/15), and holding the summit (4/14 and

10/15) were also completed. The final piece of the project, the assessment of urban agriculture practices across the state of Virginia, was completed in August 2016. Currently, urban agriculture representatives are meeting to plan next year's summit, destined for Northern Virginia.

Contributions and Roles

Many significant contributions were made by members of the planning committee. Throughout the grant period, members held monthly meetings to set all summit details. These activities included:

- Adding members to the planning committee
- Choosing conference location
- Deciding conference topics
- Coordinating conference tours
- Soliciting speakers, panelists, and poster presenters
- Reviewing expenses and determining registration cost
- Coordinating media strategy and press releases
- Outlining plan for obtaining supplementary sponsorship
- Arranging transportation, parking, and other hotel details
- Dividing responsibilities between committee members

Specifically, Lindsey Cawood and Kevin Camm, of Virginia Cooperative Extension, served as co-chairs of the summit. Their responsibilities included arranging and leading all pre-conference meetings, choosing meeting locations, taking and distributing notes, assigning tasks to committee members, conducting follow-up on assigned tasks, coordinating press releases, writing the conference agenda, designing evaluations, and providing leadership on conference decisions. Throughout the summit, Cawood and Camm greeted arrivals, introduced speakers, directed attendees, monitored timing of speakers, led question and answer periods, ensured food and other technical issues were resolved, and served as point of contact for speakers and attendees. After the summit, Cawood produced the Virginia Urban Agriculture Assessment and completed the necessary grant reports.

GOALS AND OUTCOMES ACHIEVED

Conference evaluations revealed positive, long–term impact of VUAS efforts. In regard to the 2014 summit, conference evaluations conducted one year later revealed that 94% of surveyed attendees had been able to apply the ideas, connections, or other knowledge attained to improve their urban agriculture activities. Another 72% were aware of urban agriculture projects or coalitions that were either started or expanded as a result of the 2014 summit.

Post- summit evaluations from 2015 also had favorable results. Ninety-five percent of those surveyed indicated the summit would help improve their urban agriculture activities, while 100% agreed:

- VUAS could be used as a springboard to develop or expand current/ existing urban agriculture programs.
- Learning the challenges and successes of others at the summit would help participants better respond to their own.
- Hosting VUAS is a good way to support urban agriculture activities across Virginia.

A pre-conference evaluation also showed that immediately before the summit, 29% of surveyed attendees indicated they had a sound understanding of urban agriculture activities across Virginia; post-conference, this figure rose to 90%.

While VUAS resulted in several positive outcomes, not all objectives were achieved. One performance measure of the summit was to demonstrate an increase in the proportion of urban localities practicing urban agriculture and implementing activities for specialty crop production. This was to be determined by an assessment of urban sites across Virginia, comparing results before the first summit to results collected after the second. Due to staff turnover and loss of leadership, this pre-conference assessment was not completed. Although the new community health planner, Lindsey Cawood, did not have initial data with which to compare, a post-summit assessment of urban agriculture activities across Virginia was completed in August 2016. The second main performance measure, qualitative surveys and evaluations, were conducted for both summits, the results of which are above.

BENEFICIARIES

The two summits attracted a total of 287 attendees, who directly benefited from the networking opportunities and learning provided. These attendees, in turn, will take the skills, ideas, or other knowledge back to their organizations to improve their urban agriculture activities. Although long-term impact from the second summit is currently unknown, nearly all surveyed attendees from the first summit reported long-term benefits were received and nearly three out of four knew of urban agriculture projects or coalitions that were enhanced or started due to the summit.

These new urban agriculture projects and coalitions could have an untold impact on regional economics. As the summit is now an annual occurrence, these effects could compound over time, providing untold benefit for years to come. Many communities and practitioners may also benefit from the Virginia Assessment of Urban Agriculture, which holds a wealth of information regarding the state's agriculture practices.

LESSONS LEARNED

The planning committee learned that although there is much interest in Virginia urban agriculture, especially in Richmond, the state capital may not be the best location for the conference. Since many urban agriculture activities have focused on Richmond, potential sponsors are often contacted to support these endeavors. Planning committee members found sponsors less motivated to support the summit than those located in Lynchburg. Consequently, it may be wise in subsequent years to move the summit back to Lynchburg or choose other alternate locations across the state.

Another lesson learned is that the original goals set forth in the summit plan were too great in scope. It would be difficult to measure a 30% statewide increase in urban localities practicing agriculture activities after a cumulative four days of summit. Resulting activities may be better measured on a smaller scale.

A final lessoned learned is that while those who work with those in specialty crop production (USDA, local government, Extension officers) are easily contacted, farmers themselves were difficult to reach. Although the planning committee wanted to attract at least 51% of attendees as specialty crop farmers, this task proved difficult. Coordination, email distribution lists, and other types of contact with those involved in specialty crop production were either limited or nonexistent with the specialty crop farmers.

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ADDITIONAL INFORMATION- N/A