FINAL PERFORMANCE REPORT

COVER PAGE

Vermont Agency of Agriculture, Food and Markets

AMS Agreement: 16-SCBGP-VT-0005

STATE COORDINATOR

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Submission: December 26, 2019

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GRANT INFORMATION

AGREEMENT

AMS Agreement Number:	16-SCBGP-VT-0005			
Period of Performance:	**Start Date:**	9/30/2016	**End Date:**	9/29/2019
Award Amount:	$256,939.98			

RECIPIENT

Recipient Organization Name:	Vermont Agency of Agriculture, Food & Markets
Recipient's Point of Contact	
Name:	Gina Clithero
Phone:	802-585-6225
Email:	Gina.Clithero@vermont.gov

REPORT

Report Type:	Final Performance Report
Date Report is Submitted:	12/26/2019

GRANT ADMINISTRATION

If funds were used for grant administration, indicate the amount of funding expended from the beginning of the grant to the end of the reporting period covered by this report. Also, indicate the amount charged as indirect expenses versus the amount charged as direct expenses.

Amount Requested	Direct and/or Indirect Expended to Date
$19,032.59	$17,571.18

- $19,032.59 requested, based on actual AMS award of $256,939.98.
- $19,027.61 requested in Accepted State Plan, based on published available grant allocation of $256,872.

PROJECT 1 INFORMATION

Project Title	Development of a Wash-Down, Food-Grade Salad Spinner Kit			
Recipient Organization Name:	Upstream Ag			
Period of Performance:	**Start Date:**	4/7/2017	**End Date:**	9/29/2019
Recipient's Project Contact				
Name:	Rob Rock			
Phone:	(802)233-5465			
Email:	rob.rock.pitchfork@gmail.com			

PROJECT BACKGROUND

Provide enough information for the reader to understand the importance or context of the project. This section may draw from the background and justification contained in the approved project profile.

Producing mixed salad greens is a profitable crop for growers, even on a very small scale. Greens must be washed and spun dry – this is normally accomplished with the use of a 'hacked' washing machine. Washing machines have some performance issues, are difficult to retrofit for many growers, and are difficult to clean between uses. This project sought to design and commercialize a purpose-built and food-grade salad spinner kit for small-scale greens production.

ACTIVITIES PERFORMED

Address the below sections as they relate to the entire project's period of performance.

OBJECTIVES

Provide the approved project's objectives.

#	Objective	Completed?	
		Yes	No*
1	Evaluate efficiency and food safety issues of current leafy greens wash-line practices	X	
2	Design and build an improved system	X	
3	Refine prototypes to achieve equipment which is reproducible by farmers in kit form	X	
4	Manufacture components which are unavailable for purchase and aggregate pre-existing components to provide easy access		X
5	Develop tutorials and educational materials covering assembly and use		X

**If no is selected for any of the listed objectives, you must expand upon this in the challenges and lessons learned sections.*

ACCOMPLISHMENTS

List your accomplishments for the project's period of performance, including the impact they had on the project's beneficiaries, and indicate how these accomplishments assist in the fulfillment of your project's objective(s), outcome(s), and/or indicator(s).

Accomplishment/Impact	Relevance to Objective, Outcome, and/or Indicator
We arranged an in-depth design meeting with farmers, industrial designers, engineers, and agricultural extension agents to review both problems with the current state of the art as well as potential solutions. The meeting included Chris Callahan and Andy Chamberlin, both agricultural	**Objective 1:** Evaluate efficiency and food safety issues of current leafy greens wash-line practices

engineering extension agents who have been working growers on the problem of salad spinning by hosting workshops and trainings. We covered topics ranging from farmers' attitudes towards cleaning equipment to their willingness to repair and assemble equipment that starts out in a kit form. We were also able to uncover many specific design features related to building food-safe equipment.	
A functioning beta prototype is complete. The machine can be washed in place, uses food-grade components, and completes a spin cycle faster than a washing machine. The beta prototype can be reproduced for use by other growers. This process was completed in 2 stages: Stage 1 – work out concept and mechanicals of the design, and complete a functioning alpha prototype (similar to a rough draft) Stage 2 – Break the design down into components which can be sourced by any user, and steel framing, which is a custom item that must be manufactured by a professional. A more refined prototype is then built with these parameters in mind, which is the 'beta' or 'pre-production' prototype. Spin cycle time has been reduced: 'spin-down' time has been reduced by 30 seconds per cycle (this is the time it takes for the machine to spin down to a stop from high RPMs). Gaining 30 seconds per cycle adds up over the course of a day. On my farm, this decreased time spent on a normal wash saves us about 30 minutes total Or about 22 hours over a season. Wash downtime after use has been reduced from 3 minutes to about 1 minute, a much smaller but significant efficiency gain. This data point was reached by a side-by-side comparison of a washing machine and the new technology. A tachometer was used to measure RPMs, and timers were used to record spin cycle time as well as wash downtime.	**Objective 2:** Design and build an improved system **Objective 3:** Refine prototypes to achieve equipment that is reproducible by farmers in kit form. Design equipment for a lifecycle of incremental improvements: producers can add to the equipment as capital becomes available.
Path to manufacture is reaching completion – material costs, as well as quotes from subcontractors, are compiled. Kit parts are sourced, priced, and compiled. There are two important aspects to the manufacturing process: aggregating kit parts and building the steel sub-assembly. The beta prototype was built by a sub-contractor who was able to give comprehensive quotes on the fabrication of steel components, so I now have comprehensive pricing.	**Objective 4:** Manufacture components that are unavailable for purchase and aggregate pre-existing components to provide easy access. At least some of the components in the final design will need to be custom fabricated, which could be difficult and/or dangerous for most farmers to attempt themselves. The project will have the greatest and most far-reaching impact if we continue the work of making these components available.
Demonstrations to other growers have begun. Andy Chamberlin from UVM Extension has seen a demo, and many of the farm owners on the Intervale have	**Objective 5:** Develop tutorials and educational materials covering assembly and use, provide documentation, and provide technical support.

also seen the machine in use and learned about improvements made in food safety.	

CHALLENGES AND DEVELOPMENTS

Provide any challenges to the completion of your project or any positive developments outside of the project's original intent that you experienced during this project. Also, provide the corrective actions you took to address these issues. If you did not attain an approved objective(s), outcome(s), and/or indicator(s), provide an explanation in the Corrective Actions column.

Challenge or Development	Corrective Actions or Project Change
Difficulty working with outside designers unfamiliar with farming environments and the equipment found in those environments	In the final stages of the project, we moved all design and prototyping work in-house
Underestimating the challenges involved with the design process: the concept of the machine was deceptively simple, the actual execution was much more challenging	I moved to a 'brute force' mode of prototype iteration. Rather than making sweeping design overhauls hoping to 'hit' a highly functional prototype, I began making slow incremental changes that yielded slow performance improvements. This method proved far more effective in completing the design process
Challenges with balancing off-season workload	I was able to move more of the conceptual design and planning stages to the summer, putting myself in an excellent spot this fall to begin some of the more difficult manufacturing work during the off-season from the farm
Objective 4 (Manufacture components and aggregate pre-existing components) is currently considered incomplete	The manufacturing process has been completed for the beta-prototype. Orders are taken currently to build 4 units and work has commenced
Objective 5 (Develop tutorials and educational materials) is currently considered incomplete	Active demonstrations with farmers and extension agents have begun but are not yet far-ranging. Beginning next season more media (including photos and video) can be produced, and the equipment can be taken to demos and workshops

LESSONS LEARNED

Provide recommendations or advice that others may use to improve their performance in implementing similar projects.

One very important lesson learned for others hoping to implement similar projects was the challenge associated with having the appropriate insurance**.** My farm carries several different types of insurance, including liability, but our insurance agent was unable to extend our coverage to the activities listed in this project. This came as something of a surprise and was certainly not anticipated when I was writing the grant proposal. The state required submission of proof-of-insurance before activities could commence on the project, or before any funds could be dispersed. I decided that the best option was to cover the project under Upstream Ag, which was my relatively very new farm equipment manufacturing business. I had not set up coverage for this business yet nor begun really pursuing manufacturing work, and I imagined that any activities performed on this grant project would be similar to those performed by Upstream Ag. The first agents I spoke with were unable to find an underwriter to sell me a policy; they were able however to determine that I needed product liability insurance for a manufacturing company. The reason I was having trouble finding a policy was because my business was brand new and had no production history, and also because underwriters were unfamiliar with farm equipment in general. Through a trade magazine, I found an insurance company in Texas specializing in ag manufacturing, but their quote was $7800 a year (which would have been impossible for me to pay out of pocket). I was able next to find a company in Connecticut that could sell a liability policy to basically any business for $5000 a year. As I was getting ready to take on this expense I found an underwriter in Brandon who could sell me a policy for $3600 a year – still an

extremely expensive policy for a business with no revenues to date. I bought the policy and began working on the grant, but the large expense on insurance caused me to need to take on a good deal of extra work at Upstream Ag so that I could cover my operating costs. To date, I've spent close to $10,000 on insurance. I had budgeted time in the winters away from the farm in order to work on the grant project, but found myself needing to take on more winter work than expected. As a result, it was challenging to keep work on the grant as well as paid work in the shop moving along simultaneously, and the project itself is now somewhat behind schedule. Those seeking to pursue a similar project would be advised to research insurance costs well before writing their proposals.

The Vermont Agency of Agriculture would like to visit Specialty Crop Block Grant Program grantees to showcase projects that strengthen the specialty crop industry in Vermont. Are you interested in participating in an interview to highlight your project? YES_X__ NO___

CONTINUATION AND DISSEMINATION OF RESULTS (IF APPLICABLE)

Describe your plans for continuing the project (sustainability; capacity building) and/or disseminating the project results.

Although the project period has finished, I hope to continue to work with the project. Some of the challenges I encountered along the way have put the project behind schedule.

I now have a working beta prototype ready for rigorous testing; production of the kits is following closely behind (we have a batch ready to start for early adopters). As the farm season is winding down, I will resume work on the project in the shop, making small adjustments so that the technology is easily reproducible. Data collection on improving food safety as well as work efficiencies are in process. Kits will be in production and available to early adopters this winter.

I will be meeting soon with my technical adviser, Chris Callahan, and we will make a plan for demonstrating this technology to other growers by bringing the spinner to workshops, trade shows, agricultural events, etc. Images, videos, and descriptions of the project will be published on my website and social media.

BENEFICIARIES

A descriptor for the number of beneficiaries is not required.

Number of project beneficiaries: 24 beneficiaries. 4 farms on the Intervale will begin regularly using this technology in the immediate future. I've talked directly with more than 20 growers about the technology being developed.

OUTCOME(S) AND INDICATOR(S)/SUB-INDICATOR(S)

Provide the results of the project outcome(s) and indicator(s) as approved in your State Plan and project proposal. The results of the outcome(s) and indicator(s) will be used to evaluate the performance of the SCBGP on a national level.

OUTCOME MEASURE(S)

Select the Outcome Measure(s) that were approved for your project.

- ☐ **Outcome 1**: Enhance the competitiveness of specialty crops through increased sales
- ☐ **Outcome 2**: Enhance the competitiveness of specialty crops through increased consumption
- ☐ **Outcome 3**: Enhance the competitiveness of specialty crops through increased access
- ☑ **Outcome 4**: Enhance the competitiveness of specialty crops through greater capacity of sustainable practices of specialty crop production resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources
- ☐ **Outcome 5**: Enhance the competitiveness of specialty crops through more sustainable, diverse, and resilient specialty crop systems
- ☑ **Outcome 6**: Enhance the competitiveness of specialty crops through increasing the number of viable technologies to improve food safety

☐ **Outcome 7**: Enhance the competitiveness of specialty crops through increased understanding of the ecology of threats to food safety from microbial and chemical sources

☐ **Outcome 8**: Enhance the competitiveness of specialty crops through enhancing or improving the economy as a result of specialty crop development

OUTCOME INDICATOR(S)

Provide the indicator approved for your project and the related quantifiable result. If you have multiple outcomes and/or indicators, repeat this for each outcome/indicator.

#	Outcome and Indicator	Quantifiable Results
4	Enhance the competitiveness of specialty crops through greater capacity of sustainable practices of specialty crop production resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources	**Outcome 4 – indicators 2a and 2c** Number of growers indicating adoption (to date): 4 Number of producers reporting increased dollar returns (to date): 0
6	Enhance the competitiveness of specialty crops through increasing the number of viable technologies to improve food safety.	**Outcome 6 – indicators 2 through 5** 1 new technology has been produced with improved food safety features. Number of individuals who have learned about prevention, detection, control, and intervention: more than 20 Number of improved intervention technologies: 1 Number of reported changes: 0

DATA COLLECTION

For each outcome and indicator, explain what data was collected, how it was collected, the evaluation methods used, and how the data was analyzed to derive the quantifiable indicator.

Outcome 4, Indicator 2a: By installing these machines on the Intervale 4 users will have adopted this technology by spring. Many more will adopt the technology once kits become available. **Outcome 4, Indicator 2c:** N/A. The new technology hasn't yet been implemented at any farm for a full growing season.
Outcome 6, Indicator 2: This data point was reached by the completion of the new technology. **Outcome 6, Indicator 3**: The number of farmers that reached out for advice during this project via email or other. Number of email inquiries was counted, and calls/in-person interactions were estimated. **Outcome 6, Indicator 4**: This data point was reached by the completion of the new technology. **Outcome 6, Indicator 5**: N/A. The new technology hasn't yet been implemented at any farm for a full growing season.

FEDERAL PROJECT EXPENDITURES TO DATE

EXPENDITURES

Cost Category	Amount Approved in Budget (SCBGP Funds Only)	Actual Federal Expenditures (SCBGP Funds Only)	Match Expenditures	Match Source
Personnel	$8000	$9315	$4167	In-kind labor
Fringe Benefits				
Travel	$1000			

Cost Category	Amount Approved in Budget (SCBGP Funds Only)	Actual Federal Expenditures (SCBGP Funds Only)	Match Expenditures	Match Source
Equipment				
Supplies	$8000	$8685		
Contractual	$1000			
Other			$9474	self
Direct Costs Subtotal				
Indirect Costs	-	-		
Total Federal Costs	$18000	$18000	$13641	

PROGRAM INCOME

None to date

Source/Nature (i.e., registration fees)	Amount Approved in Budget	Actual Amount Earned
Distribution and marketing of kits	$5000	$0
Total Program Income Earned	$5000	$0

Use of Program Income *Describe how the earned program income was used to further the objectives of this project.*
No program income has been earned to date. We are going to continue with further testing of the machine this summer before we are able to sell/release this technology to users off-site (away from the Intervale). Two challenges have been realizing a prototype that can be tested rigorously for a full season, and in doing so ensuring the prototype is safe for users.

ADDITIONAL INFORMATION

Please see attached appendix for more information.

PROJECT 2 INFORMATION (PREVIOUSLY ACCEPTED)

Project Title	**Maximizing Nitrogen from Cover Crops on Vermont Vegetable Farms**			
Recipient Organization Name:	University of Vermont Extension			
Period of Performance:	**Start Date:**	12/23/2016	**End Date:**	12/31/2018
Recipient's Project Contact				
Name:	Vernon Grubinger and Rebecca Maden			
Phone:	(802) 773-3349 x277			
Email:	Vernon.Grubinger@uvm.edu and Rebecca.Maden@uvm.edu			

PROJECT BACKGROUND

Provide enough information for the reader to understand the importance or context of the project. This section may draw from the background and justification contained in the approved project profile.

Vermont's new Required Agricultural Practices (RAPs) compel vegetable farmers to overhaul their nutrient management practices. In particular, many farms need to reduce the amount of phosphorus (P) they have historically applied to the soil. This project helped Vermont farmers with high soil P levels change their fertility past practices by adopting a combination of cover cropping with legumes and low-P bagged fertilizers to meet the nitrogen (N) needs of their crops.

This project conducted research on legume cover crops to better understand their potential to reduce a common practice that has led to over-application of P, and its accumulation in the soil. That practice is the use of dairy and poultry manure products to meet the N requirements of vegetable crops. These materials are affordable, available in bulk, allowed for organic farming, and can help maintain soil organic matter because they also contain carbon. But the repeated application of these materials to meet the N needs of vegetable crops also adds significant quantities of P to the soil. For example, if a grower applies poultry manure with an N-P-K analysis of 2-3-2 (percent by weight) and approximately 50% of that N will be available during the year of application, then the grower would typically apply 4 to 5 tons of manure per acre to provide 80 to 100 pounds of available N to a vegetable crop. This would also provide 160 to 200 pounds per acre of P, which exceeds the annual needs of most vegetable crops. Repeating this process over many years is one reason that some vegetable farms now have excessive P in their soil.

To help farmers avoid this scenario, growers need reliable information regarding alternative, affordable, low-P sources of N so they can transition from applications of high-P soil amendments. This project has provided some of that information by 1) quantifying the release of available N from two commonly-grown species of legume cover crops, and 2) quantifying how the timing of cover crop seeding affects the extent of cover crop growth and N accumulation. These two factors, N release rate and total N accumulated by the cover crop, significantly affect the availability of N to a subsequent vegetable crop.

Prior to our research, very little data existed that is directly applicable to Vermont vegetable farmers to help them understand how much N they will get from incorporating legume cover crops, or how to manage cover crops for optimal availability of that nitrogen. It was known that an over-wintered hairy vetch cover crop theoretically contains sufficient N to meet the needs of a subsequent vegetable crop, but data was lacking on the release rate of that nitrogen. If the N release rate does not match the timing of crop N needs, yields suffer and N released from the cover crop could be lost to the environment, causing pollution. This results of this project will also help farmers optimize the amount of biomass produced (and thus total N accumulated) by the legume cover crops studied. Data collected by this project provides insight into the effect of planting and incorporation date on the growth of legumes, this helping farmers make the most of their investment in cover cropping practices.

ACTIVITIES PERFORMED

Address the below sections as they relate to the entire project's period of performance.

OBJECTIVES

Provide the approved project's objectives.

#	Objective	Completed?	
		Yes	No*
1	Increase the acreage planted to legume cover crops on Vermont vegetable farms	x	
2	Reduce over-application of phosphate on vegetable farms by encouraging growers to obtain more N from cover crops and less N from compost, manure, and bagged fertilizer that contain P.	x	
3	Help vegetable farms comply with water quality regulations.	x	
4	Generate new information on cover crop management and provide growers with guidelines on: • Optimal seeding dates for legume cover crops; • Optimal timing of soil nitrate testing to determine cover crop N contribution; • Effect of legume cover crop on nitrogen availability for subsequent cash crops; • Financial cost/ benefit analysis of different cover crops as a primary source of nitrogen; • Potential reduction in P application as a result of switching to cover crops from manure as N source.	x	

**If no is selected for any of the listed objectives, you must expand upon this in the challenges and lessons learned sections.*

ACCOMPLISHMENTS

List your accomplishments for the project's period of performance, including the impact they had on the project's beneficiaries, and indicate how these accomplishments assist in the fulfillment of your project's objective(s), outcome(s), and/or indicator(s).

Accomplishment/Impact	Relevance to Objective, Outcome, and/or Indicator
A comprehensive, statistically valid on-farm research project was completed that quantified nitrate availability from legume cover crops. Over 1000 soil samples were collected from fifteen treatment plots on six different farms over two growing seasons, and then analyzed for their available N content. This results of this data have been used to provide Vermont farmers with guidelines on how to maximize N benefits from legume cover crops. Educational program evaluations found that at least 87 farmers have adopted new practices as a result of this, and related information. One grower wrote on a survey, "I have more than doubled the amount of	**Objective 4** "Generate new information on cover crop management and provide growers with guidelines"

cover crop seed ordered over last year and plan to obtain more nitrogen from legumes such as peas and clover"	
At least 87 growers are reporting that they have reduced P applications as a results of educational programs that helped them understand how to meet the N needs of crops by cover cropping. The results of this project have shared with growers at 4 summer field days, the 2017 New England Vegetable and Fruit Growers' Conference, a 2017 New England Vegetable and Fruit Growers' Winter Meeting, the 2017 NOFA-VT Winter Conference, the 2018 Vermont Vegetable and Berry Growers Association Annual Meeting, and the 2018 Maine Organic Farmers' and Gardeners' Association Farmer to Farmer Conference, reaching approximately **250 growers**. Additional presentations are planned for this coming winter to share the final data.	**Objective 2.** "Reduce over-application of phosphate on vegetable farms by encouraging growers to obtain more N from cover crops and less N from compost, manure, and bagged fertilizer that contain P." **Outcome 4:** "Enhance the competitiveness of specialty crops though greater capacity of sustainable practices of specialty crop production resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources." Educational workshop support **Outcome 4,** Indicators 2a and 2b. "Number of growers reporting reduction in fertilizer used/acre"
Vegetable growers are complying with water quality regulations. This compliance is due to a combination of efforts, including 5 winter workshops, reaching **100 growers** that project leaders organized in February 2018. These 100 growers represented **2,627 acres of vegetable land in Vermont,** which at average gross sales per acre of $5460 (U.S. Census of Ag 2012) **= $14.3 million potential crop value affected.** Another 6 workshops are planned for February 2019, with a **target of 120 growers attending.**	**Objective 3.** Help vegetable farms comply with water quality regulations. **Outcome 4,** Indicators 2a and 2b. "Number of growers reporting reduction in fertilizer used/acre"

CHALLENGES AND DEVELOPMENTS

Provide any challenges to the completion of your project or any positive developments outside of the project's original intent that you experienced during this project. Also, provide the corrective actions you took to address these issues. If you did not attain an approved objective(s), outcome(s), and/or indicator(s), provide an explanation in the Corrective Actions column.

Challenge	Corrective Actions
Conducting on-farm research has some inherent challenges; 1) controlling variables; 2) coordinating machinery logistics across multiple farms in different locations, each with tight production timelines; 3) optimizing farmer involvement in farm activities that affect the research plots.	We reduced the number of sites and the research plot size from our original proposal. We obtained additional funds (outside of SCBGP) to hire a field assistant. We created a Memorandum of Understanding (MOU) to help farmers understand their role in, and commitment to, the project.
One of the analytical labs we used was very slow in processing samples. We did not receive some of the results from our 2017 samples until late in 2018.	Once we realized this problem, we changed labs for analysis of soil samples collected in 2018, but we were not able to make this change for plant biomass samples, and this has delayed compilation of our complete findngs.
Positive developments—Cover crop seed was provided free of charge to our collaborating farms (with non-SCBGP funds) in recognition for their participation in this project. This resulted in an	

additional 40 acres planted to cover crops on our trial farms alone! The relationships we fostered with our partner farms will prove invaluable for future on-farm research opportunities. This project harvested 3,500 ears of fresh sweet corn from our research plots and these were donated to the Vermont Food Bank.	

LESSONS LEARNED

Provide recommendations or advice that others may use to improve their performance in implementing similar projects.

A major lesson learned is the need to put greater effort into managing the relationships with farmers that have agreed to host on-farm research. Asking a busy farmer to manage plots in a replicated complete block design is simply too burdensome. Even with a generous financial incentive, most farmers simply don't have the time for extra projects. We quickly realized that we would have to take responsibility for all mechanical work, such as planting and weed cultivation, if this was to be done in a timely fashion. The project hired a field assistant to help get this work done.

On-farm research also brings a lot of variability that cannot be controlled, but some variability, such as decisions/actions by farmers that change the nature of a treatment or affect the experimental design (loss of plots for replication, for example) and be managed.
We recommend the following to optimize on-farm research projects:

1. Develop an MOU that clearly defines the farmer's role and responsibilities, review it with the farmer and have them sign it at the beginning of the project.
2. Establish extra research sites/plots to assure that sufficient data can be collected if something goes awry on other sites/plots.
3. Keep participating farmers engaged with the project by foster a strong relationship. Visit the farm often, clearly describe the purpose and timing of research activities, and do as much of the work on your plot as you can.

CONTINUATION AND DISSEMINATION OF RESULTS (IF APPLICABLE)

Describe your plans for continuing the project (sustainability; capacity building) and/or disseminating the project results.

1. Complete statistical data analysis Dec. 2018- Jan. 2019. We will use the statistical programming language "R" to analyze the data and provide a comprehensive analysis of the treatments nd variables, presenting them in a way that farmers will find useful.
2. Project results will be shared at the Vermont Vegetable and Berry Growers' (VVBGA) Annual meeting on January 21, 2019
3. Project results will be shared at NOFA-VT Winter Conference on Feb. 16, 2019.
4. Project results will be shared and used to assist growers with developing their nutrient management plans at six winter workshops across the state.
5. Collaborate with UMASS Extension to present the results of this project from Vermont farms, alongside data from a similar study conducted in Massachusetts, at winter meetings in MA (dates TBA).
6. Develop fact sheets, graphs, and posters describing project results.
7. Create cover crop decision tools specific to Vermont conditions (modeled after those produced by Oregon State University and University of Georgia).
8. Create a cover crop nitrate-release predictor for farmOS, the new VVGBA on-line nutrient management platform.
9. Recruit farmers to provide "crowd sourced samples" of farm cover crop plots to be analyzed, to build on our understanding of cover crop N dynamics during different growing seasons.

BENEFICIARIES

A descriptor for the number of beneficiaries is not required.

Number of project beneficiaries:The primary beneficiaries are the 800 vegetable farms in Vermont; focus is on 360 member farms of the Vermont Vegetable and Berry Growers' Association (VVBGA)

OUTCOME(S) AND INDICATOR(S)/SUB-INDICATOR(S)

Provide the results of the project outcome(s) and indicator(s) as approved in your State Plan and project proposal. The results of the outcome(s) and indicator(s) will be used to evaluate the performance of the SCBGP on a national level.

OUTCOME MEASURE(S)

Select the Outcome Measure(s) that were approved for your project.

- ☐ **Outcome 1**: Enhance the competitiveness of specialty crops through increased sales
- ☐ **Outcome 2**: Enhance the competitiveness of specialty crops through increased consumption
- ☐ **Outcome 3**: Enhance the competitiveness of specialty crops through increased access
- ☑ **Outcome 4**: Enhance the competitiveness of specialty crops though greater capacity of sustainable practices of specialty crop production resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources
- ☐ **Outcome 5**: Enhance the competitiveness of specialty crops through more sustainable, diverse, and resilient specialty crop systems
- ☐ **Outcome 6**: Enhance the competitiveness of specialty crops through increasing the number of viable technologies to improve food safety
- ☐ **Outcome 7**: Enhance the competitiveness of specialty crops through increased understanding of the ecology of threats to food safety from microbial and chemical sources
- ☐ **Outcome 8**: Enhance the competitiveness of specialty crops through enhancing or improving the economy as a result of specialty crop development

OUTCOME INDICATOR(S)

Provide the indicator approved for your project and the related quantifiable result. If you have multiple outcomes and/or indicators, repeat this for each outcome/indicator.

#	Outcome and Indicator	Quantifiable Results
1	**Outcome 4, Indicators 2a** Number of growers indicating adoption of recommended practices	87
2	**Outcome 4, Indicators 2a and 2b.** Number of growers reporting reduction in fertilizer used/acre—(please note that we have changed this phrasing to "optimize P applications to better match crop needs"	42
3		
4		

DATA COLLECTION

Explain what data was collected, how it was collected, the evaluation methods used, and how the data was analyzed to derive the quantifiable indicator.

Field research data was collected using experimental methods designed in consultation with University of Vermont experts in agronomy and statistics. Please see attachment for details on research design, methods, and results analysis.

Data documenting outcome indicators was collected through evaluations after educational workshops and meetings. The overall response rate averaged 50% of attendees. Paper surveys were used and the results tabulated into an excel spreadsheet to aggregate. An on-line survey tool, Survey Monkey, was used for electronic surveys of the larger grower community. We plan to survey all farms on the VVBGA member list (n=360) this coming winter to determine recent changes in cover crop and fertilization practices as a result of our educational programs.

FEDERAL PROJECT EXPENDITURES TO DATE

EXPENDITURES

Cost Category	Amount Approved in Budget (SCBGP Funds Only)	Actual Federal Expenditures (SCBGP Funds Only)	Match Expenditures	Match Source
Personnel	22,880	17,618.32	7,801	UVM
Fringe Benefits	2,265	7,633.14	2,965	UVM
Travel	0	0	0	
Equipment	0	0	0	
Supplies	4820	4,653.49	0	
Contractual	0	0	0	
Other	0	0	6,517	UVM
Direct Costs Subtotal	29,965	29,904.95		
Indirect Costs	-	-		
Total Federal Costs	29,965	29,904.95	17,283	

PROGRAM INCOME

Source/Nature (i.e., registration fees)	Amount Approved in Budget	Actual Amount Earned
none		
Total Program Income Earned		

Use of Program Income
Describe how the earned program income was used to further the objectives of this project.

n/a

ADDITIONAL INFORMATION

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

Be sure to include any documents, publications, or other attachments referenced throughout the report. If the attachments are large, you may consider combining them as an appendix to the full report and submitting the appendix as a separate PDF.

PROJECT 3 INFORMATION

Project Title	Field testing of natural semiochemicals to control swede midge, an invasive pest of brassica crops			
Recipient Organization Name:	University of Vermont			
Period of Performance:	**Start Date:**	12/6/2016	**End Date:**	9/27/2019
Recipient's Project Contact				
Name:	Yolanda Chen			
Phone:	802-656-2627			
Email:	Yolanda.chen@uvm.edu			

PROJECT BACKGROUND

Provide enough information for the reader to understand the importance or context of the project. This section may draw from the background and justification contained in the approved project profile.

Swede midge, *Contarinia nasturtii* (Diptera: Cecidomyiidae), is an invasive pest that is now causing devastating losses for broccoli and brassica crops (cabbage, kale, collards, Brussel sprouts, bok choy, canola, etc.) in northern Vermont. Feeding by swede midge damages leaves, petioles, and meristems of brassica crops, which distorts vegetative tissues and prevents proper head formation. The young fly larvae feed by secreting fluids and then sucking in the digested plant material; the result is highly distorted plant growth that leads to unmarketable vegetables. The midge has caused up to 100% losses for organic growers in New York and Northern Vermont. Vegetable growers are currently limited pest management options for organic and low-input vegetable growers. We tested promising low-input pest management technologies for swede midge management: 1) **Objective 1-** Test if promising essential oils to reduce crop damage in the field; 2) **Objective 2-** Test if essential oils enhance efficacy of mating disruption in an olfactometer and the field; **Objective 3-** Increase grower awareness and willingness to adopt novel technologies for control of this pest**.**

ACTIVITIES PERFORMED

Address the below sections as they relate to the entire project's period of performance.

OBJECTIVES

Provide the approved project's objectives.

#	Objective	Completed?	
		Yes	No*
1	Test if promising essential oils reduce crop damage in the field	X	
2	Test if essential oils enhance the efficacy of mating disruption in an olfactometer and the field	X	
3	Increase grower awareness and willingness to adopt novel technologies for control of this pest	X	

**If no is selected for any of the listed objectives, you must expand upon this in the challenges and lessons learned sections.*

ACCOMPLISHMENTS

List your accomplishments for the project's period of performance, including the impact they had on the project's beneficiaries, and indicate how these accomplishments assist in the fulfillment of your project's objective(s), outcome(s), and/or indicator(s).

Accomplishment/Impact	Relevance to Objective, Outcome, and/or Indicator
Field testing essential oils – successfully reduced swede midge damage by 72% in infested fields	**Outcome 5, Indicator 7**

Testing the combination of essential oils (EOs) and pheromone mating disruption (PMD) in the lab	**Outcome 5, Indicator 7**
Testing the combination of EOs and PMD in the field – successfully reduced swede midge damage by 94.6% in infested fields in 2018. But when we repeated the study in 2019, we actually found higher damage in the treated plot. The main issue was the study design, and that there were different background densities of swede midge in treated and control plots. However, although the treated plots were highly damaged, we found that close to 70% of the heads were marketable. Nearby farmer plots had higher levels of damage; less than 19% of the broccoli heads were marketable by commercial standards for the plot that matured before or planting. Only 12.7% of the broccoli heads were marketable for the plot that matured the week after our planting.	**Outcome 5, Indicator 7**
We distributed our 30-question online survey via vegetable grower listservs in states and Canadian provinces where swede midge is present, including MI, NY, PA, VT, ON, and QC. 112 growers responded to our survey, of which 69% managed their crops organically and 54% had swede midge on their farm. Growers identified a need for additional alternatives to insecticides for managing swede midge. Biological control, tolerant/resistant crop varieties, pheromone mating disruption, and repellent plant essential oils were the top four management practices growers identified that they were willing to try. Most growers were currently using crop rotations, planting fewer brassicas, and insect exclusion netting to manage swede midge. Although growers responded that netting was effective, many growers voiced that they needed an alternative, saying that netting was too expensive and difficult to use. We have published a fact sheet titled, "Organic management of swede midge".	**Outcome 4. Indicator 2.a.** **Outcome 5, Indicator 8.**

CHALLENGES AND DEVELOPMENTS

Provide any challenges to the completion of your project or any positive developments outside of the project's original intent that you experienced during this project. Also, provide the corrective actions you took to address these issues. If you did not attain an approved objective(s), outcome(s), and/or indicator(s), provide an explanation in the Corrective Actions column.

Challenge	Corrective Actions
One of our challenges was finding farms with sufficient swede midge pressure and enough space to separate spatially the treatment and control plots. Because the volatile odors from the pheromones and plant essential oils could challenge the	We just found in the summer of 2019 that our treated plot had higher midge damage than the control plots. For future research projects, we will move our treatment and control plots closer.

independence of the odors, we attempted to separate the plots ~500 m apart.	

LESSONS LEARNED

Provide recommendations or advice that others may use to improve their performance in implementing similar projects.

We have learned that it is important to consider the distance between the treated and control plots for field experiments. It is important that all research plots are close to a previously infested midge site. While the plots cannot be too close without jeopardizing the independence of the plots, they can also be too far away and experience very different levels of pest pressure.

We have found through our survey that most growers were willing to spend less than $250/acre on alternatives to insecticides. This is significantly less than the total cost of our push-pull system, which includes over $400 in pheromone dispensers alone. While we find it promising that growers are willing to try our novel strategies, our survey has identified that growers continue to experience significant economic losses due to swede midge and that additional research and development efforts are needed to lower the cost of our system so that it is commercially feasible.

CONTINUATION AND DISSEMINATION OF RESULTS (IF APPLICABLE)

Describe your plans for continuing the project (sustainability; capacity building) and/or disseminating the project results.

We will be applying for more funding to continue the work. Currently, we have a Northeastern Sustainable Agriculture and Research Education Novel Approaches grant. In this grant, we are studying swede midge adult emergence and dispersal to learn how far adults actually disperse. Because we typically see close to 100% losses for late-season broccoli, our results that 70% were marketable is encouraging us to conduct additional research. We plan to apply for additional funds from Northeastern Integrated Pest Management, USDA Crop Protection and Pest Management, as well as regional grants.

BENEFICIARIES

A descriptor for the number of beneficiaries is not required.

Number of project beneficiaries: 200

OUTCOME(S) AND INDICATOR(S)/SUB-INDICATOR(S)

Provide the results of the project outcome(s) and indicator(s) as approved in your State Plan and project proposal. The results of the outcome(s) and indicator(s) will be used to evaluate the performance of the SCBGP on a national level.

OUTCOME MEASURE(S)

Select the Outcome Measure(s) that were approved for your project.

- ☐ **Outcome 1**: Enhance the competitiveness of specialty crops through increased sales
- ☐ **Outcome 2**: Enhance the competitiveness of specialty crops through increased consumption
- ☐ **Outcome 3**: Enhance the competitiveness of specialty crops through increased access
- X **Outcome 4**: Enhance the competitiveness of specialty crops though greater capacity of sustainable practices of specialty crop production resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources
- X **Outcome 5**: Enhance the competitiveness of specialty crops through more sustainable, diverse, and resilient specialty crop systems

☐ **Outcome 6**: Enhance the competitiveness of specialty crops through increasing the number of viable technologies to improve food safety

☐ **Outcome 7**: Enhance the competitiveness of specialty crops through increased understanding of the ecology of threats to food safety from microbial and chemical sources

☐ **Outcome 8**: Enhance the competitiveness of specialty crops through enhancing or improving the economy as a result of specialty crop development

OUTCOME INDICATOR(S)

Provide the indicator approved for your project and the related quantifiable result. If you have multiple outcomes and/or indicators, repeat this for each outcome/indicator.

#	Outcome and Indicator	Quantifiable Results
1	**Outcome 5, Indicator 7.** We will increase the number of viable management technologies for swede midge control from two to four.	We have increased the number of viable management strategies from 2 (ProtekNet™, rotations) to 5 (Garlic Barrier™, PMD, Garlic Barrier™+PMD, ProtekNet™, rotations).
2	**Outcome 4, Indicator 2.a.** Of the approximately 789 vegetable growers in the state of Vermont, our outreach curriculum will reach at least 25% (~200), and of this number reached, 30% (60) will identify themselves as willing to adopt our recommended practices for swede midge management.	In spring 2018, we conducted a grower survey to identify swede midge losses in the Northeast. We distributed our 30-question online survey via vegetable grower listservs in states and Canadian provinces where swede midge is present, including MI, NY, PA, VT, ON, and QC. 112 growers responded to our survey, of which 69% managed their crops organically and 54% had swede midge on their farm. We have found that the average economic loss due to swede midge in Vermont is $2,411/ year. 78% of Vermont respondents with swede midge identified themselves as "likely" or "highly likely" to try pheromone mating disruption, and 89% were likely/highly likely to try essential oils. 72% would like to spend less than $250 per acre on alternatives to insecticides for swede midge management. 84% of growers were moderately or highly concerned about swede midge losses in the future. Given the option of reducing or ceasing brassica production entirely or paying more for swede midge management, more than half of growers (56%) preferred the latter.
3	**Outcome 5, Indicator 8.** A follow-up survey will assess the gain in knowledge by growers who access our outreach materials.	All of the growers that have attended our workshops have reported a gain in knowledge on swede midge. A total of ~200 growers have attended our workshops (NOFA-VT, UCONN Vegetable Field Day, Cornell Extension outreach).
4		

DATA COLLECTION

Explain what data was collected, how it was collected, the evaluation methods used, and how the data was analyzed to derive the quantifiable indicator.

Objective 1- Test if promising essential oils reduce crop damage in the field
We tested how Garlic Barrier, Kinetic, and lemongrass essential oil influences broccoli head damage in a randomized block design. We used an index of broccoli damage. We tested how the treatment influenced the likelihood of head damage using logistic regression. We also tested how the treatments influenced the level of damage using a chi-square test.

Objective 2- Test if essential oils enhance the efficacy of mating disruption in an olfactometer and the field
We used laboratory trials (y-tube olfactometer) to test how male and female adults responded to the plant essential oils and the female sex pheromone (publications can be found below). We tested if the proportion of adults responded differently to the different odors using binary exact tests. For the field studies, we studied if the garlic barrier and pheromone mating disruption influenced the proportion of marketable broccoli heads. We used a chi-square test to compare the treatments.

Objective 3- Increase grower awareness and willingness to adopt novel technologies for control of this pest
In spring 2018, we conducted a grower survey to identify swede midge losses in the Northeast, current swede midge management practices used on farms, and to assess grower willingness to try novel management strategies. We distributed our 30-question online survey via vegetable grower listservs in states and Canadian provinces where swede midge is present, including MI, NY, PA, VT, ON, and QC. 112 growers responded to our survey, of which 69% managed their crops organically and 54% had swede midge on their farm. We calculated the percentage of individuals that responded to a survey question. We assessed the willingness of farmers to adopt new technologies by assessing the responses to those survey questions. We also collected workshop attendance to inform Outcome 5, Indicator 8.

FEDERAL PROJECT EXPENDITURES TO DATE

EXPENDITURES

Cost Category	Amount Approved in Budget (SCBGP Funds Only)	Actual Federal Expenditures (SCBGP Funds Only)	Match Expenditures	Match Source
Personnel	$19,626.91	$27,949.25	$10,738.38	Unrecovered Indirect costs
Fringe Benefits	$1,776.98	$3,518.61	$965.13	Unrecovered Indirect costs
Travel	$772.28	$164.04	$409.31	Unrecovered Indirect costs
Equipment				
Supplies	$12,711.70	$10,367.10	$8,45972	Unrecovered Indirect costs
Contractual				
Other	$7,112	0	$3,975	Unrecovered Indirect costs
Direct Costs Subtotal	$41,999	41,999	$24,593	
Indirect Costs	-	-		
Total Federal Costs	$41,999	41,999		

PROGRAM INCOME

Not applicable.

Source/Nature (i.e., registration fees)	Amount Approved in Budget	Actual Amount Earned
Total Program Income Earned		

Use of Program Income *Describe how the earned program income was used to further the objectives of this project.*

ADDITIONAL INFORMATION

Articles:

Hodgdon, Elisabeth A.; Chen, **Yolanda H.**; Hoepting, Christine A.; Hallett, Rebecca H. 2017. Organic Management of Swede Midge. New York State IPM Program. https://ecommons.cornell.edu/handle/1813/55087

Publications:

Stratton, C. A., **E. Hodgdon**, C. Rodriguez-Saona, A. M. Shelton, and **Y. H. Chen**. 2019. Odors from phylogenetically-distant plants to Brassicaceae repel an herbivorous Brassica specialist. Scientific Reports 9:10621.

Hodgdon, E. A., R. H. Hallett, K. F. Wallin, **C. A. Stratton**, and **Y. H. Chen**. 2019. Racemic pheromone blends disrupt mate location in the invasive swede midge, *Contarinia nasturtii.* Journal of Chemical Ecology 45(7): 549-558.

Hodgdon, E. A., R. H. Hallett, **C. A. Stratton**, and **Y. H. Chen**. 2019. Diel patterns of emergence and reproductive behaviour in the invasive swede midge (Diptera: Cecidomyiidae). The Canadian Entomologist 151(4): 510-520.

Stratton, C. A.*, **E. A. Hodgdon***, **S. G. Zuckerman^**, A. M. Shelton, and **Y. H. Chen**. 2018. A single swede midge (Diptera: Cecidomyiidae) can render cauliflower unmarketable. Journal of Insect Science 18(3): 1-6.

PROJECT 4 INFORMATION

Project Title	02200-SCBGP-12-4-Managing locally sourced native bees as alternative pollinators for Vermont specialty crops			
Recipient Organization Name:	University of Vermont			
Period of Performance:	**Start Date:**	11/3/2016	**End Date:**	9/27/2019
Recipient's Project Contact				
Name:	Leif Richardson			
Phone:	802-793-6449			
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PROJECT BACKGROUND

Provide enough information for the reader to understand the importance or context of the project. This section may draw from the background and justification contained in the approved project profile.

Pollination accounts for ~10% of the total economic value of agriculture, with >75% of crop plants benefiting from visitation by bees and other pollinators. Managed honey bees are used to pollinate specialty crops, yet they may be inferior to native bees as pollinators of some crops and are expensive to manage due to an array of threats, including mites and pathogens. As a compliment to honey bees, growers sometimes use commercially available native bees (e.g. bumblebees (*Bombus* spp.) and mason bees (*Osmia* spp.)) for pollination. Our research indicates that these commercially managed bees also commonly carry diseases, which they may spread to wild bees, reducing the value of the ecosystem service of crop pollination. Moreover, there is evidence that these commercial bees, developed from populations found in distinctly different climates, may interbreed with wild bees, causing loss of local adaptation for wild bees that are critical pollinators of both cultivated and wild plants.

Many native bee species forage at flowers of specialty crops, and regardless of farmers' investments in managed pollinators, these bees contribute the majority of farm pollination service. However, our previous work with highbush blueberry shows that some farms have fewer wild bees than necessary to maximize yield and farmer profits. To address this problem, we proposed to develop methods that allow Vermont farmers to rear wild bee species from local genetic stocks for use in crop pollination. We focused our efforts on two of the most important classes of native bee pollinators, bumblebees, and mason bees.

Queen-caste bumblebees emerge from natal nests in summer, and after mating, enter hibernation until the following spring, when they found colonies and produce pollinating worker-caste bees. Research by our team and others demonstrates that bumblebees may be successfully overwintered in artificial refrigeration, and will accept artificial nesting boxes in laboratory conditions. In previous work with wild-caught queens of three *Bombus* species, we successfully induced colony development by 32-85% of individuals, and these colonies were placed in field sites where they visited flowers.

Mason bees nest in aggregations in preformed above-ground cavities and lack complex social behavior. Only a few species are commercially available, and none are sourced from wild bees in the northeastern US. Vermont has approximately 10 native *Osmia* species, however, and most have not been assessed for use as managed pollinators. In previous research, we deployed more than 5,000 paper nest straws in bundles at 10 Vermont farms and studied the diversity of *Osmia* and other bee species that nested in them.

To address these challenges with the use of alternative pollinators for US specialty crops, we proposed to develop rearing and husbandry methods that would allow farmers to manage small populations of locally-sourced native bumblebees and mason bees. Additionally, we proposed to address wild bee pollinator deficits by educating specialty crop growers to improve bee habitat on the lands they manage.

ACTIVITIES PERFORMED

Address the below sections as they relate to the entire project's period of performance.

OBJECTIVES

Provide the approved project's objectives.

#	Objective	Completed?	
		Yes	No*
1	Investigate species of mason bees native to Vermont (e.g. *Osmia lignaria*, *O. albiventris*, and *O. atriventris*) that are known to accept artificial nesting substrates.	X	
2	Increase population size of target mason bee species at 3-5 farms, allowing subsequent deployment of these bee stocks at other nearby farms.	X	
3	Develop techniques for captive overwintering of locally sourced wild bumblebee queens (including *Bombus impatiens*, *B. ternarius*, and *B. vagans*), and rearing of colonies to allow pollination of field and greenhouse crops.		X
4	Demonstrate experimentally that the use of these managed native bees can improve yield for Vermont specialty crop farmers.		X
5	Through outreach, education, and technical assistance, encourage Vermont farmers to adopt native bee management practices and improved habitat management for increased pollination of specialty crops.	X	

**If no is selected for any of the listed objectives, you must expand upon this in the challenges and lessons learned sections.*

ACCOMPLISHMENTS

List your accomplishments for the project's period of performance, including the impact they had on the project's beneficiaries, and indicate how these accomplishments assist in the fulfillment of your project's objective(s), outcome(s), and/or indicator(s).

Accomplishment/Impact	Relevance to Objective, Outcome, and/or Indicator
Inventory of cavity-nesting bees at 20+ VT farms over 3 years, and increase of mason bee populations at select farms	**Objectives #1 and #2** listed above. Outcomes addressed: **Outcome 4** (Enhance the competitiveness of specialty crops through greater capacity of sustainable practices of specialty crop production resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources) and **Outcome 5** (Enhance the competitiveness of specialty crops through more sustainable, diverse, and resilient specialty crop systems) of our proposal. **Indicators addressed: 2.a., 2.c., and 7,** in which we educated growers about natural history and pollination value of native bees. Some of our apple and blueberry grower cooperators adopted our methods, deploying their own nesting substrates for mason bees, and many reported increased awareness of the wild bees visiting their orchards in spring following interactions with our team. As part of the diversity study, we attempted

	to increase mason bee populations over successive years of nest block deployment, and have evidence that we were successful in some sites.
Investigated lab-based hibernation and rearing of VT bumble bee species for deployment on farms	Objective 3. Outcome 4, Indicator 2.a.(Of 150 specialty crop growers to whom we propose to provide education and on-farm technical assistance regarding wild bee pollinators, >100 will adopt our practices and will use managed, locally sourced, native bumblebee and mason bee species to improve pollination and yield.) and Outcome 5, Indicator 7 (We propose to develop two viable technologies and processes to manage locally sourced native bumblebees and mason bees for pollination of Vermont specialty crops. As part of this innovation, we will develop a kit of materials that growers can deploy on their own farms to use these bees in pollination of field and greenhouse crops, and we will complement this with technical assistance and, where appropriate, delivery of bee stocks to start this process.) In year one we collected gyne-caste (queen) bumblebees in fall and induced diapause (hibernation) under lab conditions. We intended to break diapause in January of the following year in order to rear bee colonies for pollination, but all bees died of unknown causes. In year two we did not collect fall bees, instead of allowing them to hibernate naturally, after which we collected them in spring as they searched for nest sites. We successfully reared these colonies in the lab and deployed them in greenhouses at two farms for pollination of tomato. Lab-reared colonies foraged at crop flowers and likely contributed to crop pollination, but were stressed by environmental conditions in greenhouses. As part of these efforts, we educated growers about the utility of native bumblebees as tomato pollinators, resulting in greater awareness of these bees and pledges to improve on-farm habitat conditions for them.
Outreach to growers on pollinator habitat improvement and effects of farm management on bee pollinators	Objective 5. Outcome 4, Indicator 3 (Through outreach events, technical publications, and on-farm consultation, we will educate local growers about farm management practices that improve nesting and foraging habitats for wild and managed crop pollinators. Through this work, we propose to influence maintenance and establishment of >1,000 acres of farmland that functions as high-quality bee pollinator habitat.). During the project, we made visits to each of more than 20 farms 3 times annually, interacting with growers in each of these field visits. We worked with one newly established specialty crop grower to evaluate her pollination requirements in the field and greenhouse crops. We educated hundreds of individual growers and other

	stakeholders in speaking engagements, including at conferences hosted by the Northeast Organic Farmers Association, the VT Tree Fruit Growers' Association, and the Northeast IPM Center Northern New England Pollinator Habitat Working Group. The feedback we received at these meetings indicated that producers of apple, blueberry, and other specialty crops were interested in improving nesting and foraging habitat for native bee pollinators.
Support VT specialty crop growers by improving yields via enhanced pollination service from managed and wild native bees	**Objective 4, Outcome 4, Indicator 2.a**. (Of 150 specialty crop growers to whom we propose to provide education and on-farm technical assistance regarding wild bee pollinators, >100 will adopt our practices and will use managed, locally sourced, native bumblebee and mason bee species to improve pollination and yield.). Related to this Objective, we visited farms during orchard bloom to census bees foraging at flowers. Identifying visitors to genus and/or species level and consulting the scientific literature, we conclude that some of the wild native bees visiting crop flowers deliver a significant ecosystem value as crop pollinators.

CHALLENGES AND DEVELOPMENTS

Provide any challenges to the completion of your project or any positive developments outside of the project's original intent that you experienced during this project. Also, provide the corrective actions you took to address these issues. If you did not attain an approved objective(s), outcome(s), and/or indicator(s), provide an explanation in the Corrective Actions column.

Challenge or Development	Corrective Actions or Project Change
Challenge: bumblebee diapause	As described above, we encountered difficulty with the hibernation of bumblebees under laboratory conditions. Many previous attempts to induce bumble bee diapause have resulted in the death of bees after a relatively short period of time, but we are uncertain why we (and others) encountered this problem. It's possible that the temperature and relative humidity of our hibernation chambers were inappropriate for bumblebees. It is also possible that bees did not complete diapause due to environmental or ecological factors, such as having failed to mate, having sequestered inadequate floral resources to support diapause or pathogen infection. Judging that solutions to this issue were beyond the scope of this project, in year two we adjusted our methods by rearing spring-caught queen bumblebees and had a high rate of success inducing nesting behaviors in the lab.
Challenge: bumblebee acclimation to greenhouse pollination conditions	We encountered a second problem in year two: when we deployed bumblebee colonies as farm pollinators, most colonies did not increase in size,

	perhaps due to the high and fluctuating temperature conditions inside greenhouses. Foraging by these small colonies was inadequate to meet greenhouse tomato pollination needs. In future work, we suggest that nest architecture is critical to bees' ability to thermoregulate, thus researchers should select a construction plan that will allow bees to both heat and cool the nest efficiently.
Challenge: use of trap nest straws by non-native (invasive) bee species	As part of our mason bee diversity survey (i.e., deployment of 'trap' nesting substrate, we observed that some VT farms harbor populations of a non-native mason bee, *Osmia cornifrons*. This species was introduced to Maryland, USA in the 1980s by USDA scientists as a promising crop pollinator. *O. cornifrons* may also have been introduced along with commercially available mason bee stock produced in Oregon, where the bee is also established. *O. cornifrons* is documented to have steadily spread outward from the introduction point, appearing in VT in the last decade. Our observations suggest that an invasion front exists in VT, with farms in the northern part of the state not yet hosting the bee. *O. cornifrons* is an excellent pollinator of the specialty crops that are the focus of this project, our observations suggest that it may compete with native species such as *O. lignaria* for nest sites. When we found *O. cornifrons* established at farms, we were reluctant to move nest substrates when this might be necessary to build native bee populations. However, we responded to this challenge by educating growers about the pollination value as well as environmental risks of managing for *O. cornifrons* populations. In some sites, our observations suggest that deployment of nesting substrate allowed this species to become more abundant, likely resulting in increased crop pollination.
Development: the importance of trap nest substrates for building/sustaining populations of natural enemies of crop pests	As expected, our trap nests were commonly occupied by some non-pollinating insects that nest in cavities. These include a diverse array of wasps, especially potter wasps (Eumenidae), and we frequently observed herbivorous pest insects—for example, lepidoptera larvae and grasshoppers—as prey in these nests. We responded to this by attempting to determine whether prey insects were also crop pests. More research is needed (and underway), and we expect this will demonstrate that deployment of artificial nest sites (i.e., trap nests) can benefit growers by increasing populations of natural enemies, possibly improving the ecosystem service of pest insect control.

Challenge, **Objective 3:** Develop techniques for captive overwintering of locally sourced wild bumblebee queens (including Bombus impatiens, B. ternarius, and B. vagans), and rearing of colonies to allow pollination of field and greenhouse crops.	When we were not able to develop hibernation/overwintering techniques with fall-collected bees, we shifted to working with spring-caught bees who had hibernated naturally. As detailed here, we successfully reared these bee colonies and deployed them to pollinate greenhouse crops on farms. We had intended to investigate this further in 2020 but were not able to secure a no-cost extension due to funding cycles of the state's block grant program.
Challenge, **Objective 4:** Demonstrate experimentally that the use of these managed native bees can improve yield for Vermont specialty crop farmers.	We planned to do single visit pollen deposition experiments with both mason bees and bumblebees, but have had difficulty establishing adequate populations of these bees. In response, we have collected bee visitation data in many of the orchards where we work and will attempt to estimate pollination service from managed bees from this data.
Challenge, **Outcome 4**, **Indicator 2a**: Of 150 specialty crop growers to whom we propose to provide education and on-farm technical assistance regarding wild bee pollinators, >100 will adopt our practices and will use managed, locally sourced, native bumblebee and mason bee species to improve pollination and yield.	As described above, we did not complete the development of a program to rear and deploy either mason bees or bumblebees. This means that while we distributed bee stocks to some growers, we were not able to make them available to all of our cooperators. However, during the life of the project, we interacted with hundreds of growers, educating them about the value of bee nest box deployment to attract wild bee pollinators. Based on these conversations, we know that we influenced many of these growers to improve habitat for pollinators and to deploy artificial nest habitat.
Challenge, **Outcome 4, Indicator 2c**: Of the >100 farmers who adopt the use of managed native bees to pollinate specialty crops, >75 will experience a measurable increase in pollination and yield, resulting in greater economic return and increased farm sustainability.	As detailed above, we did not complete the project to develop bee stocks that could be deployed widely on area farms, and we consequently were not able to do the single-visit pollen deposition work that would be necessary to demonstrate an increase in crop yield. Our efforts in this area on three VT farms where specialty crops are grown in greenhouses (to exclude spotted wing drosophila) were valuable in that we were able to collect valuable data about bees' responses to being confined and to environmental conditions. We expect to leverage these lessons in 2020 when we will complete a third (unfunded) season of research in this system.

LESSONS LEARNED

Provide recommendations or advice that others may use to improve their performance in implementing similar projects.

We encountered a number of challenges in this work and think others could benefit from understanding them. 1) Access to managed locally sourced bumble bee colonies would be valuable to growers, and we believe this is a compelling reason to study diapause of this insect under artificial conditions. To this end, future workers should investigate optimal temperature and humidity conditions for bumblebee overwintering. There is a need to identify whether queens have mated, as this can affect diapause. Gyne nutritional state upon entering diapause is critical, and future work could potentially assess this before initiating diapause. Relatedly, bees could be fed artificial nectar and pollen diets before diapause is

initiated. And, pathogen/parasite of gynes should be investigated before and after diapause. 2) As described above, lab-reared bumblebee colonies were sensitive to environmental fluctuations when deployed in greenhouses. We recommend the development of nest boxes with both ventilation and insulation that can be controlled by bees. We also note that greenhouse conditions present challenging conditions for both bumblebees and mason bees, and future work should explore mitigation strategies. As one example, bumblebee colonies should be situated in shaded areas where temperature fluctuations are minimal. Access to single crop resources (e.g., tomato pollen) may also be limited to bees, and more research is needed to understand whether bees need supplemental feeding.

The Vermont Agency of Agriculture would like to visit the Specialty Crop Block Grant Program grantees to showcase projects that strengthen the specialty crop industry in Vermont. Are you interested in participating in an interview to highlight your project? YES_x__ NO___

CONTINUATION AND DISSEMINATION OF RESULTS (IF APPLICABLE)

Describe your plans for continuing the project (sustainability; capacity building) and/or disseminating the project results.

Unfortunately, we did not take advantage of the full award made to this project. Because the research was proceeding more slowly than planned, in 2019 we made the decision to seek a one-year no-cost extension, but this was not possible due to Specialty Crop Block Program funding cycles. Despite this, we plan to continue some aspects of this work in 2020. In October 2019, we have hibernating trap nested bees and wasps in place at all farms. In spring, 2020, we will complete the third year of diversity sampling of these nests. After making identifications of insects that use these nests, we will summarize our results in a manuscript for peer-reviewed publication. We anticipate that this data will identify species of mason bees (Osmia) that have a high potential for management as pollinators using our trap nesting system, and will further study how populations of these bees can be increased. We plan to continue our investigations of the use of trap nests by natural enemies of crop pests such as potter wasps in 2020. And, we will spend more time consulting with cooperating farmers who wish to improve pollinator habitat around their farms.

BENEFICIARIES

A descriptor for the number of beneficiaries is not required.

Number of project beneficiaries:.....200

OUTCOME(S) AND INDICATOR(S)/SUB-INDICATOR(S)

Provide the results of the project outcome(s) and indicator(s) as approved in your State Plan and project proposal. The results of the outcome(s) and indicator(s) will be used to evaluate the performance of the SCBGP on a national level.

OUTCOME MEASURE(S)

Select the Outcome Measure(s) that were approved for your project.

- ☐ **Outcome 1**: Enhance the competitiveness of specialty crops through increased sales
- ☐ **Outcome 2**: Enhance the competitiveness of specialty crops through increased consumption
- ☐ **Outcome 3**: Enhance the competitiveness of specialty crops through increased access
- ☑ **Outcome 4**: Enhance the competitiveness of specialty crops through the greater capacity of sustainable practices of specialty crop production resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources
- ☑ **Outcome 5**: Enhance the competitiveness of specialty crops through more sustainable, diverse, and resilient specialty crop systems
- ☐ **Outcome 6**: Enhance the competitiveness of specialty crops through increasing the number of viable technologies to improve food safety
- ☑ **Outcome 7**: Enhance the competitiveness of specialty crops through increased understanding of the ecology of threats to food safety from microbial and chemical sources

☐ **Outcome 8**: Enhance the competitiveness of specialty crops through enhancing or improving the economy as a result of specialty crop development

OUTCOME INDICATOR(S)

Provide the indicator approved for your project and the related quantifiable result. If you have multiple outcomes and/or indicators, repeat this for each outcome/indicator.

#	Outcome and Indicator	Quantifiable Results
1	**Outcome 4, Indicator 2a** (Of 150 specialty crop growers to whom we propose to provide education and on-farm technical assistance regarding wild bee pollinators, >100 will adopt our practices and will use managed, locally sourced, native bumblebee and mason bee species to improve pollination and yield.)	We have interacted with ~200 VT growers and landowners in on-farm conversations, formal presentations, and other communication regarding the use of native bees as specialty crop pollinators. While it is difficult to quantify adoption of our practices, we are confident that most of the cooperating growers at whose farms we sited nest boxes have worked to improve habitat conditions for bee pollinators, and many have expressed interest in providing their own nest substrate similar to the trap nest designs we brought to them. When we have given presentations to growers, we interacted with many attendees who said they were motivated to bring mason bees to their orchards as pollinators. These trends are encouraging, however, we caution that the technical nature of bee rearing practices presents a challenge for those not trained to do it, and future efforts should be aimed at providing growers with the materials and bee stocks necessary to grow populations of native pollinators in their areas.
2	**Outcome 4, Indicator 2c** (Of the >100 farmers who adopt the use of managed native bees to pollinate specialty crops, >75 will experience a measurable increase in pollination and yield, resulting in greater economic return and increased farm sustainability.)	While we were successful in transmitting information on native bee pollination and management to many specialty crop growers, we are not able to verify that farms experienced increased economic return as a result of our work.
3	**Outcome 4, Indicator 3** (Through outreach events, technical publications, and on-farm consultation, we will educate local growers about farm management practices that improve nesting and foraging habitats for wild and managed crop pollinators. Through this work, we propose to influence maintenance and establishment of >1,000 acres of farmland that functions as a high-quality bee pollinator habitat.)	As stated above, we interfaced with growers in numerous outreach events and on-farm consultations. We are not able to verify specific farm area actively influenced by our efforts, however, the lands managed by the growers and others we have provided consultation to total substantially more than 1,000 acres, and we know that many of these growers have implemented pollinator habitat improvement practices.
4	**Outcome 5, Indicator 7** (We propose to develop two viable technologies and processes to manage locally sourced native bumblebees and mason bees for pollination of Vermont specialty crops. As part of this innovation, we will develop a kit of materials that growers can deploy on their own farms to use these bees in pollination of field and greenhouse crops, and we will complement this	As described above, our efforts to develop a system for the management of native bumblebees on farms have not yet been successful. We continue to believe this idea has merit, and have identified (above) some challenges that must be addressed before this goal can be realized.

	with technical assistance and, where appropriate, delivery of bee stocks to start this process.)	We can report partial completion of the second technology, a suite of materials related to the use of mason bees as orchard pollinators. We have shared trap nests and trap nest designs with growers. We have provided technical consultations to many on the natural history and habitat needs of these bees. In ~5 cases, we moved bee stocks short distances to provide growers with mason bees for pollination. We subsequently monitored reproduction and population growth of these bees and provided ongoing support on how to improve this system. We have data showing that some of these efforts at population growth have not succeeded, and we will continue to monitor these nests in 2020.

DATA COLLECTION

For each outcome and indicator, explain what data was collected, how it was collected, the evaluation methods used, and how the data was analyzed to derive the quantifiable indicator.

Outcome 4, Indicator 2a: for this Indicator, our work involved the dissemination of information, not a collection of data.

Outcome 4, Indicator 2c: to measure contribution to pollination, we conducted observations of bees at flowers at a subset of the farms in each year of the study. These non-lethal surveys required that we record bee identity to whatever taxonomic level possible, usually genus. We intend to analyze this data to look for correlations between our deployment of nesting boxes and the abundance of twig-nesting bees foraging at flowers. While we lack an objective measure of pollination service to these farms before we augmented nesting substrate, we expect that our data can give a relative measure of how native bees contribute to orchard pollination.

Outcome 4, Indicator 3: our data on this Indicator consist of tables of cooperating growers, our estimates of their farm acreage, and records of attendance and communication with those who attended our outreach presentations.

Outcome 5, Indicator 7: for our bumblebee work, we collected data on the dates and locations we collected live queen-caste bees for the project; the temperature, humidity, and duration of artificial hibernation; the amount of nectar consumed daily by bees initiating nests in the lab; the dates of egg-laying, pupation, and worker emergence; and foraging activity of these colonies once placed in field situations. For the mason bee work, we recorded the number of nest straws of three diameters occupied each year by insects, and we tracked the proportion of straws sealed with various materials, including chewed leaves, mud, and mixtures of soil and plant parts. We forced insects to emerge from subsets of straws in lab conditions, recording the type of soil/plant materials used by each to cap their nests. We are in the process of identifying all insects collected in this effort and will link each taxon with its nest capping material, allowing us in the future to identify bees and other users of the nests based on the types of nest materials they incorporate. We have retained pollen samples from some of these nests, and in future work hope to study whether this pollen was collected from the focal specialty crop (which would indicate a likely pollinator) or from some other flowering plants.

FEDERAL PROJECT EXPENDITURES TO DATE

EXPENDITURES

Cost Category	Amount Approved in Budget (SCBGP Funds Only)	Actual Federal Expenditures (SCBGP Funds Only)	Match Expenditures	Match Source
Personnel	$10,426.00	$10,986.06	$10,540.69	L. Richardson labor
Fringe Benefits	$4,395.00	$4,157.75		
Travel	$864.00	$845.00	$3,817.84	Travel, L. Richardson and consultant
Equipment	$0	$0	$4,500.00	Use of consultant's tools and shop
Supplies	$8,650.00	$3,395.62		
Contractual	$11,720.00	$4,600.50	$13,335.00	Contractor time not compensated by grant
Other	$0	$0		
Direct Costs Subtotal	$36,055.00	$23.984.93		
Indirect Costs	$0	$0	$13,431.56	Waived F&A
Total Federal Costs	$36,055.00	$23.984.93		

PROGRAM INCOME

Source/Nature (i.e., registration fees)	Amount Approved in Budget	Actual Amount Earned
N/A		
Total Program Income Earned	0	0

Use of Program Income *Describe how the earned program income was used to further the objectives of this project.*
N/A

ADDITIONAL INFORMATION

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

PROJECT 5 INFORMATION

Project Title	Increasing the Competitiveness of the Vermont Wine Industry in Vermont Restaurants.			
Recipient Organization Name:	Vermont Fresh Network			
Period of Performance:	**Start Date:**	10/3/2016	**End Date:**	12/31/2018
Recipient's Project Contact				
Name:	Helen Labun			
Phone:	802-434-2000			
Email:	helen@vermontfresh.net			

PROJECT BACKGROUND

Provide enough information for the reader to understand the importance or context of the project. This section may draw from the background and justification contained in the approved project profile.

The Vermont wine industry has not been readily embraced by the Vermont restaurant trade in the same way that Vermont beer and cider have. There are a variety of factors that may contribute to this condition, not the least of which may be the vast amount of competitively priced wines from better-known wine production regions around the world. However, with the rise of interest in the regional culinary character, travelers are a target audience for foods and beverages that represent the taste of the place they are visiting. Vermont wines have tremendous potential to enhance a diner's experience but it takes a knowledgeable and enthusiastic server to help a customer understand and select the relatively unknown and unfamiliar Vermont wines. The Vermont wine industry is young and is seeking to improve in the vineyard, the tank room, and the tasting room. This project included forums, workshops, interviews, and field trips that increased connections between the Vermont restaurant industry and Vermont winemakers in an effort to both increase restaurants' knowledge of Vermont wine and identify strategic intervention points for enhancing the overall reputation of Vermont wine. We anticipate that this project will build a strong foundation for future work and collaboration between the Vermont Fresh Network and the Vermont Grape and Wine Council.

ACTIVITIES PERFORMED

Address the below sections as they relate to the entire project's period of performance.

OBJECTIVES

Provide the approved project's objectives.

#	Objective	Completed?	
		Yes	No*
1	Strengthen the connection and communication between Vermont grape growers, vintners, distributors, and culinary professionals.	X	
2	Establish baseline data of Vermont wine sales to Vermont restaurants.	X	
3	Facilitate educational and experiential activities among Vermont grape growers, vintners, distributors, and culinary professionals about each other's sector of the Vermont wine industry.	X	
4	Identify real barriers to serving Vermont wines in restaurants.	X	
5	Identify improvements/solutions worth investing in by specific stakeholders to have the greatest impact on increasing the sales of Vermont wine at Vermont restaurants.	X	
6	Increase the sales of Vermont wines to Vermont restaurants.	X	

**If no is selected for any of the listed objectives, you must expand upon this in the challenges and lessons learned sections.*

ACCOMPLISHMENTS

List your accomplishments for the project's period of performance, including the impact they had on the project's beneficiaries, and indicate how these accomplishments assist in the fulfillment of your project's objective(s), outcome(s), and/or indicator(s).

Accomplishment/Impact	Relevance to Objective, Outcome, and/or Indicator
We held three field trips (Eden Ice Cider, Lincoln Peak Vineyard, Shelburne Vineyard), three workshops (peer-based wine evaluation, restaurant buyer wine evaluation, creative wine pairings), and two webinars (distribution to restaurants and telling your winery's story).	This work provided educational opportunities (**Objective 3**) and facilitated conversations between culinary and agricultural stakeholders (**Objective 1**).
We held wine tasting & meet the maker events at 13 restaurants, held a pairing event for unusual wines and creative foods, and featured Vermont wine education at the VFN Annual Forum, these events reached both the public and industry	This work supported **Objectives 1 & 3** – see "Challenges" below for why
[Interviewed 28 professionals engaged in VT wine in different ways (distributors, writers, wine sellers, restaurant buyers, agronomists, winemakers, etc) and used this information to create a report on perceived barriers to wine sales, a report on wine tasting & description for Vermont grapes, a guide to Vermont grapes, and a web page combining these materials with notes from all of our events.	This supported data collection (**Objective 2**) and identifying key issues and potential solutions (**Objective 4**).

CHALLENGES AND DEVELOPMENTS

Provide any challenges to the completion of your project or any positive developments outside of the project's original intent that you experienced during this project. Also, provide the corrective actions you took to address these issues. If you did not attain an approved objective(s), outcome(s), and/or indicator(s), provide an explanation in the Corrective Actions column.

Challenge	Corrective Actions
In terms of Objective 6, while we anecdotally know wine sales to restaurants are slowly increasing, collecting data proved more challenging than we had anticipated. Data collection was difficult for a few reasons, but in large part, because VT wine sold to on-premise accounts is such a small sliver of distributors' portfolios it wasn't normally tracked and it fluctuated from year to year – we need more volume and more years to see any clear trend.	As we engage distributors more in local wine promotion and ask regularly for data, it should become more straightforward and we will be better able to see trend lines. We realized we need to do more restaurant staff training, so they can speak to the customers about VT wine, starting with basic Wine 101 and wine & food pairing workshops.
As noted in earlier status reports, we originally conceived of this project as industry-facing only and quickly learned that neither the producers nor the culinary side was satisfied with that. Both sets of professionals were more likely to participate if the public was also involved.	Objective 5 had us thinking creatively about how to involve the public, knowing that if the public has a good experience with VT wine, they are more likely to ask for it at VT restaurants, thus selling more VT wine in restaurants. To that end, we added public facing components, including Vermont Wine Week, a pairing workshop open to the public, and developed educational materials that can be used to communicate with the public. Our professionals-reached numbers (in the indicators section) will be a little lower than projected, but we augmented with members of the public reached. In a next phase, we aim to incorporate agritourism and

	marketing, placing wineries on culinary trails and promoting the trails. We have also identified the need for more trainings for culinary staff around VT wine.

LESSONS LEARNED

Provide recommendations or advice that others may use to improve their performance in implementing similar projects.

In our original work plan for this grant, we outlined groups of professionals we wanted to target (beverage managers, front of house staff, etc.) We would have had better luck focusing on who was already a strong proponent of Vermont wine, from whatever perspective, and building outward through those people's networks. We can craft as many materials and objective explanations for why Vermont wine deserves attention as we want, but until a culinary professional hears that pitch from someone we trust, we are going to have a difficult time making an impact. Amplifying the voice of the existing proponents is the quickest path to greater sales. We also should have done a more thorough review of the starting point for Vermont winemakers – there's a lot of work to be done in this arena *before* involving chefs, the winemakers have not shared much information with each other regarding restaurant sales and best practices, and that led to significant unevenness when trying to present the industry to restaurant buyers.

CONTINUATION AND DISSEMINATION OF RESULTS (IF APPLICABLE)

Describe your plans for continuing the project (sustainability; capacity building) and/or disseminating the project results.

We have received a second Specialty Crop Block Grant that builds on the work in this grant. During this next year, the Vermont Fresh Network will look more closely at how we're integrating Vermont wine promotion into our ongoing work, and also how we can support the Vermont Grape & Wine Council in building their capacity to engage the restaurant market.

BENEFICIARIES

A descriptor for the number of beneficiaries is not required.

Number of project beneficiaries: 95

OUTCOME(S) AND INDICATOR(S)/SUB-INDICATOR(S)

Provide the results of the project outcome(s) and indicator(s) as approved in your State Plan and project proposal. The results of the outcome(s) and indicator(s) will be used to evaluate the performance of the SCBGP on a national level.

OUTCOME MEASURE(S)

Select the Outcome Measure(s) that were approved for your project.

- ☑ **Outcome 1**: Enhance the competitiveness of specialty crops through increased sales
- ☐ **Outcome 2**: Enhance the competitiveness of specialty crops through increased consumption
- ☑ **Outcome 3**: Enhance the competitiveness of specialty crops through increased access
- ☐ **Outcome 4**: Enhance the competitiveness of specialty crops though greater capacity of sustainable practices of specialty crop production resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources
- ☐ **Outcome 5**: Enhance the competitiveness of specialty crops through more sustainable, diverse, and resilient specialty crop systems
- ☐ **Outcome 6**: Enhance the competitiveness of specialty crops through increasing the number of viable technologies to improve food safety
- ☐ **Outcome 7**: Enhance the competitiveness of specialty crops through increased understanding of the ecology of threats to food safety from microbial and chemical sources

☐ **Outcome 8**: Enhance the competitiveness of specialty crops through enhancing or improving the economy as a result of specialty crop development

OUTCOME INDICATOR(S)

Provide the indicator approved for your project and the related quantifiable result. If you have multiple outcomes and/or indicators, repeat this for each outcome/indicator.

#	Outcome and Indicator	Quantifiable Results
1	**Outcome 1:** Enhance the competitiveness of specialty crops through increased access, indicated by 15% increase in on-premise sales.	We began with 868 cases of Vermont wine distributed to restaurants (2016 numbers), and at the end of the grant (2018 numbers) had reached 970, an increase of 12% - close to our goal within our margin of error. Case prices vary from $108 to $300 (ice wine) and we consider the average to be $145. Therefore, sales increased from $125,860 (868 cases) to $140,650 (970 cases).
2	**Outcome 3, Indicator 2a:** We seek to enhance the competitiveness of Vermont wines through increased familiarity and knowledge of Vermont wines by culinary and front-of-the-house professionals. Of the 70 culinary and front-of-the-house professionals who participate in this project, 55 will gain knowledge of how Vermont grapes are grown and how Vermont wines are produced.	Participants in our events expressed a nearly universal sentiment that they learned valuable information (3 had a very high starting level and felt they did not gain new knowledge). As discussed in challenges, we found a need to diversify our audience for our events. We also found more background work needed with the winemakers before bringing in restaurant staff. That shifted the make-up of participants over the course of the grant, and we ended up with only 47 culinary professionals participating in educational events.
3	**Outcome 3, Indicator 2b:** We seek to enhance the competitiveness of Vermont wines through increased access to Vermont wines by culinary and front-of-the-house professionals. Of the 70 culinary and front-of-the-house professionals who participate in this project, 45 will report an intention to increase their access to Vermont wines.	We did not reach this goal for two very specific reasons – 1. Not everyone participating had full control over purchasing decisions, they could only say they would *advocate* for more Vermont wines and more importantly 2. buyers felt that they couldn't make a commitment without a specific conversation about price, which was out of VFN's control but is something that winemakers are working on with distributors.
4	**Outcome 3, Indicator 3i**: We seek to enhance the competitiveness of Vermont wines through increased access to restaurants. Of the 120 restaurants reached, 40 will expand or improve their offering of Vermont wines. We will specifically track the increased purchasing of Vermont wines from the culinary professionals that directly participate in this project, as well as the number of Vermont wines they offer on their wine list.	This was a poorly crafted indicator on our part. Partially this is because we didn't realize that we can't access restaurant-specific data (only aggregated) and partly because the current goal is to expand the volume sold from the *existing* Vermont wines on their menu, which will indicate the demand, which will, in turn, encourage bringing on more types of wine. To look at the variety of wines before building up the volume of standard offerings is skipping a step.

DATA COLLECTION

Explain what data was collected, how it was collected, the evaluation methods used, and how the data was analyzed to derive the quantifiable indicator.

We collected wine sales from reports by distributors and self-distributing wineries, we took attendance at events, we conducted in-depth interviews with 28 leaders in Vermont wine, we collected written responses to prompting questions from attendees at some events (it depended on the type of event), and we had group discussion leaders record notes (again, depending on event type). We attempted surveys at the beginning of the project; due to a combination of low response rates and also a small number of people we were targeting for those responses we decided it would be easier to simply talk to each of them and gather the information that way.

FEDERAL PROJECT EXPENDITURES TO DATE

EXPENDITURES

Cost Category	Amount Approved in Budget (SCBGP Funds Only)	Actual Federal Expenditures (SCBGP Funds Only)	Match Expenditures	Match Source
Personnel	17,000	18,272	4,000	VT Grape & Wine, Workshop Leaders
Fringe Benefits				
Travel			2,000	VFN, Cornell Extension, VT Grape & Wine
Equipment				
Supplies	500	500		
Contractual				
Other	2500	1228	5,000	Host venues – space, supplies & food (The Essex, Hotel Vermont, Quarry Hill, Mad River Taste Place, Eden Cider, Lincoln Peak, Shelburne Vineyard),
Direct Costs Subtotal	20,000	20,000	11,000	
Indirect Costs	- 0	-0		
Total Federal Costs	20,000	20,000		

PROGRAM INCOME

Source/Nature (i.e., registration fees)	Amount Approved in Budget	Actual Amount Earned
Registration Fees		$730
Total Program Income Earned		$730

Use of Program Income *Describe how the earned program income was used to further the objectives of this project.*
We used all program income directly to pay for VFN staff time to develop reports and educational materials following that program

ADDITIONAL INFORMATION

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

Be sure to include any documents, publications, or other attachments referenced throughout the report. If the attachments are large, you may consider combining them as an appendix to the full report and submitting the appendix as a separate PDF file. ***Please copy and paste materials into this report and/or submit a single PDF appendix file. Do not submit more than one appendix.***

All of our additional information is available online at https://vermontfresh.net/programs/vermont-wine-project/. It includes multi-media clips that cannot be transmitted via PDF.

PROJECT 6 INFORMATION

Project Title	Leek Moth Monitoring and Management Study			
Recipient Organization Name:	University of Vermont			
Period of Performance:	**Start Date:**	12/6/2016	**End Date:**	8/31/2019
Recipient's Project Contact				
Name:	Victor Izzo			
Phone:	802-999-6906			
Email:	vizzo@uvm.edu			

PROJECT BACKGROUND

Provide enough information for the reader to understand the importance or context of the project. This section may draw from the background and justification contained in the approved project profile.

Leek moth (LM) is an invasive pest severely affecting allium production in the Northeast. First positively identified in northern New York in 2010, the invasive distribution now includes New Hampshire, Maine, and Vermont. According to our recent monitoring efforts in Vermont, 75% of surveyed vegetable growers in the region with significant plots of alliums are experiencing leek moth damage. We estimate that the LM assemblage is expanding southward at approximately 33 miles/year. As such, the pest is projected to reach Connecticut by 2021.

Leek moth larvae feed internally on host plants and are therefore difficult to manage via chemical sprays. Consequently, few management tactics are proving effective for organic growers. LM is especially of concern for Northeastern diversified vegetable growers, as alliums represent a high-value and low investment crop.

Allium crops constitute a valuable portion of the local fresh vegetable market in Vermont, and therefore, represent a high-risk area for LM infestations. At least 120 small farms within Vermont currently grow allium crops exceeding a total of 110 acres. In Vermont, alliums cumulatively represent the 8th largest vegetable crop by acreage. In addition, the majority (66%) of regional allium growers responding to recent surveys indicated some degree of LM damage.

Provided the central location of Vermont within the LM's invasion front, this project is especially relevant and timely. As LM advances through the region there is little research being conducted to prevent or reduce the pest's impact on allium crops. Previous research efforts led by Dr. Masanori Seto and the Cornell Cooperative Extension (CCE) have recently come to a close. As a result, our team represents the only research group actively working with the pest within the USA.

To best address the expanding LM invasion and its potential impact for organic growers our team executed a three-part study including the following objectives: (1) statewide monitoring, (2) management trials and (3) outreach. This project assessed the seasonal phenology and statewide distribution of LM while also testing cultural LM control tactics and disseminated results via online outreach, regional workshops and field days.

ACTIVITIES PERFORMED

Address the below sections as they relate to the entire project's period of performance.

OBJECTIVES

Provide the approved project's objectives.

#	Objective	Completed?	
		Yes	No*

1	The monitoring program will include an extensive sampling effort throughout the leek moth's known and potential distribution. The objective of the monitoring program will be to describe the current distribution of the pest and to assess its local phenology – information without which effective management is impossible.	X	
2	Management trials will involve the testing of two IPM strategies, cultural (varietal trials) and physical (row cover exclusion). The objective of the management trials will be to evaluate possible IPM tactics for LM control.	X	
3	The outreach program will integrate participatory action methods of research whereby growers will inform trial design and information gained from trials will be shared via farmer-to-farmer networks. The objective of the outreach program will be to effectively extend information from our research trials and monitoring program to growers while strengthening the research trials themselves.	X	
4			

**If no is selected for any of the listed objectives, you must expand upon this in the challenges and lessons learned sections.*

ACCOMPLISHMENTS

List your accomplishments for the project's period of performance, including the impact they had on the project's beneficiaries, and indicate how these accomplishments assist in the fulfillment of your project's objective(s), outcome(s), and/or indicator(s).

Accomplishment/Impact	Relevance to Objective, Outcome, and/or Indicator
During these past three growing seasons (2017-2019) we conducted a statewide leek moth (LM) monitoring program in concert with the proposed onion varietal trials. Our monitoring program generally documented the southeastern expansion of the LM throughout Vermont. The current LM distribution includes all counties excluding Windsor, Windham and Bennington counties. Though the severity of infestations varied geographically and across seasons, the largest infestations are typically found in the northwest regions of the state (Chittenden and Franklin counties). Moreover, according to reports shared by several participating growers, it seems that areas experiencing leek moth for an extended period of time (e.g. 3+ years) tend to exhibit a decreasing amount of LM damage through time. It is important to note, LM trap numbers did not decrease in these established regions over the past several years, only the associated damage. Hypothetically, the reduced incidence of LM damage may represent an ecological response (e.g. increases in biological control agents) to the original LM perturbation.	**Objective 1**: The monitoring program will include an extensive sampling effort throughout the leek moth's known and potential distribution. The objective of the monitoring program will be to describe the current distribution of the pest and to assess its local phenology – information without which effective management is impossible. We successfully established and documented the current distribution, local phenology, and invasive potential of LM within Vermont.
We completed three separate onion variety trials, to address differences among varieties (red versus yellow) and cultivars (six per variety). For all trials, we assessed plots for preharvest foliar damage and marketable damage during curing and subsequent storage (6 months). In year 1 of our project, we tested 6 varieties of yellow onions for LM susceptibility. Damage incidence was high for all cultivars (>75%) and there was no significant variation among cultivars. In year 2 we tested 6	**Objective 2:** Management trials will involve the testing of two IPM strategies, cultural (varietal trials) and physical (row cover exclusion). The objective of the management trials will be to evaluate possible IPM tactics for LM control. Due to feedback from growers during our first field season, that row cover was not an interesting and/or needed topic to explore, we decided to focus

cultivars of red onions. Both preharvest (i.e.leaf mines) and storage damage (i.e. bulb tunnels) were minimal across all red onion cultivars. These results are in stark contrast from our 2017 yellow onion trials. Due to the contrasting results of our red and yellow onion trials, and the possibility of seasonal differences in leek moth damage, we performed a 1x1 onion trial in 2019. We selected the two best performing red and yellow onion varieties to directly assess LM preference. We also partnered with Anatis Bioprotection to pilot the release of the parasitoid wasp *Trichogramma brassicae* in onion plantings in 2018. We parlay the pilot project executed with SCBG fund to secure SARE grant funding for extensive testing of the parasitoid wasp protocol. This past season (2019) we performed a large replicated study across the northwest region of the state. Data is currently being analyzed but preliminary assessments seem to support the use of the wasp as part of an LM IPM strategy.	our IPM strategies on varietal differences and the piloting of a biological control agent.
As part of our outreach program, we hosted two leek moth field days at the University of Vermont's Horticultural Research and Education Center. The field days were both well attended (over 20 participants) and co-hosted with Northeast Organic Farming Association-Vermont (NOFA-VT) as part of their summer field day series. In addition, we shared our work at two Crops and Soils Field Days in collaboration with The University of Vermont (UVM) Extension Northwest Crops and Soils Program. We also presented our results at the 2018 and 2019 Vermont Vegetable and Berry Growers Association (VVBGA) annual conference. We posted LM updates throughout the season on the VVGBA listserve. We have also been invited to present at the 2019 New England Vegetable & Fruit Conference this coming winter. As part of our commitment to outreach, we also aided in the updating and maintenance of the Leek Moth Information Center, https://nysipm.cornell.edu/agriculture/vegetables/leek-moth/leek-moth-information-center-team/ Finally, as part of our on-going PAR work, we have been working directly with a subset of collaborating growers to best adapt and modify our pest management protocols for LM, including Catamount Farm, Jericho Settlers, Intervale Community Farm, Bear Roots Farm, Golden Russet Farm, and many	**Objective 3:** The outreach program will integrate participatory action methods of research whereby growers will inform trial design and information gained from trials will be shared via farmer-to-farmer networks. The objective of the outreach program will be to effectively extend information from our research trials and monitoring program to growers while strengthening the research trials themselves. Our well-attended field days, conferences and PAR meetings provided us the opportunity to best distribute our data and techniques to best assist growers in developing a successful IPM program for addressing issues associated with LM and LM damage.

others. To best facilitate farmer to farmer sharing, we host annual "farmer feedback" meetings with 10-15 Vermont growers and other stakeholders.	

CHALLENGES AND DEVELOPMENTS

Provide any challenges to the completion of your project or any positive developments outside of the project's original intent that you experienced during this project. Also, provide the corrective actions you took to address these issues. If you did not attain an approved objective(s), outcome(s), and/or indicator(s), provide an explanation in the Corrective Actions column.

Challenge or Development	Corrective Actions or Project Change
One major challenge (shared below) that our team faced during the outset of the project included the lack of dependability in grower data collection. Generally, growers provided a wealth of monitoring data from their farms. However, due to the ebb and flow of the growing season, the consistency and constancy of data collection significantly varied across sites.	To best address this issue, we added a set of technician-monitored traps in each county to validate local grower data and establish a dependable dataset to best estimate the phenology of the moth.
In response to explicit interest from local growers on the possibility of biological control strategies, we partnered with Anatis Bioprotection to pilot the release of the parasitoid wasp *Trichogramma brassicae* in onion plantings in 2018.	Though the scale of the pilot plots precluded us from determining the efficacy of the biocontrol agent, we parlayed the preliminary data and documented grower interest into a SARE R&E grant proposal. This proposal was awarded full funding for three years (2019-2021) to further investigate the potential of this biological control agent and the assessment of other cultural control tactics.

LESSONS LEARNED

Provide recommendations or advice that others may use to improve their performance in implementing similar projects.

One major "lesson learned" from our project centered upon the expectations and quality control of farmer-led monitoring programs. Understandably, data collection effort and accuracy varied considerably across farms. In our estimation, this variability was likely a result of a gross miscalculation of grower bandwidth. During our initial year of monitoring, our team displayed a lenient approach to our in-season data validation. We assumed that limited communication from some participating growers indicated a successful educational program rather than grower confusion and/or waning engagement. However, we quickly realized via our web-based data entry form that many growers were failing to post their trap counts. To best address this issue, we added a set of technician-monitored traps in each county to validate local grower data, fill in the gaps, and establish a dependable dataset to best estimate the phenology of the moth.

This strategy of pairing research data with grower sourced data seemed to be a viable solution. This provided us the opportunity to collect dependable phenology data, while still supporting farmer-led monitoring programs. Furthermore, those growers taking the lead on their own monitoring were able to easily receive their own real-time information on the state of the LM population in their fields regardless of their participation in the regional data collection effort.

The Vermont Agency of Agriculture would like to visit Specialty Crop Block Grant Program grantees to showcase projects that strengthen the specialty crop industry in Vermont. Are you interested in participating in an interview to highlight your project? YES_X__ NO___

CONTINUATION AND DISSEMINATION OF RESULTS (IF APPLICABLE)

Describe your plans for continuing the project (sustainability; capacity building) and/or disseminating the project results.

The results from this project, particularly the varietal trial data, will be further disseminated in upcoming regional and Vermont Veg and Berry conferences. We have been attending VT NOFA and VVBGA meetings since the first season of our grant to share our yearly results. Moreover, we are currently drafting the first of two academic manuscripts on LM to be submitted to the Journal of Economic Entomology and Journal of Pest Management.

This project will also be summarily continued as part of a recently funded SARE R&E grant. Though the scope of the upcoming grant is primarily focused upon the development of a biological control protocol, we will be continuing our monitoring program throughout the northern region of the state.

BENEFICIARIES

A descriptor for the number of beneficiaries is not required.

Number of project beneficiaries: 50

OUTCOME(S) AND INDICATOR(S)/SUB-INDICATOR(S)

Provide the results of the project outcome(s) and indicator(s) as approved in your State Plan and project proposal. The results of the outcome(s) and indicator(s) will be used to evaluate the performance of the SCBGP on a national level.

OUTCOME MEASURE(S)

Select the Outcome Measure(s) that were approved for your project.

- ☐ **Outcome 1**: Enhance the competitiveness of specialty crops through increased sales
- ☐ **Outcome 2**: Enhance the competitiveness of specialty crops through increased consumption
- ☐ **Outcome 3**: Enhance the competitiveness of specialty crops through increased access
- ☑ **Outcome 4**: Enhance the competitiveness of specialty crops though greater capacity of sustainable practices of specialty crop production resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources
- ☑ **Outcome 5**: Enhance the competitiveness of specialty crops through more sustainable, diverse, and resilient specialty crop systems
- ☐ **Outcome 6**: Enhance the competitiveness of specialty crops through increasing the number of viable technologies to improve food safety
- ☐ **Outcome 7**: Enhance the competitiveness of specialty crops through increased understanding of the ecology of threats to food safety from microbial and chemical sources
- ☐ **Outcome 8**: Enhance the competitiveness of specialty crops through enhancing or improving the economy as a result of specialty crop development

OUTCOME INDICATOR(S)

Provide the indicator approved for your project and the related quantifiable result. If you have multiple outcomes and/or indicators, repeat this for each outcome/indicator.

#	Outcome/Indicator	Quantifiable Results
1	**Outcome 4, indicator 2.a:** Fifty growers adopting the monitoring protocol	Statewide monitoring of leek moth incidence throughout Vermont was conducted. We distributed traps in all Vermont counties and monitored them throughout the season. After three years of monitoring, we have trained over 40 Vermont farmers in the monitoring protocol and aided them in successfully using the trap data for control.
2	**Outcome 5, indicator 2:**	The use of leek moth lures and traps along with various preventative control strategies have

	1 innovation adopted (trapping and monitoring)	proven to be an effective innovation. Over 40 growers have utilized this technique with the assistance of our technical support in the past three years.
3	**Outcome 5, indicator 7:** Number of viable technologies/processes developed or modified that will increase specialty crop distribution and/or production__3__	We also tested for varietal differences in leek moth susceptibility among both red and yellow onion cultivars. We determined that red onions are less susceptible to leek moth damage. In addition, pre-harvest foliar damage from leek moth (in onions) did not exhibit significant yield costs in our field trials. Our study suggests that the primary risk for onion growers, as it relates to leek moth, is damage occurring during curing/storage. Any larvae feeding during these time periods are more likely to impart significant marketable damage directly to onion bulbs. The knowledge generated by our varietal trials combined with the monitoring/trapping data may prove important for on-farm decision making regarding onion seed selection, in-field management (e.g. spray timing) and post-harvest protocols
4	**Outcome 5, indicator 6:** Trained 20 first responders in early detection and rapid response to combat LM	We also trained ~ 10 VT extension and first responders in the monitoring protocol including, Heather Darby, Abha Gupta, Vern Grubinger, Becky Madden, and Ann Hazelrigg. They have in turn extended their knowledge to their networks within the region including their own first responder technicians.
5	**Outcome 5, indicator 8:** Number of growers/producers that gained knowledge about science-based tools through outreach and education programs – 500	Over the course of the 2.5 years (2 years plus ½ year no-cost extension) of our project our team presented our research at 6 workshops & field days, 3 grower conferences and two national academic meetings. Our outreach audience far surpassed our target numbers (> 500 participants) and our research seems to have made it out to the rest of the region (personal communication from UMASS and MOFGA associates). We also developed a research brief on our research. The brief can be found here: https://www.uvm.edu/agroecology/vepart-publishes-new-research-brief/

DATA COLLECTION

For each outcome and indicator, explain what data was collected, how it was collected, the evaluation methods used, and how the data was analyzed to derive the quantifiable indicator.

Outcome 4, indicator 2.a:

Fifty growers adopting the monitoring protocol

Thirty-five growers with significant acreage in allium crops were selected via consultation with regional extension agents during 2017. By the last year of the project (2019), we actively trained approximately forty growers in the use of the monitoring protocol. In informal communications and surveys, these growers have consistently expressed their satisfaction with our outreach program and have consistently reached out to our team for added support and supplies each of the last two years.

Outcome 5, indicator 2:

1 innovation adopted (trapping and monitoring)

The same 40 growers, referenced in outcome 4, have consistently used the monitoring traps and lures in the past two years. Estimation of adoption may be verified by the number of lures that our team distributed to these growers over the course of the project and the surveys we distributed in 2017 and 2018.

Outcome 5, indicator 7:

Number of viable technologies/processes developed or modified that will increase specialty crop distribution and/or production 3

Leek Moth Monitoring Protocol

To determine the phenology of the moth within our region, we conducted multiple years of emergence and flight population data. Data collected to estimate the phenology of LM in Vermont included weekly trap counts across VT. These trap counts were then plotted geographically to assess any significant variability among regions both within and among years. Though the contribution of the development and distribution of the protocol to a reduction in LM damage or control was not directly measured. The adoption rate of growers and the increased knowledge of the LM (as recorded via our surveys) provides documentation and validation for the utility of the monitoring program for allium production.

Varietal Trials

We assessed the variability in LM susceptibility among onion varietals using a randomized complete block design with variety/cultivar as the treatment (fixed effect). We recorded above-ground damage incidence and yield for each of the three varietal trials. We determined that the reduced amount of leek moth damage in red onions may provide onion growers, dealing with a significant LM infestation, a strategy to reduce their economic risk by focusing on red onion production over yellow.

Both our monitoring protocol and varietal trial experiments generated valuable data/information for growers to consider when managing leek moth populations.

Outcome 5, indicator 6:

Trained 20 first responders in early detection and rapid response to combat LM

Vermont Extension professionals Ann Hazelrigg, Heather Darby, Vern Grubinger, Abha Gupta, and Becky Madden were all directly trained by our research team. Skills acquired during these trainings included the

deployment of LM traps, identification of LM adults, the assessment of population stage and LM phenology. According to our correspondence with this team of extension professionals, they each have trained at least one other first responder within their region and/or on their research team (~15 professionals).

Outcome 5, indicator 8:
At each meeting we distributed surveys to collect data on: a) how many people were at the event, b) their baseline knowledge of leek moth and c) what tactics they were interested in adopting and/or learning more about.

We analyzed the data using participant abundance and basic descriptive statistics (e.g. means, etc.).

100% of all completed surveys indicated that our workshops were "helpful" or "very helpful" regarding participant understanding of leek moth ecology.

Workshops and Field days:

1. NW Vermont Soils and Crops field days, Allburgh, VT (2018 and 2019): ~200 participants total → 25% of attendees interested in exploring the use of parasitoid wasps
2. Catamount Farm Leek moth field days, Burlington, VT: (2017/2018/2019): ~80 participants total → all of the attendees were interested in learning more about post-harvest handling and paras
3. Master Gardener field workshop, Burlington, VT: (2018): ~30 → 75% of the gardeners attending were interested in using insect netting as row covers

Grower conferences/meetings:

1. We also presented our research at the Vermont Vegetable Berry Growers Association annual meeting, Fairlee, VT, in 2018 and 2019: ~150 participants → 40% of growers that had leek moth damage in the past were particularly interested in our subsequent parasitoid research

2. We presented at the 2018 NOFA VT conference, Burlington, VT: ~20 people attended our session → All of the growers with a history of leek moth infestations expressed interest in insect netting for row cover.

Academic meetings:

1. We presented our research results at two consecutive Entomological Society of America Conferences (2017 & 2018), Denver, CO and Vancouver, CA.: ~ 60 attendees to our session total → we did not distribute surveys at these sessions.

FEDERAL PROJECT EXPENDITURES TO DATE

EXPENDITURES

Cost Category	Amount Approved in Budget (SCBGP Funds Only)	Actual Federal Expenditures (SCBGP Funds Only)	Match Expenditures	Match Source
Personnel	$16,240	$23,978.40		
Fringe Benefits	$4,235	$4,730.62		
Travel	$10,640	$5,884.55		
Equipment				
Supplies	$7,158	$3,451.66		

Cost Category	Amount Approved in Budget (SCBGP Funds Only)	Actual Federal Expenditures (SCBGP Funds Only)	Match Expenditures	Match Source
Contractual	$750			
Other		$507.56		
Direct Costs Subtotal	$39,023	$38,552.79		
Indirect Costs	-	-	20,683	UVM Indirect Cost
Total Federal Costs	$39,023	$38,552.79		

PROGRAM INCOME

Not applicable.

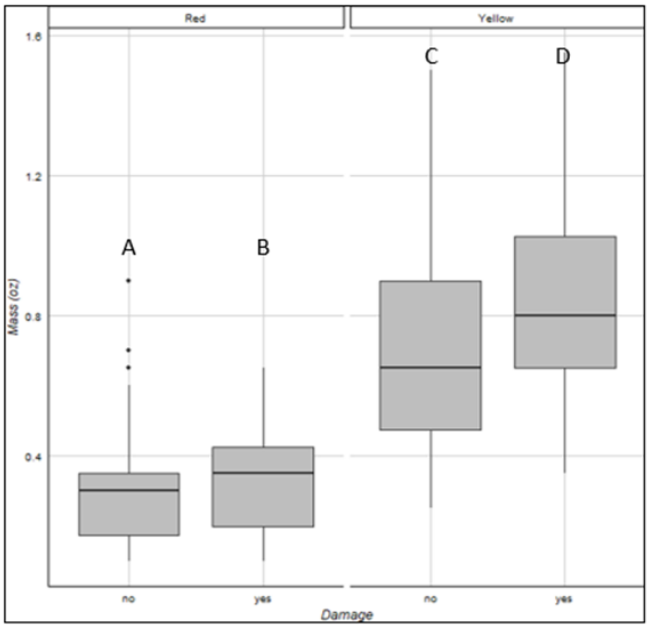
Source/Nature (i.e., registration fees)	Amount Approved in Budget	Actual Amount Earned
Total Program Income Earned		

Use of Program Income *Describe how the earned program income was used to further the objectives of this project.*

ADDITIONAL INFORMATION

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

Be sure to include any documents, publications, or other attachments referenced throughout the report. If the attachments are large, you may consider combining them as an appendix to the full report and submitting the appendix as a separate PDF file. ***Please copy and paste materials into this report and/or submit a single PDF appendix file. Do not submit more than one appendix.***



2019 Varietal Trial (Red versus Yellow)

Yellow onions exhibited significantly greater susceptibility to LM damage (i.e. higher incidence of LM damage). The higher incidence of LM damage in yellow onions suggests a (LM) preference for yellow foliage in the field. Larger onions also displayed a higher likelihood of LM feeding. Ecologically, this size-preference relationship is not particularly surprising for nocturnally feeding insect herbivores. Night flying moths likely locate host plants using plant volatile concentration gradients. Presumably, larger onions release higher concentrations of plant volatiles than smaller plants leading to a higher incidence of LM damage on larger sized plants.

Links to our LM monitoring program:

http://www.uvm.edu/vtvegandberry/VVBGAMeeting2018/Lewins_Leek_Moth.pdf

https://nysipm.cornell.edu/sites/nysipm.cornell.edu/files/shared/images/Leek-Moth-11-18-large.jpg

https://nysipm.cornell.edu/agriculture/vegetables/leek-moth/description/

Please see the appendix for more information about this project.

PROJECT 7 INFORMATION

Project Title	Development of a Direct to Consumer Marketing Program			
Recipient Organization Name:	Vermont Agency of Agriculture, Food and Markets			
Period of Performance:	**Start Date:**	10/3/2016	**End Date:**	9/30/2018

Recipient's Project Contact	
Name:	Abbey Willard
Phone:	802-272-2885
Email:	Abbey.willard@vermont.gov

PROJECT BACKGROUND

Provide enough information for the reader to understand the importance or context of the project. This section may draw from the background and justification contained in the approved project profile.

Vermont is celebrated for its strength in community-based agriculture and the ability to connect consumers directly with producers that grow their food. The Vermont Agency of Agriculture, Food and Markets are committed to establishing a direct to consumer marketing program with a full-time staff person focused on consumer access and producer marketing relationships with farmers' markets, farm stands, and CSA farms.

The program goal is to increase consumer access to sales of local, direct-marketed specialty crops by building relationships between consumers and producers, expanding the demographic of consumers that buy local food products, and specifically increasing specialty crop products in response to expanding fruit and vegetable consumption. The program aims to reach these goals through collecting local food pricing data, maintaining an accessible directory of Vermont direct to consumer operations, and promoting agricultural literacy and the value of direct marketing across the state.

ACTIVITIES PERFORMED

Address the below sections as they relate to the entire project's period of performance.

OBJECTIVES

Provide the approved project's objectives.

#	Objective	Completed?	
		Yes	No*
1	Collect and disseminate local food pricing data from farmers' markets and farm stands to both consumers and producers	X	
2	Expand the promotion and marketing of local direct to consumer markets through an online, convenient directory	X	
3	Conduct annual producer surveys for farmers' markets, farm stands, and CSAs to capture economic impact and industry demographics	X	
4	Coordinate the producer associations and organizations that support directly to consumer marketing to strategize solutions to support consumer awareness and product profitability	X	
5	Host local and regional events that support and promote local food markets and agritourism experiences	X	

**If no is selected for any of the listed objectives, you must expand upon this in the challenges and lessons learned sections.*

ACCOMPLISHMENTS

List your accomplishments for the project's period of performance, including the impact they had on the project's beneficiaries, and indicate how these accomplishments assist in the fulfillment of your project's objective(s), outcome(s), and/or indicator(s).

Accomplishment/Impact	Relevance to Objective, Outcome, and/or Indicator
Weekly farmers' market reports from June-October and monthly farmers market reports from November through April produced a total of 24 reports from 14 markets across Vermont. This was a 16% increase over last year's participation. Monthly beef reports were also produced from 23 sources. Pricing data was shared with interested producers and through various producer associations and industry listservs. Pricing reports from farm stands have been delayed due to a lack of adequate data to ensure anonymous reporting. We have however developed relationships with larger farm stands and plan to begin these reports in 2019.	**Objective 1:** Collect and disseminate local food pricing data from farmers' markets and farm stands to both consumers and producers
Updated the VAAFM online directory which has 67 Summer Farmers Markets, 15 Winter Farmers Markets, 134 Farm Stands, and 58 CSAs while aligning data with nonprofit partner listings including NOFA-VT and DigInVT.	**Objective 2:** Expand the promotion and marketing of local direct to consumer markets through an online, convenient directory
Released annual survey in the spring to VT direct to consumer operations. Tallied results from 108 producers in 2016 and 94 producers and 26 farmers' markets in 2017, which was a 14% decrease from last year's participation of producers but included sales from several large farmers markets in the state to capture that.	**Objective 3:** Conduct annual producer surveys for farmers' markets, farm stands, and CSAs to capture economic impact and industry demographics
Attended the bi-monthly Marketing and Consumer Education Working Group, Agritourism Task Force and Food Access Cross-Cutting Team meetings of the Farm to Plate Network; Attended the quarterly DigInVT committee meetings and presented at the Association of Producer Associations meetings; and attended monthly winter meetings with the Vermont Farmers Market Association Board, and monthly meetings with the VT Dept. of Tourism and marketing to collaborate and plan for future marketing initiatives.	**Objective 4:** Coordinate the producer associations and organizations that support direct to consumer marketing to strategize solutions to support consumer awareness and product profitability
VAAFM hosted and co-coordinated several local events in VT to promote Direct to Consumer marketing: 3 Buy Local Markets in 2017 and 1 in 2018 (50 vendors at each and over 1500 attendees in total); Farmers' Market Managers conference in both 2017 and 2018 with over 50 attendees; and Open Farm Week in 2017 and 2018 with over 40 farms participating and 1,000 attendees each year.	**Objective 5:** Host local and regional events that support and promote local food markets and agritourism experiences
Based upon our 2017 direct to consumer survey results, producers self-reported $10,949,930 (response rate dropped from 108 to 94 farms resulting in lower sales total due to lack of data)	**Outcome 1:** Sales increase from $10 to $11 million as a result of marketing and promotion activities
Promotion of summer and winter farmers market at Vermont's 17 rest areas and info centers with posters and brochures. These sites see over 3 million visitors annually. Posters also were shared with all chambers of commerce in Vermont, as well as, libraries, food co-ops, and other community organizations. Collaboration with VDTM, VFN, NOFA-VT on the better-unified promotion of our markets and producers. Farmers markets and farm stands are now listed on the statewide agritourism website DiginVT.com which gets approximately 40,000 online visitors annually, which is also linked to through the state's tourism website, VermontVacation.com and the state's economic development website, ThinkVermont.com.	**Outcome 3, Indicator 1a:** 50% of total consumers reached (248,000) demonstrated gained knowledge on how to access specialty crops

CHALLENGES AND DEVELOPMENTS

Provide any challenges to the completion of your project or any positive developments outside of the project's original intent that you experienced during this project. Also, provide the corrective actions you took to address these issues. If you did not attain an approved objective(s), outcome(s), and/or indicator(s), provide an explanation in the Corrective Actions column.

Challenge	Corrective Actions
Several farm stands are willing to participate in providing sales and pricing data, but many stands are small and lack a diversity of products to complete a full report.	Met with farm stand owners directly between fall 2017 and spring 2018. Targeted larger farm stand operations during summer 2018 and plan to start reporting prices in the coming spring 2019.
Farmers and producers remain hesitant to participate in an annual survey – which may be due to a concern with providing economic data. Consequently, the annual survey had a lower than anticipated response rate.	Working with a metric advisory board to improve the survey and increase response rates for 2018. Additional outreach and incentives for producers to participate are being considered.

LESSONS LEARNED

Provide recommendations or advice that others may use to improve their performance in implementing similar projects.

We will be adding incentives and making paper copies of the producer survey available at large producer events, workshops, and conferences in order to increase participation through direct interaction with producers.
While the State-managed online directory of farmers markets, farm stands, and CSAs is valuable as a general source of information, sharing this data with other organizations such as the Vermont Fresh Network (VFN) has supported the expansion and improvement to their interactive, and more user-friendly, online database DigInVT. Beyond that, our increased partnership with VFN around DigInVT has allowed us to assess the needs of Vermont's agritourism industry so that we can better provide resources and improve this potential market for specialty crops in the future.

CONTINUATION AND DISSEMINATION OF RESULTS (IF APPLICABLE)

Describe your plans for continuing the project (sustainability; capacity building) and/or disseminating the project results.

Program implementation continues with SCBGP Round 13 and 14 funding.
Beginning to implement a community development model to our direct marketing programming to build awareness and share information. This will include presenting at more meetings and attending conferences to share data results and market perspectives. Through this work we have also identified the need to increase partnerships and engagement with farmers' market boards, market managers, farmers and market vendors, local town and city government staff, downtown economic development organizations, local business associations and other technical service providers to explore alternative locations and market models to increase the viability of this important market channel for specialty crops.

BENEFICIARIES

A descriptor for the number of beneficiaries is not required.

Number of project beneficiaries:.....we estimated at least 248,000

OUTCOME(S) AND INDICATOR(S)/SUB-INDICATOR(S)

Provide the results of the project outcome(s) and indicator(s) as approved in your State Plan and project proposal. The results of the outcome(s) and indicator(s) will be used to evaluate the performance of the SCBGP on a national level.

OUTCOME MEASURE(S)

Select the Outcome Measure(s) that were approved for your project.

- ☑ **Outcome 1**: Enhance the competitiveness of specialty crops through increased sales
- ☐ **Outcome 2**: Enhance the competitiveness of specialty crops through increased consumption
- ☑ **Outcome 3**: Enhance the competitiveness of specialty crops through increased access
- ☐ **Outcome 4**: Enhance the competitiveness of specialty crops though greater capacity of sustainable practices of specialty crop production resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources
- ☐ **Outcome 5**: Enhance the competitiveness of specialty crops through more sustainable, diverse, and resilient specialty crop systems
- ☐ **Outcome 6**: Enhance the competitiveness of specialty crops through increasing the number of viable technologies to improve food safety
- ☐ **Outcome 7**: Enhance the competitiveness of specialty crops through increased understanding of the ecology of threats to food safety from microbial and chemical sources
- ☐ **Outcome 8**: Enhance the competitiveness of specialty crops through enhancing or improving the economy as a result of specialty crop development

OUTCOME INDICATOR(S)

Provide the indicator approved for your project and the related quantifiable result. If you have multiple outcomes and/or indicators, repeat this for each outcome/indicator.

#	Outcome and Indicator	Quantifiable Results
1	**Outcome 1:** Sales increase from $10 to $11 million as a result of marketing and promotion activities	producers self-reported $10,949,930 (response rate dropped from 108 to 94 farms resulting in lower sales total due to limited data)
2	**Outcome 3, Indicator 1a:** 50% of total consumers reached (248,000) demonstrated gained knowledge on how to access specialty crops	Promotion of summer and winter farmers market at Vermont's 17 rest areas and info centers with posters and brochures. These sites have an estimated 3 million visitors each year. Posters also were shared with all chambers of commerce in Vermont, as well as, libraries, food co-ops, and other community organizations. Outreach to 42 farmers market locations to maintain participation in EBT, Crop Cash, Farm to Family and Harvest Health coupon programs incentivizing the purchase of fresh fruits, vegetables, and herbs at VT farmers markets that accept 3SquaresVT/SNAP benefits. Improved outreach to SNAP-eligible customers by disseminating informational materials through Community Action Programs statewide to improve sales of local fresh fruits and vegetables at farmers markets to EBT customers.

DATA COLLECTION

Explain what data was collected, how it was collected, the evaluation methods used, and how the data was analyzed to derive the quantifiable indicator.

Sales and customer data was collected in the annual surveys to farmers' markets, CSA farms, and farm stand operations which was shared via email to all producers who had participated in previous years, along with shared on producer association and partner organization listservs and emailed to their member lists. The decrease in response rates was determined by the following assumptions: 26 farmers' market survey

responses from 68 statewide markets; 29 CSA survey responses from 120 statewide CSA farms; 42 farm stand responses out of 200 responses in 2015 which was the first year we surveyed farm stands.

The Direct to Consumer Marketing Program staff continues to work with partner organizations and a metric advisory committee to improve the aggregation and dissemination of survey data and in order to capture improved impact data and metrics.

FEDERAL PROJECT EXPENDITURES TO DATE

EXPENDITURES

Cost Category	Amount Approved in Budget (SCBGP Funds Only)	Actual Federal Expenditures (SCBGP Funds Only)	Match Expenditures	Match Source
Personnel	31,133	35,656.90	29,275.42	USDA AMS Markets News
Fringe Benefits	19,631	15,068.35	11,988.73	USDA AMS Markets News
Travel	1,500	995.65	1,390.55	USDA AMS Markets News
Equipment				
Supplies	539	1,082.10	206.59	USDA AMS Markets News
Contractual			2,375	USDA AMS Markets News
Other				
Direct Costs Subtotal	52,803	52,803	45,236.29	
Indirect Costs	-	-		
Total Federal Costs	52,803	52,803		

PROGRAM INCOME

Not applicable.

Source/Nature (i.e., registration fees)	Amount Approved in Budget	Actual Amount Earned
Total Program Income Earned		

Use of Program Income *Describe how the earned program income was used to further the objectives of this project.*

ADDITIONAL INFORMATION

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

Be sure to include any documents, publications, or other attachments referenced throughout the report. If the attachments are large, you may consider combining them as an appendix to the full report and submitting the appendix as a separate PDF file. ***Please copy and paste materials into this report and/or submit a single PDF appendix file. Do not submit more than one appendix.***

VT Agency of Agricultures directory of farm stands, CSAs, and farmers markets can be found at https://agriculture.vermont.gov/node/1237 ; The NOFA-VT directory can be found at https://nofavt.org/find-organic-local-food ; and the Dig In Vermont website at https://www.diginvt.com/

Poster that was shared in 17 VT Info Center reaching over 3 million visitors annually. In 2018 we also created an informational brochure as well as a winter farmers market pos