South Carolina
DEPARTMENT OF AGRICULTURE
Hugh E. Weathers, Commissioner

Final Report

Specialty Crop Block Grant Program
Agreement 15-SCBGP-SC-0013

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Project One: Expanding Wholesale Specialty Crop Market Opportunities in South Carolina
Project Partner: GrowFood Carolina

Project Summary
GrowFood Carolina addresses the difficulty that farmers face as they attempt to enter the local wholesale market. Produce distributors, packing sheds, and warehouses offer significant advantages to large-scale farmers, particularly in the export arena. Similar opportunities, support, and services are not available to small and mid-sized farmers.

GrowFood Carolina works to maximize specialty crop farmers' profits and enhance the market's reliable access to local food through collaborative partnerships with growers to improve farming practices, and to provide warehousing, aggregation, sales, marketing, and distribution services. We market more than 300 items (primarily specialty crops). GrowFood has also had notable success cultivating the demand side of the market – produce is available regionally in three major retail chains (EarthFare, Whole Foods and Harris Teeter), more than 120 Charleston-area restaurants, and a small number of private institutions and schools.

As part of our 2015 SCBGP grant, GrowFood Carolina and our partner Lowcountry Local First hosted a *Wholesale Success* training in January 2016, targeted to local, specialty crop farmers. Additionally, during the grant period, GrowFood worked toward $1,000,000 in gross sales, with $800,000 going back to local farmers.

Recent studies found three of South Carolina's coastal areas to be the fastest growing regions on the entire east coast, placing South Carolina at high risk for rural land loss due to development and conversion to urban uses. Our rural areas also suffer from high levels of poverty and unemployment, underfunded health care, and schools that rank among the worst in the nation. At the same time, South Carolina consumers spend $11+ billion per year on food, but less than 10% comes from in-state farms. Within the 30-mile radius of GrowFood, residents consume more than 96 million pounds of fresh fruits and vegetables, 90% of which is imported. Simultaneously, South Carolina exports more than 296 million pounds of fresh produce. While these statistics are alarming, they present a great opportunity.

GrowFood has achieved significant success recruiting new growers, diversifying our product offering, and marketing to consumers, but we identified a need for additional efforts to increase marketing and expand sales to wholesale customers. Fully tapping into the wholesale market is essential to GrowFood's ability to support small and mid-sized farmers and scale up to the level of sales required to reach financial sustainability. This is also key to creating a strong regional food system.

Our 2015 SCBGP funding helped GrowFood expand wholesale market sales through farmer education. Specifically, we hosted a *Wholesale Success* training in January 2016, targeted to local, specialty crop farmers. Family Farmed worked with GrowFood Carolina and Lowcountry Local First and conducted a workshop customized for South Carolina farmer's specific needs.

In addition to the training, GrowFood's comprehensive efforts throughout the year support specialty crop farmers through activities like: creating lasting partnerships with growers by visiting participating farms, facilitating regular communication and engaging in important issues related to crop planning, regulatory compliance, GAP and organic certification, post-harvest handling, and marketing; inspecting and storing produce in the Charleston warehouse focusing on traceability and food safety; enhancing and diversifying consumer demand; and marketing, selling and distributing local produce.

GrowFood Carolina has been awarded two SCDA Specialty Crop Block Grants – funding in 2012 supported outreach and recruitment of specialty crop farmers and funding in 2014 supported general operations to better serve specialty crop farmers. These funds helped to bridge the revenue gap until 2017 and 2018 when sales are projected to be at a level to permit GrowFood to operate sustainably.

Project Approach

In November and December 2015, GrowFood Carolina and Lowcountry Local First worked with Family Farmed, LLC to create a customized workshop for specialty crop growers in South Carolina specific needs.

Posters, postcards, and relevant social media/digital graphics were designed by Lowcountry Local First's Graphic Design and Marketing department. Fifty posters and nearly 200 postcards were distributed. Physical mailings, including postcards, were sent statewide to 46 Clemson Cooperative Extension offices, 47 South Carolina Farm Bureau offices, 6 Natural Resource Conservation Services (NRCS) offices, and 9 USDA offices. Posters were distributed via mail and in person to key relevant regional partners for distribution (SCDA, SC Farm Bureau, Clemson Extension), in both the Charleston area and surrounding rural areas. Remaining postcards and posters were distributed at Carolina Farm Stewardship's Sustainable Agriculture Conference (November 2015), Lowcountry Local First's GOODFarming Whole Farm Planning Workshop (November 2015), our Apprenticeship and Incubator Training (October 2015), and during one-on-one meetings with local farmers. Four separate emails were sent out to Lowcountry Local First's listserv of more than 320 farmers. Three separate newsletter emails were sent to a selected group of 250 individuals (save the date, registration announcement, and registration reminder).

The *Wholesale Success* full-day training was held at the Phillips Market Center in West Columbia on January 20, 2016. In total, 98 attendees participated in the training. Attendees learned 1) about crop specific tools and recommendations for harvesting, washing, cooling, and storing specialty crops; 2) gained assistance with developing marketing skills and customizing food safety plans; and 3) discussed opportunities to scale up and meet large buyers' needs. Attendees also received a 316-page technical assistance manual, *Wholesale Success: A Farmer's Guide to Food Safety, Selling, Postharvest Handling and Packing Produce.*

Lowcountry Local First surveyed attendees and received 57 completed surveys. Additionally, we used Wholesale Success training as an opportunity to collect basic farmer data and a needs assessment (a current project of our parent organization, the Coastal Conservation League) which will be helpful as GrowFood plans for the future services, support and programs in continued assistance to rural specialty crop growers.

Throughout the grant period, GrowFood's team of eight continued to efficiently and effectively manage general operations to work toward our project goal of $1,000,000 in gross sales, with $800,000 going back to local farmers. This work includes visiting participating farms, facilitating regular communication, and engaging in important issues related to crop planning, regulatory compliance, third party certifications, post-harvest handling, and marketing; aggregating and storing produce in our warehouse while focusing on traceability, single source identification, and food safety; enhancing and diversifying consumer demand; and the marketing, selling, and distributing local produce.

Goals and Outcomes Achieved

The *Wholesale Success* full-day training was held at the Phillips Market Center in West Columbia on January 20^{t,} 2016. In total, 98 attendees participated in the training. While our goal was 100 attendees,

this is an unprecedented attendance for a training of this kind. We attribute this to strong collaborative partnerships, not only with Lowcountry Local First but also with Clemson, SCDA, Carolina Farm Stewardship Association and others. Attendees learned about crop specific tools and recommendations for harvesting washing, cooling, and storing specialty crops; gained assistance with developing marketing skills and customizing food safety plans; and discussed opportunities to scale up and meet large buyers' needs.

Based on the *Wholesale Success* survey responses, the overwhelming majorities (more than 40%) of attendees found the workshop to be excellent and answered that they would be able to and plan to better manage their farm or improve some aspect of their overall operation to expand sales into wholesale markets. However, at the time of submitting this report, it is difficult to extrapolate the total quantification of the amount of sales that the program *Wholesale Success* will have for the participants. Many of these specialty crop growers have begun to make incremental changes at the farm (adding a packing line or triple wash sink for greens, etc.) after they participated in the training and saw the benefits related to improving their postharvest measures but may take as many as three years to realize any significant changes in sales/volume increases.

Understanding the complexity and amount of information disseminated at the training and speaking to individual farmers, the benefits and outcomes of this training will not be immediately quantifiable. It also was apparent that follow-up on-farm trainings are needed. The survey provided space for suggestions for future trainings. Organic certification training was the most common response.

As part of a larger effort undertaken by the Coastal Conservation League, GrowFood also surveyed attendees at the Wholesale Success training. In total 64 growers were surveyed between January 2016 and April 2016. Surveys included demographic information, such as farm location, size, age, etc; information with respect to how the farm generally operates in terms of irrigation, farming method, information on sales outlets and challenges/barriers.

Upon analysis and reporting, this data will be shareable and will be used to improve GrowFood's programs and services to enhance the production and sales of specialty crop farmers as well as distribution statewide. Additionally, this information will also be utilized to inform local and state policy.

Gross sales during the 11 months of the grant period that his final report covers (October 1 2015 – August 30, 2015) totaled $1,196,670, which translates to $957,000 in new annual revenue to the farmers and their communities. (Approximately 85% of our total revenue is generated by the sale of specialty crops.) GrowFood has already exceeded our proposal goal of $1,000,000 by nearly $200,000. We are project that September sales will be $110,000, likely putting our total sales for the grant period at more than $1,300,000.

Beneficiaries

GrowFood Carolina now works with 80 farmers producing on more than 1870 acres. Our eight full-time staff members work to maximize specialty crop farmers' profits and enhance the market's reliable access to local food through collaborative partnerships with growers to improve farming practices, and to provide warehousing, aggregation, sales, marketing, and distribution services for specialty crops.

During the grant period, Jimmy and Jo Livingston of Wabi Sabi Farm prepared to become GAP certified. While initially hesitant to undertake the significant amount of time effort and resources to become GAP certified, GrowFood Carolina's Farm Coordinator provided support and assistance by only outlining the

many marketing benefits that accompany certification, but by also connecting Jimmy and Jo with resources within South Carolina to help streamline the process. Wabi Sabi was GAP certified in June 2016. Jimmy is glad to have the certification and access to new and larger customers, and he advised that the process was not as cumbersome as he anticipated. He will be an advocate for GAP certification to other partner farmers.

Josh Johnson of Old Tyme Bean, Company diversified his crop production and added white acre peas, Crowder peas, and English peas. Several of our restaurant customers were asking for these varieties, and after assessing demand, GrowFood Carolina staff worked with Josh during our semi-annual crop planning to enable his production to meet demand.

Dotson Farms is a newer partner. GrowFood Carolina began working with Jeff Dotson in spring 2016, and he was growing carrots, rutabaga, beets, radish, delicata squash on four acres. We planned for the upcoming season with him in July, and he has planted on eight acres for the fall of 2016 to meet the demand for his specialty crops.

When asked via survey at the training, "What is your biggest barrier to selling more of your product locally?" Answers included: infrastructure; marketing; distribution; inability to access to schools and institutions; and lack of labor. GrowFood Carolina is currently addressing all barriers but the labor issue.

Lessons Learned

With regard to the Wholesale Success training, we found that the time of year was perfect and the central location in the Midlands was also helpful for ease of attendance. Also, the collaboration between Lowcountry Local First and GrowFood Carolina was very productive. We believe that the ultimate training would be two full days with mornings spent in the classroom and afternoons spent in the field (for example, the Student Organic Farm at Clemson University). A significant takeaway, and we received several comments, is that classroom instruction is not a conducive learning environment for most farmers. Additionally, trainings need to be more crop-specific.

Moving forward, we understand that there needs to be more training in this realm. Post-harvest handling is and will continue to be GrowFood Carolina's biggest challenge – and we need to dedicate even more resources to work with farmers to improve their practices. We continue to cultivate buyer relationships farther from the warehouse to larger buyers (a key to our growth and success). However, at this time, we can only ship a limited number of items from a handful of growers due to short shelf life and quality concerns. Better post-harvest handling practices can solve these issues and offer more opportunities to specialty crop farmers.

A critical requirement for small and mid-size farmers' ability to tap into larger markets is GAP certification. Of GrowFood Carolina's 80 partner farmers, only ten are GAP certified. Facilitating GAP certifications has been and continues to be a significant challenge for GrowFood Carolina and this is one of our highest priority initiatives in the next one to five years. After a year of pushing our farmers to pursue GAP and despite the increasing demand from retail and institutional customers, they continue to be resistant. Recognizing the necessity of GAP certification for the success of our farmers, GrowFood Carolina has decided to pursue the recently accessible for small and mid-sized producers by allowing farmers, food hubs, and other marketing organizations to work together to undergo GAP certification as a group. With GrowFood as the coordinator, GroupGAP will enable our farmers to pool resources to implement food safety training programs, share the cost of certification, and benefit from a systematic effort. This goal is to launch the program by January 2018.

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Project Two: SC Farm to Institution Farmer Outreach, GAP Certification Training and Value-Added Freezer Program

Project Partner: South Carolina Department of Agriculture, South Carolina Farm to School Program

Project Summary

The project was created to enable SC Farm to School, in collaboration with SC Farm to Institution, to help specialty crop growers promote and market their products in institutional settings such as school districts by (1) expanding the capacity of SC farmers and distributors to supply locally grown produce to additional institutions through continued training and cost share support for Good Agricultural Practices (GAP) Certification, and (2) testing the feasibility of a Value-Added Freezer Pilot Program through a partnership with a distributor of local produce in Charleston County, GrowFood Carolina.

Essential to the project are outreach activities and technical assistance to farmers on meeting food safety requirements for institutional markets, primarily GAP Certification. Program outreach focuses on establishing networking opportunities and partnerships between farmers and institutions to facilitate changes in institutional procurement practices.

The project was allotted an additional year of funding (September 2016-September 2017). Many key changes happened during this year and are further described in the project activities section.

Project Approach

This project sought to (1) expand the volume supplied by SC growers and distributors of specialty crops to additional institutions, with a particular focus on schools, through increased knowledge of food safety requirements; and (2) develop, test and determine the feasibility of a quick freeze system in which extra produce can be flash frozen and delivered to schools during the off-season production months.

Tailored support for farmers is critical to ensuring adequate SC produce is available to support the demands of institutional markets. A key piece of expanding farmer capacity was providing better understanding of the changing food safety guidelines and rules. One focus of this project was to create avenues for farmers to ask questions and get more information about the changes, as well as providing clear direction on who to ask for future questions. Establishing this avenue was crucial for farmers in getting accurate, reliable information about the changes.

While GAP Certification is required or at least preferred by most schools and many other institutions, smaller farmers, who most need these additional market opportunities, often have difficulty with the cost of GAP audits. For this purpose, a significant portion of the funds for this project have been dedicated to cost share reimbursement for farmers who receive GAP certification to offset audit costs.

One barrier schools face in serving locally sourced produce is the availability of in-season items (Roche & Kolodinsky, 2011). Given that schools are only in session for a portion of the most productive growing season, freezing produce grown during this period for use by schools throughout the year is one strategy to increase farmer participation in the school market. Local produce that is frozen as part of farm to school programs has been shown to increase the exposure students have to local produce, is often a high-quality product and therefore more accepted by students, and reinforces the relationship between local farmers and schools (Conner et al., 2012).Thus, partnering with Grow Food Carolina to develop and test a produce freezing system in which local produce can be flash frozen and delivered to schools increased farmer capacity to sell more products to institutions.

During the project period October 1, 2015 – September 30, 2017, thirty eight (38) cost share reimbursements were issued to farmers who received GAP Certification for a total of 20,744.00. The contribution to this cost share helped farmers to receive the safety certification most likely required by school districts, thus increasing their capacity to sell to schools.

This project was a working partnership between the South Carolina Department of Agriculture (SCDA) and South Carolina Farm to Institution. SCDA staff monitored the GAP reimbursement program, reported on grant activities, participated in food safety trainings and onsite technical assistance, and sought out participation from farmers in the freezer pilot programs. Farm to Institution met monthly to monitor project scope and evaluation. Farm to Institution also served as the platform in which trainings and the cost share were marketed. Two of the most attended Farmer education trainings were hosted at the 2017 Farm to Institution Summit. GrowFood Carolina and Dorchester School District 2 were intended to also be project partners but lack of communication, crop damage, and change in leadership caused this commitment to fall through.

Due to the nature of some of this project as a pilot, the original and final goals and activities changed significantly throughout the project period to meet those challenges. These changes are described in the "Goals and Outcomes" section. The activities and related goals are shown in the table below.

The scope of this project solely benefitted specialty crops.

Goal 1: Increase the capacity of at least 50 farmers interested in SC Farm to Institution to sell directly to schools.

Tasks
Raise food safety knowledge of SC farmers
Disseminate information to raise farmer capacity to sell to distributors

Goal 2: Determine the feasibility of a Value-Added Freezer Pilot Project in one institution.

Tasks
Target farmers that may be interested in participating through existing networks, such as GrowFood Carolina.
Target associations and institutions that would be willing to buy the produce from the freezer pilot
Determine price points for produce that is beneficial to both farmers and institutions
Facilitate distribution of frozen produce to institutions that are interested
Examine invoices from GrowFood Carolina to determine success and obtain benchmarks.

Goals and Outcomes Achieved

Goal 1: Increase the capacity of at least 50 farmers interested in SC Farm to Institution to sell directly to schools.

Tasks	Performance Measure	Target	Outcome
Raise food safety knowledge of SC farmers	Attendance records at Farm to Institution Summit information sessions	Provide consistent messaging around FSMA that aligns with SCDA and Clemson University.	The first SC Farm to Institution (F2I) Summit was held in September 2017. Part of the event was an educational track geared toward farmers called Exploring Market Opportunities. Panel members from the SCDA Produce Safety and Clemson University Food Science Departments along with Carolina Farm Stewardship Association presented a session regarding food safety resources where 20 participants attended. A video recording is available on the F2I website. Additionally, the F2I Advisory Council is planning farmer outreach activities around food safety in the next year.
Disseminate information to raise farmer capacity to sell to distributors	Information and resources distributed at events targeting farmers.	Staff attended farmer-targeted conferences throughout the year. At the first annual SC F2I Summit, a track was assigned specifically for farmers. This track included more information on various market opportunities and resources, and will be developed in partnership with Clemson University, Agribusiness Extension.	Conferences attended included Fruit and Vegetable shows, Agritourism Annual meeting, Resource Rodeo, and the SC Agribusiness Conference. Listservs of associations targeted include: New and Beginning Farmers, SCDA Farmer Listing, Certified SC Grown Farmer list, Agritourism list, Specialty Food List. As stated above, the first SC Farm to Institution (F2I) Summit was held in September 2017. Part of the track for farmers included a session introducing them to different types of institutions and markets, moderated by Clemson Agribusiness. Roughly 50 people were in attendance for this session. Another session, facilitated by the SC Department of Education (SCDE) Farm to School Coordinator, featured information on local procurement with key stakeholders from GrowFood Carolina and Senn Brothers. Roughly 45 people attended the session.

Goal 2: Determine the feasibility of a Value-Added Freezer Pilot Project in one institution.

Tasks	Performance Measure	Target	Outcome
Target farmers that may be interested in participating through existing networks, such as through GrowFood Carolina.	Number of farmers targeted gathered monthly through interviews with the SCDA and SCDE Farm to School Coordinators	25 contacts made with farmers. These contacts can include those made at the SC Farm to Institution Summit.	Conferences attended included Fruit and Vegetable shows, Agritourism Annual meeting, Resource Rodeo, Midlands Food Alliance farmer networking events, SC Food Policy Meetings and the SC Agribusiness Conference. Listservs of associations targeted include: New and Beginning Farmers, SCDA Farmer Listing, Certified SC Grown Farmer list, Agritourism list, Specialty Food List.
Target associations and institutions that would be willing to buy the produce from the freezer pilot	Number of contacts targeted gathered monthly through interviews with the SCDA and SCDE Farm to School Coordinators	Host meeting between distributors interested in freezing and targeted large school districts about challenges and opportunities, including Titan Farms.	50 contacts have been made with individuals within associations. These include the SC School Nutrition Association, SCDE listserv, school districts around Charleston, F2I listserv, College of Charleston, Daniel Island and Archway Academies. Titan Farms is now represented on the F2I Advisory Council and F2I programming staff will plan the meeting between distributors and school districts in the next year.

Tasks	Performance Measure	Target	Outcome
Determine price points for produce that is needed for both farmers and institutions	Discussions with GrowFood Carolina, targeted farmers, and targeted institutions. Data gathered through monthly interviews with the SCDA and SCDE Farm to School Coordinators	All produce that is a part of the pilot will reflect the pricing target	Due to issues with the blueberry and peach crops, it was difficult getting produce from farmers. Due to issues with lack of capacity around processing, crop selection was extremely limited. Therefore, there were no price points to be determined.
Facilitate distribution of frozen produce to institutions that are interested	SCDA and SCDE Farm to School Coordinators, and GrowFood Carolina facilitate this process. Data gathered through monthly interviews with the SCDA and SCDE Farm to School Coordinators	Technical assistance and coordination provided for distribution issues as needed. Host meeting between distributors interested in freezing and targeted large school districts about challenges and opportunities, including Titan Farms.	Titan Farms is now represented on the F2I Advisory Council and F2I programming staff will plan the meeting between distributors and school districts in the next year. A lesson learned from this project and an obstacle still to overcome, is that many produce distributors in SC do not have freezer storage in their facilities or on their trucks and transporting frozen product may be an issue depending on the time held in storage.
Examine invoices from GrowFood Carolina to determine success and obtain benchmarks.	GrowFood Carolina invoices monthly.	One institution will buy produce from freezer pilot project.	Unfortunately, due to the high price point of the organic blueberries, no schools were able to afford to buy from the project. This was noted and the goal was added to monitor price points for future purchases.

Proposal Goals vs. Final Goals

Goal 1: Increase the capacity of at least 50 farmers interested in SC Farm to Institution to sell directly to schools.		
Original Goal	**Final Goal**	**Rationale for Change**
Provide onsite individual assistance in GAP certification and school procurement	Raise food safety knowledge of SC farmers	In Spring 2016, it was discovered that SCDA had partnered with Clemson University Extension in conducting all food safety trainings statewide. This created confusion about whether or not SCDA was authorized to conduct GAP trainings of any kind. This confusion, along with confusion around the new FSMA rules, made project personnel change the focus from strictly GAP to disseminating information about what was known about the FSMA changes and directing farmers on where to get future information. This was to ensure reliable, accurate information distributed from one source. The Food Safety Manual never finished development by partners; therefore, the project could not distribute it.
Disseminate GAP certification/Food Safety materials to farmers	Disseminate information to raise farmer capacity to sell to distributors	
Host workshops on Food Safety Manual and GAP		

Goal 2: Determine the feasibility of a Value-Added Freezer Pilot Project in one school district.		
Original Goal	**Final Goal**	**Rational for Change**
Host informational and educational events to recruit specialty crop producers interested in selling to area schools	Target farmers that may be interested in participating through existing networks, such as through GrowFood Carolina.	Feedback from farmers indicated they did not have time to attend new workshops, so it was best to target them at conferences and workshops that they were already attending.
Provide technical assistance to interested growers in becoming suppliers to the schools and institutions	Target associations and institutions that would be willing to buy the produce from the freezer pilot	In order to get buy in from farmers to become suppliers, we had to first target institutions and associations that would buy the produce. We did originally partner with Dorchester School District. However, the School Nutrition Director of Dorchester School District changed positions and the new director has not signed onto the project. The SCDE Farm to School Coordinator made contact with the new director in August and is still working to secure a partnership. Other partnerships were explored as well. These included the College of Charleston, Charleston County School districts, and Charleston-area early childhood education centers such as Daniel Island Academy.
Transform freezer	Transform Freezer	No Change Occurred.
Facilitate distribution of frozen produce to schools in Dorchester School District	Determine price points for produce that is needed for both farmers and institutions	See above response regarding Dorchester School District. Due to the high price point of the organic blueberries that were secured, we felt this should be a goal to watch for future procurement.

Goal 2: Determine the feasibility of a Value-Added Freezer Pilot Project in one school district.		
Original Goal	**Final Goal**	**Rationale for Change**
Examine school district data, plate waste, and procurement records to determine success and obtain benchmarks (numerical indexes) for future projects	Facilitate distribution of frozen produce to institutions that are interested	The anticipated partnership with a school district did not materialize; therefore, project personnel needed to put efforts toward recruiting institutions.
Examine invoices from GrowFood Carolina to determine success and obtain benchmarks.		No change

Beneficiaries
Farmers, distributors, schools and other institutions are the potential beneficiaries of this project. Thirty-eight (38) farmers received GAP reimbursement assistance, increasing their capacity to sell to school and other institution or wholesale markets. Nineteen (19) farmers benefitted from Farmer Profiles that were created as a marketing tool to promote that farm's available produce; these were displayed on the Farm to Institution website for schools to locate local growers willing to sell specialty crops to schools. At least three (3) distributors were positively affected by this project and the increase of GAP certified farmers willing and qualified to sell to wholesale markets.

The South Carolina Department of Agriculture (SCDA) intends to continue and potentially expand the GAP assistance cost share program since SCDA believes this program has increased the opportunities available for SC specialty crop growers.

Lessons Learned
One of the greatest lessons learned revolves around food safety rule changes, which is one of the biggest concerns of farmers. More resources are needed to disseminate information. Farmers need one clear and consistent message from all food safety organizations within the state. Food safety rules greatly impact farmers' willingness to sell to schools and participate in the Farm to Institution program.

Regarding the freezer pilot project, a great deal of buy in from institutions, farmers, and distributors is needed in order to achieve a successful freezer project. This will require more education to each of these groups as well. Price point and convenience are key factors for schools' participation. Logistical issues, such as back hauling and limited choices when considering freezing produce that didn't need to be processed, did affect the feasibility. However, when these discussions happened in spaces where two of the three areas were involved (institutions, farmers, and distributors), creative problem solving occurred. Opportunities to get all 3 areas involved were limited and difficult to coordinate. Future efforts need to make this a priority. Understanding this, the F2I Advisory Board now has representatives from each of these areas, so these discussions can continue.

Additionally, the blueberry and peach seasons were hit by weather-related issues, making the yields low during the grant period. This greatly affected outcomes. Having very little choices due to lack of processing is an issue. In the future, processing capability will need to be built.

Farmers, distributors, and institutions have all benefitted from the lessons learned on this project. A better understanding of farmers' needs and concerns regarding food safety was gained, as well as how to better engage and communicate with farmers. Because of this grant, project stakeholders have a better understanding about the challenges in the system that make freezing and distributing local produce difficult. We have brought together partners from different areas of the food system and started conversations about how to connect more effectively.

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Additional Information

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Project Three: Seasonal High Tunnel Outreach and Education
Project Partner: Carolina Farm Stewardship Association

Project Summary
Federal cost share programs for adopting conservation farming practices, such as the Natural Resources Conservation Service Environmental Quality Incentive Program (NRCS EQIP), provide opportunities for South Carolina (SC) specialty crop producers to increase their competitiveness in the local food market. In 2010, the NRCS started a Seasonal High Tunnel Initiative to provide cost share assistance for the construction of high tunnels to promote conservation practices that improve plant, soil, water, and air quality, reduce nutrient and pesticide transport, and reduce energy use through local production of fruits and vegetables for local consumption. In addition to addressing environmental resource concerns, the use of seasonal high tunnels can help specialty crop producers increase their competitiveness in the local produce market by utilizing seasonal high tunnels for specialty crop production. The main advantage of high tunnels is that they allow producers to extend their growing season, producing crops earlier in the spring and later in the fall. The ability to sell crops from a high tunnel when field grown crops are not available enables growers to sell high tunnel crops at a premium. Moreover, being the only one at market with those crops helps build customer loyalty.

Since 2010, SC NRCS has awarded contracts for Seasonal High Tunnels to over 250 farmers. Many of these contracts are to "new and beginning" and "historically underserved" farmers. Contract recipients are required to develop production plans that address irrigation, nutrient, and pest management; propose crop rotations plans; and provide a means to divert runoff from the structure. However, many contract recipients lack the production knowledge required to be successful and specifically identify micro-irrigation management as an obstacle. As a result, some Seasonal High Tunnel recipients have had contracts terminated and many more are in similar danger.

This project addressed these challenges by developing an integrated, multi-faceted solution that included three of the SCDA Specialty Crop Block Grant Program's funding areas and priorities: 1) improving efficiency and reducing costs of production; 2) developing organic and sustainable production practices; and 3) developing local and rural agriculture economies and improving access to fresh fruits and vegetables in underserved communities. The objectives of this project were as follows: 1) provide on-farm high tunnel production training to 170 specialty crop producers; 2) twenty of whom would receive one-on-one training; and 3) publish the SC Organic Seasonal High Tunnel Production Guide and the High Tunnel Micro-Irrigation Guide on the Carolina Farm Stewardship Association (CFSA) website. The success of the project was to be measured by increase in annual sales from crops grown in high tunnels by program participants.

Project Approach
Through this project we conducted 9 workshops for 309 program participants, provided direct consulting services to 15 specialty crop producers, developed 2 online resources and wrote 5 *Expert Tip* newsletter articles on topics related to seasonal high tunnel production (Table 1). This project was promoted on CFSA's website and Facebook page, through targeted email outreach, at tabling and speaking events, through our monthly electronic newsletter, and through our program partners' communication channels.

Table 1: *Expert Tip* articles in CFSA's electronic newsletter from Oct. 1, 2015 to Sept. 30, 2018.

Expert Tip	Unique Views
Irrigation in High Tunnels	365
When to Plant in YOUR High Tunnel	163
Reducing Disease in Field Tomatoes	289
Successful Transplant Production	107
Grafting Heirloom Tomatoes	339

Collaboration with partners was essential in conducting this project. Partners included Clemson University's Sustainable Agriculture program, the SC Sustainable Agriculture Research and Education program, Cooperative Extension, the Natural Resource Conservation Service, County Soil and Water Conservation and local farms. These collaborations helped to grow the project and increase farmer awareness of the project. Contributions from partner collaborations included program marketing, workshop support, presentations and promotion of the consulting services. Our recommendations for future projects would be to encourage collaboration across South Carolina's agricultural organizations to create more robust and cohesive trainings for residents.

It is very uncommon for growers to utilize high tunnels for non-specialty crop production, therefore, **this project solely benefitted specialty crops.**

Goals and Outcomes Achieved

The original project proposal was for a three-year period, however, based on the award amount, it was shortened to a two-year period. Given the number of farmers receiving cost share assistance for high tunnels through the NRCS EQIP Cost Share program we anticipated receiving 10 applications a year for one-on-one assistance. However, in year one, we only received six applications, of which five producers were eligible for consulting. Therefore, in Year Two we submitted a modification to the work plan (Table 2), extending the project period out to three years.

Table 2. Modified project work plan, submitted 10/12/17 and approved on 12/29/17.

YEAR 1: COMPLETED TECHNICAL ACTIVITIES	STATUS
Conduct ten one-on-one on-farm high tunnel trainings.	Completed 5
Conduct three on-farm workshops on high tunnel production.	Completed 3
Publish the *SC High Tunnel Micro-Irrigation Guide* on CFSA's website.	Completed
Survey program participants' pre- and post-program participation to document annual sales from high tunnel production.	Postponed until 2017 due to limited consulting applications received.
YEAR 2: COMPLETED TECHNICAL ACTIVITIES	**STATUS**
Conduct ten one-on-one on-farm high tunnel trainings.	Completed 4
Conduct three on-farm workshops on high tunnel production.	Completed 3
Conduct high tunnel workshop at CFSA's SAC Conference.	Completed
Publish the *SC Organic Seasonal High Tunnel Production Guide* on CFSA's website.	Completed
Survey program participants' pre- and post-program participation to document annual sales from high tunnel production.	Postponed until 2018

YEAR 3: PROPOSED MODIFICATION of TECHNICAL ACTIVITIES	STATUS
Conduct six one-on-one on-farm high tunnel trainings.	Completed 6
Conduct four on-farm workshops on high tunnel production.	Completed 3, canceled 1
Survey program participants' pre- and post-program participation to document annual sales from high tunnel production.	Completed

GOAL 1: Increase the success of NRCS Seasonal High Tunnel recipients by providing on-farm high tunnel production training through workshops and one-on-one consulting.

Pre- and post-test questionnaires were administered during workshops in order to assess increased knowledge regarding high tunnel production. All program participants were surveyed to determine the impact that participating in the program had on their operations. One-on-one consulting services, which consisted of a site visit and ongoing assistance, were provided to 15 specialty crop producers on topics including high tunnel construction, production planning, crop/variety selection and irrigation (Table 3). Unfortunately, we did not meet our original goal of conducting one-on-one consulting to 20 specialty crop producers. However, we exceeded the target of 150 total program participants attending a workshop by 159 participants.

Table 3: Program participants who received direct consulting, which included a site visit and ongoing technical assistance through the Seasonal High Tunnel Outreach and Education program.

Farm Name, Location	
Timberock at Hopkins Farm, Simpsonville	Green Pond Farm, Fountain Inn
Foxberry Farm and Vineyard, Eastover	A Thrashers Farm, Pelzer
Sylvan Farm, Saluda	Victoria Farms, Dalzell
Five Forks Sustainable Farm, Pageland	Field to Fork, Sumter
Howell Specialty Farmz, Fort Mill	J & J Farm, Clover
Cooper Family Farms, Bishopville	Cedar Knoll Farm, Belton
Herb N Berries U-Pick Blueberries, Aiken	Zolian S. Zoong Lwe, Pendleton
Clemson Student Organic Farm, Clemson	

Conducted nine workshops on seasonal high tunnel production to 309 specialty crop producers, extension agents, and government agriculture agency representatives. Workshops included:

- **Organic Production in High Tunnels, Greenwood, SC on Jun 13, 2016 (13 attendees).** Topics included organic vegetable production and considerations for organic production in high tunnels.
- **Introduction to High Tunnels, Abbeville, SC on Jun 27, 2016 (14 attendees).** Topics included high tunnel production and management.
- **Introduction to High Tunnels, Charleston, SC on Oct 26, 2016 (30 attendees).** Topics included high tunnel production, management and construction.
- **High Tunnel Production and Management, Columbia, SC on Mar 15, 2017 (54 attendees).** Topics Included production, management, and construction.
- **Diversified Farming Enterprises: Livestock, High Tunnels and Marketing, Saluda, SC on Apr 25, 2017 (12 attendees).** Topics included high tunnel crops, production techniques and finding a market.
- **High Tunnel Production, Clemson, SC on November 15, 2017 (43 attendees).** Topics included high tunnel production, management, and exotic crops.

- **High Tunnel Production and Management: AgBiz Expo, Florence, SC on Jan 18, 2018 (30 attendees).** Topics included high tunnel management and production techniques.
- **Conservation Partnership Field Day, Bishopville, SC on Mar 15, 2018 (80 attendees).** Topics included NRCS Equip Program and high tunnel construction and purchasing.
- **Summer High Tunnel Production and DIY Construction, Charleston, SC on Apr 12, 2018 (33 attendees).** Topics included summer crops in high tunnels and high tunnel construction.
- **High Tunnel Field Day, Fort Mill, SC on Sep 18, 2018.** Cancelled due to damage from Hurricane Florence. While we will not be able to reschedule this workshop before the grant period ends, we plan on conducting this workshop at a future date.

The quantifiable success of this program's short-term outcomes is based on pre- and post-test questionnaires and surveys completed by workshop participants. We had hoped to be able to quantify the program's long-term success based on a comprehensive final electronic survey of all program participants. However, the completion rate of the final survey was very limited, and only three participants answered questions about changes in practices or income. We discuss our evaluation challenges in detail in the Lessons Learned section below.

Based on the pre- and post-test questionnaires, workshop attendees increased their knowledge of high tunnel production and management by an average of 28.5%. Based on workshop evaluations, 65% of participants rated the workshop *Excellent* while the remaining 35% rated the workshop either *Very Good* or *Good*. Participants went on to say that the workshops provided "great information and clarity", noting that the event was "comprehensive" with "great presentations". As a result of attending these workshops 96% of participants either planned to or were considering installing a high tunnel. Participants suggested that the program could be improved by adding hands-on construction workshops for high tunnels.

In their responses to our 2017 High Tunnel Consulting Survey, one-on-one consulting program participants responded that they sought high tunnel consulting services in order to learn about high tunnel planning (65%), purchasing and constructing (18%), irrigation (24%), and assistance addressing specific issues (35%). All program participants said they gained sufficient information to be able to incorporate recommendations and 88% of them rated the consulting services as *Excellent* or *Very Good*. Forty-three percent said they sold less than $2,500 from their high tunnel production, 36% sold $2,500 to $5,000 and 21% sold more than $5,000. Of those 21%, reported sales ranged from $12,000 to $40,000. Program participants identified tomatoes, cucumbers, peppers, greens, and herbs as their most profitable crops. Due to the limited response rate on the 2018 survey, quantitative results are unavailable. However, most one-on-one program participants from 2018 shared with us that they were able to increase their efficiency with high tunnel production, gained confidence in variety selection, and were better able to determine which crops would be best suited for their operations and markets.

GOAL 2: Develop and publish the *SC Organic Seasonal High Tunnel Production* and *SC High Tunnel Micro-Irrigation Guide.*

The *SC High Tunnel Micro-Irrigation Guide* was published on CFSA's website in December 2016. Topics include: 1) basic soil science; 2) soil wetness; 3) how to determine plant water needs; 4) microclimate considerations; 5) types of micro-irrigation; 6) irrigation capabilities; 7) fertilizer injection; and 8) how to calculate irrigation amounts. The document was reviewed externally by Joshua Spencer, Water Quality Specialist, NC USDA/NRCS; John Beck, Extension Associate, North Carolina A&T University; and Joseph

Moore, Owner/Operator, Mill Creek Farm. It was promoted in our electronic newsletter and has received 652 unique views.

The *SC Organic Seasonal High Tunnel Tomato Production* guide was published on CFSA's website in January 2018. Topics include: 1) variety selection; 2) assessing the microclimate; 3) creating a production plan; 4) bed preparation; 5) trellising methods; 6) transplant to harvest; and 7) economics and potential profits. The document was reviewed externally by Gordon Mikell, Agronomist, SC USDA/NRCS and John Ivey, Owner/Operator, Jive Farm. It was promoted in our electronic newsletter and has received 212 unique views.

The two resources received a combined 864 unique views, exceeding our original Performance Measure of 300.

Beneficiaries

Direct beneficiaries of this project were specialty crop producers who received direct technical assistance for high tunnel production or attended a workshop on high tunnels. Beneficiaries served include:

TYPE of INFORMATION DISSEMINATION	NUMBER OF BENEFICIARIES
Viewed Online Resources	2,127
Attended a Workshop	309
Received One-on-One High Tunnel Consultation	15
Received technical assistance producing high tunnels	11

Lessons Learned

CFSA launched the High Tunnel Initiative with funding from this project. At launch we did not know what the demand would be for one-on-one consulting services. Based on feedback from the SC NRCS state office regarding the number of high tunnel contracts they had approved and their concern that many of those contract recipients were struggling to implement the practice, we anticipated that more specialty crop farmers would apply for one-on-one consulting services. Advocating for SC NRCS to include promotional material for this program with their High Tunnel contracts may help increase the number of program participants who take advantage of CFSA's one-on-one consulting services. However, it is clear there is demand for high tunnel workshops, evidenced by the fact that 309 program participants attended a workshop. This is twice the number that we anticipated (150). The overall number of program participants who received technical assistance on high tunnel production through this program was 190% higher than anticipated, which is a huge success.

We intended to measure the success of this project by measuring self-reports of the increase in annual sales from crops grown in high tunnels by program participants. However, we have found it very difficult to gather this information from program participants. Only 4.8% of program participants completed our final survey after three attempts to contact each participant. Moreover, only one survey respondent answered questions about increased income as a result of participating in this program and only three answered questions about how this program resulted in changes to their operations. Based on these results, it is clear that alternative methods of quantitatively evaluating the program's success are necessary. While time-consuming, follow-up interviews with program participants who received one-on-one consulting may help provide this vital feedback. We also learned that surveying program participants every year does not allow enough time for participants to implement what they learned through the program nor realize the benefits from those activities and leads to survey fatigue.

Project participants were required to already have a high tunnel constructed in order to be eligible for one-on-one assistance. However, it became clear that producers also need assistance with purchasing decisions, construction, and initial site planning. As a result of this finding, we have included these topics in proposals to other funders of this work. However, we did include construction and purchasing on the agenda of high tunnel workshops conducted during this project.

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Additional Information

High Tunnel Consulting
Seasonal High Tunnel Production: Organic Tomato Guide
High Tunnel Micro-Irrigation Guide
Irrigation in High Tunnels
When to Plant in YOUR High Tunnel
Reducing Disease in Field Tomatoes
Successful Transplant Production
Grafting Heirloom Tomatoes

Project Four: Sky High: Education and Training for the SC Ornamental Horticulture Industry
Project Partner: South Carolina Nursery and Landscape Association

Project Summary
The South Carolina Nursery and Landscape Association (SCNLA) successfully planned and implemented a multi-day, multi-topic educational program with very reasonable registration fees that featured 20 seminars for ornamental horticulture professionals and their direct influencers (those that buy and use nursery crops) over a three-day period in February 2016. Despite a snow storm that hit most of South Carolina and the East coast during the time of the conference the total seminar registration was 397 persons and 729 Continuing Education Units (CEU) were earned among the participants. Seminar topics included new plant varieties, weed control, equipment safety, regulatory issues, sustainability topics, pest control, design and more. Thirteen of the 20 seminars offered at least one type of CEU.

The educational program was planned by our Education Committee based on a variety of inputs: industry trends, suggestions for topics from earlier surveys, speakers/topics they had heard at other events, criteria form the Specialty Crop Block Grant Program, and current industry issues, i.e.; legal workforce.

The purpose of the project was to deliver an educational program with timely information on new plants (trees, shrubs, turfgrass, annuals and/or perennials) which helps producers and their direct influencers better market their product to the final consumer, problem solving information on current plant pests and diseases identification (identification, prevention, treatments for our area), and topics on employee safety and management. These programs also needed to offer Continuing Education Units that are required for many in the horticultural industry to maintain their various certifications.

Project Approach
Offering Continuing Education Units is an important element of our programming. The different certifications have different renewal cycles, emphasis areas, and number of units required per cycle. We try to offer a consistent venue with multiple opportunities for credit units so that people in the industry know they have a dependable source and can budget their time and finances to earn their credits.

SCNLA strives to offer education for our diverse industry, not just our members. This educational opportunity, as with all our education workshops, was open to the entire industry. We also attract attendees with a wide range of skill levels. Some attendees are entry level workers, some are business owners, and many are in between.

The educational program was open to all horticulture industry professionals, so attendees came from production nurseries, production greenhouses, retail garden centers, public gardens, landscape design and installation companies, landscape maintenance companies, technical colleges and universities.

Due to the financial assistance of the Specialty Crop Block Grant, SCNLA was able to keep the full day of seminars at $75.00 per day.

All activities listed in the approved project work plan were completed in a timely manner.
The program was designed with the needed topics, speakers provided their presentation title and description, print pieces were developed and mailed, the conference was held, and the follow up work of paying bills, tallying evaluations, etc. was completed.

The attendee evaluations were tallied. The attendee assessment of the information provided and their statements on how they would use what was learned validated the success of the overall program. The number of CEUs earned (729) and the number of registrations (397) reflected the need for the courses offered and the interest of the participants in the specific topics offered. This information will also be used for planning future educational programs.

Goals and Outcomes Achieved
Goal – Respondents in each class gain useful knowledge
Target – 60% of respondents will learn at least one useful item of information in each class
Goal Completed – Overall total of 87% of respondents agreed that the program provided them with timely knowledge that they could use in their work. Only one program had a 53% average, but it should be noted this was the student presentation. Three programs had a 100%. Eight had a 90-99%; 6 had a 80-89%; 2 had a 70-79%.

Goal – At least 6 seminars approved for CEUs will be offered.
Target – 200+ CEUs will be earned
Goal Completed – 13 seminars offered CEUs. 598 Pesticide Applicators License CEUs were earned; 31 International Society of Arboriculture CEUs were earned; 100 Landscape Contractor CEUs were earned.

Goal – Develop and offer a program with at least 18 hours of valuable topics for the ornamental horticulture industry and to have at least 250 participants/registrants.
Goal Completed – Our program had 20 hours of education and 397 registrations.

Beneficiaries
This program attracted attendees from all segments of the "green" industry: those who grow trees, shrubs, turf grass, annuals, and perennials and those that add value to the product (landscape contractors, landscape maintenance, arborists, etc.) and those that make it available to the final consumer (public gardens, and retail garden centers).

We are pleased to report an increase in the number of participants over last year and that in the evaluations, sharing information with fellow employees was listed numerous times. It is rewarding to learn that our participants felt that the information they learned was important enough to make sharing it a priority. Ultimately the final consumer benefits because the education provided to the industry helps them provide a better (healthier, more variety, etc.) product and to be more conscientious of the pests, diseases, and chemicals that are a part of plant production and the landscape environment. Making the best choices when chemicals must be used is also a better economic decision for the user as well as better for the environment. This is also true of awareness of invasive plant species. The more people who are educated on the costs of invasive species in our environment the better. A higher ability to identify and properly remove invasive plants benefits and improves the environment for everyone.

While our participants vary greatly in skill and knowledge levels we strive to offer topics that provide information to a variety of people. Although the economic impact cannot be measured, the fact that so many chose to spend their time and money to attend reflects their confidence that SCNLA educational programs have a history of offering value and that this program specifically was of value to them. Our trade show that follows the educational conference offered participants with opportunities to meet growers and make purchasing decisions on plant material.

It cannot be stated enough that this conference is for the industry and not just SCNLA members. Of the total number of attendees only 20% checked off that they were SCNLA members. We want to provide the opportunity for anyone in the industry to gain knowledge and improve their businesses and to purchase plant material from South Carolina Growers.

From a practical perspective those that do not earn the required CEU's for their licenses and certifications will lose those designations which will impede their ability to do their work and their ability to earn an income in this field.

There were almost 400 total participants in the classes offered. And while there is no way to measure it, participants do go back and share what they learn with their employees or fellow workers.

Lessons Learned

While we have had requests for a full day design class we were hesitant to plan one because the registration fee would be expensive compared to our other events but 100% of those who completed the evaluation of the program gave it a 5/strongly agree to the question "Today's overall program was worth the time away from work and the registration fee" so it appears people understand that they have to pay more for detailed instruction on a specialty topic.

We still continue to urge more people to complete the evaluations so that we can better provide the education they want and need. Having the moderators encourage attendees to complete the surveys helps to some degree. It appears that participants are less likely to complete evaluations later in the day. We will also consider an on-line evaluation option in the future. On-line evaluations will be totaled quickly and neatly, although we have come concerns that participants may be less like to answer the open-ended questions. The open-ended responses provide better information for planning future seminars. We will research this option more before making a decision.

Having open-ended questions about future topics that participants would like continues to be a good source of information for planning for us.

Promotion of the event requires multiple methods. While emails are good for deadline reminders, many people still want to receive the complete paper brochure. This means it is difficult to reduce printing costs.

At the request of the Specialty Crop Block Grant Administrator we reworded a survey question to ask participants to list specific information that was learned from a seminar and it was good to see what they learned and how they wanted to implement what was learned. The knowledge level of the participants was also reflected, some are new and take away so much new information and some have years of experience and are harder to impact but they all seem appreciative of the speakers' knowledge and willingness to share.

Contact Person

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Project Five: **Nutritional and Biological Yield Improvement of 'SC Grown' Kale**
Project Partner: Clemson University, Dr. Dil Thavarajah

Project Summary
Kale is a leafy green brassica vegetable rich in dietary fiber; vitamins A, K, and C; and essential minerals potassium (K), calcium (Ca), and magnesium (Mg). Kale also provides significant levels of vitamins and prebiotic carbohydrates, although to date those nutrients have not been well characterized. By necessity, kale marketing and consumer nutritional education is based on the very limited nutrient composition data available from the USDA (National Nutrient Database for Standard Reference). The USDA data are both limited and of questionable relevance to modern kale varieties as they are based on analyses of a limited number of kale varieties available in the early 1980s.

Consumption of non-digestible, fermentable carbohydrates (or prebiotics) stimulates the growth and activity of hind gut bacteria that provide an energy source for colonocytes, strengthen the gut mucosal barrier, and suppress colonization by pathogens. Major dietary sources of prebiotics are cereals, legumes, and vegetables. The quantity of prebiotic carbohydrates in grain products ranges from 0 g in rice, 0.6 g in dark rye bread, 0.11 g in oats, and 1.12 g in wheat to 13-15 g in lentil per 100 g per portion size. Kale could be an excellent source of prebiotic carbohydrates, however research on kale prebiotic carbohydrates offer new opportunities to uncover detailed information to increase consumer education of kale as a nutritious food. Our proposed study was the first preliminary research to determine the types and levels of prebiotic carbohydrates and essential minerals in SC-grown kale.

South Carolina is a major fresh market kale producer in the USA, but no detailed nutritional quality data are available for the locally grown kale. Clemson University hired Dr. Dil Thavarajah to establish a Specialty Crop Nutritional Quality program especially for brassica vegetables – kale and collards. In consideration of growing obesity and micronutrient malnutrition concerns within the state and across the USA, results from this study will (1) be used to position SC kale as a whole food solution to obesity and micronutrient malnutrition, (2) contribute to the development of evidence-based marketing strategies for kale grower organizations and industry partners, and (3) provide science-based information for greater consumer education regarding the nutritional quality of SC kale. The proposed project activities were only aimed to enhance specialty crops grown in SC. This project is not a continuation of a previous project and has not been submitted to another Federal or State grant program.

Motivation for this project was to understand the nutritional quality of locally grown kale to establish a future kale biofortification research program. Specific projects goals were to (1) develop comprehensive nutritional composition data for SC grown kale, and (2) select kale varieties that produce higher biomass and nutritional quality under greenhouse conditions towards increase kale production.

This project was not built on a previously funded project.

Project Timeline:
Objective 1: Oct 2015-Sep 2016
Objective 2: Oct 2016- Sep 2017
Project completion: Oct 2017-Sep 2018

Activity	Time line (Months)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep
1. Objective 1												
2. Objective 2												
3. Manuscript 1												
4. Manuscript 2												
5. Nutrient database												
6. Meting growers												
7. Surveys/meetings												
8. Final report												

Project Approach

Objective 1: determine the nutritional composition (energy, protein, mineral, and prebiotic carbohydrate concentrations) of 25 different kale varieties grown in Pelion, South Carolina, USA, and to determine whether kale is a potential whole food source of daily essential minerals and dietary fiber (*Please see the attached manuscript published in Journal of Food Composition and Analysis*).

Approach: Field-grown fresh kale samples were collected from variety trials conducted by Walter P. Rawls and Sons, Inc. in Pelion, SC, USA. Twenty-five commonly grown kale genotypes were selected based on market class, consumer demand, disease resistance, biological yield, and preference for future breeding and selection research **(Table 1)**. Kale plants were harvested at physiological maturity. Fresh leaf samples (250 g) were taken randomly from the entire harvested plant of each of four independent replicated field plots and subjected to energy, protein, mineral, and carbohydrate analyses. A total of 100 individually replicated kale leaf samples were collected. The samples were immediately freeze dried and stored at -40 °C until analysis.

Energy and Protein Analysis: Finely ground freeze-dried kale samples were compressed into a pellet, and then ignited in an oxygen-rich closed environment using a Parr Bomb Calorimeter. Total nitrogen was determined using a LECO FP3000 CNS analyzer. Kale protein content was calculated as a percent value by multiplying the total N by 6.25.

Mineral Concentration: Total mineral concentrations in kale samples were determined using a modified HNO3-H2O2 digestion method (Thavarajah et al. 2009). Approximately 500 mg tissue samples were digested with 6 mL of concentrated nitric acid (70% HNO3) overnight. Samples were then heated to 90 °C for 1 h, after which 3 mL of 30% hydrogen peroxide (30% H2O2) were added and the sample digested for a further 15 to 20 min. The digested samples were reduced with 3 mL of 6M hydrochloric acid at 90 °C for another 5 min. Samples were then filtered and made up to 10 mL in Milli-Q water. Mineral concentrations were determined by ICP-OES (6500 Duo, Thermo Fisher Scientific, PA, USA). Percent recommended daily allowance (%RDA) was calculated based on the mean mineral concentration for a 100 g portion size of fresh kale for adults aged 19-50 years: K=4.7 g/d for males and females; Ca=1000 mg/d for males and females; Mg=420 mg/d for males and 310-320 mg/d for females; Fe=8 mg/d for males and 18 mg/d for females; Zn=11 mg/d for males and 8 mg/d for females; Mn=2.3 mg/d for males and 1.8 mg/d for females; Cu=900 µg/d for males and females; and Se=55 µg/d for males and females (National Academy of Sciences, 2004).

Prebiotic Carbohydrate Analysis: Ground kale samples (~500 mg) were weighed into 15 mL polystyrene conical tubes. Extraction was carried out using a previously described method (Muir et al., 2009). Detection was carried out using a pulsed amperometric detector (PAD, Dionex) in congruence with a working gold electrode (Thermo Fisher Scientific, Inc.) with a silver-silver chloride electrode at 2.0 µA. Hemicellulose was measured as described above method after digesting 500 mg of sample with 5 mL of 7% (w/w) hydrochloric acid (HCl) at 55 oC for 120 minutes.

Statistical Analysis: The experimental design was a complete randomized block design with four replicates for 25 commercial kale genotypes (n=100). Replicates and genotypes were considered as random factors. Class variables include genotype and replication. A mixed model analysis of variance was performed using the PROC GLM procedure of SAS version 9.4 (SAS Institute SAS User's Guide, 2012). Means were separated by Fisher's protected least significant difference at $P < 0.05$.

Significant Results: Kale grown in SC was found to be a low-calorie food (36-98 Kcal/100 g) that is a rich source of protein (1.6-5.9 g/100 g), essential minerals, and prebiotic carbohydrates. Kale was a rich source of K (188-873 mg/100 g), Ca (35-300 mg/100 g), Mg (20-100 mg/100 g), Fe (0.5-2.3 mg/100 g), Zn (0.2-1.6 mg/100 g), Mn (0.2-2.3 mg/100 g), Cu (2.0-116 µg/100 g), and Se (0-17 µg/100 g). In addition, kale contained a range of prebiotic carbohydrates including sugar alcohols (0-59.8 mg/100 g), simple sugars (0.4-3348 mg/100 g), and hemicellulose (0-703 mg/100 g). The total identified prebiotic carbohydrates in kale ranged from 0.4-6.7 g/100 g; however, another 5.0-8.0 g/100 g was classified as unidentified "other" prebiotics **(Table 2)**.

A 100 g serving of fresh kale provides a significant percentage of the RDA for all analyzed mineral micronutrients except Fe for females **(Table 3)**. Kale is a "good source" of minerals as one serving (100 g) provides more than 10% of the RDA. Furthermore, substantial genotypic differences in mineral concentration were observed for all elements, and more than 50% of tested genotypes could provide at least 10% of the RDA for the minerals considered. Among these genotypes, curly kale genotype 'Frizzy Lizzy' had significantly higher concentrations of K, Ca, Mg, Fe, and Zn than many other varieties, as did 'Lacinato', 'Fizz', and 'Frizzy Joe'. Most of these kale genotypes were also high in Mn and Cu; however, Se concentrations were relatively low in all genotypes **(Figure 2)**.

Prebiotic carbohydrate concentrations varied by genotype. For sugar alcohols, 'Frizzy Joe' (39.2 mg/100 g) had the highest concentrations of sorbitol, and 'Darkibor' (33.2 mg/100 g) had the significantly highest concentration of mannitol. For simple sugars, 'Italian Kale' (145 mg/100 g), 'withheld' (cultivar name withheld by grower (103 mg/100 g), and 'Frizzy Joe' (101 mg/100 g) had the highest concentrations of sucrose, and' Frizzy Joe' and 'Dauro' had the highest concentrations of fructose (1246-1080 mg/100 g) and glucose (1715-1947 mg/100 g). For hemicellulose, 'Frizzy Joe' had the highest concentrations of mannose (403 mg/100 g) and xylose (201 mg/100 g). In contrast, arabinose concentration was the highest in 'Darkibor' (166 mg/100 g) and 'withheld' (156 mg/100 g). Energy, protein, and total prebiotic carbohydrates clearly varied with kale genotype **(Figure 1)**. 'Black Magic', and 'Fizz' had the highest protein levels of the genotypes tested. 'Frizzy Joe' and 'Dauro' had higher levels of total prebiotic carbohydrates and moderate levels of protein and energy compared to the other genotypes **(Figure 1)**.

Table 1: Kale genotypes grown in Pelion, SC, USA.

Market Class	Genotype
Curly	Darkibor, Dwarf Green Curled Afro, Pentlang Brig, Red Russian, Redbor, Reflex, Ripbor, Scarlet, Star & Stripes, Starbor, Vates, Winterbor, *withheld* (cultivar name withheld by grower), Blue Ridge, Blue Knight, Maribor
Portuguese	Beira, Dauro
Dinosaur	Black Magic, Bonanza, Italian Kale, Lacinato
Ornamental	Fizz
Mustard	Frizzy Joe, Frizzy Lizzy

Table 2: Nutritional profile of kale genotypes grown in SC, USA.

Nutrient	Concentration [a]		USDA [b]	Genotype effect [c]
	Range	Mean		
Protein (g/100 g)	1.6-5.9	4.2	4.28	*
Energy (Kcal/100 g)	36-98	66	49	*
Minerals (mg/100 g)				
K	188-873	488	491	*
Ca	35-300	106	150	*
Mg	20-100	44	47	*
Fe	0.5-2.3	1.1	1.47	*
Zn	0.2-1.6	0.7	0.56	*
Mn	0.2-2.3	0.8	0.65	*
Cu (µg/100 g)	2-116	55	149	*
Se (µg/100 g)	ND [e] -17	2.3	65	*
Prebiotic carbohydrates (mg/100 g)				
Sugar alcohol				
Sorbitol	ND-59.8	24.5	-	*
Mannitol	ND-45.4	17.9	-	*
Simple sugars				
Glucose	69-3348	993	-	*
Fructose	29-1933	545	-	*
Sucrose	0.4-212	39.3	-	*
Hemicellulose				
Arabinose	ND-245	73.5	-	*
Mannose	ND-703	241	-	*
Xylose	ND-320	59.9	-	*
Total identified prebiotic carbohydrates (g/100 g)	0.4-6.7	1.9	-	
Other prebiotic carbohydrates (g/100 g)	5.0-8.0	5.5	-	

[a] Values based on 100 data points [fresh weight, 85% moisture)] from current study.

[b] A single data point [fresh weight, 84% moisture] from USDA Standard Nutrient Data base

[c] Genotype effect is significant at $P<0.05$ (n=100).

[e] ND, not detectable levels

Table 3: %RDA of different minerals from a 100 g serving of fresh kale grown in SC, USA.

Element	%RDA from 100g [a]	Recommendation
K	5.4-14.3	Male/Female (4.7 g)
Ca	5.2-17.2	Male/Female (1 g)
Mg	6.3-16.5	Male (400-420 mg)
	8.1-21.3	Female (310-320 mg)
Fe	6.8-20.3	Male (8 mg)
	3.0-9.0	Female (18 mg)
Zn	3.4-10.5	Male (11 mg)
	4.6-14.4	Female (8 mg)
Mn	18.3-60	Male (2.3 mg)
	23.3-77	Female (1.8 mg)
Cu	2.8-11	Male/Female (900 µg)
Se	0.7-26.7	Male/Female (55 µg)

[a] Percent recommended daily allowance (%RDA) was calculated based on National Academy of Sciences, 2004. Values are based on fresh weight (85% moisture), n=100 per nutrient

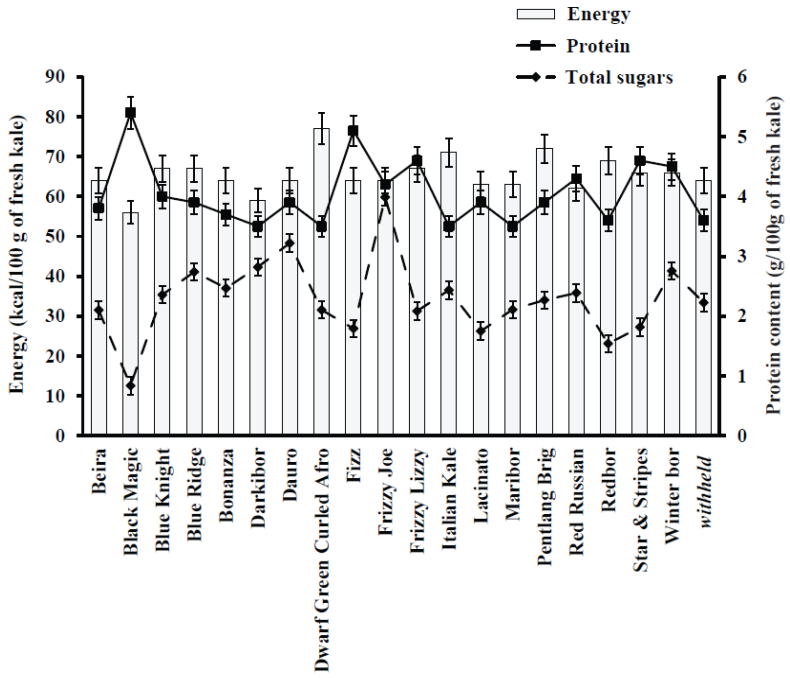
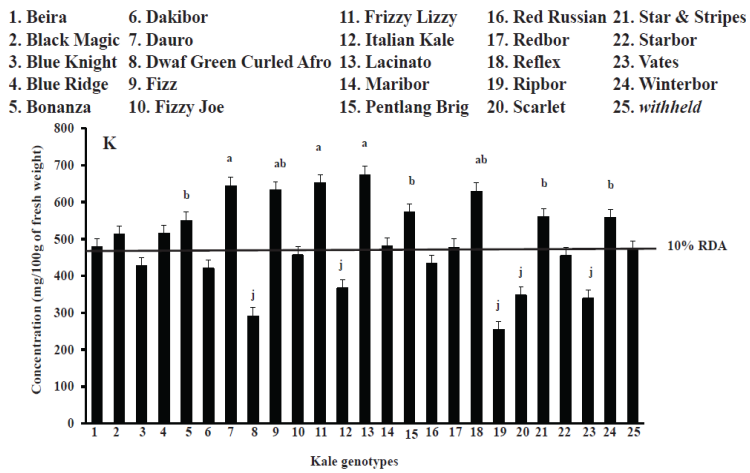


Figure 1: Variation in energy, protein, and total sugar concentration of 20 kale genotypes



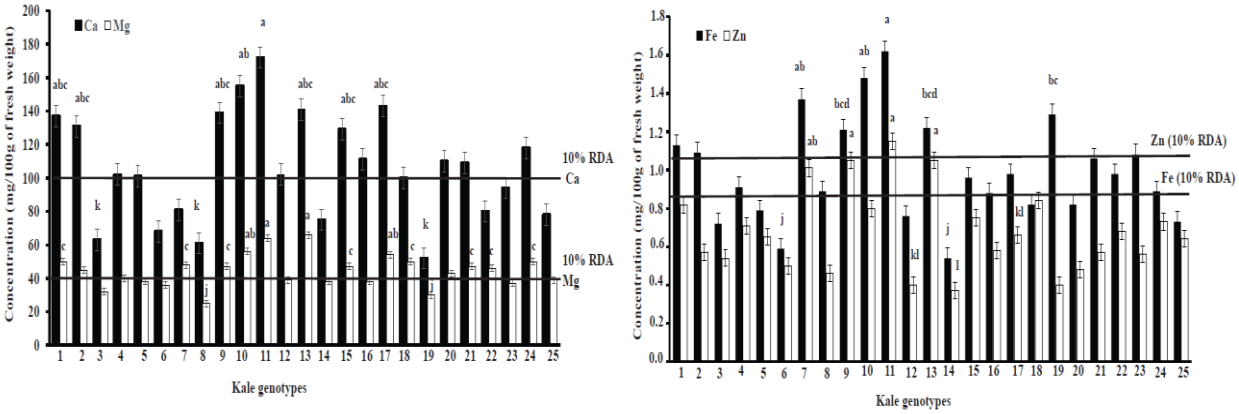


Figure 2: Genetic variation of mineral concentrations in 25 kale genotypes: (a) K; (b) Ca and Mg; (c) Fe and Zn. Means with in the bars (element) followed by different letters are significant at $P<0.05$ (differences were shown only for highest and lowest values).

Objective 2: determine which commonly grown kale genotypes in southern US regions respond to moisture stress with minimal compensating losses in biomass, minerals, and prebiotic carbohydrate levels under greenhouse conditions.

Approach: Ten kale genotypes were chosen based on their market class, consumer preference, and the potential for follow-up genetic studies based on contrasting nutritional profiles **(Table 4)**. Kale seeds were planted in transplanting trays filled with potting soil (Sun Gro Horticulture Distribution Inc., MA). Kale seedlings were treated with a low rate (2 kg/ha) of 18-6-12 N-P-K osmocote fertilizer (Everris NA Inc., Dublin, OH) and grown in a glass-glazed greenhouse germination room (Clemson University, Clemson, USA). Seedlings were watered 3 to 5 times a day using an auto sprinkler system and kept at saturated soil moisture conditions. After 4 weeks, seedlings were transplanted into 6" plastic pots filled with approximately 300 g of a peat-perlite-vermiculite mixture (Sun Gro Horticulture Distribution Inc., MA). The soil in each pot was saturated with deionized water, allowed to drain overnight, and then the weight of each pot recorded. At time of transplant, moisture content was at 80% field capacity. Greenhouse conditions were as follows: day/night temperatures of 22/15 °C; photosynthetically active radiation levels of 300 µmol m-2 s-1 using a 14 h photoperiod beginning at 0600 local time, and 55-65% relative humidity. A total of 80 pots were transplanted: four replicates of the ten kale genotypes at two different moisture conditions applied at 4 weeks after transplanting. Pots were watered to approximately 80% of free draining moisture content every day, and 250 mL of nutrient solution were added to all pots every week, as per standard procedures for kale cultivation at the Clemson University Pulse/Vegetable Quality and Nutrition program. Nutrient concentrations of the all-purpose 15-5-15 fertilizer solution (Everris NA Inc., Dublin, OH) were 15% total N, 5% total P, 15% soluble K, 0.02% B, 0.05% chelated Cu, 0.1% chelated Fe, 0.05% Mo, 0.05% Zn, and 1% EDTA. Four weeks after transplanting, plants were subject to one of two moisture conditions (80% moisture: control; 40% moisture: moisture stressed) for two weeks. Tissue samples were collected and then plants were allowed to recover at 80% moisture for another 2 weeks. Fresh leaf samples (10 g) were taken randomly before the recovery period from the entire plant of each of four independent replicates of the two moisture treatments. A total of 80 replicate kale leaf samples were collected. Moisture content of fresh sub-samples (105 °C for 16 h) was measured, and oven dried-tissue samples were stored in air-tight containers at -20 °C until analysis. Prior to each analysis, the oven-dried samples were finely ground using a mortar and pestle. Nutrient composition data are reported on a fresh weight basis (85% moisture, and 15% dry matter). At leaf maturity (after the recovery period), plants were hand harvested and the fresh weight of biomass recorded.

Minerals and prebiotic carbohydrates were measured as described in objective 1.

Statistical analysis: The experimental design was a complete randomized block design with four replicates for 10 commercial kale genotypes with two moisture treatments (n=80). Replicates and genotypes were considered as random factors. Class variables include genotype, replication, and treatment. A mixed model analysis of variance was performed using the PROC GLM procedure of SAS version 9.4 (SAS Institute SAS User's Guide, 2012). Means were separated by Fisher's protected least significant difference at $P < 0.05$.

Significant Results: Most mineral concentrations significantly decreased with moisture stress compared to controls; the exceptions were Ca, Mg, and Zn, for which concentrations remained within tight ranges across both control and drought samples (180-189 mg/100 g, 86-92 mg/100 g, and 0.7-0.7 mg/100 g, respectively) **(Table 5)**. The genotype effect was only significant for Ca, K, Mg, and P. For kale genotype 'Dwarf Green Curled Afro', Ca and K concentrations significantly decreased in response to water stress. In contrast, Ca and Mg concentrations significantly increased but P concentration significantly decreased in

response to water stress for kale genotype 'Fizz'. Furthermore, water stress resulted in significantly decreased Mg concentrations in 'Starbor' and 'Vates' and significantly reduced P concentration in 'Red Russian' and 'Scarlet'. Individual mineral concentrations in genotypes 'Beira', 'Black Magic', 'Darkibor', and 'Lacinato' did not change in response to moisture stress and visual symptoms of water stress were not evident.

The response of sugar alcohol levels to moisture stress varied, i.e., sorbitol significantly increased (from 154 mg/100 g in the control to 234 mg/100 g with moisture stress) and mannitol significantly decreased (from 42 to 32 mg/100 g; **Table 5**). Simple sugar concentrations generally increased in response to moisture stress, but this was only significant for sucrose (from 284 to 431 mg/100 g). Similar to simple sugars, raffinose/fructooligosaccharide concentrations increased with moisture stress, but this was only significant for verbascose + kestose (from 165 to 195 mg/100 g). In contrast to minerals, the genotype effect was significant for all types of LMWC. For sugar alcohols, sorbitol typically increased, and mannitol typically decreased in response to moisture. Sorbitol significantly increased in kale genotypes 'Darkibor', 'Dwarf Green Curled Afro', and 'Starbor' and mannitol significantly decreased in 'Black Magic', 'Darkibor', 'Dwarf Green Curled Afro', and 'Lacinato'.

Kale biomass content significantly reduced with moisture stress for all genotypes **(Fig 3)**. Relative proportion of biomass reduction for kale genotypes from control to drought treatment varied from 19-35%. 'Beira' and 'Lacinato' showed the highest biomass reduction followed by 'Darkibor' and 'Vates' showed the lowest biomass reduction with response to drought **(Fig 3)**. Among genotypes, 'Beira', 'Darkibor', and 'Red Russian' showed significantly higher biomass in control treatment (i.e. larger plant per area) compared to others despite moisture stress.

Table 4: Kale cultivars and treatment design.

Market class	**Cultivars** (n=10) × 2 treatments [80% moisture (control), 40% moisture stress (drought) for 2 weeks] × 4 replicates = 80
Curly	Darkibor, Dwarf Green Curled Afro, Red Russian, Scarlet, Starbor, Vates
Portuguese	Beira
Dinosaur	Black Magic, Lacinato
Ornamental	Fizz

Table 5: Minerals and prebiotic carbohydrate profiles of kale in response to moisture stress.

Nutrient [a]	Control		Moisture stress		Genotype effect [b]
	Range	Mean	Range	Mean	
Minerals (mg/100g)					
Ca	273 - 120	180 *a*	71 - 494	189 *a*	*
K	370 - 502	416 *a*	322 - 410	369 *b*	*
Mg	68 - 123	92 *a*	53 - 174	86 *a*	*
P	81 - 134	105 *a*	74 - 106	90 *b*	*
Fe	0.7 - 1.3	0.9 *a*	0.7 - 0.9	0.8 *b*	NS
Mn	0.3 - 0.6	0.4 *a*	0.2 - 0.4	0.3 *b*	NS
Zn	0.5 - 1.5	0.7 *a*	0.5 - 0.9	0.7 *a*	NS
Cu (µg/100g)	30 - 60	40 *a*	030 - 50	30 *b*	NS

LMWCs (mg/100 g)					
Sugar alcohols					
Sorbitol	88 - 276	154 *b*	97 - 406	234 *a*	*
Mannitol	10 - 81	42 *a*	8 - 90	32 *b*	*
Simple sugars					
Glucose	91 - 179	155 *a*	122 -318	175 *a*	*
Fructose	38 - 302	118 *a*	27 - 374	131 *a*	*
Sucrose	81 - 500	284 *b*	315 - 531	431 *a*	*
Raffinose/Fructooligosaccharides					
Raffinose + Stachyose	9 - 23	18 *a*	9 - 32	19 *a*	*
Verbascose + Kestose	61 -282	165 *b*	83 - 282	195 *a*	*

[a] Values reported as fresh weight (85% moisture and 15% dry matter).
[b] Genotype effect significant at P <0.05 (n=80) indicated by *.
* Significant at P <0.05.
[c] NS, genotype effect not significant at P <0.05 (n=80).
Means within a row with different letters significantly different at P <0.05 (n=80).

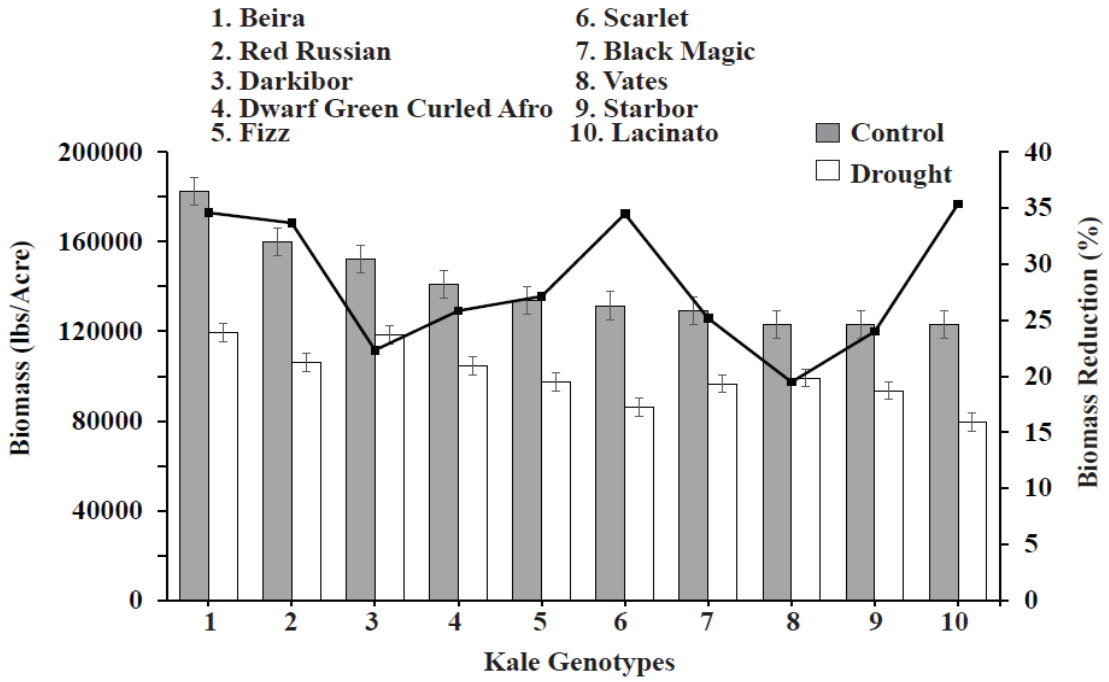


Figure 3: Biomass of 10 kale genotypes in response to moisture stress. For all kale genotypes, drought significantly reduced biomass at P<0.05.

Conclusions and Recommendations

- A 100 g single serving of fresh kale provides significant concentrations of K, Ca, Mg, Mn, Cu, and Se as well as 0.4-6.7 g of total beneficial prebiotic carbohydrates, 1.6-5.9 g of protein, and 36-98 Kcal of energy.
- Genotypes, 'Lacinato', 'Frizzy Lizzy', and 'Dauro' are particularly rich in nutrients.
- Kale is a whole food source of essential minerals K, Ca, Mg, Mn, and Cu as well as dietary fiber including sugar alcohols, simple sugars, and hemicellulose. Kale is also low in calories and provides moderate levels of protein. Therefore, kale is a good source of minerals and prebiotic carbohydrates for consumption in American diets as per the recommendations of the 2015 Dietary Guidelines Advisory Committee.
- Moisture stress significantly alters mineral and prebiotic carbohydrate concentrations in kale.
- 'Black Magic' and 'Lacinato' are the most suitable genotypes for moisture stress conditions.
- Further studies are recommended for other essential nutritional quality parameters including folates, carotenoids, and antioxidant levels.
- While nutritional data for conventionally grown kale has been documented, nutritional quality data is not yet available for organically grown kale. Kale producers recommend expanding this study to develop nutritional quality parameters for organic kale grown in SC.
- Further studies are needed to select kale cultivars with biomass and nutritional profiles that respond well to changing moisture and temperature in different field environments.

Research and education:

- Dr. Thavarajah's team has published three peer review manuscripts in high impact Food Science Journals (***manuscripts are attached***) to promote kale as a whole food to increase human health.
    - Indika Pathirana, Pushparajah Thavarajah, Niroshan Siva, Anuradhi N. K. Wickramasinghe, Powell Smith, Thavarajah Dil, **2017**. Moisture deficit effects on kale (Brassica oleracea L. var. acephala) biomass, mineral, and low molecular weight carbohydrate concentrations, Scientia Horticulturae 226:216-222.
    - Thavarajah, Dil, P. Thavarajah, A. Abare, S. Basnagala, C. Lacher, P. Smith, G. Combs Jr. **2016**. Mineral Micronutrients and Prebiotic Carbohydrate Profiles of USA-grown Kale (*Brassica oleracea* var. *acephala* L.), Journal of Food Composition and Analysis, 52:9-15 (*Impact factor 3.302*).
    - Migliozzi[*], M., Dil Thavarajah[‡], P. Thavarajah, P. Smith. **2015**. Lentil and kale: complementary nutrient-rich whole food sources to combat micronutrient and calorie malnutrition. *Nutrient*, 7 (11): 9285-9298, (*Impact factor 4.064*).
- Graduate/undergraduate student poster presentation.
    1. McSwain, M., Nicolas, B., Dale, S., Sterling, A., Schueren, F., Younts, G., Behnke, M. F., Edwards, R. M., Gallagher, S. R., Mapapathirannehelage, I. P., Siva, N., Thavarajah Dil. **2018**. Tiger Gardens: Healthy urban vegetable production. The 13th Annual Focus on Creative Inquiry Poster Forum (FoCI). Clemson University, USA.
    2. Seiter, N., Siva, N., Pathirana, I., Nicolas, B. R., Dale, S. M., Schueren, F. C., Gruber, K. M., Thavarajah, Dil**. 2018**. Smart Kale. Cultivate CAFLS Symposium, Clemson University, USA.
    3. Pathirana, I., Thavarajah Dil, **2017**. Moisture deficit effects on kale (Brassica oleracea L. var. acephala) biomass, mineral, and low molecular weight carbohydrate concentrations, Poster Presentation, Eighth Annual Conference of American Council for Medicinally Active Plants. Clemson University, USA.
    4. Pathirana I., Niroshan S., Thavarajah Dil., Thavarajah P., Smith P. **2016**. Terminal Drought on Kale (*Brassica oreracea* var. acephala) Mineral Concentration. Poster Presentation, CBAAS, Clemson University, February 20, 2016.

5. Meredith Mcswain, Brodie Cox, **Thavarajah Dil, 2017**. Tiger Garden – approach to prevent local hidden hunger, CU Global Food Security Institute, October 11, 2017.
6. Meredith Mcswain, **Thavarajah Dil**, **2017**. Tiger Gardens: Educating Future Generations on Health and Sustainability, 12th Annual Focus on Creative Inquiry, Clemson University, April 5, 2017.

- USDA Standard Nutrient Data base has been updated with kale dietary fiber and mineral data for all users in the US and worldwide
- We were also planning to develop a kale nutritional quality website in summer 2018. Graduate student obtained cascade training on website development, however website development is still underway.
- Mr. Indika Mapa graduated with a master's degree (May 2018).
- Total of 48 undergraduate students were trained on growing kale and nutritional quality during this project period – Students enrolled as a regular Creative Inquiry "Healthy Home Gardens – Tiger Garden" class for last 3 years.
- Three student interns were trained.

SC Grower Education

1. Scientific data on minerals and dietary fiber has submitted to the SC kale growers to incorporate our data to their marketing program – for example, accurate mineral nutrition data is available to display in their regular kale bags labelling for dietary fiber and minerals –calcium and potassium for heart health.
2. Dr. Thavarajah has written an extension fact sheet on kale nutrition quality. Dr. Thavarajah has also written a section on SC kale nutritional quality on SC Vegetable Gardening manual. Manual will be published in fall 2018 (Article is attached).
3. Drs. Thavarajah and Powell Smith delivered a kale nutrition quality presentation to annual Vegetable Expo Meeting and updated growers with our research.
    - **Thavarajah D. 2017**. Pulses and Kale, Invited Plenary Lecture, Invited Seminar American Council for Medicinally Active Plants, Clemson University, SC, June 20-23, 2017.
    - **Thavarajah D. 2018**. Invited talk at UC Davis, California – August 23, 2018.
    - **Thavarajah D. 2017**. Pulses/leafy vegetables as Whole Food Solution to Global Health Challenges, Invited Keynote Lecture, Plant Breeding and Genetics, Cornell University, Ithaca, NY, March 27-28, 2017.
    - **Thavarajah D. 2016.** Clemson University Extension Horticulture Program Team Meeting, Invited seminar on "Clemson Specialty Crop Research", March 10, 2016.
    - Thavarajah, Dil. "Why Your Mother Always Told You to Eat Your Greens". Invited Seminar, 29th Annual Southeast Vegetable and Fruit Expo, Kingston Plantation Embassy Suits, Myrtle Beach, SC, Dec 2-3, 2014.
    - **Thavarajah D. 2016.** SC grown kale as a Kale: a super leafy green for improved human Nutrition. Invited Seminar, 30th Annual Southeast Vegetable and Fruit Expo, SC Nov 30, 2016.

4. Our team has also contacted SC growers regularly and updated nutritional quality data, however kale processers are requesting other nutritional quality data such as folate and carotenoids.
5. Dr. Thavarajah has given several presentations to update the Clemson University Horticulture Extension team with kale nutritional data to share with growers around the state.
    - Thavarajah D. 2016. Food System linking to human health (pulses and vegetables as whole

foods. Invited Seminar, Sustainable Agriculture and Food Systems Seminar, Sep 28, 2016.

- Thavarajah D. 2016. Invited lecture/laboratory, Kale Minerals, AGED 2030 - Teaching Agriscience Lab, April 6, 2016.
- Thavarajah D. 2016. Food security linking to human health. Invited lecture, PES 4220/6220, March 22, 2016.
- Thavarajah D. 2016. Clemson University Extension Horticulture Program Team Meeting, Invited Seminar on "Clemson Specialty Crop Research - Kale", March 10, 2016.

6. Invited Dr. Gerald F Combs Jr, USDA Human Nutrition Director to meet with SC kale growers – WP Rawl and other kale growers in SC

Project results demonstration activities

1. 2018, Smart Kale https://www.youtube.com/watch?v=CtbANInCKcI&feature=youtu.be
2. 2018, Clemson students grow Lunchbox Garden to promote healthy eating. http://newsstand.clemson.edu/clemson-students-promote-healthy-eating-with-lunchbox-garden/
3. 2018, Vegetable Crops to Solve Malnutrition, Obesity. http://vscnews.com/vegetable-crops-solve-malnutrition-obesity/
4. 2018, Clemson researchers: Kale could help billions overcome 'hidden hunger. http://newsstand.clemson.edu/mediarelations/clemson-researchers-kale-could-help-billions-overcome-hidden-hunger/
5. 2018, Meet a Tiger, http://newsstand.clemson.edu/meet-a-tiger-dilrukshi-dil-thavarajah/
6. 2017 American Council for Medicinally Active Plan, https://www.youtube.com/watch?v=ws7r4jlKQdw
7. 2017 Tiger Garden, Decipher Magazine, Creative Inquire
8. 2016 Tiger Gardens expand to elementary schools
9. http://newsstand.clemson.edu/mediarelations/clemson-students-share-gardening-knowledge-with-pendleton-elementary-students/
10. 2016 Tiger Gardens. http://newsstand.clemson.edu/mediarelations/students-grow-tiger-gardens-in-quest-to-fight-obesity-in-south-carolina/?utm_source=feed

This project solely benefitted specialty crops.

Dr. Dil Thavarajah (PI): Dr. Thavarajah is the PI for this grant and her roles include graduate student supervision (Mr. Indika Mapa), undergraduate student supervision, experimental design, greenhouse experiments, coordination of vegetable sample collection with the Clemson extension services, supervise experiments, data collection, data interpretation, statistical analysis, manuscript preparation and final report preparation.

Dr. Powell Smith-Collaborator: Dr. Smith is an extension associate and was the program leader in Lexington County, SC. Dr. Smith assisted on this project to collect vegetable samples from SC, data interpretation, manuscript preparation, and communication with SC kale growers and other extension personnel. In addition, Dr. Smith met with our stakeholders and updated them on research data at our annual vegetable production meetings.

Dr. Gerald F Combs Jr-Collaborator: Dr. Gerry Combs is a world leading human nutrition expert and has published numerous scientific studies on human nutrition. Dr. Combs Jr. assisted on data interpretation related to human nutrition, incorporated data into USDA Nutrient Reference Data Base, made vegetable prebiotic recommendations based on the serving size, and completed manuscript and final nutrition report preparation. In addition, Dr. Combs Jr. also met with WP Rawl, and Dr. Smith to support the awareness of kale as a super food.

Dr. Pushparajah Thavarajah-Collaborator: Dr. P Thavarajah is a leading food chemist with national and international research activities. Dr. Thavarajah assisted carbohydrate and mineral analysis and participated in several stakeholder meetings with Drs. Dil Thavarajah, Powel Smith, Gerald Combs Jr. and WP Rawl.

Goals and Outcomes Achieved

Performance goal:

1. Develop comprehensive nutritional composition data for SC grown kale
2. Select kale varieties that produce higher yield and nutritional quality under greenhouse conditions

Activities completed:

- Three peer reviewed research publications
- Educate stakeholders via research talks and meetings
- Six poster presentations at research/extension workshops
- Developed two extension fact sheets and created garden manual
- Updated USDA nutrient reference data base
- Developed kale food recipes for school lunch menus
- Introduced kale gardening procedures to three SC elementary schools
- Increased scientific knowledge of kale to public through cited articles in the Google Scholar
- Approached SC Fruit, Vegetable and Specialty Crop growers to share research progress
- A masters level graduate student was trained
- 48 undergraduate students participated in Dr. Thavarajah's "Tiger Garden" class for the last three years.

Most of the proposed activities were completed, however promotion of kale as a super food must be a continuous process throughout the United States.

Actual accomplishments are aligned with the proposed goals – please see above section (all the goals and proposed activities were completed).

Nutritional quality data for kale has been collected. We completed three peer reviewed research articles and updated USDA data base. Therefore, this preliminary published data will be used to develop a future comprehensive kale nutritional breeding program with support from a USDA-SCRI proposal.

Approximately 10-20 kale growers in SC, 13 produce buyers, 25-30 food servicers and wholesales, food processing industry partners in the USA, and 8-10 county nutrition and extension personnel in SC directly benefited. By approaching school lunch programs, this research can also benefit thousands of school children and, in turn, their families. One graduate student, 48 under graduate students, three interns were trained.

Beneficiaries
Approximately 300 consumers benefitted from this project.

Lessons Learned
We would have preferred to complete the entire project within two years, but because of limited funding, are very happy to have completed a large portion of the work with the funding awarded from SCBGP. Also, we believe our data will be greatly suitable for a large-scale funding opportunity for USDA-SCRI to establish a kale biofortification program.

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Project Title: **Promoting Spinach Consumption and Sustainable Agricultural Practices in School using Aquaponics**

Project Partner: Clemson University, Dr. Kimberly Baker

Project Summary

The goals of this project were to: 1) increase nutritional knowledge and consumption of leafy green vegetables; 2) enhance good handling practices and food safety during production and preparation; and 3) promote South Carolina agriculture and sustainable production practices. The Centers for Disease Control and Prevention (CDC) reports that in 2013 to 2014, over 20% of adolescents aged 12 to 19 years old were obese (CDC, 2017). The CDC also reported in their 2018 State Indicator Report on Fruits and Vegetables that only 2% of American adolescents meet the current vegetable recommendation (CDC, 2018). The United States is currently making it a priority to identify nutrition intervention strategies that effectively reduce obesity rates, increase consumption of fruits and vegetables and promote life-long behavior changes in adolescents (Robinson-O'Brien, et al., 2009). Information on food consumption patterns reveals that children and adolescents will consume more than the average of particular foods when they have participated in growing and/or preparing the food. Aquaponics and nutrition education in the classroom may be an effective intervention strategy to use with adolescents, which provides the opportunity for hands-on learning about nutrition, food safety, food production and sustainable agricultural practices and may in turn increase consumption of vegetables, particularly those grown in an aquaponics system.

School gardening is not a new concept for teaching children about food production and encouraging consumption of fresh fruits and vegetables. However, teaching concepts of sustainable agriculture is an emerging concept in schools. This method of food production has been embraced around the world as it promotes the conservation of natural resources. Additionally, sustainable agriculture systems offer a good learning experience for students as the components of the system rely on each other to yield safe, quality foods. An example of sustainable agriculture is aquaponics. Aquaponics is a recirculating system that produces both fish and plants. The fish have a dual role in the system as they can be produced and harvested from the system while serving as the natural provider of fertilizer (fish waste) for the plants to grow. Natural bacteria in the system also play a vital role in converting the fish waste to a form of nitrogen that is available for use by the plants. The size of an aquaponics system can be easily adaptable to the needs of specific locations and can be made to fit in small locations within school classrooms.

This project introduced and piloted the use of an aquaponics system in two high schools located in South Carolina. Spinach was used as the crop in the system as it is a dark leafy green vegetable that is not only under-consumed by adolescents but also is a good source of Vitamins K, C, B_2, and B_6, potassium, iron, magnesium and calcium. The project provided an opportunity for the participating students and teachers to learn about sustainable agriculture, nutrition, food safety along with how to grow spinach in an aquaponics system and prepare spinach for consumption. Combined, these accomplishments may have increased the spinach consumption among participants.

Project Approach

The project began by identifying two high schools in South Carolina that had teachers with an interest in aquaponics and sustainable agriculture, and willingness to participate in the project. Two teachers were identified in Upstate South Carolina high schools: Daniel High School and Pendleton High School. The participating teachers then worked with Drs. Baker and Beecher to obtain formal approval from their school administration to participate in the project. This process took significantly more time than estimated and final approval took place in September 2016, which delayed the start of the project.

In initial conversations with the participating teachers, it was determined that due to the available locations and size constraints for the aquaponics systems, it would not be feasible to produce enough spinach for the entire school's use. The proposed classroom systems would, however, provide enough spinach for one class in each high school to participate in growing, harvesting, preparing, and taste-testing. Once this was determined, the formal development of the project began. Dr. Baker first began working on developing the pre- and post-tests that would be used by the instructors and students to evaluate the impact of the project's goals. Dr. Beecher tested a new variety of heat-tolerant spinach in his aquaponics system to ensure that it would work well in the systems located at the high schools. Dr. Baker wrote the food safety and nutrition-related lessons: Food Safety Basics; Safe Handling of Produce, and Preparation and Nutrition of Spinach (see appendices A, B, and C for complete lesson plans). Dr. Beecher wrote the Aquaponics and Sustainable Agriculture lesson plan (see appendix D for complete lesson plan). Once the lessons and pre- and post-tests (see appendix E) were completed, they were reviewed by the full project staff for revisions and final approval.

Drs. Baker and Beecher communicated with the participating teachers about the implementation of the project. It was suggested that the pre- and post-tests be given via SurveyMonkey for ease of use by the students. The teachers expressed their concerns about having time in their current class schedule to include the content from the four lessons on this project. They stated that they would be able to build the lessons into their class planning for the beginning of the following new school year (Fall 2017). After this meeting with the teachers, the IRB paperwork required for this project was written and submitted. The project received approval on May 12, 2017 and qualified as exempt under category B1 in accordance with federal regulations 45 CFR 46.101.

To facilitate the implementation of the project, Dr. Baker sent the participating teachers a checklist of the steps to take for the project along with required documents including the instructor consent letter, instructor pre-test, parent and student consent letters, a pre-written email and link to the pre-test (to be sent to participating students at the beginning of the study in the Fall) and copies of the four lesson plans. Before the start of classes in August 2017 and during the first month of the school year, Dr. Beecher worked with the teachers to install the aquaponics systems in the schools. The system located at Daniel High School was placed in the classroom and used koi fish (Figure 1). The Pendleton High School system was located in the teacher's greenhouse and was stocked with tilapia (Figure 2). Dr. Beecher germinated spinach in his Clemson University greenhouse and transferred the seedlings to each system when they were ready. He also continuously worked with the teachers to teach them how to work and maintain the systems. Specialized maintenance needed by the system at Daniel High School was the installation of a feeding system and installation of temperature probes to help maintain water temperature and analyze water quality when the transplanted seedlings began to struggle. The system at Pendleton High School required the installation of a heating system since it was located in an outdoor greenhouse, and regular maintenance to analyze and maintain water quality. Dr. Baker provided teaching supplies to assist the teachers when teaching the food safety basics lesson to the students. These supplies included a GloGerm™ kit to help demonstrate proper methods of handwashing and a variety of cooking and refrigerator thermometers to show proper use when preparing food safely. Throughout the full implementation of the project Dr. Beecher remained in constant contact with the teachers to support them with the use of the aquaponics system.

The teachers began implementation of the project by reading an informed consent letter. After providing their consent they completed an instructor pre-test on SurveyMonkey to evaluate their previous knowledge of spinach, nutrition of spinach, food safety practices, aquaponics, sustainable agriculture, and spinach consumption. Instructors then emailed an informed consent letter to each of

their students' parents. Students who were allowed to participate were also provided an informed consent letter via email and a link to the pre-test in SurveyMonkey. After pre-tests were completed, instructors were then allowed to begin teaching the students about the aquaponics system by using the aquaponics system to grow spinach and incorporating the four lesson plans. The final lesson plan (Preparation and Nutrition of Spinach) included six recipes: 1) spinach hummus; 2) caramelized onion, bacon and spinach pizza; 3) spinach, strawberry and mozzarella salad; 4) pizza spinach salad; 5) vegetarian stuffed pasta shells; and 6) fruit smoothie with spinach. Each class chose one recipe to prepare and taste in the classroom using the spinach they grew in the aquaponics system. After completion of the lessons and taste-testing, students and instructors were sent an email with a link to the post-test in SurveyMonkey.

Once the post-tests were completed, Dr. Baker compiled the results from the pre- and post-tests. When taking the tests, the instructors and students were required to create a unique and unidentifiable user id to keep their data anonymous. Dr. Baker sorted the data so that comparison of the pre- and post-tests could be analyzed. A graduate student of Dr. Beecher's assisted with the analysis and interpretation of the data reports.

Overall, the project opened the student's minds to eating spinach and dishes that include spinach (92.7% were likely/very likely compared to 79.6% before the aquaponics experience). Overall, more students had increased interest in a variety of dishes that included spinach as a main ingredient. They also reported that they were consuming spinach more often and in larger quantities. After the project implementation, 92.7% of students (from the previous 88.1%) answered that they were likely or very likely to try a new vegetable.

In general, the project was quite a success. Our goal was to increase nutritional knowledge and consumption of leafy green vegetables which is clearly demonstrated in many different aspects of our results. The students not only had an increased interest in spinach, they were able to answer nutritional questions correctly more consistently. They also showed more enthusiasm about vegetables in general. Implementing an aquaponics system and demonstrating a unique type of sustainable agriculture in the classroom along with lessons noticeably sparked students into consuming more vegetables. Another goal for the project was to inform students about food safety and good handling practices. While the post-test didn't show a difference in food handling and safety responses, the results were still overwhelmingly positive (over 95% of students wash vegetables before eating and over 70% wash their hands before preparing food) and we are optimistic that minor changes in the project will produce an increase in food safety awareness. This project solely benefitted the specialty crop of spinach as the consumption of spinach is low among adolescents and the goal of the project was to encourage the increase of spinach consumption as well as increase nutrition, food safety and sustainable agriculture knowledge.

The project concluded with Dr. Beecher presenting the project and results at the annual Aquaponics Association meeting in Hartford, Connecticut on September 22, 2018. The meeting was attended by approximately 200 people eager to pursue interests in aquaponics. The STEM section, where the results of this project were presented, contained several studies and projects on implementing aquaponics in the classroom and offering various mechanisms to increase awareness on the importance of food production and preparation. In the session where this project was presented, participants included science teachers, school leaders, and other educators who were interested in developing an aquaponics program. Most of the follow-up questions asked were based on trying to establish an aquaponics system and in search of advice on getting school officials on board with allowing such a system to exist.

Overall the presentation was well received and sparked interest in their pursuits to introduce aquaponics.

We did receive feedback from the instructors about the project, so we could have a better understanding of the positive outcomes of the project and where improvement was needed. They stated that the overall project was well received by the students, and that they enjoyed the hands-on aspect of learning what they were being taught. Students enjoyed seeing the fish and having a chance to work directly with the aquaponics system. Other positive feedback from the instructors was that this project was a great way to teach sustainability and food safety, and that the students enjoyed growing food that they could eat. Both instructors reported a need for more water quality information in the lesson plans for the students in relation to the fish and plants in the aquaponics system. They also suggested more information about plant problems that can occur and how to remedy these when needed. Both suggestions are excellent and can easily be included in the future when this learning model is implemented in other schools.

The project team found that one of the biggest challenges was finding instructors who have the ability and time to commit to maintaining an aquaponics system. Aquaponics systems require day-to-day monitoring and therefore need to be maintained on weekends, holidays, and days when school is not in session. Teachers also plan their lesson for the school year well in advance. This scenario caused a delay in our project, so this needs to be considered in the future. Teachers using this curriculum will need to know the time needed to implement the lessons far enough in advance to be able to write them into their school year plans. Each school and classroom are very different with varying types of locations and space for an aquaponics system. Logistics of the location including accessibility, plumbing, lighting, etc. must also be considered. Because of this, there is a significant amount of time that is required on the person who is working with the instructor to design and build an aquaponics system for the classroom. Once the system is in place then the required on-going instruction and support requires a significant amount of time until the instructor is knowledgeable enough to manage the system primarily on their own. During this project, the spinach in both schools had difficulty growing. Both schools were able to produce enough for their taste-testing, but the spinach proved to be somewhat difficult to grow in an aquaponics system.

Goals and Outcomes Achieved

The main goal of the project was to increase the knowledge and utilization of a sustainable agriculture model in South Carolina schools, while promoting the increased production and consumption of spinach. To accomplish this goal, lesson plans were written to be used to teach the concepts covered in the project's goal. Pre- and post-tests were also written for the instructors and students to use to measure the knowledge gained.

The project incorporated four lessons for the students: 1) Aquaponics and Sustainable Agriculture; 2) Food Safety Basics; 3) Safe Handling of Produce; and 4) Spinach Nutrition and Cooking. The objectives of the aquaponics and sustainable agriculture lesson were: 1) to compare and contrast different concepts and components of an aquaponics system and a hydroponics system; 2) to define the basic terms, concepts, and components that accompany an aquaponics system; and 3) to explain the basic terms, concepts, and components that accompany an aquaponics system. This lesson, in addition to the hands-on use of the aquaponics system, worked in coordination with each other to teach concepts of aquaponics and sustainable agriculture. The objectives of the food safety basics lesson plan were: 1) to identify a foodborne illness and the leading cause for foodborne illness outbreaks; 2) to understand how pathogens grow and cause illness; 3) to identify Time and Temperature Control for Safety (TCS) Foods

and how they become contaminated; and 4) to explain the four steps of safe food handling (clean, separate, cook, refrigerate). In this lesson, the students had an opportunity to practice proper handwashing techniques using a GloGerm™ kit, which simulates bacteria when applied to a surface, and to see a variety of thermometers used to cook foods to their proper internal temperature including a bimetallic-stemmed thermometer, digital thermometer and a roast thermometer. The objectives of the safe handling of produce lesson were: 1) to understand the prevalence of foodborne illnesses related to produce and the pathogens of concern; 2) to identify the government regulations that have been implemented to ensure safety of produce; and 3) to explain food safety practices used during the growth, harvest, storage, and preparation of produce. Students had a chance to practice these food safety principles while growing, harvesting, and preparing the spinach grown in the aquaponics system. The objectives of the spinach nutrition and cooking lesson were: 1) to identify the four different varieties of spinach; 2) to explain the recommended serving sizes for spinach and recommended servings per week for men and women; 3) to list the vitamins and minerals that are good sources found in spinach; and 4) to identify and define common cooking methods used to prepare spinach. At the conclusion of this lesson, students were provided a packet of recipes that incorporated spinach as a main ingredient. Each class had the opportunity to choose a recipe to prepare and taste-test in the classroom using the spinach grown in the aquaponics system. The provided recipes included: 1) spinach hummus; 2) caramelized onion, bacon and spinach pizza; 3) spinach, strawberry and mozzarella salad; 4) pizza spinach salad; 5) vegetarian stuffed pasta shells; and 6) fruit smoothie with spinach. One class chose the spinach hummus; and the other chose the spinach, strawberry and mozzarella salad.

Questions from the pre- and post-tests were used to test the knowledge gained from the lessons and hands-on activities of using the aquaponics system. Additional questions were used to determine consumption patterns and attitude towards spinach. Additionally, instructors were asked some specific questions to understand their previous experience in teaching concepts of nutrition, food safety, and sustainable agriculture. The instructor-specific questions were:

1. If you have used an aquaponics system before, what type of produce did you grow in the system?
2. Do you have previous experience in teaching students about aquaponics systems?
3. Do you have previous experience in teaching sustainable agriculture practices?
4. Do you have previous experience in teaching concepts of food safety to students?
5. Do you have previous experience in teaching nutrition concepts to students?

Overall, the goal to increase knowledge of a sustainable agriculture model as well as nutritional knowledge and consumption of spinach was achieved. Data comparing the pre- and post-tests demonstrated a 13% increase in students who would consume more spinach and spinach containing foods. Over 92% were likely/very likely compared to over 79% before the aquaponics experience. The post-test also showed that students were consuming spinach more often and in larger quantities than before the implementation of the project (Figures 3, 4 and 5).

The students' knowledge of the nutritional attributes of spinach remarkably increased through the project. From pre- to post-test, there was over a 20% increase in correctly identifying the rich nutrient source in spinach (Figure 6).

The survey results did not show a significant difference in food handling or safety-related responses. Over 95% of students wash vegetables before eating (Figure 7) and over 70% of students wash hands before preparing food. The survey results also indicated that the students were aware that aquaponics

was a method of sustainable agriculture before and after the implementation of the project. In the pre-test, 9% of students marked that an aquaponics system was not a form of sustainable agriculture compared to 2% in the post-test.

The major successful outcome of the project was seeing the increase of spinach consumption as reported in the surveys. Not only did students eat spinach more often, but they additionally increased the average quantity consumed with each serving (Figure 8). The results of the survey comparisons show that implementing an aquaponics system and demonstrating sustainable agriculture in the classroom along with structured lessons notably encouraged students to eat more vegetables.

Beneficiaries

This pilot project benefitted both the students who participated as well as the 2 instructors. There were 38 students who completed both the pre- and post-tests and 10 students who completed only one of the tests. Although not measurable from this study, it is likely that students and instructors talked about the project at home and may have a positive influence on other family members by talking about the experience and lessons learned during this time. The project may also spark an interest in some of the students to grow spinach and/or use an aquaponics system in the future because of the experience they have had in school.

Considering that this was a pilot project, the project staff and Clemson University has benefited in the completion of the project. The project staff was able to determine the feasibility of this teaching model, and the potential learning outcomes. The staff will be able to edit the project based on these outcomes and the needed areas of improvement in order to introduce this project into more schools throughout South Carolina, which will in turn benefit more instructors, students, and their families.

Lessons Learned

The first challenge of the project was finding teachers who have the ability to commit to maintaining an aquaponics system. Aquaponics systems require around the clock monitoring including weekends, holidays, and other days when schools are not in session. This project requires having a teacher who is willing to care for the system during these off-hours and making sure they have access to the system in the school during these times as well. It was also difficult for the teachers to incorporate the lesson plans from the project into their pre-planned school year. Because of this, the project was delayed so that implementation could begin with a new school year when the teachers could write the project and lessons into their master plan for the year. Another challenge was the time commitment for the project staff member who worked on the design, installation, and maintenance of the systems. These aspects of the project were crucial for the success of the project and took a significant amount of time as well. Fortunately for this project, both participating high schools happened to be within a short travel distance from Dr. Beecher, which made helping the schools easier. In the future, it will become more of a significant challenge working with schools that are long-distance as travel time and commitment needed will increase significantly. The work on this project also revealed that growing spinach in an aquaponics system is a challenge. Surprisingly, it is not a crop that takes easily to the system, and despite testing and working with a variety that is heartier to environmental changes, the spinach crops in both systems struggled to produce. Both systems were able to produce enough spinach for the class; however, it did not produce overabundantly like most aquaponics systems do with other varieties of leafy green vegetables. Both participating instructors, when asked about needed improvements, mentioned that more information needs to be added in the lessons about water quality in relation to the fish and plants, and about plant problems and how to remedy them when they occur.

Results from the pre- and post-tests showed that little food safety knowledge was gained in the project. This may be the result of the pre- and post-tests lacking questions to better evaluate knowledge gained, or the lesson plans containing basic information already known by the students. Both the pre- and post-tests and the lesson plans will need to be re-evaluated before this project is implemented again and modified as needed.

Figure 1. Daniel High School Aquaponics System

Figure 2. Pendleton High School Aquaponics System

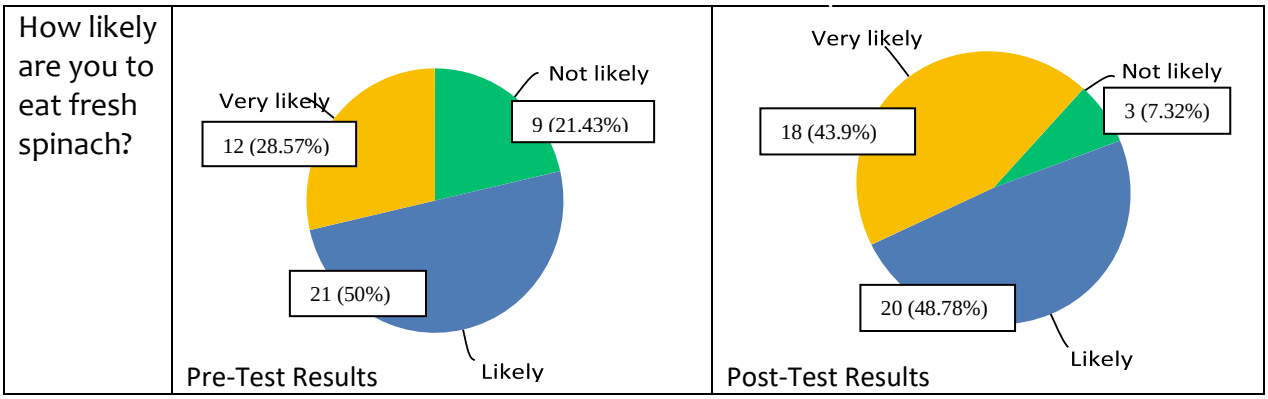


Figure 3. Pre- and Post-test comparison

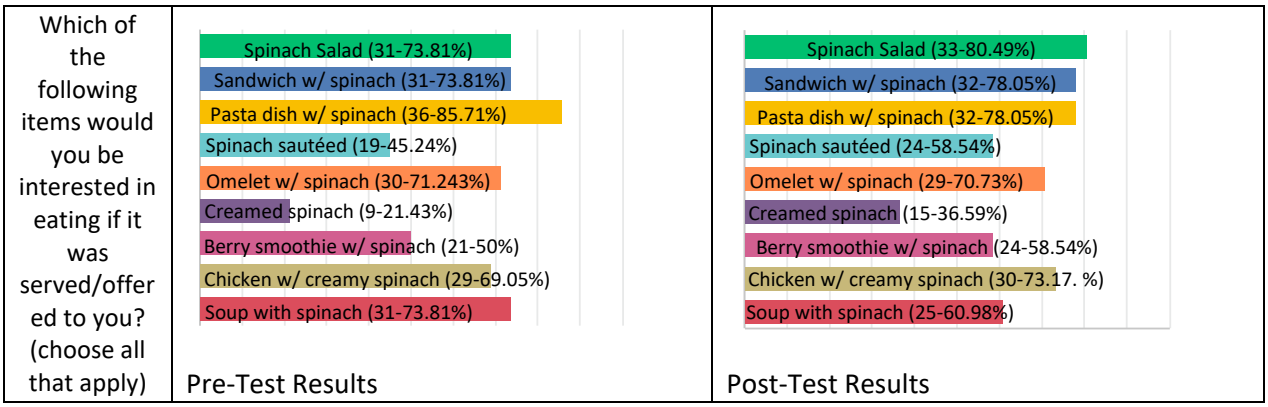


Figure 4. Pre- and Post-test comparison

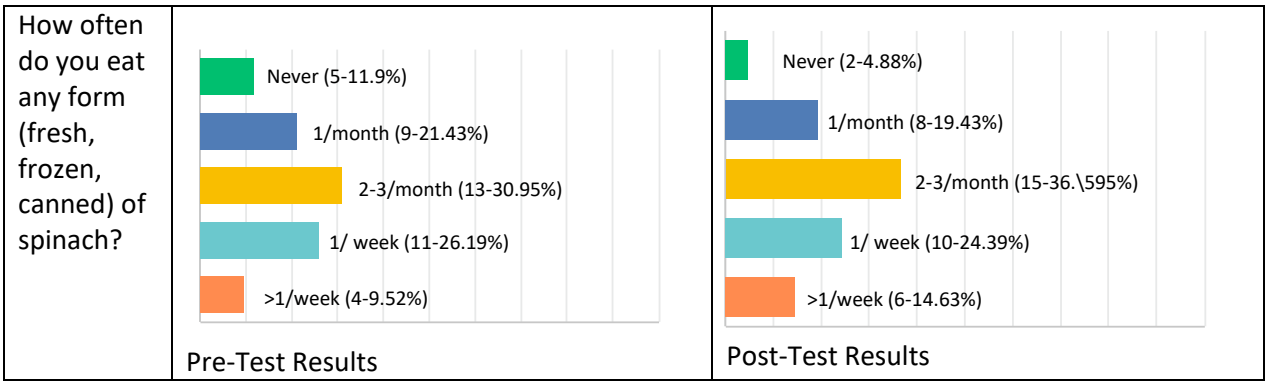


Figure 5. Pre- and Post-test comparison

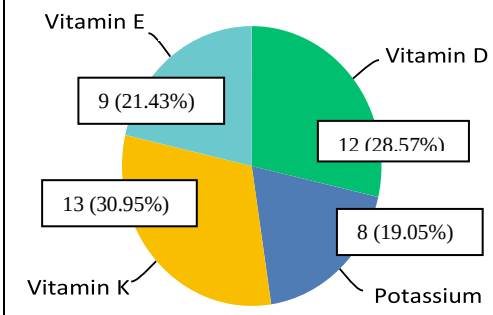
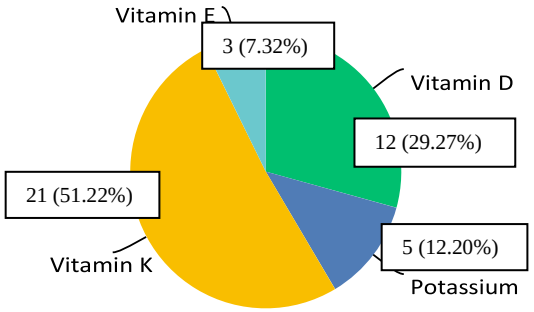
Spinach is rich in which nutrient?	 Pre-Test Results	 Post-Test Results

Figure 6. Pre- and Post-test comparison

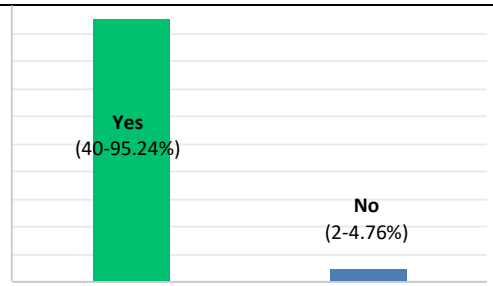
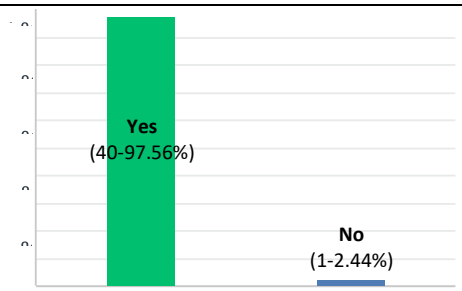
Do you wash vegetables before eating?	 Pre-Test Results	 Post-Test Results

Figure 7. Pre- and Post-test comparison

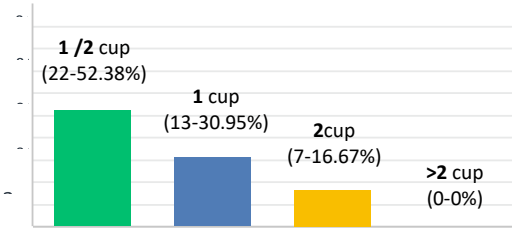
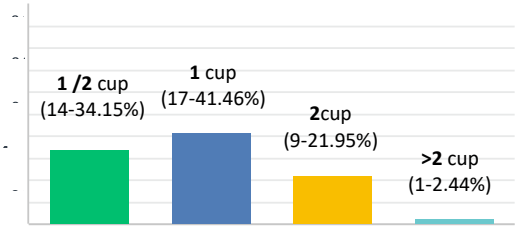
If you eat spinach, on average about how much spinach do you eat at one time?	 Pre-Test Results	 Post-Test Results

Figure 8. Pre- and Post-test comparison

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Centers for Disease Control and Prevention (CDC). 2017. Obesity and overweight. Atlanta, GA: Centers for Disease Control and Prevention. Available from: https://www.cdc.gov/nchs/fastats/obesity-overweight.htm. Accessed September 17, 2018.

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Robinson-O'Brien, R., Larson, N., Neumark-Sztainer, D., Hannan, P., Story, M. 2009. Characteristics and dietary patterns of adolescents who value eating locally grown, organic, nongenetically engineered, and non-processed food. Journal of Nutrition Education and Behavior 41(1):11-18.

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Project Title: **Investigation into the Occurrence, Prevalence and Cause of Peach Fruit Bronzing**

Project Partner: Clemson University, Dr. Guido Schnabel

Project Summary

In South Carolina, blotches on peach skin generally referred to as 'bronzing', decrease profitability of commercial peach production. In some years bronzing can cause significant losses to the farm in the form of decreased freshmarket sales, load rejections, and may even impact farm reputation and relationships with retail stores. The cause of bronzing is unknown and no management recommendations are available. Using funds from the Specialty Crop Block Grant Program we were able to exclude thrips, mites (preliminarily), calcium deficiency, irrigation schedule, and crop load as possible causes. We observed however some unexpected patterns in our field trials that may provide some clues. Bronzing did not always show up on the same trees and was unevenly distributed within the trial area. Furthermore, we observed that bronzing is not correlated solely with frequent precipitation during the fruit production season. Other factors must also be involved and therefore more research is needed. All funds were used for specialty crop research only (peach) and this project did not build on any previous project. This project was initiated because blotches on peach skin, referred to as bronzing in this proposal, can significantly reduce marketable yield and negatively influence grower relations with retail stores and consumers. No management strategies are in place. Therefore, we need to conduct research to find the cause of this disorder.

Project Approach

Determine the occurrence and prevalence of bronzing on fruit from multiple cultivars and locations.

In two consecutive years, six cultivars were investigated at three grower farms (Watsonia, Titan Farm, Dixie Bell Farms). A total of 400 fruit from 4 bins (100 fruit each bin) were labelled, rated, and investigated for bronzing occurrence and severity. In each of the blocks six trees were tagged and fifty fruit were monitored for 4 weeks prior to harvest and eventually harvested at the end of the commercial growing season. The fifty observed fruit were from one limb or adjacent limbs. The limbs with experimental fruit were flagged to make sure that the same area of the tree was monitored weekly. Fruit with atypical coloration was tagged, numbered, and photographed. After harvest, the occurrence, severity, and distribution of blotches was recorded. Specifically, the area of the fruit where bronzing occurred (top, center, or bottom), and the pattern that the bronzing took on the fruit (connected or scattered). The experiment was repeated in 2016, however, none of the fruit were bronzed. This data is not shown in this report. Bronzing was not observed on any fruit until the day of harvest. Bronzing incidence varied between varieties and seemed to be more prevalent the later the fruit was picked, with the highest incidence occurring in the Sweet Dream variety. Bronzing incidence indicates how many fruit had any sign of bronzing whereas severity indicates how much of the surface area on each fruit was affected by bronzing. Titan Farms Sweet Dream was represented at two locations and had the highest incidence of blotches. Scarlet Prince blocks showed no bronzing at any of the three locations. The highest severity was found in Sweet Dream at Watsonia Farms.

The pattern of bronzing showed that a high percentage of the damage occurred either on the top, the bottom and/or a circular pattern around the fruit. This rather organized and non-random pattern indicates that the cause may be physiological in nature. That is because the center of the peach is the region where the most growth occurs and is heavily influenced by nutrient and water uptake. No pathogen or spray injury we are familiar with would follow such a pattern. Fruit with severe bronzing, i.e. over twenty-five percent of the fruit affected, had bronzing in all three regions of the fruit. Light and

barely visible peach skin discoloration observed at harvest on mature fruit did form the typical bronzed blotches in storage indicating that bronzing occurred in the field and not during transport or storage. The occurrence of bronzing on fruit freshly picked from the tree eliminates handling or postharvest packaging damage as causative factors.

Determine associations between bronzing, thrip damage, weather data, spray data, and heavy metal content of spray material. Thrip management was intensified and thrip damage was recorded at the three farms in two consecutive years. Results indicated that there was no link between thrip management intensity, thrip occurrence and bronzing. There were no mites or other insects observed. No fungi or bacteria were isolated from the bronzed area. No phytoplasmas were detected with degenerate primers. Associations between bronzing incidence and rainfall, temperature were observed in 2016 and 2017, but there appears to be no link. For example, bronzing occurred in 2016, a year with average rainfall but did not occur in 2017, a year with above average rainfall during peach production. That is in contrast to previous observations that bronzing occurs after rainfall close to harvest. Field trials were conducted in 2016 and 2017 in two Scarlet Prince blocks. Crop load, calcium deficiency and irrigation schedule were the repeated treatments. Neither treatment influenced the level of bronzing over three picks in 2016. No bronzing was observed in 2017 in either treatment.

Reproduce bronzing symptoms under controlled conditions. We over sprayed peach trees with Imidan and Captan in form of biweekly applications for 8 weeks but were unable to induce bronzing symptoms. Analysis of micro and macroelements of bronzed versus non-bronzed skin did not reveal any differences. One study suggested skin deterioration in fruits could be a consequence of a P and K imbalance and that Mn applications appeared to diminish this imbalance in Honeycrisp apples. Therefore, we sprayed in two different locations 10 Scarlet Prince trees with Manganese foliar nutrient three times prior to harvest in 10-day intervals. Fruit of sprayed trees and control trees were harvested separately for each tree, cooled down and rated for bronzing incidence. No bronzing was found in either treatment.

Goals and Outcomes Achieved

By monitoring the fruit samples as outlined above, we increased our knowledge about the occurrence and factors that may or may not cause bronzing. It is becoming increasingly clear that bronzing is not caused by a single factor, but instead that multiple factors may contribute. During the experimental years 2016 and 2017 bronzing was less prevalent compared to previous years by at least 20%. We shared our research results with about 150 growers at production meetings in Gaffney, SC and Edgefield, SC; at the regional Fruit Workers Meetings in Gainesville, FL and Winchester, VA; and at the Southeast Regional Fruit and Vegetable Conference in Savannah, GA. We published our results in South Carolina Peach Council Research Reports for our stakeholders.

Schnabel, G. J. Allran, and JC Melgar 2016. Progress in our understanding of peach skin bronzing. Southeastern Professional Fruit Workers, Conference, Gainesville, FL.

Schnabel, G., J. Allran, MJ Hu, and JC Melgar 01/2017. Update on peach skin disorders bronzing and streaking. Fruit and Vegetable Conference, Savannah, GA. **Invited Presentation.**

Schnabel, G., J. Allran, MJ Hu, and JC Melgar 12/2016. Mystery blotches on peach; what we know does not cause bronzing. Shenandoah Fruit Workers Meeting, Winchester, VA.

Hu, M.J. and G. Schnabel 2016. Peach Skin Bronzing: Could a virus or viroid be involved? South Carolina Peach Council Research Reports 16:60-66.

Boatwright, H. and G. Schnabel 2016. Investigation of bronzing on mid-season peach varieties. South Carolina Peach Council Research Reports 16:67-70.

Beneficiaries
This project benefited approximately 150 growers.

Lessons learned
It is becoming increasingly clear that bronzing is not caused by a single factor, but instead that multiple factors may contribute. Any activity to strengthen the peach skin and to optimize water relations in the fruit should help manage bronzing. These activities include optimizing crop load, soil water content, and tree health in general. The latter can be achieved by optimizing planting depth, crop load, and soil drainage.

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Project Title: **SC Watermelon Disease Survey**
Project Partner: Clemson University, Dr. Anthony Keinath

Project Summary
No statewide survey of watermelon diseases had ever been done in South Carolina. Informal surveys in the early 1990's showed that gummy stem blight was the most common disease observed in the major watermelon-producing counties in the Savannah River Valley and Chesterfield County (Keinath and Cook, unpublished). Since 2013, however, anthracnose has become much more prevalent than it was 20 years ago. In addition, since the late 1990's, powdery mildew has been found on watermelon in South Carolina. Since the late 2000's, downy mildew also has been found on watermelon, even though it was rarely observed previously. A watermelon disease survey would provide empirical data on how widespread foliar diseases are on watermelon in South Carolina. This data will be used to tailor fungicide recommendations to focus on the most common diseases that occur most years. The recommendations will be provided via the Clemson Extension website. (https://www.clemson.edu/extension/publications/files/horticulture/hor01-watermelon-fungicide-guide.pdf)

Project Approach
A stratified two-stage cluster sampling design was used to sample symptomatic watermelon leaves from commercial fields in spring 2015, spring and fall 2016, and fall 2017 (Table 1). The strata were preselected counties with the highest recorded watermelon acreage in South Carolina (USDA, NASS 2014). Six counties were sampled in 2015, seven in the spring of 2016, and six in the fall of 2016, and one in fall 2017 (Table 1).

Table 1. Watermelon fields sampled in four seasons from 2015 to 2017 in South Carolina

Season, year	County	Number of growers sampled	Number of fields sampled
Spring 2015	Bamberg	4	4
	Barnwell	5	5
	Beaufort	2	4
	Clarendon	1	1
	Colleton	2	4
	Hampton	3	3
	Subtotal	**17**	**21**
Spring 2016	Allendale	1	1
	Bamberg	3	4
	Barnwell	5	6
	Beaufort	2	4
	Clarendon	2	2
	Colleton	3	4
	Hampton	3	3
	Subtotal	**19**	**24**
Fall 2016	Allendale	1	1
	Bamberg	2	2
	Barnwell	1	1

	Beaufort	1	2
	Colleton	2	3
	Hampton	1	2
	Subtotal	**8**	**11**
Fall 2017	Beaufort	2	4
Total		**27***	**60**

*Note: Fields of some growers were sampled in multiple years. 27 different growers participated.

A square shape consisting of four perpendicular transects 50 m in length that encompassed an area of 2500 m^2 (0.62 ac) was sampled in each field. Along each transect five leaves with spots were collected at each of five sampling points spaced 10 m apart resulting in a total of 20 sampling points and 100 leaves collected per field. Leaves were examined with a stereomicroscope and reproductive structures observed were used for identification of pathogens. Presence of pathogens was recorded for each leaf. SAS (SAS Institute Inc., Cary, NC) statistical software was used for all analyses. PROC SURVEYMEANS was used to obtain estimates of the overall proportions of pathogen occurrence on leaves with spots. In a combined analysis, data from all seasons were analyzed together by including each county-season combination as a separate stratum.

Gummy stem blight was the most common disease found during this survey, and powdery mildew was the second-most common disease (Table 2). Cercospora leaf spot, downy mildew, anthracnose, and Myrothecium leaf spot was found on less than 10% of the leaves but in more than 20% of the fields. Anthracnose and Myrothecium leaf spot were not found in spring 2015, and downy mildew was not found in spring 2016. Target leaf spot and virus occurred only in the fall.

Table 2. Estimated statewide occurrence of cucurbit diseases in South Carolina, 2015-2017

Disease	Proportion of leaves	Percentage of fields
Gummy stem blight	0.41 a*	100
Powdery mildew	0.26 b	68
Cercospora leaf spot	0.06 c	52
Anthracnose	0.04 c	35
Downy mildew	0.05 c	22
Alternaria leaf blight	0.01 d	28
Myrothecium leaf spot	0.04 c	27
Target leaf spot	0.01 de	5
Virus	0.004 e	5

*Proportions with the same letter do not differ significantly based on 95% confidence intervals.

Gummy stem blight was more likely to occur in fields with a previous cucurbit crop. Gummy stem blight, powdery mildew, Cercospora leaf spot, and downy mildew were less likely to occur in fields aligned towards southwest or west. Application of fungicides 1 or 2 weeks before sampling significantly reduced the probability of observing Cercospora leaf spot, downy mildew, and gummy stem blight in 2015 and powdery mildew in spring 2016.

The results of this project revealed the importance of crop rotation and fungicide applications to manage foliar diseases on watermelon, particularly gummy stem blight, powdery mildew, and downy mildew. Crop age, cultivar type, and field alignment also were found to significantly influence the

probability of disease occurrence. To the best of our knowledge, this is the first study examining the influence of various factors on foliar diseases of watermelon with data collected from commercial fields.

This project solely benefitted specialty crops.

Partners in the project were the 27 South Carolina watermelon growers who allowed project staff to sample their fields. The Agricultural Society of South Carolina, Charleston, SC, provided the Thomas Heyward Graduate Fellowship for G. Rennberger, Ph.D. student, who sampled the fields, identified the fungi, analyzed the data, and wrote the publications, which was valued at $92,000.

Goals and Outcomes Achieved

- Publications produced (3)
  Rennberger, G., Gerard, P., and Keinath, A. P. 2019. Occurrence of foliar pathogens of watermelon on commercial farms in South Carolina estimated with stratified cluster sampling. Plant Disease 103: in press.
  Rennberger, G., Gerard, P., and Keinath, A. P. 2018. Occurrence of foliar pathogens of watermelon on commercial farms in South Carolina estimated with stratified cluster sampling. Plant Dis. 102: (in press).
  Keinath, A. P., and Rennberger, G. 2017 (rev). Powdery Mildew on Watermelon. Clemson Univ. Extension HOR 02 (http://www.clemson.edu/extension/publications/files/horticulture/HOR02 Powdery Mildew on Watermelon.pdf)

- Presentations given (8)
  Rennberger, G., Keinath, A.P., and Gerard, P. 2017. Factors influencing the occurrence of foliar pathogens in commercial watermelon fields in South Carolina in 2015 and 2016. (Abstr.) Phytopathology 107: S5.76. 2017 American Phytopathological Society annual meeting.
  Rennberger, G. 2017. Occurrence of foliar pathogens of watermelon on commercial farms in South Carolina – Field survey results from three seasons in 2015 and 2016. Seminar, Dept. Plant & Environmental Sciences, Clemson University, Sep. 4, 2017.
  Rennberger, G., Keinath, A.P., and Gerard, P. 2017. Occurrence of foliar pathogens of watermelon on commercial farms in South Carolina - Field Survey results from three seasons in 2015 and 2016. 2017 Watermelon Research and Development Group Meeting, Feb. 4, 2017.
  Rennberger, G., Keinath, A.P., and Gerard, P. 2016. Occurrence of Foliar Diseases of Watermelon on Commercial Farms in South Carolina - Field Survey Results from 2015 and 2016. Southeast Vegetable & Fruit Expo, Nov. 30, 2016.
  Rennberger, G. Keinath, A.P., Gerard, P. 2016. Occurrence of foliar diseases of watermelon on commercial farms in South Carolina in 2015. (Abstr.) Phytopathology 106: S4.3. 2016 American Phytopathological Society annual meeting.
  Rennberger, G., Keinath, A.P., and Gerard, P. 2016. Foliar diseases of watermelon in South Carolina - Field survey results from 2015 and preliminary results from 2016. 2016 Edisto Research and Education Center Watermelon Field Day, Jul. 14, 2016.
  Keinath, A. P., and Rennberger, G. R. "Results of the 2015 South Carolina Watermelon Disease Survey." Watermelon Growers Meeting, Bamberg, SC, Dec. 8, 2015.

Rennberger, G., Keinath, A.P., and Gerard, P. 2015. Foliar pathogens on watermelon - preliminary results from field survey. 2015 Edisto Research and Education Center Watermelon Field Day, Jul. 9, 2015.

The Expected Measurable Outcomes target for the project was 50 watermelon fields sampled. In actuality, 60 fields were sampled during this project, or 120% of the target. This is the first watermelon disease survey in South Carolina, so there was no baseline data prior to this survey. The long-term goal is to improve management of foliar diseases of watermelon in South Carolina to improve yields and profitability of the crop. The fact that powdery mildew was the second most common disease found in this project shows the need for more fungicides targeted against this disease.

Beneficiaries

Approximately 195 watermelon growers, county Extension agents, agribusiness personnel, and commercial scouts were educated in five grower presentations about the diseases found during the survey. Severe levels of disease, that is, disease on 50% or more of the leaves collected, was documented for gummy stem blight in 45% of the fields, powdery mildew in 27% of the fields, and anthracnose in 3% of the fields sampled. Based on a 2016 watermelon crop value of $40.95 million for South Carolina (USDA, NASS, 2017), if 50% of growers improve their fungicide use and other disease management strategies, potential economic impacts are estimated to be $1.32 million for gummy stem blight, $2.28 million for powdery mildew, and $0.46 million for anthracnose. **The total potential economic impact of this project is $4,056,000.**

Lessons Learned

In analyzing the data, the most important factor is the number of fields sampled. Future surveys should be designed to maximize the number of fields sampled, even if that means collecting and examining fewer than 100 leaves per field. In general, more leaves were diseased in small fields (less than 5 acres) than in large fields (10 or more acres). This may be related to the degree of management conducted by smaller, part-time growers compared to full-time commercial growers.

Three new diseases, not previously observed on watermelon in South Carolina, were found during the survey. They included target leaf spot, caused by the fungus *Corynespora cassiicola*, in fall 2017. A second fungus reported to cause gummy stem blight, *Stagonosporopsis caricae*, was found in spring 2015. Myrothecium leaf blight, caused by several closely related fungi, was found in all four seasons, but particularly in fall 2017.

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Project Title: **SC Grown Christmas Tree Marketing Campaign**
Project Partner: South Carolina Christmas Tree Association

Project Summary
The South Carolina Christmas Tree Association requested funds to promote South Carolina grown Christmas trees. The purpose of the project was to develop a campaign to make the public aware of the live tree industry and its benefits to the environment and thereby promote the sale of 'SC Grown' Christmas trees. Over the past several years, live Christmas tree sales have been on a decline, in part due to families purchasing artificial trees. As a result, numerous farms have gone out of business. The objective of the project was to make families more aware of the environmental benefits of live trees and of creating family traditions by supporting local Christmas tree farms, thereby improving long term Christmas tree sales in South Carolina.

The project involved a marketing campaign using digital media. A video was created of a family visiting a local farm and choosing a Christmas tree. This video was shown on cable TV channels such as: Hallmark, Family Channel, Nickelodeon, Lifetime, MSNBC, OWN and the Travel Channel. This video was broadcast throughout South Carolina. Banner ads were also created and shown over the internet. All ads directed viewers to the South Carolina Christmas Tree Association's website, where they could read about the environmental benefits of live trees and find tree farms close to them.

The results of the campaign were an increase from the previous year in traffic to the website (http://www.scchristmastrees.org/) of 7.5% and an increase of pages viewed of 10%. Sales of trees declined from the previous year by 9.3% due to several factors. Four farms closed from the previous year and thus generated no sales. Further, several farms had a reduced inventory of trees and thus had fewer trees to sell. Many growers remarked that early sales were higher than the previous year and as a result they sold out of trees, closing up two weeks earlier than usual.

Project Approach
All aspects of the work plan were completed. The advertising agency was chosen and developed the marketing campaign through digital media. A video was shown on cable TV channels and banner ads were shown on the internet. Both directed families to the South Carolina Christmas Tree Association website. There customers could get information on tree varieties, care of trees, environmental benefits and directions to local farms. From the previous year website traffic increased 7.5% and page views increased 10%. Tree sales decreased by 9.3% overall due to four growers going out of business after last year's sales and low inventories of saleable trees (due to decreasing sales in previous years). The marketing campaign appeared to be successful in that growers reported higher than normal sales in the first week and thus sold out of trees much earlier than usual. This resulted in many farms closing earlier and having to turn away numerous customers.

Goals and Outcomes Achieved
There were two performance goals outlined for this project. The first goal was to increase views on the South Carolina Christmas Tree website by 25%. In 2014 there were 28,453 visits to the website with 90,000 pages viewed. In the 2015 season there were 30,586 visits with 99,000-page views. Visits increased by 7.5% which was a significant increase but fell short of the stated goal of 25%. Page views showed an increase of 10%.

The second goal was to increase tree sales by 10%. This turned out to be too optimistic as tree sales actually decreased from 27,002 in 2014 to 24,500 in 2015. This was a loss of 2502 trees. Two factors weighed into this result. First, four growers went out of business and had no sales. These growers would have sold potentially 2000 plus trees based on previous year's sales. Secondly, several farms reported lower sales due to lower inventory levels. Because they sold out of trees early, they had to turn away customers. Christmas trees mature in five to six years. Because of declining sales in previous years, fewer trees had been planted which resulted in shortages.

In retrospect the goals were too high. The hits on the website were a significant increase over previous years, showing success with the marketing campaign. Even though overall tree sales were disappointing, the increase of tree sales during the first week indicated the success of the marketing campaign. Long term, more families are now aware of the SC Christmas tree industry, the website, as well as the benefits of live versus artificial tree. This should result in an increase in future sales.

Beneficiaries

The 44 Christmas tree growers in South Carolina are the beneficiaries of this marketing campaign. The sales in 2015 of 'SC Grown' Christmas trees was approximately $500,000.00 We anticipate an increased public awareness of environmental benefits of a live tree and in creating family traditions. Plus, by being better informed, customers buy from a local South Carolina tree farm and thus build support for years to come.

Lessons Learned

The goals of this marketing campaign fell short and were overly optimistic. The measurement for the increase in website hits was significant (7.5%) but short of the stated 10% goal. The results of the banner ads were disappointing having only 2120 clicks based on 2,802,277 showing, a 0.07% response. It is doubtful that banner ads will be included in future marketing efforts. Tree sales were disappointing because of low inventory levels, but also because of increased traffic and sales during the first week, it is believed that the video was effective in directing customers to the website and will result in increased sales in years to come.

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Project Title: **Marketing Campaign Promoting South Carolina Peaches – One Year Program**
Project Partner: South Carolina Peach Council

FINAL REPORT

Project Summary
The South Carolina Peach Council (SCPC) utilized funding to promote the SC Peach industry to retailers, wholesalers, and to the consuming public via a viral and print media campaign. The project objectives were 1) to increase the purchase of SC peaches by retail and wholesale buyers, 2) increase the consumption of peaches, while 3) providing education regarding the health benefits of fresh SC Grown peaches. The campaign focused on retail and wholesale buyers through marketing channels exclusive to the produce industry and a social media blitz focused on driving consumer purchases.

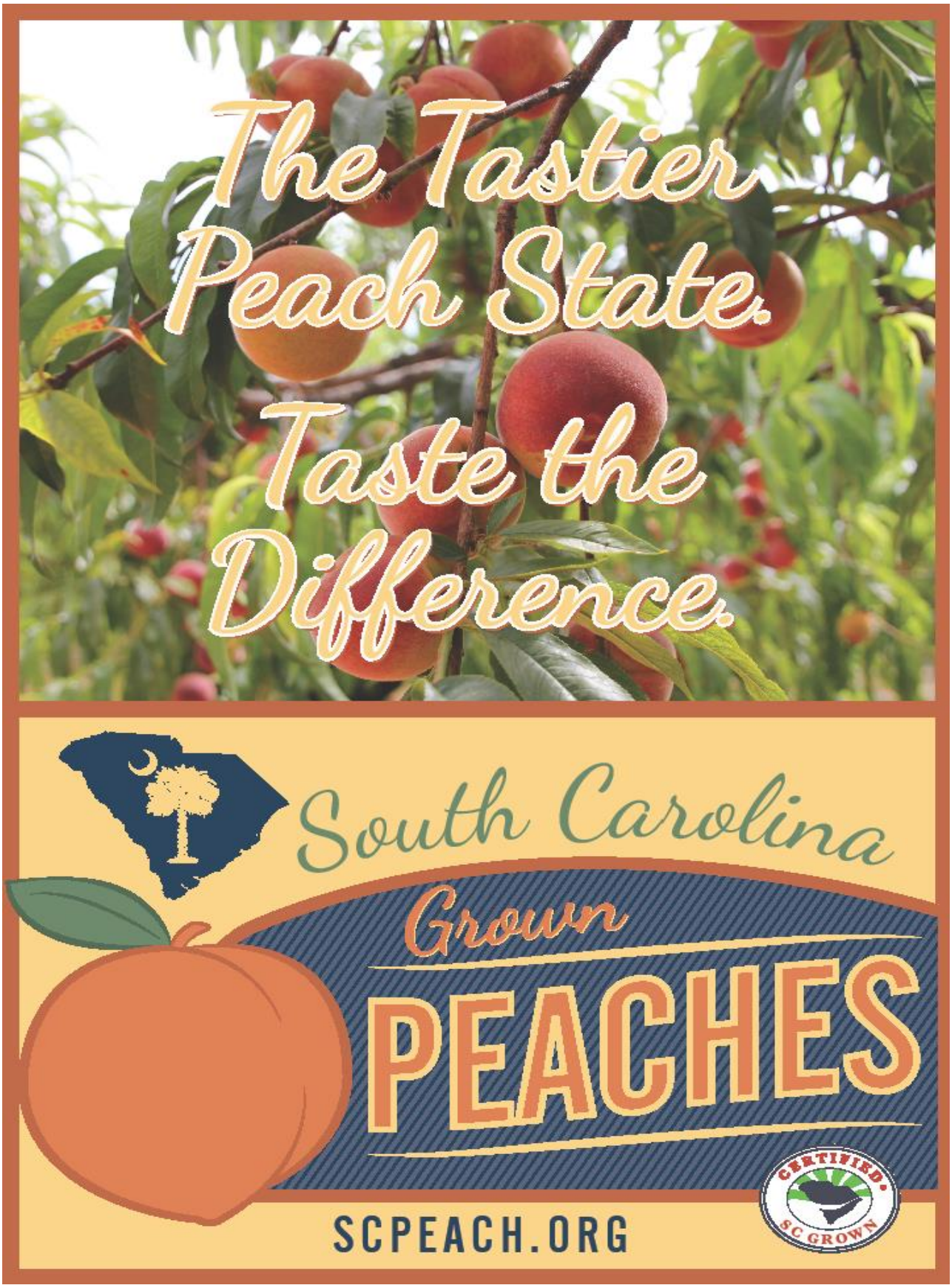
South Carolina is the number one peach producing state in the Eastern US.

Project Approach
An intern was hired during the summer season to assist the SCPC Executive Director with executing the project. Over the twelve-week peach producing season (mid-May through Mid-August), the intern posted an average of 2-3 facts/recipes/etc. per day on the SC Peach Council Facebook page. The intern was in charge of posts and content, as well as helping develop the graphics and content for the digital and print advertisements. The intern worked about 30 hours per week and was paid directly by the SC Peach Council.

Most social media posts and advertisements directed traffic to visit the SC Peach Council website, scpeach.org.

Full page, color print ads ran in The Produce News, on June 13, June 27, July 11 and July 25th. Web based ads ran through the season on Produce News Email blasts, The Packer, and Produce Business. Each web-based ad linked to scpeach.org. The Packer was the digital newsletter, The Produce News was digital and print, and Produce Business was digital and print, as each was outlined in the approved project work plan.

The following graphic is an example of the print ad run for the campaign funded by this project:


The Tastier Peach State.
Taste the Difference.
South Carolina
Grown
PEACHES
SCPEACH.ORG
CERTIFIED
SC GROWN

Goals and Outcomes Achieved

We can measure our reach to over 100,000 consumers with this project via tracking of consumers' views on the SCPC website and social media pages in addition to sales figures provided by retailers. We reached this goal through advertisements running throughout the season.

The SCPC's social media presence gained tremendous traffic through use of grant funds. With over 770 likes the SCPC's Facebook presence helped to directly interact with consumers during the season. The SCPC saw particular increase in followers both men and women ages 35-44 at 15%. The second highest increase was both men and women in the 25-34 age group at 13%. These two groups are highly sought after as produce consumers. Statistics show the older age group tends to buy for families, which drives higher volume purchases and the younger group tends to form purchasing habits at this age. By engaging these groups, the SCPC hopes to continue to drive demand for peaches and form buyer habits for the future. Since SC Grown peaches are naturally ripened, this product meets a demand for a quality, locally-sourced product that these two demographics typically react to in a positive manner.

The second target audience was buyers from major retail and wholesale operations. By driving demand among consumers and ensuring buyers have purchased peaches to be sold in stores when the consumer arrives, the SCPC creates a full cycle of demand to grow business for their stakeholders. These advertisement pieces were published in industry specific periodicals that are distributed to over 6530 retail chains, wholesale grocers and top wholesale clubs. Advertisement was also directed via online newsletters that reached over 30,000 produce buyers from these major companies. South Carolina growers noted an increased demand for early season fruit and a wider range of buyer contacts from Canada, Texas, and Mid-West region markets.

The 2016 peach season was especially challenging for growers in our state due to weather patterns during the fall and winter that adversely affected the crop. The required number of chilling hours needed for peach fruit to set properly was not reached in many varieties, thus affecting the sizing of fruit. Inconsistent fruit size leads to an inconsistent market. While the volume was good, and fruit matured at an early date, the majority of the fruit was smaller than usual, and this drives the price down in the marketplace. The large amount of fruit creates more cost to growers to harvest and due to small size, bring in less income from buyers. During these types of years, promotional activities that cater to markets outside of the Southeast become especially important. Traditionally the Southeast market buyers prefer larger fruit while the outside markets will still pay premium pricing for smaller fruit due to high demand and lack of local fruit during these time periods. By utilizing these grant funds the SCPC was able to increase demand from these outside markets by over 30%, which helps provide viable channels for South Carolina growers to move fruit.

Despite the climatic challenges, the goal of increasing sales of SC Grown peaches by 10% in the wholesale marketplace was realized. According to the Southeastern Peach Report, published by SCDA Market News Division in conjunction with USDA AMS Fruit and Vegetable Division, the South Carolina growers sold 91,129,500 pounds of fresh peaches on the wholesale market in 2015. In 2016, the SC peach growers sold 100,292,500 pounds of fresh peaches on the wholesale market. This translates to 9,163,000 pounds of fresh SC peaches, or just over the 10% volume increase target, between the two comparative years for the purpose of this report.

Beneficiaries

As the largest peach producing state on the east coast it is imperative that the South Carolina Peach Council continues to aggressively promote SC Grown peaches. While this marketing program benefits

over 20 companies that are currently growing, packaging, selling and shipping peaches in SC, it also affects many other allied industry members in the state. By increasing sales and consumption, this program also increases business for all parties. These agricultural product or service companies depend on the success of the SC peach farmers. From providing a variety of farming equipment, packaging materials, seed, fertilizers, pesticides and other essential pieces of agricultural business, these companies rely on expanding sales of peaches.

Lessons Learned

During promotional time periods the SCPC saw increased interest from buyers outside of our region (Southeast). By utilizing advertisements beginning months before the harvest, buyers were already interested in SC grown peaches, and many had already contacted growers to secure future orders. The SCPC will continue to work on advertisements during the spring months to secure business for growers once the season begins. In addition, advertising through these channels provided reach to many markets outside the Southeast. By focusing on other markets, the SCPC was able to help growers move fruit during a challenging year. These different markets provide growers with the ability to receive premium prices for fruit that may not be as desirable in a local market. In the future, SCPC will continue to advertise and promote the health benefits of SC Grown peach to markets outside of our region.

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Project Title: **Marketing Campaign Promoting South Carolina Watermelons**
Project Partner: South Carolina Watermelon Association

Project Summary
The South Carolina Watermelon Association (SCWA) used SCBGP funding to promote the SC watermelon industry to retailers, wholesalers, and to the consuming public via an extensive Industry Spokesperson program. The SCWA Industry Spokesperson was an ambassador and public relations representative for the SC Watermelon Association. The project objective was to increase the consumption of SC Grown watermelon while providing education regarding the health benefits of our product. Promotions included appearances at a wide range of retail food stores, professional and collegiate sporting events, media appearances via television, radio, and print, and participation in various festivals and food show events to promote watermelon.

The project's purpose was to educate consumers on the benefits of eating watermelon and to promote the sales of South Carolina Watermelon during promotional events. As a result of educating consumers at these events, we saw an increase in demand for watermelon throughout the 2016 season.

Watermelon production in the state of South Carolina ranks in the top 10 nationally every year. In South Carolina, over 7500 acres of watermelon are planted each year. This reflects a significant portion of overall fruit production in the state and provides significant income to the state.

Project Approach
The SC Watermelon Spokesperson served as an industry spokesperson during a summer tour. This requires attention when working media or promotional events and the representative must be well versed in current agricultural trends, watermelon production, and the benefits of consuming watermelon. Our representative was able to utilize their training and promoted our message to more than 300,000 consumers throughout the 2015-16 grant period.

Recently published scientific studies have shown watermelon is superior to sports drinks when used for replenishment during athletic activities. By promoting this message in a timely manner at actual sporting events, the spokesperson was able to effectively promote the message and influence market demand for watermelon. Research shows that consumers are more concerned about the quality of foods they use before, during and after exercise than ever before. By promoting the health benefits of watermelon to these consumers we are able to help establish healthy eating habits that include an increased consumption of SC grown watermelons.

Completed Activities

Promotion	**Timeline**
University Sports Programs • Clemson University • SC State University • The Citadel • Furman University • Presbyterian College • University of South Carolina	July 2016- September 2016
Food Shows	January 2016 – October 2016

• Southeast Produce Council Southern Exposure, PMA Fresh Summit, Eastern Produce Council Produce Show, Regional SYSCO/US Foods events, Regional Retailer Food Shows	
Development of promotional materials for use at promotional events	October 2015 – April 2016
Media Appearances • Local News, Social Media and radio participation before and after events	April 2016 – August 2016
Retail Promotions • Bi-Lo, Food Lion, Harris Teeter, Walmart, IGA, Ingles, Lowes Foods, Piggly Wiggly, Giant Foods and Earth Fare	April 2016 – October 2016
Media Appearances throughout State • "Your Carolina", Greenville • "Lowcountry Live", Charleston • "Taste of SC", Columbia • "WYFF", Greenville • "WLTX", Columbia • "Making It Grow", Sumter • "Watermelon Field Day", Blackville	April 2016 – September 2016
Festival Activities • Hampton and Pageland Watermelon Festival • Shutzenfest • SC State Fair • SC Commissioner's Cup BBQ	April 2016 – October 2016
Visits to Watermelon Farms • Melon One, Coosaw Farms, Goat Hill Farms, Williams Farms, Kinard Farms	April 2016 – August 2016
Sporting Events • Cooper River Bridge Run, Charleston • Charleston Riverdogs Baseball	March 2016 – July 2016
Appearances and Promotions at Farmers Markets • Columbia • Greenville • Florence	March 2016 – September 2016

Goals and Outcomes Achieved

This marketing program was successful in reaching our target of over 300,000 customers. The Cooper River Bridge Run in Charleston was a tremendous success, reaching over 40,000 runners and additional attendees. Utilizing these grant funds, we were able to distribute over 25,000 individual samples of fresh cut watermelon and interact with runners, fans and media covering the event. With all this combined, we reached an audience of more than 95,000 persons.

During retail store promotions we were able to talk with consumers while shopping in stores. We received positive results from grocers, several reporting a watermelon sales increase of over 20% when we had a representative in the store interacting with customers. Studies have shown that over 35% of those who sample a product will purchase it. We saw this impact in person with local grocery stores. In addition, many consumers also asked for help in identifying other locally grown fruits and vegetables. This further shows how positive interactions and presentation of information can positively affect sales not only in watermelon but other SC Grown fruits and vegetables. It should also be noted that sales ads for watermelon were up from 287 in 2015 to over 300 in the 2016 season. This is an additional increase from past years. Retailers said they were more likely to continue with ads during our promotional events and when SCWA sponsors or contributes to events in their town.

During promotions with sports nutrition groups and athletic teams from six major university sports programs the SCWA saw significant interest in watermelon consumption by athletes and faculty. Sport nutrition directors interviewed after events all agreed that watermelon was an excellent, natural source of nutrients for athletes and several plan to utilize watermelon for their athletes in their nutrition programs going forward. Athletes also gave positive feedback with nearly 90% saying they would consume watermelon before, during or after a practice or a sporting event if it was available as a source of replenishment. The association plans to build on this momentum in the future.

The 2016 season was challenging for growers due to weather conditions during planting and harvest in South Carolina. The unprecedented “1000 Year Flood” South Carolina experienced in the fall of 2015 destroyed many quality production acres in the low-lying elevation areas in our state, where most of the watermelon production occurs. As a result, production was down more than 20% (56,080,000 pounds sold in 2016 vs 74,880,000 pounds sold in 2015). However, despite the -20% availability in volume produced, growers continued to see increased demand. This increased demand helped growers overcome a smaller crop by driving up the average price per pound from an average of $0.32/pound in 2015 to $0.33/pound during the 2016 season as reported by data gathered by the national watermelon promotion board. In a continued trend the demand for cut and packaged melon continues to stay strong at around $1.60/pound. This demand gives additional outlets for growers to sell melons to processing facilities and fresh-cut/packaging companies. However, it is clear that due to the reduced volume for market availability in 2016, a 10% increase in sales did not occur. It may be concluded that had the production volume been the same as it historically is for South Carolina, the growers would have experienced an increase in sales. The increase in prices stated above can be used in support of this conclusion.

Beneficiaries

This program directly benefits over forty companies that are currently growing, packing, selling and shipping watermelons in the state of South Carolina. In addition, allied industry members see growth in their business as a result of these successes. These agricultural service companies depend on the success of watermelon growers in order for their business to thrive. This could include farm equipment, packaging materials, seed, fertilizer, pesticides and other essential pieces of business.


WATERMELON
FUELS
ATHLETES


MOVE IT!
CHARLESTON COUNTY
ROPER ST. FRANCIS
PHYSICIANS ENDOWMENT
CharlestonCountyParks.com

Lessons Learned

During promotional events all consumers responded positively to information regarding watermelon as a healthy option for replenishment after sporting events. We found increased interest while at an actual sporting event and more interest than we expected with athletes and spectators. At events where the SCWA provided samples of melon, we saw the most positive response. While expensive, we will try to have fresh watermelon available during future events. We will also focus more heavily on events and promotion towards children and young adults. We found that many millennials and older age groups enjoyed printed information and visual marketing pieces while children and younger adults reacted to samples. We also identified this young age group as making more of an impact when it comes to sales. Parents and guardians were more likely to purchase melons when combined with facts regarding nutritional value and the demand from the children or dependents. We saw a positive response from athletes and training staffs when supplied with watermelon and noted a positive reaction from fans when seeing watermelon consumer by athletes. We will use this knowledge in future marketing campaigns to build growth in the SC watermelon business.

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Project Title: **Heightening Consumer Awareness of the Availability of Fresh, Locally Grown Fruits and Vegetables**

Project Partner: South Carolina Department of Agriculture (SCDA)

Project Summary

The specific objective of this project was to increase the sales of specialty crops grown in South Carolinians, by utilizing radio as a means of advertising to heighten awareness of when various and specific crops are available. As competition continues to increase from out of state growers, as well as globally-sourcing prerogatives increase among the larger retail chain stores, it is both timely and important to remind those that live in or are visiting our state of the need to support the rural economies, the rural infrastructure, and ultimately individual growers from the throughout the state. The height of fruit and vegetable production in South Carolina occurs from May through September with June and July being the peak production months.

In conjunction with the contracted public relations agency Chernoff-Newman, the SCDA Certified South Carolina Program Coordinator worked to develop a product specific radio campaign to emphasize the variety of produce grown in South Carolina to local consumers, as well as visitors to our state. Upon development, Chernoff-Newman purchased air time from independent non-conglomerate stations across South Carolina. The SCDA has the capability within its finance department to segment funds so that the Specialty Crop Block Grant Program funds were only used to pay for air time during the months when specialty crops were promoted via this radio campaign. This project was not supplemented with additional federal or state grant program funds. However, to achieve completion it was supported by additional monies allocated from the SCDA Marketing Division appropriated budget.

Commercials promoting and titled accordingly were “Roadside & Farmers Markets”, “Peaches”, “Tomatoes”, and “Watermelons” were aired in the summer months of 2016. All production time, creative costs, and airtime for the “Roadside and Farmers Markets” messaging and commercials were paid for out of the SCDA marketing funds from appropriated dollars as mentioned above.

The amount of radio spots purchased differed by market area. The radio spots were purchased by Chernoff-Newman on behalf of SCDA, and these purchases are based off of GRP levels. The primary target audience was a Caucasian demographic aged 25-54. The radio ads aired 5/16 – 5/29 and 6/6 – 6/19 for a total of four weeks.

The following transcripts provide an example of the commercials that supported the sales of SC Grown specialty crops:

‘Certified SC Grown’ Watermelon

MALE ANNCR VO:
I am a Certified SC Grown watermelon. Behind me?... more Certified SC Grown watermelons.

OTHER WATERMELON VO:
What’s up? Hi there. How’s it going? Hey, ya’ll.

[ALT FOR OTHER VOs]
Mmm, mmm, mmm. Don’t you wanna slice one open and have a taste?

MALE ANNCR VO:

And this is a beauty shot of a Certified SC Grown watermelon. Aren't they just a little slice of heaven?

Why the fuss? That's because the juiciest, sweetest and most deliciously refreshing watermelons are grown in South Carolina.

After all, it's a matter of taste.

'Certified SC Grown' Tomatoes

FEMALE ANNCR VO:
We are Certified SC Grown tomatoes. Sure… you might think we lead charmed lives. Grown in nutrient-rich soil, basking under sunny South Carolina skies…

But as soon as we ripen into some of the most deliciously plump, rich and juicy tomatoes…

Oh, no… they've got Beefsteak Billy!

If only no Certified SC Grown tomatoes were harmed in the making of this commercial. I guess it's a matter of taste.

Project Approach

The activities were completed in the time frame provided below. The planning and implementation of the project was completed in 2 years rather than in the 3 years originally proposed.

Project Activity:	**Person(s) Responsible:**	**Complete by:**
Developed scripts for radio campaign - one script for each specialty crop listed in this project. *The goal of each script was to create messages specific to SC Grown specialty crops that would stimulate interest in consumers, and thereby increase sales.*	Chernoff/Newman	Mid- January 2016
Scripts were approved. *Each script was reviewed to insure that ads would solely promote specific SC Grown specialty crops.*	Certified Program Director and SCDA Grant Administrator	Mid-February 2016
Ads were created/produced	SCDA and Chernoff/Newman	March 2016
Purchased time/media buys for statewide coverage; heavier purchasing along SC coast	Chernoff/Newman	March 2016
Aired radio ads based on purchased timeslot approvals	SCDA, Chernoff/Newman	May 2016 – April 2017

Compiled statistics on consumer impressions made, per demographic information for each market area	Chernoff/Newman	June 2016 – May 2017
Determined of success of project by research and examination of 2015 NASS Survey Statistics	SCDA Marketing Division	December 2017

Goals and Outcomes Achieved
Top of mind consumer awareness was gained from this project. Reminding consumers when specific specialty crops are in season is critical due to seasonal availability of said specialty crops. Out of the 7,500 radio spots bought statewide over 7.9 million impressions were made (refer to chart that follows the end of this report).

Below is the data collected from the National Association of Statistical Services (NASS) for peaches, tomatoes and watermelons in 2015 and 2016.

Peaches:
2015- $64 million
2016- $14 million (Estimated value based on historical data from NASS)
Tomatoes:
2015- $44 million
2016- $32 million

Watermelons:
2015- $37 million
2016- $34 million

2016 created many obstacles for growers in South Carolina. Less than ideal winter followed by spring freezes impacted the tomato, peach and watermelon crops to different degrees.

The peach crop was almost a total loss. However, it became important to move forward with what fruit we had in state. The radio campaign reminded consumers that we still in fact had peaches available. While we did not increase overall sales by 10%, we did increase consumer awareness and it helped producers sell what little crop that remained.

Tomatoes and watermelons were also impacted. The 10% goal was not met but sales of available product were enhanced by this effort.

Outcomes:
Overall the radio campaign was carried out to completion as proposed. The Chernoff-Newman report shows we made 7,967,700 impressions on consumers. The campaign certainly helped remind consumers to seek out local peaches, watermelons and tomatoes.
However, mother nature impacted overall available volume. We did not reach our overall 10% growth goal due to weather disasters in 2016.

Beneficiaries
Over 100 peach, watermelon and tomato growers across the state and over 200 roadside market operations across the state benefited from this radio campaign.

Lessons Learned
Top of mind consumer awareness was gained from this project. Reminding consumers when specific specialty crops are in season is critical due to seasonal availability of said specialty crops

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CHERNOFF NEWMAN MEASURE

SC Department of Agriculture - 2016 Commodity Radio

Market Breakdown

Market	$ Spent	Spots Bought	W25-54 GRPs Bought	A25-54 GRPs Bought	W25-54 Impressions	A25-54 Impressions
Augusta	$ 16,305	1,088	665.9	599.1	725,800	1,281,700
Charleston	$ 20,823	1,079	596.4	517.5	917,400	1,568,800
Columbia	$ 21,000	1,288	606.8	455.6	846,200	1,238,800
Florence	$ 9,640	854	597.5	542.1	243,300	420,400
Greenville	$ 28,764	1,452	598.8	503.8	1,298,100	2,123,900
Myrtle Beach	$ 9,792	744	601.2	527.2	403,400	694,000
Savannah	$ 14,582	1,041	580	424.1	440,100	640,100
Totals	**$ 120,906**	**7,546**	**4,246.6**	**3,569.4**	**4,874,300**	**7,967,700**

Creative Breakdown*

Creative	$ Spent	Spots Bought	W25-54 GRPs Bought	A25-54 GRPs Bought	W25-54 Impressions	A25-54 Impressions	Traffic Rotation
Roadside/Farmers Market	$ 30,227	1,887	1,061.65	892.35	1,218,575	1,991,925	25%
Tomatoes	$ 30,227	1,887	1,061.65	892.35	1,218,575	1,991,925	25%
Peaches	$ 45,340	2,830	1,592.48	1,338.53	1,827,863	2,987,888	37.50%
Watermelons	$ 15,113	943	530.83	446.18	609,288	995,963	12.50%
Totals	**$ 120,906**	**7,546**	**4,246.6**	**3,569.4**	**4,874,300**	**7,967,700**	**100%**

*estimates based off of traffic rotation

Project Title: Advertising Events related to "Certified SC Grown" Specialty Crops through Social and Digital Media Monitoring

Project Partner: South Carolina Department of Agriculture, Marketing and Public Information Divisions

Project Summary

The purpose of this project was for South Carolina Department of Agriculture (SCDA) marketing staff to employ alternative approaches to advertising specialty crops at the three State Farmers Markets. Marketing staff was concerned that previous dollars being spent on the typical avenues of advertising in print and outdoor boards were becoming inefficient in engaging consumers and specialty crop growers to attend events hosted at state facilities, specifically the three State Farmers Markets in the cities of Columbia, Florence, and Greenville, which are operated by SCDA. With knowledge transfer in the realm of social and digital media increasing, marketing staff determined that the 'Certified SC Grown' logo branded by SCDA needed to become more visible and integrated into these channels so that attendance and participation in 'Certified SC Grown' events would increase thus increasing sales and encouraging consumption of specialty crops made available to consumers at these venues.

Project Approach

Since October 2015, twenty-five different events have been highlighted through SCDA social and digital media platforms. This surpasses our original goal of advertising a minimum of 18 events. By placing targeted ads in both digital and social media platforms during the time of peak volume availability at the farmers markets, SCDA hopes to increase sales of specialty crops by increasing awareness of their availability among consumers. Through a four-month campaign with The State Media Company and Pandora to perform advanced audience targeting in Columbia, Greenville, and Florence markets, as well as search engine marketing, 533,830 overall impressions were made. Pandora's contract included :30 audio with display that was targeted to a specific farmers market region. The overall campaign reached 3,697,384 listeners. This far surpasses the original expected outcome estimate of 83,000.

Significant contributions from the SCDA Marketing and the Public Information Divisions included negotiating contracts with The State Media Group and Pandora for a four-month campaign to promote specialty crops at the three State Farmers Markets. The Marketing Division and Public Information Division worked with SCDA in-house graphic designer to develop appropriate specialty crop images and copy for said advertisements. Procurement was made by the Public Information Division. These efforts led to over 500,000 impressions and reached over three million listeners.

This project solely benefitted specialty crops.

Goals and Outcomes Achieved

In order to achieve the performance goals and measurable outcomes identified in the approved project proposal, targeted ads were broadcasted in both print and social media platforms during the time of peak volume availability. SCDA marketing staff negotiated contracts with both Pandora and The State Media Company to promote specialty crops at the three State Farmers Markets. The State Media Company included targeted ads focused on content on how to select and store specific commodities (i.e. strawberries, peaches, cucumbers). They also utilized search engine marketing in the Columbia, Greenville, and Florence markets following keywords like farmers market, fresh market, and local produce. Pandora's four-month contract utilized :30 audio with display added value to increase accessibility and awareness of services offered by SCDA's three farmers markets. Each audio ad and display ad were targeted to its specific regional market: Columbia, Greenville, or Florence. SCDA's viral communications coordinator also scheduled paid advertisements on the SC State Farmers Market

Facebook page to promote specialty crops each month. The SCDA Branding Coordinator also negotiated a contract with The State Media Company for a four-month campaign that included (2) ¼ color page ads in The State newspaper (a local publication that reaches on average 183,991 adults each week) twice a month on Sundays and/or Wednesdays; 975 Advanced Audience Impressions per month; and 79,500 Mobile Geo-Fence Impressions per month.

The actual activities were in line with the proposed goals. We advertised 18 events; six plant and flower festivals, seven specialty crop grower meetings, and five specific specialty crop promotional timeframes.

Since October 2015, twenty-five different events have been highlighted through SCDA social and digital media platforms. Through four-month campaigns with The State Media company, there were 533,830 overall impressions made. Pandora's four-month campaign successfully reached 3,697,384 listeners.

Beneficiaries
All SC specialty crop producers who participate in events and festivals at the SCDA farmers markets benefitted from the completion of this project's accomplishments due to increased accessibility and advertising of events and services offered by SCDA across social and digital media platforms.

The beneficiaries of this project who were affected by its accomplishments are the approximately 250 specialty crop producers involved in each plant and flower festival. Along with those 250 specialty crop producers, the approximately 400 growers that are interested in attending workshops and trainings that take place at the market indirectly benefitted from the targeted social media ad campaigns.

Lessons Learned
The alternative approach that the SCDA marketing team employed on Facebook, Pandora and carefully selected radio channels to enlighten a targeted demographic about specific events and meetings hosted for specialty crop growers at the three State Farmers Markets was well received. The overall campaign was successful with 533,830 overall impressions.

While the numbers are strong some of the institutional knowledge was lost due to two key persons involved in this project leaving the SCDA.

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Appendix A

Food Safety Basics Student Lesson Plan

Foodborne Illness

A foodborne illness outbreak is when two or more people get the same illness from consuming the same food. The Center for Disease Control (CDC) estimates that 1 in 6 Americans develop a foodborne illness each year. This is equal to about 48 million people getting sick. Of these, 128,000 become hospitalized and about 3,000 will die. Foodborne illnesses are caused by pathogens (bacteria, viruses and parasites) or toxins produced in some mushrooms and seafood. The top 5 pathogens that cause foodborne illnesses are: 1. Norovirus 2. *Salmonella* 3. *Clostridium perfringens* 4. *Camphylobacter* 5. *Staphylococcus aureus* The top 5 pathogens that cause foodborne illness and result in hospitalization are: 1. *Salmonella* 2. Norovirus 3. *Camphylobacter* 4. *Toxoplasma gondii* 5. *E. coli O157* The top 5 pathogens that cause foodborne illness and result in death are: 1. *Salmonella* 2. *Toxoplasma gondii* 3. *Listeria monocytogenes* 4. Norovirus 5. *Campylobacter* Foodborne illness symptoms vary depending on the infecting pathogen. Most begin to affect the gastrointestinal tract first causing nausea, vomiting, diarrhea, abdominal cramps and/or fever.	Ask students to raise their hands if they or someone they know has ever had a foodborne illness. Have students count off from 1 to 6, and then have all the students that counted 1 stand. This is an estimate of the number of the class that could contract a foodborne illness this year. Divide the class into 8 groups and have them research one of the pathogens listed below and answer the following questions about each pathogen. Each group will then report their findings to the rest of the class. This can be used as a homework assignment if time does not allow in the classroom. Pathogens: 1. Norovirus 2. *Salmonella* 3. *Clostridium perfringens* 4. *Camphylobacter* 5. *Staphylococcus aureus* 6. *Toxoplasma gondii* 7. *E. coli O157* 8. *Listeria monocytogenes* Questions to answer for each pathogen: 1. Name of pathogen and list any nicknames this pathogen may have. 2. Where can this pathogen most commonly be found? 3. What foods are most commonly linked to this pathogen? 4. What are the common symptoms if someone becomes ill from this pathogen?

Symptoms can begin to occur a few hours to several days after consuming a contaminated food. Those who are young (infants and preschool aged children), elderly, pregnant women and those who are sick or have compromised immune systems are most susceptible to getting a foodborne illness when eating a contaminated food.	5. How can we prevent contamination of this pathogen on food?

Pathogen Growth

Pathogens grow most quickly when their environment has all of the conditions that support their growth. The acronym for this is FAT TOM. F = Food A = Acidity (pH) T = Time T = Temperature O = Oxygen M = Moisture <u>Food:</u> Like all living things, pathogens need food to grow. <u>Acidity:</u> Pathogens grow best in environments that have a pH of about 5.0 to 9.0. Water has a neutral pH of 7.0, and many foods (particularly meat, poultry, eggs, dairy, and vegetables) have a pH in this range. <u>Time:</u> When all conditions are met for growth, each pathogen present can double every 20 minutes. The growth pattern for one cell could look like this: 0 minutes = 1 cell 20 minutes = 2 cells 40 minutes = 4 cells 1 hour = 8 cells 2 hours = 64 cells 4 hours = 4,096 cells	

This is the reason why we do not want to leave potentially hazardous foods (also called time and temperature control for safety foods or TCS foods) out at room temperature for more than two hours. <u>Temperature:</u> Most pathogens grow best between 70°F and 125°F, but they can continue to actively grow between the temperatures of 40°F and 135°F. This temperature range is called the Temperature Danger Zone. Foods must be kept out of this danger zone as much as possible and for no longer than 2 hours. A common phrase for this is: "keep hot foods hot and cold foods cold". <u>Oxygen:</u> Most pathogens grow in an environment with oxygen. There are a few exceptions such as *Clostridium botulinum*, which grows in oxygen-free environments, and *Campylobacter*, which prefers to grow in low oxygen environments. <u>Moisture:</u> Pathogens need moisture to grow. As moisture is removed, their ability to grow decreases. Overall, when one or more of these elements is reduced or eliminated then the growth of pathogens will be reduced and/or stopped.	

Time and Temperature Control for Safety (TCS) Foods

Foods that are most susceptible for the growth of pathogens (meet all elements of FAT TOM) are called Time and Temperature Control for Safety (TCS) Foods. These are also sometimes called Potentially Hazardous Foods. Examples are: • Meat and poultry • Seafood (fish, shellfish, and crustaceans) • Milk and dairy products • Eggs	

• Sliced melons • Cut tomatoes • Cut leafy greens • Baked potatoes • Tofu and other soy proteins • Cooked rice, vegetables, and beans • Sprouts and sprout seeds • Untreated garlic and oil mixtures	

How Does Food Become Contaminated?

Pathogens are naturally found in our environment. However, when they enter our food supply and have the right conditions to grow they can grow to enough numbers to make someone sick (Did you know that just 1 cell of *Salmonella* is enough to make someone sick?!). This is called contamination. Cross contamination can occur when a contaminated food comes in contact with another food, food contact surface (cutting board, knife, etc.), or someone's hand and the pathogen is transferred to that other surface. Examples of how food can become contaminated include: • Intestinal tract of animals • Contaminated water to wash produce • Contaminated water where seafood are living and harvested • Unwashed hands from those touching food • Contaminated equipment (knives, cutting board, conveyor belt, etc.)	Before providing the examples of how foods become contaminated, have students guess the answers and write them on the board for everyone to see. Review any that were not given by the students.

Four Steps to Safe Food Handling

1. Clean Pathogens are easily transferred to food from unclean hands and surfaces. <u>Hand washing:</u> It is critical to keep hands clean when handling and preparing foods. Know the proper steps to hand washing and follow them: 1. Wet hands and arms with hot running water. 2. Apply enough soap to create a good lather.	Using a GloGerm® kit, choose 3 volunteers. Have each volunteer put the GloGerm® (lotion or power) on their hands. Have one person rinse and dry their hands and another wash their hands following proper hand washing procedures. The third volunteer should not wash their hands. Then turn lights off in the

3. Scrub hands and arms for 10 to 15 seconds. Do not forget cuticles, tops of hands, and thumbs. 4. Rinse with warm running water. 5. Dry with a single-use paper towel or hand dryer. Note: Hand sanitizers should not be used in place of proper hand washing when handling and preparing food. Wash hands: • Before handling food • Before and after handling any raw meat, poultry, or seafood • After using the restroom • After sneezing or coughing • After eating, drinking, or chewing gum • After handling garbage • After touching hair, face, or body • After handling dirty dishes • After touching clothing or apron • After touching any pets • After touching any surfaces that may be contaminated (dirty equipment, telephone, etc.) <u>Food contact surfaces and equipment:</u> To prevent cross contamination, all food contact surfaces must be kept clean. This includes: • Knives • Utensils • Cutting boards • Bowls and pans • Counters Clean food contact surfaces and equipment in-between uses, particularly when working with raw meats, poultry, produce and ready-to-eat foods. Hot soapy water should be used for cleaning these items. Be sure to allow items to air-dry or use single-use paper towels or clean cloth towels for drying. Do not recontaminate these items by using a dirty cloth! <u>Wash produce:</u>	classroom and show everyone what their hands look like under the black light. Can they see the difference between each volunteer and the amount of "germs" remaining and where they are concentrated on the hands? (*Optional – choose a 4th volunteer and have them apply hand sanitizer after applying the GloGerm®. How do their hands compare to the other three volunteers?)

Produce (fruits and vegetables) can carry pathogens on their outer surfaces from the field where they were grown and/or from the handler who picked them. It is important to wash all produce before cutting and eating. The best way to wash produce is with cool running water. For items with hard outer surfaces (like melons), a clean produce brush can be used to scrub the outside. Do not soak produce in water, or wash produce in a tub of water as this can cause contamination if one piece was contaminated and the pathogens are transferred to the wash water that is reused.	
2. Separate Cross contamination can occur when a contaminated food touches another food. Therefore foods, particularly raw meat, poultry, seafood and eggs, should be kept separate from all other foods. • When shopping keep these foods in a different area of your cart than produce, dry foods, and other ready-to-eat foods. Do the same when bagging the groceries. • In the refrigerator, keep raw meat, poultry, seafood, and eggs from other refrigerated foods. • Keep raw meat, poultry, and seafood on the bottom shelf of the refrigerator to prevent these items from dripping raw juices onto foods that may not be cooked before eating. • When preparing foods, keep raw meat, poultry, and seafood away from other foods. Use different cutting boards and keep enough space in between to prevent splashing or touching or prepare these items at different times and clean utensils, counters, etc. in between.	
3. Cooking Cooking foods to the proper minimal internal temperature can kill pathogens that may be present on the food. Using a properly-calibrated food thermometer is the only way	

to ensure that the food has been cooked to the right temperature. The most common types of thermometers used for cooking foods at home are the bimetallic-stemmed thermometer, digital thermocouple, or roast thermometer. <u>Bimetallic-stemmed thermometer:</u> This thermometer is the most commonly used food thermometer. It has a dial or digital reading area located on the top. The stem or probe is the portion of the thermometer that is placed in the food. These thermometers often have a dot or line etched towards the center of the probe. The tip of the probe to this mark is called the sensing area. The full sensing area should be covered in the food to get an accurate reading. These thermometers (particularly the dial variety) need to be calibrated regularly. To calibrate, place crushed ice in a container tall enough to cover the sensing area and then fill with water. Place the thermometer into the ice water slurry and wait for 15 seconds or when the dial stops moving. The temperature should read 32°F. If it doesn't, then while still in the ice water, adjust the nut under the dial of the thermometer until the thermometer reads 32°F. For digital thermometers follow manufacturer's instructions for calibration. <u>Digital thermocouple:</u> This thermometer is digital and has a very small probe. Oftentimes, the sensing area is located on the tip of the probe only. Some thermocouples have probes that can be changed to measure temperatures of various foods (for example a very small probe for hamburgers and very long probes to measure the temperature of a large pot of soup). Follow manufacturer's instructions for use and calibration. <u>Roast thermometer:</u> This thermometer has a large dial and short thick probe. It is used for cooking roasts and	Show an example of each of these types of thermometers to students. Pass them around the classroom so they can see them up close. Ask for a volunteer or 2 and have them practice calibrating a thermometer and allow the rest of the class to watch.

other large cuts of meat or poultry and is designed to stay in the meat throughout the duration of the cooking time. Oftentimes it has marks on the dial (in addition to temperatures) to indicate the final cooking temperature of different cuts of meat and poultry. <u>Thermometer placement:</u> It is important to place the thermometer into the food properly in order to get an accurate reading. The sensing area of the probe should be inserted into the thickest portion of meat (Note this may not always be the center) or the center of a liquid, soup or casserole. Do not allow the probe to touch bone or part of the roasting pan. When taking the temperature of a small item, like a chicken breast or hamburger, insert the probe through the side instead of the top so the sensing area is adequately covered. The following are minimal internal cooking temperatures for various food items: • Ground meat - 160°F • Ground poultry - 165°F • Meat (steak, roast, ham) - 145°F for 3 minutes • Poultry - 165°F • Egg dishes - 160°F • Leftovers and casseroles - 165°F • Fin fish - 145°F • Microwaved foods - 165°F Once cooked, foods should either be consumed immediately, kept hot (>135°F), or refrigerated/frozen.	
4. Refrigerate All perishable foods should be kept refrigerated (or frozen). Do not let perishable foods to be in the temperature danger zone for more than 2 hours. <u>Thawing foods:</u> Do not thaw foods on the counter at room temperature. There are 4 acceptable methods of thawing food:	

• In the refrigerator • In cool running water • In the microwave (be sure to cover the item and stir/turn often to prevent hot spots) • As a part of cooking <u>Shelf life of refrigerated perishable foods:</u> Do not keep perishable foods in the refrigerator past their recommended shelf life. Some pathogens can still grow (although slowly) at refrigerated temperatures. It is important to know the temperature of your refrigerator and ensure that it stays below 40°F to maximize shelf life and safety. These are general guidelines for storing perishable foods in the refrigerator: • Opened deli meat and other raw meats – 3-5 days • Raw poultry – 1-2 days • Prepared foods/leftovers – 3-4 days	

Appendix B

Safe Handling of Produce from Growth through Preparation

Foodborne Illnesses and Produce

Between 1998 and 2008, fruits and vegetables were the cause for nearly half (46%) of all reported foodborne illnesses. Produce was also the cause of about 23% of all foodborne illness related deaths at this time. Leafy vegetables were the type of produce that contributed to most of the fruit-and vegetable-related foodborne illness-related illnesses and deaths. From 1996 to 2010 there were about 131 produce-related foodborne illness outbreaks reported which resulted in 14,350 with foodborne illnesses, 1,382 hospitalizations, and 34 deaths. Approximately 20 different types of fresh produce caused these outbreaks. Pathogens of most concern with produce are: • *Clostridium botulinum* • *Escherichia coli* O157:H7 (*E. coli*) • *Salmonella* • *Shigella* • *Listeria monocytogenes* • Norovirus • Hepatitis A In 2006 there was an *E. coli* outbreak caused from spinach. This outbreak caused 204 people to be sick, 104 people were hospitalized and 3 died.	

Produce Related Government Regulations to Ensure Safety

Good Agricultural Practices (GAPs) • Developed by the USDA • Practices and procedures that help to prevent cross contamination on produce during growth, harvest, and packaging. • Farmers can participate in a GAPs audit to verify they are following the proper practices and procedures.	Ask students if they have heard of GAPs before. Can anyone describe what it is and the purpose of GAPs?

• Some grocery stores require that their produce farmers are GAPs certified. Food Safety Modernization Act (FSMA) • Signed into law January 2011. • A new food safety system that focuses on prevention versus reaction. • Ensures safety of foods produced in United States and imported foods. • Includes the produce safety rule specific to produce commonly consumed raw. Produce Safety Rule • Minimum standards for growing, harvesting, packing and holding fruits and vegetables • Includes regulations for: o Hazards found in produce (natural, unintentional and intentional) o Soil amendments (manure and compost) o Worker hygiene o Packaging o Temperature control o Animal control (domestic and wild) o Water quality – irrigation and post-harvest o Regulations for growing sprouts These government regulations are for farmers/producers of these foods for sale. How in-depth they are regulated on these areas of growing and selling produce is related to how much they sell annually.	Ask students if they have heard of FSMA. Can anyone describe what it is and the purpose of FSMA?

Ensuring Food Safety of Produce During Growth, Harvest, Storage and Preparation

Food Safety During Growth • Store seeds to prevent contamination • Keep pets, pests and wild animals away from growing area. • Wash hands before touching seeds and growing plants. • Keep aquaponics system in proper working condition.	Divide class into four groups. Assign each group to either food safety during growth, harvest, storage or preparation. Give each group 10-15 minutes to discuss methods to keep spinach (or other produce) safe during each stage. Then have a represenitive of each group list their methods. Supplement the list with any methods that were left out.

• Avoid having aquaponics water come in contact with spinach leaves as much as possible. Food Safety During Harvest • Wash hands before touching/harvesting produce. • Ensure containers, knives/scissors, and all other harvest supplies are clean before harvest. • Do not set harvested produce on the ground or on any unclean surface • Refrigerate perishable produce (like spinach) immediately after harvest. Refrigerator temperature should be less than 40°F. • Store produce in the refrigerator covered and in a location to prevent contamination from other foods such as raw meats, poultry and fish Food Safety During Storage • Store in a clean refrigerator at 40°F or below. • Ensure that the storage container is clean and covered to prevent cross-contamination. • Keep produce away and/or placed above raw meat, poultry and seafood. • Fresh picked spinach will last for 3-5 days when stored in the refrigerator. Food Safety During Preparation • Wash hands before handling and preparing produce. • Ensure all food contact surfaces are clean (cutting board, knife, plate, etc.). • Wash produce directly before use. • Wash produce in cool running water. Do not soak in water. • When produce has a firm outer surface scrub under cool running water with a clean produce brush before cutting and/or peeling. • Refrigerate all produce after cutting and/or peeling.	

• Keep all raw meat, poultry, and seafood away from produce during preparation. • Do not use any produce that has an off odor or appearance (slimy, moldy, discolored, etc.)	

Appendix C

Spinach Nutrition and Cooking

Spinach

Types of Spinach
• Savoy
  ○ Dark green, crinkly and curly leaves
  ○ Crisp
  ○ Often used in salads
• Semi-savoy
  ○ Semi-crinkly leaves
• Flat or Smooth Leaf
  ○ Smooth spade shaped leaves
  ○ Often used for canned or processed spinach
• Baby
  ○ Young flat leaf spinach
  ○ Very tender
  ○ Often used in salads
	Have pictures or samples of each type of spinach to show to the class. Ask students which types of spinach they have eaten before.

Spinach Nutrition

• Recommended Servings
  ○ 1 cup cooked spinach
  ○ 2 cups raw spinach
• Servings per week
  ○ Women – 3 cups per week
  ○ Men – 4 cups per week
• Nutrients
  ○ 1 cup of spinach is an excellent source of vitamins A and K
  ○ Vitamin A
  ▪ A form of beta-carotene. Beta-carotene is part of the carotenoid family and is an antioxidant. The brighter the vegetable the higher the content. Beta-carotene makes Vitamin A.
  ▪ Promotes eye health
  ▪ Boosts immune function
  ▪ Promotes skin health
  ▪ Promotes bone health
  ○ Vitamin K
	Show students what 1 cup of cooked and 2 cups of raw spinach looks like.
	
	Divide students up into 4 groups. Have each group choose two of the following nutrients and have them report to the class the role each nutrient plays in the body and how much of the nutrient is in 1 cup of spinach.
	• Vitamin A
	• Vitamin K
	• Folate
	• Iron
	• Fiber
	• Magnesium
	• Calcium
	• Vitamin C

▪ Helps to build strong bones ▪ Essential for blood clotting o Other nutrients found in spinach include: ▪ Folate – helps to prevent anemia ▪ Iron – helps to prevent anemia ▪ Fiber ▪ Magnesium – needed for growth and muscle development ▪ Calcium ▪ Vitamin C • Fresh, frozen and canned spinach provide all the same nutrients. If choosing canned spinach, choose a variety that has little to no added salt.	

Cooking Spinach

Common Cooking Methods • Sauté – 2 to 3 minutes in oil or stock/broth o Add garlic, lemon juice, red chili flakes, or other spices or flavorings to give the spinach extra flavor. • Steam – 3 to 5 minutes • Microwave – Wash without drying. Place in microwave safe bowl covered loosely with plastic wrap. Microwave for 4 to 5 minutes Common ways to add spinach to your diet • Salads • Sandwiches • Lasagna and other pasta dishes • Soups • Stir-fries • Omelets • Casseroles • Smoothies	

Recipe Preparation

Cooking with Spinach	Have students choose from one of the provided recipes to prepare in the classroom. Allow each student to sample the prepared dish. Provide copies of all the recipes for students to take home. Any remaining spinach or additional spinach grown from the system can be divided and given to the students to take home for their own use or additional recipes can be prepared in the classroom for the students to try if time allows.

CLEMSON
COOPERATIVE EXTENSION

Spinach Hummus

1 cup cooked spinach
1 tablespoon olive oil
1 tablespoon lemon juice
2 cloves garlic, minced
1 can chickpeas, drained
Salt and Pepper to taste

Directions: Place all ingredients in a food processor. Blend until smooth. Serve with crackers, tortilla chips or pita chips.

Yield: about 13 servings

Nutrition Facts

about 13 servings per container
Serving size **2 Tbsp. (28g)**

Amount per serving
Calories **30**

	% Daily Value*
Total Fat 1.5g	**2%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 110mg	**5%**
Total Carbohydrate 3g	**1%**
Dietary Fiber 1g	**4%**
Total Sugars 0g	
Includes 0g Added Sugars	**0%**
Protein 1g	
Vitamin D 0mcg	0%
Calcium 13mg	2%
Iron 0mg	0%
Potassium 44mg	0%

*The % Daily Value tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

CLEMSON
COOPERATIVE EXTENSION

Caramelized Onion, Bacon and Spinach Pizza

1 pound pizza dough
3 tablespoons cornmeal
8 slices bacon cooked and chopped
8 ounces baby spinach
1 large sweet onion, thinly sliced
3 tablespoons canola oil, divided
1 cup pizza sauce
8 ounces part-skim mozzarella cheese, shredded

Directions:

1. Preheat oven according to directions for the pizza dough. (Usually about 400-425°F)
2. Spray pizza pan or large baking sheet with non-stick cooking spray and then sprinkle evenly with cornmeal
3. In a sauté pan, heat about 1-1/2 tablespoons oil and then sauté spinach just until wilted. Transfer spinach to a plate covered with paper towels to absorb excess oil.
4. Add about 1-1/2 tablespoons into sauté pan and add onions. Sauté on medium to medium-low heat stirring frequently until softened and they begin to brown. Transfer onions to a plate covered with paper towels to absorb excess oil.
5. Shape pizza dough into a 12-inch round circle on the prepared pan. Spread pizza sauce on dough evenly leaving a ½ to 1-inch border around the edge uncovered. Sprinkle bacon, spinach and onions on top of sauce. Evenly sprinkle top of pizza with mozzarella cheese.
6. Bake pizza in oven until dough is cooked through and cheese is beginning to brown. Approximately 18-25 minutes.

Yield: 8 servings

Nutrition Facts

8 servings per container
Serving size **1 slice (199g)**

Amount per serving
Calories **340**

	% Daily Value*
Total Fat 15g	**19%**
Saturated Fat 4.5g	**23%**
Trans Fat 0g	
Cholesterol 20mg	**7%**
Sodium 530mg	**23%**
Total Carbohydrate 36g	**13%**
Dietary Fiber 1g	**4%**
Total Sugars 5g	
Includes 0g Added Sugars	**0%**
Protein 15g	
Vitamin D 0mcg	0%
Calcium 250mg	20%
Iron 3mg	15%
Potassium 219mg	4%

*The % Daily Value tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

CLEMSON
COOPERATIVE EXTENSION

Spinach, Strawberry and Mozzarella Salad

2 tablespoons orange juice
1 tablespoon olive oil
1/4 teaspoon pepper
2 ½ cups baby spinach leaves
1 cup sliced strawberries
¼ cup red onion, thinly sliced
¼ cup part-skim Mozzarella cheese, diced or shredded

1. In a small bowl, blend orange juice, olive oil and pepper with a whisk until combined or use a blender or food processor.
2. Gently toss dressing with remaining ingredients in a large bowl until coated.

Yield: 3 servings

Nutrition Facts

3 servings per container
Serving size **(137g)**

Amount per serving
Calories **110**

	% Daily Value*
Total Fat 7g	**9%**
Saturated Fat 1.5g	**8%**
Trans Fat 0g	
Cholesterol 5mg	**2%**
Sodium 100mg	**4%**
Total Carbohydrate 9g	**3%**
Dietary Fiber 2g	**7%**
Total Sugars 4g	
Includes 0g Added Sugars	**0%**
Protein 4g	
Vitamin D 0mcg	0%
Calcium 123mg	10%
Iron 2mg	10%
Potassium 137mg	2%

*The % Daily Value tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

CLEMSON
COOPERATIVE EXTENSION

Pizza Spinach Salad

1 cup baby spinach
½ small tomato diced
¼ cup diced bread or breadsticks, toasted
2 tablespoons mini pepperoni, or peperoni, diced
2 tablespoons shredded mozzarella cheese
1-2 tablespoons low fat Italian dressing

1. Place all ingredients in a small bowl and toss gently until combined.
2. Enjoy!

Yield: 1 serving

Nutrition Facts

1 servings per container
Serving size **(185g)**

Amount per serving
Calories **260**

	% Daily Value*
Total Fat 17g	**22**%
Saturated Fat 7g	**35**%
Trans Fat 0g	
Cholesterol 40mg	**13**%
Sodium 1150mg	**50**%
Total Carbohydrate 12g	**4**%
Dietary Fiber 2g	**7**%
Total Sugars 4g	
Includes 0g Added Sugars	**0**%
Protein 12g	
Vitamin D 0mcg	0%
Calcium 184mg	15%
Iron 3mg	15%
Potassium 145mg	4%

*The % Daily Value tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

CLEMSON
COOPERATIVE EXTENSION

Vegetarian Stuffed Pasta Shells

10-ounce package frozen chopped spinach, thawed
12-ounce carton low fat cottage cheese or ricotta
1 ½ cups shredded mozzarella cheese, divided
½ teaspoon dried oregano
½ teaspoon black pepper
26 ounce jar low-fat tomato basil pasta sauce
1 cup water
8-ounce package uncooked large pasta shells

1. Preheat oven to 375°F. Lightly coat a 13 x 9 baking dish with cooking spray; set aside. Drain spinach by placing in a sieve and pressing with a spoon to remove as much liquid as possible.
2. Place dried spinach in medium bowl. Add the cottage cheese, 1 cup of the mozzarella cheese, oregano and pepper to the spinach. Stir to mix thoroughly. Pour half of the spaghetti sauce into prepared baking dish. Add water and stir to mix.
3. Spoon about 3 tablespoons cheese mixture into each uncooked pasta shell and arrange in a single layer over sauce. Pour remaining sauce over top. Sprinkle the remaining ½ cup mozzarella cheese evenly over sauce. Cover tightly with foil. Bake for an hour or until shells are tender. Let stand 1 minute before serving.

Yield: 8 servings

Nutrition Facts

8 servings per container
Serving size **(249g)**

Amount per serving
Calories **270**

	% Daily Value*
Total Fat 8g	**10%**
Saturated Fat 4g	**20%**
Trans Fat 0g	
Cholesterol 30mg	**10%**
Sodium 670mg	**29%**
Total Carbohydrate 33g	**12%**
Dietary Fiber 1g	**4%**
Total Sugars 8g	
Includes 0g Added Sugars	**0%**
Protein 16g	
Vitamin D 0mcg	0%
Calcium 288mg	20%
Iron 2mg	10%
Potassium 460mg	10%

*The % Daily Value tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

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Fruit Smoothie with Spinach

1 cup frozen strawberries
1 cup canned or fresh pineapple
1 cup fresh or frozen blueberries
¾ cup spinach torn into small piceces

1. Place all ingredients in a blender.
2. Blend until smooth.
3. Serve immediately.

Yield: about 3 servings

Note: Try using different types of fruit, other than those listed above for different flavor combinations. If frozen fruit is not used, then ice may need to be added.

Nutrition Facts

3 servings per container
Serving size **6 ounces (168g)**

Amount per serving
Calories **70**

	% Daily Value*
Total Fat 0g	**0**%
Saturated Fat 0g	**0**%
Trans Fat 0g	
Cholesterol 0mg	**0**%
Sodium 10mg	**0**%
Total Carbohydrate 18g	**7**%
Dietary Fiber 3g	**11**%
Total Sugars 12g	
Includes 0g Added Sugars	**0**%
Protein 1g	
Vitamin D 0mcg	0%
Calcium 31mg	2%
Iron 1mg	6%
Potassium 88mg	2%

*The % Daily Value tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Appendix D

Daily Lesson Plan

Teacher: Dr. Lance Beecher

Course:	Aquaculture: Feeding the Future
Grade Level:	11
Unit:	Aquaponics
Unit EQ:	What is aquaponics?
Materials:	PowerPoint, handouts
Equipment:	Computer, Projector
References:	
Daily Topic:	Introduction to the aquaponics system
Lesson Essential Question(s):	What is aquaponics? What are the basics of an aquaponics system? How to monitor for success?
Standards:	
Objective(s):	*TSWBAT:* 1. Compare and contrast different concepts and components of an aquaponics system and a hydroponics system. 2. Define the basic terms, concepts, and components that accompany an aquaponics system. 3. Explain the basic terms, concepts, and components that accompany an aquaponics system.

Notes:

Differentiated Instructional Techniques:
Instructor will provide a lesson using multiple modalities in order to reach all students. Instructor will also tailor learning activities to fit student needs. Instructor will provide a note sheet to help struggling and unmotivated students stay motivated.

Technology Integration:
Instructor is integrating technology by using PowerPoint slides, which may be a new type of presentation method for some students. The instructor will also be describing detailed figures with additional handouts in the lecture.

Lesson Introduction

Estimated Time: *5 minutes*

Introductory Interest Approach:

Introduction: Define and explain terms and components of Aquaculture and Hydroponic systems.

- Define Hydroponics and system layout.
- Define aquaponics and system layout.

Why *is this information important? Aquaponics is a new type of agriculture for food production and is also very conscious of natural resources and used mainly for conservation purposes.*

How or why *is this information relevant to students? Students are exposed every day to food production and should understand what it takes for production to take place. They are also experiencing conservation practices and interested in better understanding the quality of food.*

Activating Strategy ("Hook" and Engagement): Students will be able to see an actual system in the classroom.

Learning Activity I

Approach: ***Estimated Time:*** *30 minutes*

Objective(s):

1. Compare and contrast different concepts and components of an aquaponics system and a hydroponics system.
2. Define the basic terms, concepts, and components that accompany an aquaponics system.
3. Explain the basic terms, concepts, and components that accompany an aquaponics system.

Teacher Guide: Teaching Strategies

Method of Instruction: Lecture

Type of Activity: Lecture with Questioning

Materials Needed: Computer, Projector, and PowerPoint Presentation.

Directions:

Instructor will instruct lecture material by stopping after each lecture point in the lesson to ask students the following questions:

1) What is the difference between hydroponics and aquaponics?
2) What are the primary components of the aquaponics system?
3) Why is aeration important for the system?
4) What is the primary source of nutrients in the system?

Instruction Guide: Brief Content Outline

Hydroponics is the cultivation of plants by placing the roots in liquid nutrient solutions rather than in soil.

Aquaponics is a form of aquaculture in which the waste produced by farmed fish supplies nutrients for plants grown hydroponically.

Aquaponics can be utilized to provide a sustainable and organic farming source for various produce and ornamentals, using only 10% of the water of soil based farming. Waist-high aquaponics gardening eliminates weeds, back strain and small animal access to your garden. Systems can be as small as a countertop fish tank, or large scale enough to produce commercial crops and even steady harvests of fish. The application can involve producing organisms for stocking lakes and streams, for sale as human food, for sale as ornamentals, and for sale as bait.

System components include:

- Fish Tank
- Filter
- Water Pump
- Air Pump
- Plant Grow Bed

The person in control of the system is also in control of the fish's life. This is why aeration is important. The fish relies on aeration to simply breathe.

Fish are fed a nutritious balanced diet which in turn provide proteins for the fish to grow and the essential nutrients for the plants to grow.

Appendix E

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Spinach and Aquaponics Pre-Test

The overall goal of this project is to promote spinach consumption and sustainable agriculture practices in schools using aquaponics. This pre-test will be used to assess your knowledge of spinach and aquaponics systems and your responses will be confidential. The amount of time required for your participation in this survey will be less than 5 minutes.

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Spinach and Aquaponics Pre-Test

Thank you for participating in the pre-test. Your contributions to this research study is important.

1. Create your own unique User ID by identifying your favorite number followed by a "-", your favorite color, followed by a "-" and then the first letter of your middle name, last letter of your birth month and second letter of your last name. For example: 58-purple-AHA. This User ID will be used throughout the research study and will allow your identity to be confidential to the researchers but allow the researchers to match your pre- and post-test data.

User ID

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Spinach and Aquaponics Pre-Test

* 2. How likely are you to eat fresh spinach?

- ◯ Not likely
- ◯ Likely
- ◯ Very likely

* 3. How likely are you to try new vegetables?

- ◯ Not likely
- ◯ Likely
- ◯ Very likely

* 4. How often do you eat any form (fresh, frozen, canned) of spinach?

- ◯ Never
- ◯ 1 time per month
- ◯ 2-3 times per month
- ◯ 1 time per week
- ◯ More than once per week

* 5. If you eat spinach, on average about how much spinach do you eat at one time?

- ◯ 1/2 cup
- ◯ 1 cup
- ◯ 2 cups
- ◯ More than 2 cups

* 6. Do you have a vegetable garden at home?

- ◯ Yes
- ◯ No

* 7. Which of the following items would you be interested in eating if it was served/offered to you? (choose all that apply)

- ☐ Spinach salad
- ☐ Sandwich with spinach
- ☐ Pasta dish with spinach
- ☐ Spinach sauteed with garlic
- ☐ Omelet with cheese, spinach, and other vegetables
- ☐ Creamed spinach
- ☐ Berry smoothie with spinach
- ☐ Chicken with a creamy spinach sauce
- ☐ Soup with spinach

* 8. What part of spinach is most commonly consumed?

- ◯ Leaf
- ◯ Root
- ◯ Stem
- ◯ Flower

* 9. Spinach is rich in which nutrient?

- ◯ Vitamin D
- ◯ Potassium
- ◯ Vitamin K
- ◯ Vitamin E

* 10. Do you wash vegetables before eating?

- ◯ Yes
- ◯ No

* 11. How often do you wash your hands before preparing food?

- ◯ Never
- ◯ Sometimes
- ◯ Always

* 12. Are you a vegetarian?

- ◯ Yes
- ◯ No

* 13. Have you used an aquaponics system before?

- ◯ Yes
- ◯ No

* 14. Is an aquaponics system a method of sustainable agriculture?

- ◯ Yes
- ◯ No