IOWA DEPARTMENT OF AGRICULTURE AND LAND STEWARDSHIP

Bill Northey, Secretary of Agriculture

Iowa Department of Agriculture and Land Stewardship

State Point of Contact:

Stephanie Groom – Grant Administrator
Iowa Department of Agriculture and Land Stewardship
Phone: (515) 725-1179
Email: Stephanie.groom@iowaagriculture.gov

Specialty Crop Block Grant Program – Farm Bill
14-SCBGP-IA-0019

Final Performance Report
January 29, 2018

Table of Contents

- Practical Farmers of Iowa - *Record Keeping Education and Data Collection to Improve Crop Insurance, Recordkeeping Literacy and Profitability for Iowa Fruit and Vegetable Farms.....Final Report.....3*

- Iowa State University - *Minimizing Food Safety Risk at the Farmer's Markets through Online Education for Producer Vendors and Market Managers.....Final Report...*.....10

- Iowa State University - *Evaluating Zone 4 and 5 Conifers for Potential Use in the Iowa Christmas Tree and Nursery Industries Germinated and Grown in Two Systems.....Final Report…….15*

- Iowa State University - *Establishing a Standard of Identity for Jams and Jellies made from Aronia Berries.....Final Report.....19*

- Lutheran Services of Iowa - *Investing in Refugee Specialty Crop Producers.....Final Report.....38*

- Prairie Rivers of Iowa - *Understanding the Feasibility of a Central Iowa Nonprofit Fresh Produce Food Hub to Aggregate and Distribute Fresh Produce to Wholesalers and Retailers.....Final Report.....47*

- Iowa State University - *Grower-based Participatory Research to improve Tomato Production Efficiency Through Grafting.....Final Report....51*

- IDALS - Add it Up: Farm to School Makes Cents.....*Final Report….64*

- Native Fruit Association - *Assessing Promising Bush Fruit Adaptability: Dwarf Sour Cherry and Honeyberry and Showcasing Iowa's Best Pawpaws.....Final Report.....70*

- IDALS - *Measuring Stress on Fine Roots in Retail Centers.....Final Report….77*

- IDALS – Iowa Grown is Iowa Good……..*Final Report*…..87

Final Report to Iowa Department of Agriculture and Land Stewardship from Practical Farmers of Iowa
December 7, 2015 (updated Feb. 10, 2016)

Project Title

Recordkeeping education and data collection to improve crop insurance, recordkeeping literacy and profitability for Iowa fruit and vegetable farms

Project Summary

Forty percent of farming members of Practical Farmers' 2,500 members are fruit and vegetable farmers. Almost 50% of our beginning 1,500 – and growing – beginning farmer network raises fruits and vegetables. Many fruit and vegetable farms with a passion for growing food lack recordkeeping skills needed to track production and profit. Furthermore, lack of suitable crop insurance makes growing fruits and vegetables a risky business, especially considering a large percentage of Iowa counties were declared disaster areas due to weather events five of the past six years.

The purpose of this project was to:
1) Increase recordkeeping skills among fruit and vegetable growers in Iowa;
2) Increase profitability of fruit and vegetable farms due to changes made based on recordkeeping.
3) Increase the visibility of fruit and vegetable farm production, profitability and profit potential in Iowa.

The following outcomes were achieved in pursuit of our goals:

1) Enhanced **350 farmer's financial and recordkeeping skills** through one day-long workshop, one half-day workshop, two field days, and two farminars (farmer-led webinars), and a farmer-researcher meeting and follow-up presentation. An **additional 296 people viewed** the archived farminars;
2) Involved **33 farmers** in research and reached over 1,000 more, increasing understanding of the current status of fruit and vegetable farm financial viability and crop-specific yields for growers in the state. This was done through two farmer-led research projects, research reports, and media on the findings.
3) Increased awareness of over **114,000 individuals** about the importance and issues facing fruit and vegetable farm profitability in Iowa through news releases, event summaries on the PFI blog, and social media posts.
4) Shared yield and production data collected by **23 farmer-researchers** with the Non-insured Crop Disaster Assistance Program (NAP) to create baseline data and standards for crop-specific fruit and vegetables in Iowa.

The project included follow-up assessments for every event to ensure continued efficacy of Practical Farmers' programming.

Project Approach

Practical Farmers' approach for this project, in accordance with our mission, is to create opportunities for farmers to share knowledge with each other, and to help them increase their knowledge through on-farm research. For the research portion, interested fruit and vegetable farmers meet in December at the Cooperators' Meeting to review projects from the previous year and design and discuss projects for the upcoming year. For this grant, those research projects were related to yield recordkeeping and whole farm financial analysis.

For knowledge-sharing, Practical Farmers organized events ranging from farminars (farmer-led webinars) to field days to full-day workshops – each with a farmer leading the discussion and presenting from their own experience. Farmers continue to report that they learn best from other farmers, and ask that we continue providing farmer-to-farmer opportunities.

Activities Performed

All activities are listed and discussed in the "Goals and Outcomes Achieved" section of this report. Below is a summary list of the activities performed:

- 2 field days (July 6, 2015; July 15, 2015)
- 2 farminars (Jan. 20, 2015; March 21, 2015)
- 1 day-long workshop (Feb. 21, 2015)
- 1 half-day workshop (Jan. 23, 2015)
- 2 meeting presentation (Dec. 8, 2014; Feb. 12, 2015)
- 3 farmer-led research projects (2014)
- 3 research reports published (2014-2015)
- 1 data appendix published (2015)
- Yield data shared with RMA and FSA (2015)
- 4 news releases (Jan. 8, 2015; Feb. 6, 2015; June 22, 2015; July 1, 2015)
- 5 blog posts (Feb. 26, 2015, March 16, 2015; July 8, 2015; July 27, 2015; Sept. 28, 2015)

Goals and Outcomes Achieved

Outcome 1: Enhanced 350 (goal was 330) individual farmer financial and recordkeeping skills.

Practical Farmers achieved this outcome through one day-long workshop, one half-day workshop, two field days, and two farminars (farmer-led webinars), and a Cooperators Meeting presentation. Event overview and evaluation (as available) from each event are described below.

Cooperators' Meeting Presentation: Dec. 8 – Whole Farm Financial Project Update – Rick Hartmann (29 participants)

At the annual Cooperators' Meeting, farmer-researcher Rick Hartmann of Small Potatoes Farm discussed the initial findings from the Whole Farm Financial Project, and led a discussion of analysis farmers would be interested in seeing.

Farminar: Jan. 20 – "Scale and Profitability: The Right Fit for Two Vegetable Farms" – Dan Guenther and Mike Racette (33 live participants, 202 archive views)

Seasoned CSA farmers Dan Guenthner and Mike Racette from Wisconsin discussed the process of piecing together the infrastructure needed for a viable small farming operation. Both Dan and Mike have over 20 years

of experience running a CSA, and will discuss the land, machinery, and financial chronology their farms went through to get where they are today.

Half-Day Workshop: Jan. 23 – "Cards on the Table: Putting Farm Financials in Context" – Melissa Dunham, Craig Chase, Kay Jensen and Rob Faux (53 Attendees)

During this workshop, farmers Melissa, Rob, and Kay shared their complete farm financials with the audience. Craig Chase, a trusted farm management specialist with Iowa State University, analyzed and asked questions of the farmers to elucidate their financial goals and strategies for their farms, and pointed out strengths and areas for improvement.

Evaluation from attendees said:

"Thanks to the presenters for being so open and willing to share their information."

"Very brave presenters. Good level of detail."

"Best workshop I have ever been to."

"I learned how to take information from financial sheets and use them to help make decisions. Now I just have to start using it!"

"Awesome! Setting a new precedent of sharing financial info-this is so needed and desired.

"**Presentation: Feb.12 - Whole Farm Financial Project and On-Farm Recordkeeping – Rick Hartmann and Liz Kolbe (26 attendees)**

PFI staffer Liz Kolbe joined farmer-researcher Rick Hartmann to present about PFI's research at a community meeting in Dallas County, Iowa.

Full-Day Workshop: Feb. 21 – Successful Biological Orcharding with Michael Phillips - (100 attendees)

Michael Phillips owns and operates Lost Nation Orchard in northern New Hampshire, and is acclaimed for his expertise and practical approach to biological orcharding. During this event he discussed practical decisions for production and marketing for orchardists that will improve orchard profitability. Ninety-two percent of attendees rated the event as 'very effective' or 'extremely effective.' 100% reported a change in knowledge and 98% plan to improve their orchard businesses as a result of attending.

Attendees reported:

"We were really impressed with the depth, organization level and respectful, professional manner that Michael Phillips and everyone involved displayed. We learned so much and were extremely inspired and empowered."

"This event changed the way I think about farming more than anything else I have been too. It brought the meta concepts in-step with practical applications something lacking in many presentations I have seen in the past."

"This was possibility the most useful event I've attended in a year. Excellent."

"We feel confident we could and should practice holistic orcharding and that this will benefit the entire endeavor."

"Paradigm changing for me and our orchard! I'm glad that I could be a part of this."

"As one who is not a part of PFI, but has interest in organic orcharding, I must thank you for your bringing this speaker and giving all the opportunity to hear him."

Farminar: March 31 – "Food Safety Modernization Act: Implications for Farmers" – Sophia Kruszewski and Chris Blanchard (19 live participants, 69 archived views)

Sophia Kruszewski, a policy expert at the National Sustainable Agriculture Coalition, and Chris Blanchard, an organic farmer and consultant, presented the details of the Food Safety Modernization Act, what its implementation will mean for different types of farmers, and how you can best organize your farm and farm records to comply with new rule and regulations.

Participants evaluated this farminar as "very good," and had a "moderate to large" gain in knowledge from the presentation. Some noted they would make immediate changes to their in-field and office recordkeeping. Said one participant:

"I was very grateful for how clearly this information was presented. I just finished a GAP training with Linn County Extension. I trust the information from this farminar much more than the two day training I just completed. How frustrating is that?"

Field Day: July 6 – Collaborative CSAs: Some Assembly Required – Morgan Hoenig, Mogo Farms (25 attendees)

Farmers Morgan Hoenig and Shanti Sellz discussed the management, bookkeeping, production agreements, and financial arrangements they use (and don't use) for their collaborative CSA, Green Share LLC. Attendees reported the effectiveness and quality of the event as 4.6/5, and changes in knowledge from "moderate" to "very large." Said one attendee:

"Great event and structure of event. I learned a lot from the farmers; especially liked the tool examples and financial sharing. Very helpful!"

Field Day: July 15 – A Vegetable Farm Start-Up: The First Five Years – Danelle Myer, One Farm (65 attendees)

At her field day, Danelle shared her production practices, marketing strategies, and farm and financial decision-making throughout her first five years farming vegetables. Bed making, field layout and organization, and raising vegetables at scale for restaurant and wholesale were noted as most impactful topics to attendees. Danelle's field day included her recordkeeping practices using Quickbooks, which attendees noted they would like to hear more about at future events. Overall, attendees rated the field day's effectiveness and quality at 4.7/5.

Outcome 2: Involved 22 farms (33 farmers) in 2014-2015 research and reached 1,379 more, increasing understanding of the current status of fruit and vegetable farm financial viability and crop-specific yields for growers in the state. This was done through farmer-led research projects, research reports, and media on the findings.

Research Project: Whole Farm Financial Project, Year One (11 farms, 16 farmers)

Research Report: Whole Farm Financial Report, Year One: http://practicalfarmers.org/farmer-knowledge/research-reports/2015/903-clay-st/

Research Project (in progress): Whole Farm Financial Project, Year Two (expect 20 farms)

Research Report: Yield Data Collection Project, 2014 (9 farms; 17 farmers) http://practicalfarmers.org/farmer-knowledge/research-reports/2015/fruit-vegetable-production-data-collection-2013-2014/

Research Report Appendix: Yield Data Collection Project, 2014: http://practicalfarmers.org/farmer-knowledge/research-reports/2015/fruit-and-vegetable-production-data-collection-2013-2014-appendix-4/

Research Project: Yield Data Collection Project, 2015 (11 farms; 19 farmers). Publication expected March 2016.

Research Report (in progress, expected publication February 2016): Yield Data Collection Project, 2015

Blog: The Practical Blog. March 16, 2015. "Research Report: Year Two: Fruit and Vegetable Yield Data Collection." http://practicalfarmers.org/blog/2015/03/16/research-report-year-2-fruit-and-vegetable-yield-data-collection/

Blog: The Practical Blog. Sept. 28, 2015. "Research Report: Whole Farm Financial Project – An Analysis of 2013 Financials." http://practicalfarmers.org/blog/2015/09/28/research-report-whole-farm-financial-project-an-analysis-of-2013-financials/

Outcome 3: Reached over 114,000 individuals about the importance and issues facing fruit and vegetable farm profitability in Iowa through news releases, event summaries on the PFI blog, and social media posts. On the PFI website alone, press releases and blogs from these events received over 1,400 views. In addition to being archived on practicalfarmers.org, state-wide news releases are sent out to 321 media contacts; targeted releases for field days are sent to an "ag core" list and media outlets in the host county and surrounding counties. Practical Farmers' news releases are frequently picked up by state-wide and local news.

News Release: Practical Farmers of Iowa. Jan. 8, 2015. **"**Practical Farmers of Iowa's 2015 winter Farminar series starts Jan. 13." http://practicalfarmers.org/news-events/newsroom/news-release-archive/15516/

News Release: Practical Farmers of Iowa. Feb. 6, 2015. "Practical Farmers of Iowa offers "Successful Biological Orcharding" workshop with Michael Phillips holistic orchard production workshop." http://practicalfarmers.org/news-events/newsroom/news-release-archive/15811/

Blog: The Practical Blog. Feb 26, 2015. "Learning from Michael Phillips, the holistic orchardist." http://practicalfarmers.org/blog/2015/02/26/learning-michael-phillips-holistic-orchardist/

News Release: Practical Farmers of Iowa. June 22, 2015. "Mogo Farms field day will explore benefits, challenges of collaborative CSAs – July 6, Mount Pleasant." http://practicalfarmers.org/news-events/newsroom/news-release-archive/17381/

News Release: Practical Farmers of Iowa. July 1, 2015. "Learn about starting a vegetable farm at One Farm field day – July 15, Logan." http://practicalfarmers.org/news-events/newsroom/news-release-archive/17486/

Blog: The Practical Blog. July 8, 2015. "Field Day Recap: Learning from a collaborative CSA, July 6." http://practicalfarmers.org/blog/2015/07/08/field-day-recap-learning-from-a-collaborative-csa-july-6/

Blog: The Practical Blog. July 27, 2015. "Field Day Recap: The first five years of a vegetable farm, July 15." http://practicalfarmers.org/blog/2015/07/27/field-day-recap-the-first-five-years-of-a-vegetable-farm-july-15/

Outcome 4: Practical Farmers of Iowa shared collected yield and production data with RMA (Whole Farm Revenue, FSA (for NAP), and mailed each participating farmer their cleaned up data along with aggregated data. Nine farms (17 farmers) participated in this project for the 2014 growing season (11 farms and 16 farmers are participating during the 2015 season). Farmers reported data for 23 FSA crop categories: apples, asparagus, beans, broccoli, cabbage, carrots, cauliflower, cucumbers, eggplant, garlic, greens, herbs, kohlrabi, leeks, lettuce, okra, onions, peas, peppers, potatoes, sweet potatoes, squash and tomatoes. Data represented 48 FSA type categories (sub-categories of crop categories). For example, onions tracked included types red, storage, sweet early, white and yellow hybrid. Summary data are included in this report. Total harvest includes units per crop type and includes culls due to insect- and producer-caused damage to crops (damage not due to natural disaster). Marketable harvest units exclude culls. Total acreage includes walking paths in production areas. Additional data beyond FSA requirements were collected to enhance producer comparisons included: variety name, plant spacing, irrigation, planting notes and harvest notes.

Beneficiaries:

This project targeted Iowa fruit and vegetable farmers, people considering adding fruit and vegetable production to an existing farm and those considering starting a fruit and vegetable farm.

The direct beneficiaries of this project were fruit and vegetable producers, both in Practical Farmers' membership as well as beyond: For example, 52% of attendees to the field days were not members of Practical Farmers of Iowa.

Lessons Learned:

Practical Farmers of Iowa encourages open sharing of information among farmers. This takes shape in mentorships, field days, and research reports, and many farmers will even publish enterprise budgets comparing different farm practices. Financials for the whole farm business, however, are a private matter. To some degree, willingness to share farm financials is generational; younger farmers are more willing to show and discuss their books and financial decision making. Older farmers are more cautious, and if they're willing to participate at all, ask that care be taken to assure anonymity.

We were mindful of this, aggregating data to remove identifying features and removing farm names. Aggregating the data in this way, or transforming farm-level data into financial ratios rather than dollar figures, obscures some of the unique qualities of these farms that may have affected their financial statements that year, or over time. This was frustrating for some participants who wanted more clear examples of farm finances. However, this conservative approach allowed more farmers to feel comfortable participating, especially in the first year, and forced farmers to look at their own finances through a new lens.

Farmers who participated in the Whole Farm Financial project are eager to do the next year of analysis, to include more farms, and build a longer-term picture of diversified fruit and vegetable farm financials.

In addition to the Whole Farm Financial Project, several farmers, Melissa Dunham, Rob Faux, and Kay Jensen, opened their books in a live presentation during the 2015 annual conference. This opened their financial decision making to the scrutiny of their peers, which was daunting for them (but a little cathartic, they admitted later). As noted above, attendees of this session appreciated the bravery and openness of the presenters; several said it was the most helpful and inspiring workshop they have attended.

Program Budget

Iowa Specialty Crop Block Grant Program November 1, 2014 - October 31, 2015

	Budget	Expended To Date
EXPENDITURES:		

1.	Personnel	16,200.00	16,200.00
2.	Fringe Benefits	2,048.00	2,048.00
3.	Travel	672.00	672.00
4.	Supplies	500.00	500.00
6.	Other		
	Conferences/Meeting	1,330.00	1,330.00
	Speaker/Trainer Fees	2,750.00	2,750.00
	Publication Costs	500.00	500.00
TOTAL EXPENDITURES		**24,000.00**	**24,000.00**

Contact: Sally Worley, sally@practicalfarmers.org, 515-232-5661

FINAL REPORT CHECKLIST

PROJECT REPORT(S)

PROJECT TITLE:

Minimizing Food Safety Risk at the Farmers Markets through Online Education for Producer Vendors and Market Managers

PROJECT SUMMARY

With the dramatic increase in the number of farmers markets, coupled with an estimated 46% of foodborne outbreaks attributed to fresh produce and nut items, it is critical to educate producers selling at these venues about safe food practices. However, farmers are often reluctant to commit to attending educational programs due to weather, time away from the farm, cost of travel, and/or schedule conflicts. Thus, our team developed four online modules about specific food safety practices/policies to educate farmers market vendors who grow specialty crops and market managers on how to mitigate food safety risk.

Module One provides vendors with fundamental information about good agricultural practices (GAPs) prior to harvest. Module Two includes GAPs during harvest through sales. Module Three provides education on how to market and communicate the farmers' food safety efforts and Module Four focuses on value added products as well as sampling practices and personnel health and hygiene issues. Each module includes knowledge quizzes, reflective questions, and resource guides. Participants chose to complete one or all of the modules based on their needs.

Our **goal** to educate about one fourth of the vendors and managers at Iowa's farmers markets (estimated population of 1,200) was met with 296 certificates issued for completion of at least one of the modules over the two years of the grant. Our **target number** for completion of modules by vendors or managers was 400 over the course of the grant's two years, or 100 participates in each of the four modules. Although we were shy in meeting targeted number of participants, we are pleased to continue offering the online modules available at http://safeproduce.cals.iastate.edu/farmers-market-food-safety-training and expect to reach more growers and market managers.

In 2012, our team was funded with a SCBGP grant titled "Statewide On-Farm Food Safety Program". Through this grant award, our team developed a three-level on-farm food safety program designed to provide educational guidance based on the marketing venue level of choice to address food safety assurance. At the conclusion of the grant in 2015, 530 growers were reached directly through 14 Good Agricultural Practices level courses, 2 webinars (Wholesale for Success and Produce Sanitizers) and 1 in-person additional education seminar (Iowa Fruit and Vegetable Growers Association). These two project complemented each other because they both provided food safety education to fruit and vegetable growers with the statewide program being for a general audience while the farmers' market grant being more focused on those producing on a smaller scale. The desire for the focused grower trainings was discovered as a result of the statewide grant. Another factor that enhanced the Farmers Market grant project was the recognition of a need for online courses rather than face to face. Many of the growers responded verbally or in writing the desire for more flexibility with the course. We recently transition our GAP level 1 course into an online format to meet that need as well. The farmers'

market project was enhanced by the previous grant because much of the information in the statewide project was general and this provided an opportunity to narrow the food safety focus to smaller growers.

PROJECT APPROACH

Between October of 2014 and December 2016, the On Farm Food Safety Team (Naeve, Shaw, and Strohbehn) developed four online modules about specific food safety practices/policies to educate farmers market vendors who grow specialty crops and managers on how to mitigate food safety risk. Each module contained a pre-post knowledge quiz, delivery of information via a narrated power point presentation, reflective questions, and resource guides. Narrated power point presentations ranged in length from about 35 minutes to 69 minutes. Module One, led by Dr. Catherine Strohbehn, provides vendors with fundamental information about good agricultural practices (GAPs) prior to harvest. Module Two, also led by Dr. Strohbehn, includes GAPs from harvest through sales. Module Three, led by Ms. Linda Naeve, M.S., provides education on how to market and communicate the farmers food safety efforts, and Module Four, led by Dr. Angela Shaw, focuses on value added products as well as sampling practices and personnel health and hygiene issues. Project team members independently reviewed all modules and resources to ensure accuracy of content and to avoid repetition of information. Participants could choose to complete one or all of the modules based on their needs. They could complete the modules in one sitting or multiple sittings. Information about the modules was promoted among growers in multiple venues using various methods. In fall of 2016, three additional modules were filmed in an effort to reach a broader audience.

GOALS AND OUTCOMES ACHIEVED

At the conclusion of the grant in 2016, 296 certificates were issued via the online modules. Our proposed participation goals and actual completion rates are shown below.

Proposed Participation Goals (400 overall target number):

- Module One Completions: 50 participants in Year 1 and 50 in Year 2 (total 100)
- Module Two Completions: 50 participants in Year 1 and 50 in Year 2 (total 100)
- Module Three Completions: 50 participants in Year 1 and 50 in Year (total 100)
- Module Four Completions: 50 participants in Year 1 and 50 in Year 2 (total 100)

Actual Participation Rates (296 participants):

- Module One Completions: 33 farms year 1; 64 in year 2; total of 97
- Module Two Completions: 25 farms year 1; 50 in year 2; total of 75
- Module Three Completions: 23 farms year 1; 44 in year 2; total of 67
- Module Four Completions: 17 farms year 1; 40 in year 2; total of 57

Many of the certificates were issued to the name of the farm, which often included a husband wife team, thus actual number of participants may exceed completion rates shown above. Of the 97 that completed the Pre-Harvest Module, the mean pre-module knowledge score was 7.74 /10 with a mean post knowledge score of 9.25/10. Of the 75 who completed the post-harvest module and received certificates, mean pre-module knowledge score of 7.44/10 and mean post-module score of 8.62/10 were calculated; again, an increase in knowledge was seen. We had 67 complete Module Three with pre-module knowledge mean score of 6.63/10 and post-module knowledge mean score of 8.92/10. The Value Added Module was completed by 57 with pre-post module

knowledge mean scores of 6.36/10 and 8.87/10, respectively. As a result of completing the modules, an increase in food safety knowledge was seen for all courses.

Participants were able to provide suggestions to improve the modules. Many of these were incorporated into the final versions of the modules, which were uploaded in July 2016 and remain available for viewing at http://safeproduce.cals.iastate.edu/farmers-market-food-safety-training. Additionally, three videos with broader applications of GAPs beyond farmers markets were produced to support these farmer market modules, provide an alternative delivery format, and introduce pending Produce Safety Rule information. The modules that were videotaped included an Introduction, Pre-Harvest GAPs and Post-Harvest GAPs. These videos were developed in summer of 2016 and recorded in October and November of 2016. Each is about one hour in length. These were posted on the Safe Produce website (http://www.safeproduce.cals.iastate.edu) in January 2017. All produce safety materials are free to anyone.

We have shared our online modules with extension personnel through the U.S. via listservs and professional conferences. As a result of this work, an extension publication and poster presentations at national conferences occurred:

- Extension publication titled *Make Food Safety a Priority at the Farmers Market*. It can be found at https://store.extension.iastate.edu/Product/14829 .
- We presented our results at the 2015 National Extension Tourism Conference in Galveston, TX (Strohbehn, C., **A. Shaw**, and L. Naeve. 2015. *Minimizing food safety risk at the farmers markets through online education for producer vendors and market managers*. Poster Presentation: 2015 National Extension Tourism Conference. Galveston, TX)
- We presented at the 7th National Small Farms Conference in Virginia Beach, VA (Strohbehn, C., **A. Shaw**, and L. Naeve. 2016. Minimizing food safety risk at the farmers markets through online education for producer vendors and market managers. Poster Presentation: 7th National Smalls Farm Conference. Virginia Beach, VA.

We also hope to promote the results of this work through Journal of Extension, Ideas at Work.

The ISU On-Farm Food Safety Team farmers market program provides growers with a holistic approach to food safety education with specific application to the farmers market venue. Our program has shown that growers improved their knowledge after completing each of the modules. Promotion of this resource continues. Additional data will be collected to document the impact of these tools which meet the needs of growers. Support by this grant to develop the online modules allows continued training opportunities to be available, which is important given increasing numbers of farmers markets in Iowa. Through this grant, we were able to structure a four-part online farmers market food safety program, educate other Extension Educators about this resource, and expand offerings of produce safety training resources.

BENEFICIARIES

The farmers who produce specialty crops were the direct beneficiaries of this proposal (at this writing, 296 total farms were reached). They increased their knowledge and were able to capitalize on the education to expand their markets with confidence they were taking steps to

ensure safety of the food they produced and sold. These values were noted in the change in knowledge in all four online module.

Other beneficiaries were consumers of specialty crops marketed through Iowa's Farmers Markets, grocery stores, and retail foodservices. Through the post-module survey, it was estimated each grower marketed to at least three different vendors; therefore there is a multiplier effect by influencing the safety of purchased food from the reported 300 farmers markets from growers educated about safe food handling.

LESSONS LEARNED

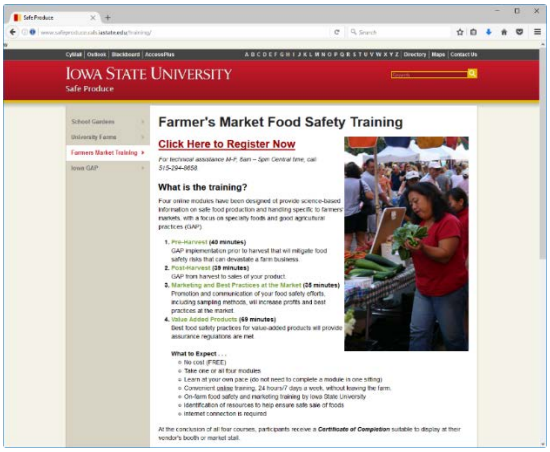
Inclusion of local farmers market coordinators that work directly within communities was essential for successful promotion of the farmers market programming. We attended the Annual Iowa Farmers Market Association Workshop in February of each year to promote the online modules. As part of that outreach effort, we encouraged attendees to complete the training and showcase the earned certificates at market to document their commitment to selling safe food. It can be difficult to recruit participants for trainings on topics not required by regulation or topics not deemed as important. We recognize that we did not met the goal of 400 but we are still promoting the program and hope to increase these numbers over time. The 24/7 availability and no cost should result in greater participation. The pre- and post- knowledge quizzes provided assessments to document impact of the modules and data we can publish in journals and disseminate to other extension educators.

CONTACT PERSON

- ☐ Angela M. Shaw
  - 515-294-0868
  - angelaml@iastate.edu

PROJECT OUTCOMES

Farmers Market Online Website:
http://safeproduce.cals.iastate.edu/farmers-market-food-safety-training



Extension Publication: https://store.extension.iastate.edu/Product/14829

Last Modified: 2/7/2018

FINAL REPORT CHECKLIST

The final report will be posted on the SCBGP-FB website and represents an important vehicle for sharing project findings with Federal and State agencies and the public. Final performance reports must illustrate the completion of the activities and outcomes associated with each project within the grant agreement.

PROJECT REPORT(S)

PROJECT TITLE

Evaluating Zone 4 and 5 Conifers for use in both the Iowa Christmas Tree and Nursery Industries which are Germinated and Grown in Two Systems (Old vs. New Technologies)

PROJECT SUMMARY

Iowa conifers have been hit with a myriad of insect and disease issues severely limiting the current suite of species applicable to the Iowa landscape. Issues with pine wilt, *rhizosphaera* and *stigmina* needlecast diseases, and *Dothistroma* and *Diplodia* fungal pathogens have reduced the use of several key conifers in Iowa leading to fewer and fewer species accounting for the majority of trees in new plantings. This study was designed to identify conifers from zones 4 and 5 from around the world as potential replacement tree species for both the Christmas tree and nursery industries serving windbreaks on other farm / acreage uses. It was also to evaluate early growth potential of each species in standard seedling germination and production methods (styroblocks) vs. new hydroponic methods using rock wool in flood and drain systems. The longer-term stages of this project utilize a common garden trial across the major soil and environmental gradients that Iowa has. We will utilize the current ISU research and demonstration farms across Iowa (NW, SW, SE, Central, and NE) to test and demonstrate the conifers ability to survive, grow, resist insect, disease, drought etc, as well as its form and management needs. This grant appears to have generated more questions than answers but did show significant germination and growth gains for 14 of 24 viable species in hydroponic systems and showed what species (7) to avoid with hydroponics.

This project does not build on a previously funded project with the SCBGP or SCBGP-FB.

PROJECT APPROACH

This project had a series of studies within the 30 month grant cycle. The first was to select, stratify, germinate and grow 35-38 different species of conifers from around the world from Zones 4 and 5. From the start it became clear that seed germination was an issue. Our first round of seeds had only 12 of 38 species germinate in sufficient quantities. Of those that did germinate, growth was significantly greater in hydro than conventional styro blocks. The downside of this enhanced

growth was the increase difficulty in hardening off, separating root systems from adjacent rock wool cubes and over winter survival. Growth for some species in the hydro equaled 3 years of growth in a traditional styro block. Our second round had the same poor germination but was halted by a power interruption that caused a pump to malfunction and we lost the entire second project to desiccation. After creating a redundant water system (to minimize loss from pump failure) we had enough seeds to stratify 28 species for round 3. Following stratification we placed those seeds into petri dishes with blotter paper and held them in a growth chamber with light and heat to break dormancy. As seeds germinated, we carefully hand transplanted them into either styro or rock wool cubes. These seedlings will be tracked for growth, survival, and be transplanted into 1 gallon pots next spring for a one year grow out until they are planted into the common garden trial with the larger seedlings. This trial is still ongoing and will continue well beyond the grant lifecycle. These trees will be evaluated for the next 10-15 years for growth, form, management needs, and disease/insect problems.

In late 2016 and early 2017 we stepped back and worked in controlled environments (growth chambers) to initiate germination of the individual species where we had troubles with germination (over ½ the species failed to germinate the first few rounds). Seeds were soaked, placed into labeled petri dishes on blotter paper and placed into controlled temp and light environments. They were checked daily and if seeds had germinated with an emerged radical they were transplanted into either styroblocks or hydro rock wool. Of the 28 remaining species that had enough seeds remaining we had 7 that never germinated under ideal conditions, 5 species started to germinate and then stopped, and the remaining 16 are still adding viable seedlings to the design numbers. Once radicles emerged we carefully transplanted them into individual styroblock cells and tracked them for survival and growth.

GOALS AND OUTCOMES ACHIEVED

Evaluate new production techniques. With the increasing interest in hydroponic production, which offers a longer production season, more controlled nutrient and fungicide treatment options, and in most systems, faster growth, this study seemed to generate more questions than answers. Across the board germination was poor at best from our commercial seed vendors for these more rare zone 4 and 5 conifers calling into question if growers can rely on vendors for quality seed. We estimated a target of 15-25% germination and growth bump for hydroponic vs styroblocks and given the uniformly poor germination across the board we cannot say with confidence that one system provides better germination. We were forced to alter our methods to get germination and instead going straight from stratified seed to either media we had to stratify seed and place into growth chambers and hand transplant into respective treatments. For species that did germinate, growth was 200-400% greater in hydroponic vs traditional styroblocks which greatly surpassed our target goal. While we initially viewed this as a major positive breakthrough Issues arose when we attempted to transition the conifers from hydroponic rock wool cubes to pots with a standard grow media. The roots from the rock wool seedlings had grown laterally and intertwined with neighboring seedlings making determinations of percent growth impossible. Anecdotally, it appears that the root systems in hydroponic systems were larger as a whole and had better architecture than the “root bound” seedlings in the styroblocks. Once roots were cut

and allowed to recover for 2 weeks it was easier to transplant and initially they looked great. We placed the seedlings outside as we would any other potted tree to harden off and overwinter. We had major losses from hydroponically grown seedlings across all species. After further consultation with several greenhouse researchers that work with hydroponic systems and or conifers it is clear we need to try to alter the NPK ratio as we begin the hardening off period prior to transplanting to pots. While the NPK ratio alterations have been researched and refined for bedding plants transitioning conifers has not and this is a major area of future research prior to full scale grower implementation. It is also clear that we need to work with the producers of rock wool cubes to generate a deeper cube with individual hard sides to control/ reduce lateral root expansion if trees are to be successfully grown and transitioned to traditional pots.

Demonstration site to help growers identify new conifer tree species ability to survive, grow, withstand Iowa's weather variations, and produce trees with the proper form.

The remaining portion of this project is as a long-term trial and demonstration of the various species across Iowa's main climate and soil productivity zones. These sites will be at the ISU Research and Demonstration farms and will enable research and Extension based work to continue. Given most conifer tree insect and disease problems arise after the period of juvenile resistance is over and when the trees begin to fill out and create a working windbreak it will be close to 2 decades before we have a more complete understanding as to appropriateness of all the zone 4 and 5 trees in the trial.

BENEFICIARIES

Given the extreme challenges we faced with seed viability and germination rates, the low outplanting numbers available and the fact that it takes 10-15 years of growth to get a tree past juvenile resistance to determine longer-term growth, survival, pest and pathogen pressures we have routinely presented preliminary findings to our instate Christmas tree growers (100+) at the summer meetings and will present the findings at the winter research meeting in Ames in February. These meetings are also attended by several (~6) regional nurseries that supply tens of millions of conifer seedlings nation-wide. These growers have begun to ask questions on the techniques and infrastructure needed to grow hydroponically but it will be a major capital investment to switch even a small portion of their operation over. With that said that ability to grow a conifer nursery seedling to saleable size in 12-16 months is much better than the 3-5 years with current practices. My hope is that as the work progresses at ISU and we overcome the germination hurdle and refine the transition of seedlings from hydro to soil the nursery production will follow.

Both commercial nursery growers across the US and the 100+ Iowa based Christmas tree growers are in need of new conifer species to meet the growing demand in their respective industries. To stay competitive in a globalized market, growers in Iowa need to find alternatives that are healthy and have appropriate technical information to raise and bring to market a tree under Iowa conditions.

The commercial growers need information to better plan for future inventory and to tailor production of conifers for windbreaks. The demand for new conifers is growing as the ISU online windbreak application and Forestry Extension activities exposes more Iowans to the current suite of issues with matching trees to soils at the planting sites. Further exacerbating the issue of needing new trees is the increasing incidences of needlecast diseases and insect outbreaks as our windbreaks become over mature.

LESSONS LEARNED

Germination was poor at best for all commercially purchased seed for these rare zone 4 and 5 conifers. Part of the issues might be low demand for the seed and therefor the seed we received was from old stock that had been in storage. As the demand for these new species increases, the hope is that the commercial seed dealers will have “fresh” seed stock to sell. For seed that did germinate, growth was 2-4 times greater in hydroponic vs traditional styroblocks which was initially viewed as a major positive breakthrough. Issues arose when we attempted to transition the conifers from hydroponic rock wool cubes to pots with a standard grow media. The roots from the rock wool seedlings had grown laterally and intertwined with neighboring seedlings. Once roots were cut and allowed to recover for 2 weeks it was easier to transplant and initially they looked great. We placed the seedlings outside as we would any other potted tree to harden off and overwinter. We had major losses from hydroponically grown seedlings across all species. After further consultation with several greenhouse researchers that work with hydroponic systems it is clear we need to try to determine standard procedures to alter the NPK ratio and timing of these alterations as we begin the hardening off period prior to transplanting to pots. It is also clear that we need to work with the producers of rock wool cubes to generate a deeper cube with individual hard sides to control root expansion laterally if trees are to be successfully grown and transitioned to traditional pots. To date, the single biggest issue has been with seed procurement and this has been a major hurdle. In the future, we now know to ask the seed lot date of collection and not accept anything that is 3-5 years old. For these rare zone 4 and 5 conifers that would have reduced our species count by over half. In the latest round of seed trials, seed was placed in a growth chamber under ideal germination contions once its stratification period had been reached. Seeds were checked daily and if root radicles had emerged they were immediately transplanted into either rock wool cubes for the hydroponics system or the traditional styroblocks. Out of the 36 seed lots 24 had enough viable seed for both treatments. Of those 24, 14 species showed significant increases in survival and growth in the hydroponic systems while 7 showed significant declines.

CONTACT PERSON

- ☐ Jesse Randall
  - 515 294 1168
  - Randallj@iastate.edu

ADDITIONAL INFORMATION

Aronia Berry Jams and Jellies

Project Summary:

Activities Performed

The goal of the Aronia Jam and Jelly study was to have the Food and Drug Administration (FDA) include Aronia berries in the list of approved fruit for jams and jellies in Title 21 of the Code of Federal Regulations, and establish a Standard of Identity of Aronia berry jams and jellies. This study involved donors sending samples of their Aronia berries, recipe, and jam or jelly. This gave us Aronia berries (frozen) and the jams and jellies from over the course of four harvest seasons (2013-2016). The jams and jellies received were tested for water activity, degrees Brix and pH, in order to make sure that they comply the FDA standards. In order to meet the FDA standards of identity, the jam or jelly must have at least a degrees Brix of above 65.00. In discussions with the FDA, they also wanted pH and water activity date, to determinate safety from foodborne illness microorganisms. As of September 30, 2016, 69 jams/jellies have been received and tested. Overall, 34 jams/jellies have met all three criteria. From the jams and jellies that met the criteria, recipes were selected to replicate in the laboratory test kitchen in 2015 and 2016 to verify the recipe. Commercial fruit Jams and jellies (national and store brands), for comparative standards, were purchased from local grocery stores. These commercial, non-Aronia fruits jam and jelly standards were also tested for water activity, degrees Brix and pH. Total pectin content, both on a percent wet and dry basis, of Aronia berries were also analyzed in 2016. In addition to the Standard of Identity requirement of a minimum of degree Brix, initial specifications were set for pH and water activity for all products (the jam or jelly must have a pH of below 4.20, a water activity level of below 0.8000) to provide microbial safety.

For comparison purposes, and to answer the FDA questions, our previously reported *Determining the Optimum Harvest Time for Aronia Berries to Maximize their Antioxidant and Sensory Properties trend* data (pH, degree Brix, sugar/acid ratio, titratable acidity, and Trolox equivalency of Aronia berries) was included.

Project Approach

A. Jam and Jelly Donations

Potential donors were contacted through the Midwest Aronia Association and Iowa State University Extension Services by postings on their websites. Berries were received from the following states: Iowa, Nebraska, Illinois, California, Wisconsin, South Carolina, South Dakota, Alabama, and Oregon. When jams/jellies were received, all information provided was recorded including name of sender/organization, address, date berries harvested and jam processed, and recipe ingredients and procedure. Jams and jellies were also assigned a randomized three-digit number. If more than one sample came from a person, the sample was denoted with an additional letter, a-i (Example: 463a and 463b). Aronia berries received were labeled and put into freezer storage until testing. After jams/jellies are tested, they were labeled with their opened date and refrigerated.

B. Letters to Donors

After all testing was completed per donor sample, a letter including the donor's results was written. This letter contains a brief explanation of the study, the standards that were analyzed for the FDA, the results, and suggestions on how to appropriately meet the standards, if the results did not

meet the criteria. It concludes with appreciation for participating in the study and a reminder to please make sure all three components are sent (recipe, jam/jelly, and Aronia berries). Once all three components were collected, participants received compensation of $30.00.

C. Comparative Standards

As noted earlier, Jams and jellies for comparative standards were purchased from local grocery stores, The types of jams and jellies tested included apple jellies, blackberry jellies, Concord grape jellies, seedless blackberry jam, peach preserves, strawberry preserves, strawberry jelly, and seedless blackberry preserves. All jams and jellies were assigned a random 3 digit code and multiple samples of the same brand and type were denoted with A, B or C (ex. 902A for the first jar of type 902, 902B for the second jar etc.). The tests performed on the comparative standards included water activity, degrees Brix, and pH. Each test was evaluated from the top, middle, and bottom of the jam or jelly jar. The three values (top, middle, and bottom) were averaged and reported in the following graphs. The FDA standards for jams and jellies are listed under the Code of Federal Regulations (CFR). For soluble solids of jellies: 21 C.F.R. § 150.140 (2015) and soluble solids of jams: 21 C.F.R. § 150.160 (2015). These were used as the criteria for product evaluation. The values from 21 CFR were that the jam/jelly must contain at least 65 degrees Brix or higher. The same internal specifications of a pH below 4.2 and water activity below 0.8000 were used.

Goals and Outcomes Achieved:

D. pH Results

Figure 1 below shows the first of the three criteria tested, pH for jams and jellies. The pH must be below 4.20 to prevent microbial spoilage/health issues. The Fisher Scientific Accumet AR15 pH probe was used to measure pH. **All** 69 jams and jellies received to date have met this requirement. Many samples were far below this pH, the lowest having a pH of 2.21, and the highest recorded pH sampling was 3.89. This is possibly due to the high acidity of Aronia berries, as well as most recipes added additional lemon juice, which would decrease pH. Differences in pH were likely dependent on harvest year (berries received from 2013, 2014, 2015, and 2016 harvests), month of harvest, and weather conditions.

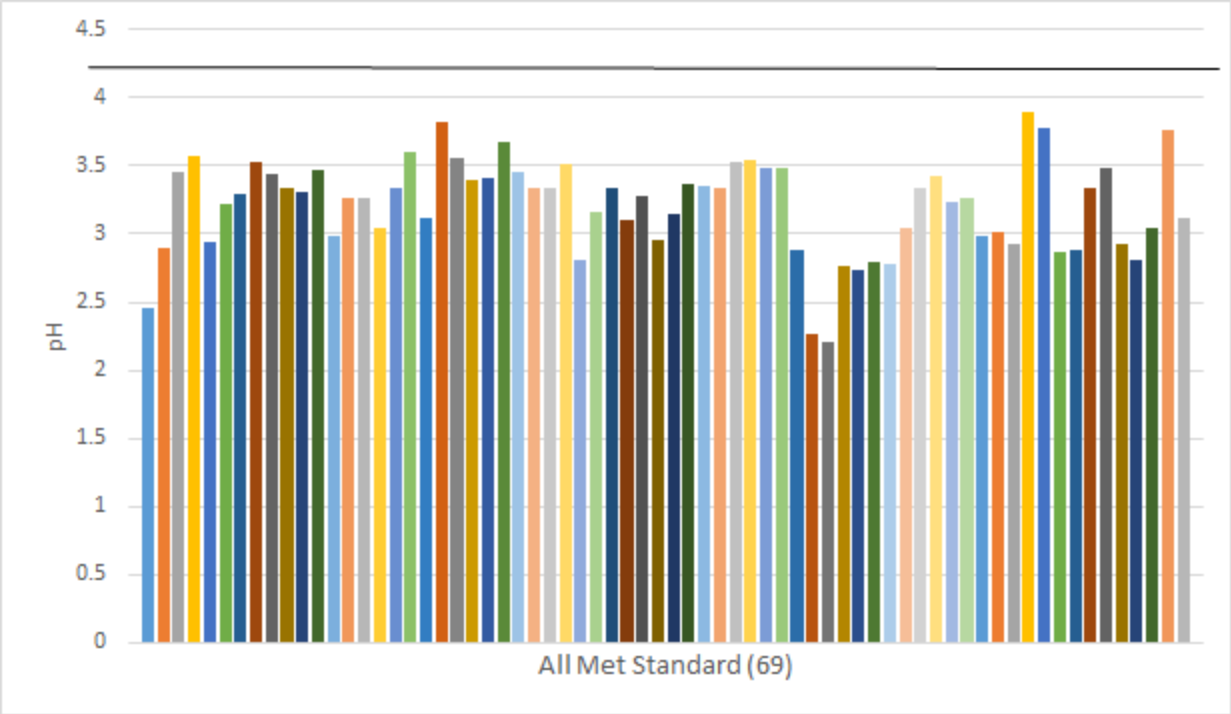


Figure 1: pH Results for Jams and Jellies from 2013 to 2016

E. Water Activity Results

Figure 2 below illustrates the second criteria, having a water activity of the jam/jelly below 0.8000. This is also an important characteristic to prevent microbial spoilage/health issues. 34 out of the 69 samples met this requirement, ranging from 0.6415 to 0.7987. The average water activity of the samples that met the criteria is 0.7604 (well above the minimum standard). 35 samples did not meet the requirement, having a water activity between 0.8032 and 0.9653. The average water activity value of the samples that did not meet the criteria is 0.9002. These donors were contacted immediately, and given warnings and suggestions to to meet the standards. Water activity was measured using a water activity meter (AquaLab 4TE) and each jam/jelly was tested in triplicate, using the average value.

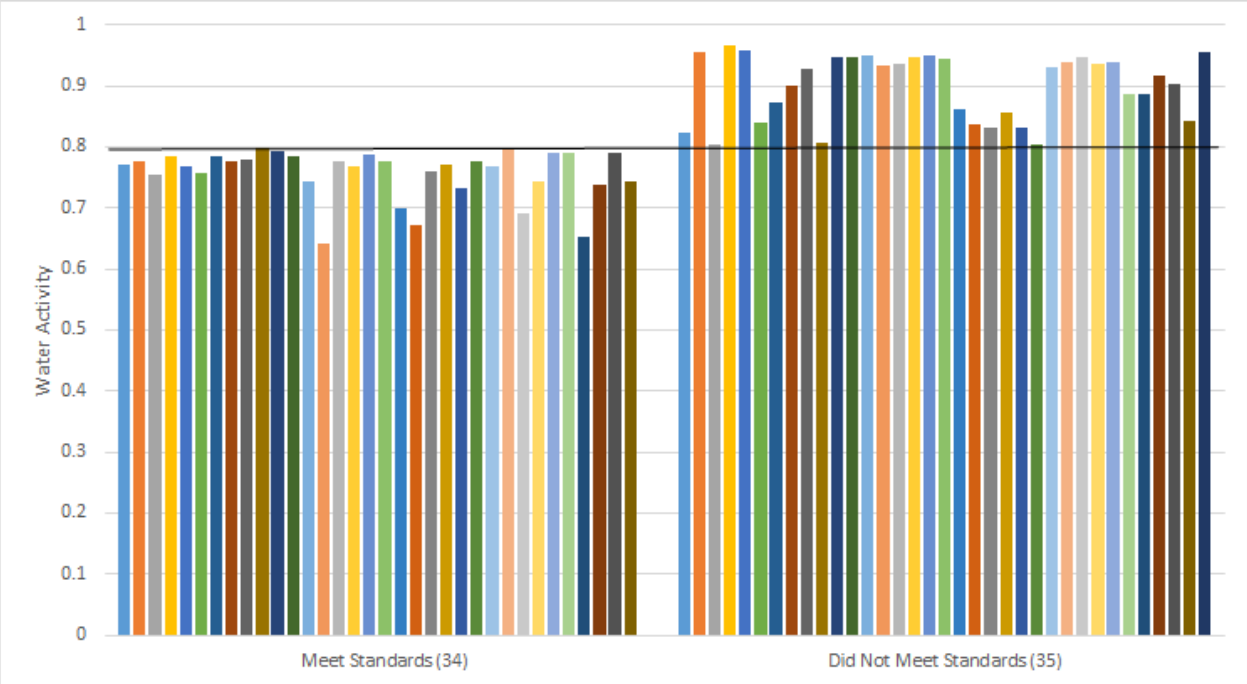


Figure 2: Water Activity Results for Jams and Jellies

F. Degrees Brix Results

The degree Brix value is a measurement of the dissolved sugar content of the juice blended from each harvest date gathered. For gathering data the digital Pocket Refractometer PAL-1 from Atago USA, Inc. was used, testing in triplicate and calibrating the sensor with distilled water in between each reading. Figure 3 depicts the third criteria of degrees Brix, to measure the sugar content of the jam or jelly. The FDA Standard of Identity acceptable level is set at greater than or equal to 65 degrees Brix. 36 of the received samples met or exceeded this standard, having an average value of 69.4 degrees Brix. 33 of 69 samples fell below 65 degrees Brix, having an average value of 45.2 degrees Brix. Donors were contacted about the results, and suggestions for meeting the standard were given.

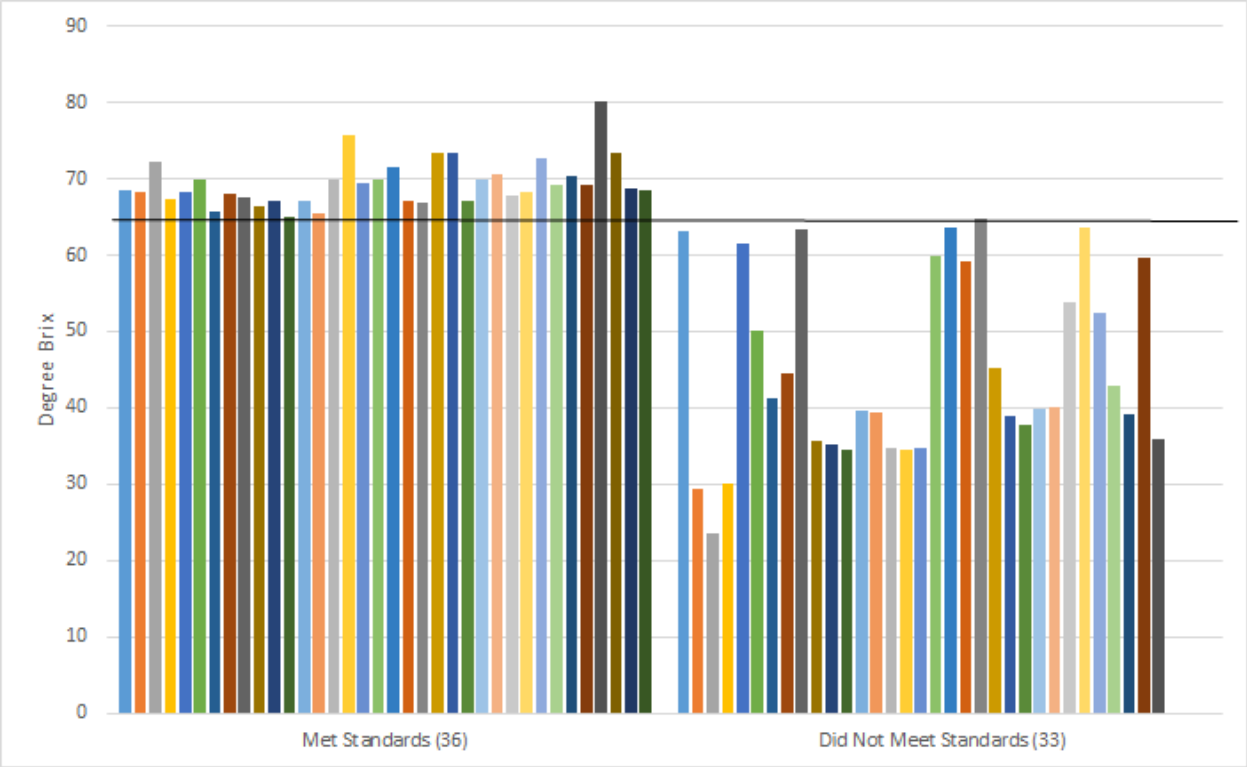


Figure 3: Degrees Brix Results for Jams and Jellies

G. Data Analysis: Comparative Standards

Jams and jellies for comparative standards were purchased from local grocery stores, including name brand and store brand varieties.

According to Figure 4a, all of the analyzed jams and jellies were below a pH of 4.2, so they all met the requirement. All of the pHs were around 3.00, except for sample 902C, which had a value of 2.42. Low pH helps prevent microbial growth.

Figure 4b shows the results of water activity analysis on the jams and jellies. Our specification requires that jams and jellies have a water activity of 0.8000 or lower, which also helps prevent microbial growth. Almost all of the standards for comparison had a water activity value of over 0.80 except for two of the samples (902B and 111). 902B had a water activity of 0.7473 and 111 had a value of 0.7927. Additionally, two samples, 902A and 637 were slightly above the 0.80 standard at values of 0.8045 and 0.8027, respectively. All samples were under a water activity value of 0.83.

Figure 4c shows the results of the average degrees Brix for all jams and jellies tested. The FDA, under 21 CFR 150.140 and 150.160 requires the degrees Brix content to be 65 degrees Brix or more. All samples tested were above this value, with an average of 66.3 degrees Brix, excluding the outlier value from 902B, which had a degrees Brix of 71.

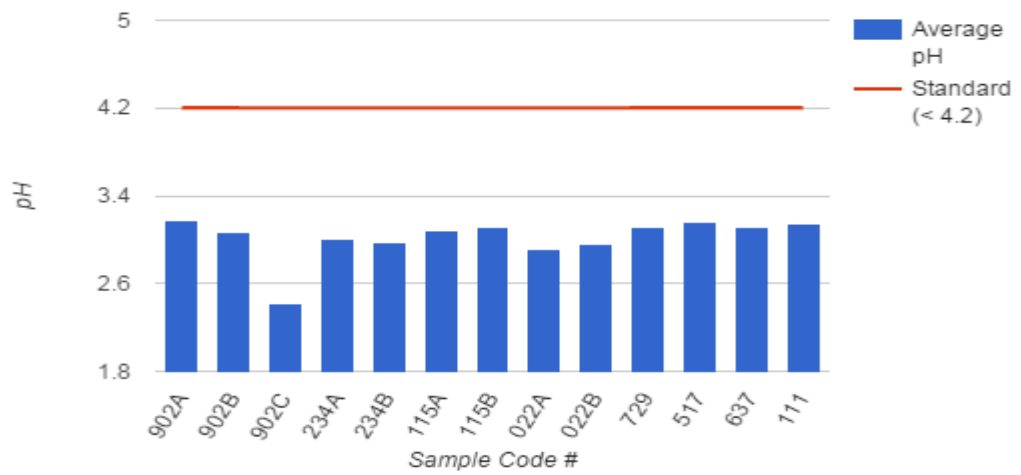


Figure 4a. Average pH for Standard Jams and Jellies

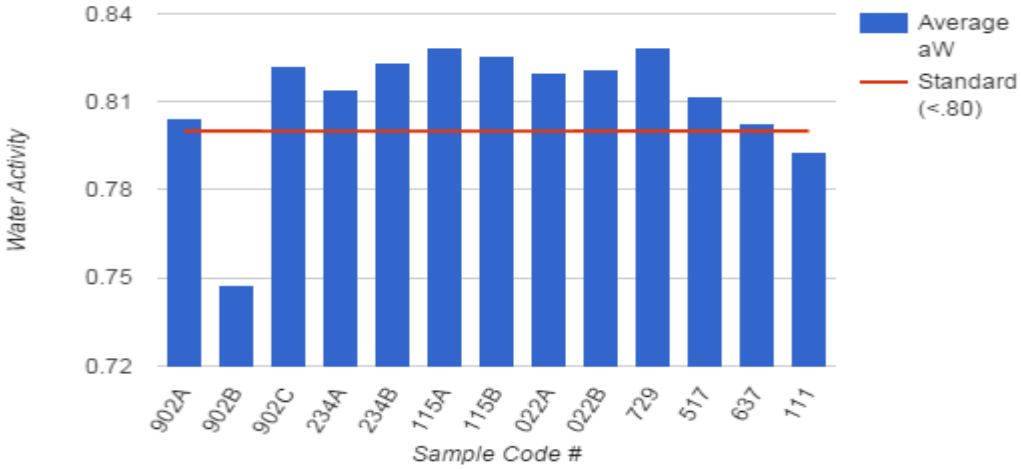


Figure 4b. Average Water Activity for Standard Jams and Jellies

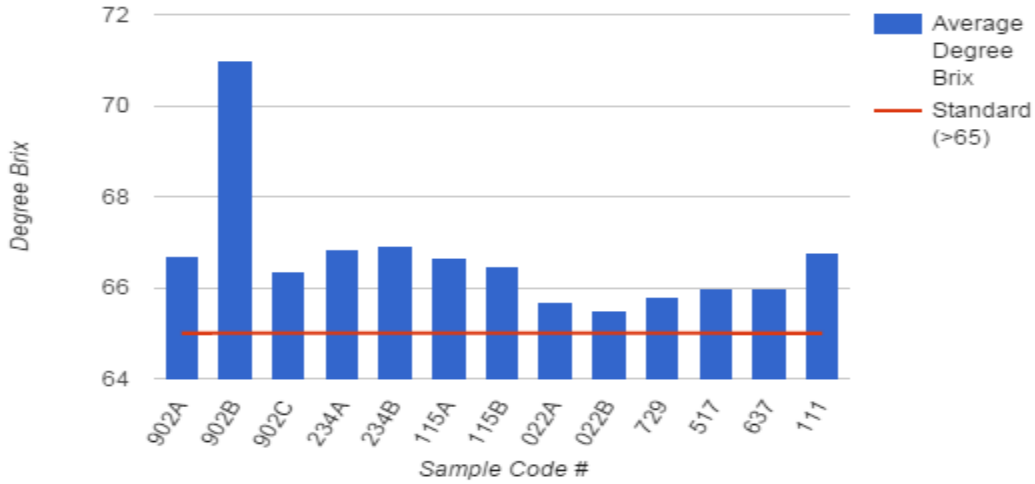


Figure 4c. Average Degrees Brix for Standard Jams and Jellies

H. Data Analysis: Standardized Recipe Results 2015 and 2016

The recipes collected from the jam and jelly donors which met all the tested criteria (pH, degrees Brix and water activity) were then analyzed for similarities in ingredients and procedures. Three jam recipes and three jelly recipes were selected in 2015 to replicate in order to find the best standardized recipe which consistently met all criteria. In 2016, three jam and three jelly recipes were also tested from new donors. Tests were duplicated in 2016. Overall in 2015, five of six recipes met all three criteria again (from donor's trial and the lab replication trial). Recipes for the 2016 trials were more variable, with only one jelly recipe met all three criteria for both duplications (747 a,b). Only one other 2016 jam recipe was close to passing twice (639 a,b), with 639a being 0.01 over the 0.80 specification limit for water activity.

All the pH for standardized jam and jellies recipes in 2015 were below 3.5 as shown below in figure 5a. Therefore, all the standardized recipes met the standards. Half the tested sample results were below pH 3.0 and the rest were below pH 3.5.

Figure 5b shows the degrees Brix of the standardized recipe in 2015. All but one of the sample (362) did meet the FDA recommended standard (65 degrees Brix). Sample 362 was found to be at 61 degrees Brix. The rest of the samples were 2 to 10 degrees more than the standards.

The water activity data for 2015 standardized recipes are presented in figure 5c. With the FDA water activity standards at 0.8000, all the samples met the standards except for sample 362 which had a water activity measured at slightly higher than the recommendation. The other samples had a water activity ranging from about 0.69 to 0.76 which are within the FDA required standards.

However, the 2016 standardized recipe results were significantly different than the 2015 standardized recipe results, except for the pH data. Similar to the 2015 pH data, in pH for standardized recipe results in 2016 all met the specification standard of having pH lower than 4.2. The samples tested had a range of pH 2.7 to pH 3.4 as shown in figure 5d.

Figure 5e represents the data collected for degrees Brix for standardized recipe results in 2016. The FDA standard is limited at 65 degrees Brix as mentioned previously. Seven out of twelve samples did not met the FDA standard. Sample 747a had a degrees Brix at about 74 which is the highest degrees Brix. Sample 563a have the lowest degrees Brix result, at about 61 degree Brix which is well below the FDA limit of 65 degrees Brix. This was surprising, as these were all commercial products, and are clearly mislabeled.

The water activity for standardized recipe results of 2016 are shown in figure 5f. All of the samples were above the water activity specification (Figure 5f).

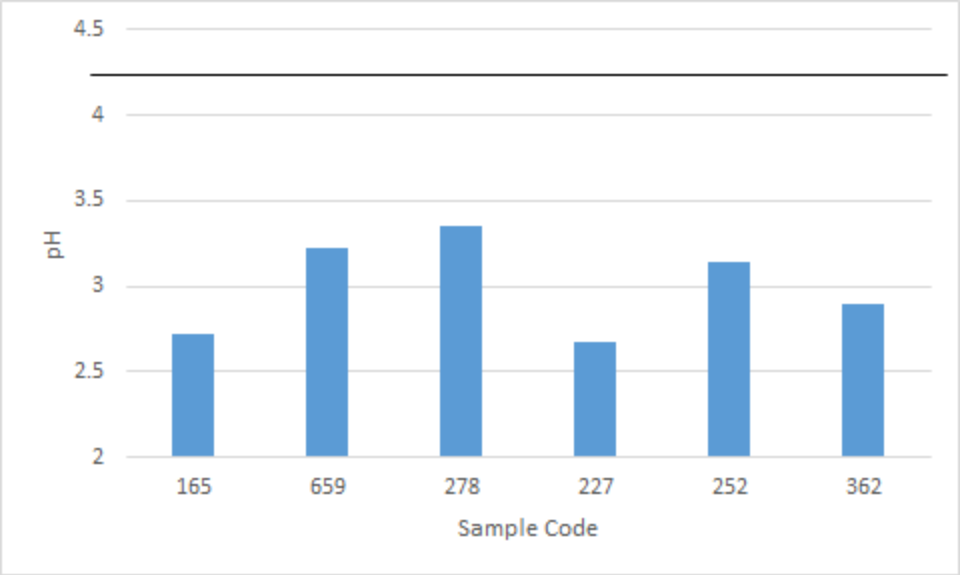


Figure 5a. pH for Standardized Recipe Results 2015

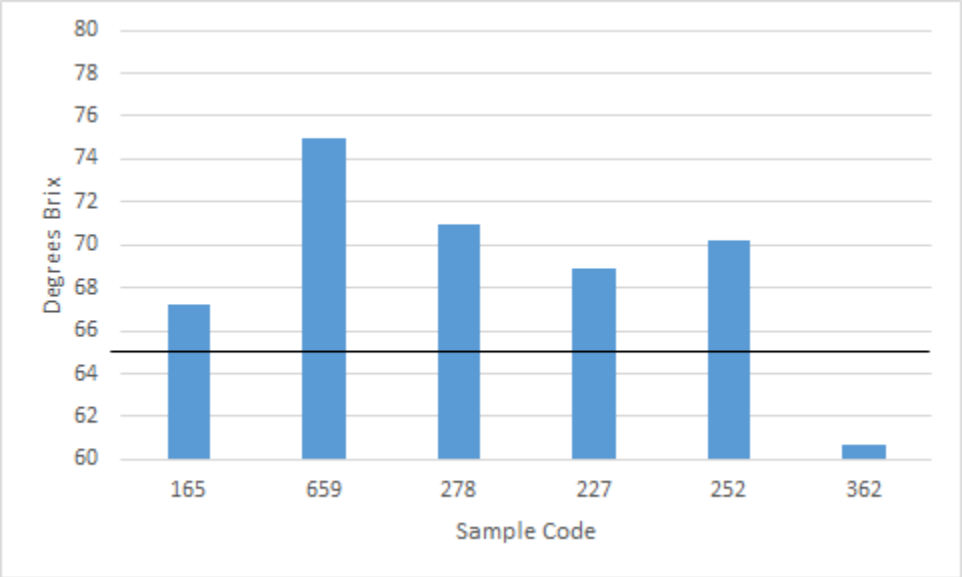


Figure 5b. Degrees Brix for Standardized Recipe Results 2015

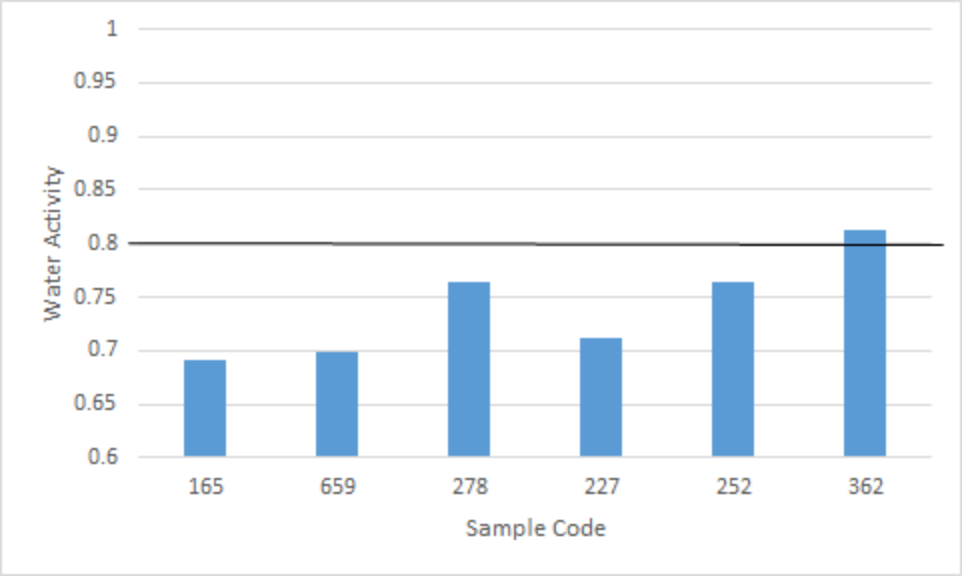


Figure 5c. Water Activity for Standardized Recipe Results 2015

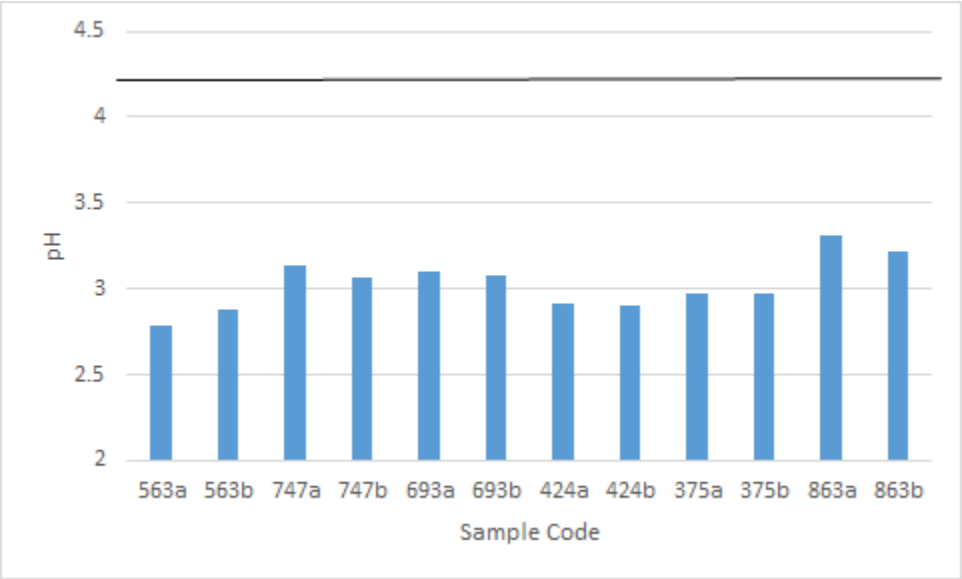


Figure 5d. pH for Standardized Recipe Results 2016

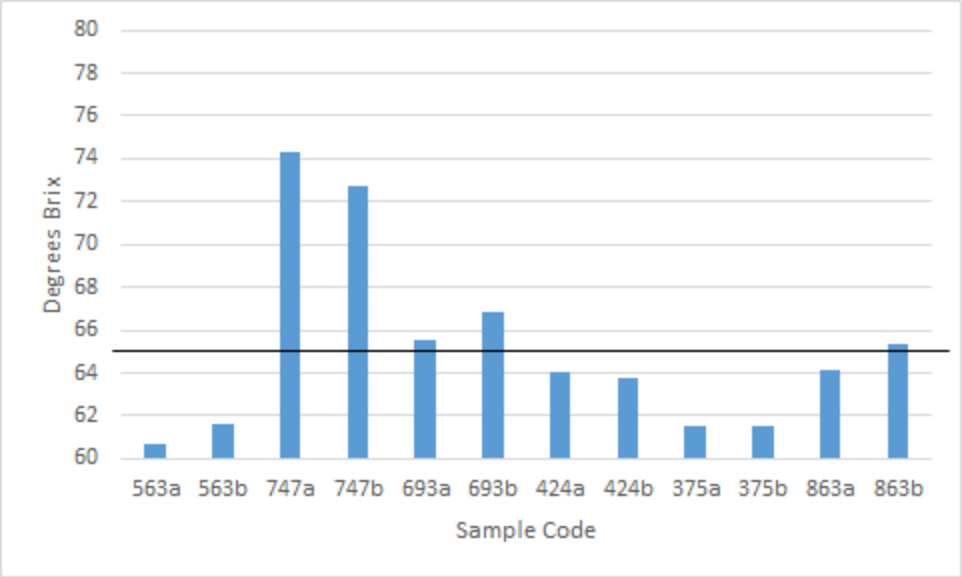


Figure 5e. Degrees Brix for Standardized Recipe Results 2016

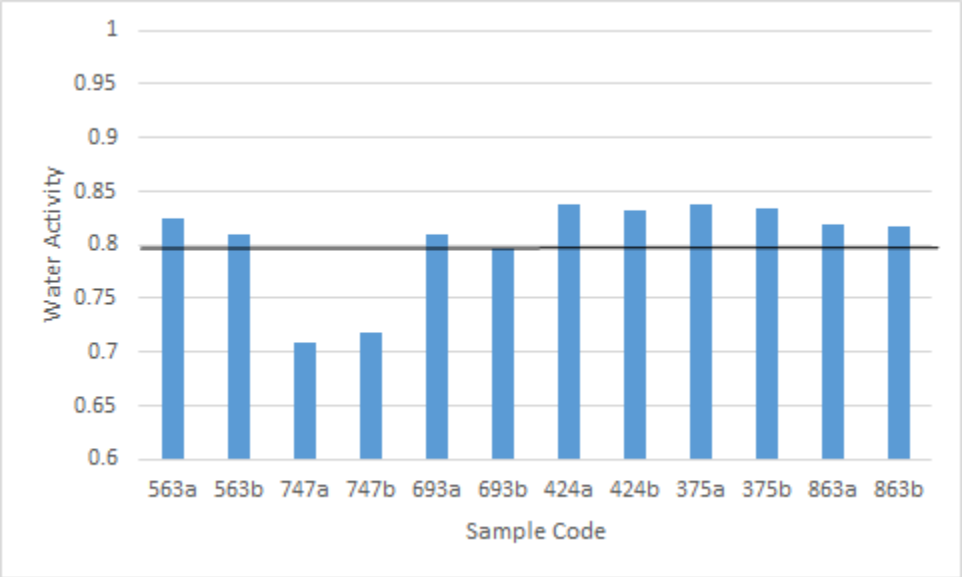


Figure 5f. Water Activity for Standardized Recipe Results 2016

I. Group Classification

In the final rule published in 39 FR 31304-31309, August 28, 1974, the standard of identity established that jam composed of Group I fruits would consist of not less than 47 parts by weight of the fruit ingredient to 55 parts by weight of the saccharine ingredient; in all other cases, jam would consist of 45 parts by weight of the fruit ingredient to 55 parts by weight of the saccharine ingredient. The soluble solids content of the finished jam in all cases was required to be not less than 65%. Below is a selection of jams that passed all of the above tests. The fruit/sugar ratio was calculated to see if it would fall into Group I or Group II. To be Group I, the fruit/sugar ratio must be higher than 47/55 or 0.855. Anything lower is Group II. Overall, all but one jam falls into Group II, so **the recommendation will be to put Aronia berries into Group II.**

Table 1. Aronia Jam Fruit to Sugar Ratio

Jam	% Sugar	% Fruit	Fruit/Sugar ratio	Degrees Brix
1	45.02	31.47	0.699	80.7
2	43	33.86	0.787	68.0
3	45.85	40.60	0.885	68.3
4	46.83	27.66	0.591	68.2
5	55.4	12.47	0.225	68.5
6	67.96	26.21	0.386	80.7

For the following information, the tests were run on the BERRIES used to make the jams or jellies provided by the donors, not the jams or jellies themselves. This is a continuation of the 2012-2014 study, *Determining the Optimum Harvest Time for Aronia Berries to Maximize Their Antioxidant and Sensory Properties,* to evaluate the optimum Aronia berry harvest time. Twenty Aronia berry samples were collected from jam and jelly donators. The data below demonstrates the influence of time (year and month0 on the composition of Aronia berries that would be used in jam and jelly manufacture.

J. pH of Berries

The pH of Aronia berries has also been monitored from 2012-2014, as mentioned above in the "Activities Performed." Figure 6 below shows the changes in pH of Aronia berries over the harvest season. Overall, the pH increased slightly over time. In 2012, the average pH was significantly higher than the two subsequent years. The pH range for the 2012 harvest year was from around 3.6 to 3.9. During 2013, pH dramatically increased during late August through early September. 2013 also contained the lowest recorded pH values. The pH range for that year was between 3.0 and 3.45. For 2014, a large decrease in pH occurred on August 19th. The pH had an increasing trend from August 1st to September 3rd. During 2014, there was an increase in precipitation during the end of August that could have caused this increase. The pH range was from 3.06 to 3.42. These differences between years were possibly due to varying environmental and weather conditions from year to year.

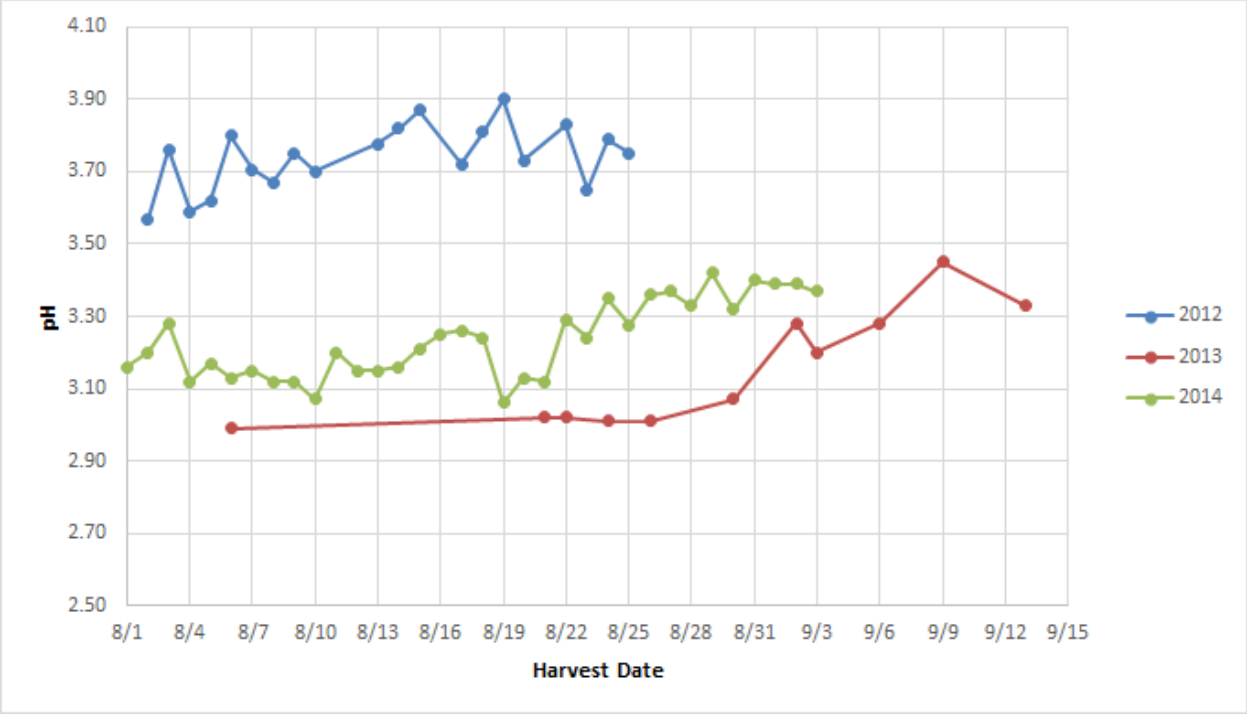


Figure 6: pH of Aronia Berries from 2012-2014

K. Titratable Acidity

Figure 7 shows the titratable acidity of the Aronia berry samples for each month. The primary acids in Aronia berries are tartaric, malic, and citric acid. The pH of the Aronia juice was measured using a pH meter probe (Fisher Scientific Accumet AR15), and was also used for conducting the titratable acidity test. The pH probe was first calibrated with pH 4.0 buffer and a pH 7.0 buffer. pH and titration to determine titratable acidity were performed in triplicates.

To set up the titration test, 10 mL of the Aronia juice were measured. The titration solution uses 1N NaOH diluted to a concentration of 0.2N NaOH. 50 mL were prepared per test and placed in a titration burette. The 10 mL of juice was placed in a beaker wide enough to allow the pH probe to rest in it while the test was performed. Since color change of the juice was not a good titration indicator, the NaOH solution was slowly added until a pH of 8.2 was achieved. The solution was manually stirred while the NaOH was added by constant flow until a pH 6.0. Then, the titration was continued by adding NaOH drop by drop until pH 8.2 was reached. The acids present in Aronia berries are weak acids, therefore the equivalence point can be presumed to be around a pH of 8.2. The starting and ending volume on the burette were recorded and volume added was calculated. The added volume of NaOH was used to determine the titratable acidity (TA) of the Aronia berry juice. The malic acid milliequivalent is equal to 0.067grams/milliequivalent.

$$Titratable\ Acidity = \left(\frac{Normality\ of\ NaOH \times Volume\ of\ NaOH}{Volume\ of\ Sample}\right) \times 100\ \times Malic\ Acid\ Milliequivalent$$

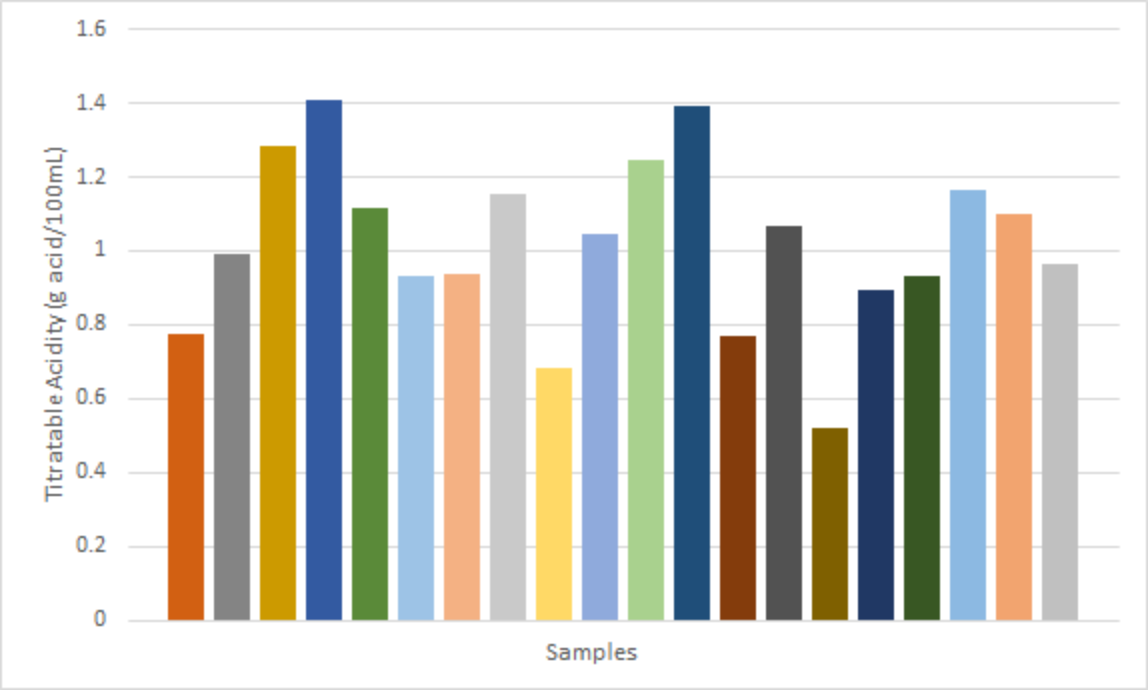


Figure 7: Titratable Acidity for Aronia Berries

L. Pectin Analysis

Pectin was analyzed as this influences gel formation, and the need for added pectin in jam and jelly manufacture. Figure 8a shows the change in pectin (on a wet and dry basis) over the month of August. In general, total pectin content decreases as harvest time goes on.

Figure 8b shows the late harvest total pectin content of the water basis and dry basis from 2012 to 2015. The total pectin content on a wet basis remained consistent at the same period of harvest time from 2012-2015. However, the total pectin content of the dry basis had a slight increase between 2013 and 2014. Pectin content is an important part of the consistency of a jam or jelly after it sets up, so it is critical to understand the pectin content of the fruit used in a jam or jelly.

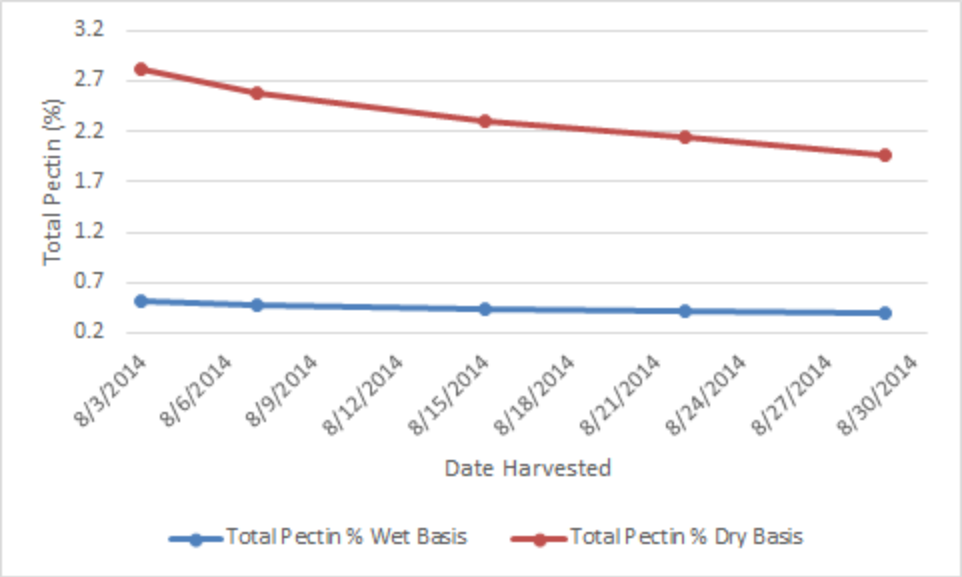


Figure 8a. Total Pectin Content of Aronia Berries Over Time

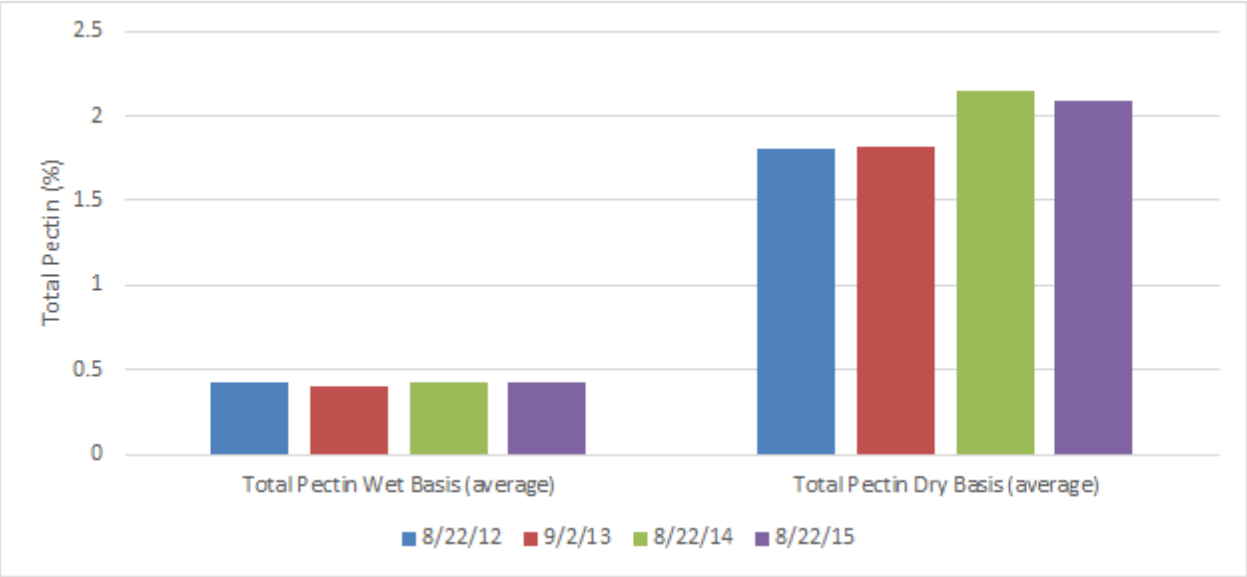


Figure 8b. Late-Harvest Total Pectin Content of Aronia Berries

M. Sugar/Acid Ratio

Sugar/Acid ratio (°Brix/ g/100 mL) as seen in Figure 9, was determined by taking the degrees Brix for the sample and dividing it by its Titratable Acidity percentage.

$$Sugar/Acid\ Ratio = \frac{Average\ Degrees\ Brix}{TA}$$

This shows the maturity of the fruit because the sugar/acid ratio increases as the fruit ripens. Higher values indicate a higher sugar content in the berry, whereas lower values show more acid is present, giving a tart flavor. Results analyze the berries harvested in the months of August 2015 to September 2016.

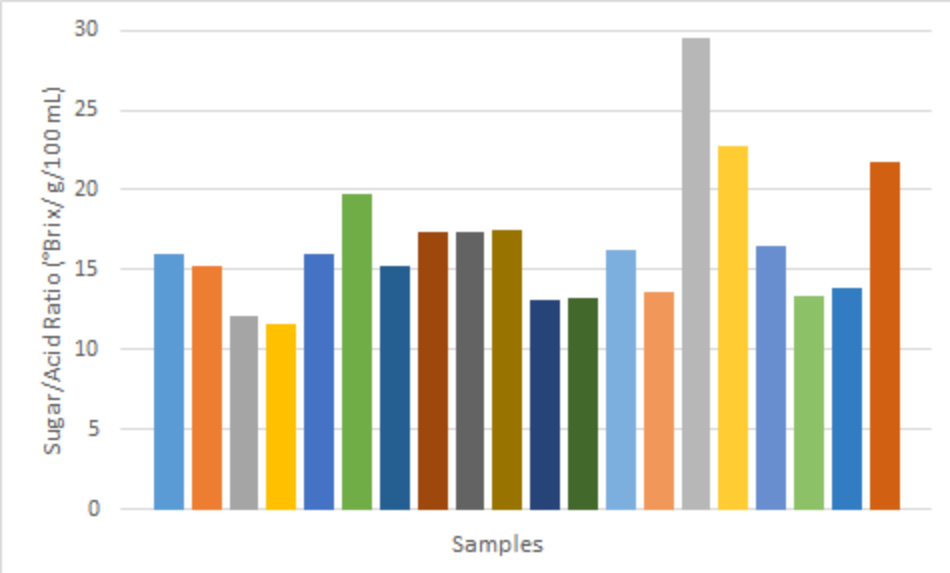


Figure 9: Sugar/Acid Ratio for Jams and Jellies

N. Trolox Equivalency (TE)

Trolox Equivalency per 100g Fresh Weight (TE/100g FW) is a measurement of the antioxidant activity as compared to Trolox (Figure 10). Trolox, an analog of Vitamin E, is a readily available antioxidant with easily replicable values and so has become the standard of comparison for the antioxidant activity of different varieties of food. Both the Aronia juice and Trolox solution were mixed with a prepared DPPH solution, DPPH being a ready to use, stable radical that is commercially available. DPPH assay tests are used to measure the radical inhibition capabilities of the Aronia berries by absorbance at 517nm. TE/100g FW can be calculated to compare antioxidant activities. The calculations are as follows:

1) After measuring absorbance values for the sample dilutions and the Trolox dilutions, find the percent inhibition.

$$\%\ Inhibition\ = \frac{Blank\ Absorbance - Dilution\ Absorbance}{Blank\ Absorbance} \times 100$$

2) Once the % Inhibition values are calculated, use Excel to create a graph and compute a line of best fit and use the linear equation (y= mx+b) to determine EC50 (g/mL) for both the Aronia Sample and the Trolox, using an XY Scatterplot with smooth lines and markers.

3) Next, convert EC50(g/mL) into EC50(g) for both the Sample and the Trolox. (Sample size = 0.05 mL).

EC50(g)=EC50(gmL)*sample size

4) Determine TE/100g FW

$$Trolox\ Equivalence\ (TE) = \frac{Trolox\ EC50\ (g)}{Sample\ EC50\ (g)} \times 100$$

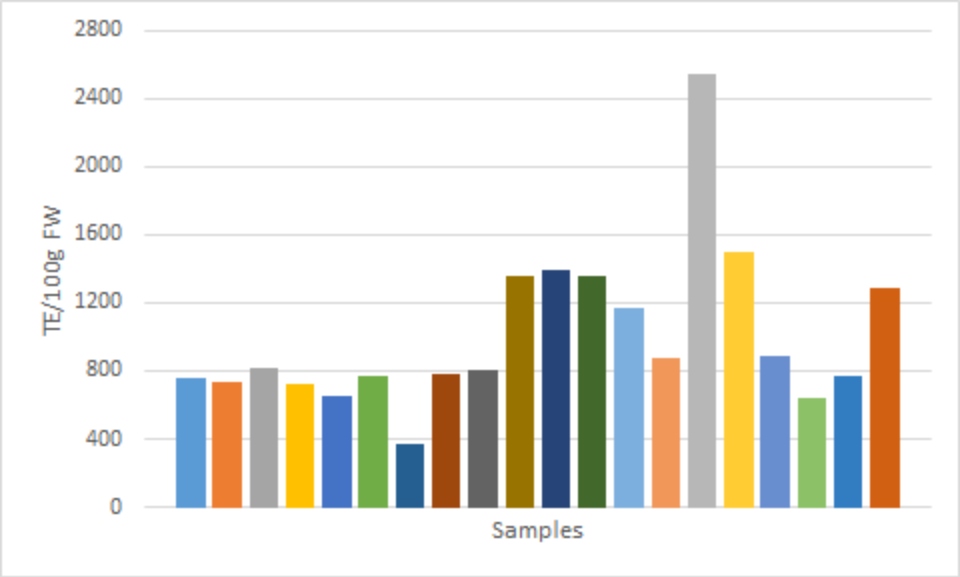


Figure 10: Trolox Equivalent (TE/100g FW) for Aronia Berries

O. Conclusions and Recommendations

All samples, except sample 436b and 278b, had a correlation between degrees Brix and water activity. If For sample 436b it loosely follows this correlation, as it has 65.5 degrees Brix, but had a water activity value of 0.8309. Sample 278b also generally followed this trend as it met criteria for pH (3.52) and degrees Brix (69.8), but was only marginally over but acceptable water activity, having an average of 0.8032. Deviation from the other results could be due to the recipe ratio of sugar to acid components and cooking time, which would allow more water to evaporate to reduce water activity.

For titratable acidity, all samples remained fairly constant around 1 g acid/100 mL of sample across month and year. For the sugar/acid ratio, it is the highest in September. This makes sense because the sugar content of the berries continues to increase through September, while the amount of acid stays the same, so one would see an increase in the sugar/acid ratio. Trolox equivalence saw a significant drop in 2014 from August to September which means that the berries were not as high in antioxidants in September compared to August. The antioxidant levels were overall lower in 2015. Overall, samples from the September 2015 harvest would be convenient in comparing how titratable acidity, sugar/acid ratio, and Trolox equivalence changed throughout the entire 2015 harvest season.

The overall results of this study show that acceptable and legal Aronia jams and jellies can be made by farmers, consumers, and food companies. They must use the appropriate formulation in order to produce a legal (Standard of Identity) product and have a legal label on their products. This will allow the producers to produce jams and jellies for sale at Farmer's Markets without having them being removed by federal and state inspectors. Aronia falls into Group ll fruit in the Standard of Identity.

It is also of concern that several commercial jams and jellies found in grocery stores did not meet the Standard of Identity for Jams and Jellies.

Lessons Learned:

Problems and Delays

As participation was voluntary, receiving jams and jellies was a staggered process. Other delays were experienced when participants did not send all three required components (recipe, Aronia berry sample and jam/jelly). Letters were sent to those who need to complete the requirement as a reminder. Also, due to the flooding in north- northeast Iowa, Aronia harvest in Fall 2016 was delayed and jams and jellies that would have been received from the area were not able to be processed. This resulted in fewer 2016 samples received2015 harvest samples were accepted until September 30th, 2016.

Future Project Plans

This was the final year of the project. The findings of this study will be submitted to the FDA in order to establish modify the current Standard of Identity or develop a Standard of Identity of Aronia berry jams and jellies. To do this, we or the Midwest Aronia Association will submit a citizens petition to the FDA (21 CFR §10.30). We will also submit these results to the Iowa Department of Inspection and Appeals as they expressed interest in the project and requested our results. The results of this project will be presented at the 2017 Midwest Aronia Association meeting in march 2017, at the NC-1023 (USDA Engineering Food Safety and Quality) meeting in 2017, 2017 IFT meeting, and published in Extension and peer-reviewed publications.

Beneficiaries:

This will benefit farmers and others who wish to manufacture and sell legal Aronia berry jams and jellies. Also stopping their products to be removed from the market place by inspectors. Beneficiaries include the Midwest Aronia Association, Food companies that make jams and jellies, consumers, and Aronia berry farmers.

Contact Person:

Dr. Lester Wilson

Number: 515-294-3889

Email: lawilson@iastate.edu

Additional Information: Example Aronia jam and jelly recipes that meet federal standards.

Aronia Jelly Recipe

Makes 8, ½ pints

Ingredient	**Grams**	**English**
Aronia berry juice	571	3 1/2 cups
fresh lemon juice	91.5	1/2 cup
pectin	50	1 package
sugar	1200	6 cups

Directions:

Wash fruit and cover with water, simmer 15 minutes. Strain the juice. Pour measured amount into a 6-8 quart non-reactive kettle such as enamel or stainless steel. Add lemon juice, pectin, stir. Bring to a boil, add sugar, stir, and bring to a full rolling boil. Boil exactly two minutes. Skim and pour into clean, hot jars. Seal. Process in boiling water bath 10 minutes. Remove and cool. After jars cool, check seals.

Aronia Jelly Recipe

Makes: 5, ½ pints

Ingredients:	**Grams**	**English**
Aronia berry juice	652	4 cups juice
Sure jell pectin	50	1 package
Sugar	900	4.5 cups of sugar

Directions:

Stem and crush fruit thoroughly using juicer. Measure fruit juice into a 6- or 8-qt saucepot. Stir pectin into prepared fruit in saucepot. Bring mixture to full rolling boil, stirring constantly. Stir in sugar. Return to a full rolling boil and boil exactly 2 minute stirring constantly. Remove from heat. Skim off any foam with a spoon. Ladle immediately into prepared jars filling within 1/4 inch of tops. Wipe jar rims and threads. Cover with two piece lids. Screw bands tightly. Process in boiling water bath 10 minutes. Remove and cool. After jars cool, check seals.

Aronia Jam Recipe
Makes 5, 1/2 pints
Ingredients:

Ingredients	Grams	English
Ground Aronia berries	540 g (whole)	4 cups
Water	118.5	1/2 cup
Sure Jell Pectin	50	1 package
Sugar	600	3 cups

Directions: Grind whole Aronia berries in food processor (about 20 pulses). Bring ground Aronia berries and water to simmer over low heat and cook, covered, for 5 minutes. Add Sure Jell and stir. Cook for 1 minute. Add sugar and stir. Bring to a rolling boil and boil, uncovered, for 1 minute, stirring constantly. Put in sterilized jars and seal with sterilized lids. Process for 10 minutes. Remove and cool. After jars cool, check seals.

Aronia Berry Jam
Makes: 9, ½ pints
Ingredients:

Ingredients	Grams	English
Water	559.32	2 ¼ cups + 1 ½ T
Berries - thawed	978.75	7 ¼ cups
concentrated lemon juice	122	1/2 cup + 2 T
Sure Jell Pectin	50	6 T
Sugar	1400	7 cups

Directions: Cook berries and water, bring to boil and simmer 15 minutes. Crush berries with potato masher or mason jar. Pour 4 cups of crushed berries and juice into pot. Bring to a simmer, then add lemon juice and pectin. Stir well until dissolved. Bring to boil, add sugar, stir to dissolve. Bring rolling boil for 2 minutes. Skim off foam, pour into jars. Process for 10 minutes. Remove and cool. After jars cool, check seals.

Final Report - Lutheran Services in Iowa (LSI)
Investing in Refugee Specialty Crop Producers

Project Summary:

Iowa communities have a wealth of skills and knowledge available to them through individuals who have moved to Iowa from farming backgrounds in their home countries. They are eager to use their skills in farming and contribute in their new communities. With training and support they can help to increase the consumption of specialty crops within their own families, ethnic groups and the geographic regions in which they reside.

Many of the most recent arriving refugee groups in Des Moines come from agricultural backgrounds. Farming, both for home consumption and for profit, has been for many, a way of life. Several refugee groups have expressed a deep desire to return to the land in order to provide food for themselves, maintain their culture, and create new forms of income. However, they are faced with an inability to access land and training resources due to the language and cultural barriers as well as a lack of resources.

Over the last four years, LSI has worked with a wide array of community partners, volunteers, and individuals from the refugee community to make that desire a reality. In 2011, LSI executed a planning grant through the Leopold Center entitled "Iowa Immigrant and Refugee Incubator Program." The planning effort focused on creating a model for training refugee and immigrant growers to utilize their existing farming experience to establish successful small farm businesses in the Des Moines area. In order to create that model and plan, LSI and the involved planning team visited and learned best practices from existing training farm models across the country. The full results of that planning effort can be found at http://www.leopold.iastate.edu/grants/m2011-13. From this planning process LSI identified some key phases of the model. Phase 1 connects refugee gardeners to small community garden plots near their homes and neighborhoods. Phase 2 creates a training farm that can provide larger plots of land and the intensive support and training needed to assist growers in developing viable small-market businesses over a three to five year period. Phase 3 transitions growers off of the training farm and onto their own land in order to operate their own independent farming businesses.

The 2012 Iowa Specialty Crop Block Grant Program supported LSI's proposed project entitled, "Increasing Fruit and Vegetable Production by Refugee Groups through Land Access and Grower Education." This project primarily focused on Phase 1 of the model mentioned above. As a result of the project the City of Des Moines' garden contract was translated into Kirundi, Karen, Burmese, and Nepali and is being used to continue to help interested gardeners connect to community garden plots. Additionally, a new community garden was established on the SE side of Des Moines where there were many families on the waiting list. A total of 160 families were connected to food gardens as a result of the project. LSI was also able to identify, as a result of the project, a site for the incubator training farm described in Phase 2 above. That site has been developed into Global Greens Farm and includes water access, a supply of shared-use tools, a wash station and cooled storage areas for harvested produce. It serves as the training and business development site described in Phase 2. Finally, twenty-one growers began growing at Global Greens Farm on 50'x50' plots and participated in a series of trainings. One hundred percent (100%) of these growers stated that they had learned and

increased knowledge about growing food in Iowa. They also stated that they wanted even more extensive trainings on a variety of production topics.

The 2013 Iowa Specialty Crop Block Grant Program supported LSI's project titled, "Increasing Iowa Specialty Crop Production and Consumption through Empowerment of Refugee Producers." The primary objective of this project was to provide an initial year of intensive training and support for the 8 market farmers that had been accepted into Phase 2 of the program. During the project period, LSI provided trainings in Seeds and Seed Saving Techniques, Production Basics, Record Keeping and Finances, Seedlings and Crop Planning, and Soil Science and Fertility. Staff also worked with growers to order seeds, start seedlings and begin planting in April. Additionally, LSI secured a 3-year commitment from Valley Church to utilize not only the 1.5 acres that was used the previous year, but an additional 2 acres of land where the 8 Advanced Market Farmers in Phase 2 were trained on ¼ acre plots. The project established yield and market sale benchmarks in order for each grower and LSI to measure subsequent years' progress.

The current project completed over the course of 2014 – 2015 built upon the previous years by developing and implementing a second level of training and technical assistance for the 8 Advanced Market Farmers (AMF) engaged in Phase 2 at Global Greens Farm. The objective of this project was to help these farmers develop further in their production and marketing practices and show growth and improvement in their yields, market sales, and business skills. As the farmers' skills adapted and grew through training and support, the quality and quantity of specialty crops available to local markets, communities, and families increased as well. Additionally, less-common specialty crops became more readily available.

Project Approach:

Several methods were implemented to achieve these objectives. First, drawing from farmer responses surveyed at the end of April, 2014, LSI established a series of workshop topics and farm visits throughout the project period that provided greater detail on various aspects of market farming. These were originally laid out in the project proposal work plan. These trainings were open to both Advanced and Beginning Market Farmers (BMF). Much of the off season training focused on record keeping, business development and crop and market planning in support of increased income by farmers (Objective 2), while the summer trainings focused on production, in support of increased production specialty crops (Objective 1). Classroom trainings averaged 30 farmers in attendance. Training topics included:

- AMF crop and market evaluation and planning, both individual and group sessions (November-December)
- New Season Orientation and Contract Renewal (January)
- Seed Orders & Seed Saving with Crop Planning (January)
- Practical Farmers of Iowa Annual Conference (January)
- Business Planning (January)
- Understanding Your Place in the Local Food System (February)
- Record Keeping for Taxes (February)
- Individualized Business Planning with PFI mentors (February-March)

- Marketing (March)
- Earthway seeder operation (April)
- Irrigation & Drip Tape (April)
- WIC and Senior Market Voucher Program (May)
- BCS safety training and beginning use (June)
- Soil improvements for uncultivated land (June)
- Summer transplanting for Fall vegetables (July)
- Weed fabric for winter squash production (July)
- Vegetable Quality and Professional Responsibility with customers (August)
- Garlic planting (August)
- John Deere tractor usage and beginning use (June-September)

Farmers also attended three Practical Farmers of Iowa (PFI) Field Day events including education on soil fertility, worm composting, fall crops, season extension and visiting a variety of farms on the Annual Farm Crawl in southern Iowa. All 7 AMFs currently enrolled in the PFI Savings Incentive Program visited their mentor's farm at least once this season. Many of the mentors visited the AMF's farms at Global Greens Farm as well.

In order to increase overall farmer production during the growing season the Farm Associate (FA) and Farm Marketing Specialist (FMS) were on-site at Global Greens Farm for at least 2 ½ days each week to focus on individualized training, trouble-shooting and technical assistance to growers with their specialty crops. The FA spent time working on pest and disease control, harvest techniques and soil improvements with farmers. During the spring (before market began in late May) staff worked with farmers every Saturday to prep the farm and provide education on transplants, irrigation, fencing and other issues. Fridays were busy harvest days. Therefore the FA spent most Fridays at the farm providing technical assistance to farmers.

Another large contributor to farmers increase in productivity can be attributed to a BCS walk-behind tractor with flail mower and rototiller and a utility tractor that were acquired by the program. This equipment allowed farmers to eliminate finished crops, till, and replant quickly. Plowing a 4'x200' bed with the mattock hoe took each farmer approximately 4 hours to complete. The tractor allowed them to complete the same task in one or two passes in about 5 minutes. Additionally 3 of the 8 farmers decreased the size of their walkway paths which increased their number of beds.

In order to increase income through market development and training, staff worked both in the field and in the office to help develop farmers' skills and comfort levels with the variety of markets available. The FA worked with farmers to fill orders every Thursday for the new Local Food Box Project, as well as, other wholesale orders throughout the season. The FMS spent time working with farmers on posting available produce to the Iowa Food Coop which included field walks to review varieties and predictions of when produce would be ready for harvest. The FMS also assisted farmers in

understanding orders, proper packaging and delivery for this market. The FMS met with farmers in the office on a monthly basis to review record-keeping logs and continue working on goals towards the creation of a business plan.

The LSI Global Greens Farmers Market was also a focus of this project. The market ran from 9:30 am – 2:30 pm on Saturdays, starting on May 23 through October 10, and grew from an average of 125 customers each week in 2014 to 200 customers weekly in 2015. Staff secured a SNAP machine vendor for wireless transactions and completed training with all growers to accept WIC and Senior Market vouchers. A few of the farmers were trained on using the SNAP machine independently. Staff found these programs (SNAP, WIC and Senior Market Vouchers) to be essential forms of payment as they comprised 40% of the farmers' total income in 2015. To better familiarize those unaccustomed to cooking with certain produce, such as red shell beans, isogo and lenga lenga, staff worked with farmers to develop a bank of recipes to distribute to customers that utilized these crops. A few farmers also volunteered to perform on-site cooking demonstrations to allow customers to try new foods.

The overall scope of this project focused solely on the enhancement and competitiveness of specialty crops as Global Greens farmers do not grow any non-specialty crops on their land. Project outcomes and key project partners are included below:

Lutheran Services in Iowa - Global Greens QUANTITATIVE OUTCOMES

Number of participants	33 AMF & BMF
Number of gardens/farm plots	28
Number of garden/farm sites	2
Average plot garden/farm plot sizes	18 -50'x50' plots
	10- 100'x 100' plots
Primary purpose of growing	
Home use only	0
Some market sales	18
Incubator farm	10
Independent farmer	0
Number of participants in classroom/field training classes	33
Number of sales venues	
Farmers markets	3
Farm stands	2
CSAs	1
Grocery stores	2 (online food cooperative)
Restaurants	2
Total dollar sales: AMF ONLY	**$40,915**
Total donated produce: AMF & BMF	$1950 (1300 lbs. * $1.50/lb.)
Total estimated home consumption: AMF	$3,755
Dollar sales from SNAP/WIC/Senior Market Vouchers: AMF & BMF combined	$5,297

Program Partners:

Valley Church – Provides incubator farm land and barn

Plymouth Church – Local church that has a farmer micro-loan program and after service farm-stand/market

Eat Greater Des Moines – An organizational hub for local food activities in Central Iowa offering promotion and resource support.

Practical Farmers of Iowa (PFI) – PFI is a farm-membership organization that provides networking, research, and support to sustainable farmers across Iowa. They also support beginning farmers through a matched savings and mentorship program called Savings Incentive Program (SIP) and offer field days throughout the season to share information amongst farmers. Growers in LSI's program attended their annual conference and participated in field days. All 8 AMF participants in LSI's program are enrolled in PFI's Savings Incentive Program (SIP). LSI and PFI are working together with the hope that after farmers have incubated their business and graduate off of Global Greens Farm that they will have a PFI mentor and be able to independently operate their business and call upon the resources of PFI as they continue to grow and develop.

Wabi Sabi Farm – Local organic CSA farm that has assisted LSI with seed ordering and greenhouse space.

Iowa Food Cooperative (IFC) – IFC is an on-line farmers market that not only provides a consistent market outlet for farmers, but has partnered with LSI on events and promotion of the Global Greens farmers market by telling the program's story to their customers. The IFC has many connections in local food and farming in the Des Moines and surrounding areas which they are free to share in order to advocate for farmers' success.

Leopold Center for Sustainable Agriculture – In addition to providing funding for the program, Leopold has also provided technical support and consulting for program development in the areas of learning objectives and farmer assessments.

Goals and Outcomes Achieved:

LSI's goal for this project was to increase the amount of specialty crops available to the general public and to lower-income children and families through tracking production and sales of Global Greens farmers. This was to be shown through 80% of farmers showing an increase in pounds of produce harvested as well as 80% of farmers showing an increase in income through sales, including acceptance of SNAP, WIC and Senior Farmers Market voucher programs.

Performance Measure #1: It was originally proposed that the amount of produce grown by each farmer would be measured through harvest records maintained by each farmer. It was projected that 80% of farmers would show an increase in production amounts. This method proved difficult for farmers, in addition to the business of general farm work and other record keeping requirements. However, pounds of produce was recorded by the program in a few areas. From 2014 to 2015 LSI found a 66% increase in the number of pounds brought to the LSI farmers market. Additionally, wholesale production increased from 338 lbs. in 2014 to 1,396 lbs. in 2015. These numbers are only reflective of what staff was able to record on their own and does not reflect the full amount going to markets, home sales and home consumption. LSI is assessing better ways to track production amounts but this will ultimately need to come from the farmers. However, in viewing the substantial increase of income by farmers, LSI is confident that production rates have significantly increased.

Performance Measure #2: LSI proposed that the amount of produce sold at local markets to the general public as well as recipients of SNAP, WIC and Senior Market vouchers would be collected through monthly meetings with the growers with 80% of participants showing an increase in sales. One farmer that participated in 2014 did not continue in the program and was replaced by one new farmer in 2015. Of the 7 farmers that grew in both 2014 and 2015, 88% (6 of the 7 farmers) showed an increase in income. Overall, these increases were very significant with an average increase of 157%. One farmer increased sales from $1,966 in 2014 to $7,271 in 2015; a 270% increase! The farmer that did not show an increase in income was due to her participation in an extra market at a local church in 2014. The income earned from this

market in 2015 decreased by $1,595. Staff speculate that the novelty of her booth at the church possibly decreased and this type of market may be a better one year fit rather than two.

A summary of income, participation and what LSI staff learned this year about each of the major markets for Global Greens farmers is included below. The numbers include reported income for the eight AMFs, though many Beginning Market Farmers (BMFs) also participated in the LSI Farmers' Market and home sales, and a small number of BMFs sold through our wholesale markets. Overall, sales for the AMFs grew from $22,586 in 2014 to $40,916 in 2015; an 81% increase. This growth included the addition of the Local Food Box and Downtown Farmers' Market as well as increased sales through the Iowa Food Cooperative (increased from $3,459 to $10,145), at the LSI Farmers' Market (increased from $8,381 to $14,308), and through home sales (increased from $1,590 to $3,755).

2014 Income Chart: **Total Income = $22,586**

Cash Flow Actuals	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Income													
Valley Farm Stand	-	-	-	-	-	480.00	622.00	761.00	490.00	100.00	-	-	2,453.00
Home sales	-	-	-	-	100.00	320.00	200.00	580.00	389.50	-	-	-	1,589.50
Farmer Market	-	-	-	-	-	1,059.10	1,328.00	1,344.00	844.00	867.00	243.00	-	5,685.10
WholeSale	-	-	-	-	-	102.00	174.00	364.00	264.50	-	38.50	-	943.00
Iowa Food Coop	-	-	-	-	-	-	731.86	872.31	1,109.84	513.00	232.06	-	3,459.07
LSI market	-	-	-	-	-	1,384.00	2,021.00	3,214.00	1,632.16	130.00	-	-	8,381.16
Misc	-	-	-	-	-	-	-	10.00	1.70	33.00	-	-	44.70
	-	-	-	-	-	-	-	-	30.00	-	-	-	30.00
Total Cash Inflows	0	0	0	0	100	3345.1	5076.86	7145.31	4761.7	1642.995	513.56	0	22585.525

2015 Income Chart: **Total Income = $40,916**

Cash Flow Actuals	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Income													
Valley Farm Stand	-	-	-	-	280.00	1,224.00	712.00	347.00	134.00	170.00	-	-	2,867.00
Home sales	-	-	-	-	-	479.00	1,174.00	847.00	430.00	825.00	-	-	3,755.00
Farmer Market	-	-	-	-	628.00	980.00	1,387.00	1,483.00	1,510.00	414.00	-	-	6,402.00
WholeSale	-	-	-	-	24.00	378.75	1,000.00	1,258.00	777.50	-	-	-	3,438.25
Iowa Food Coop	-	-	-	-	368.00	1,994.75	3,550.75	1,597.75	1,293.75	895.00	445.25	-	10,145.25
LSI market	-	-	-	-	464.00	3,384.00	3,223.00	3,556.00	3,191.00	490.00	-	-	14,308.00
Misc	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Cash Inflows	0	0	0	0	1764	8440.5	11046.75	9088.75	7336.25	2794	445.25	0	40915.5

Beneficiaries:

The specialty crop beneficiaries of the project were the 8 AMF's growers who participate in the production and marketing trainings. The trainings and support allowed these 8 growers to expand their skills and knowledge in order to be more competitive in producing and marketing specialty crops. The project also benefitted the 18 BMF's who participated in some of the trainings and made sales at markets. LSI often considers there to be about 33 participants in the program because often the farming operations are not just one family member but spouses or adult children attending trainings as well. The economic impacts for these growers have already been quantified above.

Additional beneficiaries of the project were the families and communities of the growers who benefited from the food that was produced for their family's consumption or given to the refugee community as a donation. Between AMF and BMF farmers an estimated $14,000 was taken home and consumed by the growers' families while an estimated $1,950 was donated. Most of the donations from the farm went directly to the refugee community through the LSI community center. Lower-income families and children were benefited through increased access to fresh, culturally appropriate produce through the use of SNAP, WIC and Senior Market voucher users. Farmers sold a total of $5,297 worth of produce through the use of these benefit programs.

LSI has observed that other groups of people who were specialty crop beneficiaries are the congregants of Valley Church, Plymouth Church, LSI market attendees (an average of 200 customers per week), Iowa Food Coop members, Downtown Market customers, the 40 Local Food Box participants and attendees at the Multicultural Market.

Lessons Learned:

Many lessons were learned from this second year of operating the incubator training:

- Experienced-based training, especially with non-English speaking farmers, is always the best method. This is difficult at times when the most time for training comes during the winter season. It is best to review and expand upon concepts such as marketing platforms or systems, farmers have already experienced in the classroom setting while new concepts are hard to introduce without an experiential component. In-field training and simply working along side farmers is often the best time to trouble shoot and teach. Additionally, some trainings like crop rotation and soil improvement and valuable but hard to teach and implement when farmers are still at such a small scale. Staff also try hard to focus on letting farmers learn through experience when it comes to customer satisfaction. Instead of saying something is not high enough quality; staff may ask what the customer might think of it. While at times staff give their opinion on a product there is also value in letting the customer's reaction be the teacher.
- Staff have spent more time with farmers working on business planning and record keeping and have worked to find the right tools that work well for farmers. Each farmer has developed a different way of tracking income, expenses, mileage etc. and is not necessarily using LSI forms that were developed. Staff feels like it was a good starting point but with experience each individual defines what works best for them. Most farmers have not relied as heavily on written form of records which has formed an impressive level of being able to keep track of things in their head. Training surrounding record keeping and setting longer term goals with action steps in business planning have helped them to get their ideas down on paper with more detail and flesh out their action steps more fully. It feels as though it is a good mix of using pre-existing intuitive skills with helpful methods for keeping data that will be helpful in the long run.
- Staff has originally hoped to have farmers attend a Good Agricultural Practices (GAP) training and while there was a session offered in the fall of 2015 staff felt that since the training would be in English only with no time for interpretation it would not be beneficially for most of the farmers. Even for those farmers who speak more English having a specialized class with time for extra questions is necessary. LSI is working on the possibility of having a GAP training specifically for LSI farmers which would allow for interpretation and/or having a staff member certified to teach this training in the future.
- LSI also examined each market outlet for pros and cons affecting both the LSI program and farmers ability to move forward in each market as seen in the chart below. LSI is continually examining the effectiveness and efficiency of each market and whether or not new market outlets should be added.

Market	Number of Farmers	What We Learned
LSI Farmers' Market	8	• Low-risk, low-cost incubator market • Good place to practice/develop English and marketing skills • Familiar type of market • Important place for farmers to provide their communities access to culturally preferable, healthy food
Downtown Farmers' Market	8	• Familiar type of market • Very large market (average attendance is 20,000) with potential for many new customers and high sales • Low-risk way for farmers to consider pursuing this independently in the future
Valley Church Farm Stand	5	• Important for relationship with key partner • Farmers enjoy interacting with church members at this market • Good source of income for some farmers • Graduate farmers will not continue at this market
Plymouth Church Farm Stand	1	• Significant source of income for one farmer • Important for building relationships with customers and partnership with church • Two-year market only – farmer will need to replace this large piece of income with other markets
Local Food Box	5	• Good market for developing wholesale skills • Good source of income for farmers who have enough volume • Many farmers do not have enough volume of individual crops to participate regularly in wholesale markets
Other Wholesale	6	• Did not focus a great deal on these markets this season • Supported one farmer in developing more independent relationship with restaurant • Farmers will need more support in order to establish and maintain independent wholesale markets
Iowa Food Coop	8	• Customers are committed to local food and willing to pay high retail prices • Coop staff and members are very supportive of Global Greens • Good market for developing harvest and packaging skills • High risk market – required to forecast what will be available up to two weeks in advance • Complicated computer system – independent management will require strong English skills and advanced computer skills
Home Sales	4	• Familiar type of market • Significant source of income for some farmers • Important way for farmers to provide their communities with access to culturally preferable, healthy food • Currently an independent market for farmers

Contact Person:

- Name the Contact Person for the Project - Nicholas Wuertz, Director of Refugee Community Services
  - Telephone Number - 515.271.7443
  - Email Address – nicholas.wuertz@lsiowa.org

Additional Information:

- LSI hosted a number of farm tours for various groups and funders, including the United Way, John Deere and attendees of the EMPOWER luncheon, LSI's annual fundraiser. At the luncheon one farmer from Global Greens was highlighted, telling her story in a video found at: https://www.youtube.com/watch?v=QFcqUTabF5A
- This year staff created and published "The Dirt" a weekly e-newsletter to share photos, program highlights, upcoming events, a list of produce available at our market, and a recipe. Issues are archived at: http://us2.campaign-archive1.com/home/?u=1bbadc0e0368b62446fe979dd&id=e048251486
- In September, Urban Ambassadors honored LSI's Global Greens as Partner of the Year. Urban Ambassadors is a volunteer-led, community driven nonprofit whose mission is to "plant the seeds of sustainability for a greener greater Des Moines", and the award highlights an organization that shows strong support for community building sustainability projects. http://www.urbanambassadors.org/news/2015/10/1/thanks-for-friend-raising

PRAIRIE RIVERS of Iowa

Understanding the Feasibility of a Central Iowa Nonprofit Fresh Produce Food Hub to Aggregate and Distribute Fresh Produce to Wholesalers and Retailers

FINAL REPORT – 12/2015

1. Project Summary

Background: Our project was to complete a feasibility study for a Central Iowa Non-profit Food Hub that would aggregate and distribute from local produce farmers fresh produce to buyers. Five main focuses included: (1) Conduct secondary research of other nonprofit food hub success stories around the country- their challenges, threats, and successes to developing a successful fresh produce food hub. (2) Conduct primary research by (a) identifying and surveying local produce farmers utilizing one-on-one interviews and Survey Monkey. Our surveying will help us understand the farmers' potential for growing including expanding their crop acres, harvesting and storing, purchase price expectations and delivery capabilities. (b) In addition, we will be conducting one-on-one interviews with potential wholesale and retail buyers' identifying their interest in selling locally grown fresh produce and purchasing from a food hub aggregator. (3) We will conduct a SWOT analysis informed by our research. (4) We will study equipment needs and requirements for building a food hub. (5) Develop three-year pro forma for launching a nonprofit produce food hub in Central Iowa.

Importance/Timeliness of Project: Food Hubs are emerging all across the country today. A food hub facilitates the aggregation, storage, processing, distribution, or marketing of differentiated products, particularly from small and midsized farmers and ranchers. The food hub may benefit produce farmers by creating more markets, even larger markets to sell their produce into. The food hub also improves the distribution of locally fresh produce and offers the opportunity to reduce produce loss for farmers. For a farmer, selling to a food hub even a portion of their crop, may open the possibility of increasing their revenues as much as 1/3 to ½ of their planted crop.

This is a timely project because of the enormous interest in Iowans to buy local produce. Iowa farmers want to meet the demand for their local produce, however currently in Iowa we have very limited ways to aggregate and distribute for the small or mid-sized producer. The larger food distributors have difficulty understanding the local produce farmers' interests and needs, and do not want to spend the time to build the aggregation system for them. Therefore, it is an appropriate role for a nonprofit to develop this model for producers in Iowa.

2. Project Approach

The Objective:

1. To better understand Central Iowa produce farmers' interest and attitudes toward selling to an aggregator in order to complete a feasibility study to build a nonprofit food hub that will sell more fresh Iowa produce.

Our Schedule:

Timeframe	Work Completed
Nov 1-Dec 31st, 2014	• Developed list of fruit and vegetable growers in Central Iowa totaling 122 producers within fifty miles of Ames. • Developed list of wholesale produce buyers in Central Iowa totaling 37 wholesalers within fifty miles of Ames. • Utilized IDALS system, Iowa Market Maker, and White Pages for contact information.
Nov 2014-Feb 2015	• Secondary research and success stories from other nonprofit food hubs around the country completed.
Jan-Feb 2015	• Crafted surveys for farmers and wholesale buyers based on other food hubs and prior knowledge of necessities in a startup business. See in feasibility study attachment B for a copy of each survey.

March-November 2015	• Completed 10 one-on-one surveys of farmers at their farm establishment. Goal accomplished. • Sent an on-line survey to another 112 producers – 14 were completed. Goal accomplished. • Total number of surveys 24.
April-October 2015	• Completed 7 one-on-one surveys of wholesale buyers at their respected places of employment and one survey was completed online. We surveyed 37 buyers in total. We had hoped for at least ten buyer responses and achieved 8 responses.
November 2015	• Completed a SWOT analysis. See feasibility study. • Completed equipment needs analysis and first draft of a 3-year pro forma. Our feasibility study stills needs to be reviewed by two external experts.
December 2015	• Submitted final report to IDALS.

Significant Results: FARMERS -- From our primary research, *p*roducers are interested in growing any fruit or vegetable that will make them more money including growing niche crops such as garlic to bring in more income. Of the surveyed producers, 48% have been in farming for over ten years. 87% of producers have land for expansion with one of the producers stating that they need to maximize their current space before expanding. Based on the survey, only one producer is GAP certified furthering our desire to provide training that will help producers increase their knowledge, safety, and productivity. Surveying farmers within 70 miles of Ames provided a clear picture of who is interested in the Food Hub based on their preferred radius per mile, which averaged 43 miles from farm. Overall, the producers are above average in their interest in a Central Iowa Non-profit Food Hub to potentially increase their revenues for their farms.

BUYERS -- All of the buyers surveyed are interested in purchasing from a Central Iowa Non-profit Food Hub with 75% of them very interested. 87.5% of buyers are already purchasing from local farmers currently, but 75% state that they do experience barriers when purchasing from local farmers. These barriers include farmers who are not able to follow through on quantities, food safety concerns, timely invoicing, and other business management issues. These survey results are promising based on the focus and goals of starting a nonprofit food hub.

Conclusions and Recommendations: Based on the collected data and significant buy-in from wholesale buyers, Prairie Rivers of Iowa will embark on developing a business plan for the Central Iowa Non-profit Food Hub that could be launched in 2017. The Food Hub will need to spend time with interested producers to increase their knowledge of selling through a wholesale market, a brand will need to be developed that explains the local specialty and honors the farmers selling through the food hub.

Significant Contributors: Iowa State University Extension and Outreach provided assistance with contacts for farmers and setting up survey meetings at farms. All Prairie Rivers of Iowa employees and board members through their work, spread the word to producers and buyers to complete surveys online.

3. Goals and Outcomes Achieved

Survey Distribution and Results: One project goal was to visit the producer at his/her farm to complete the survey. We wrote the survey in a fashion that allowed us to complete it while the farmers were still working on their farm, following them around as they did their work. The farmers were contacted via email and phone call to set up the interviews. Twenty-four producer surveys and eight buyer surveys were completed. Ten of the producer surveys were completed in one-on-one meetings. Seven of the buyer surveys were completed in one-on-one meetings. These meetings allowed for tours of the farm/business establishment and an opportunity to build a relationship while gathering data necessary for the feasibility study.

The survey results were favorable from both audiences. Producers are interested in making more money through increased yield with assurance that produce will be sold. Buyers are interested in meeting product demands at a decent price. They were all aware that purchasing local produce would potentially increase food costs for them. The measurable outcomes are outlined clearly in the feasibility study.

4. Beneficiaries

Produce farmers will benefit by being able to increase their crop production in available acres and resting assured that the crop will have a buyer and not rot in their field. This will increase their annual income. With the nonprofit focus, the extra monies will be invested back into the producers to allow for trainings, equipment purchases, and other investments that producers deem fitting.

Buyers will benefit by working with an experienced middle man, who will assure quantity, food safety, and quality standards. Buyers surveyed were aware of the benefits of using locally grown produce, but since they run a business, ordered produce must be delivered at time request at all times to continue their success.

5. Lessons Learned

- We will need to continuously explain what a food hub is, which was learned when surveying. Almost no one actually had a working grasp of the concept of a food hub. This will need to be explained in our marketing materials, at presentations and outlined clearly for farmers and buyers when bringing them on-board the food hub.
- Some producers believed that there are already food hubs established in Central Iowa, which there are not, who aggregate and distribute local produce. Based on the 10+ years of most of the producers' experiences, many recall an attempt by a gentleman several years ago to start a food hub. This was a poor experience for producers and buyers. Because of this, there is major fear from both parties in starting a new food hub, since many bridges were burned between producers and buyers through this experience. Given the 20+ years of Penny Brown Huber, parties were calmed by her experience of writing five business plans and working in the local food system.
- We asked in our farmer survey to rank three ways that produce pricing would be set for their produce. We were surprised that 47% of producers preferred that the food hub set the price per pound, while 33% of farmers desired to become a member of the food hub with a nominal fee and allowing for a joint meeting with the producers to set the price per pound in early spring. The one-on-one conversations showed a strong distrust in outside entities setting prices and something the food hub staff will have to work through with the farmers.
- Another challenge was getting the buyers to give us pricing for various produce. Not one buyer would provide any pricing. We believe it is because whatever the price is, they double or triple it for the consumer and then whether it sells or not is dependent on the quality and ability of the food hub to brand our products. The buyers will do little to promote one producer over another or to create marketing tools to help sell the produce.

6. Contact Person

Contact Person: Penny Brown Huber, Executive Director
Telephone Number: 515-232-0048
Email Address: pbrownhuber@prrcd.org

7. Additional Information

This study was made possible through the support of USDA and Iowa Department of Land Agriculture and Stewardship in partnership with Prairie Rivers of Iowa Resource Conservation and Development. The feasibility study may be obtained by contacting Penny Brown Huber at pbrownhuber@prrcd.org.

Grower-based participatory research to improve tomato production efficiency through grafting

Ajay Nair, Patrick O'Malley, and Joseph Hannan

Project Summary

Figure 1. An example of a typical high tunnel (30' x 96') that is used by Midwest growers.

Research on tomato grafting for high tunnel tomato production provided valuable information to Iowa growers who are growing tomatoes annually in their high tunnels (Figure 1). Grafting is a risk management tool to prevent crop losses due to soil-borne diseases and increased soil salinity. Providing information through hands-on training workshops allowed growers to network, ask questions, and develop plans to improve their production methods. The beneficiaries of this project were fruit and vegetable growers who utilize high tunnels on their farm, local consumers who purchase off-season produce, and the overall local economy. The information presented provided approximately 125 specialty crop producers with resources and knowledge to increase productivity, product quality, and profitability from their high tunnel. Although grafted tomato transplants have higher associated variable costs compared to non-grafted transplants due to increased seed costs, grafting materials, and labor, higher yield and returns from grafted plants compensates for additional costs and clearly outweigh returns from non-grafted plants. An added advantage for growers would be to learn the technique themselves, as it will save them an additional $0.40 to 0.60/transplant as compared to purchasing grafted plants, thereby increasing their profitability even more.

In Iowa, tomato grafting is practiced on a limited scale, but it is being widely used in other vegetable growing regions of the United States. Lack of proper information regarding grafting, management of grafted plants, yield and disease suppression potential of grafted plants have been preventing this technology from being widely adopted in the past. However, with the recent development of efficient commercial production techniques for grafted seedlings and the introduction of new rootstocks with desirable traits compatible with locally selected fruiting cultivars, grafting technology offers a great opportunity to manage and enhance high tunnel vegetable production in Iowa.

Through this project we conducted a grower-based participatory research study that directly benefited specialty crop growers and the rapidly expanding high tunnel and local food segment of Iowa agriculture. Delivery of results through on-farm trials and field days was a critical

component of the project and we partnered with growers to ensure the likelihood of their adoption of project findings. We reached tomato growers in the state through outreach events such as field days, grower conference presentations, and workshops. The training workshop included a comprehensive hands-on grafting exercise along with dissemination of results from our research. In addition, we developed posters, an extension publication, and videos highlighting grafting procedure and results from our studies. The project is a MS thesis chapter of a graduate student. In addition the project offered internships and trained several undergraduate students. A Masters student (Gilbert Asasira) from Uganda and a Horticulture Lecturer from Malawi (Ms. Jacinta Nyaika) also got an opportunity to work on the project and learn about high tunnel tomato production, which could be used to increase productivity and profitability of marginal farmers in their respective countries.

From a production standpoint, feasibility for the adoption of any production system or technique is often driven by cost of associated with it. It was necessary to determine the cost benefit associated with grafting so that growers had benchmarks on which to base their decisions.

Project Approach

One of the core objectives of this project was to build grower capacity and directly engage growers in project guidance and decision making from the start. Grower participation, involvement, and feedback were critical component of the project to maximize the likelihood of relevant applicability and farmer adoption of research findings. This project established a high tunnel tomato grafting experiment at the Horticulture Research Station, Ames, IA in summer 2015 and 2016.

The study included four treatments (grafted and non-grafted plants of two tomato cultivars- Mt. Fresh and Cherokee Purple) and was arranged in a randomized complete block design with four replications. Data was collected on plant height, stem diameter, chlorophyll content, and plant biomass. At each harvest, fruit was graded, counted, and weighed to determine marketable and non-marketable yield and number. Quality was assessed by measuring average fruit weight, firmness, density and total soluble solids. Environmental factors including light, temperature, and soil nutrient content were also analyzed. Grower collaborator plots were setup with similar objectives and treatments but were comprised of a scaled down version to accommodate grower resources and needs.

Goals and Outcomes Achieved

Materials and Methods. The 2015 growing season of this project conducted a total of five trials, four of them at grower collaborator farms, and in 2016 there was one grower collaborator. The main trial was conducted at the Horticulture Research Station, Iowa State University, Ames, IA. This trial compared the effect of grafting on two tomato cultivars Cherokee Purple (heirloom tomato; indeterminate type) and Mountain Fresh (hybrid tomato; determinate type). The

rootstock utilized for grafting was RST-04-106-T (DP Seeds LLC., Yuma, AZ), which is resistant to Fusarium Wilt, Bacterial Wilt, and Tomato Mosaic Virus.

Figure 2. Newly grafted tomatoes on April 1, 2016.

The study utilized a randomized complete block design to compare grafted and non-grafted plants for both tomato cultivars in both years. Tomatoes were seeded in an Iowa State University greenhouse on March 19, 2015 and March 11, 2016. Three weeks after seeding half of the tomatoes were grafted using the splice grafting method. This required cutting the rootstock stem at a 45 degree angle below the cotyledon (seed leaf). The scion stem was cut at the same angle above the cotyledon. The two stems were joined together and held in place utilizing a silicon grafting clip (Figure 2). The transplants were then placed in a high humidity, light blocking "healing chamber" for three days before being re-acclimated to ambient greenhouse conditions.

On May 7, 2015 and April 29, 2016 transplants were planted in a ClearSpan™ high tunnel with dimensions of 30'W x 12'H x 96'L covered with six millimeter polyethylene film (Figure 3). Automated roll-up sides on the high tunnel had a set-point of 80 degrees Fahrenheit. The tomatoes were planted 18 inches apart with ten plants in each of the four treatment plots. Rows were replicated four times within the high tunnel at a spacing of five feet. Mountain Fresh tomatoes were grown using a stake and weave support system. Cherokee Purple tomatoes were grown as a single leader using the lower and lean trellis technique supported on the Rollerhook® system. A drip tape irrigation system was utilized to water in 200 gallon increments for up to 600 gallons weekly. The entire high tunnel was mulched to a depth of six inches using switchgrass mulch. On July 27, 2015 and June 9, 2016 a 30% shade cloth was added to the high tunnel to reduce light levels and moderate temperature.

Figure 3. Students planting tomatoes in the high tunnel on April 29, 2016.

Harvest took place ten times throughout the 2015 season from July 22 – October 12 and fourteen times during the 2016 season from July 6 – October 3 (Figure 4). Mountain Fresh tomatoes were harvested at the breaker stage of ripeness and were graded utilizing the USDA size standards for diameter to determine grade one (greater than 2 ¾ inches), two (greater than 2 ½ inches), and three (greater than 2 ¼ inches). Non-marketable Mountain Fresh tomatoes included fruit 2 ¼ inches and smaller as well as fruit with major surface defects and insect and disease damage. Cherokee Purple tomatoes were harvested at the "pink to red" stages classified according to the USDA maturity standards. The fruit was graded visually to determine marketability. Non-marketable Cherokee Purple fruit was sorted into categories based on fruit cracking, damage from sunscald, scab as a result of cat-facing, severely misshapen fruit, and insect damage. Fruit count and weight in kilograms was recorded for all categories of fruit for each harvest.

Plant vigor in response to grafting was evaluated using several parameters. During the peak of tomato production, five plants per treatment plot were sampled for chlorophyll content using an optimal spectrometer to determine an average SPAD reading (Figure 5). At the end of each season, five plants per plot were measured for stem diameter at a point 15 centimeters above the soil surface. Additionally, three plants from each plot were removed by collecting all shoot tissue and digging an 18 inch circumference hole to collect a uniform root sample. Roots and shoots from each plant were separated, dried and weighed to compare biomass. Post-harvest fruit quality was determined by

Figure 5. An intern from Uganda assisting with a late season harvest of tomatoes.

Figure 4. Undergraduate research assistants collect chlorophyll leaf content data.

Figure 6. Marketable Fruit from Cherokee Purple (left) and Mountain Fresh (right).

collecting samples of marketable fruit (Figure 6) for lab analysis during both years. One whole fruit from each plot was blended in a food processor and fruit juices were sampled in a refractometer to measure soluble solids (Brix°). In 2016 a penetrometer was used on marketable fruits to measure firmness. One measurement was taken on each fruit equatorially. Data were analyzed PROC GLIMMIX of SAS Version 9.3.

Results and Discussion. In the analysis of harvest data from 2015 and 2016 the study found that the grafted rootstock, RST-04-106-T, significantly increased the marketable number of fruit overall (Table 1). Grafting increased production by 16,200 fruits per hectare (p-value = 0.04). As expected there was a significantly higher number of fruit produced by Mountain Fresh Plus as compared to Cherokee Purple. However; when considering the weight of marketable fruit the fruit, the grafted rootstock did not have a significant effect. With the exception of Mountain Fresh Plus in 2016, grafting appeared to slightly lower the average size of individual marketable fruit. The percentage of marketable fruit was not affected by grafting, but was significantly higher for Mountain Fresh Plus (85.9%) as compared to Cherokee Purple (51.8%). Marketability (%) of all treatments was significantly improved in 2016, although overall fruit numbers were lower as compared to 2015.

When considering plant vigor we did not find any difference between the roots or shoot biomass of grafted and non-grafted plants (Table 2). This was somewhat surprising as the assumption was that the improved rootstock would have significantly higher biomass and thus confer that growth to the rest of the plant. This result signifies that is not the case for RST-04-106-T. We did however find a highly significant increase in stem diameter on the grafted plants – the increased stem diameter could be valuable for increased strength of the overall plant, especially under windy conditions of Midwest plains. The chlorophyll content of grafted plants had a significant interaction with cultivar. There was an increase in SPAD readings for grafted Cherokee Purple tomatoes, but a decrease in SPAD readings for Mountain Fresh Plus.

Our analysis of fruit quality (Table 3) found that there was an overall decrease of soluble solids (Brix°) in grafted fruit (p-value = 0.04). This result is interesting, because our hypothesis was that grafting would increase sugars within the fruit. We also found that grafting did not significantly increase the firmness of the fruit. Not surprisingly, we did find that Mountain Fresh Plus was significantly firmer than Cherokee Purple.

Overall, our results showed that use of the rootstock RST-06-104-T can have some benefits for yield and plant health, but it may not significantly increase marketability of fruit or contribute to higher fruit quality. It is important to look at multiple studies with a wide variety of tomato rootstocks bred for grafting to continue to drive sound management decisions. An offshoot experiment of this project was a study that evaluated appropriate environmental conditions for healing of the graft union. The experimented investigated the effect of light and root zone temperature on health and quality of grafted tomato plants. A transplant with successful graft union and robust growth attributes are a must for successful field production.

Learning Outcomes:

1. Increased grower knowledge and understanding of tomato grafting. We showed that grafting has the potential to increase yields and provide protection from soil-borne pests and diseases.
2. Documentation of crop performance, yield, and the effect of grafting on tomato fruit quality.
3. Identification and resolution of issues associated with tomato grafting. In addition, grower collaborators provided valuable input on what might and might not work in the field.
4. Creation of cost benefit evaluation tools for growers to evaluate tomato grafting.
5. Greater communication and cooperation (stronger partnership) between ISU, growers, grower organizations, and project partners.

Action Outcomes:

1. Increased grower adoption of grafting technique to increase crop performance and yield.
2. Growers gained advanced knowledge and resources to increase production and profitability from their specialty crop production systems.
3. Reduced use of pesticides and/or crop losses due to soil borne disease.
4. Grower utilization of enterprise budgets to estimate the cost involved and the overall return of adopting grafting in their cropping systems.
5. Dissemination of relevant information regarding grafting by growers within their communities and grower organizations.

Beneficiaries

Grower Collaborator Trials. Grower participation, involvement, and feedback are critical component of the project to maximize the likelihood of relevant applicability and farmer adoption of research findings. This project had following grower collaborators:

1. Chris French, French Family Farm, Wiota, IA
2. Marcus Johnson, Buffalo Ridge Orchard, Central City, IA
3. Jill Beebout, Blue Gate Farm, Chariton, IA
4. Bob and Karen VanBrocklin, Alley Greenhouse, Montrose, IA
5. Steve and Nicole Jonas, Red Granite Farm, Boone, IA

Figure 7. Grower collaborator, Steve Jonas, assisting with the planting of the grafted tomato trial.

Tomatoes were seeded in an Iowa State University greenhouse on in March of 2015 and 2016. Three weeks following seeding half of the seedlings were grafted using the splice grafting method. The transplants were then placed in a high humidity,

light blocking “healing chamber” for three days before being re-acclimated to ambient greenhouse conditions. Treatments for grower collaborator trials were similar to what was tested at the Horticulture Research Station. Eight transplants from each treatment were transported to grower sites (Figure 7). Growers grew those plants as per their production system and collected data on crop yield. Growers also provided feedback on overall tomato performance:

1. Grafted tomato plants showed vigor over non-grafted plants
2. Often times the graft union got buried under the soil when transplants were pushed in to the soil. It will be useful to graft transplants a little higher on the rootstock
3. Grafted plants yielded higher that non-grafted plants and have the potential to boost productivity and profitability
4. Growers need more information to properly graft and heal the grafted plants
5. Adequate grafting facility and planning is needed to schedule early planting of grafted transplants in high tunnels.
6. Growers realize pitfalls associated with continuous tomato production in high tunnels. High disease incidence, pest pressure, and loss of productivity are often observed. Tomato grafting along with other cultural practices such as crop rotation is a valuable resource that can be tapped to mitigate these issues in high tunnel crop production

Project Outreach. The project disseminated research results through annual field days at the ISU Horticulture Research Station organized in partnership with Iowa Fruit and Vegetable Growers Association and Practical Farmers of Iowa – over 80 attendees were present in both 2015 and 2016. The field day gave growers an opportunity for a real time assessment of new, innovative, and sustainable research initiatives in the area of fruit and vegetable production, of which this grafting project was one of the stops. Kristine Neu, graduate student on this project, explained the project and provided growers information on tomato grafting. Several aspects such as cost, construction, maintenance, and production methodologies in high tunnel crop production were also discussed. Many growers took interest in the project and assed growth and development of tomato plants in the high tunnel. Additionally, an on-farm field day was held on May 10, 2016 with grower-collaborator Chris French with approximately 20 growers attending (Figure

Figure 8. Joe Hannan (center), ISU Extension and Outreach, addresses grower questions at the May 10, 2016 on-farm field day.

8). This field day allowed ISU faculty and staff to interact with growers in Western Iowa who may not have attended the research farm field day(s).

Throughout both research seasons farm tours included stops at the high tunnel with an explanation of the tomato grafting research (Figure 9). Layperson audience members included local and state leaders, students (elementary through undergraduate), and local community members. The projected also hosted an international delegation of the International Fertilizer Development Center which had delegates from over 25 countries. Delegates got an opportunity to learn about tomato grafting and high tunnel tomato production. Additionally, 32 undergraduate students in the Horticulture 471 – Vegetable Production course at ISU participated in tomato grafting as a means to educate the future generation.

Figure 9. Visitors to the Horticulture Research Station explore the high tunnel and compare the grafted and non-grafted plants.

Project PIs and a graduate student made poster presentations in 2015/2016 at state, regional, and national meetings [IFVGA Annual Conference, Ankeny, IA (100 Attendees); Great Plains Vegetable Growers Conference, St. Joseph, MO (400 Attendee); and Great Lakes Fruit and Vegetable Expo, Grand Rapid, MI (1000+ Attendees)]. Both the PI and graduate student also participated in the 4th Annual National Vegetable Grafting Symposium held at the 2015 Great Lakes Fruit and Vegetable Expo. Topics discussed at the symposium included propagation technology developments, research on tomato and cucurbit grafting methods, industry rootstock trials, performance of grafted plants under many conditions, and rootstock breeding and marketing. Growers at the symposium discussed their successes and challenges in using grafted plants in both large-scale field production and high-tunnel production. The graduate student and project PI will be

Figure 10. Mennonite growers gathered at the Cedar Valley Produce Auction for a hands-on grafting workshop in February 2016.

presenting final research results at Great Plains Growers Conference, St. Joseph, MO and IFVGA Annual Conference, Ankeny, IA in January 2017.

The project also organized a hands-on grafting workshop in February 2016– this workshop targeted Mennonite vegetable growers surrounding the Cedar Valley Produce Auction near Elma, IA. Approximately 54 growers participated in this event (Figure 10). The workshop covered multiple aspects of tomato production, with a heavy emphasis high tunnel production and the results of our grafting research. After the demonstration of the grafting technique all participants were given an opportunity to practice grafting with aid from ISU faculty, staff, and students.

Online videos were developed that highlighted proper grafting practices, field activities, crop growth stage, and harvest. These videos were posted on ISU Extension and Outreach sustainable vegetable production website (http://extension.iastate.edu/vegetablelab. To capitalize on information technology we used multimedia tools such as YouTube, websites, and blogs to upload videos and information for wider dissemination of research results and impact of the project. An ISU Extension publication featuring tomato grafting is set for release in January 2017 to extend our reach to grower audiences. To contribute and share our findings with colleagues and academic peers we plan to publish our research results in one of two peer reviewed journals (*HortTechnology* or *HortScience*).

Lessons Learned

Based on results from year one there were some changes for 2016 on the crop management side at the Horticulture Research Station. As the 2015 season progressed, we observed serious sun scaling on fruits in the high tunnel. A 30% shade cloth was immediately installed over the high tunnel during the week of July 27, 2015. In 2016, the shade cloth was installed on June 9 to minimize crop injury due to sun scald and potential loss of marketable fruits. The issue of heat stress caused us to question how this may be best addressed through the use of shade cloth. A newly funded study will examine the effects of light and temperature reduction on colored bell peppers in 2017 and 2018.

During the 2015 season there was a high incidence of yellow should which is a physiological disorder of tomatoes that is characterized by discolored regions under the skin that show through and reduce the quality of the fruit. A pre-plant application of 22 lbs/acre potash was incorporated for the 2016 season to alleviate this issue.

Cherokee Purple tomatoes showed a lot of cracking in both 2015 and 2016, but irrigation was spread over 2-3 days per week in 2016 to reduce the incidence of cracking. Due to the diverse nature of the Horticulture Research Station, there are apple orchards located in close proximity to the high tunnels. In 2016 an application of Paraquat was applied near apple trees with a resulting pesticide drift that damaged many tomato transplants at two weeks of growth in the

high tunnel. Plant damage was assessed and plots were replanted as needed with plants recovering across treatments as the season progressed.

During this research project we discovered that questions still exist about methods that growers can use to improve their grafting technique as well as their success with healing the grafted plants. We have implemented a greenhouse study of post-grafting healing techniques utilizing heat mats as well as plastic domes and 0, 4, and 6 days of darkness. This graft healing research will continue into 2017 with the goal of providing growers with a low-input means to successfully heal grafted tomatoes.

Contact Person

For additional information on this project please contact Dr. Ajay Nair.

Additional Information

Acknowledgements. Special thanks to the Iowa Department of Agriculture and Land Stewardship Block Grant Program for providing the funding for this study. Thank you to graduate students John Krzton-Presson, Moriah Bilenky, Dana Jokela, Ray Kruse, and Jen Tillman; and undergraduate research assistants Elizabeth Boehm, Sydney Beaurivage, Gabriel Johnson, Amanda Groleau, and Rachel Sporer for their assistance with plot establishment and data collection. A special thank you to Nick Howell, Brandon Carpenter, and the entire ISU Horticulture Research Station staff for their technical support throughout both seasons.

Table 1. Marketable fruit, total fruit, and marketability of grafted and non-grafted Cherokee Purple and Mountain Fresh Plus tomatoes grown in 2015 and 2016 at the Iowa State Horticulture Research Station in Ames, IA.

Cultivar	Graft	Marketable Fruit			Total Fruit			Marketability (%)	
		Yield (Mg ha^{-1})	No. of fruits (no. ha^{-1} x 1000)	Fruit Size (g)	Yield (Mg ha^{-1})	No. of fruits (no. ha^{-1} x 1000)	Fruit Size (g)	Yield	No. of fruits
					2015				
Cherokee Purple	Grafted	35.2 c[z]	118.7 c	295.7 ab	67.5 bc	219.3 d	306.0 ab	52.3% bc	54.0% c
	Non-grafted	29.7 c	97.8 c	308.4 a	64.7 bc	203.9 d	319.9 a	45.8% c	47.3% c
Mountain Fresh Plus	Grafted	103.5 a	380.0 a	272.2 bc	121.9 a	482.9 a	252.7 cde	84.8% a	78.8% b
	Non-grafted	102.4 a	352.0 a	292.0 ab	115.4 a	416.1 b	279.1 bcd	89.0% a	85.0% ab
					2016				
Cherokee Purple	Grafted	37.1 c	120.8 c	302.7 ab	65.3 bc	219.7 d	295.3 ab	55.5% b	53.8% c
	Non-grafted	30.3 c	99.2 c	306.8 ab	53.8 c	188.8 d	284.4 abc	56.0% b	52.0% c
Mountain Fresh Plus	Grafted	65.2 b	268.9 b	242.3 cd	70.6 b	295.2 c	238.8 de	92.5% a	91.3% a
	Non-grafted	62.0 b	274.3 b	224.7 d	69.5 b	309.6 c	223.2 e	89.5% a	88.5% a
					Significance				
Cultivar (C)[y]		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Graft (G)		0.117	0.040	0.560	0.063	0.021	0.677	0.565	0.472
Year (Y)		0.022	0.071	0.115	0.017	0.027	0.083	0.052	0.043
C x G		0.440	0.502	0.653	0.544	0.878	0.814	0.382	0.095
Y x G		0.749	0.272	0.166	0.768	0.110	0.056	0.976	0.564

[z]Mean separation (across years in columns) based on least significant differences at $P \leq 0.05$.
[y]P values based on F test.

Table 2. Plant biomass, stem diameter, and chlorophyll readings of grafted and non-grafted Cherokee Purple and Mountain Fresh Plus tomatoes grown in 2015 and 2016 at the Iowa State Horticulture Research Station in Ames, IA.

Cultivar	Graft	Shoot Biomass (g/plant)	Root Biomass (g/plant)	Stem Diameter (mm)	SPAD
			2015		
Cherokee Purple	Grafted	111.7 b[z]	5.8 c	15.4 a	44.4 cd
	Non-grafted	115.58 b	5.8 c	14.7 ab	43.4 cd
Mountain Fresh Plus	Grafted	339.8 a	14.9 a	15.2 ab	45.7 bc
	Non-grafted	346.2 a	12.9 ab	14.3 b	47.0 b
			2016		
Cherokee Purple	Grafted	154.62 b	8.0 c	15.1 ab	44.0 cd
	Non-grafted	145.20 b	7.5 c	14.4 ab	42.8 d
Mountain Fresh Plus	Grafted	338.8 a	11.6 b	15.2 ab	47.9 ab
	Non-grafted	334.0 a	10.9 b	14.3 ab	49.45 a
			Significance		
Cultivar (C)[y]		<0.0001	<0.0001	0.556	<0.0001
Graft (G)		0.975	0.162	0.005	0.725
Year (Y)		0.467	0.570	0.689	0.168
C x G		0.8381	0.340	0.708	0.047
Y x G		0.7727	0.719	0.978	0.958

[z]Mean separation (across years in columns) based on least significant differences at $P \leq 0.05$.
[y]P values based on F test.

Table 3. Soluble solids and firmness of grafted and non-grafted Cherokee Purple and Mountain Fresh Plus tomatoes grown in 2015 and 2016 at the Iowa State Horticulture Research Station in Ames, IA.

Cultivar	Graft	Soluble Solids (Brix°)	Firmness (kgf)
		2015	
Cherokee Purple	Grafted	5.1 ab	-
	Non-grafted	5.3 a	-
Mountain Fresh Plus	Grafted	4.5 c	-
	Non-grafted	5.4 a	-
		2016	
Cherokee Purple	Grafted	5.0 ab	2.4 ab
	Non-grafted	5.1 ab	1.8 b
Mountain Fresh Plus	Grafted	4.7 bc	2.8 a
	Non-grafted	4.5 c	2.6 a
		Significance	
Cultivar (C)[y]		0.003	0.017
Graft (G)		0.036	0.088
Year (Y)		0.074	-
C x G		0.508	0.424
Y x G		0.006	-

[z]Mean separation (across years in columns) based on least significant differences at $P \leq 0.05$.
[y]P values based on F test.

Project Title: Add it up: Farm to School Makes "Cents"

Project Summary: Increasing supply and demand for locally-grown specialty crops through education and food opportunities. The environment in Iowa is perfect for increasing locally grown produce in schools. Tools have been put in place to track (voluntarily) schools' purchases of locally grown food. In addition, a Farm to School Directory has been established to allow school food service the opportunity to place bid requests for locally grown items to multiple growers in one email. The time is right to engage our students in Farm to School. Offering students the opportunity to learn about food by eating and gardening will allow them to have the "experiences" that are critical elements in true understanding**.** This grant offered students the opportunity to learn through "doing" by offering gardening opportunities, participation in farmers market scavenger hunts, and completing a food journal. This project is not a continuation of any previous projects.

Project Approach: Kids learn more through hands on experiences. Not only is this true with gardening but also with eating. Giving students the opportunity to grow their own food in school gardens, try fruits and vegetables they have never experienced and then incorporate herbs to change those flavors will help them form a food opinion that they will carry into adulthood. This project achieved all of those goals by providing garden supplies, herb kits, cookbooks and food journals to challenge them to eat more fruits and vegetables.

The following opportunities were offered to increase awareness and consumption of specialty crops:

<u>A Garden is the Way to Grow/Spicing up the Garden</u>
This initiative targeted classroom teachers and provided a multitude of learning opportunities as there are so many uses for herbs. Teachers could decide whether their focus was medicinal, aromatic or culinary. They were encouraged to create a lesson in botany to increase student's knowledge of plants and edible portions or focus on the difference the use of herbs can make in the taste of the food we eat. Through a partnership with Gardeners Supply Company, schools purchased items to support an herb garden and received a 25% discount on their purchases. Through this partnership, schools were able to source additional garden supplies throughout the year, utilizing the 25% discount. This initiative impacted over 1100 students and focused on more than 15 herbs.

<u>Farm to School to Market</u>
For several years, IDALS partnered with Iowa Farmers Markets to offer a Farmers Market Scavenger hunt to keep kids engaged and learning about fruits and vegetables all summer long. Participating students filling out the fruit & vegetable scavenger hunt received a free piece of fruit or vegetable from the participating farmers market. Because not all students will be able to attend a farmers market, we partnered with classroom teachers to bring the market to their students. Teachers were offered $30 to buy produce from a farmers market and incorporate it with a classroom lesson and let the students sample the produce. Nearly half (49%) of the students tried something for the first time. Produce shared with their classroom included: squash, kohlrabi, arugula and kale.

<u>Harvest the Fun of Iowa Farm to School</u>
To celebrate our local growers and Farm to School month, we offered Harvest the Fun of Iowa Farm to School. This initiative offered classroom teachers to pick from multiple levels of participation such as: purchase locally-grown specialty crops and incorporate them into classroom lessons, participate in the Great Midwest Apple Crunch and skype with or invite a grower into their classroom.

Participants in this initiative received educational items for their classroom such as Apple Cookbook or Fresh from the Farmstand Cookbook. In addition, classes participating in all levels received a booklet

entitled "ABC's of Iowa Farm to School" for each student. This colorful booklet features specialty crops grown in Iowa along with photos of the featured crop, some of the growers growing them and their favorite recipes.

Iowa Planting and Harvest Calendars

This educational 12 month calendar provided suggested planting dates and harvest dates for Iowa for as many as 30 specialty crops. Each month offered a harvest bar showing which crops may be harvested that month. In addition, recipes and other helpful facts such as tips on picking or storage of specialty crops were included in this learning tool. Calendars were distributed to schools and public events such as the Iowa State Fair, Extension Offices, and through sister agencies such as Iowa Department of Public Health or other locations where consumers seek knowledge and community outreach could be most effective.

- 5,000 educational calendars featuring harvest dates and recipes were distributed in 2015

Farm to School Chapters

The Farm to School Chapters create their own plan to increase knowledge and consumption of specialty crops creating long-term impacts. Approved chapters must have 7 members or more. Four chapters were formed impacting 2,202 students (plus families). Some of the highlights of their work include:

- Created 10 week course at pilot schools (spring & fall) that taught lessons on soil quality, plant science, pollinators, food insecurity & waste, cooking, nutrition, food preservation, garden care, season extension – also field trip to a local farm
- Created learning labs in school gardens (6 classes)
- Knife training for food service/fresh fruits/vegetables
- Improved nutrition outcomes by educating students about eating fresh, healthy foods
- Mini farmers market with fruits and vegetables at back to school night (parent/community event) event included samples of fresh produce, recipes and a nutritionist to answer questions
- Formed partnership with Future Farmers of America (FFA) and local growers
- Started seeds in a greenhouse to transplant into school garden

Pick it, Wash it, Eat it

This initiative, offered during Farm to School month, allowed schools to create their own celebration to support our local growers and the food they grow while educating students on the importance of making healthy food choices. Teachers selected from the following activities: Show your Farm to School spirit by decorating your classroom, hall or CAFETERIA and incorporate a classroom lesson; taste test or try a new recipe focused on Iowa-grown fruits or vegetables; introduce herbs to their class by showing students how a piece of fruit or vegetable can take on new flavors by using herbs in different ways; create a social media/promotional blitz taking Farm to School home to parents by encouraging students and parents to eat more fruits and vegetables through tweets, newsletters, Facebook posts and classroom displays; invite a grower into their classroom to talk about growing fruits & vegetables and the importance of eating them. To help them achieve their goals educational supplies were provided. Items included: herb growing kit and cookbook, Get Growing (Farm to School bulletin board kit), Poster sets (Local Grown Foods, Enjoy More Fruits & Vegetables (shows how specific fruits and vegetables effect the body (carrots/eyes…) and food journals. Two food journals were created (k-2, 3-8). These journals focused on what parts of the plant we eat, different uses for fruits/vegetables and a challenge to track the fruits and vegetables eaten for 30 days. A pre-survey and post-survey measured his/her consumption change from beginning to end.

- 1,700 educational food journals were provided to students

Goals and Outcomes Achieved:
The initiatives offered within the Farm to School Program have a far-reaching impact that is beyond the one-time offering. A Farm to School chapter may also start a school garden just as offering a student the opportunity to try a fruit or vegetable for the first time may occur within a Farm to School to Market initiative. A Goal of having 440 students try a new fruit or vegetable from the garden experience should be expanded into all of the Farm to School initiatives. An average of 44% of the students tried a fruit or vegetable for the first time through these initiatives. Using that average, 2874 students would have tried a specialty crop for the first time through the initiatives funded through this grant.

As described in Lessons Learned, collecting produce sale data has been very cumbersome and did not provide an up-to-date reflection of what was currently happening in the State. Our partnership with USDA's AMS has allowed us to collect school information (voluntarily) and show updated purchases monthly. A 25% increase in the purchase of locally grown produce was reported in the first year. This information is collected voluntarily and data is only being collected at this time by 3% of the school districts in the state. This will grow significantly as awareness of this resource grows.

A goal of increasing the number of new growers selling produce to schools by 10% was achieved. Of the school districts currently reporting, 10 new growers were reported along with 3 food hubs (which encompasses multiple/many growers) and 7 new growers through the Farm to School to Market initiative.

Beneficiaries:
Farm to School impact is felt statewide. The fruit and vegetable samplings and garden initiatives expose students to new specialty crops and the knowledge of how to grow them and the nutritional benefits of including them in their diets. Today's students are tomorrow's consumers and this increased awareness exceeds the school activity to which it is associated.

A sampling of direct beneficiaries for some of the Farm to School Initiatives is listed below:

Initiative	Students Impacted	Grower Impact $	Benefits
Farm to School Chapter	2202	$1100.00*	Sales/consumption/awareness
Farm to School to Market	1782	$600*	Sales/consumption/awareness
A Garden is the way to Grow	1100	Indirect	Awareness/consumption
Pick it Wash it Eat it	1700	Indirect	Sales/consumption/awareness

*Many schools spent additional funds to implement the project to the school or to a larger scale

Lessons Learned:
Capturing sales information from growers is a very difficult and daunting task. Being able to compile this information and keep it current would be an extremely difficult task. We were able to partner with USDA's AMS to create an Iowa Farm to School Local Purchase Report. This report collects data directly from School Food Service Directors. The data collected reports on purchases made within Iowa and a 30 mile border surrounding our state and shows a price range and product form of items being purchased by schools. This report is updated monthly and is used to show growers what schools are interested in purchasing and the price being paid. At the same time, it is a great tool to be used to encourage schools that are not currently procuring locally grown foods to consider local purchases. An increase in partnerships among state agencies, universities and non-profit groups allowed for larger Farm to School opportunities and platforms. The collaboration planned with this grant was not held, instead multiple

meetings and conferences were held with partners around the state to showcase Farm to School and increase the competitiveness and consumption of specialty crops.

Contact:
Tammy Stotts
Farm to School Coordinator
Iowa Department of Agriculture and Land Stewardship
502 E 9th Street
Des Moines, IA 50319

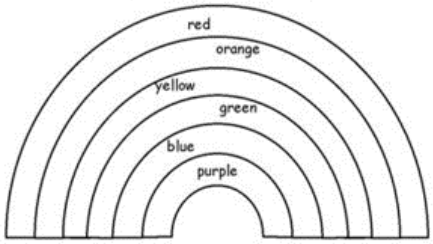
Excerpts from K-2 Food Journal

Rainbow of Colors

Fruits and vegetables help us grow strong and healthy. They also taste great and add color and fun to your meal. Did you know that different colored fruits and vegetables help in different ways?

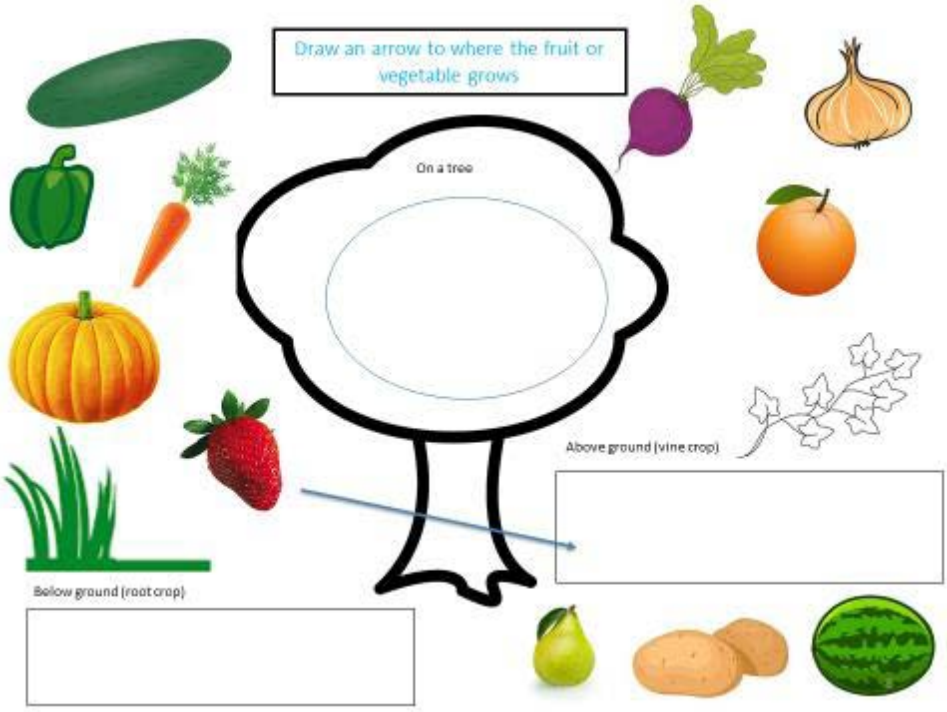
- Red: help keep your heart strong
- Orange: help keep your eyes healthy
- Yellow: help keep you from getting sick
- Green: help make your bones & teeth strong
- Blue & Purple: help your memory

Eat a Rainbow!



Rainbows are made up of these colors: red, orange, yellow, green, blue & purple. Keep track of the fruits and vegetables you eat in one week. When you eat a fruit or vegetable, color in the right color and see if you can fill in your rainbow!

11



Excerpts from grades 3-8 Food Journal

Pick a fruit or vegetable of the week!

There are so many ways to eat a fruit or vegetable. Try this challenge:
Take 1 fruit or vegetable of your choice and eat it for 5 days in a different way.

Example: Strawberries

- Day 1: in a fruit salad
- Day 2: in a yogurt smoothie
- Day 3: as a strawberry vinaigrette
- Day 4: peanut butter toast with sliced strawberries on top
- Day 5: grilled chicken tacos with strawberry salsa

Write down the recipe you used each day. Don't forget to put a star by your favorite!

Strawberry vinaigrette ★ Mash a handful of strawberries with fork. Whisk in ¼ c balsamic vinegar. Slowly add ½ c olive oil. Drizzle over your favorite salad.			

12

Now, I've tried that!

(Post-assessment)

Put a ✓ under all of the specialty crops that you ate this month.

Apples	Arugula	Asparagus	Beans	Blueberries	Broccoli	Cabbage	Cantaloupe	Carrots	Cauliflower	Cherries	Cucumbers	Eggplant	Grapes	Kale	Kohlrabi	Leeks	Lettuce	Okra	Onions

Peaches	Peas	Pears	Peppers	Plums	Potatoes	Pumpkins	Radishes	Raspberries	Rhubarb	Rutabaga	Spinach	Squash	Strawberries	Sweet Corn	Sweet Potatoes	Tomatoes	Turnips	Watermelon	Zucchini

Look at the pre-assessment you took at the beginning of the month. List the names of the fruits and vegetables that you tried for the 1st time: _____

_____

_____

SCBG PROJECT REPORT(S)

PROJECT TITLE

Assessing Promising Bush Fruit Adaptability: Dwarf Sour Cherry and Honeyberry and Showcasing Iowa's Best Pawpaws

PROJECT SUMMARY

Fruits well adapted to the Midwest that were relatively unheard of in Iowa a decade ago, pawpaw, dwarf sour cherries, and honeyberries have received increased attention by innovative growers. Growing pawpaw, dwarf sour cherry, and honeyberry, have the potential to become profitable ventures for commercial Iowa specialty crop growers. The project conducted by The Native Fruit Association had three goals. The first was to provide cultural information on how to grow these fruits in Iowa soil and climatic conditions. The second was to educate the public about the economic viability of these fruits. The third, specific to dwarf sour cherry and honeyberry, was to assess adaptability to Iowa. This project did not build on a previously funded project with the exception of paw paw which had been part of a 2013 Specialty Crop Block Grant titled Demystifying Iowa's High Value Native Fruits: Growing, Harvesting, Processing, and Marketing of Persimmon, Pawpaw, and Aronia. That previous SCBG project had objectives to evaluate processing and storage of pawpaw, aronia, and persimmon and to educate and distribute these fruits to the general public and to restaurant chefs. The current project furthered what had previously been done with paw paw by selecting the best known varieties and to assess and make available to the public.

PROJECT APPROACH

During 2015, the SCBG to assess promising bush fruits in Iowa began. The first task required researching and locating multiple cultivars. At that time, the majority of planting stock could only be purchased from nurseries located in Canada. This task was performed by Levi Lyle. In early spring, plans were made for site preparation through collaboration with the Washington County Conservation Board who provided land for the variety trials. Patrick O'Malley, Tom Wahl, and Levi Lyle planted the 100 seedlings of dwarf sour cherry and 100 seedlings of honeyberry in a cultivar trial design located at MAAR Park in Washington County, Iowa. These project tasks were successfully implemented near the end of June and the beginning part of July. Tom Wahl researched and purchased pawpaw cultivars which were planted by him and Levi Lyle in mid-summer.

During year two of the SCBG to assess promising bush fruits, work plan activities were completed as scheduled. Routine visits were made to the trial site by Patrick O'Malley of Iowa State University Extension & Outreach, Levi Lyle of Levi's Indigenous Fruit Enterprises, and Tom Wahl of Red Fern Farm, to maintain the shelters and care for the honeyberries, dwarf sour cherries, and pawpaw.

In 2015 and 2016, a primary task was to share the objectives and progress of the project at 11 events. Patrick O'Malley talked about the project at Horticulture Showcase in Nashua to about 25 people. He shared progress on the project with monthly horticulture phone conference between ISU Horticulturists and IDALS personnel (Maury Wills, Mike Naig, Bill Northey) also with ISU Extension & Outreach Southeast Area Ag.

Team. Patrick O'Malley used information gained from the project to help guide growers on fruit planting decisions.

The First Annual Pawpaw Day at the Iowa City Farmer's Market held in September of 2016. At this event, samples of fresh pawpaw were available for all. More than 300 patrons had a chance to try pawpaw- many for the first time. Tom Wahl, Patrick O'Malley, and Levi Lyle organized the event, which included preparing and processing samples beforehand and assisting at the booth to talk to the public.

Levi Lyle presented at the Iowa Organic Conference in Iowa City in November of 2016. The presentation informed 30 people of the project and introduced interested farmers to opportunities to grow and market these fruits. Other events were conducted by Tom Wahl during the year and include hosting an ISU Agronomy class at his farm and speaking events at MUM University in Fairfield, Indian Hills Community College in Ottumwa, Trees forever in Centerville, and other guided tours of honeyberry and pawpaw projects on his farm.

Tasks related to the education of the public included Tom Wahl's research and preparation of educational flyers on how to grow pawpaws from seeds and how to care for pawpaw trees. He also created flyers telling how to utilize the fruit that included recipes and featured information about Zebra Swallowtail butterflies a symbiotic partner to the Pawpaw. These flyers were distributed at the Iowa City Farmer's Market on Pawpaw Day.

The task of maintaining the project during the summer months was conducted by Washington County Conservation who mowed and applied herbicides when needed during 2015 and 2016. The survival rates remain near 95% which is well above the predicted survival rate for a cultivar trial of this type at this stage of growth and development. So far, the project seems to be indicating positive adaptability for both dwarf sour cherry and honeyberry, but more time and exposure to climactic averages is required before drawing conclusions.

In January 2017, signage to post at the site to communicate to the public was purchased. Also, a soil test at the site and consultation with an agronomist was performed. At the end of the project, more than $2000 of in-kind labor and resources had been donated to the project by Levi's Indigenous Fruit Enterprises, Red Fern Farm, and The Washington County Conservation Board. These activities were documented with the final invoices reported to the project.

In addition to the partner contributions of Red Fern Farm, Levi's Indigenous Fruit Enterprises, Iowa State University Extension & Outreach, Native Fruit Association, and Washington County Conservation, the following organizations contributed to the project by furthering the mission to promote specialty crops in the region: The Pawpaw Foundation, The Northern Nut Growers Association, Iowa Fruit and Vegetable Growers Association, New Pioneer Food Coop, Practical Farmers of Iowa, and The Midwest Aronia Association.

The grant project did not generate any income and did not benefit commodities other than the specialty crops of pawpaw, dwarf sour cherries, and honeyberries.

GOALS AND OUTCOMES ACHIEVED

This project had three goals. All three were completed successfully. The first was to provide cultural information on how to grow these fruits in Iowa soil and climatic

conditions. The second was to educate the public about the economic viability of these fruits. The third and final goal, specific to the dwarf sour cherry and honeyberry was to assess the adaptability of varieties in Iowa.

Work Plan tasks, as described in the project approach, were carried out in order to achieve the performance goals and measurable outcomes of the project. The first two goals were measured by:

(1) number of participants at presentations and educational events.

-More than 400 people were informed of the project at professional association annual conferences, and educational events. The highlight of these was the 2016 Paw paw Festival in Iowa City featuring project outcomes.

(2) number of copies of publications distributed to growers.

-Educational fliers with growing information and recipes were distributed to the public totaling more than 250 copies. The distribution of educational information successfully met the objective relay educational information onto the public.

(3) number of growers, acres, and quantity of marketable produce of the specialty crops.

-Data on number of growers and acres in production cannot be accurately disseminated at this time because the strongest most reliable assessment is the Iowa Agricultural Census which has not yet been made available to the public.

The final/3rd goal, specific to the dwarf sour cherry and honeyberry was to assess the adaptability of varieties in Iowa. This was successfully completed. Indications for the health of dwarf sour cherry and honeyberry, which includes climactic adaptation and pest and disease resistance, indicate these fruits are thriving. The survival rates remain near 95% which is well above the predicted survival rate for a cultivar trial of this type at this stage of growth and development. The project seems to indicate positive adaptability for both dwarf sour cherry and honeyberry, (However, as with any crop, a longer period of evaluation can offer a more dynamic scope of climactic averages to help form definitive conclusions).

Fruit yield and harvest efficiency were not objectives to be assessed by this project. These long term outcomes can be measured by increase in the availability of fresh, Iowa-grown specialty fruit, overall higher profitability for Iowa specialty crop growers, and an increase in number of acres and yield. The 2012 USDA Census of Agriculture Iowa Statistics provide a base line for this data and can be contrasted with release of the next Iowa Agricultural Census. Demand for these fruits is increasing with the spread of awareness and further research on dwarf sour cherries is being conducted by a partner organization, Practical Farmers of Iowa.

BENEFICIARIES

Beneficiaries of this project include Iowa's Specialty Crop producers and the organizations that serve them. In 2017, Practical Farmers of Iowa is conducting further trials in Dwarf Sour Cherry. The outcomes of this project will directly serve to provide guidance to 2,500 PFI members, 88% are residents of Iowa, and include both commercial

production by farmers and those seeking to develop edible landscapes in their gardens. Other organizations who share a common purpose to increase specialty crop availability may benefit from the lessons and outcomes of this project. These include The Pawpaw Foundation, The Northern Nut Growers Association, Iowa Fruit and Vegetable Growers Association, New Pioneer Food Coop, and The Midwest Aronia Association.

As Iowa's Specialty Crop Industry is young, the economic impact of developing these crops is greater than 10 million dollars annually during the 5-10 year period. Further beyond this time period is an outlook that breaks into the hundreds of millions of dollars in potential annual economic impact. These estimates can be inferences by drawing conclusions based on other established perennial; fruit crops in other regions of the country. Growing berries for local consumption would decrease the need to import produce into the state from long distances. The recent development of an aronia berry industry for example demonstrates how a shift in consumer consumption of a fruit can benefit Iowa. Iowa's aronia berry industry establishes a valuable foundation for Iowans to consume regionally grown fruit. Production, harvesting, and processing practices for dwarf sour cherry and honeyberry are similar to Aronia berry. It is also notable that honeyberries are harvested in May/June and dwarf sour cherries are harvested in July. The ripening period of these fruits further compliment the development of an aronia berry industry as Aronia berries ripen and are harvested in September. A well established aronia berry industry would reciprocate benefits to honeyberry and dwarf sour cherry by creating greater efficiencies in production and manufacturing of all three.

The potential for greater development of a pawpaw industry in Iowa may be fueled by its potential as a nutraceutical and cancer treatment produced from the seeds and bark. Further research is needed to develop these avenues.

LESSONS LEARNED

Objectives during the project were met without delay. A problem area is the presence of wildlife pressure at the site of the plantings. Rabbits and deer take a liking to the early spring growth and browse on the honeyberries, pawpaw, and dwarf sour cherries. Still, the plants appear in good condition having emerged from the top of their grow shelters. All three plant species appear to be well established and demonstrate resilience to normal levels of pressure from wildlife.

CONTACT PERSON

- Levi Lyle
- Phone: 319-961-1438
- Email: Aronialife@yahoo.com

ADDITIONAL INFORMATION

See photos attached

Japanese and Russian crosses
Berry Blue
Tundra
Borealis
Borealis Blizzard
Berry Smart Blue
Honeyberry blossoms, Iowa Specialty Crop Block Grant , 2017

Honeyberry

Synergistic Crops

Honeyberry **June** Harvest

Dwarf Sour Cherry **July** Harvest

Aronia's **September** Harvest

Marr Park as a Regional Trial Site

- #1 Dwarf Sour Cherry and Honeyberry Trial (200 bushes)
- #3 Pawpaw Demonstration (10 trees)

Dwarf Sour Cherry
USA availability
Carmen Jewel
Romeo
Juliet

2017 Final Report for the Iowa Specialty Crop Block Grant

Project Title

Measuring Stress on Fine Roots in Retail Garden Centers

Grantee: Ryan Krull November 4th, 2017

Iowa Department of Agriculture and Land Stewardship

Researcher Dr. Randall and Ryan Krull

Project Title; Measuring Stress on Fine Roots in Retail Garden Centers

Project Summary

The most recent USDA survey estimates yearly sale of hardy nursery stock in the United States at approximately 3.8 billion dollars. The majority of these sales are through larger retail stores selling nursery stock. Many of these retail locations utilize parking lots and do not have proper facilities to protect nursery stock from the variable and harsh environmental conditions.

The project duplicated the typical nursery setting to gather temperature and plant stress indicators to determine how the parking lot conditions affect the plant material. It is our hope that this information will help support best management practices that can be implemented in retail center operations to protect the plants from environmental stress.

Results of the project indicate that pot temperatures in the retail setting can achieve greater than 120F temperatures on regular bases with maximum recorded temperatures reaching 137F. Previous supporting research indicates the roots of plants cannot tolerate temperatures above 95F temperature with some enzymatic breakdown occurring as low as 85F. With billions of dollars in planting material moving through retails stores annually, if left uncorrected current operations will continue to place trees at increased rates of transplant shock and mortality. Increase stress and mortality costs will directly impact the homeowner, requiring successive replanting and/or increased pesticides /fertilizers applications to protect the tree from harmful pests targeting stressed plants.

This project or any other similar project was not previously funded with SCBGP or SCBG-FB grant dollars.

Project Approach

There is a lack of information on environmental impacts in the retail phase of nursery stock potentially leading to long-term plant health issues. Current state regulations have varied language that does not allow the plant material to be in direct contact with asphalt and as such retailers often utilize pallets or a 4 inch layer of mulch on the ground to insulate the pots from heat accumulating in the asphalt. The project desires to identify temperature extremes that root zones are being exposed during the typical

sales season and how pot color, pot face direction and surface types all impact soil root zone temperatures.

Researched followed the proposed workplan as outlined in the proposal and highlighted in light blue below, the project compared the effects of solar radiation on black versus white nursery pots and the effects of different surface types such as asphalt and pallets. We also incorporated 4 different species of trees to see if there were differences between species. The project had 3 different harvest dates including May, July, and August corresponding to early, mid and late season sales.

Plants originated from Iowa DNR state forest nursery, were graded/sorted for uniformity, planted in assigned colored nursery pots. The plants were established in the pots for 1 growing season and then assigned to treatment blocks. The treatment blocks were set up in a split plot randomized complete block design.

During the project, the plants were located on one of ISU campus parking lots. Plant material was watered uniformly with drip irrigation. A representative sample of plants were sampled for external and internal pot temperatures with data loggers. Weekly, a small percentage of plants were selected to measure leaf photosynthetic, and gas exchange using LiCor 6400 instrumentation.

Harvest dates included May, July and August and compared growth and mass to determine treatment effects. Entire plants were destructively harvested and measured for growth and treatments effects. Roots were carefully scanned to measure length and width to capture root volume and size ratings using specialized software.

The project was designed to identify primary sources of the heat. Some literature indicates the heat originates from the solar radiation (convective) from the side walls of the pot. Other literature indicate from the transfer of heat from the asphalt to the pot (conductive). If we can identify and quantify effects of these sources of heat and educate the retailers, they can modify their nursery facilities in an effort to maintain high value nursery stock during the retail phase. The project was intended to measure how much could a more reflective surface such as white versus black to mitigate the soil media temperature. The project seems to clearly determine significant differences of treatment effects contrasting colors and internal and external temperature differences (see below). The project clearly determines that there are significant differences in soil media temperatures between pallets and asphalt surface types. There seems to be differentiation between how the four tree species tolerate from both a belowground and aboveground perspective) and how both zones respond to the conditions. Some species seem to be more resilient than others (hackberry vs oak). The project incorporated a powerful piece of equipment that measured leaf gas exchange and photosynthetic responses to the treatments and has not been fully analyzed at this point. This project clearly indicates there are significant modifications that can be implemented to maintain plant quality during the retail phase of nursery stock (i.e. white pot on pallets). This information will help guide best management practices for retailers and it is our hope that it can inform homeowners to avoid plant material that has not had some of these management practices implemented. Some of the results and suggestions will be addressed in the Goals and Outcomes achieved.

Expected Measurable Outcomes:

To our knowledge, there is no present research that has determined the stress on fine roots in retail centers, and as such the data from this study will create the benchmark. It is likely that further research will be needed to identify cultural methods to reduce plant stress in retail centers.

Work Plan(light blue = original work plan)

Research design

Plot designs:

This project requests covered 30 months and constructed simulated ~~production and~~ parking lot garden center settings. This project selected nursery stock from the Iowa Department of Natural Resources State Forest Nursery located in Ames, Iowa. The plants will be selected and graded for uniformity and planted in SB 300 potting soil in commercially available 5 gallon nursery pots. They will be grown for one growing season before pots will be randomly assigned to treatments (2 common retail storage and display methods for container grown woody nursery stock. (hard surfaced areas such as concrete or asphalt and raised up from hard surfaced areas on wood pallets)). The research will take place at the Iowa State University Forestry Greenhouse parking lot. ISU will hire 2 undergraduates to water and care for the trees and take measurements throughout the main growing seasons.

The research project will have a split plot-randomized block design. There will be 3 harvest dates including initial May harvest, and July and August harvest dates. There will consist 5 treatment blocks per harvest date. Each treatment block will consist of 4 plants of each species of trees. Each block will consist of 16 plants. Each block will have 1 of each treatments on all 4 species of plants; white pot on pallet, black pot on pallet, white pot on asphalt, black pot on pallet. In July and August approximately 120 plants were harvested.

During the growing season data collection will include*; date of bud break and date of full leaf expansion, green wood expansion, stomatal conductance and photosynthesis rates, as well as internal and external container temperature will be measured. Weather stations will track weather, internal and external pot temperatures every five minutes to correlate with both plant photosynthesis and conductance measurements. The project will also destructively sample trees at initiation point, the initial planting date, T1 and T2, where root length and mass, root to shoot ratio, specific root mass, stem caliper and height, whole plant leaf area . ISU will hire additional undergraduates to process the destructive samples in early fall.*

Activity (yellow = additional edits)	***Who***	*Timeline*	*Status of Activity (red = latested edits)*
Fall 2014; Purchase from the IDNR State Forest Nursery-Large 18-30 inch nursery stock of 4 species (red oak,	*Iowa State Forestry*	*Fall 2014 after IDNR harvests trees from Ames*	*Seedlings were purchased from IDNR stte forest nursery and held in ISU forestry greenhouse cooler until the*

swamp white oak, river birch, hackberry) store in cooler for dormancy period 2 months		*production fields.*	*start of the project*
Early Spring 2015; In Early February sort seedlings to uniform seedling size and plant seedlings into 5 gallon pots in SB 300 potting soil. During Establishment year, seedlings will be allowed to grow in ISU Greenhouse under 16/8(Day/night) light regime from February until late June. Seedlings will be watered twice daily and fertilized weekly w/ a complete fert.	*ISU Technician, 2 students, Randall, Krull*	*February-June 2015*	*Over 600 plants of 4 species in 2 pot colors were graded for uniformity both above and belowground structures. Stored in the cooler at ISU and allowed to hydrate and warm stratify with roots in water for 48-72 hours before planting. They were all planted within 48 hrs and transported to one of 2 greenhouse bays with 16/8 (day/night) light availability and watered twice daily and fertilized weekly. It became evident that twice a day watering was too much and was backed down to once every other day.*
August 2015; Seedlings will be removed from the greenhouse facility and be placed on benches outside to begin hardening off process.	*ISU Technician, 2 students, Randall, Krull*	*August 2015*	*Seedlings were removed from the greenhouse and placed on elevated platforms outside in mid august to harden off.*
Fall 2015; Construct the field production simulation trial at the Horticulture Farm. Seedlings will be moved to the overwintering facility owned by the IDNR State Forest Nursery once all seedlings have gone dormant (mid--November)	*ISU Technician, 2 students, Randall, Krull*	*July-November 2015*	*Field production site had grown cover fabric placed down and all pots were placed on it. They were staked so wind did not knock them over. Drip irrigation was run. We opted to us an open hoop house with temperature controlled autorollup sides at the hort farm instead of the IDNR nursery facility. We found that the overwinter temperature in the facility did not get low enough and remain consistent enough for proper overwintering of hardwoods.*
Spring 2016; Remove seedlings from the storage facility and randomly assign the pots to treatments. (T1) Destructively sample 25 individuals to obtain initial growing season root length, mass, non-structural carbohydrate reserves, C:N ratios, individual tree ring growth, caliper and height measurements. Install "permanent" hobo instruments in each of the 7 treatments.	*ISU Technician, 2 students, Randall, Krull*	*Spring 2016*	*Removed all pots and reduced down to 440 seedlings in the above mentioned classes (species, white vs black pot, asphalt vs pallet blocks). T1 pots were destructively harvested and sectioned for above and belowground measures. Hobo data loggers along with a suite of sensors were installed and activated*
Summer 2016; Throughout the spring and summer we will evaluate date of bud break, leaf expansion, green wood expansion in the early summer grow	*ISU Technician, 2 students, Randall, Krull*	*Summer 2016*	*All measures were collected and entered into the database . data collections was a continuous process. Daily external pot temps at 3 defined*

out period. Measure stomatal conductance and photosynthesis weekly for a randomly selected subset of replicate trees and treatments once full leaf expansion has occurred. External pot temperatures will be taken with a laser temperature gun on all 4 sides of the replicate pots.			*times per day occurred almost daily unless rain. Photosynthesis occurred daily unless rain or high humidty did not allow for vapor pressure differences to be determined.*
September 2016; (T2) Destructively harvest the remaining 5-10 seedlings to quantify root length and mass, root to shoot ratios, specific root length, specific root mass, root, stem and leaf C:N ratios, stem caliper and height growth, whole plant leaf area, stem bark thickness.	*ISU Technician, 2 students, Randall, Krull*	*September 2016*	*Modified harvest timing in response to ISU research committee. Initially harvested 60 randomly selected plants in May for baseline of starting values for project. A team of undergraduate research techincians destructively harvested the seedlings and scanned all roots . by the last harvest there was over 15,000 images from the 440 pots. It took a team of 4 undergraduates 3000 hrs to individually clean each image and analyse it for root length, volume by size class. This work is so labor instensive that virtually no other study has looked at complete root systems.*
Fall-Summer 2016-2017; All samples will be dried at 70C, ground in whiley mill, and analyze for C:N, fresh root length and leaf area will be calculated with WinRhizo software, and dried leaf, stem and root mass will be measured. Results will be analyzed with JMP analytical software. Prepare written extension materials, peer reviewed publications, and presentations throughout the process. Results and written materials will be sent to retailers statewide while making presentation and extension materials available online.	*ISU Technician, 2 students, Randall, Krull*	*Fall-Summer 2016-17*	*Modified harvest timing in response to ISU research committee. Due to change of location of project from Hort farm to Parking lot design was modified. Split-Plot Randomized block design was chosen. Two harvest dates during treatments including July and August. Each harvest date had 5 blocks consisting of 16 plants, harvesting 120 plants per harvest. The data collection indicated in work plan was mostly followed excluding C:N ratio. Data is currently being analyzed and extension material, publications and outreach is still planned for future.*
Late Summer 2017 Report to funding sources	*Krull, Randall*	*Summer 2017*	
Additional activity:			
Present information to the Iowa Nursery Landscape Association, Horticulture Inspection Society, Central Plant Board and other organizations	*Krull, Randall*	*When research is finalized*	*When data analysis analyzed will plan to present at the INLA, Hort Inspection society, and central plant board organizations as well as shade tree short course*

Goals and Outcomes Achieved (directly from the proposal highlighted in light blue)

The research from this project will quantify the amount of root death occurring across a range of retail variables and if successful, the work will lead to calculations of plant stress and loss of growth. These calculations will be valuable to all aspects of the nursery industry and will provide information to state regulatory authorities, growers, and retailers to promote change in the cultural methods of caring for retail nursery stock. The long term goal of this research is to provide science based research that will help establish new BMP's for the garden center industry and at the same time give consumers the highest quality nursery stock to plant in Iowa.

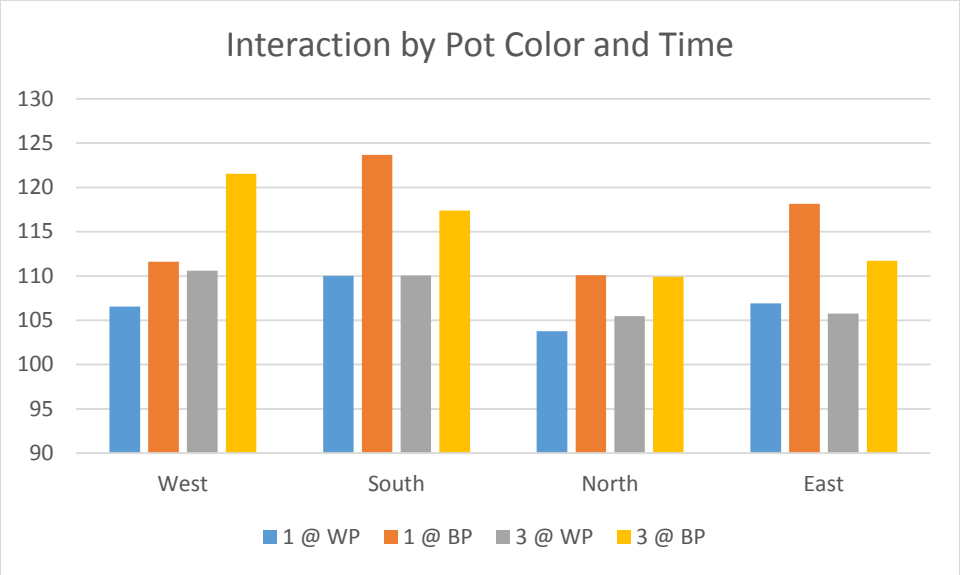
Identified were several key factors in best management practices that could be easily implemented in the retail phase for nursery stock.

- South and Western exposed pot surfaces were consistently hotter than East and North sides by an average of 8-12 degrees F. concomitantly internal pot media temperatures on black pot with asphalt surface were also 10-12 degrees warmer than white pots on Pallets. The BMP take home – protect / shade the sides of the pot on the south and west side and preferably grow or purchase only seedlings in white pots. Also putting both white and black pots on pallets helps so a combination of white pots on pallets protected from the suns radiation on the west and south will improve soil temperatures.
- Block 3 August Average temperatures

Avg. by Time of Day	West	South	North	East
1pm	109.16	117	107	112.7
3pm	116.4	113	107.8	108.9

External Pot Temperatures were taken and the following graphs were used to show interactions of treatments as follows

Graph 1. Interaction by Pot Color and Time of Day



- White pots cooled down in the overnight period close to ambient temperatures, whereas black pots did not, and this was even more impacted by surface type with pallet cooling greater than asphalt.
- Species do vary in their ability, to some degree, to tolerate increased root zone temperatures.
    - Red oak seedlings grown in black pots on asphalt had 50% fewer roots by mass that seedlings in black pots on pallets. There is less of a surface type influence when red oak is grown in white pots but asphalt still reduced root mass by ~30%.
    - White oak seedlings showed the greatest response to both pot color and surface type treatments among all seedling types tested. White oak grown in white pots on pallets were almost 375% greater than white oak seedlings grown in black pots on asphalt.
    - Hackberry, the most “environmentally plastic species” of all tested, showed very little root difference or “preference” across surface type or pot color in terms of overall root mass (g).

BMP take home messages – If growers are not willing to grow in white pots or dealers (box stores) buy for resale trees in white pots or present them for sale on pallets to provide an air buffer from the asphalt it is best to sell more environmentally plastic species such as hackberry. Additionally dealers and growers should increase the return / replace warranty (typically 1 year) up to 5 years for anything but hackberry. From the regulatory standpoint it should be mandated that only white pots are to be sold in

iowa, and retailers should never store potted living trees on asphalt, and some form of south or west pot shading should be used.

Beneficiaries

Due the transient nature of the industry, in that such high volumes of matueral is transported in from wholesale commercial growers it is hard to determine the number of beneficiaries for the production side of the research. As stated above the national industry in potted trees is estimated by USDA to be a 3.8 billion dollar industry and this work will or should influence every single commercial grower if state regulatory agencies read and act on the findings of this work. Locally to Iowa it is directly applicable to 300 growers and over 2000 tree nursery stock dealers (lowes, Walmart, home depots, thesiens, bomgaars etc.

Lessons Learned

The project was very successful and was able to identify and partially separate the different factors impacting root zone temperatures during the retail phase of nursery stock. Black pots on asphalt significantly had increased media temperatures compared to the White pots on pallets. The project showed that multiple times the media temperatures were above 120F throughout the growing season. The project as anticipated showed that there is an accumulative effect of both solar radiation on the sides of the pots and absorbed heat from the surface types. The surface types showed the least amount of overnight cooling occurred on asphalt, not allowing the soil media to cool overnight. This lead to increase fine root death as the soil literally baked the seedling roots. The project also was able to determine that the South and West facing pot exposures were impactful on root growth. The pictures Figures 1-4, shows root death and the plant was likely not able to tolerate the higher media temperatures in those respective quadrants of the pots. In the coming months we will be quantifying the root length data by size class to accurately describe which size class(s) of roots are impacted by elevated soil media temperatures. Reductions of fine roots can lead to reduced nutrient and water uptake leading to lower overall plant growth and functioning which is reflected in higher plant stress and mortality. Interestingly, species more accustom to variable environments (flood zones etc.) tolerated the treatments than the species accustomed to drought conditions. White pots had significant effects on seedling root temperatures keeping the roots cooler throughout the day across the growing season. West and south facing pot sides and soil temps were hottest and plants responded by growing fine roots on the north and west side (See Figures 1-4) Major take home messages from this work would be 1. Nursery growers should only grow plants for retail center sales in white pots, and 2. Retail centers could create a small light colored barrier to block the sun radiance from hitting and warming the south and west side of the pots. They could also have drip irrigation that is tied to both soil moisture content but also soil temperature, watering for both hydration needs and cooling. They could also time watering applications for the period between 1-4 pm to reduce media temperatures via evaporative cooling.

Figure 1 Hackberry Number HB05BP (Black Pot)

Figure 2 White Oak Number WO33BP (Black Pot)

Figure 3 Red Oak Number RO04WP (White Pot)

Figure 4 Red Oak Number RO30WP (White Pot)

*Left side of images are the west facing side of the pot

Figure 1

Figure 2

Figure 3

Figure 4

Contact Person

Jesse Randall – 515 294-1168

Ryan Krull – 515-330-7453

Additional Information

Project Title: Iowa Grown is Iowa Good Promotion (radio campaign)

Project Summary: Increasing supply and demand for locally-grown specialty crops by utilizing a radio campaign. This campaign targeted the harvest season of less recognized Iowa specialty crops and tied them into other Farm to School initiatives to create a larger impact.

This project was timely due to other efforts to increase knowledge of less commonly procured fruits and vegetables. School campaigns focused on things not automatically associated with summer in Iowa (sweet corn on the 4th of July). Instead we introduced other seasonal items such as peppers, asparagus, berries and melons. By celebrating our local produce and those growing it during National Farm to School Month, school's had the opportunity to receive fruit and vegetable journals. These journals offered recipes and alternative ways to eat fruits and vegetables (steaming them) or creating noodles out of squash. At the same time, students were to track their intake of fruits and vegetables while setting a goal to increasing their consumption of them.

Project Approach: We contacted our State of Iowa's Department of Administrative Services to seek information on companies in the state of Iowa that could:

- Create short, 15 and/or 30 second customized ad for each crop/season with unique messaging,
- Ability to record radio spots via professional production services
- Contracting and invoicing through one contact
- Provide summary of total stations, total local messages, total campaign weeks
- Radio stations selection must utilize both metro and rural radio stations targeting all 99 Iowa counties
- Campaigns must air around harvest times of selected specialty crops

A notice was sent to 5 companies and a contract was provided to Learfield Communications, Inc. Several meetings were held to discuss the promotions and crops to be featured. Creative sessions were held to create ads featuring berries, melons, asparagus and peppers in conjunction with the harvest of each. We utilized the voice of our highly-respected Secretary of Agriculture to remind consumers that "Iowa grown fruits and veggies are Iowa good, for all of us."

Goals and Outcomes Achieved:

The total campaign exposure equaled: 812,200 net reach (statewide) with a frequency of 3.2 (average number of times the same person was reached) for a total gross impression of 2,609,800 (total number of times the campaign was heard including multiple impressions. To simplify the numbers, we blanketed the state as inclusively as we could with 65 radio stations that broadcast into 69 markets.

The Local Farm to School Purchase Report compiled by AMS showed an increase of 215% in the purchase of local fruits and vegetables from $62,722 to $134,852 (July 2017). Unfortunately, it falls short of the goal of increasing the number of schools reporting.

Beneficiaries:

Consumers across the state, students and specialty crop producers benefited as a result of this project.

Our students benefit from the education and opportunity to experience fresh fruits and vegetables – many of which they are trying for the first time. Having a tool to show growers the purchases being made by schools and the prices paid, takes many questions and some risk out of the equation. If

they know there is a market, they can increase production while minimizing risks, ultimately increasing access and consumption of the specialty crops.

The commercials drew attention to the availability of specialty crops that are not necessarily common knowledge for Iowans.

New information available based on Nielsen Research, the campaign total listenership impact shows that 589,000 people heard these messages with a frequency of 2.7 times and a total gross impressions of 1,1571,800.

Lessons Learned:
Radio was a cost effective way to spread the word across the state about the harvest schedule and benefits of purchasing locally grown specialty crops. While the AMS Local Farm to School Purchase Report is a wonderful tool to increase knowledge and ultimately production of specialty crops, the reporting is anonymous. Promotions of this have occurred through the Iowa Department of Education state meetings and conferences as well as in newsletters. Without the ability to know which schools are reporting it makes increasing the school base more difficult as we do not know what areas of the state to have a more concentrated effort.

AMS is responsible for multiple market reports. The anonymity used to protect businesses is also applied to this program; however, we are working with AMS to begin collecting additional items such as the number of different growers in which schools are purchasing.

Contact:
Tammy Stotts,
Farm to School Coordinator
Iowa Department of Agriculture and Land Stewardship
502 E 9th Street
Des Moines, IA 50009
Tammy.stotts@iowaagriculture.gov
515-281-7657