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DEPARTMENT OF AGRICULTURE

Specialty Crop Block Grant Program FY 2014 Annual and Final Performance Reports

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Project Title

Determining the Incidence and Distribution of Important Diseases of Dry Yellow Peas, a New Crop for Nebraska – PI – Robert M. Harveson

Project Summary

The last several years have been characterized by a substantial increase in interest for growing dry yellow peas in Nebraska and other states in the surrounding Central High Plains. A large part of this interest in the cultivation of dry peas is based on its role as a short season crop with a relatively low water requirement. This is good news for those who may be severely restricted without access to readily available water resources. Additionally, previous work from South Dakota has observed yield increases from dryland wheat following the pea crop, presumably due to the nitrogen put back in the soil by the peas.

Due to the rapid increase in interest and planted acreage of dry peas throughout western Nebraska we conducted a comprehensive 3-year study (2015-2017) with the purpose of identifying the most prevalent and important diseases in Nebraska dry pea production. Over this period we surveyed more than 90 fields (30 in 2015, 41 in 2016, and 20 in 2017). From these fields, we collected and processed more than 700 samples cumulatively representing the majority of the counties in western Nebraska that grow peas, including Sheridan, Box Butte, Sioux, Morrill, Keith, Garden, Deuel, Cheyenne, Kimball, Banner, and Scotts Bluff. We additionally visited and collected samples from two seed production fields in central Nebraska in Arnold County, northeast of North Platte in 2015.

The concept for this project was similar to one we conducted several years ago that was also funded by the Nebraska Department of Agriculture. We previously surveyed western Nebraska production fields looking for dry bean–pathogenic bacterial wilt isolates found associated other crops grown in rotation with beans including corn, wheat, soybean, proso millet, sunflower, and sugar beets. As a result of this study, we developed several novel techniques for rapidly isolating and identifying bacterial isolates from large numbers of plant samples, and that information learned was implemented in the present 3-year dry pea survey.

Project Approach

The primary goal for this study was to conduct a comprehensive survey of Nebraska production fields to determine incidence and distribution of diseases affecting yellow peas. In 2015, we collected 105 bacterial isolates that were identified as either: *Pseudomonas* spp. or *Xanthomonas* spp. and 5 unknowns. In addition we also tested another approximately 50 plants that were affected by root/stem diseases. We isolated and identified 24 fungal isolates consisting of *Fusarium* spp*., Rhizoctonia solani, Pythium* spp., *Sclerotinia sclerotiorum,* and *Macrophomina phaseolina*. These five soil borne pathogens are responsible for Fusarium and Rhizoctonia root rots, white mold, and ashy stem blight, respectively. Lastly we also identified another foliar fungal disease, powdery mildew, in one field late in the season.

The studies from 2016 and 2017 produced very similar results. Bacterial isolates collected numbered 143, which was almost 75% of the total samples collected. Of this number of isolates, more than one half were identified as *Pseudomonas* spp. Approximately 10-15 additional *Xanthomonas*-like isolates were also collected as well as another 55-60 unidentified bacterial isolates. The unidentified bacterial are probably a *Pseudomonas* spp., but that is yet to be determined.

Forty-five additional samples yielded several fungal root and stem pathogens including *Rhizoctonia, Pythium,* and *Fusarium*, with *Fusarium solani* being the most prominent fungal pathogen detected, as seen from 2015. However, powdery mildew, white mold, and ashy stem blight were not detected from any samples collected in 2016 or 2017.

Our primary collaborators in this study to date were growers and crop consultants who helped us locate fields and collect samples, but we scouted fields and collected the majority of the samples. Some samples (approximately 10-15%) were collected and brought to us for disease identification by crop consultants.

Goals and Outcomes Achieved

As a result of this 3-year project, we have identified what appear to be the most important diseases of dry peas in Nebraska. By far, the most consistently occurring problem that has been observed across the entire region is a bacterial blight of pods and foliage. These diseases are caused by at a complex of at least two different, but closely related pathogens: *Pseudomonas syringae* pv*. pisi* (*Psp*) and *Pseudomonas syringae* pv. *syringae* (*Pss*). The *Pss* pathogen is well-known to dry bean growers in Nebraska as it is the causal agent for the bacterial brown spot disease. The *Psp* is more restricted in host range, causing a leaf spot and blight disease primarily on peas.

We also suspect that yet another bacterial pathogen(s) may be involved in this disease complex. As a result of this study we have additionally acquired approximately 20-25 isolates presumed to be in the genus *Xanthomonas* and a number (35+) of unidentified isolates. All these unknown isolates will have to be tested eventually for pathogenicity on peas as a part of their continued identification and characterization. Lastly, in one location in 2015 we found another bacterial disease called pink seed, caused by *Erwinia rhapontici.* This finding was published as a first report for this uncommon disease occurring in Nebraska (see ADDITIONAL INFORMATION).

In addition we also collected and tested another approximately 95 plants over this 3-year period that were affected by root/stem diseases and one foliar fungal disease (powdery mildew). These pathogens consisted of *Fusarium* spp*., Rhizoctonia solani, Pythium spp., Sclerotinia sclerotiorum,* and *Macrophomina phaseolina*.

Beneficiaries

This information should be of benefit to any grower or crop consultant in Nebraska that has any involvement with dry peas. A major anticipated measurable outcome was to identify the most commonly occurring diseases of pea in Nebraska. A second one was to learn to recognize signs and symptoms associated with certain diseases and how to distinguish them from each other.

Both of these outcomes are important for future disease management. We need to know which diseases are causing problems currently, and how to recognize and differentiate them. For producers to choose the right management tool, they also must understand which diseases are present, the differences between them, how to distinguish them, and why certain control methods would be effective for some diseases but not others. We feel like we have successfully accomplished these two outcomes.

The results obtained from the study have been delivered to many different constituents. We have presented our findings at various meetings (UNL Crop Protection Clinics, Nebraska Dry Bean Growers Association annual meetings) consisting primarily of producers and crop

consultants. Over the 3 year period, this includes well over 600 participants. We have also published results in grower newsletters and local newspapers. Circulation of these publications exceeds 20,000, so this is a relatively accurate estimate for potential readers and users we have reached.

Lessons Learned

The primary and most important lesson we have learned from this survey was that bacterial blight was the most commonly occurring and widespread disease of dry peas in Nebraska. We also learned that this blight was caused by a complex of several different bacterial pathogens, with the highest incidence being two *Pseudomonas syringae* pathovars (*PSP* and *PSS*). It was also important for us to conclude that root rots caused by several soilborne fungi are not as important as the bacterial blight diseases. This is radically different from the situation in a major neighboring dry pea- producing state (North Dakota), where the predominant diseases are the root rots. Therefore we feel confident that we achieved our primary goal with surveying and identifying the most important diseases for later management decisions.

Previous reports have suggested that the pea bacterial blight pathogen, (*Psp*) was an early-season, cool weather pathogen, restricted primarily to the lower part of the plant canopy. Thus it should not theoretically pose a severe risk for Nebraska producers once conditions become hot. However, we consistently noted bacterial infections on pods and upper leaves occurring from numerous fields in all 3 years of the survey during the heat of mid-summer with the subsequent isolation of bacteria resembling *Pseudomonas syringae*. It is likely that this is due to the brown spot pathogen (*Pss*) that is more commonly associated with warm conditions, but we have not completed the tests that separately identify the correct pathovar from all the *Pseudomonas* isolates collected. This technique for distinguishing between the two pathogens was also developed as a result of this study. This is an important finding as it indicates that *Pss* is widely distributed and thus will be a force that will also require attention.

Furthermore, the discovery of multiple *Xanthomonas*-like isolates was somewhat surprising, but their role is yet unknown. The bacterial pathogen, *Xanthomonas axonopodis* is known to cause two distinct diseases of dry beans (common and fuscous blights), but is thought to be rare in peas. In fact, we are uncertain whether it has ever been reported on dry peas.

Lastly, as a result of this survey, we identified and published a refereed journal article on a new disease previously never reported from Nebraska called pink seed. This is another bacterial disease that produces a pink pigment that discolors plant tissues and seeds. More work is required for complete confirmation, but we are certain that this survey has uncovered the presence of one previously unidentified bacterial disease in Nebraska pea production (pink seed) with the strong possibility for finding another disease with common blight.

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Project Title

Hops: Building a Sustainable and Successful Foundation

Project Summary

The project purpose was to enhance knowledge and education regarding hops production in Nebraska thereby encouraging growth of this industry. Increasing production in this specialty crop will serve to close the gap between supply and demand.

Two specific issues/needs that were addressed are:

1) Lack of knowledge about hops production in Nebraska as a viable specialty crop. People wre genuinely unaware that hops production can be successful in Nebraska. Growth of the hop industry will allow Nebraska breweries to diminish their dependence on ingredients acquired out of the state. Using local suppliers also translates to overall energy savings and less of a negative environmental impact. Education about hops as a specialty crop is essential to bridging the gap on this need.

2) There is a demand market for hops in Nebraska. In 2012, the National craft beer industry experienced 15% growth by volume and 17% by retail dollars to $14.3 billion according to the Brewers Association (Laurel White, Brewer's Association, 3/18/14). This is reflective of the growth in the Nebraska craft beer industry which has experienced consistent double digit growth since 2008.

This project is important and timely because hops are an essential ingredient in beer production. The hop industry is ill equipped to supply the craft beer industry with its current production volume and this is especially true in Nebraska. Significant demand for locally grown hops exists currently in Nebraska which far outweighs local production.

The objective of this proposal was to create awareness and recognition that hops can be a sustainable specialty crop in Nebraska. This objective illustrates evidence of hop production growth and enhanced overall knowledge of this specialty crop along with documented evidence of commercial brewer demand.

Project Approach

Year 1

GOAL #1: Increase commercial hop grower production 20% by September 2016.

During 2014-2015, education and consultation on hops production was achieved through use of the Nebraska Hop Growers Association (NHGA) Facebook page, membership meetings, and educational seminars. Below is a summary of the Project Approach.

The NHGA Facebook page, which can be found at https://www.facebook.com/Nebraska-Hop-Growers-Association-385532614825381/?fref=nf, has 559 followers. Members share pictures, stories, knowledge, and and use it as a forum to ask questions to other growers. In Septermber 2015, NHGA selected and meet with a website and marketing material contrctor to outline the expectation and timeline for deliverabls. The contractor will work with NHGA to develop the website, produce brochcures, and other marketing materials to aid in the promotion of the hops

industry. A team of members have been identified to assist in the development of brochure content.

A NHGA officer meeting was held in February 2015 to review the details of the SCBGP grant. The officers outlilned the grant deliverables, outcomes, potential contractors, survey tools for baseline data measurement, and timeline. An Educational Committee was formed to focus on creating member opportunities for collaboration and learning.

Several events have been held to promote hops as a sustainable crop and to provide members and new hops enthusiasts with crop information. Educational events have included the following:

1. Information table on display at Big Green Tomato in October 2014. Approximately 20 people attended.

2. Presentation at the Nebraska Sustainable Ag Society in Nebraska City in October 2014. A total of 15 people attended this meeting.

3. Hop yard educational tour at Duffin Knudson Hop Growers was held in March 2015. A total of 21 people attended this event.

4. Hops presentation was delivered at the Farmers Grange Society in July 2015.

5. Hop yard tour at the Bauman Hop Farm was held in July 2015, and approximatly 13 people attended this event.

6. A tour of Midwest Hops Yards was held in October 2015. Approxiately 18 people attended this event.

A goal was established in the grant to increase commercial hop grower production 20% by September 2016. NHGA's membership has increased from 14 commercial hop growers in 2014 to 18 in 2015. The 2015 NHGA member contact list illustrates achievement of this goal. NHGA hopes to reach 19 members by the end of 2016.

GOAL #2: Define and increase commercial brewer demand for locally grown hops 20% by 2016.

In 2014, a commercial brewer survey was written. It was designed to determine how many commercial breweres use (and would like to acquire) locally grown hops. Surveys were sent to 15 commercial breweries to caputure the demongraphis, inventory, and interest in sourcing locally grown hops. They were also used to maintain NHGA's contact list of brewers, growers and partnerships. All of the surveys sent out were completed and returned.

<u>Year 2</u>

GOAL**:** #1) Increase commercial hop grower production by 20% by September 2016.

During 2015-2016, education and consultation on hops production was accomplished through use of the Nebraska Hop Growers Association (NHGA) Facebook page, membership meetings, and educational seminars. The NHGA Facebook page currently has 816

followers, a 31% increase over last year. Members share pictures, stories, and beer information. It is used as a forum to ask questions of other growers.

Three meetings were held on February 13th, 2016. An officer meeting was held (attendance-4) to develop a Website Committee and a Marketing Mmaterials Development Committee. An NHGA grower meeting (attendance-24) was held to approve the final 2015 grower member list, elect officers, discuss special project committees, review financials, define the NHGA logo, and receive an update on the Hop Cup event.
A general membership meeting was held (attendance-38) to provide updates on the USDA grant deliverables, LB 1152, and the NHGA Education Committee. A report from the University of Nebraska-Lincoln was released and discussion ensued regarding current collaboration efforts. President Silas Clark gave a "State of the NHGA Address" to the audience.

Several events were held from 2015-2016 to promote hops as a sustainable crop and to provide members and new hops enthusiasts with information about the crop.

Educational events included:

- Hop Cup Event 1/31/16 (110 attendees)
- Basic Hop Grower Workshop by Midwest Hops 2/20/16 (45 attendees)
- Advanced Hop Grower Workshop by Midwest Hops 2/21/16 (45 attendees)
- Bauman Hop Yard Tour 5/14/16 (10 attendees)

2016 NHGA Grower Survey Data:

Number of Respondents	16
Average years growing	3
Maximum years growing	8
Minimum years growing	0
Mean years growing	2
With formal training	6
Average people tending hops	2.066667
Maximum people tending hops	5
Minimum people tending hops	1
Mean people tending hops	2
Average number hop yards	1.3125
Maximum number hop yards	4
Minimum number hop yards	1
Mean number hop yards	1
Acres in yards	34.72143
Growers using tepee	4
Growers using rows	13
Length of linear rows	18467
Average plant to plant spacing	34.76923
Max plant to plant spacing	42
Min plant to plant spacing	15

Mean plant to plant spacing	36
Average same species row to row spacing	9
Max same species row to row spacing	14
Min same species row to row spacing	3
Mean same species row to row spacing	10
Average different species row to row spacing	10.11111
Max different species row to row spacing	14
Min different species row to row spacing	0
Mean different species row to row spacing	12
Single string trellis	4
V trellis	11

Hop Varieties:

Cascade	8
Centennial	7
Chinook	6
Magnum	5
Sorachi Ace	4
Nugget	3
Willamette	3
Crystal	2
NEO1	2
Perle	2
Saaz	2
Zeus	2
Amalia	1
Brewer Gold	1
Cashmere	1
Cluster	1
Fuggle	1
Glacier	1
Newport	1
Northern Brewer	1
Sterling	1
Tahoma	1
Ultra	1

2016 Hop Crop Reports:

Grower Member State	**Dried Pounds**	**Wet Pounds**
Nebraska	1899 lbs.	425 lbs.
Iowa	1200 lbs.	325lbs.
South Dakota	461 lbs	

A target was established in the grant to increase grower members beyond the 2014 number of 14 with a targeted growth of 20% to 16 commercial growers during the grant. In 2015, the NHGA member contact list illustrated achievement of this goal at 18

commercial growers. A stretch goal for 2016 was set to reach 19 growers. The 2016 grower member total reached was 21, a 24% increase over the original target goal. In the final year of the grant, NHGA will set a stretch goal to reach 25 members during the grant period, which more than doubles the original target.

GOAL: #2) Define and increase commercial brewer demand for locally grown hops by 20% by 2016.

A 2014 commercial brewer survey was completed. The survey inventoried Nebraska commercial brewers who use locally grown hops and those who would like to acquire locally grown hops for their use. Survey return rate was 100% (15 commercial brewers). An annual contact list of brewers, growers and partnerships is maintained.

In 2015 – 2016, through the push of the NHGA growers, two additional Nebraska brewers (Keg Creek & Upstream Brewing Co.) utilized wet hops in their beers. One out-of-state brewer also obtained wet hops from a member grower. Combined, these three brewers achieved the second goal of this project.

The use of wet hops in the production of beer allows the area growers to be more profitable because input costs are decreased by not having to dry and package the hops before the use in beer. As breweries have beers on tap with NGHA grower hops, our NHGA facebook page is used to share this information. As the craft beer industry continues to grow, the support of this grant to achieve development of our NHGA website will serve as a tool to share best practices and support both growers and brewers in this important partnership.

Year 3 and Project Conclusion

Nebraska Hop Growers Association (NHGA) leadership convened to define the problem/issue to be addressed by the grant; defined necessary timelines and activities, and have overseen the deliverables and outcomes of the grant project.

Numerous surveys were completed with NHGA grower members and commercial breweries though out the grant cycle to assess progress on defined objectives. In addition, NHGA officers, reviewed progress of website and other marketing materials throughout the grant cycle.

The monitoring plan for these goals, objectives, and performance measures was ongoing. A progress report was completed annually and updates were provided during NHGA meetings.

Grant Activities :

- New NHGA logo created
- NHGA website developed-average 542 site visits/month
- Marketing materials created-NHGA table throw; NHGA rack card; NHGA banner; and NHGA tin tackers (see pictures at end of report)
- Numerous educational and promotional events sponsored and attended (see table 1)

Table 1:

NHGA Educational & Promotional Events (2015-2017)

Event	Year	Attendees
Ne Lead Program Hop Yard Tour	2017	25
Inaugural Grower-Brewer Conference	2017	85
Farmer's Ranchers Tailgate Event	2017	400
UNL Hop Harvest Demonstration	2017	52
Horticulture Inspection Society	2017	35
Food Security Workshop	2017	55
Basic Hop Grower Workshop	2016	45
Advanced Hop Grower Workshop	2016	45
Bauman Hop Yard Tour	2016	10
Midwest Hop Yard Tour	2015	21
Duffin Knudson Hop Yard Tour	2015	21
Presentation at Ne Sustainable Ag Society	2015	15
Table/Info Display at Big Green Tomato	2015	13

Source: NHGA Members

The Hop Cup has become an annual event. The goal is "growers and brewers working together to advance craft beer in Nebraska". Nebraska Brewing Company hosts this event along with NHGA and the Nebraska Craft Brewers Guild (NCBG). Each year the event has grown (see Table 2 and 3). This event engages numerous Nebraska Breweries with NHGA Growers to create special beer using only 100% Nebraska grown hops. Attendees at the event have the opportunity to vote for their favorite beer. A traveling trophy is housed at the Brewery that wins this People's Choice event. All proceeds go to benefit the NHGA and the NCBG.

Table 2:

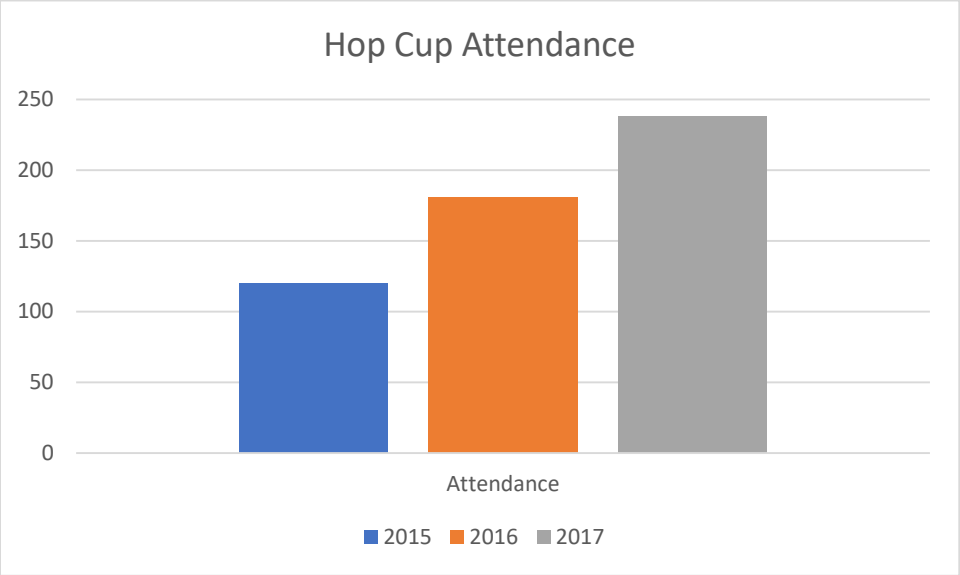
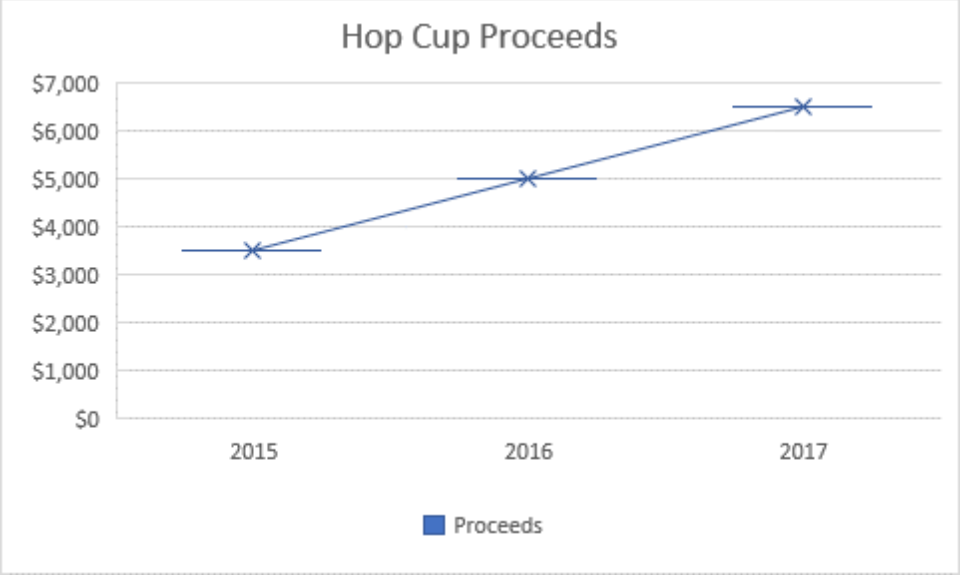


Table 3:



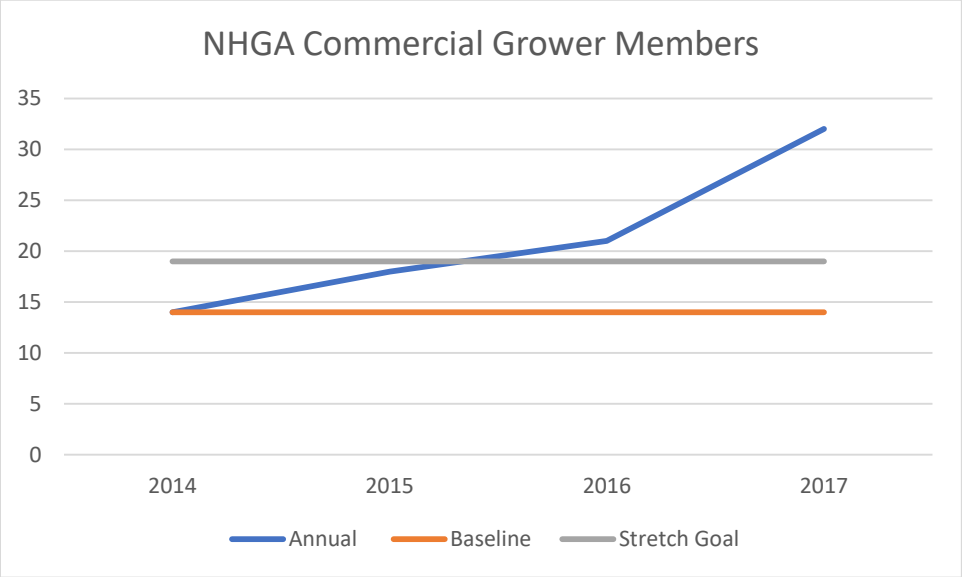
Goals and Outcomes Achieved

NHGA commercial grower members were engaged in annual meetings and various educational events. In addition, growers were surveyed to understand member demographics (hop type; challenges; acres, number of plants, etc.). See 2016 progress report.

A major project goal was to increase Hop Grower production by September, 2016. An outcome indicator of this goal was an increase in NHGA grower member numbers. A goal was

established in the grant to increase grower members beyond the 2014 number of 14 with a targeted growth of 20% to 17 commercial growers during the grant. In 2015, the NHGA member contact list illustrated achievement of this goal at 18 commercial growers. A stretch goal for 2016 was set to reach 19 growers. The 2016 grower member total reached was 21, a 34% increase over the original target goal. In the final year of the grant, NHGA set a stretch goal to reach 25 grower members, a 44% increase in growers during the grant period which more than doubles the original goal. NHGA has achieved a grower member increase from 2016 from 25 to 32 in 2017. (see table 4).

Table 4:



Beneficiaries

The NHGA's four target beneficiaries of this project included: a) Beer and hop enthusiasts who are involved in agriculture and eager to bring a new specialty crop to their local community; b) Craft commercial brewers who are interested in using local agriculture products in their brews thus developing a self-sustaining local community; c) Home brewers interested in using local hops in their brews; and d) Nebraskans and those visiting within the state that enjoy craft beer and appreciate it even more if local products are used in the brewing process.

The Brewer's Association stated that the Nebraska craft beer industry reported in 2012 a total labor income of $59.7 million and in 2013 a total economic impact of $193.6 million economic impact will be realized by hop growers, commercial brewers, home brewers and beer enthusiasts.

Specialty crop stakeholders who were involved and supported this project included numerous commercial brewers (eg. Upstream Brewery, Blue Blood Brewing Company, Scratchtown Brewing Company), home brewers, commercial hop growers, beer enthusiasts who are NHGA members, and the Nebraska Sustainable Agriculture Society.

Lessons Learned

- Everyone likes beer. It was a fun project and members were engaged in making it successful.
- In a volunteer organization, it can be challenging to get everyone coordinated in completion of a large grant.
- Partnerships with the Brewer's Guild and UNL leveraged success of the grant.
- Creation of a website is labor intensive and requires a plan for sustainment.

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Project Title

Extrusion Processing of Dry Edible Bean to Increase *In Vitro* Magnesium Bioaccessibility

Project Summary

Despite the abundance of food in America, 45% of individuals have chronically low magnesium intakes. Low magnesium intake leads to insulin resistance, which is a risk factor for type 2 diabetes, a major health problem in the US. Dry edible beans are particularly high in magnesium (50-70 mg/serving) compared to whole grains (about 25-40 mg/serving) and commonly consumed fruits and vegetables (8-20 mg/serving); however, intake of beans in the US is low, and beans contain many components that can reduce magnesium bioaccessibility for human nutrition (e.g., phytic acid, antinutritional factors, and dietary fiber). In this project we focused on extrusion, a processing technique that involves pressure, shear, and heat, to create ready-to-eat products from beans that contain an increased in vitro magnesium bioaccessibility, which is an indicator of bioavailaibility in vivo. Our results showed that most severe processing conditions, such as low processing moisture and high screw speed lead to higher in vitro magnesium bioaccessibility. Providing attractive snacks and pastas from beans that also have enhanced magnesium bioaccessibility could have a positive impact on magnesium nutritional status of Americans. This would also benefit the economy in the panhandle of Nebraska, where dry edible bean production is an important part of the economy.

Project Approach

Pinto beans and Great Northern beans (GNB) were obtained from the Panhandle Research and Extension Center. Beans were milled and then extruded under varying conditions of moisture content (MC; 17-25%), screw speed (SS; 150-250 rpm), and temperature (T (90-140°C) using an inscribed central composite rotatable design. The primary response variable was magnesium bio-accessibility measured after in vitro digestion and dialysis. In the Pinto bean extrudates, secondary response variables included phytic acid concentration, soluble and insoluble dietary fiber (S/IDF), and physical properties, including density, color, and hardness. In the Great Northern bean extrudates, secondary response variables included phytic acid concentration, trypsin inhibitor, and physical properties, including density, color, and hardness.

Extrusion had a significant effect on bio-accessibility of elements, phytic acid, and tannins in Pinto beans. Overall, MC and SS were the main extrusion parameters affecting bio-accessibility while T had little or no effect. K and Mg bio-accessibility was mainly influenced by MC; SS affected Fe and P bio-accessibility. For both K and Mg, increasing MC beyond 21% reduced bio-accessibility, suggesting extreme extrusion conditions of low MC improved the bio-accessibility of these elements. For Fe, higher SS significantly improved the bio-accessibility implying high shear conditions are beneficial for bio-accessibility of this element. The bio-accessibility of Mg, Fe, K and P was negatively correlated with heavy elements (Cd and Pb), indicating that extrusion had different effects on bio-accessibility of different elements. There was a significant increase in SDF (~50%) and a reduction in IDF (~25%), phytic acid (~50%) and tannins (~80%) upon extrusion of Pinto bean flour. There was also a significant decrease in insoluble fiber and an increase in soluble fiber. Some of the decrease in insoluble fiber was due to lignin degradation and some was due to conversion to soluble fiber. Although the solubility of dietary fiber improved on extrusion, the remaining IDF was found to associate with magnesium possibly due to the affinity of uronic acid type compounds to bind with divalent ions like Mg^{2+} and Ca^{2+} in the native conformation. The observed improvement in bio-accessibility of P, Mg and Fe may either be due to destruction of phytic acid and tannins or extrusion-induced

changes in the salts of these elements in beans. Fortunately, bioaccessibility of toxic elements, Cd and Pb, were not significantly increased by extrusion.

GNB flour had 2668 mg/kg of magnesium. Extrusion conditions did not significantly affect total magnesium in beans, but did significantly improve bioaccessibility of magnesium upon extrusion when compared with raw bean flour. On an average, there was a 45% improvement in bioaccessiblity of magnesium upon extrusion when compared with raw flour. In contrast to Pinto beans, SS and T had the greatest influence on bioaccessibility of magnesium. These variables both had had quadratic effects on bioaccessible magnesium, where the most severe processing conditions resulted in the highest magnesium bioaccessiblity. The effect of MC was significant in interaction with SS; mainly lower MC when coupled with high SS gave the highest magnesium bioaccessiblity. SS had similar effects on bioaccessibility of other elements, including P, Ca and Fe, but not K. The bioaccessiblity of Fe was influenced more by MC, which was linked to the destruction of phytates under the low MC extrusion. As with Pinto beans, all beneficial elements (Mg, Fe, Ca) had opposite the opposite trends in comparison with bioaccessibility of Cd: lower bioaccessibility of Cd was observed with extreme extrusion conditions.

These results were presented at the 101st and 102nd annual meetings of the American Association of Cereal Chemists International, which consisted of approximately 1,000 attendees. We plan to publish these results in a peer-reviewed journal in the coming year.

The activities that were completed were extrusions of Pinto and Great Northern beans. Partners at the Panhandle Research and Extension Center have been essential in the completion of this project by supplying material for evaluation.

Goals and Outcomes Achieved

The original objectives were to determine optimum parameters for extruding dry edible beans under high shear, high temperature conditions (for ready-to-eat snacks) and low shear, low temperature conditions (for pasta) to: 1) increase in vitro magnesium bioaccessibility and 2) decrease anti-nutritional factors (i.e., phytic acid, trypsin inhibitor).

Beneficiaries

The public is one beneficiary of this research. Providing snacks from beans that have enhanced magnesium bioaccessibility could have a positive impact on magnesium nutritional status of Americans. Another beneficiary are dry edible bean producers. Increased demand for dry edible beans will benefit the economy in the panhandle of Nebraska, where dry edible bean production is an important part of the economy. The benefits to these parties will be realized through continued efforts in dry bean research and promotion.

Lessons Learned

The most important finding from this work was that magnesium bioaccessibility from beans can be altered by changing extrusion processing conditions. In particular, more severe processing conditions such as low MC or high SS tend to produce extrudates with higher magnesium bioaccessibility. Unfortunately, it appears that the extrusion parameters affect magnesium bioaccessibility differently for different market classes of beans. For instance, MC was the main factor that affected magnesium bioaccessibility in Pinto beans, while SS and T were the main factors that affected this parameter in GNB. Finally, an unexpected finding was that Cd bioaccessibility, a toxic element, was not affected by extrusion processing.

The activities that were completed were extrusions of Pinto and Great Northern beans. Partners at the Panhandle Research and Extension Center have been essential in the completion of this project by supplying material for evaluation. Only the properties of Pinto beans were evaluated. Great Northern beans will be evaluated in the future. This will be valuable for stakeholders because Pinto and Great Northern beans are produced in the greatest abundance in the Great Plains region. We plan to disseminate these results to stakeholders in subsequent years of this project.

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Project Title

Growing Potato Starch Under Dryland Conditions in Western Nebraska

Project Summary

Growing potato specifically for the dehydration market, i.e., starch and dry matter, is not economically feasible under conventional practices. For dry matter-specific production to be feasible, the input costs must be reduced, that is no irrigation, no pesticides, etc. Most of the cost of production would be the price of seed potato tubers themselves. Using organic production practices, potato dry matter and starch could be used in organic-based dehydration products. Potato tubers grown as raw material for dehydrated products do not need to be, and usually are not, market quality. Therefore to lower potato seed tuber cost, determining the most economical seed-piece size and spacing of a high-starch cultivar is essential for success. To date, there has not been any completed study of growing potatoes specifically for starch production using sustainable agricultural practices under semi-arid conditions. Western Nebraska is an ideal location for such a study due to its rich soil, dry climate, and low disease and insect pressures. The objective of this study was to produce a high-yielding potato crop with high dry matter under dryland conditions utilizing the principles of sustainable agriculture to keep costs to a minimum. The specific objective was to lower production cost by comparing five plant spacings and five seed-piece weights for high-yield and high-dry matter content using the potato cultivar Atlantic. In preliminary testing of several varieties, Atlantic was found to be the best under these circumstances. The principle reasons motivating growers and industry in this study are to:

1. Establish a consistent source of potato dry matter so that dependency on culls is avoided;

2. Produce raw potato without the use of pesticides; and

3. Be able to provide potato dry matter and starch organic products to consumers.

Project Approach

Seed tubers of the potato cultivar Atlantic were cut into five size/weight classes, 1.5, 2, 2.25, 2.5, and 3 ounces, and allowed to suberize (heal) at 60 to 70F and acclimate for a few weeks before planting. Planting was in mid May according to soil temperature. Seed-pieces were planted 6, 9, 12, 15, and 18 inches apart in 36-inch rows at a 4 inch depth using a horizontal-cup planter for precision planting. No pesticides or fertilizers were added. Mechanical cultivation was used twice for weed control and once at the end of the season to aid harvest. Soil samples were taken at the start and conclusion of the season to determine moisture and nitrogen contents. Plants were observed throughout the season for unusual growth patterns. Tubers were harvested in October to achieve maximum yield and tuber maturity. Yields were weighed and specific gravity determined using a hydrometer after harvest. Dry matter and starch contents can be calculated using an established formula. Plot were two rows, 45 feet long, 36 inches apart. Each seed size by seed spacing plot were replicated 5x in a factorial design, resulting in 25 treatments, five seed sizes and five seed spacings, and 125 total plots. Statistical analysis used SAS software. An economic analysis was conducted at the end of the project to evaluate the economic feasibility of dry matter production in western Nebraska.

Goals and Outcomes Achieved

The overall goal of this study was to determine the feasibility of growing potatoes under semi-arid conditions using sustainable, organic farming practices in western Nebraska. The following summarizes the results and conclusions of the project.

The project wanted to identify most economical seed-piece size and in-row plant spacing to lower the cost of seed potatoes while producing the greatest amount of starch.

There was a significant difference in yield between different seed-piece spacing while there was no significant yield differences based on seed-piece weight, i.e., size (Table 1). The highest yields occurred with placing seed-pieces 6 inches apart. At this spacing, yield was 12% higher than at 9 and 12 inch spacings, and 38% higher than at 15 and 18 inch spacings. If highest yield was the goal, then 2 to 3 oz seed-pieces planted close together would accomplish this. The yields in 2015 were similar to that of 2014. Both years were significantly higher than 2013. Seasonal rainfall in May, June, July, and August of 2015 was higher than normal and the temperature was 1° F below average. In comparing the years, 2014 was somewhat dry and cold while 2013 was very dry and hot. Therefore, the higher yields of 2015 and 2014 may be due to a more normal rainfall, +/- 30% and cooler temperatures, compared to 2013 with less than half the average rainfall (very dry) plus above average temperature (hot).

Table 1. Yield in cwt/acre, 2015.

Seed Spacing (in)	Seed Size in Ounces (oz)					
	1.5	2.0	2.25	2.5	3.0	Mean
6	152	166	158	160	164	160 A
9	144	128	135	142	149	140 B
12	136	150	146	143	158	147 B
15	116	122	110	112	121	116 C
18	107	111	122	126	121	117 C
Mean	131	135	134	137	143	136

* Numbers in column followed by the same capital letter are not significantly different at the 95% confidence level.

Another key tuber characteristic is the amount of dry matter produced. Dry matter content is generally calculated from the tuber specific gravity. Neither seed-piece size nor spacing affected tuber specific gravity (Table 2). The average dry matter content was 23.2% (specific gravity = 1.094). This is similar to that of 2014 with 24% dry matter and higher than that of 2013 with 21% dry matter. Note also that in both previous years, there was a slight effect on spacing. When calculating the average dry matter production per acre, 2,700 lbs were produced with the wide plant spacings and 3,800 lbs/acre for the narrow spacings.

Table 2. Specific Gravity (1.0xx), 2015

Seed Spacing (in)	Seed Size in Ounces (oz)					
	1.5	2.0	2.25	2.5	3.0	Mean
6	96	97	96	95	98	96 A
9	95	93	95	97	98	95 A
12	95	95	93	93	97	94 AB
15	93	92	92	93	94	93 B
18	93	94	91	93	91	92 B
Mean	93	94	94	94	95	94

This project also focused on the idea that if the input costs of seed potatoes could be lowered while producing the greatest amount of starch using organic requirements, new markets could be available for organically-produced food products.

The field project successfully grew potato tubers without the use of any pesticides. Disease and insect infestations did not occur. Weed pressure was minimal and controlled using two early-season mechanical cultivation passes. No fertilizer was applied. Potato was planted after potato and residual N was about 10 to 15 lbs/acre in the top 16 inches of soil. Therefore, practices were such that organic raw material was produced suitable for the organic dry matter market.

The performance of the potato plants were measured throughout the season using plant growth determinations, weed competitiveness, and tracking production costs."

Emergence was normal, occurring in early June, less than three weeks after planting. There was no significant difference in emergence between the plant spacing and seed-piece size combinations. Emergence ranged from 68 to 77%. Flowering was visually estimated from June to August and showed no significant effect. The percentage senescence (vine death) was visually estimated in late September and showed no significant effect.

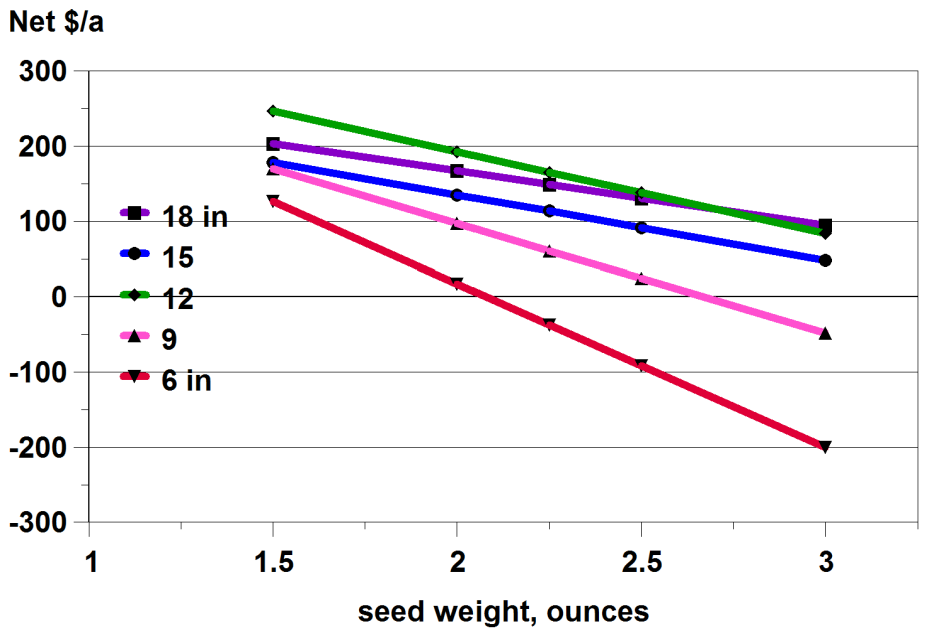
Careful record-keeping of minimal production inputs, excluding seed tuber costs, were performed. It was estimated that planting costs would be $20/acre, 4 cultivation passes would be $20/acre, and harvesting costs would be $30/acre. The total operating cost would be $65-$70/acre. There was no irrigation cost.

The economic return of this agronomic practice was calculated based on market prices paid by dehydrators.

Seed tuber costs were identified to be up to $11/cwt plus $1/cwt for cutting or a total of $12/cwt. Calculating the amount of potato seed-pieces planted per acre for the various combinations of seed-piece spacing and size, the amount of seed tubers to be purchased ranged from 9.08 cwt/acre (18-inch spacing and 1.5 oz seed-piece) to 54.45 cwt/acre (6-inch spacing and 3 oz seed-piece). The cost of the seed would range from $108.96/acre to $653.40/acre. Production costs were $70/acre, which consisted of planting, cultivating and harvesting the potatoes. Added

to this cost is shipping from Imperial, NE to Wray, CO at $1.70/mile for a total of 75 miles in a non-refrigerated semi-truck. The total production costs per acre used in the calculations are the sum of seed costs (varies with seed-piece size and spacing), plus operating costs, plus shipping costs. The purchasing of potatoes ranged from $3.50 to $5.50/cwt yield. These costs were used for conventionally-produced harvested potatoes and not for organically-produced tubers as the latter market would be new and relatively unknown. To be conservative, the price of $3.50/cwt was used to calculate the gross income per acre based on yield. To identify net income (profit), the total production cost per acre was subtracted from the gross income per acre. Figure 1 shows that return for 2015. Although seed spacings of 6 and 9 inches yielded the highest, they were less profitable than spacings of 12, 15, and 18 inches. For the highest profit, spacing further apart and using seed-pieces between 2 and 2.25 ounces could achieve the target profits greater than $100/acre (Figure 1). These results are similar to that of 2013 and 2014.

Figure 1. Net Income based on $ 12/cwt Seed Cost & $ 3.50/cwt Sales, 2015
(note includes shipping from Imperial NE to Wray CO)



The one distinct and measurable outcome external to the project will be the interest and planning of dehydrators.

The economics of producing potatoes under this scenario was compared to the production of dryland millet and wheat for profitability. Table 3 summarizes one comparison based on the yield of planting 15 or 18 inches apart with seed size of 2 and 2.25 oz/seed-piece, 120 cwt/acre, sold at the low end of $3.50/cwt. Seed cost at the high end of $12/cwt and shipping cost from Imperial, NE to Wray, CO were added to operational costs. Potatoes, when properly sized and spaced at planting, can result in a higher profit to growers than wheat or millet (Table 3).

Table 3. Comparison of Potato to Millet and Wheat, 2015.

Expenses	Millet	Winter Wheat	Potato
operation	$ 75	$ 80	$ 70
seed	$ 7	$ 25	$ 145-195
shipping	-	-	$ 30
pesticides	$ 13	$ 30	0
fertilizer	$ 25	$ 60	0
total expenses	$ 120/acre	$ 195/acre	$ 245-295/acre
yield	40 bu/a	40 bu/a	120 cwt/a
price	$ 4.80/bu	$ 6.80/bu	$ 3.50/cwt
gross	$ 190/a	$ 270/a	$ 420/a
net	$ 80/a	$ 75/a	$ 125-175/a

For sufficient information to be accumulated to interest a dehydrator and for scientific dissemination, this project needed to be repeated at least an additional year.

This study was completed in 2016 after three seasons of field trials. The results of this study were published in the American Potato Journal.

Contact has been on-going with the two dehydration-product companies interested in this study to identify the feasibility of contracting growers for production.

Beneficiaries

The results of this year's project were disseminated to target audiences. This research study is now completed. The target audiences are potato growers, scientists and industry representatives.

The results of this project were shared with audiences who attended the below events:

1. Organic Farming Conference in Torrington, Wyoming, was held on February 11, 2015. A total of 63 growers attended;

2. Nebraska Potato Development Committee Annual Meeting in Kearney, Nebraska, was held on March 4, 2015. A total of 14 growers attended;

3. The Potato Association of America Annual Meeting in Portland, Maine was held on July 22, 2015, and it consisted of over 200 attendees;

4. American Association of Horticultural Science Annual Meeting in New Orleans, Louisiana, on August 7, 2015, and consisted of over 80 attendees from around the world;

5. Central Great Plains Working Group Annual Meeting in Akron, Colorado was held on August 12, 2015, and 32 attendees from Nebraska and neighboring states attended this event;

6. Western Nebraska Sustainable Ag Crops and Livestock in December 2015 in Ogallala, NE with a target audience of 40 growers;

7. Central Great Plains Working Group in August in Hays, KS with a target audience of 50 USDA-ARS researchers and Extension specialists from the University of Nebraska – Lincoln, Colorado State University, Kansas State University, University of Wyoming, and South Dakota State University.

8. Potato Expo 2017 in January 2017 in San Francisco, CA with a target audience of 3,000, growers, corporations, and processors; and

9. The full study was published in the American Journal of Potato Research. It has a target audience consisting of approximately 1,000, U.S. growers, scientists, corporate representatives, and government representatives. The study is listed as follows:

   Pavlista, A.D. and J. Groskopf. 2016. "Growing Potato Profitably for Organic Dry Matter Production in Western Nebraska." American Potato Journal 93:509-517. DOI 10.1007/s12230-016-9527-3. Seed size and spacing on profitability for dry matter production in an organic, dryland system in western Nebraska. Contact has been on-going with the two dehydration-product companies interested in this study to identify the feasibility of contracting growers for production. An abstract of this publication can be found at http://link.springer.com/article/10.1007/s12230-016-9527-3.

Below are the plans for long-term dissemination:

1. The study will be incorporated into UNL's Potato Education Guide website, which can be found at http://cropwatch.unl.edu/potato-education-guide. It is estimated to reach 1,000 people.

2. *NebGuide*, which is a UNL Extension publication. The target audience is approximately 1,000 readers.

3. Presentations to the dehydration industry, especially those with an interest in contracting dry matter/starch production and organic consumer products.

Lessons Learned

In summary, below are the lessons learned from this project:

1. The seed-piece size and spacing combinations resulting in the highest yield were the least profitable ("less is more" concept);

2. Growing dryland potato organically can be at least as profitable as growing winter wheat or millet in western Nebraska;

3. The recommendation from the completed three-year study showed that for profitability greater than $100/acre, plant seed-pieces should be 2 to 2.25 oz in weight and spaced 15 to 18 inches apart. These parameters would result in planting between 12 and 16 cwt/acre, and a population density ranging between 9,700 to 11,600 plants/acre. These recommendations have been consistent in all three years of the study.

Contact Person

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Project Title

Agronomic Practices for Fenugreek Production in Western Nebraska

Project Summary

Fenugreek is an annual legume of which 75% is grown in India. It is an important medicinal crop with properties alleviating many conditions such as Type 2 diabetes and inadequate lactation in nursing mothers. Fenugreek is not grown in the Western Hemisphere. Can western Nebraska take the lead and become a source of fenugreek products in North America? There is no information on this possibility. Therefore, the overall objective to accomplish this was to identify several key production parameters for western Nebraska. The specific objectives of this study were to identify the amount of irrigation needed, the best planting date in the spring, and the timing of harvest for optimal seed yield. Western Nebraska is an ideal location for this study due to its similarities to the fenugreek growing province of Rajasthan, India. Similarities include a dry, well-drained sandy loam soil that is slightly alkaline and highly calcareous. Annual rainfall and seasonal temperature are similar to western Nebraska. The benefit was to introduce a new crop and new industry into western Nebraska and entice interest from pharmaceutical companies to consider Nebraska as a source of raw product.

Project Approach

This project identified production parameters for fenugreek for optimal seed yield and irrigation levels for fenugreek in western Nebraska. Fenugreek has an indeterminate growth habit and was previously observed in a trial to produce flower and fruit from July to October. To accomplish this project, two fenugreek cultivars, Tristar and Amber, were studied. After planting at three dates, the crop was exposed to three levels of irrigation and it was harvested three times during the year. Performance of fenugreek was measured on growth and development patterns weekly throughout the growing season as a guide for future growers. Seed yield ad quality was measured at the end of the season and correlated with irrigation, planting dates, and harvest dates.

Goals and Outcomes Achieved

The overall goal of this study was to develop the technology and determine the feasibility of grown fenugreek under the semi-arid conditions of western Nebraska. The three measurable agronomic outcomes was the determination of:

1. Irrigation requirement for optimal fenugreek production;
2. Appropriate spring planting dates for seed production; and
3. Appropriate summer harvest dates.

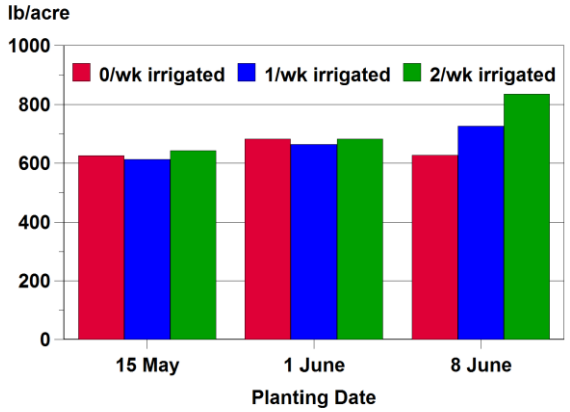
The principle measurable outcome of this field study was the identification of appropriate production practices for fenugreek in western Nebraska to be outlined in a UNL Extension Guide that would be available to western Nebraska crop farmers. The results would also be presented at grower meetings.

Expected Measurable Outcome #1: Irrigation requirement for optimal fenugreek production.

The growing-season variable was irrigation. Three regimes were instituted: no irrigation, half irrigation or 0.5 inch per week, and full irrigation or 1 inch per week. After each planting, a quarter inch of irrigation was added to promote emergence when needed and pre-emergence weed control with a herbicide (trifluralin) was applied. Irrigation treatments, full, half, and none, began on July 2 with the first irrigation. Irrigation for full treatment was applied twice a week. The target total for full irrigation was 12 inches during the growing season depending on harvest date. Total irrigation from early June to early September was 0, 4½ and 10½ inches. When rainfall was added into the calculation, total water exposure ranged 4½ to 13 inches, 5 to 15 inches and 5 to 16 inches for each harvest, respectively.

Yield was not affected by the amount of irrigation for the first two planting dates but did increase yield when the planting date was June 8 (Figure 1). Since applied water (rain + irrigation) in July and Aug. was similar in all years, the difference may be rainfall during planting in May. The High Plains Climate Center showed that in 2013, rainfall in May was 1.4 inch while in 2014, rainfall was 3.7 inch and in 2015, it was 6.8 inch. June rainfall was similar in all three years with 1.5 to 2 inches. The year 2013 was a very dry year and irrigation began on June 10 shortly after the last planting. In 2014 and 2015, with higher spring rainfall, irrigation did not begin until July 3 and July 7, respectively, a month after the last planting. Tentatively, the comparison of the three years suggests that if there is considerable early rains in May, that irrigation may be able to be reduced and planting later is more important factor. Another comparison of the years is that the May temperature in 2013 was a 0.6 ^{o} F above normal or warm; in 2014, the temperature was near normal, and in 2015, the temperature was cold at 4.6 ^{o} F below normal in May. This may have played a role as well. Yields in 2015 were much lower than previously believed possibly because the high early rains may have washed out the shallow planted seed and root water-logging may have also occurred.

Figure 1. Amber Seed Yield Harvested in mid-late Sep, 2015



Soil nitrogen in the top 16 inches of the soil was determined in June. The results indicated an adequate level for fenugreek production. Soil moisture was measured using gravimetrics in July after emergence of the last planting and will be measured again after the last harvest. No nitrogen was added since the preliminary trial data indicated that sufficient N (30-40 lb/a) was in the soil. Plants were sown in 12-inch rows at a seeding rate of 18 lb/a resulting in a density of 13,000 plants per acre or 3 to 4 plants per square foot. A separate trial in 2014 indicated that this was the optimal seeding rate. Plots were placed in a 3x3 Latin square design with irrigation level as the main plot. These were split into three planting dates and each of these sub-plots were split between the two cultivars. This allowed all parameters to be statistically compared

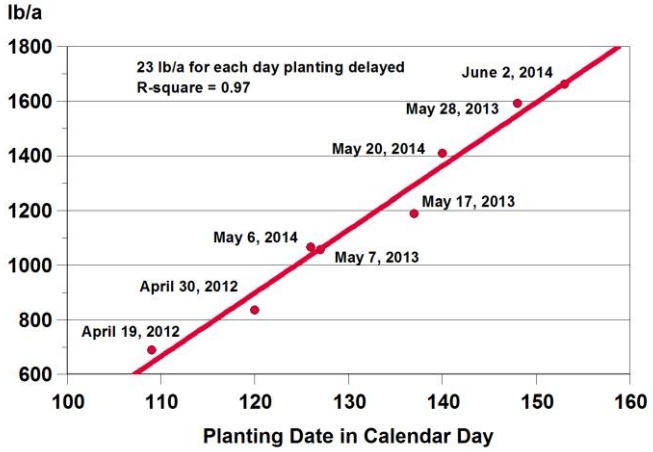
using SAS software.

Expected Measurable Outcome #2: Appropriate spring planting dates for seed production.

Fenugreek seed of varieties Amber and Tristar harvested by the Principal Investigator (PI) in 2014 were tested for germination to determine viability and seeding rate. Planting was on May 15, June 1 and June 8, 2015. There was a delay in planting due to heavy rains and cold temperatures in early May. Based upon 2013 data, it was apparent that the May 28 planting may not have reached maximum yield. Therefore, the last planting was delayed one week later than anticipated. Planting, cultivating and herbicide application activities were on schedule. An unfunded supplement to the project was a trial on seeding rate and harvest method.

Combining data from 2012, 2013, 2014, and 2015 under full irrigation and harvested in mid-September, a linear relationship appears between planting and yield (Figure 2). The graph suggests that planting date may reach optimal in the first week of June. From mid April to early June, each day delayed in planting increased yield by 23 lb/a, highly significant at r^2=0.97.

Figure 2. Yields (in Sep) by Planting Date, Full Irrigation



To determine growth pattern as influenced by planting date and irrigation level, vine height were measured weekly during the months of July, August, and early September. Vine fresh and dry weights were measured before each harvest. Plant stand was counted in late June and population density was determined.

Although a later planting date delayed the onset of growth, the vines of later planting dates grew faster and all plants, regardless of planting date, reached maximum height by August 12 (Figure 1 below). The pattern was similar to the two previous years. Maximum height occurred between 4 and 5 weeks after the start of irrigation for all planting dates (e.g., May 15 (Figure 2. WAP=weeks after planting, WAI=weeks after irrigation started) agreeing with 2013 and 2014 results.)

Figure 1. Amber Height, Full Irrigation, by Planting Date, 2015

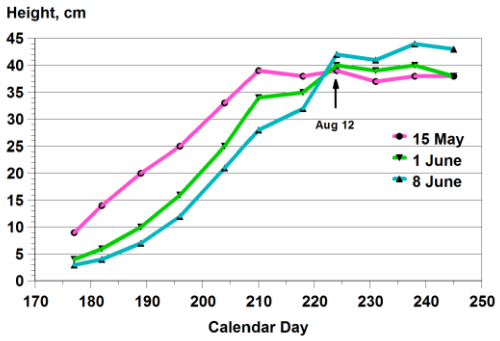
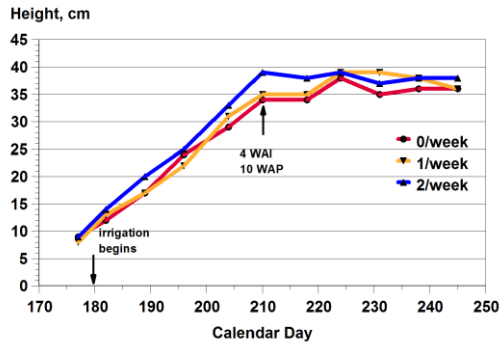


Figure 2. Amber Height, Planted 15 May (135d), 2015



Plants from all three planting dates showed no change in dry weight from the end of August to the end of September (Figure 3 below). Note that the weights were lower than in previous years and this may be attributed to a severe hail storm occurring at the end of July. Irrigation level affected the ability of plants to recover weight after the hail storm. The half-irrigated plants gained weight to achieve the same level of fully-irrigated plants by the end of September. (Figure 4 below).

Figure 3. Amber Dry Weight, Full Irrigation, by Planting Date, 2015

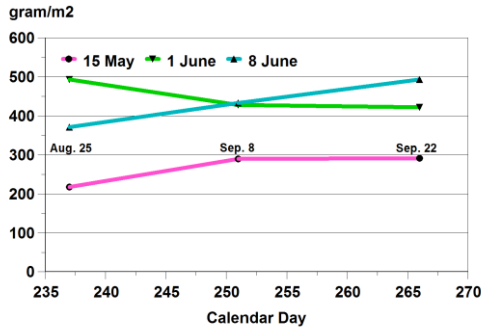
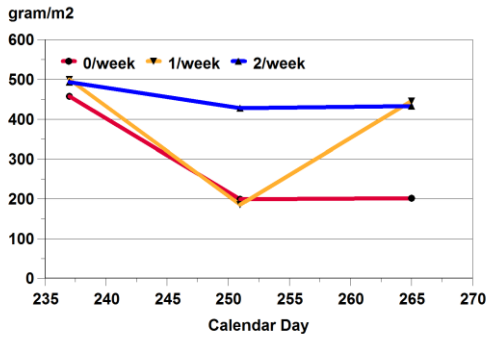


Figure 4. Amber Dry Weight/area, Planted 1 June (152d), 2015



Flowering dates and peak of green pods were later for the two plantings in June compared to May 15. Pods appearance peaked for June planting in early August while the May planting peaked at the end of July (Figure 5 below). There was a severe hail storm on July 27 and this severely affected the timing of pod appearance. Irrigation levels had no effect on pod formation (Figure 6 below). Again note the drastic dip in pods observed two days after the hail storm.

Figure 5. Amber Green Pods under Full Irrigation, 2015

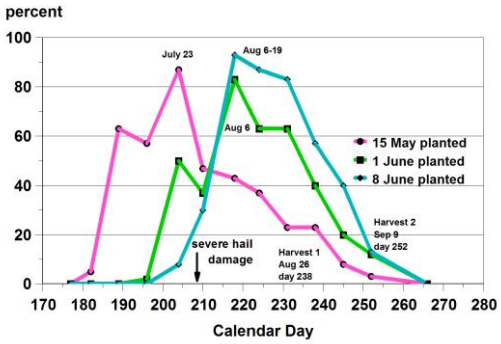
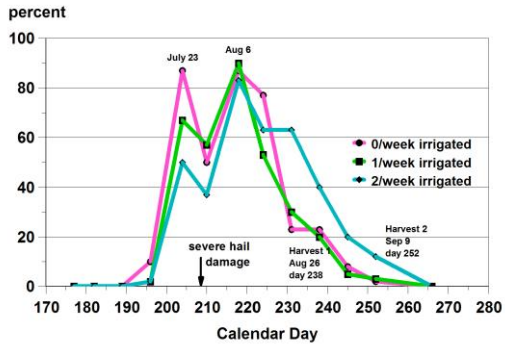


Figure 6. Amber Green Pods Planted 1 June, 2015



Expected Measurable Outcome #3: Appropriate summer harvest dates.

One-third of each plot was harvested on August 26 (first harvest), September 9 (second harvest), and September 26, 2015. Plants are dried and threshed after harvest. The seed is collected, cleaned and weighed. Data will be tabulated during the winter and spring months. Amber and Tristar, behaved much the same way; therefore, Amber will be reported.

Harvesting date showed an effect on seed yield with the optimal period being mid-September (Figures 3 and 4 below). A planting date versus harvesting date interaction was identified with June planting showing the highest yield in September. This year's data confirms last year's in that harvesting in September achieved the greatest yields and allowed greater flexibility in planting between late May and early June regardless of irrigation level.

Figure 3. Fenugreek Amber Harvest Yield, full irrigation, 2015

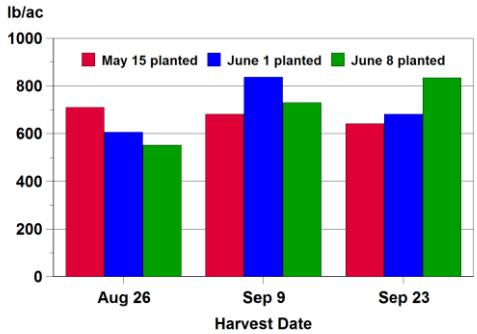
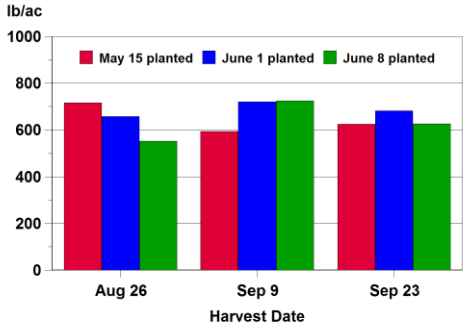


Figure 4. Fenugreek Harvest Yield, no irrigation, 2015



Beneficiaries

Contact has been on-going with the University of Nebraska Food Science Department and Food Processing Lab. Interaction with the University of Nebraska Medical Center has started through the "Food for Health" program. Through separate grants, genetic lines will be analyzed for medicinal compounds and adaptation to western Nebraska.

The full study was published in the Industrial Crops and Products publication. The study is listed as follows:

Pavlista, A.D. and Santra, D.K. 2016. "Planting and Harvest Dates, and Irrigation on Fenugreek in the Semi-arid High Plains of the USA." Industrial Crops and Products 94:65-71. DOI 10.1016/j.indcrop.2016.07.052. An abstract of this publication can be found at http://www.sciencedirect.com/science/article/pii/S0926669016305015.

The results of this project were shared with audiences who attended the below events:

1. Western Nebraska Sustainable Ag Crops and Livestock in December (2015) in Ogallala, Nebraska = 100, growers.

2. Central Great Plains Working Group in Aug. in Hays, Kansas = 50 attendees representing USDA-ARS researchers and Extension Specialists from the Universities of Nebraska, Colorado State, Kansas State, Wyoming, and South Dakota State.

3. PREC Cropping School in June in Scottsbluff, Nebraska = 60 growers.

The long-term plans to disseminating the result of this project are as follows:

1. List it on the UNL website, which could reach 1,000 growers, researchers and government representatives worldwide. A new website specifically for fenugreek will be initiated.

2. UNL Production Guide, which could reach approximately 1,000 growers.

Lessons Learned

There was a delay in planting due to heavy rains and cold temperatures in early May. Based upon 2013 data, it was apparent that the May 28 planting may not have reached maximum yield. Therefore, the last planting was delayed one week later than anticipated.

Also, the weight results were lower than previous years and this may be attributed to a severe hail storm occurring at the end of July. Irrigation level affected the ability of plants to recover their weight after the hail storm. The half-irrigated plants gained weight to achieve the same level of fully-irrigated plants by the end of September.

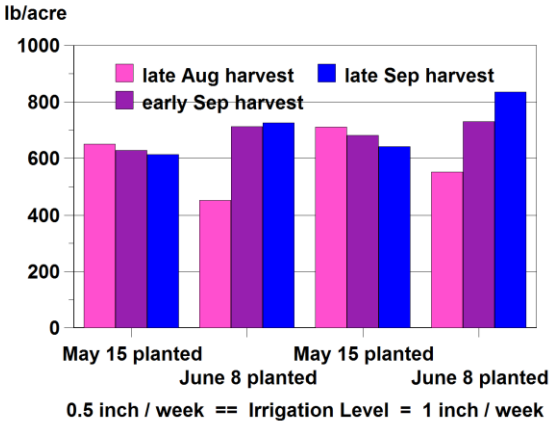
There was significant interaction between planting and harvest dates. If there is sufficient rainfall before planting, fenugreek might be able to be grown without irrigation. From the third year's results, highest yields were achieved at the September harvest with both 0.5 and 1 inch irrigation per week (irrigated once or twice per week when planted in early June). At the earlier August harvest, the highest yield was achieved only with full irrigation (1 in/week) and planting in mid-May. The resulting recommendations are as follows:

1. If irrigation is not limited (1 inch/week) and harvest is planned for late August, then planting should be in mid-May. If harvest is planned for September, then planting may be from mid-May to early June.

2. If irrigation is limited (0.5 inch/week), planting should be in mid-May and harvest may be from late August to early September.

3. Yield was the lowest when harvest was in early October.

Figure 5. Amber Seed Yield, 2015



Contact Person

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Project Title

Columbia Root Knot Nematode Survey

Project Summary

The goal of this project is to facilitate the trade of Nebraska-grown potatoes and horticultural nursery stock on the international market, by documenting Nebraska's freedom from Columbia root knot nematode (*Meloidogyne chitwoodi*). This was achieved through the inspection of seed potatoes imported into Nebraska, and by conducting soil surveys from potato and nursery fields across the state.

Project Approach

2015

NDA Entomology staff conducted soil surveys for CRKN. Thirty-three samples were pulled from potato and nursery fields across the state. Samples were processed, and all were negative. The negative results from these soil surveys continue to uphold our freedom from CRKN status.

From February through April, 2015, NDA Entomology staff conducted inspections of seed potato distribution facilities. One hundred twenty-six locations in 20 counties were inspected to confirm compliance with the NDA CRKN quarantine. Six violations of the quarantine were found.

2016

NDA Entomology staff conducted soil surveys for CRKN again in 2016. Twenty-seven samples were pulled from potato and nursery fields across the state in Fall and early Winter 2016. Samples were processed, and all were negative. The negative results from these soil surveys continue to uphold our freedom from CRKN status.

From February through April, 2016, NDA Entomology staff conducted inspections of seed potato distribution facilities. One hundred three locations in 20 counties were inspected to confirm compliance with the NDA CRKN quarantine. Seven violations of the quarantine were found.

2017

From February through March, 2017, NDA Entomology staff conducted inspections of seed potato distribution facilities. Sixty-four locations in 20 counties were inspected to confirm compliance with the NDA CRKN quarantine. Thirteen violations of the quarantine were found.

Goals and Outcomes Achieved

1. Documenting the number of certificates issued for potatoes and nursery stock
2. Disseminating survey information in the NDA Entomology Program Annual Report;
3. Incorporating project results on the NDA web site; and
4. Inclusion of survey results on NDA Entomology Program display booth at the Nebraska Great Plains Conference.
   Each of these objectives has been met. The supporting documentation for this is given below.

Beneficiaries

2015

NDA issued one federal phytosanitary certificate for nursery stock shipments to Canada from October 2014 to October 2015. These certificates have facilitated the movement of 1,472 Nebraska grown nursery stock plants to Canada. Additionally, 16 Federal phytosanitary certificates were issued for Nebraska grown seed potatoes to Canada, totaling 279,455 pounds. These shipments were made possible because of the soil sampling conducted by NDA.

2016

NDA issued three federal phytosanitary certificates for nursery stock shipments to Canada from November 2015 to October 2016. These certificates have facilitated the movement of 5,354 Nebraska grown nursery stock plants to Canada. Additionally, four Federal phytosanitary certificates were issued for Nebraska grown seed potatoes to Canada, totaling 9,565 pounds. These shipments were made possible because of the soil sampling conducted by NDA.

2017

NDA issued one federal phytosanitary certificate for nursery stock shipments to Canada from November 2016 to March 2017. This certificate facilitated the movement of 1,396 Nebraska grown nursery stock plants to Canada. Additionally, two Federal phytosanitary certificates were issued for Nebraska grown seed potatoes to Canada, totaling 1,140 pounds. These shipments were made possible because of the soil sampling conducted by NDA.

Project results were included in the 2014, 2015 and 2016 NDA Entomology Program Annual Report, which is distributed at various events, and updated on the NDA website at the conclusion of the survey season.

NDA disseminated information on CRKN activities at the Nebraska Great Plains Conference in Omaha in January 2015, 2016 and 2017. This included information on each year's survey results and violations found. This event has 800 registered attendees from the nursery, landscape and forestry industries annually. Additional outreach was conducted at the Governor's Ag Conference, March 2015, 2016 and 2017, with 200 attendees from various agricultural sectors; Great Plains NNLA/NAA Summer Field Day, August 2015, with an approximate attendance of 75 individuals from the nursery and arborist industries; and Husker Harvest Days, September 2015, with an attendance of over 100,000.

Lessons Learned

Because of these official survey efforts, we have documented that Nebraska remains free of Columbia root knot nematode. The Nebraska Department of Agriculture continues to educate industry professionals on this pest, including the benefit of participating in the voluntary survey, quarantine requirements, and who to contact with concerns about the nematode.

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Project Title

Japanese Beetle Survey

Project Summary

The goal of this project is was to conduct a comprehensive survey of Nebraska nursery dealers and growers and determine the presence or absence of Japanese Beetle (*Popillia japonica*) populations at those facilities. This information is then used to certify Nebraska grown nursery stock for international and interstate movement, to areas that have enacted quarantines to prevent the introduction of JB. Since April 15, 2015, NDA Entomology staff have recorded over 820 hours and have driven over 17,428 miles to meet the goals of this project.

Project Approach

2015

In 2015, a total of 220 JB traps were set in non-infested counties. Thirty-four traps were set in known infested counties. In total, thirty-seven counties were trapped. Traps were located at airports, state parks, special quarantine compliance areas, and nursery growers and dealers. Nursery dealers and growers in non-infested counties that import balled and burlapped nursery stock are considered high-risk sights and, therefore, trapped individually. The traps were in place from the end of May until October.

Soil sampling for JB grubs was conducted in 2015, at select firms in known infested counties, where JB populations had previously been confirmed via trapping. Firms were selected based on several factors, including level of infestation, nursery production methods, and desire to ship out-of-state. A total of 185 soil samples were collected on over 42 acres from three firms in four counties. No JB grubs were found.

In addition, NDA staff witnessed six treatments of plants being treated as part of the JB certification process for five different firms in five counties. They conducted one inspection of bareroot nursery stock, and five container accreditation inspections, all in support of JB certification activities.

2016

In 2016, a total of 134 JB traps were set in non-infested counties. Fifty-three traps were set in known infested counties. In total, twenty-five counties were trapped. Traps were located at airports, state parks, special quarantine compliance areas, and nursery growers and dealers. Nursery dealers and growers in non-infested counties that import balled and burlapped nursery stock are considered high-risk sights and, therefore, trapped individually. The traps were in place from the end of May until November.

Soil sampling for JB grubs was conducted in 2016 at select firms in known infested counties, where JB populations had previously been confirmed via trapping. Firms were selected based on several factors, including level of infestation, nursery production methods, and desire to ship out-of-state. A total of 325 soil samples were collected on over 371 acres from five firms in five counties. No JB grubs were found.

In addition, NDA staff witnessed two treatments of plants being treated as part of the JB certification process for two different firms in two counties. They conducted one inspection of

bareroot nursery stock and two container accreditation inspections, all in support of JB certification activities.

Goals and Outcomes Achieved

Each of the goals and outcomes of this project are complete. The supporting documentation is listed below.

Survey information was disseminated in the NDA Entomology Program Annual Report and the project results can be found on the NDA web site at http://www.nda.nebraska.gov/plant/entomology/annual2015.pdf. NDA Entomology Annual Report included information on the results of the 2014 and 2015 JB survey. This report is disseminated at various meetings and events throughout the year.

JB certification requirements were mailed to all Nursery Stock Distributors in the spring of 2015 and 2016, which consisted of approximately 1,300 letters and licensees each year;

Information on the NDA JB Survey activity was disseminated at the Nebraska Great Plains Conference in Omaha in January 2016, which consists of 800 registered attendees from the nursery, landscape and forestry industries. The information included the 2015 survey results and updated information on infested counties. Information on how to request a site to be surveyed was available at this event, along with information on interstate and international shipping and receiving requirements.

Information was disseminated at the Great Plains NNLA/NAA Summer Field Day in August 2015, with approximate attendance of 75 individuals from the nursery and arborist industries. It was also disseminated at Husker Harvest Days in September 2015, with attendance of 100,000 individuals. This outreach included display boards and informational handouts with specific information on JB, NDA Entomology Program Annual Report, survey and trapping work, and interstate and international shipping and receiving requirements.

A JB Japanese beetle certification article was published in the NNLA spring newsletter (http://nnla.org/wp-content/uploads/2015/04/NNLA_Spring-2015.pdf), and the winter 2016 newsletter (http://nnla.org/wp-content/uploads/2016/01/NNLA_Winter-2016-NEW.pdf). Newsletters are mailed to all NNLA members.

Beneficiaries

This project provided benefits nursery growers across the state by allowing the export of their plant products.

Lessons Learned

While Japanese beetle has become established in parts of the state, we can still mitigate trade implications for Nebraska producers through the continuation of this project. Communication with industry on the distribution of Japanese beetle in the state, and how that may impact shipping requirements is vital, to ensure the ability of industry to move product. Educating industry on these requirements and the various means of meeting them is ongoing.

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Project Title

Thousand Cankers Disease of Walnut Survey

Project Summary

The overall goal of the project was to facilitate interstate trade of Nebraska walnut products, by documenting Nebraska's freedom from TCD. This was achieved through the inspection of walnut trees for signs/symptoms of TCD and trapping for the walnut twig beetle. An equally important goal of the survey was to inform stakeholders such as campground owners, walnut growers, sawmills and nurseries about the potential devastation TCD may cause in Nebraska.

Project Approach

- **2015**
  - Beginning in May, 2015, Nebraska Department of Agriculture field staff were assigned to set, monitor, and retrieve 63 traps in 13 counties, with an emphasis on high risk sites for introduction or establishment of the disease. Sample collection took place approximately every 14 days. All results were negative.
  - Visual inspections of walnut trees were conducted at 9 locations in 6 counties.
  - Inspections of firewood distribution facilities were conducted at 185 locations in 30 counties. Zero violations of the Nebraska TCD Quarantine were discovered.

- **2016**
  - Beginning in May, 2016, Nebraska Department of Agriculture field staff were assigned to set, monitor, and retrieve 56 traps in 11 counties, with an emphasis on high risk sites for introduction or establishment of the disease. Sample collection took place approximately every 14 days. All traps were negative.
  - Inspections of firewood distribution facilities were conducted at 52 locations in 13 counties. Three violations of the Nebraska TCD Quarantine were discovered.

Goals and Outcomes Achieved

1. Disseminating survey information in the NDA Entomology Program Annual Report;

2. Incorporating project results on the NDA web site; and

3. Inclusion of survey results in the NDA Entomology Program display booth at the Nebraska Great Plains Conference and Governor's Ag Conference.

Each of these objectives either has been met, or is on track to be met. The supporting documentation for this is given below.

Beneficiaries

This project provided benefits to walnut nursery growers across the state by allowing the export of their plant products.

Information on the NDA TCD quarantine and survey activities were disseminated at the Nebraska Great Plains Conference in Omaha, January 2015 and 2016. This included information on previous survey results and updated information on known infested areas outside

Nebraska. This event attracts more than 800 attendees each year from the nursery, landscape and forestry industries.

Results from the 2015 and 2016 NDA TCD survey were updated on the NDA web site. All survey results have been negative.

Additional outreach was conducted at the Governor's Ag Conference, March 2015 and 2016, with 300 attendees; Nebraska Outdoor Discovery Days, April and May 2015 and 2016, with 400 attendees; Great Plains Summer Field Day, August 2015, with approximately 75 attendees; the Nebraska State Fair, September 2015 and 2016, with attendance of over 300,000; and Husker Harvest Days, September 2015, with over 100,000 attendees. A presentation on TCD was also given at the Nebraska State Fair in the Raising Nebraska building in August 2016 to approximately 50 attendees. This outreach included display boards and informational handouts with specific information on Thousand Cankers Disease of Walnut, the NDA Entomology Annual Report, and survey and trapping work.

Lessons Learned

Because of these survey efforts, we know that Nebraska remains free of walnut twig beetle and TCD. Many industry professionals were made aware of the disease complex, signs and symptoms of affected trees, and who to contact in case of suspected TCD.

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Project Title

Locally Grown Locally Owned

Project Summary

The Healthy Neighborhood Store (HNS) project began in Douglas County, Nebraska in 2010, following a Nutrition Environment Measures Survey conducted in 2009. The survey identified distinct areas in Douglas County, where residents had to travel greater than one mile to access healthy food options, such as fresh fruits and vegetables. Locally Grown Locally Owned builds on the existing HNS model, which worked with identified stores to enhance their business plans and expand their offerings of healthy food options. The purpose of Locally Grown Locally Owned was to increase access to locally grown produce to Douglas County residents by 2017. By providing four Healthy Neighborhood Store owners with a variety of farm-to-store implementation strategies, connecting them with a local producer, and providing nutrition education demonstrations to customers, access to locally grown Nebraska produce was to increase. In addition, the Locally Grown Locally Owned project expanded on the 3 P's (price, promotion and placement) to integrate procurement strategies of locally grown produce into their business models.

Project Approach

Work on the Locally Grown Locally Owned project began in February 2015 when an executed contract between Nebraska Department of Agriculture and the Douglas County Health Department (DCHD) was approved by the Board of Health. Health Department staff worked with identified partners to finalize sub-awardee agreements, which were approved by the Board of Health in May 2015.

Project partners (University of Nebraska Extension in Douglas-Sarpy Counties, Nebraska Farmers Union, and Gretchen Swanson Center for Nutrition) met with DCHD staff eight times between May 1, 2015 – June 7, 2016, to discuss the project work plan, timeline, evaluation process, and expectations. In addition, to face-to-face meetings, emails, and phone calls between DCHD and project partners allowed for expansion of ideas and facilitated genuine partnerships. An average of four partners were in attendance at each meeting.
Prior to store recruitment, DCHD staff modified existing HNS tools such as the store owner interview and proposal to develop an improved understanding of store needs and goals for the project (see Appendix A and B). Recruitment of the four stores was completed in early 2016 to allow DCHD staff adequate time to complete the store owner interview, proposal, and training before the 2016 growing season commenced. The four stores recruited have participated in the HNS program for over five years and have expressed a desired interest in procurement of local produce. After numerous one on one meetings with existing HNS owners by DCHD staff, it was decided by partners to include Phil's Foodway, 3030 Ames Ave., Omaha, NE, JND Grocery, 6341 North 24th St., Omaha, NE, KNJ Grocery, 3301 California St., Omaha, NE, and Cubby's, 15625 C W Hadan Dr., Bennington, NE in the Locally Grown Locally Owned project.

A store owner training was held on April 27, 2016, at Nebraska Extension in Douglas-Sarpy Counties office located at 8015 West Center Road, Omaha, NE. Due to varying schedules and limited store coverage, store owners were unavailable to attend the training. However, eight individuals representing project partners were in attendance at the training. A staff member from DCHD and GSCN made single training opportunities available to each of the four store owners May 24 – 27, 2016. The training opportunity allowed store owners to learn farm-to-store

implementation strategies, the value added to their business by working with local producers, and integration of farm-to-store strategies into their business models. A pre- and post-test was distributed to each store owner during the training session (See Appendix C and D). The post-test revealed that 100% of the store owners were confident in their knowledge and ability to sell and promote locally grown produce in their store. After the training, store owners were able to identify the farm-to-store strategy that would be appropriate for their store. Three of the four stores selected in-store sale of locally grown produce, while one store selected starting a farm stand. An updated HNS proposal was completed with each store owner to identify each store's needs and goals while participating in Locally Grown Locally Owned.

Project staff contacted 13 local producers during the 2015 growing season. Staff was able to reach four producers participating in the Charles Drew Farmers Market, two producers participating in the Benson Farmers Market, one producer participating in the Florence Farmers Market, and four producers participating in the Omaha Farmers Market. Aside from the many producers participating in local farmers markets, staff was able to reach out to two additional producers that were not participating in local farmers markets. Initial discussion with producers included interest in project, produce grown, size of operation, and location of operation. In early 2016, staff from the Nebraska Farmers Union and DCHD worked to add new candidates to the list of potential producers. Contacts were made with approximately five new producers prior to the 2016 growing season, in addition to reconnecting with the 13 producers from the 2015 growing season. To keep the project streamlined and uniform, it was concluded that one producer would be selected. Project partners met on June 7, 2016, to approve the utilization of Omaha Home for Boys Cooper Memorial Farm as the producer for the Locally Grown Locally Owned project. Project partners agreed that Omaha Home for Boys Cooper Memorial Farm had the capacity to support all four stores and at this time no additional producers would be pursued. Each store owner and producer was provided with a copy of the farm-to-store toolkit, sample memorandum of understanding (MOU), contact information of producer and store owner, and specific Locally Grown Locally Owned price tags to feature produce supplied by Omaha Home for Boys (see Appendix E for sample MOU). Locally Grown Locally Owned was officially implemented on July 26, 2016 in Douglas County, NE. Numerous farm-to-store activities were held at the four store locations from July – October 2016. Sixteen farm-to-store activities were held at Phil's Foodway, with a total of 1,200.5 pounds of produce obtained from Omaha Home for Boys. Three farm-to-store activities were held at KNJ, with a total of 137 pounds of produce acquired. Two farm-to-store activities were held at JND, with a total of 60 pounds of produce purchased. One farm-to-store activity was held at Cubby's in Bennington, NE with a total of seven pounds purchased. Relationships have been made between store owners and producer to help sustain the efforts of Locally Grown Locally Owned into future growing seasons.

Nebraska Extension in Douglas-Sarpy Counties conducted a total of 40 nutrition education demonstrations focusing on locally grown produce and a total of 3,565 customers received food samples with varying levels of nutrition education during July and August. Also, customers were given the opportunity to receive informational recipes cards for four pre-determined local produce items (tomatoes, collard greens, broccoli, and apples) during nutrition education demonstrations. Recipe cards contained selection, storage, usage, recipe and fun fact information of a specific local produce item. Nutrition education flyers were provided during the farm stand at Cubby's in Bennington, NE that focused on produce available for purchase.
To facilitate lessons learned from the Locally Grown Locally Owned project, GSCN created and distributed satisfaction surveys to store owners, producer, and customers (see Appendix F, G, and H). During the month of August, 41 customers were given a four question pre- and post-test to determine their acceptance of locally grown produce. Most customers (88%) surveyed

either strongly agreed or agreed that they had tried a new fruit or vegetable because the store had offered locally grown produce. A majority of the customers (92%) surveyed strongly agreed or agreed that they would be more likely to purchase local produce now that it is offered in the store. Ninety-five percent of the customers surveyed strongly agreed or agreed that local produce looks and tastes better and being able to purchase local produce is important to them. A producer and store owner satisfaction survey was created and administered by a GSCN staff member in early October 2016. The surveys focused on the effectiveness of the project and lessons learned from the project. All four store owners completed the store owner satisfaction surveys following the completion of Locally Grown Locally Owned. All store owners either strongly agreed or agreed that Locally Grown Locally Owned was a positive experience and would be inclined to sell local produce in the future. Seventy-five percent of store owners strongly agreed that customers responded positively to the offering of local produce. When asked if Locally Grown Locally Owned enhanced the stores connection to the community, 75% of store owners either strongly agreed or agreed. The producer from Omaha Home for Boys agreed that Locally Grown Locally Owned was a positive experience for him and he would sell to small corner stores again. Also, the producer agreed that he learned something from the experience and helped his farm connect better to the community. At the conclusion of the 2016 growing season, all work plan activities and objectives of the Locally Grown Locally Owned project were completed.

Goals and Outcomes Achieved

The Locally Grown Locally Owned project had three expected measurable outcomes. The three outcomes included:

1. increasing access to locally grown fruits and vegetable to Douglas County residents in identified areas;

2. increasing the number of HNS locations that integrate farm-to-store activities into their business model; and

3. increasing store owner knowledge and awareness of the importance of locally grown produce in their store.

The first goal of Locally Grown Locally Owned was to increase access to locally grown produce to 20,000 Douglas County residents by September 2017. Prior to Locally Grown Locally Owned, focus groups had conveyed that many residents rely on small corner stores, such as HNS, to fulfill their food needs between trips to larger grocery stores. Since HNS have not been able to obtain local produce through the available distributors, residents living in close proximity to the four HNS stores were unable to purchase local produce. Activities supporting this outcome included the implementation of the Locally Grown Locally Owned project. Through the project, store owners were connected with a producer that supplied local produce to all four stores. Additionally, 40 nutrition education demonstrations lasting approximately two hours each were held at three of the four stores in July and August and were able to reach 3,565 customers. Point-of-purchase prompts were available to each store to stimulate customer demand. Baseline data previously revealed that access to local produce was limited or non-existent prior to Locally Grown Locally Owned. Additionally, prior discussions with store owners revealed that each store location has 5,000 unduplicated customers each month. With continued support through technical assistance from a DCHD staff member in future growing seasons, the goal of 20,000 Douglas County residents having access to local foods seems attainable.

The second goal of Locally Grown Locally Owned was to increase the number of HNS locations that integrated farm-to-store activities. As mentioned, prior to implementing Locally Grown Locally Owned, HNS were unable to obtain local produce. Following the training, store owners were able to identify the farm-to-store strategy that best fit their store. Store owners were able to complete a Locally Grown Locally Owned proposal and identify at least one goal to attain. Each store owner and producer was given a sample MOU to facilitate the partnership. At the completion of the project, all four stores have connected with the Omaha Home for Boys and held at least one farm-to-store activity from July – September 2016. A majority of the store owners have plans to continue the connection with Omaha Home for Boys into next year's growing season.

The final goal was to increase 75% store owner knowledge and awareness of the importance of locally grown produce in their stores. This goal was accomplished by providing all four store owners with individualized training on farm-to-store strategies through the use of the farm-to-store toolkit and continued technical assistance from a DCHD staff member. The store owner training post-test revealed that all four store owners were confident in their ability to implement a farm-to-store strategy in their business following the training. Satisfaction surveys revealed Locally Grown Locally Owned was a positive experience for all store owners involved.

Beneficiaries

Three distinct beneficiaries of Locally Grown Locally Owned included residents living in close proximity to the HNS, HNS store owners, and Omaha Home for Boys. Previously, no baseline data was available for the number of small- to medium-sized stores selling local produce; therefore, the work of the Locally Grown Locally Owned project has shown a positive impact on the economic benefit for store owners and producer.

Formerly, residents living in distinct areas of Douglas County were challenged to purchase local produce without having to travel large distances to chain stores. Through the customer surveys, residents have shown that not only does local produce taste better but purchasing local produce is important to them. During the three month implementation of Locally Grown Locally Owned in Douglas County, 3,565 customers encountered local produce through nutrition education demonstrations that otherwise may have never been able to experience.

The four selected HNS participating in Locally Grown Locally Owned have been involved with the HNS project for over 5 years, but didn't have the mechanisms in place to be able to obtain local produce. Store owners have benefited from Locally Grown Locally Owned through increased knowledge of procurement of local produce and increased sales. One participating store revealed that sale of produce has increased nearly 50% compared to the same time last year. Several store owners have expressed a desire to continue the work that has started with Omaha Home for Boys and have begun planning for next year.

Omaha Home for Boys is an organization that provides care and support for at risk youths through various programs in Omaha, NE. The Omaha Home for Boys Cooper Memorial Farm is located in north Omaha and allows at risk youth to learn and experience local agriculture. Prior to Locally Grown Locally Owned, Omaha Home for Boys Cooper Memorial Farm produce was utilized in the Omaha Home for Boys on-site kitchen and sold at the Benson Farmers Market held on Saturday mornings May – September. Scott Yahnke, agriculture program coordinator at Omaha Home for Boys, conveyed that prior to Locally Grown Locally Owned an abundance of produce resulted in food waste. Locally Grown Locally Owned opened up new avenues and

relationships for the agriculture program and allotted $1,312.84 earned to be returned to Omaha Home for Boys.

Lessons Learned

During the recruitment of stores, project staff discovered that two of the four stores are an approved vendor for the Special Supplemental Nutrition Program for Women, Infant and Children (WIC). Requirements are enforced for approved WIC vendors to use approved distribution companies for WIC approved foods. Conversations by email and phone were held between DCHD staff and Nebraska State WIC staff to allow the distribution of local produce by a local producer to the two WIC vendor stores. The solitary concern from Nebraska State WIC staff was to educate store owners and producer that WIC vouchers were not to be handled by the producer but rather continue to be processed by store staff. State WIC staff was notified of the local produce distributor prior to implementation of Locally Grown Locally Owned.
The weather in Nebraska can be unpredictable and cause added pressure for individuals involved in agriculture. Cubby's in Bennington, NE decided to establish a farm stand as a way to increase access to Nebraska grown produce. A farm stand was held on September 13, 2016; however, inclement weather deterred the sale of produce. Project staff is confident that future farm stands will occur in future growing seasons.

Although project staff, store owners, and producer were pleased with the outcomes from Locally Grown Locally Owned, there are opportunities for improvement. Store owners and producer will be encouraged to work together for future growing seasons to possibly increase the variety of produce available. Planning for next growing season can never start soon enough. Omaha Home for Boys suggested that work needs to begin in the fall to prepare for the next growing season. One store owner suggested looking into additional methods to promote local produce in the community.

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Additional Information

Locally Grown Lemon Cucumbers at Phil's Foodway

Price tags containing “Locally Grown Produce by Omaha Home for Boys” at Phil’s Foodway.

Locally grown green beans available for purchase at Phil’s Foodway.

Locally grown eggplant and squash available for purchase at KNJ Grocery.

Farm stand selling local produce at Cubby's in Bennington, NE.

Locally grown watermelon available for sale at Cubby's farm stand in Bennington, NE.

Appendix A
DC = Taken from Washington DC survey
Delridge = Taken from Delridge survey

Healthy Neighborhood Store Owner Interview
Introductions
• Have you received information about the Healthy Neighborhood Store Project? If so, where did you hear about the project? [Readiness - Support of Influential Leaders]

Background
• How long have you owned or operated the store? (Delridge)

• Have you been involved with the store since it opened? (DC)

• Has the store changed much since it opened? (DC & Delridge)

• How many employees do you have now? (DC & Delridge)

• On average, how many customers shop here a day?

• What is your busiest time of day? Who is visiting at that time?

Customers
• What types of customers shop at the store most frequently? (DC & Delridge)

• How do you think people living around here feel about the store? (DC modification) [Readiness]

• Do you think that corner stores should support their communities? [Based on the answer to this question, decide whether to ask the next question] In what ways does the store support the community?

• Looking at your customers' purchases, do you think they have healthy eating habits? [Readiness – Motivation for Change – Perceived Need]

• What role do you think this store could play in promoting healthy eating in the community? [Readiness – Motivation for Change – Perceived Need]

Probes: Willing to expand offerings?; Willing to rearrange store?; Willing to hang educational/promotional materials? Willing to hang a bulletin board/provide space for

communication? Willing to host demonstrations?

• If you offered more healthy options such as fresh fruit and vegetables, do you think your customers would buy them? [Readiness – Motivation for Change – Perceived Effectiveness]

• If you offered more healthy options such as fresh fruit and vegetables, do you think you would get new customers? [Readiness – Motivation for Change – Perceived Effectiveness]

• Would you be interested in working with youth groups and other neighborhood residents to make store improvements? (Delridge) [Readiness- Motivation for Change]

Inventory

• How do you decide which items are sold? (Delridge)

• What company do you use?

• What items do you sell most of? (DC & Delridge)

• What items do you sell least of? (DC & Delridge)

• I noticed that you do/ do not sell fresh produce in the store. I'd like to hear a little about that decision. In other words, what are the advantages and disadvantages? (DC & Delridge)

• I noticed you sell _____[whole grain options; low-fat milk; etc.]. Do you have any problems when selling these types of items? (DC)

• Is there anything about the types of foods you sell that you would like to change? [Examples: Quality; Selection] (DC modification) [Readiness – Perceived Need]

• Do you currently have reliable refrigeration units for refrigerated and frozen foods? [Readiness – Capacity]

• How do you track your inventory? (Delridge) [Readiness - Capacity]

• If you decide to participate, would you be willing to share financial records with project staff to determine changes in sales of healthy foods? Records would be kept confidential. [Readiness - Capacity]

WIC and Food Stamps

• I see that you accept WIC. Do many of your customers use WIC coupons? What have been the barriers? (DC)

• I see that you DO NOT accept WIC. Has the store ever considered accepting the WIC vouchers?

• What issues have factored into the decision NOT to accept WIC? (DC & Delridge)

• I see that you accept food stamps/EBT. Do many of your customers use food stamps/EBT? What have been the barriers? (DC)

• I see that you DO NOT accept food stamps/EBT. Has the store ever considered accepting them? What issues have factored into the decision NOT to accept food stamps/EBT? (Delridge)

Alcohol and Tobacco Presence

• How often do tobacco (cigarette) company reps visit your store? Do you have contracts with them? (Delridge)

• Do alcohol and/or tobacco reps place ads/promotional items in your store? If yes, do you receive incentives (i.e. payment, discounts) for the placement of these promotional items? If yes, how much? Do you have contracts with them? (Delridge)

• Do they place ads/promotional items in your store? If yes, do you receive incentives (i.e. payment, discounts) for the placement of these promotional items? If yes, how much? (Delridge)

Alignment with the Goals of the Store

• After hearing more about the Healthy Neighborhood Store project, do you think the project fits within your business plan? [Readiness – Motivation for Change - Alignment]

Specialty Crop Block

• How do you currently obtain produce?

• What challenges do you face with offering fresh produce at your store? Quality, quantity or pricing issues?

• Do you currently (or previously) have/had any locally grown produce being supplied to your store?

• What locally grown produce would sell best in your store?

• What advantages do you anticipate by selling locally grown produce?

• What challenges do you anticipate by selling locally grown produce?

Closing Question

Is there anything else you would like to share?

Appendix B

Locally Grown Locally Owned Proposal

Store: _____Store Owner/Manager: _____

Date: _____

DCHD Staff: _____Plan Duration (start and end date):_____

This proposal will help identify strategies, in the above mentioned store to increase access to locally grown produce to Douglas County residents; increase the number of Healthy Neighborhood Stores (HNS) integrating farm-to-store activities, and increase store owner knowledge and awareness of the importance of locally grown produce. Prior to completing this proposal HNS Owner/Manager(s) should have met with representation from the Douglas County Health Department (DCHD) to discuss findings from the Nutrition Environment Measures Survey, identified one farm-to store strategy and developed a project plan that meets the goals of both the store and project.

Overall Store Goal:

_____

_____

Strategies Identified to Meet Goal:

_____

_____

Resources/Materials Needed: (Please describe the steps that will be taken, the resources needed, and the time frame for the implementation of the changes.)

_____

_____

_____

University of Nebraska-Lincoln Extension provides nutrition education a minimum of one (1) times per month.

DCHD will provide the store owner/manager with assistance in enhancing store layout for storage and display of locally grown produce. Additionally, project staff will provide in-store education opportunities featuring locally grown produce for customers (cooking demonstrations, one on one educations etc.), free advertisement and promotional materials for locally grown food items (shelf signs), training and information on farm-to-store strategies for owners regarding purchasing, pricing, stocking and marketing locally grown produce.

I agree to meet with DCHD staff to assess progress and re-evaluate strategies and project plan as needed, and participate in training opportunities. DCHD will assist the store owner/manager in connection with potential producers. It is the responsibility of the store owner to identify and obtain any required documentation to facilitate the sales of locally grown produce within the store setting on or on the premises. Maintaining the identified farm-to-store strategies will be the responsibility of the store owner/manager and producer.

Store Owner shall provide a certificate of insurance (either standard AIA form or comparable form) or update form evidencing the existence of both general liability and premises coverage and is attached to this proposal.

I verify that my most recent Douglas County Food Inspection meets the minimum requirements for my establishment and that should any of the changes made require additional food protection I agree to meet those standards at my own expense.

Further it is agreed that each party (Store, DCHD, Producer, UNL Extension, Gretchen Swanson Center for Nutrition and Nebraska Farmers Union) will indemnify, defend and hold harmless the other party from any and all liability, expense, cost, attorney's fees, claim,

judgment, suit and/or cause of action (whether or not meritorious), settlement or demand for personal injury, death or damage to tangible property which may accrue against the other party to the extent it is caused by the negligent acts or omissions of the indemnifying party, its offers, employees, agents, or subcontractors while performing their duties under this agreement, provided that the other party gives the indemnifying party prompt, written notice of any such claim, suit, demand or cause of action. The other party shall cooperate in the defense or settlement negotiation of cause of action. The other party shall corporate in the defense or settlement negotiation of such claim, suit, demand or cause of action. The provisions of this section shall survive expiration or termination of this agreement.

Store Owner Signature _____ Date _____

DCHD Approval for Proposal: NO YES Initials: _____

Appendix C
Farm-to-Store Training
Store Owner Pre-Survey

Please complete this survey in order to provide information to help us improve future Farm-to-Store training courses. Please be as honest as you can, as there are no “right” or “wrong” answers. This survey will take about 3 minutes to complete. Place an “X” in the box below the response option that best represents your answer. At the bottom of the page please provide your birth month and date as ID.

I am confident in my knowledge and ability to...

1. ...name at least three benefits of locally grown produce that do not apply to conventionally grown produce.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

2. ... select locally grown fruits and vegetables my store’s clientele would be interested in purchasing.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

3. ... build a strong business relationship with a local producer.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

4. ... draft a Memorandum of Understanding (MOU) between myself and a local producer.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

5. ... receive and maintain safe and high quality local produce in my store.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

6. ... identify at least two ways I can promote local produce in my store.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

Appendix D
Farm-to-Store Training
Store Owner Post-Survey

Please complete this survey in order to provide information to help us improve future Farm-to-Store training courses. Please be as honest as you can, as there are no “right” or “wrong” answers. This survey will take about 3 minutes to complete. Place an “X” in the box below the response option that best represents your answer. At the bottom of the page please provide your birth month and date as ID.

I am confident in my knowledge and ability to...

1. ...name at least three benefits of locally grown produce that do not apply to conventionally grown produce.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

2. ... select locally grown fruits and vegetables my store’s clientele would be interested in purchasing.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

3. ... build a strong business relationship with a local producer.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

4. ... draft a Memorandum of Understanding (MOU) between myself and a local producer.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

5. ... receive and maintain safe and high quality local produce in my store.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

6. ... identify at least two ways I can promote local produce in my store.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

Appendix E

Memorandum of Understanding
between
Name of Store Owner, Store Name ("Store")
And
Name of Producer ("Producer")

Purpose and Scope of MOU
a. The purpose of this Memorandum of Understanding (MOU) is to clearly identify the roles and responsibilities of "Store Owner" and "Producer" as they relate to providing locally grown fresh produce for sale at _____ (Fill in Name of Store).

MOU Term
a. The term of this MOU Agreement is the period within which the project responsibilities of this agreement shall be performed. The term commences – _____ (Date) and terminates _____ (Date).

Store Responsibilities
a. Store owner shall undertake the following activities during the duration of the MOU term:
i. Provide producer with weekly produce requests at least 24 hours prior to the designated delivery/pick-up date.
ii. Review and approve all produce that is provided to the Store.
iii. Provide adequate space for the promotion of local produce.
iv. Promptly reimburse allowable expenses according to the terms and conditions set forth in this MOU according to the described schedule.
v. Adherence to the responsibilities and compensation sections of this MOU.

Producer Responsibilities
a. Producer shall undertake the following activities during the duration of the MOU term:
i. Provide weekly produce requests to Store on designated delivery dates.
ii. Provide store owner a minimum of 24 hour notice of deviations from specific delivery dates or produce requests.
iii. Adherence to the responsibilities and compensation sections of this MOU.

Compensation
a. The Store shall reimburse the Producer the pre-designated amount for the requested produce.
b. Outlined below is the weekly produce request and pre-designated amounts for each item. Note: Produce items and amounts may vary due to availability.

Produce Item	Quantity	Price

Modification and Termination
a. This agreement may be cancelled or terminated without cause by either party by giving (30) calendar days advance written notice to the other party. Such notification shall state the effective date of termination or cancellation and include any final performance and/or payment invoicing instructions/requirements.

b. Any and all amendments must be made in writing and must be agreed to and executed by the parties before becoming effective.

Effective Date and Signature
This MOU shall be effective upon the signature of Store and Producer authorized officials. It shall be in force from _____ (Start Date) to _____(End Date). Both parties indicate agreement with this MOU by their signatures.

Signatures and dates

[Authorized signature from Store]	[Authorized signature from Producer]
Name of Store	Name of Producer
Date	Date

Appendix F
Locally Grown, Locally Owned
Satisfaction Survey
Store Owner/Manager

Please complete this survey in order to help us understand your experience as a local vendor during the "Locally Grown, Locally Owned" project. There are no "right" or "wrong" answers. This survey will take about 3 minutes to complete. For questions 1-4, place an "X" in the box next to your response. For questions 5-6, write your responses in the spaces offered.

1. "Locally Grown, Locally Owned" was a positive experience for me as a store owner/manager.

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

2. Customers responded positively to the store's offering of locally grown produce.

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

3. "Locally Grown, Locally Owned" enhanced my store's connection to the community.

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

4. I am more inclined to sell locally grown produce in the future due to my participation in "Locally Grown, Locally Owned".

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

5. Please describe what you liked best and least about participating in "Locally Grown, Locally Owned".

Best: _____

Least: _____

6. Is there anything else you'd like to share about being involved in this project?

_____

_____

Appendix G

Locally Grown, Locally Owned
Satisfaction Survey
Producer

Please complete this survey in order to help us understand your experience as a local food producer during the "Locally Grown, Locally Owned" project. There are no "right" or "wrong" answers. This survey will take about 3 minutes to complete. For questions 1-4, place an "X" in the box next to your response. For questions 5-6, write your responses in the spaces offered.

1. "Locally Grown, Locally Owned" was a positive experience for me as a local food producer.

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

2. Through participating in this project I learned at least one valuable skill (i.e., storing/transporting produce, safe handling of produce, creating a Memorandum of Understanding) that I will use as a food producer in the future.

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

3. "Locally Grown, Locally Owned" enhanced my farm's connection to the community.

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

4. I am more inclined to sell locally grown produce for resale in the future due to my participation in "Locally Grown, Locally Owned".

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

5. Please describe what you liked best and least about participating in "Locally Grown, Locally Owned".

Best: _____

Least: _____

6. Is there anything else you'd like to share about being involved in this project?

_____

_____

Appendix H

2016 USDA Crop Block Grant Consumer Survey
In the summer of 2016 this store began selling fruits and vegetables grown by local farmers. Please select how much you agree or disagree with the following statements on local produce.

1. I have tried a new fruit or vegetable because of this store offering locally grown produce.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

2. I am more likely to buy locally grown produce now that it is offered at this store.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

3. Local food looks and tastes better.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

4. Having local food for purchase is important to me.

☐ Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree

Project Title

Expanding Production of Vegetables in the Western Nebraska Panhandle Region
by Extending Growing Season Using Geothermal Heated Greenhouse

Project Summary

Successful vegetable producers in the southern panhandle region of western Nebraska are interested in expanding production by extending their growing season. Hoop houses are utilized for this purpose, but winter conditions limit their use and traditional greenhouse heating costs for growing during December - February curtail this practice.

This project explored utilizing greenhouses with geothermal heating to further extend the growing season and expand production in the western Nebraska Panhandle region. The project determined the feasibility, application and fit to farm sites then created a plan for producers to raise the capital to implement the practice. At the end of the project, a farm workshop was completed to let others know about the practice. Producers from the area, High Plains Food Coop (HPFC), Nebraska Food Coop, Triple Crown Commodities (now WyoFresh) and Nebraska Farmers Market Association were invited to participate. The workshop included a meal from local products and technical team members were available to help answer questions.

Increasing production by extending their growing season and controlling heating costs, vegetable producers can better utilize their capital resources (land and equipment) and human resources (management and labor) to be more competitive specialty crop producers. This project also helps very rural Nebraska producers expand their farm specialty crop production to bring much needed jobs to the area. With this type of expansion farm owners can easily bring a young person back home and integrate them into the farm operation. This region of Western Nebraska has lost 56% of its population over the last 40 years and is in desperate need for young adults to return to the region to stem this tide.

It is critical that this project be completed to help meet the growing demand across the Country for fresh vegetable products direct from the farm. For example, the High Plains Food Co-op's (HPFC) monthly vegetable sales grew by 800% from 2012 to 2017. HPFC customers are the most likely outlets for the expanded production. Comprised of nearly 50 producers and 300 customers within a 250 mile radius of Denver, HPFC aggregates and distributes 500-700 products monthly with its innovative farm-to-fork on-line ordering system (www.highplainsfood.org). The Front Range of Colorado is the closest (2 hours) major metro area for producers from the western Nebraska region compared to Omaha (7 hours).

The project did not build upon a previously funded Nebraska SCBGP project.

Project Approach

The following activities were performed during the project and represent the tasks in the work plan of the approved project proposal:

Organized Project
In the first year, a project kickoff meeting was facilitated, regular project communication was established with project team and a detailed work plan was completed. Regular project team communication and work plan updates were completed as needed.

Visited and Assessed Farm Operations

Four farm operations of producers in the Project Producer Group were visited in person. In addition, 3 other interested producers were contacted and interviewed by phone. These interviews were completed to gather operational and production information. The data gathered was summarized and a data review and analysis were initiated. Producers were again contacted in Year 2 to gather updated information and farm data was revised as a result.

Gathered Geothermal Heating Data

Initial geothermal heating system construction, operational and cost data were gathered. Two system operators were interviewed, and 4 sites of geothermal heating system users were visited. A review and analysis of the geothermal heating system, construction and costs was completed. That analysis was then integrated into production scenarios to estimate projections.

Developed Production Scenarios / Determine Producer Fit

Specialty crop production scenarios for using the geothermal technology were identified and the development of the scenarios was completed. Four scenarios of crop options and layouts were considered and analyzed for feasibility of layouts and fit to producer's operations. The scenarios were applied to one producer operation to determine producer fit. Other producers originally interviewed did not fit, were not interested to being involved or became unavailable for continuing dialogue.

Explored Funding Sources/Funding Outline

Exploration of options for funding sources for greenhouse installation was completed with four outside options considered. None of the outside options explored were identified to be likely funding source. Nonetheless, an outline of a proposal was prepared to be used for initiating funding development. This outline is included in the technical report.

Dissemination of Project Information

A farm workshop was held on July 9th, 2017. A workshop agenda was prepared, workshop location defined, and speaker venue developed, a meal was planned and prepared, a workshop schedule and workshop marketing were completed. A farm tour was originally proposed, however, with a limited number of farms using the technology and available to tour, the workshop was held in one location. The workshop attracted significant interest with over 50 participants in attendance. The workshop was held on a farm that represented a good fit for utilizing the system and a tour of that farm was completed in conjunction with the workshop. A locally sourced and prepared meal was part of the workshop as well.

In addition, information about the project will be reported at the early 2018 HPFC Annual Meeting. That meeting has historically been attended by over 150 producers and customers interested in the HPFC. A link to the workshop PowerPoint presentation is made available as part of the Technical Report.

Prepared Technical Report

A technical report on the project has been completed. The major recommendation promulgated by the report proposes development of a demonstration site as the next step. A demonstration site would confirm production data and generate actual output numbers to compare with projections. To view the technical report:
http://advancingruralprosperity.org/foodsystems/images/NDA SCBG Project Report 2017.pdf

Managed Project and Completed Reporting Tasks

Project activities were coordinated and managed to ensure activities and deliverables are accomplished on time and within budget. Teleconferences were facilitated with key project personnel to track project progress, problem solve and communicate project activities. The technical assistance team worked closely with the project host to ensure that the reporting requirements were met, and expense billing was submitted. Project management, coordination and reporting continued throughout the project.

BeeHaven Farm Roadside Market was the host for the project. BeeHaven is a small family owned business that includes a market garden and pasture raised meats and eggs. Located near Harrisburg, Nebraska, BeeHaven is owned and operated by Rick and Jennifer Rutherford. Rick and Jennifer opened their farm to host the farm workshop then planned and led the effort to prepare and serve a delicious meal as part of the workshop.

The established market system of the High Plains Food Coop (HPFC) provided the backdrop for determining product needs and pricing. Access to HPFC's market system and knowledge base proved vital to the success of analyzing the feasibility of the greenhouse system.

Advancing Rural Prosperity (ARPI) provided technical assistance to the project. ARPI brought an implementation oriented approach to the project to confirm the practical application of the greenhouse system to producer farms.

Goals and Outcomes Achieved

The following objectives of this project were completed:

1. Determine feasibility of small to medium sized greenhouses utilizing geothermal heat for year round vegetable production
2. Apply feasibility scenario to up to 3 producer operations in the southern Nebraska panhandle area to determine fit
3. Prepare a plan to raise capital for those producers with the best fit for the practice
4. Deliver a farm tour of producers involved to share project information with other producers and raise awareness about the production practice

Using forced air geothermal greenhouse technology applied to vegetable crop production would lead to increased individual farm's production and revenues was the original project goal. The proposed target for this project was to increase individual farm's vegetable production 30 to 50% and revenues by $5,000 to $15,000. Additionally, another overall outcome of this project was increase regional production by the same amount and adding 2 to 3 new jobs to the region.

Farm, HPFC and added job revenues were projected on a 10-year growth path with adding 2 greenhouse units in the region each year based on average gross revenue of $25,000 per CIS greenhouse from the proposed production scenarios. Over 10 years, farm gross revenues increased from $47,720 to $549,200 with the addition of 20 greenhouses into production in the region. HPFC gross sales and annual membership revenues increased from $19,930 to $217,300 if the assumptions made about the marketplace are valid. If these projections are realistic that could mean an increase of more than 6 full-time and 18 part-time jobs for the region over 10 years.

For an on farm example, BeeHaven Farm's annual sales for vegetables were just under $10,000 in 2016. Integrating a greenhouse unit into the farm operation and utilizing production scenario #1 citrus trees, raspberries and spinach year round could eventually produce an

additional $28,000 of gross revenue to that operation. That could be nearly a 300% increase in gross revenue to the operation over time. Even taking in account the learning curve reduction in first two years a more than 30% to 50% increase in revenues could likely be achieved early on.

While these outcome measures are long term they are achievable according to the projections developed here. If 20 system units are installed in the region in the next decade, it is projected that additional on-farm gross revenues from vegetable and fruit production could expand from roughly $50,000 to $550,000 representing a 10-fold increase. Individual farms could realize more $20,000 of additional revenues from each unit.

Beneficiaries

Beehaven Roadside Farm directly benefited from the project by getting a financial and production picture for using the geo-thermal greenhouse technology that could significantly increase their small diversified farming operation as noted in the previous section. In addition, the greenhouse system allows for specialty crop production for expanding or new farm operations of which could benefit minority and socially disadvantaged farmers. Potentially, if more of these farms were to expand in a similar manner and new specialty crop farms were able to be established, the result could bring new families to the area, to realize an economic impact to the region.

Increased vegetable production benefits local farmers markets, grocers and other retail outlets in the region by increasing the supply and variety of vegetables available. Through additional outreach and education, schools, food banks and senior centers could gain access to the quality healthy local food being produced. The data collected from this project can be used for local food production planning for existing or start-up food co-ops, aggregators and distributors as well as guidance for institutions and organization looking to fund local food projects. For instance, as the High Plains Food Co-op expands and develops their aggregation and distribution systems over the next 3 to 5 years, the use of the geothermal greenhouse technology can be integrated into both production and financial planning.

The awareness of the benefits of cold climate vegetable growing for food hubs, food cooperatives and beginning specialty crop farmers could lead to an increase in specialty crop production in neighboring states. This could then directly benefit consumers, producers and rural communities in Nebraska, Kansas, Colorado and Wyoming. Interest in this work has been generated in neighboring states.

Lessons Learned

While the projections from the scenarios imply that this system will enhance producer revenue, a number of challenges or lessons learned were revealed through the project.

- Efficient use of space in the greenhouse is critical to maximizing production. Since the greenhouse covers an evacuated dugout area, maximizing the use of the remaining surface area in the dugout area for planting is important.

- Being realistic about the availability and use of a producer's own construction skills and labor contribution to the unit's construction will be important as well. Producers must be careful not to over estimate how much one can do and underestimate how much time it will take to complete the construction.

- It makes the most sense to integrate the greenhouse system into small to medium sized diverse operations that are already operating. A successful application scaled up or operating as a business by itself was not identified.

- Depending on the location, including an extra heat source is a strong recommendation. If citrus trees are involved, they can be highly sensitive to cold and having an extra heat source can be crop saving insurance. Producers must be prepared and plan for winter crop production. In addition to the risk of frozen crops, frozen water pipes, heavy snow loads and loss of power are few winter challenges that need to be taken into account.

- If citrus trees are involved, producers must bear in mind the life cycle of the trees. It takes time for them to begin bearing fruit and depending on care they have a certain life span. Taking the life cycle into consideration in planning for production will be important.

- An unexpected finding of the utilization of the greenhouse system was the need to address overheating and humidity control. Overheating and humidity control can be moderated by use of fans which need to be included in the construction costs.

- Being cognizant of drainage needs around and within the facility is critical to its success as well. Since a portion of the facility is “underground”, flooding is a risk to content with. It is also not recommended to site the facility where ground water depth is shallow.

- Fitting production into a current, ongoing market system would useful as well. This would limit the producer’s risk for marketing and offer an existing market channel to readily move product.

- This is an emerging and developing technology or system. The producers visited were all early adopters experimenting with the first years of production and had not yet realized anticipated levels of production.

Contact Person

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Project Title

Potato Cyst Nematode Survey

Project Summary

The overall goal of the project is to facilitate trade of Nebraska grown potatoes on the international market, by documenting Nebraska's freedom from PCN.

Project Approach

The overall goal of the project is to facilitate trade of Nebraska grown potatoes on the international market, by documenting Nebraska's freedom from PCN.

2014 Survey

Beginning in October 2014, NDA field staff conducted soil sampling surveys of seed and tablestock potato fields in five counties in Nebraska, collecting 1,972 samples from these fields. Samples were processed by a USDA lab in Idaho, and all results were negative.

2015 Survey

Beginning in October 2015, NDA field staff conducted soil sampling surveys of seed and tablestock potato fields in five counties in Nebraska, collecting 1,710 samples from these fields. Samples were processed by a USDA lab in Idaho, and all results were negative.

2016 Survey

Beginning in September 2016, NDA field staff conducted soil sampling surveys of seed and tablestock potato fields in four counties in Nebraska, collecting 1,498 samples from these fields. Samples are being shipped to a USDA lab in Idaho to be processed.

2017 Survey

In March, April, and September of 2017, NDA field staff conducted soil sampling surveys of seed poato fields in three counties in Nebraska, collecting 928 samples from these fields. Samples were sent to the USDA lab in Idaho for processing. The March and April samples were negaitve, and the results for the September samples are pending.

Goals and Outcomes Achieved

The measurable outcomes for this project include the following:

1. Disseminating survey information in the NDA Entomology Program Annual Report;

2. Incorporating project results on the NDA web site; and

3. Inclusion of survey results on the NDA Entomology Program display booth at the Nebraska Great Plains Conference and the Governor's Ag Conference.

Beneficiaries

Information on the federal PCN quarantine and survey activities was incorporated into the NDA Entomology Program Annual report in 2014, 2015, and 2016.

Results from the 2014, 2015 and 2016 NDA PCN surveys were updated on the NDA web site. All results were negative. 2017 survey data will be added after results are confirmed.

Outreach was conducted at the Nebraska Great Plains Conference in Omaha, January 2015, 2016, and 2017 with attendance of 800; the Governor's Ag Conference, March 2015, 2016 and 2017 with 300 attendees; and Husker Harvest Days, September 2015, with attendance of over 100,000. This outreach included display boards and informational handouts with specific information on Potato Cyst Nematode, the NDA entomology Annual Report, and survey and trapping work. Additional information was provided directly to the Nebraska Potato Council at their meeting in March 2015, with eight industry council members attending and in February 2016, with six members attending, and in November 2016, with five council members attending, and also nine other individuals from industry and associated organizations.

Outreach included display boards and informational handouts with specific information on Potato Cyst Nematode, the NDA Entomology Annual Report, and survey and trapping work.

Lessons Learned

Because of these official survey efforts, we have documented that Nebraska remains free of potato cyst nematodes. This survey has directly facilitated the export of Nebraska grown potatoes to international markets. Industry professionals continue to be educated about the risks that this pest poses for the Nebraska potato industry, and have been provided information on who to contact for more information.

Contact Information

Julie Van Meter
Program Manager/State Entomologist
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(402) 471-6847

Project Title

Establishment of an Aphid Monitoring Network for Potatoes

Project Summary

Aphids are global pests of many plants and are economically important insects that greatly affect potato growers in the United States. They spread circulative and non-circulative pathogens, resulting in diseases by feeding on the sap in stems and leaves. This allows for easy transmission of viruses such as Potato Leaf Roll *Polerovirus* (PLRV) and Potato *Potyvirus* Y (PVY) between plants. The viruses infecting potato plants slow foliage and tuber growth, cause tuber necrotic diseases, and generally weaken the plant ultimately affecting tuber quality and production yield. Seed potatoes grown from diseased plants generally will not be marketable.

Two aphid species, green peach aphid *Myzus persicae* (GPA) and potato aphid *Macrosiphum euphorbiae* (PA) are commonly found colonizing and feeding on potatoes. Direct feeding alone by these colonizing aphids can harm the health and productivity of potato plants but more devastating to potato growers is their potential to spread PLRV and PVY. GPA is a most efficient vector of PLRV and PVY of any aphid species in the United States. In 2001, more than 50 species of aphids were reported to transmit PVY. Beside the colonizing aphids, transient aphids will sample or “taste” plants while migrating in search of a preferred host and while doing so may pick up and transfer pathogens. While not as effective vectors as colonizing aphids the transient group does pose a risk for disease transmission, especially when conditions are prime for aphid flight and population growth and dispersal. Monitoring for population presence and changes at or near the interface between potato fields and outside them, and noting other crops nearby will provide crucial information to local growers about needed pest management.

Nebraska has no modern data on current aphid species present in the potato growing areas of the state let alone any information on transient aphid migration time and patterns of aphids frequenting potato fields. Other regions of the US have established and maintained aphid monitoring networks for detecting colonizing and transient aphids. For example, North Central IPM is a network of 10 Midwestern states that use suction traps to monitor aphid populations and their migration. They provide valuable information describing aphid populations in their states.

The purpose of this Nebraska project was to establish a monitoring network, employing most effective trapping methods. Suction traps have been shown to be very effective and even favored status as monitoring tools for aphids. They trap areas from several feet above the soil surface and are effective in assessing seasonal aphid flights. Pan traps and sticky traps are other trapping methods that are comparatively used in the potato fields. These traps are useful in determining abundance and diversity at the field level that they are deployed. Once aphids are detected more intensive monitoring of an area can be established, such as leaf sampling and sweeping to check for threshold numbers. Growers were instructed and equipped to maintain and improve monitoring systems to allow growers to be involved in the monitoring process. Coordinating with all the growers throughout the integrated pest management process will increase control of the pest.

The project will directly benefit Nebraska potato growers. The total potato acres in the state are approximately 20,000 to 25,000. Nebraska’s seed industry enjoys a reputation for lower virus levels than most seed producing areas in the US. Continuation of the seed potato crop will save

hundreds of thousands of dollars not to mention the residual monetary effect on grower reputation.

In any given year there are approximately 20 to 25 grower/shipper entities involved with Potato Certification Association of Nebraska, all potentially benefitting from this project.

Beneficiaries are expected to receive timely information on the mode of establishment of the pest in areas in the state. Future benefits to all growers will likely include advanced IPM strategies and a better understanding of the biology of the insect and pathogen and how to handle the information provided by the established network.

The project is expected to allow producers opportunity to save thousands of dollars in combined savings in properly placed expensive pesticides and losses due to uncontrolled pest occurrences leading to badly diseased crops. The goal is to utilize the material gathered to determine long-term future monitoring and management steps and create a program that the growers can better support.

The project is expected to benefit all growers and shippers in the state, including those producing potatoes for chipping, french fries, tablestock and seed.

Project Approach

Personnel hiring process began the fall of 2014. Purchasing supplies for and construction of Suction traps occurred during winter and spring months. Training of identifiers began at the beginning of the aphid monitoring season.

Individual grower meetings were held by visitation at growers' offices and included monitoring site visits and demonstrations of sampling and trap and supply deployment as deemed appropriate. Weekly scheduling of sample retrieval and/or shipments to the laboratory for analyses occurred these meetings.

Suction traps were deployed after planting and cultivation are met for aphid flight initiation. Pan traps were deemed redundant and were omitted from the project. Winged adults were expected to be found in the suction and pan traps prior to establishment and damage is done. The population level of adults found in pan and suction traps and eggs found on leaf/petiole samples describes the pest pressure. Finding wingless forms on the leaf/petiole samples marks insecticide loss of effectiveness and possibly need for application of soft chemistry systemic insecticides directed at colonizing aphids.

Weekly reporting of sample analysis findings were tabulated and reported with wind, weather and other pertinent information as appropriate. Additional reporting of monthly summaries were not deemed useful since data provided weekly included an accumulation of data over the growing season.

End of the season total tabulations, weather event occurrences and events believed to influence the monitoring season are being summarized to be reported at individual meetings conducted by PCAN and at an annual meeting scheduled by the grower group(s).

Goals and Outcomes Achieved and Lessons Learned

Initial testing has shown that approximately 20 survey sites across the state can be surveyed on a weekly basis. Sweeps were used periodically comparatively where deemed appropriate. A trap-changing schedule was worked out with the participating growers.

We now have species data as related to the time of capture, conveying migration timings. This is information that can be fed into best management practices programs which help producers avoid the negative impacts of aphid presence, pressure and untimely pesticide applications.

Weekly detailed reports, disseminated to all growers outlining species, and numbers, potential migration patterns of the pests, timing of treatments used, and other relevant data were produced. This data will also be shared at the annual Potato Development Committee meeting as well as other relevant producer outreach opportunities, reaching potentially all 20 to 25 potato production entities in the state.

The measurable outcome of potential of decreased negative impacts from aphids as reported by participating growers who innovate and implement new management practices based on the monitoring network information as reported at the meeting at the end of the season is still undetermined. This is a much longer term outcome that will not be determined this season as this will be a long-term benefit not realized until tuber quality is evaluated at shipment time and changes are made as a result of the data generated herein.

Beneficiaries

This project directly benefits Nebraska potato growers. The total potato acres in the state comprised less than 20,000 in 2015. While growers in the eastern part of the state are less often affected by the pest and disease, it has been known to occur in that area. In any given year, there are approximately 20 to 25 grower/shipper entities, all potentially benefitting from the project.

The project benefited all participating potato growers and shippers in the state, including those producing potatoes for chipping, french fries, tablestock and seed.

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Project Title

Potato Psyllid Monitoring Network for Nebraska

Project Summary

Potato Psyllids are an insect pest causing psyllid yellows, rendering the affected plant and its tubers essentially sterile. Psyllids can also transmit the cause (*Candidatus Liberibacter solanacearum* (Lso)) of more devastating damage (Zebra Chip disease (ZC)) to potato crops if not intensely protected by the potato grower. This can affect table, chipping, french fries, even seed if severely infested by psyllids. This emerging tuber disease has caused millions of dollars of damage in the potato industry of the southwestern United States. Texas, Nebraska, Colorado, and Wyoming have been under the great scrutiny because the intensity of pest pressure is most notable in this region. Nebraska is also being scrutinized because our seed supplies in most of these areas. Nebraska may get elevated direct psyllid pressure once every 3 to 5 years, which is enough to damage a market. If severely affected, fresh or processed potatoes could be shipped out, affecting competitiveness in domestic and foreign markets. A psyllid monitoring network was established by scientists in Texas. Most of the science is done, establishing the pathogen, Lso. More tools and chemistries are being developed in this fight to manage this psyllid and ZC, but none more important than a monitoring network and its tools. The Texas scientists have indicated that states and grower groups must engage in regional monitoring. Recognizing the value in the network, PCAN is coordinating work in Nebraska and tailoring the network to suit the needs of Nebraska grower groups. In order to have access to the information generated from the trapping network, the grower groups needed to be further equipped and trained to replace, maintain and improve on recent efforts and innovations. New/improved tools and chemistries need to be evaluated early on to determine long term usefulness and need. Preseason warning systems needed refinement, further established and coordinated through grower communications and cooperation.

Project Approach and Goals and Outcomes Achieved

Previously adopted psyllid monitoring methods were used. All methods and materials continue to undergo refinement as innovation allows and is appropriate. Uniformity in data accumulation and correlation as well as usability and practicality are stressed. Use of logistical and financial information and the experience generated previously concerning protocols continue to meet the grower's needs, while allowing for improvement of methodology as it became available during this project.

Organizational and individual grower meetings were conducted or co-hosted by PCAN personnel with all involved parties in February, March and April of 2015. The meetings were used to report findings the year before in Nebraska as well as in the expanded regions covering Northern and Northeastern Colorado, Eastern Wyoming, and some of Kansas and New Mexico as well. The interest level was high. Workload, expectations and information reporting forms were discussed and tentatively agreed to. Contact information, needs assessment, and relationship establishment was accomplished here. Growers were again very interested in any kind of method of prediction and exchanges of control strategies were also discussed.

The personnel recruitment process began the fall of 2014 for identifiers and laboratory personnel by PCAN staff. Immediately after the grower organizational meeting, supply purchases were made. Training of the laboratory and survey personnel began at the beginning of the psyllid monitoring season by experienced PCAN staff and entomologist.

Individual grower meetings were held by visitation at growers' offices, and field monitoring sites. Monitoring site audits/visits and demonstrations of sampling and trap deployment were done as needed. Weekly target scheduling of sample delivery, retrieval and analysis occurred casually at these meetings or by phone/email. Trapping supplies were distributed when available and as needed.

In general, yellow sticky traps were deployed within three to four weeks after planting. Leaf/petiole sampling started shortly after 4 fully expanded leaves were formed and before planting insecticide effectiveness is expected to subside. Adults were expected to be found on the yellow sticky traps prior to establishment and damage is done. Eggs may be found on the leaves/petioles prior to or at establishment. The population level of adults found on sticky traps and eggs found on leaf/petiole samples describes the pest pressure. Finding nymphs on the leaf/petiole samples marks insecticide loss of effectiveness and need for application of soft chemistry systemic insecticides directed at the potato psyllids. All adult psyllids will be probed and analyzed for *Ca.* Liberibacter *solanacearum*. Approximately 30-40 fields spread across the state were surveyed on a weekly basis.

Weekly reporting of sample analysis findings were tabulated and reported in detail with summary, wind/weather and pertinent information available.

Traps were placed in potato fields the week of August 17, 2015, and inspected for potato psyllids the week of August 24. All adult potato psyllids received were tested. Results were updated as the data became available. The attached documents and information below represent the findings for both networks.

<u>Nebraska/Wyoming</u>
A total of 168 potato psyllids were found in 15 different fields. A total of 94 eggs, 72 small nymphs, and 27 large nymphs were found on leaf samples from 13 out of 13 fields with leaf samples.

<u>High Plains</u>
A total of 3,311 adult potato psyllids were found in 37 different fields. A total of 7 eggs, 34 small nymph, and 5 large nymphs were found on leaf samples from 4 out of 6 fields with leaf samples.

End of the season total tabulations, weather event occurrences and events believed to influence the monitoring season are being summarized. General findings are described below and will be reported in greater detail at the annual meeting hosted by PCAN and scheduled by the grower group in February/March. This will reach approximately 20 – 25 potato production entities in the state.

Preseason warning systems have been partially defined and needed further refinement, establishment and coordination through grower communications and cooperation. PCAN has been and will be testing new methods and refinements for detection of the insect and the pathogen as they become available. Growers need chemistries tested on a production scale and so they are best equipped to do this testing. Through all the collaborative efforts in sample collection and meeting at the identifiers' offices and various other places, communication among growers is rampant. Identifying chemistries on reports has also been useful as well as verbal reporting at grower meetings. Through this cooperation and public promotion of the concerted effort to coordinate all the growers, and all of the information to best be funneled into a well-thought out IPM program for control of the pest and the diseases it causes. This cooperative effort by very innovative growers in a fairly broad geographical region has stimulated

collaborative efforts among growers and others with more specialized areas of expertise. This clearly will be an ongoing effort for the foreseeable future.

This project will utilize the information gained from the monitoring network to improve best management practices that will help producers minimize the negative impacts of the psyllid pest.

Beneficiaries

This project directly benefits Nebraska potato growers. The total potato acres in the state comprised less than 20,000 in 2015. While growers in the eastern part of the state are less often affected by the pest and disease, it has been known to occur in that area. In any given year, there are approximately 20 to 25 grower/shipper entities, all potentially benefitting from the project.

Beneficiaries received weekly reports on the mode of establishment of the pest in areas in the state. Future benefits to all growers will likely include advanced IPM strategies and a better understanding of the biology of the insect and pathogen and how to handle the information provided by the established network.

The project benefited all participating potato growers and shippers in the state, including those producing potatoes for chipping, french fries, tablestock and seed.

Lessons Learned

The project was expected to allow producers to save production dollars in combined savings in properly placed expensive pesticides and losses due to uncontrolled pest occurrences leading to badly diseased crops. This year, due to lesser psyllid activity, actually provided the survey the opportunity to allow growers to hold off on pesticide application until needed. Better knowledge of pesticide timing and placement of pesticides lent itself to elegance in control regimes.

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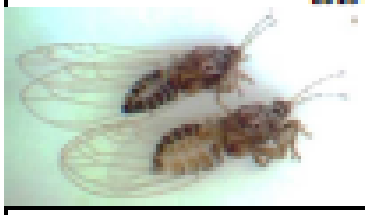
Additional Information

Below is an example of a Weekly Report electronically distributed to the growers reporting numbers, life stages, and trending graphs.

POTATO CERTIFICATION ASSOCIATION OF NEBRASKA

2015 POTATO PSYLLID SURVEY

WEEK OF 8/24/15



Week 32. 17 fields were included in this week's analysis. 358 potato psyllids were found in 15 different fields and will be tested for Liberibacter. There were 94 eggs found in 13 different fields this week.

COUNTRY PRIDE POTATOES							INSECTICIDE TREATMENT
Field \ Week	20-Jul	27-Jul	3-Aug	10-Aug	17-Aug	24/8	
HV	9	66	NT	36	NT	NT	
VIN	18	48	NT	21	NT	NT	

CSS-Cady							
Field \ Week	20-Jul	27-Jul	3-Aug	10-Aug	17-Aug	24-Aug	2.4lbs of Platinum Thg on in furrow. On 7/14 Agri-mek 1.5oz and on 7/21 Movento 9oz. All fields had Puffs applied at 2.7lbs on 7/16.
B1	1,2,0,0	2,1,0,0	0,1,0,0	0,1,0,0	1,1,0,0	NT	Each location 40 leaves.
B4	0,0,0,0	0,5,0,0	1,0,0,0	0,7,0,0	0,1,0,0	NT	
B5	0,1,0,0	0,4,0,0	0,2,0,0	2,1,0,0	0,1,0,0	NT	
B2	0,1,0,0	0,7,0,0	1,8,0,0	0,3,0,0	0,1,0,0	NT	

CSS Farms - DICKENS							
Field \ Week	20-Jul	27-Jul	3-Aug	10-Aug	17-Aug	24-Aug	
Top Soil	3,0,0,0	4,0,0,0	4,2,0,0	3,0,0,0	1,0,0,0	NT	20-Jul nymphs from 10-20 leaves.
RM,CS-8	8,0,0,0	6,0,0,0	8,2,2,0	0,0,0,0	8,1,0,0	NT	27-Jul nymphs from 10-20 leaves.
Fresno	0,0,0,0	0,0,0,0	2,4,0,0	0,0,0,0	0,0,0,0	NT	
Walter	NT,0,0,0	6,0,0,0	6,3,0,0	2,0,0,0	0,0,0,0	NT	

CSS Farms - MINDEN							
Field \ Week	20-Jul	27-Jul	3-Aug	10-Aug	17-Aug	24-Aug	
Patterson	18,2,0,0	39,0,0,0	16,1,0,0	14,4,0,0	7,1,0,0	2,3,0,0	7/10: Admire Pro in furrow, 2.5oz Agri-Mek 7/21; 9oz Movento 7/31; 10oz Spirotetramat 8/7
Hartman	8,1,1,0	13,3,0,0	2,8,3,0	6,1,0,0	1,1,0,0	4,7,3,0	7/10: Admire Pro in furrow. 7/16 CS-10: Relief @ 1.5 oz

O'Neill NESP/SXP							
Field \ Week	20-Jul	27-Jul	3-Aug	10-Aug	17-Aug	24-Aug	
O-10	NT	1,1,0,0	1,1,0,0	1,1,1,0	0,1,0,0	2	
HX-19	1,0,0,0	2,0,0,0	1,7,0,0	3,2,1,2	3,1,0,0	1	

[1]Potato Psyllid count: (Adult, eggs, small nymphs, large nymphs) 4 Traps/Field, 100 Leaves/Field unless otherwise indicated.

[2]Legend: AdP=Admire Pro; Thm=Thimet; Qdn=Quadris; Rgt=Regent; Pltr=Platinum; Inf=In Furrow; Shk=Shanked; at pl=At Plant

THOMPSON SEED POTATOES							INSECTICIDE TREATMENT
Field \ Week	20-Jul	27-Jul	3-Aug	10-Aug	17-Aug	24-Aug	
Carter	2	6	7	NT	NT	NT	
Snyder	0	8	0	NT	NT	NT	
SC25	1	3	1	NT	NT	NT	
DC4	1	3	27	NT	NT	NT	
Ocken S	0	4	8	NT	NT	NT	27-Jul= 3 Traps
WALTHER FARMS							Admire Pro at Plant.
Field \ Week	20-Jul	27-Jul	3-Aug	10-Aug	17-Aug	24-Aug	
BB19	4,2,0,0	5,1,0,0	6	41,8,3,1	18,3,0,0	10,7,0,1	27Jul=3 Traps; 3 Aug= 3 traps no leaves
BB20	0,0,0	22,6,0,0	10,5,0,0	9,13,0,0	16,5,0,1	0,6,0,0	
BB21	4,2,1,0	8,2,0,0	NT	19,7,0,0	9,6,0,0	1,8,0,0	27Jul=3 Traps; 3 Aug= no traps/leaves
BB22	6,2,0,0	10,5,1,0	6,7,0,0	12,2,0,0	6,7,0,0	6,2,0,0	27Jul=3 Traps; 3 Aug= 2 traps/26leaves
BB23	3,4,0,0	5,3,0,0	14	14,6,0,0	10,11,0,0	2,3,0,1	50 leaves; 3 Aug= 3 traps/ no leaves
MC21	24,1,0,0	26,5,0,0	9,2,0,0	33,6,0,0	30,12,0,0	11,4,1,2	3 Aug= 3 traps/30 leaves
MC22	63,2,0,0	23,7,0,0	9,0,0,0	69,58,38,6	108,12,30,1	44,29,63,13	3 Aug= 1 trap/ 21 leaves
MC23	58,1,0,0	18,1,0,0	26,1,0,0	132,28,0,0	157,3,1,0	50,6,2,1	27Jul=2 Traps
WESTERN POTATOES, INC.							
Field \ Week	20-Jul	27-Jul	3-Aug	10-Aug	17-Aug	24-Aug	
Gardner	2,0,0,0	7,1,0,0	14,1,0,0	5	13	6,13,0,1	
Kloch	5,4,0,0,	11,4,0,0	13,2,0,0	11,5,1,0	8,4,0,0	5,2,2,2	
Colson	2,7,0,0	21,0,0,0	13,6,0,0	11	7	12	
Lil Western	1,1,0,0	9,0,0,0	16,0,0,0	13,1,0,0	19,4,1,0	12,4,1,6	

High Plains Psyllid
2015 Potato Psyllid Survey Report

Grower	Psyllids Captured [1,3]								
Week of:									
FVP KS									
NE 3-27-36									
NE 7-27-35									
NE 20-27-36									
Pesticide Treatment[2]									
FVP- IMPERIAL									
Week of:	6/29	7/6	7/13	7/20	7/27	8/3	8/10	8/17	8/24
C-1	0,0,0,0	17,15,2,0	28,29,11,0	47,65,45,4	43,54,17,0	109,187,78,1	73,67,54,10	13	56
G-1	10	20	44	72	93	85	NA	NA	NT
M-1	4	10	47	22	50	47	42	NA	NT
M-2	2,0,0,0	28,12,4,0	22,21,29,3	46,0,11,0	31,85,68,14	76,34,67,4	106,44,37,12	20	NT
M-3	2	7	20	14	17	105	NA	NA	NT
M-4	7,2,0,1	13,33,37,1	46,74,30,2	80,21,58,16	79,26,26,14	370,42,56,7	140,45,54,2	66,9,20,6	48
S-1	11	58	45	152	90	118	136	28	60
W-1	11	11	151	43	30	92	60	11	7
Pesticide Treatment[2]									
Kramer Farms									
Week of:	6/29	7/6	7/13	7/20	7/27	8/3	8/10	8/17	8/24
L-5	15	65	57	35	33	49	141	61	26
L-6	21	36	44	50	40	90	116	63	40
L-7	32,0,0,0	95	92,18,34,1	39	39,2,3,2	83,53,201,60	253,55,4,34	119,0,1,1	NA
L-11	8	49,9,15,2	102,22,27,0	59,6,9,4	48	66,75,103,25	185,554,237,60	131,1,36,35	81
J-4	17,0,0,0	58,0,0,0	70,10,0,0	96,0,1,1	51,45,17,25	282	NA	0	NA
Pesticide Treatment[2]									
Lenz Farms									
Week of:	6/29	7/6	7/13	7/20	7/27	8/3	8/10	8/17	8/24
8	3	10	37	65	32	48	116	116	NA
Sitz 2	1	17	23	24	73	NA	NA	NA	NA
N2	1	9	45	53	26	40	127	184	NA
15	2	26	43	74	37	66	103	256	55
22	1	7	29	89	56	61	144	155	60
Pesticide Treatment[2]									

High Plains Psyllid
2015 Potato Psyllid Survey Report

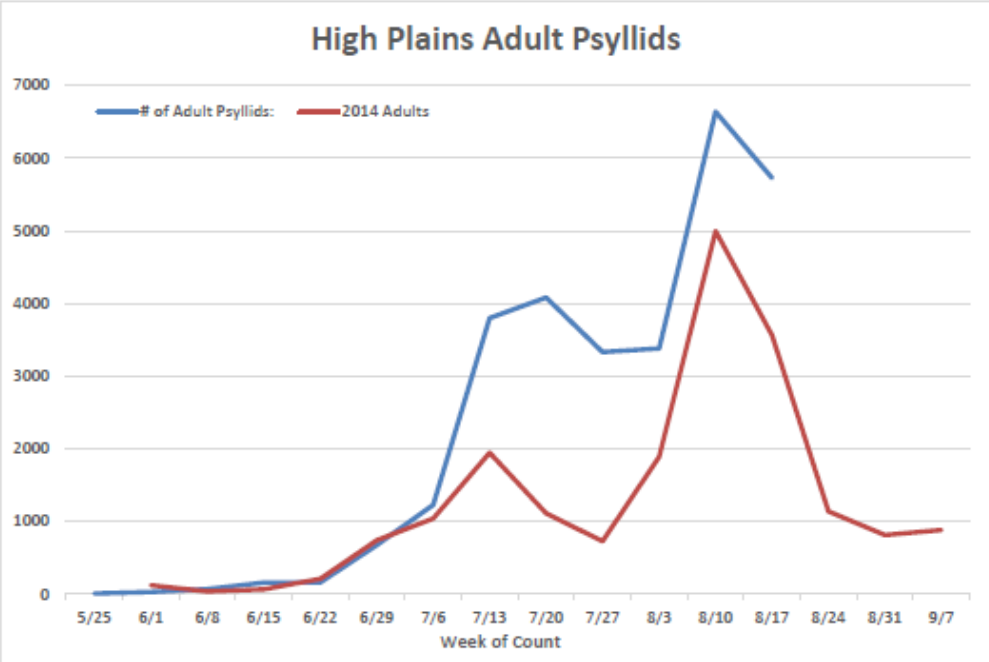
Grower	Psyllids Captured [1,3]								
Week of:	6/29	7/6	7/13	7/20	7/27	8/3	8/10	8/17	8/24
Western Potatoes Inc. (Holyoke)									
Weiss	3,0,6,0	7,0,1,0	34,0,0,0	39,5,2,0	42,33,15,0	29,1,3,0	40	55	191
Salvador West	6,0,2,0	0,0,0,0	30,0,0,1	28,7,0,0	46,25,7,1	13,1,9,0	18	44	68
Salvador East	1	1	32	37	49	11	33	40	154
Milner North	7	16	70	54	40	31	32	52	96
Milner Middle	4	6	122	45	45	22	65	116	80
Milner South	11,0,0,0	2,0,0,0	32,5,2,0	56,0,0,0	30,7,4,0	52,18,17,2	60	44	117
South Valley	1	4	44	48	38	40	83	56	130
Pesticide Treatment[2]									
Strohauer Farms									
Week of:	6/29	7/6	7/13	7/20	7/27	8/3	8/10	8/17	8/24
T9	16,0,2,1	18,0,3,0	13,3,2,5	NA	NA	NA	NA	NA	NA
7 East	44,3,6,8	13,1,9,1	22,0,0,0	NA	NA	NA	NA	NA	NA
7 West	0,3,0	0,3,0	NA	NA	NA	NA	NA	NA	NA
ACDC12 East	5,0,1,0	4,0,0,0	NA	NA	NA	NA	NA	NA	NA
ACDC 12 West	0,0,0	NT	NA	NA	NA	NA	NA	NA	NA
A3	21	1	NA	NA	NA	NA	NA	NA	NA
N3 East	17,0,0,0	6,0,0,1	0,0,0	NA	NA	NA	NA	NA	NA
N3 West	0,2,0	NT	NA	NA	NA	NA	NA	NA	NA
13	5	5	NA	NA	NA	NA	NA	NA	NA
MF2	5	0	NA	NA	NA	NA	NA	NA	NA
Lehan	5,0,3,0	22,0,3,1	27,3,1,3	NA	NA	NA	NA	NA	NA
Burns	1,0,0,0	7	8,0,0,0	NA	NA	NA	NA	NA	NA
Keiser	3,0,1,0	26,5,1,0	37,4,0,0	NA	NA	NA	NA	NA	NA
Geis	8	39	NA	NA	NA	NA	NA	NA	NA
Lost Creek	3,0,0,0	1,0,0,0	3,0,0,0	NA	NA	NA	NA	NA	NA
11	NT	NT	NA	NA	NA	NA	NA	NA	NA
9	NT	NT	NA	NA	NA	NA	NA	NA	NA
RLF	NT	NT	NA	NA	NA	NA	NA	NA	NA
RLF13			NA	NA	NA	NA	NA	NA	NA
Girvan Organic	0	3	6	NA	NA	NA	NA	NA	NA
Knaub Organic	0	2	4	NA	NA	NA	NA	NA	NA
Pesticide Treatment[2]									

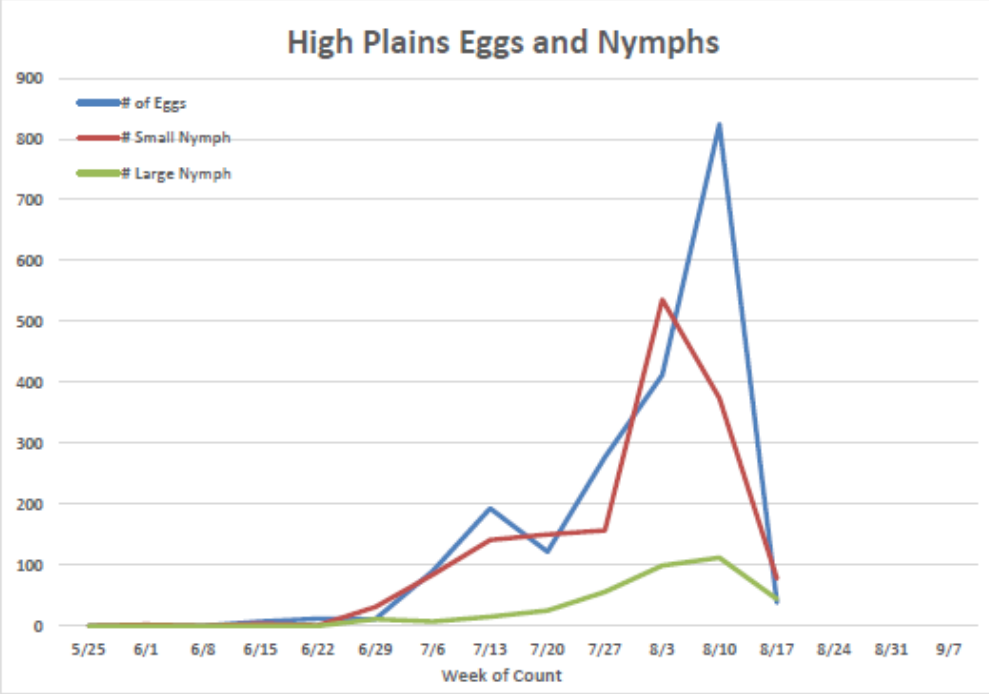
High Plains Psyllid
2015 Potato Psyllid Survey Report

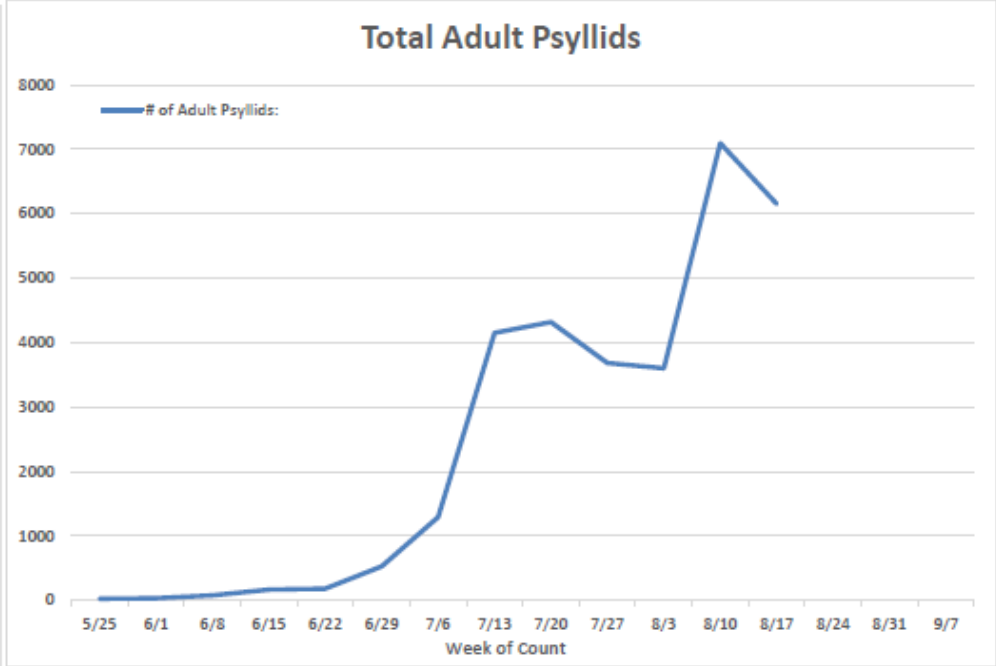
Grower	Psyllids Captured [1,3]								
Week of:	6/29	7/6	7/13	7/20	7/27	8/3	8/10	8/17	8/24
Cornerstone									
O-3	3	14	32	45	109	NA	132	15	NA
O-4	0	3	35	50	37	50	160	68	NA
O-5	0	5	30	65	69	47	50	18	NA
O-6	2	0	79	52	56	48	455	138	NA
P-1	0	10	36	61	61	66	67	43	NA
B-1	2	16	24	60	25	51	138	112	NA
B-2	0	12	82	123	88	69	134	75	NA
Blecha-1	0	3	79	51	48	17	112	212	NA
B-20	1	15	70	99	40	80	NA	NA	NA
Gr-1	1	8	105	96	73	45	145	55	NA
PH-B-5	0	1	52	62	150	10	142	203	179
PH-5-2	2	3	56	118	83	18	313	421	208
PH-5-15	4	9	85	128	108	41	231	186	124
PH-WST	7	17	55	61	37	19	255	270	107
PH 5-32	0	8	73	117	86	24	163	226	177
PH 5-11	1	23	99	97	93	32	271	197	235
G10	3	8	63	41	65	46	366	124	NA
G14	0	17	NA	165	92	66	NA	168	NA
BR-2	2	13	25	33	54	96	107	NA	NA
BR-3	1	2	12	53	30	63	102	115	NA
Blach-1	0	2	59	40	75	65	172	95	NA
Schafer	NT	9	47	51	52	97	165	247	NA
W-1	0	10	64	38	33	69	81	47	NA
W-2	4	11	87	42	119	141	68	118	NA
Pesticide Treatment[2]									
James Ewing									
Week of:	6/29	7/6	7/13	7/20	7/27	8/3	8/10	8/17	8/24
North	2	4	3	NA	NA	NA	NA	NA	NA
South	2	5	10	NA	NA	NA	NA	NA	NA
1	0,1,0	NT	0,0,0	NA	NA	NA	NA	NA	NA
2	0,0,1	NT	1,0,0	NA	NA	NA	NA	NA	NA
3	0,0,0	NT	0,1,0	NA	NA	NA	NA	NA	NA
4	0,0,0	NT	0,2,0	NA	NA	NA	NA	NA	NA
5	0,0,0	NT	0,0,0	NA	NA	NA	NA	NA	NA
6	NT	NT	NT	NA	NA	NA	NA	NA	NA
Pesticide Treatment[2]									

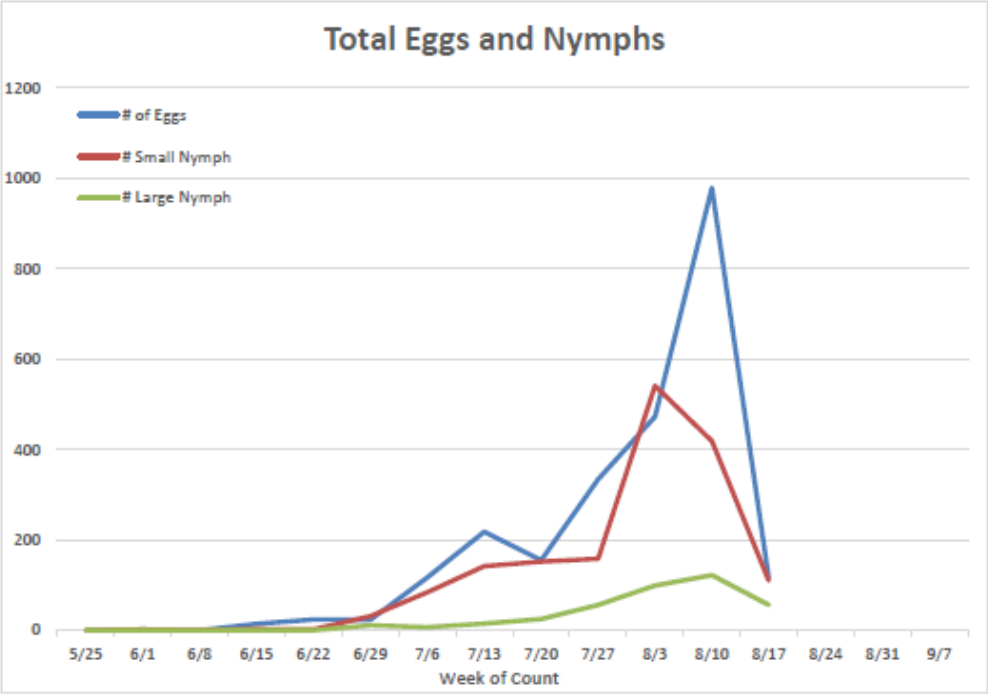
High Plains Psyllid
2015 Potato Psyllid Survey Report

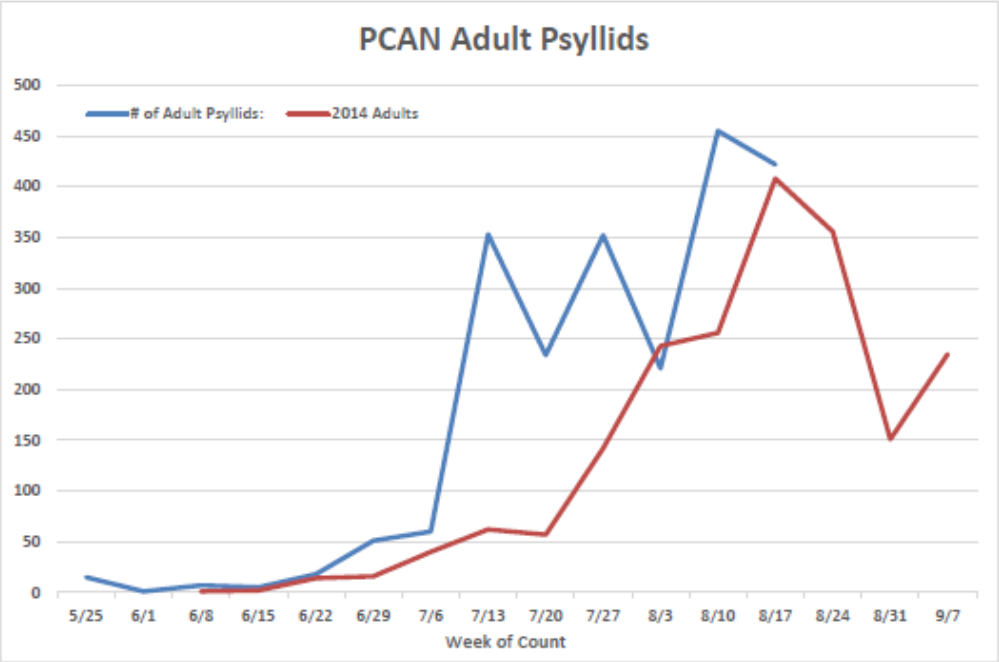
Grower	Psyllids Captured [1,3]								
Week of:	6/29	7/6	7/13	7/20	7/27	8/3	8/10	8/17	8/24
Wallace									
Vote	1,0,0,0	0	0	11,0,0,0	19,0,0,0	5,1,2,0	7,1,7,2	7,6,1,0	18,0,0,0
RM-1	0,0,0,0	0	4	10,0,0,0	10,0,0,0	8,0,0,0	28,5,1,0	17,5,2,0	45,0,0,0
Koop	3	1	3	34	50	29	60	47	49
K-1	2	2	2	15	3	11	30	13	47
K-2	2	3	4	15	29	42	80	NA	89
K-3	0	1	8	24	24	43	111	52	63
Pesticide Treatment[2]									
Walther Farms									
Week of:	6/29	7/6	7/13	7/20	7/27	8/3	8/10	8/17	8/24
FM14	13	19	64	92	29	NA	47	28	183
FM15	1	15	38,0,0,0	39	18	NA	21,3,0,0	58,4,2,0	26
FM16	11	39	38,0,0,0	70	23	NA	63	41,6,12,0	52
FM17	18	15	87	61,3,5,0	48	NA	51,4,12,0	29	46,1,10,3
FM18	5	10	41	78,0,7,0	20	NA	31	34	78
YC 30	36	17	47	50	15	NA	30	88	NA
YC31	40	9	44,0,0,0	73,3,0,0	42	NA	20	88	NA
YC32	0	6	25,3,2,0	38	10	NA	21,4,0,2	107,7,4,2	104,6,9,1
YC33	3	2	46	55	17	NA	16	84	63,0,14,1
YC34	4	3	33,0,0,0	22,5,8,0	3	NA	23,8,5,0	123	52,0,1,0
YC35	54	34	101	135,5,3,0	52	NA	31	83	44
YC36	15	72	232	146,2,1,0	79	NA	68,14,17	48	54
YC25	NT	NT	NA	NA	NA	NA	NA	NA	NA
YC26	NT	NT	NA	NA	NA	NA	NA	NA	NA
Pesticide Treatment[2]									

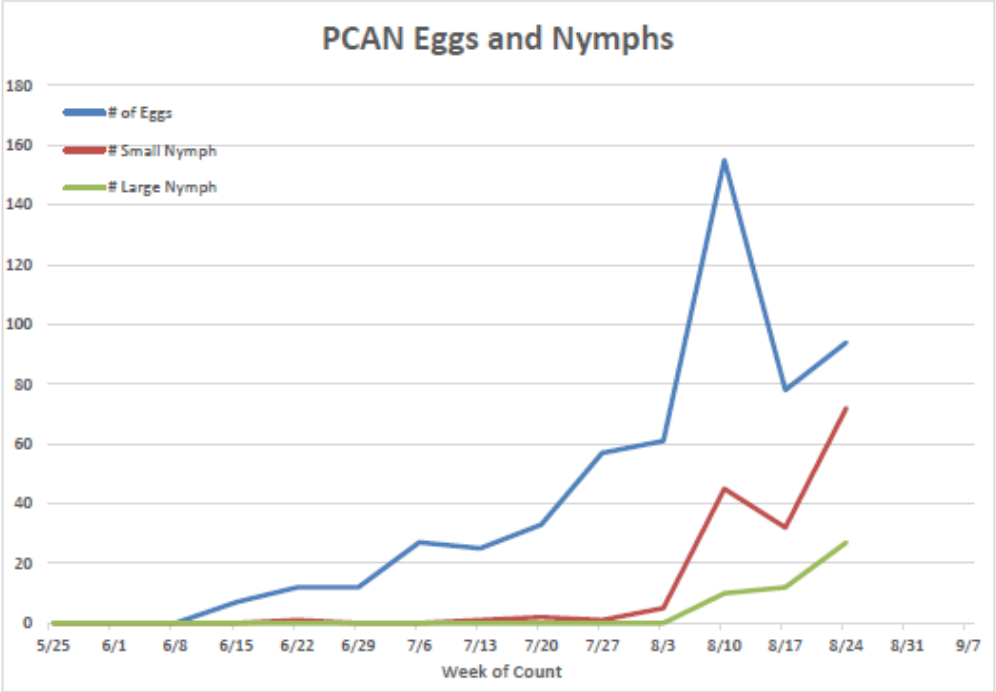

High Plains Adult Psyllids
# of Adult Psyllids:
2014 Adults
7000
6000
5000
4000
3000
2000
1000
0
5/25
6/1
6/8
6/15
6/22
6/29
7/6
7/13
7/20
7/27
8/3
8/10
8/17
8/24
8/31
9/7
Week of Count


High Plains Eggs and Nymphs
# of Eggs
Small Nymph
Large Nymph
900
800
700
600
500
400
300
200
100
0
5/25
6/1
6/8
6/15
6/22
6/29
7/6
7/13
7/20
7/27
8/3
8/10
8/17
8/24
8/31
9/7
Week of Count


Total Adult Psyllids
# of Adult Psyllids:
8000
7000
6000
5000
4000
3000
2000
1000
0
5/25
6/1
6/8
6/15
6/22
6/29
7/6
7/13
7/20
7/27
8/3
8/10
8/17
8/24
8/31
9/7
Week of Count


Total Eggs and Nymphs
# of Eggs
Small Nymph
Large Nymph
1200
1000
800
600
400
200
0
5/25
6/1
6/8
6/15
6/22
6/29
7/6
7/13
7/20
7/27
8/3
8/10
8/17
8/24
8/31
9/7
Week of Count


PCAN Adult Psyllids
# of Adult Psyllids:
2014 Adults
500
450
400
350
300
250
200
150
100
50
0
5/25
6/1
6/8
6/15
6/22
6/29
7/6
7/13
7/20
7/27
8/3
8/10
8/17
8/24
8/31
9/7
Week of Count


PCAN Eggs and Nymphs
# of Eggs
Small Nymph
Large Nymph
180
160
140
120
100
80
60
40
20
0
5/25
6/1
6/8
6/15
6/22
6/29
7/6
7/13
7/20
7/27
8/3
8/10
8/17
8/24
8/31
9/7
Week of Count

Project Title

Rediscovering our Roots: Promoting Late-season Crops Through Market Diversification and Producer and Consumer Education

Project Summary

The high demand for late-season, specialty crops was demonstrated at Lincoln's first winter market in November 2013. More than 1,800 customers attended the Holiday Harvest Farmers' Market, an event that was organized by Community CROPS in partnership with Old Cheney Road Farmers' Market (OCRFM), and Open Harvest with funding remaining from a 2013 Specialty Crop Block Grant Program (SCBGP) grant. Farmers and processors reported that $14,500 was generated in sales as a result of participating in this market. However, the demand for specialty crops exceeded the supply, and all twelve farmers selling at the market sold out of produce within hours of the market starting. Specialty crop producers who have not invested in season extension techniques are missing out on an emerging market. For a sustained expansion of late-season specialty crops, interest and education needed to continue to encourage consumer demand and increase producer profits.

To firmly establish, sustain, and expand winter markets, this project addressed the need to increase both consumer demand and the supply of specialty crops after the regular farmers' market season has ended. This project relied on three components: consumer education, producer education, and diversified markets.

Funding from the 2013 SCBGP-FB entitled, "Extending the Season and Increasing Farmer Income in Southeast Nebraska" supported the establishment of the first winter market, and provided a baseline from which this project worked from to identify the number of specialty crop producers, sales of specialty crops, customers attending the indoor markets, purchases of late-season crops, and growth in late-season markets.

From 2015 through 2016, we recruited more specialty crop producers, provided them with educational resources, and added more markets for late-season specialty crops. With project funding, a better indoor facility was secured to host the markets to accommodate more producers and more customers. This project was instrumental in expanding the regular farmers market season into winter markets, which has encouraged more specialty crop producers to invest in and expand their season extension practices.

Project Approach

Activities under this project centered around consumer education; providing resources and support to producers; and organizing five indoor, winter markets over two years.

Project Activities: Consumer Education

The first year OCRFM partnered with Open Harvest, Lincoln's food cooperative, to provide consumer education and to support the markets' promotional activities. Open Harvest created the Holiday Harvest Farmers Market (HHFM) logo, a media kit for OCRFM and vendors to use, a marketing calendar, and hosted consumer classes the first year with Community Crops. Although the partnership with Open Harvest was short lived and did not extend to 2016, much of the materials they designed for the 2015 winter markets are still being used today.

In 2015, Community Crops and Open Harvest hosted a “Soup-er Suppers” class under this project. We had 13 register for the class and 10 people show up. They were introduced to the holiday markets and online ordering option by the instructor. Many of the ingredients used that evening were the same that would be available at the following markets. People expressed excitement about the markets and interest in the online ordering option. At the November 2015 HHFM, a Crops instructor hosted a class in a separate room off the main market area. Even though we had advertised the class well through email, social media, and with posters at the Market, people were reluctant to participate. It was our sense that the Market doesn’t present itself as a place where people want to stay or attend because of the class, rather they are there to do their shopping and leave. We don’t have vendors with ready-to-eat food or invite people to sit and linger. It was decided that having classes available at the Market was not the most effective way to get information to consumers.

We modified the consumer outreach in 2016 to offer resources at the Old Cheney Road Farmers’ Market (OCRFM) over 2 weeks. On October 9th and October 16th, Crops set up a booth at the OCRFM to promote the HHFM to market attendees and share information with consumers about food preservation techniques and the possibilities of eating local food year round. During the two days of outreach, Crops handed out over 75 information packets on how to store specialty crops in homes without a root cellar. The packets detailed the best locations in homes for a wide variety of specialty crops including carrots, beets, cabbage, winter squash, green tomatoes and more.

Additionally, Crops staff provided samples of fermented foods and handed out more than 50 information sheets on how to ferment your own food. There was lots of interest in the fermented foods and many people took the opportunity to try all the samples. Fermented specialty crops available for sample included turnips, beets, daikon radishes, garlic, ginger, and chili peppers. Finally, Crops received 50 entries for a free entry raffle of prizes that included potato and onion storage bags, air locks for fermenting in a mason jar, and a book on root cellaring. Some comments from attendees of the market included: “So glad you are doing this. We all need to be educated more on these topics!” and "My grandmother used to do this kind of stuff. This is a lost art. Thank you for sharing this information.”.

There were also many anecdotal stories about personal experiences with fermented foods and many seeds were planted with the idea that people could stock up on local foods at the HHFM and with a little planning and coordination could keep eating local year-round.

On Monday, November 14th, six days before the HHFM, Community Crops also hosted a hands-on fermentation class. The class provided a classroom type lecture about the benefits of fermented foods and a broad how-to overview of the process. The second portion of the class was a hands-on session where each participant made their own chopped vegetable mix and packed into a mason jar for fermentation at home. The ingredients in the class were sourced local whenever possible and specialty crops used included: carrots, beets, Napa cabbage, cabbage, daikon radishes, radishes, garlic, and chili peppers. 14 people attended this class.

Crops also had a booth at both November and December HHFMs with information on storing root vegetables, recipes, and information on fermenting. Several people stopped to ask questions and pick up information, which got out more educational resources than the previous attempt to host a class at the Market.

Goals and Outcomes Achieved and Beneficiaries

After the official announcement that this project received funding, the main goal was to inform producers of the additional late-season markets with enough time to plan their 2015 winter crop production. The intention to expand late-season markets in 2015 with two indoor markets and two online buying cycles was communicated to Old Cheney Road Farmers' Market (OCRFM) vendors in various ways starting as early as December 2014. Vendors initially were notified via email. The OCRFM manager and board also presented the project at OCRFM's Annual Meeting in February 2015. OCRFM has 37 vendors who are primarily specialty crop growers. Fliers with information about the markets and online expansion were distributed at the 2015 Healthy Farms Conference hosted by the Nebraska Sustainable Agriculture Society (NSAS). The OCRFM manager attended this conference and spoke at workshops about the expanded opportunities for late-season markets, reaching approximately 150 producers, the majority of whom are specialty crop growers. An email to the NSAS listserv announcing the winter markets for specialty growers was also sent out in July 2014. Following early announcements, the OCRFM manager and Community CROPS continued to promote and encourage late-season crop production by visiting farmers at markets throughout the season. OCRFM presented to 15 of CROPS' Beginning Farmers program participants and discussed the growing demand for late-season, specialty crops, and the opportunities to participate in the Holiday Harvest Farmers Markets (HHFM). It's estimated that from the point the project funding was announced to when the applications were available for the HHFMs, that at least 400 producers were made aware of the opportunity, the vast majority of whom were specialty crop growers.

One of the challenges we've had with producers participating in the late-season, HHFMs is not promoting the opportunities to specialty crop growers with enough time to plan their late-season production. Because of the timing of the grant announcement and our recruitment plan, the early announcement was done successfully. This gave specialty crop growers enough time to plan and increase their production of late-season crops. With better recruitment efforts, the assurance of support from SCBG funding, and growing popularity of these market, <u>we were able to add 5 new specialty crop growers as participating vendors in 2015 and 2 new specialty crop growers in 2016</u> and a local winery who grows a small portion of their own grapes.

As we added more late-season opportunities for growers, the competition to participate increased. It wasn't until after applications had closed in September 2016 that we heard from at least two other growers interested in participating. In 2017, we moved the notice and application process up to include in our regular season application in February 2017 and to put out to non-OCRFM vendors in Spring 2017. This gave more growers time to consider extending their season, especially when they could be assured of market opportunities. We also included an option on the Holiday Harvest Farmers Market website for producers to sign-up for email alerts as applications are due.

The second goal in our work plan was to develop a web page platform specific to the HHFM online bulk purchases of storage crops by September 2015. Initially, this was contracted to be done with the Nebraska Food Cooperative (NFC). The OCRFM and CROPS planning team met with NFC several times between January and July 2015. However, due to circumstances beyond our control, NFC announced in August that they would not be able to continue with the project. After reviewing our options, OCRFM started working with Lone Tree Foods (LTF) to perform the tasks and goals of the project. Lone Tree Foods connects local farmers with wholesale buyers in eastern Nebraska and western Iowa. They function similarly as NFC, but specialize in larger, wholesale accounts and bulk orders. Because they already work with wholesale orders, they were able to assist our growers and provided information on how to sell

online including what quantities should be offered, wholesale pricing, and packaging for online retail.

One unseen outcome of the partnership between the project and LTF was introducing more individual buyers to their online market. Because they specialize in larger, wholesale accounts, their purchasers tend to be grocery stores and restaurants. The project's aim is to encourage consumers to buy larger quantities of local, late-season storage crops such as potatoes, beets, and carrots. This partnership gave consumers another market for doing so, while also introducing more specialty crop growers to LTF and selling wholesale.

Lone Tree Foods also streamlined their process for registering producers onto the site. In doing so, there were at least 4 producers, three of whom are specialty crop growers (Grandview Farm, Pekarek's Produce, and Heartland Nuts n' More), who had been undecided about selling with LTF until this opportunity. Because this project provided additional promotion for the online HHFMs and because LTF agreed to make it easy for producers to participate, we saw many who joined to try it out, and who stayed selling with LTF through the following year.

The goal of creating an online market for bulk purchases of specialty crops was met, and in time to recruit and sign up new producers. Additionally, prior to adding this online option for the HHFMs, Lone Tree Foods had stricter guidelines on production practices for participating farmers. Because some of the participating HHFM growers have more conventional farming practices, LTF had to make some adjustments in their messaging to buyers about production practices. After the first year with the online ordering option, LTF decided to open up their registration to conventional growers as well. It's a credit to this grant and adding the online option that LTF more quickly moved to change their policies, and in doing so created an additional market through the year for more local growers. Through 2016, the three specialty crop growers mentioned prior had combined sales on LTF of nearly $35,000.

Table I is the report from the first year of online ordering.

Table I						
2015 Lone Tree Foods' Online Ordering REPORT						
Online Order	**# Producers**	**# of orders**	**# Specialty Crop Growers**	**# Items Sold**	**Average Sales / Order**	**Total Producers ' Sales**
Nov 2015	11	27	8	102	$93	$2,513
Dec 2015	11	14	8	53	$87	$1,219

While this project has not completed the goal of hosting six consumer education classes, the goal of reaching out to at least 100 people had been achieved with Crops' outreach efforts at the markets and two classes.

However, the main purpose of hosting classes for consumers was to increase interest and consumption of late-season crops. Surveys from both 2015 and 2016 indicate that purpose was achieved. Customers were given surveys as they came into the market in November 2015 and

the first market in December 2016. Table II is a report of the survey findings. In 2015, nearly 70% of customers indicated that the HHFM increased their consumption of local produce. In 2016, another 70% of customers indicated the HHFM increased their consumption. In order to understand if customers are looking for better or more resources, the customer survey on December 4, 2016 HHFM asked “Would you like more information or opportunities to learn about how to prepare, store, or preserve fall vegetable?”. Of those who answered the question, respondents interested in such information and those who were not was nearly split. The other third of respondents either didn’t answer or answered “maybe”; 10 indicated they had received information already from Crops or at the HHFM.

Table II					
Survey Question: Has the Holiday Harvest Farmers Market increased your consumption of local produce this fall?					
Date	**# Responses**	**YES**	**NO**	**SAME**	**NOT SURE**
11/22/15	236	165	8	29	34
12/4/16	311	219	13	40	39

Our final goal was to organize and host two HHFMs in 2015 and three in 2016. This was successfully achieved. Table III shows how the HHFMs have grown since they started and into the grant-funded years. Grant funding began with the November and December 2015 Markets. With the funding, we were able to secure a larger facility, and thus have 10 more specialty growers participate, increasing total sales for specialty crop growers by 76%; growers’ total sales amounted to $34,384 at the holiday market in 2015.

TABLE III							
2013 - 2016 FARMERS MARKET REPORT							
HHFM	**# Producers**	**# Specialty Crop Growers**	**Average Producer Sales**	**Total ProducerSales**	**Estimate Grower Sales**	**Customer Count**	**Total Tokens Sold**
Nov 2013	18	11	$853	$14,500	$9,383	?	
Nov 2014	19	12	$941	$11,288	$11,292	?	$995
Dec 2014	18	10	$824	$9,885	$8,240	750	$1,070
Nov 2015	23	16	$1,143	$26,301	$18,288	1,500	$3,021

Dec 2015	24	16	$1,006	$21,303	$16,096	1,215	$2,562
Nov 2016	24	17	$1,400	$33,600	$23,800	1,258	$2,220
Dec 2016	24	17	$1,050	$25,200	$17,850	958	$1,834

Lessons Learned

Challenges came up in this project with completing the goals of consumer and producer education. First, the workshops that were to be organized to support producers through the grant cycle have not happened. It was determined that the best way to go about this is not directly through Community Crops, but rather seeking out people who have specialized in late-season marketing and season extension. For example, LTF provided how-to guides on pricing and packaging for wholesale. These late-season, online markets are important to growing the supply of late-season produce and many new producers were introduced to wholesale markets. Also, both Open Harvest and OCRFM provided useful marketing tools and assistance that have helped expand sales and exposure for vendors.

The consumer classes are also different than we had originally envisioned with this project. Significant staff time and resources can be used to host mini-workshops and classes, while the number of people who actually participate in them is relatively very low. We found better outreach opportunities in 2016 by having a presence at the regular season markets, sharing information vie social media and email, and providing resources at the HHFMs with recipes and handouts. Developing more of these resources and having them available earlier in the season at market and online was a better way to reach consumers.

Last, the goal of having at least 20 specialty crop producers participate in each indoor HHFM was not fully achieved; 16 participated in each market. The goal of having 25 specialty crop producers participate at each indoor HHFM in 2016 was also not achieved. It was determined that in order for the demand to encourage the supply, producers need to be successful each year. The supply of late-season produce needs to grow with the demand. While that increases each year, the project's goals were minimally aggressive. The additional challenge with having a market with so many specialty crop growers is there is less variety in the crops that can be available in late fall and winter. Recruiting more diverse specialty crop growers is one way to meet this challenge.

This project aims to shift the consumer's perspective of what it means to eat local year-round through age-old techniques such as canning, preservation, and storing potatoes in root cellars or a cold closet. A shift like that doesn't happen in a year, rather it's gradual and done by providing effective, sound advice, access, and resources. We're on that path if by simply providing more market opportunities for consumers to eat local longer, but the more we do to make late-season markets both successful for local producers and to encourage higher customer sales, will only ensure continued success and growth in the future.

Contact Person

Sarah Smith, Market Manager
(402)937-1630
ocrfm.manager@gmail.com

FARMERS' MARKET FRESH
Storing & Preserving Fall Produce

Edible	Store	In What	Time	Preserve
Brussels Sprouts	Fridge	Plastic bag	3-5 weeks	Blanch and freeze
Beets/carrots/turnip	Cut off greens and store in fridge hydrator drawer	Wrap greens in a damp cloth or plastic bag; put root vegetables in plastic bag	2-4 weeks	Pickle, or shred and freeze
Broccoli	Fridge, hydrator drawer	Plastic bag	1 week	Blanch and freeze
Cabbage	Fridge, hydrator drawer	Plastic bag to retain moisture, but not necessary	3 weeks - 2 months	Ferment
Cauliflower	Fridge, hydrator drawer	Plastic bag	1 week	Blanch and freeze
Celery	Fridge, hydrator drawer	Wrap in damp towel, plastic bag, or upright in a container of water	2 weeks	Freeze
Cabbage	Fridge, hydrator drawer	Plastic bag to retain moisture, but not necessary	3 weeks - 2 months	Ferment
Garlic	Cool, dark space	Uncovered	Several months	Mince, blend with olive oil and freeze
Greens (collard, spinach, kale, arugula, mustard, etc.)	Fridge, hydrator drawer	Unwashed and wrapped in a damp towel, or loosely tied plastic bag	1 week	Blanch and freeze
Herbs	Fridge (Except Basil)	Wrapped in a damp towel	1-2 weeks	Freeze or dehydrate
Kohlrabi	Fridge	Plastic bag	1 month	Ferment, pickle, or freeze
Onion	Cool, dry space (not with potatoes)	Uncovered	Several months	Freeze
Potato	Cool, dark space (not with onions)	Uncovered	2-4 weeks	Freeze as mashed potatoes or hash browns
Radishes	Fridge	Plastic bag	2-4 months	Ferment or pickle
Sweet Potatoes	Warm, dry space (55-60°)	Uncovered (Keep @ 80% Humidity)	4-6 months	Freeze or can as mashed
Winter Squash	Warm, dry space (50-55°)	Uncovered (Keep @ 50-60% Humidity)	2-6 months	Quick blanch, shred and Freeze

HOLIDAY HARVEST
FARMERS MARKET

DECEMBER SHOPPING LIST

____ Asian Greens
____ Beets
____ Boc Choi
____ Broccoli
____ Brussels Sprouts
____ Cabbage
____ Carrots
____ Cauliflower
____ Celeriac
____ Celery
____ Collard Greens
____ Garlic
____ Green onion
____ Kale
____ Kohlrabi
____ Leeks
____ Lettuce
____ Mushrooms
____ Mustard Greens
____ Onions
____ Pecans

Meats, etc

____ Beef
____ Broilers
____ Pork
____ Eggs
____ Honey
____ Cheese

____ Peppers
____ Pie Pumpkins
____ Potatoes
____ Radicchio
____ Radish
____ Salad Mix
____ Spinach
____ Sweet Potatoes
____ Swiss Chard
____ Tomatoes
____ Turnips
____ Winter Squash

Specialty Items

____ Breads & Pastries
____ Preserves
____ Pasta
____ Caramel Candies
____ Gelato
____ Gluten-free goods
____ Flowers/Plants
____ Wreaths
____ Gift baskets
____ Gift certificates
____ Dried peppers
____ Truffles
____ Soups To-go
____ Herbal teas
____ Tea towels, aprons, etc.

VENDORS

— Branched Oak Farm —
certified organic cheeses, beef and pork, gift sets

— Capo di tutto Pasta —
artisan pastas and specialty items, gift sets

— Common Good Farm —
certified organic produce, herbs, eggs, beef

— Community CROPS —
certified naturally-grown produce, herbal teas, specialty items

— Everything Caramel —
homemade caramels, gift sets

— Gelato to Go —
cones and pints of gelato, nut rolls, gift sets

— GreanLeaf Farm —
certified organic produce

— Grandview Farm —
seasonal produce

— Hunter's Honey —
local honey, pollen, creamed honey

— Johnson's Farm —
seasonal produce, pepper blends

— Kat's —
wild crafted wreaths, bouquets, soups, pastries

— Lakehouse Farm —
certified organic produce

— Le Quartier Baking Co —
artisan breads, pastries, to-go soups, dinner rolls

— Medinger's Market —
tomato and apple chips, seasonal produce, jell-jam

— Nebraska Mushroom —
fresh, gourmet mushrooms, mushroom extracts, dog treats

— Open Sky Farm —
grass-fed, hormone and antibiotic-free beef, steaks

— Pekarek's Produce —
seasonal produce

— Prairieview —
seasonal produce, jams/jellies, honey, hand-sewn items

— P.S. It's Gluten Free —
gluten-free pastries, breads, baked-goods

— Robinette Farms —
naturally grown produce, herbs, eggs

— ShadowBrook Farm —
naturally grown produce, artisan goat cheeses, pork, gift sets

— Twin Springs Pecans —
pecans

— Wolff Farms —
certified organic produce, whole broilers, grains

Farmer Flyer

Late season markets are expanding in Lincoln with indoor farmers' markets on Nov. 22nd and Dec. 13th and two, new ordering cycles through the Nebraska Food Cooperative for consumers to buy large quantities of staple and storage crops direct from farmers.

The **Holiday Harvest Farmers Markets** and community **bulk buying events** are sponsored by the Old Cheney Road Farmers' Market in partnership with Community Crops, NFC, and Open Harvest. Funding provided in part by the Nebraska Department of Agriculture's Specialty Crop Block Grant to support season extension efforts and promotional activities.

If you're interested in the **2015 winter markets**, contact Megan Jackson at 402.309.9096 or ocrfm.manager@gmail.com.

Project Title

Using Ozone to Develop Environmentally Preferable Disease Control in Grapes and Orchard Fruits

Project Summary

The purpose of this project was to determine whether spraying fruit and vines with ozonated water would control and/or eliminate diseases better than would typical chemical pesticide usage. Should it be determined that disease control could be realized with a chemical free or chemically-reduced process, this project could potentially impact every specialty crop producer in the state of Nebraska.

Potential Impact

1. The grower could eliminate or reduce a substantial portion of their chemical spray program. This economic impact could increase the competitiveness of the industry.

2. Problems of disease control, the build-up of chemical resistance, chemical residual in the soil and garden, not being able to spray at or during harvest could be minimized or eliminated.

3. Improved safety and image of safety for the consumer could significantly impact the marketing/sales of Nebraska specialty crops.

4. Improved food product safety for the consumer could directly also significantly impact the marketing/sales of the Nebraska specialty crop.

Project Approach

Task #1. “Research Coordinator” met with vineyard and orchard managers and trained in research protocol (October 2014 – March 2015). Project team (including representatives from James Arthur Vineyards, Mac’s Creek Vineyards, Reno Ridge Vineyards, Cardinal Orchards, Ozone Consultant, and Research Consultant) met on March 6 to outline the overview and details of the project. Decisions were made thereby integrating the goals and measurable targets of the project with the “typical real world” production of grapes/fruits (e.g, typical chemical spraying schedule, locations of plots to minimize any carryover/drift from other areas, ozone spray schedule, etc.)

Task #2. (April 1-April 15, 2015). Identify research trial plots in each vineyard and orchard. A minimum of 40 grapevines were identified in each of three groups per each cultivar: Control = were not sprayed at all; Treatment Group A = sprayed with ozone; Treatment Group B = sprayed with pesticides. Orchard groups were as described above with three trees identified for each group for each cultivar.

Task #3. (April 1- April 15, 2015). Research Coordinator trained Research Assistants in data collection to r=.80 inter-rater reliability. Observational Rating Scale was used; ratings from 1-5 (1= no observable disease, 5=high disease pressure). Research Site Assistants were trained to use the Observational Rating Scale. Approximately 10% of the practice ratings were

randomly selected and rated by a second observer (Research Coordinator) for reliability check (inter-rater reliability >90% agreement).

Task #4. . (Late April – Early May 2015). Began spraying regimen. Chemical spraying began as per normal vineyard practices for each participating vineyard/orchard (approximately once every 10-14 days). Each time chemicals were sprayed so too was ozone sprayed. JAV began spraying during the last week of April and Mac's Creek, Reno Ridge and Cardinal Orchards began during the first week of May.

Task #5. . (May - August 2015). Begin testing of ozone concentration needed to kill disease. Not completed. University lab was unable to conduct this testing and subsequently this task was cancelled. Research Coordinator and Site Manager (Seth McFarland who also serves project as ozone consultant) monitored spray practices to assure ozone concentration of at least 750 mv was being used to spray fruits.

Task #6. (May 1 - October 15 2015). Spray every 10-14 days. Spraying continued throughout project period as per normal vineyard/orchard practices.

Task #7. (August 1 - Late October 2015). Sent fruit to NDSU for fruit quality analysis and resveratrol elicitation Two samples (approximately 1-2 lbs each) of each cultivar were collected and frozen and sent to North Dakota when their lab was ready to receive. Fruit was actually sent in November 2015.

Task #8. (May 1 - October 31 2015). Collect and analyze data. All vines/trees were rated bi-monthly by an assistant who did not know which plants belong to which treatment groups (to eliminate possible bias in the ratings). All rating forms were forwarded to the Research Coordinator. Group average ratings (every two weeks) were compared to determine differences across all cultivars, within each cultivar, and within types of cultivars (e.g. Univ of Minnesota cultivars, Elmer Swenson cultivars, and French American cultivars).

Task #9. (November 1 - December 31 2015). Complete Analysis and Write Final Report. Data analysis is complete. Summary report from NDSU Fruit Analysis lab (Dr. Kalidas Shetty) is complete:

Summary of results of Fruit Quality Analysis conducted by North Dakota State University lab (Dr. Kalidas Shetty):

- Ozone stimulates phenolic bioactives in grapes.
- The stimulation of phenolics results in increased antioxidant function and we are still assimilating data whether this stimulates bioactives for glycemic control associated with type 2 diabetes using our in vitro assay models.
- We suspect that an improvement in disease protection associated with ozone addition is linked to phenolic stimulation.
- Overall early indications are that increased phenolic stimulation from ozone addition has benefits for both plant disease protection and increased fruit bioactives that has human disease modulating benefits.
- The ozone effects on phenolic bioactive enrichment is highest and most significant in Frontenac and Vignole and not very prominent in other varieties.
- In Vignole in particular it is significant and off the charts with very high bioactive response to ozone that also translates into high inhibitory activity against glycemic control (alpha-amylase and alpha-glucosidase inhibition associated with sugar control).

- Vignole has very potential as a specialty grape targeted for health benefits and the response to ozone is just fantastic.

Task #10. (February – March 2016). Conduct “Field Day” dissemination. Not completed. This Field Day option for dissemination was cancelled due to scheduling problems.

Task #11. (February/March 2016). Present data at the Nebraska Winery and Grape Growers Association annual meeting. Call for proposals for the UNL Forum was not sent out. Project results were accepted/presented at the VitiNord International Cold Climate Conference in November 2015.

VitiNord 2015 Conference Attendance

Disaggregated by :

Country

USA	=	191	Sweden	=	2
Canada	=	20	Germany	=	3
Denmark	=	4	Norway	=	1
Estonia	=	3	Switzerland	=	1
Finland	=	2	UK	=	1

State

Alaska	=	1	Michigan	=	3
California	=	3	South Dakota	=	5
Indiana	=	1	North Dakota	=	20
Colorado	=	1	Montana	=	9
Wyoming	=	1	Missouri	=	11
Illinois	=	6	Vermont	=	2
Iowa	=	7	Pennsylvania	=	1
Minnesota	=	19	New York	=	6
Wisconsin	=	10	Ohio	=	1
Kansas	=	10	Nebraska	=	72
Maine	=	1			

Knowledge/satisfaction gained from conference was measured.

To measure this goal, a post-conference evaluation was conducted. Forty-nine surveys were returned representing an approximate 21% return rate. Ratings of satisfaction with various components of conference were rated as follows:

1. Keynote Sessions = 4.5
2. General Sessions = 4.4
3. Parallel Sessions = 4.4
4. Viticulture Strand = 4.4
5. Enology/Winery Strand = 4.3
6. Poster Sessions = 3.9
7. Wine Tasting Sessions = 4.4

These ratings ranged from 3.9 – 4.5 with an overall average rating of 4.33 on a 5 point scale (1 = Very Dissatisfied ; 5 = Very Satisfied).

Ratings of overall impressions of the conference components:

1. The keynote sessions were relevant and useful = 4.5
2. I can put what I learned to immediate use = 4.3
3. The speakers were knowledgable and dynamic = 4.4
4. The sessions met my expectations = 4.3
5. The conference met my expectations = 4.5

These ratings ranged from 4.3-4.5 with an overall average rating of 4.4 on a 5 point scale (1 = Strongly Disagree; 5 = Strongly Agree).

Goals and Outcomes Achieved

Goal 1

The first goal was to develop environmentally preferable disease control practices that have a less harmful effect on human health and the environment when compared with competing traditional practices. This will lead to eco-friendly alternatives resulting in environmentally sound practices with equal or improved disease control reducing harmful environmental impact, disease resistance and chemical build up in the soil by using natural resources such as ozone spray.

Performance Measure

The researcher developed an Observation Rating Scale. Research Assistants were trained on each site and made ratings every one - two weeks. Each plant was rated on a five (5) point

scale (1=no observable disease; 5=High disease pressure).

Each cultivar was divided into three groups.

1. The Control Group did not receive spray treatment of any kind.
2. Treatment Group A received ozone spray treatment.
3. Treatment Group B received pesticide spray.

Effects upon the plants treated with ozone (Treatment Group A) were scored against the Control Group and Treatment Group B. A comparison was made between Treatment Groups A and B. This enabled the researcher to measure the effectiveness of disease control among the three groups. A minimum of 40 grapevines were identified in each of the three groups per each cultivar. Orchard groups will be identified the same with three trees for each group for each cultivar.

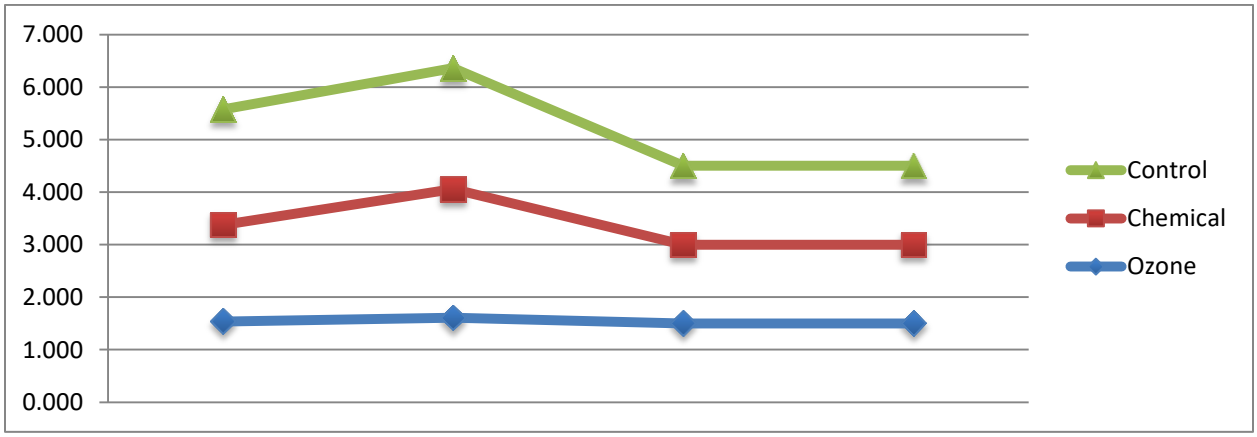
Benchmark

Small pilot studies have shown encouraging results in disease control using ozone treatment in vineyards, orchards, and tomatoes. Ozone has been applied to Marechal Foch, Edelweiss, Brianna, and deChaunac grape cultivars in south central Nebraska. Preliminary results suggest a positive effect on disease control, especially Downy Mildew, With ozone application applied to Edelweiss, Vignoles and Lacrosse grape cultivars in eastern Nebraska, preliminary results suggest an inconclusive effect on the Vignoles and Lacrosse cultivars, but a positive effect on disease control on Edelweiss. Ozone has been applied to crab apple and Bartlett pear trees in south central Nebraska. Preliminary results suggest a positive effect on disease control on both cultivars.

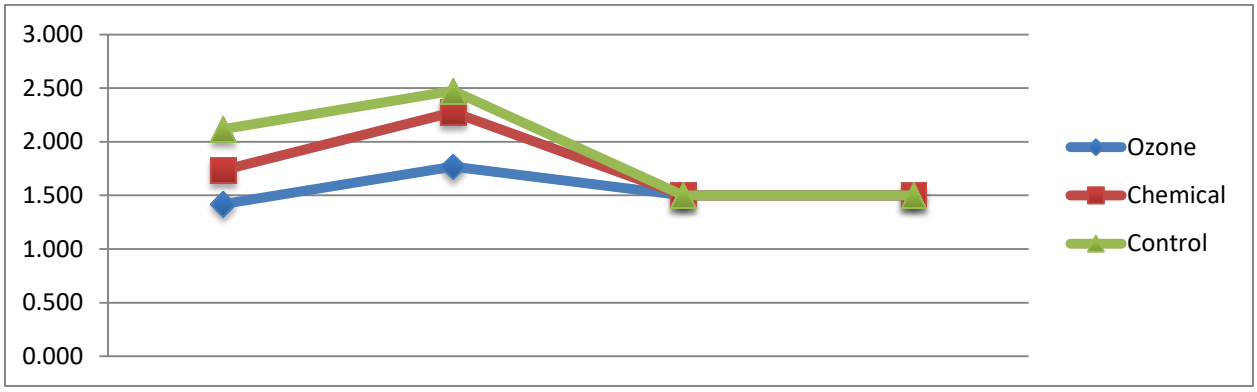
Target

It is estimated that ozone treated plants, on the average, will show less disease pressure compared to the Control group. It is estimated that ozone treated plants will, on average, rate $\leq$ 3 points on a 5 - point rating scale [created by the Research Coordinator]. Weekly- bi-monthly observational/ratings were made on all plants.

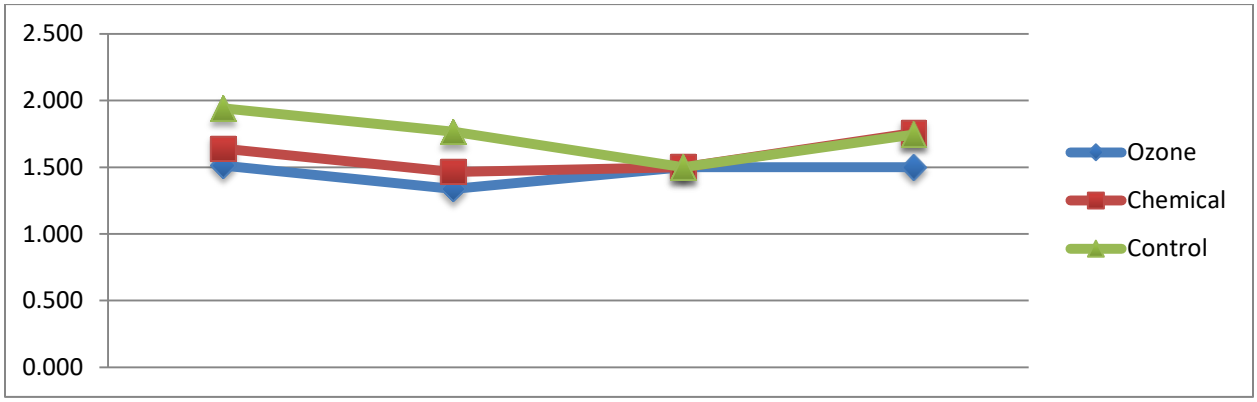
Brianna



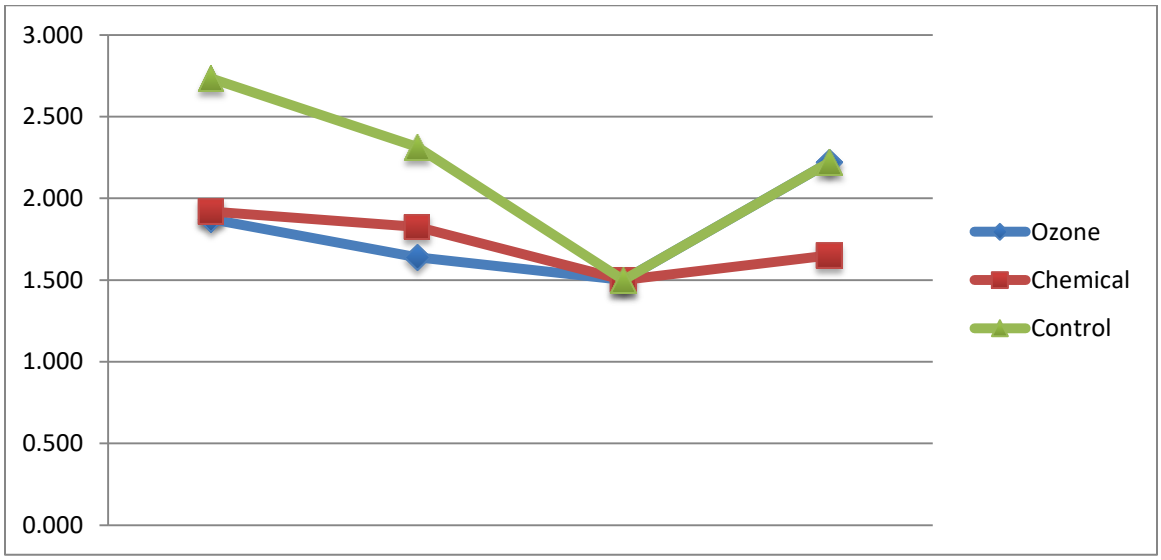
De-Chaunac

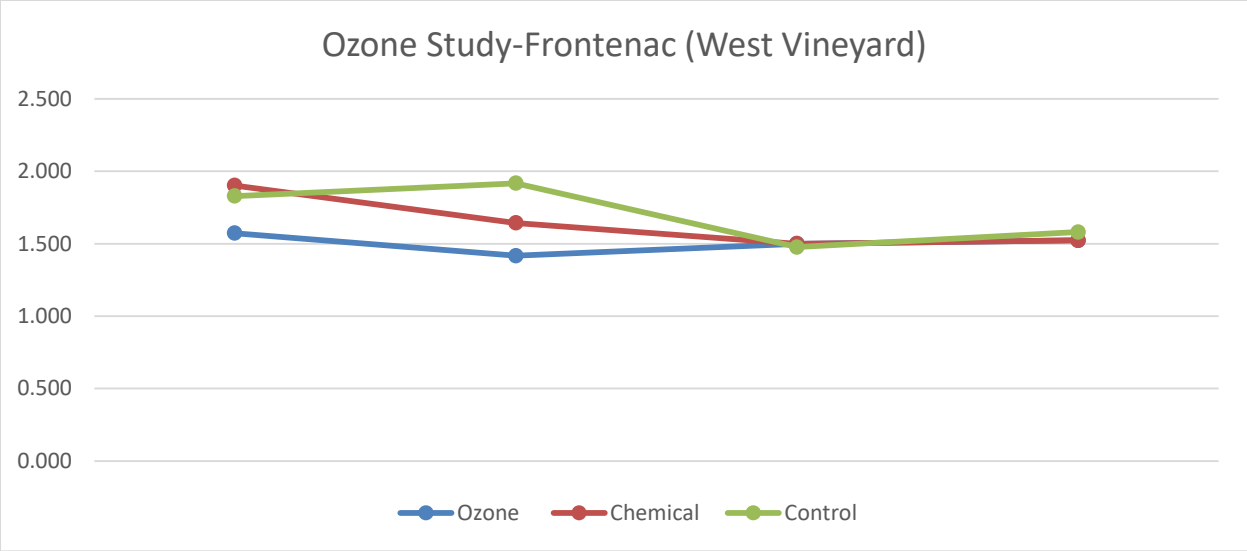


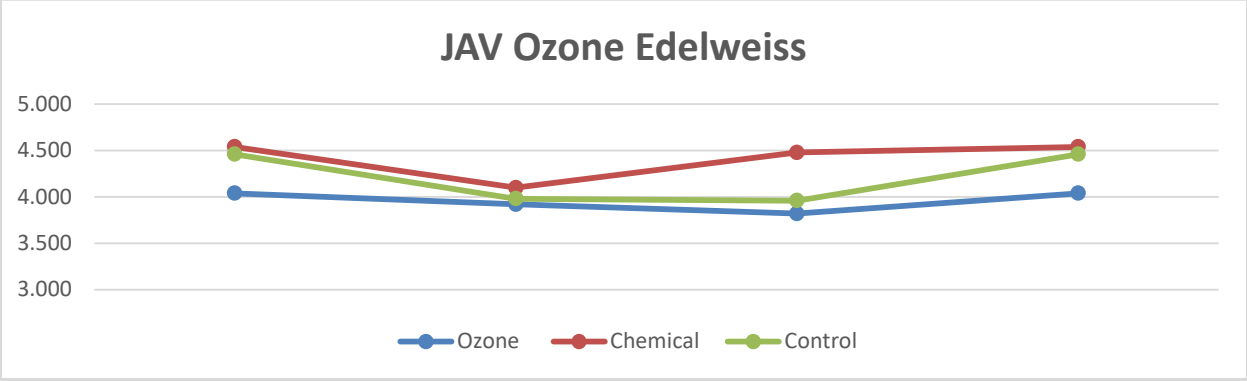
Edelweiss



Marechal Foch




Ozone Study-Frontenac (West Vineyard)
2.500
2.000
1.500
1.000
0.500
0.000
Ozone
Chemical
Control


JAV Ozone Edelweiss
5.000
4.500
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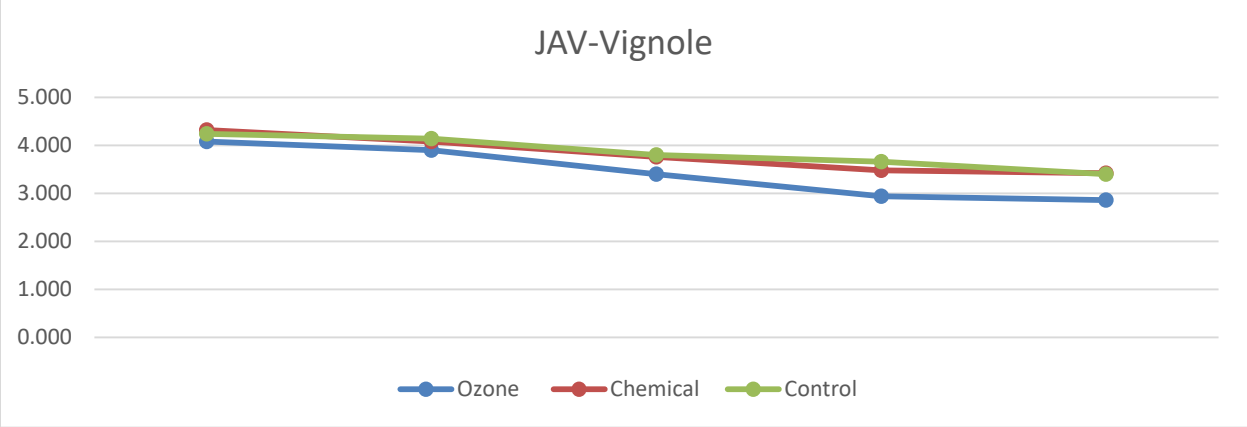
3.500
3.000
Ozone
Chemical
Control


JAV-Vignole
5.000
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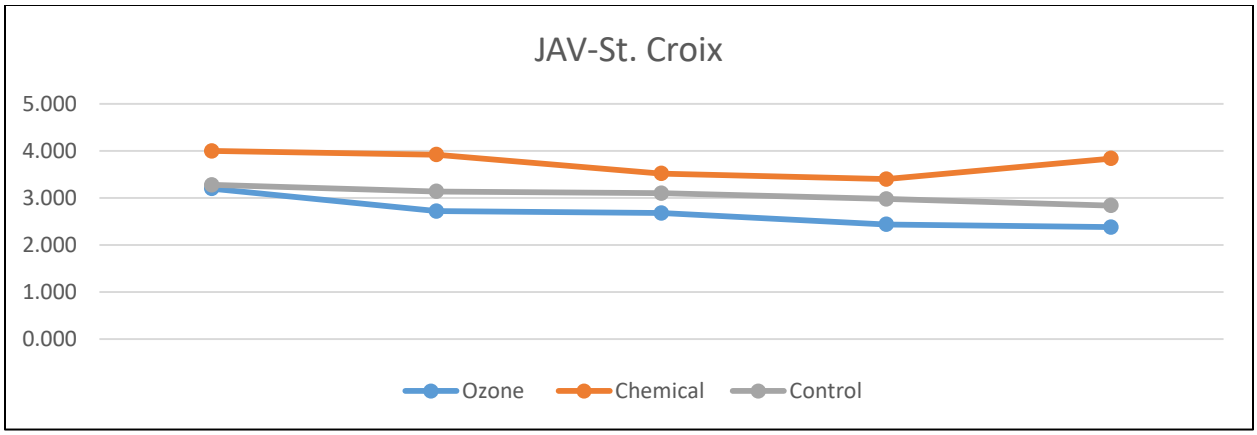
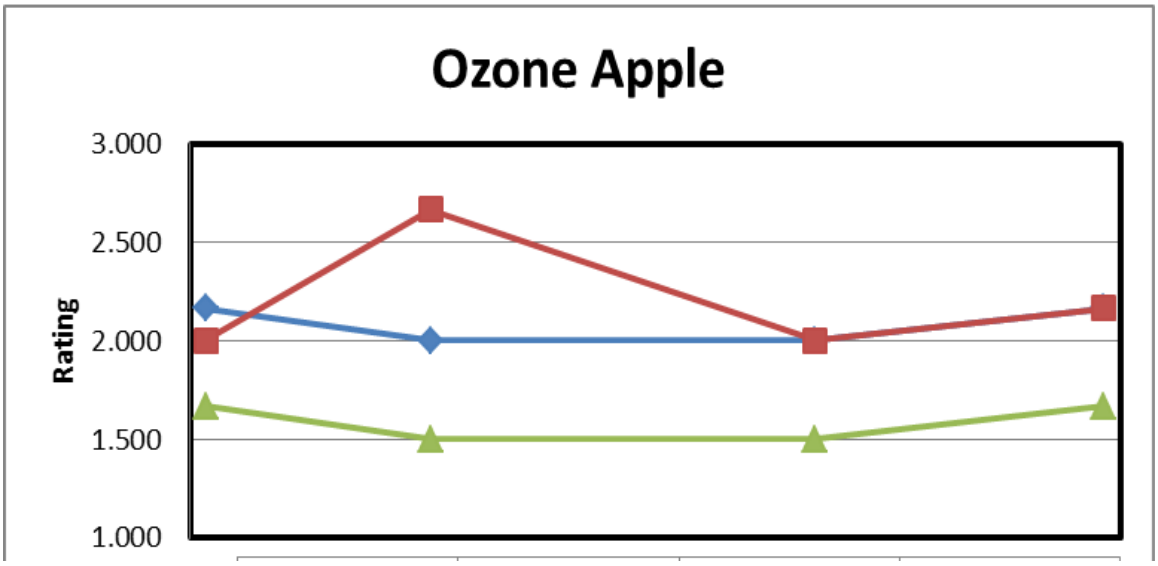
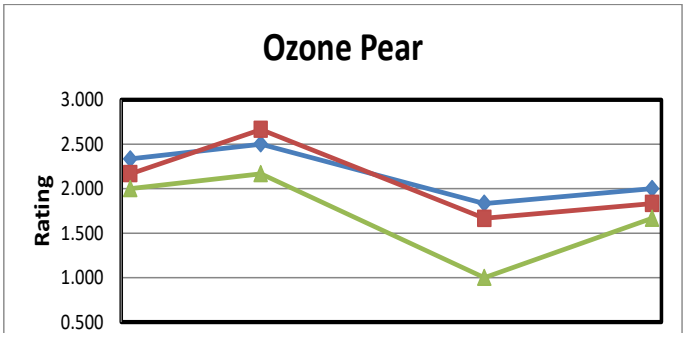
Ozone
Chemical
Control





Control	2.167	2.000	2.000	2.167
Chemical	2.000	2.667	2.000	2.167
Ozone	1.667	1.500	1.500	1.667



Efficacy related to grapevine samples:

1. Ozone treated vines were consistently rated as having significantly less observable disease than Control Group (no treatment group).

2. Ozone treated vines were consistently rated as having significantly less observable disease than Chemical sprayed vines.

3. Differences in efficacy of chemical treatment were found between the eastern Nebraska site and the central site. On the central site, chemical usage was moderately effective with most cultivars, albeit rated significantly less effective than ozone. On the eastern site, with two of the three cultivars (Edelweiss and St. Croix), usage of chemicals was found not be effective, showing even more disease pressure than the Control Group which was not sprayed at all. This finding raises many questions:

   a. Is it cultivar specific;

   b. Is it a micro-climate difference due to much more moisture and resulting disease pressure in eastern compared to central Nebraska micro-climate;

   c) Is it an issue of disease resistance to chemical(s) being used.

   Additional research will be needed in order to continue trying to discern answers to these questions.

Efficacy related to orchard fruits:

Efficacy of treatment of orchard trees was significant; however, there was very little disease pressure occurring during this summer (even in the non-treated Control Group). During this growing season, a horticulture expert was invited to evaluate the orchard sample groups. The expert was not informed as to which trees belonged to which of the three project groups (i.e., Control vs Chemical vs Ozone treatments). The expert was able to accurately identify each tree, which had been sprayed with ozone. These trees were described as “more robust, darker green canopy, larger/fuller tree canopy and an overall healthier looking tree.” This evaluation was extremely encouraging and certainly suggestive as to the efficacy resulting from ozone spraying. Future research is needed across multiple growing seasons, varying seasons as to disease pressure and with larger samples in order to further document these possible effects.

Beneficiaries

Benefits to the ecology could be positive and significant. These benefits are multi-faceted.

1. Reduced build-up of disease resistance to chemicals. The build-up of disease resistance to currently used chemicals is a major problem today in production agriculture. Even with recommended alternating use of chemicals, resistance to herbicides, fungicides and insecticides develops. The use of ozone will not result in any such known resistance build-up.

2. Reduced usage of toxic chemicals.

3. Reduced chemical residual build-up in soil and/or water supply and increased consumer and product safety.

Benefits to Nebraska specialty crop producers could also be multifaceted and include the following:

1. Move more closely to organic production. With the elimination or reduction of the use of chemicals in the production of the food product (tomatoes in this case) the producer will move more closely to an “organic” method of production.

2. Safer raw product. The industry has done a good job of training/informing producers such that hopefully all products being used are labeled for usage with grapes and the application of the products are within safety and legal parameters. However, even with these safeguards in place, the continued and increased usage of these practices is resulting in the ever-increasing concern that these chemicals are potentially harmful to the environment and consumers.

3. Flexibility for disease control at the time of harvest. Each of the pesticides use recommended “harvest intervals”, which is the amount of time the grower must wait after application until the tomatoes can be safely harvested. When the disease pressure is heavy, this restricts the pesticides available for use, and/or can result in tomatoes that are sprayed and must be left hanging on the vine until the harvest interval has passed. This can result in poor tomato quality. Using ozone could mean that spraying for disease control can be done immediately prior to harvest with no harvest interval being necessary.

Project Partners include the following:

- James Arthur Vineyards: Provided vineyard for research plot; cared for plants throughout the growing season; provided ozone spraying equipment; provided research assistant to make weekly-bi-monthly ratings, spray chemicals, harvest; provided disease identification consultation; provided reliability observations to assure accuracy of disease ratings; and gathered fruit samples.

- Mac’s Creek Vineyards (Ozone Consulting). Five years of experience in ozone spraying of grapevines. Provided ozone generator/spraying equipment and Research Assistant to spray grape vines and orchard.

- Cardinal Orchards: Provided orchard for research plot; cared for trees throughout the growing season; provided ozone spraying equipment; provided research assistant to make weekly-bi-monthly ratings, spray chemicals, harvest; provided disease identification consultation; provided reliability observations to assure accuracy of disease ratings; and gathered fruit samples.

- Research Coordinator: Thirty years research experience at the University of Nebraska for research consultation. Created entire research protocol; trained observers; created Observation Rating Scale; trained all partners in protocol; created schedules; write reports; and create/coordinate conference presentation with partners.

- Nebraska Grape and Winery Board: Providing funding for fruit analysis at North Dakota State University.

- North Dakota State University: Conducting fruit quality analysis with all samples of all grape cultivars and orchard apples. Analysis is complete and summary report is attached.

Lessons Learned

Although these data should be considered preliminary results, they are extremely encouraging. Ozone treatment consistently, across the rating period, documented significantly less disease pressure than the untreated controls and vines sprayed with pesticides. Even during the time span of the most observable disease pressure, the ozone treated vines continued to exhibit minimal presence of disease ranging from no to moderate disease pressure. These data are consistent with previous research in showing positive effects on disease control (primarily downy mildew) when used on grapevines.

An additional and somewhat alarming finding suggests that in several cases, across the rating periods, chemical pesticides commonly used in the grape specialty crop industry (i.e. fungicides) show little if any effect as measured by rater's observation of disease pressure (i.e., disease pressure being rated at levels equal to the Control Group, which received no treatment at all.) This finding could be indicative of the build-up of chemical resistance, which has become so pervasive in the usage of pesticides.

Additional research is necessary to replicate these findings across multiple years (i.e., differing weather conditions from summer to summer), multiple specialty crop sites (and thus microclimates throughout Nebraska), and across multiple cultivars. Research is also needed to investigate varying volumes of application and intervals to incur equal disease control.

Contact Person

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Project Title

Micro-Climate Temperature Inversions Near Sensitive Crops

Project Update

This project was intended to examine the occurrence and frequency of ground-effect temperature inversions as they impact herbicide drift on to select specialty crops. Herbicide drift is a significant problem for those who apply them commercially or on private property, because off-target movement often results in damage to desirable plants or the environment.

This project has been cancelled. Funds allocated to this project will not be directed to another project and instead will be returned to the USDA.

No funds were expended with regards to this project.